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THE

POPULAR SCIENCE MONTHLY.

NOVEMBER, 1881.

THE INDUSTRIAL TYPE OF SOCIETY.*

By HERBERT SPENCER.

HAVING nearly always to defend themselves against external enemies, while they have to carry on internally the processes of sustentation, societies, as remarked in the last chapter, habitually present us with mixtures of the structures adapted to these diverse ends. Disentanglement is not easy. According as either structure predominates, it ramifies through the other: instance the fact that, where the militant type is much developed, the worker, ordinarily a slave, is no more a free agent than the soldier; while, where the industrial type is much developed, the soldier, volunteering on specified terms, acquires, in so far, the position of a free worker. In the one case the system of status, proper to the fighting part, pervades the working part; while, in the other, the system of contract, proper to the working part, affects the fighting part. Especially does the organization adapted to war obscure that adapted to industry. While, as we have seen, the militant type, as theoretically constructed, is so far displayed in many societies as to leave no doubt about its essential nature, the industrial type has its traits so hidden by those of the still dominant militant type that its ideal form is nowhere more than very partially exemplified. Saying thus much to exclude expectations which can not be fulfilled, it will be well, before proceeding, also to exclude probable misconceptions.

In the first place, industrialism must not be confounded with industriousness. Though the members of an industrially-organized society are habitually industrious, and are, indeed, when the society is a developed one, obliged to be so, yet it must not be assumed that the industrially-organized society is one in which, of necessity, much work

* Part XI of the series on "The Development of Political Institutions."

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is done. Where the society is small, and its habitat so favorable that life may be comfortably maintained with but little exertion, the social relations which characterize the industrial type may coexist with but very moderate productive activities. It is not the diligence of its members which constitutes the society an industrial one in the sense here intended, but the form of coöperation under which their labors, small or great in amount, are carried on. This distinction will be best understood on observing that, conversely, there may be, and often is, great industry in societies framed on the militant type. In ancient Egypt there was an immense laboring population, and a large supply of commodities, numerous in their kinds, produced by it. Still more did ancient Peru exhibit a vast community purely militant in its structure, the members of which worked unceasingly. We are here concerned, then, not with the quantity of labor, but with the arrangements under which it is carried on. A regiment of soldiers can be set to construct earthworks; another to cut down wood; another to bring in water; but they are not thereby reduced for the time being to an industrial society. The united individuals, doing these several things under command, and having no private claims to the products, are, though industriously occupied, not industrially organized. And the same holds throughout the militant society as a whole, in proportion as the regimentation of it approaches completeness.

The industrial type of society, properly so called, must also be distinguished from a type very likely to be confounded with it—the type, namely, in which the component individuals, while exclusively engaged in production and distribution, are under a regulation such as that advocated by socialists and communists. For this, too, involves, in another form, the principle of compulsory cŏoperation. Directly or indirectly, individuals are to be prevented from severally and independently occupying themselves as they please; are to be prevented from competing with one another in supplying goods for money; are to be prevented from hiring themselves out on such terms as they think fit. There can be no artificial system for regulating labor which does not interfere with the natural system. To such extent as men are debarred from making whatever engagements they like, they are to that extent working under dictation. No matter in what way the controlling agency is constituted, it stands toward those controlled in the same relation as does the controlling agency of a militant society. And how truly the *régime*, which those who declaim against competition would establish, is thus characterized, we see both in the fact that substantially communistic forms of organization existed in early societies which were predominantly warlike, and in the fact that at the present time communistic projects chiefly originate among, and are most favored by, the more warlike societies.

A further preliminary explanation may be needful. The structures proper to the industrial type of society must not be looked for in dis-

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tinct forms when they first appear. Contrariwise, we must expect them to begin in vague, unsettled forms. Arising as they do by modification of preëxisting structures, they are necessarily long in losing all trace of these. For example, transition from the state in which the laborer, owned like a beast, is maintained that he may work exclusively for his master's benefit, to the condition in which he is completely detached from master, soil, and locality, and free to work anywhere and for any one, is through gradations. Again, the change from the arrangement proper to militancy, under which subject-persons receive, in addition to maintenance, occasional presents, to the arrangement under which, in place of both, they receive fixed wages, or salaries, or fees, goes on slowly and unobtrusively. Once more it is observable that the process of exchange, originally indefinite, has become definite only where industrialism is considerably developed. Barter did not begin with a distinct intention of giving one thing for another thing equivalent in value, but it began by making a present and receiving a present in return; and even now in the East there continue traces of this primitive transaction. In Cairo the purchase of articles from a shopkeeper is preceded by his offer of coffee and cigarettes; and, during the negotiation which ends in the engagement of a *dahabeah*, the dragoman brings gifts and expects to receive them. Add to which that there exists under such conditions none of that definite equivalence which characterizes exchange among ourselves: prices are not fixed, but vary widely with every fresh transaction. So that, throughout our interpretations, we must keep in view the truth that the structures and functions proper to the industrial type distinguish themselves but gradually from those proper to the militant type.

Having thus prepared the way, let us now consider what are, *a priori*, the traits of that social organization which, entirely unfitted for carrying on defense against external enemies, is exclusively fitted for maintaining the life of the society by subserving the lives of its units. As before, in treating of the militant type, so here, in treating of the industrial type, we will consider first the ideal form.

While corporate action is the primary requirement in a society which has to preserve itself in presence of hostile societies, conversely, in the absence of hostile societies, corporate action is no longer the primary requirement.

The continued existence of a society implies, first, that it shall not be destroyed bodily by foreign foes, and implies, second, that it shall not be destroyed in detail by failure of its members to support and propagate themselves. If danger of destruction from the first cause ceases, there remains only danger of destruction from the second cause. Sustentation of the society will now be achieved by the self-sustentation and multiplication of its units. If his own welfare and

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the welfare of his offspring are fully achieved by each, the welfare of the society is by implication achieved. Very little corporate activity is now required. Each man may maintain himself by labor, may exchange his products for the products of others, may give aid and receive payment, may enter into this or that combination for carrying on an undertaking, small or great, without the direction of the society as a whole. The remaining end to be achieved by public action is to keep private actions within due bounds; and the amount of public action needed for this becomes small in proportion as private actions become duly self-bounded.

So that, whereas in the militant type the demand for corporate action is intrinsic, such demand for corporate action as continues in the industrial type is mainly extrinsic—is called for by those aggressive traits of human nature which chronic warfare has fostered, and may gradually diminish as, under enduring peaceful life, these decrease.

In a society organized for militant action, the individuality of each member has to be so subordinated in life, liberty, and property, that he is largely, or completely, *owned* by the state; but, in a society industrially organized, no such subordination of the individual is called for. There remain no occasions on which he is required to risk his life while destroying the lives of others; he is not forced to leave his occupation and submit to a commanding officer; and there ceases to be any need that he should surrender for public purposes whatever property may be demanded of him.

Under the industrial *régime*, the citizen's individuality, instead of being sacrificed by the society, has to be defended by the society: the defense of his individuality becomes the society's essential duty. That, after external protection is no longer called for, internal protection must become the cardinal function of the state, and that effectual discharge of this function must be a predominant trait of the industrial type, may be readily shown.

For it is clear that, other things equal, a society in which life, liberty, and property, are secure, and all interests justly regarded, must prosper more than one in which they are not; and consequently, among competing industrial societies, there must be a gradual replacing of those in which personal rights are imperfectly maintained by those in which they are perfectly maintained. So that by survival of the fittest must be produced a social type in which individual claims, considered sacred, are trenched on by the state no further than is requisite to pay the cost of maintaining them, or, rather, of arbitrating among them. For, the aggressiveness of nature fostered by militancy having died out, the corporate function becomes that of deciding between those conflicting claims the equitable adjustment of which is not obvious to the persons concerned.

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With the absence of need for that corporate action by which the efforts of the whole society may be utilized for war, there goes the absence of need for a despotic controlling agency.

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Not only is such an agency unnecessary, but it can not exist. For, since, as we see, it is an essential requirement of the industrial type that the individuality of each man shall have the fullest play consistent with the like play of other men's individualities, despotic control, showing itself as it must by otherwise restricting men's individualities, is necessarily excluded. Indeed, by his mere presence an autocratic ruler is an aggressor on citizens; actually or potentially exercising power not given by them, he in so far restrains their wills more than they would be restrained by mutual limitation merely.

Such control as is required under the industrial type can be exercised only by an appointed agency for ascertaining and executing the average will; and a representative agency is the one best fitted for doing this.

Unless the activities of all are homogeneous in kind, which they can not be in a developed society with its elaborate division of labor, there arises a need for conciliation of divergent interests; and, to the end of insuring an equitable adjustment, each interest must be enabled duly to express itself. It is, indeed, supposable that the appointed agency should be a single individual. But no such single individual could arbitrate justly among numerous classes variously occupied, and numerous groups variously localized, without hearing evidence; from each there would need to come representatives setting forth its claims. Hence the choice would lie between two systems, under one of which the representatives privately and separately stated their cases to an arbitrator on whose single judgment decisions depended; and under the other of which these representatives stated their cases in one another's presence, while judgments were openly determined by the general *consensus*. Without insisting on the fact that a fair balancing of class-interests is more likely to be effected by this last form of representation than by the first, it is sufficient to remark that this last form is more congruous with the nature of the industrial type, since men's individualities are in the smallest degree trenched upon. Citizens, who, appointing a single ruler for a prescribed time, may have a majority of their wills traversed by his during this time, surrender their individualities in a greater degree than do those who, from their local groups, depute a number of rulers; since these, speaking and acting under public inspection and mutually restrained, habitually express the wills of the majority.

The corporate life of the society being no longer in danger, and the remaining business of government being that of maintaining the conditions requisite for the highest individual life, there comes the question, What are these conditions?

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Already they have been implied and comprehended under the administration of justice; but so vaguely is the meaning of this phrase commonly conceived that a more specific statement must be made. Justice, then, as here to be understood, means preservation of the normal connections between acts and results—the obtainment by each of as much benefit as his efforts are equivalent to—no more and no less. Living and working within the restraints imposed by one another's presence, justice requires that individuals shall severally take the consequences of their conduct, neither increased nor decreased. The superior shall have the good of his superiority, and the inferior the evil of his inferiority. A veto is therefore put on all public action which abstracts from some men part of the advantages they have earned and awards to other men advantages they have not earned.

That from the developed industrial type of society there are excluded all forms of communistic distribution, the inevitable trait of which is that they tend to equalize the lives of good and bad, idle and diligent, is readily proved. For, when, the struggle for existence between societies by war having ceased, there remains only the industrial struggle for existence, the final survival and spread must be on the part of those societies which produce the largest number of the best individuals—individuals best adapted for life in the industrial state. Suppose two societies, otherwise equal, in one of which the superior are allowed to retain, for their own benefit and the benefit of their offspring, the entire proceeds of their labor, but in the other of which the superior have taken from them part of these proceeds for the benefit of the inferior and their offspring. Evidently the superior will thrive and multiply more in the first than in the second. A greater number of the best children will be reared in the first, and eventually it will outgrow the second.*

Otherwise regarded, this system, under which the efforts of each bring neither more nor less than their natural returns, is the system of contract.

We have seen that the *régime* of status is in all ways proper to the militant type. It is the concomitant of that graduated subordination by which the combined action of a fighting body is achieved, and which must pervade the fighting society at large to insure its corporate action. Under this *régime*, the relation between labor and produce is traversed by authority. As in the army, the food, clothing, etc., received by each soldier are not direct returns for work done, but

* It must not be inferred that private and voluntary aid to the inferior is negatived, but only public and enforced aid. Whatever effects the sympathies of the better for the worse spontaneously produce, can not, of course, be interfered with, and will, on the whole, be beneficial. For, while, on the average, the better will not ordinarily carry their philanthropic efforts so far as to impede their own multiplication, they will carry them far enough to mitigate the ill-fortunes of the worse without enabling them to multiply.

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are arbitrarily apportioned, while duties are arbitrarily enforced, so throughout the rest of the militant society, the superior dictates the labor and assigns such share of the return as he pleases. But as, with declining militancy and growing industrialism, the power and range of authority decrease and uncontrolled action increases, the relation of contract becomes general, and in the fully-developed industrial type it becomes universal.

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Under this universal relation of contract when equitably administered, there arises that adjustment of benefit to effort which the arrangements of the industrial society have to achieve. If each as producer, distributor, manager, adviser, teacher, or aider of other kind, obtains from his fellows such payment for his service as its value, determined by the demand, warrants, then there results that correct apportioning of reward to merit which insures the prosperity of the superior.

Again changing the point of view, we see that, whereas public control in the militant type is both positively regulative and negatively regulative, in the industrial type it is negatively regulative only. To the slave, to the soldier, or to other member of a community organized for war, authority says: "Thou shalt do this; thou shalt not do that." But, to the member of the industrial community, authority gives only one of these orders, "Thou shalt not do that."

For people who, carrying on their private transactions by voluntary coöperation, also voluntarily coöperate to form and support a governmental agency, are, by implication, people who authorize it to impose on their respective activities only those restraints which they are all interested in maintaining—the restraints which check aggressions. Omitting criminals (who under the assumed conditions must be, if not a vanishing quantity, still very few), each citizen, while not wishing to invade others' spheres of action, will wish to preserve uninvaded his own sphere of action, and to retain whatever benefits are achieved within it. The very motive which prompts all to unite in upholding a public protector of their individualities will also prompt them to unite in preventing any interference with their individualities beyond that required for this end.

Hence it follows that, while, in the militant type, regimentation in the army is paralleled by centralized administration throughout the society at large, in the industrial type, administration, becoming decentralized, is at the same time narrowed in its range. Nearly all public organizations save that for administering justice, necessarily disappear; since they have the common character that they either aggress on the citizen by dictating his actions, or by taking from him more property than is needful for protecting him, or by both. Those who are forced to send their children to this or that school, those who have, directly or indirectly, to help in supporting a state-priesthood,

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those from whom rates are demanded that parish officers may administer public charity, those who are taxed to provide gratis reading for people who will not save money for library subscriptions, those whose businesses are carried on under regulation by inspectors, those who have to pay the cost of state science and art teaching, state emigration, etc., all have their individualities trenched upon; either by compelling them to do what they would not spontaneously do, or by taking away money which else would have furthered their private ends. Coercive arrangements of such kinds, consistent with the militant type, are inconsistent with the industrial type.

With the relatively narrow range of public organizations, there goes, in the industrial type, a relatively wide range of private organizations; the spheres left vacant by the one being filled by the other.

Several influences conspire to produce this trait. Those motives which, in the absence of that subordination necessitated by war, make citizens unite in asserting their individualities, subject only to mutual limitations, are motives which make them unite in resisting any interference with their freedom to form such private combinations as do not involve aggression. Moreover, beginning with exchanges of goods and services under agreements between individuals, the principle of voluntary coöperation is simply carried out in a larger way by any incorporated body of individuals who contract with one another for jointly pursuing this or that business or function. And yet, again, there is entire congruity between the representative constitutions of such private combinations and that representative constitution of the public combination which we see is proper to the industrial type: the same law of organization pervades the society in general and in detail. So that an inevitable trait of the industrial type is the multiplicity and heterogeneity of associations, religious, commercial, professional, philanthropic, and social, of all sizes.

Two indirectly resulting traits of the industrial type must be added. The first is its relative plasticity.

So long as corporate action is necessitated for national self-preservation—so long as, to effect combined defense or offense, there is maintained that graduated subordination which ties all inferiors to superiors, as the soldier is tied to his officer—so long as there is maintained the relation of status which tends to fix men in the positions they are severally born to—there is insured a comparative rigidity of social organization. But, with the cessation of those needs that initiate and preserve the militant type of structure, and with the establishment of contract as the universal relation under which efforts are combined for mutual advantage, social organization loses its rigidity. No longer determined by the principle of inheritance, places and occupations are now determined by the principle of efficiency; and changes of struct-

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ure follow when men, not bound to prescribed functions, acquire the functions for which they have proved themselves most fit. Easily modified in its arrangements, the industrial type of society is therefore one which adapts itself with facility to new requirements.

The other incidental result to be named is a tendency toward loss of economic autonomy.

While hostile relations with adjacent societies continue, each society has to be productively self-sufficing; but with the establishment of peaceful relations this need for self-sufficingness ceases. As the local divisions composing one of our great nations had, while they were at feud, to produce each for itself almost everything it required, but now, permanently at peace with one another, have become so far mutually dependent that no one of them can satisfy its wants without aid from the rest, so the great nations themselves, at present forced in large measure to maintain their economic autonomies, will become less forced to do this as war decreases, and will gradually become necessary to one another. While, on the one hand, the facilities possessed by each for certain kinds of production will render exchange mutually advantageous, on the other hand, the citizens of each will, under the industrial *régime*, tolerate no such restraints on their individualities as are implied by interdicts on exchange.

With the spread of the industrial type, therefore, the tendency is toward the breaking down of the divisions between nationalities, and the running through them of a common organization—if not under a single government, then under a federation of governments.

Such being the constitution of the industrial type of society to be inferred from its requirements, we have now to inquire what evidence is furnished by actual societies that approach toward this constitution accompanies the progress of industrialism.

As, during the peopling of the earth, the struggle for existence among societies, from small hordes up to great nations, has been nearly everywhere going on, it is, as before said, not to be expected that we should readily find examples of the social type appropriate to an exclusively industrial life. Ancient records join the journals of the day in proving that thus far no civilized or semi-civilized nation has fallen into circumstances making needless all social structures for resisting aggression, and from every region travelers' accounts bring evidence that, almost universally among the uncivilized, hostilities between tribes are chronic. Still, a few examples exist which show with tolerable clearness the outline of the industrial type in its rudimentary form—the form which it assumes where culture has made but little progress. We will consider these cases first, and then proceed to disentangle the traits distinctive of the industrial type as exhibited by large nations which have become predominantly industrial in their activities.

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Among the Indian hills there are many tribes belonging to different races but alike in their partially nomadic habits. Mostly agricultural, their common practice is to cultivate a patch of ground while it yields average crops, and when it is exhausted to go elsewhere and repeat the process. They have fled before invading races, and have here and there found localities in which they are able to carry on their peaceful occupations unmolested: the absence of molestation being, in some cases, due to their ability to live in a malarious atmosphere, which is fatal to the Aryan races. Already, under other heads, I have referred to the Bodo and to the Dhimáls as wholly unmilitary, as having but nominal head-men, as being without slaves or social grades, and as aiding one another in their heavier undertakings; to the Todas, who, leading tranquil lives, are "without any of those bonds of union which man in general is induced to form from a sense of danger," and who settle their disputes by arbitration or by a council of five; to the Mishmies as being unwarlike, as having but nominal chiefs, and as administering justice by an assembly; and I have joined with these the case of a people remote in locality and race, the ancient Pueblos of North America, who, sheltering in their walled villages and fighting only when invaded, similarly joined with their habitual industrial life a free form of government: "The governor and his council are [were] annually elected by the people." Here I may add sundry kindred examples. As described in the Indian Government Report for 1869–'70, "the 'white Karens' are of a mild and peaceful disposition; . . . their chiefs are regarded as patriarchs, who have little more than nominal authority"; or, as said of them by Lieutenant McMahon, "they possess neither laws nor dominant authority." Instance again the "fascinating" Lepchas—not industrious, but yet industrial in the sense that their social relations are of the non-militant type. Though I find nothing specific said about the system under which they live in their temporary villages, yet the facts told us sufficiently imply its uncoercive character. They have no castes; "family and political feuds are alike unheard of among them"; "they are averse to soldiering"; they prefer taking refuge in the jungle and living on wild food "to enduring any injustice or harsh treatment"—traits which negative ordinary political control. Take next the "quiet, inoffensive" Santals, who, though they fight if need be with infatuated bravery to resist aggression, are essentially unaggressive. These people "are industrious cultivators, and enjoy their existence unfettered by caste." Though, having become tributaries, there habitually exists in each village a head appointed by the Indian Government to be responsible for the tribute, etc., yet the nature of their indigenous government remains sufficiently clear: while there is a patriarch who is honored, but who rarely interferes, "every village has its council-place . . . where the committee assemble and discuss the affairs of the village and its inhabitants. All petty disputes, both of a civil and crimi-

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nal nature, are settled there." What little is told us of tribes living in the Shervaroy Hills is, so far as it goes, to like effect. Speaking generally of them, Shortt says they "are essentially a timid and harmless people, addicted chiefly to pastoral and agricultural pursuits"; and, more specifically describing one division of them, he says, "They lead peaceable lives among themselves, and any dispute that may arise is usually settled by arbitration." Then, to show that these social traits are not peculiar to any one variety of man, but are dependent on conditions, may be recalled the before-named instance of the Papuan Arafuras, who, without any divisions of rank or any hereditary chieftainship, lead harmonious lives controlled only by the decisions of their assembled elders. In all which cases we may discern the leading traits above indicated as proper to societies not impelled to corporate action by war. Strong centralized control not being required, such government as exists is exercised by a council informally approved—a rude representative government; class distinctions do not exist, or are but faintly indicated—the relation of *status* is absent; whatever transactions take place between individuals are by agreement, and the function which the ruling body has to perform is substantially limited to protecting private life by settling such disputes as arise and inflicting mild punishments for the small offenses which occur.

Difficulties meet us when, turning to civilized societies, we seek in them for the traits of the industrial type. Consolidated and organized as they have all been by wars actively carried on throughout the earlier periods of their existence, and mostly continued down to comparatively recent times, and having simultaneously been developing within themselves organizations for producing and distributing commodities, which have little by little become contrasted with those proper to militant activities, the two are everywhere presented so mingled that clear separation of the first from the last is, as said at the outset, scarcely practicable. Radically opposed, however, as is compulsory coöperation, the organizing principle of the militant type, to voluntary coöperation, the organizing principle of the industrial type, we may, by observing the decline of institutions exhibiting the one, recognize, by implication, the growth of institutions exhibiting the other. Hence, if, in passing from the first states of civilized nations, in which war is the business of life, to states in which hostilities are but occasional, we simultaneously pass to states in which the ownership of the individual by his society is not so constantly and strenuously enforced, in which the subjection of rank to rank is mitigated, in which political rule is no longer autocratic, in which the regulation of citizens' lives is diminished in range and rigor, while the protection of them increased, we are by implication shown the traits of a developing industrial type. Comparisons of several kinds disclose results which unite in verifying this truth.

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Take first the contrast between the early condition of the more civilized European nations at large and their later condition. Setting out from the dissolution of the Roman Empire, we observe that for many centuries, during which conflicts were effecting consolidations, and dissolutions, and reconsolidations in endless variety, such energies as were not directly devoted to war were devoted to little else than supporting the organizations which carried on war: the working part of each community did not exist for its own sake, but for the sake of the fighting part. While militancy was thus high and industrialism undeveloped, the reign of superior force, continually being established by societies one over another, was equally displayed within each society. From slaves and serfs, through vassals of different grades up to dukes and kings, there was an enforced subordination by which the individualities of all were greatly restricted. And, at the same time that, to carry on external aggression or resistance, the ruling power in each group sacrificed the personal claims of its members, the function of defending its members from one another was in but small degree discharged by it: they were left to defend themselves. If with these traits of European societies in mediæval times we compare their traits in modern times, we see the following essential differences. First, with the formation of nations covering large areas, the perpetual wars within each area have ceased; and, though the wars which from time to time occur are on larger scales, they are less frequent, and they are no longer the business of all freemen. Second, there has grown up in each country a relatively large population which carries on production and distribution for its own benefit; so that, whereas, of old, the working part existed for the benefit of the fighting part, now the fighting part exists mainly for the benefit of the working part—exists ostensibly to protect it in the quiet pursuit of its ends. Third, the system of *status*, having under some of its forms disappeared and under others become greatly mitigated, has been almost universally replaced by the system of contract. Only among those who, by choice or by conscription, are incorporated in the militant organization does the system of *status*, in its primitive rigor, still hold so long as they remain in this organization. Fourth, with this decrease of compulsory coöperation and increase of voluntary coöperation, there have diminished or ceased many minor restraints over individual actions. Men are less tied to their localities than they were; they are not obliged to profess certain religious opinions; they are less debarred from expressing their political views; they no longer have their dresses and modes of living dictated to them; they are comparatively little restrained from forming private combinations and holding meetings for one or other purpose—political, religious, social. Fifth, while the individualities of citizens are less aggressed upon by public agency, they are more protected by public agency against aggression. Instead of a *régime* under which individuals rectified their private wrongs by force as well as they

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could, or else bribed the ruler, general or local, to use his power in their behalf, there has come a *régime* under which, while much less self-protection is required, a chief function of the ruling power and its agents is to administer justice. In all ways, then, we are shown that, with this relative decrease of militancy and relative increase of industrialism, there has been a change from a social order in which individuals exist for the benefit of the state to a social order in which the state exists for the benefit of individuals.

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When, instead of contrasting early European communities at large with European communities at large as they now exist, we contrast the one in which industrial development has been less impeded by militancy with those in which it has been more impeded by militancy, parallel results are apparent. Between our own society and Continental societies, as, for example, France, the differences which have gradually arisen may be cited in illustration. After the conquering Normans had spread over England, there was established here a much greater subordination of local rulers to the general ruler than there existed elsewhere; and, as a result, there was not nearly so much internal dissension. Says Hallam, speaking of this period, "We read very little of private wars in England." Though from time to time there were rebellions, and under Stephen a serious one, and though there were occasional fights between nobles, yet for some hundred and fifty years, up to the time of King John, the subjection maintained secured comparative order. Further, it is to be noted that such general wars as occurred were mostly carried on abroad; descents on our coasts were few and unimportant, and conflicts with Wales, Scotland, and Ireland, entailed but few intrusions on English soil. Consequently, there was a relatively small hindrance to industrial life and the growth of social forms appropriate to it. Meanwhile, the condition of France was widely different. During this period and long after, besides wars with England (mostly fought out on French soil) and wars with other countries, there were going on everywhere local wars. From the tenth to the fourteenth century perpetual fights between suzerains and their vassals occurred, as well as fights of vassals with one another. Not until toward the middle of the fourteenth century did the king begin greatly to predominate over the nobles; and only in the fifteenth century was there established a supreme ruler strong enough to prevent the quarrels of local rulers. How great was the consequent repression of industrial development may be inferred from the exaggerated language of an old writer, who says of this period during which the final struggle of monarchy with feudalism was going on, that "agriculture, traffic, and all the mechanical arts ceased." Such being the contrast between the small degree in which industrial life was impeded by war in England and the great degree in which it was impeded by war in France, let us ask, What were the political contrasts which arose? The first fact to be noted is that in the

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middle of the thirteenth century there began in England a mitigation of villanage, by limitation of labor-services and commutation of them for money, and that in the fourteenth century the transformation of a servile into a free population had in great measure taken place; while in France, as in other Continental countries, the old condition survived and became worse. As Mr. Freeman says of this period, "In England villanage was on the whole dying out, while in many other countries it was getting harder and harder." Besides this spreading substitution of contract for *status*, which, taking place first in the industrial centers, the towns, afterward went on in the rural districts, there was going on an analogous enfranchisement of the noble class: the enforced military obligations of vassals were more and more replaced by money payments of scutages, so that, by King John's time, the fighting-services of the upper class had been to a great extent compounded for, like the labor-services of the lower class. After diminished restraints over persons, there came diminished invasions of property by the charter, arbitrary tallages on towns and non-military king's tenants were checked; and, while the aggressive actions of the state were thus decreased, its protective actions were extended: provisions were made that justice should be neither sold, delayed, nor denied. All which changes were toward those social arrangements which we see characterize the industrial type. Then, in the next place, we have the subsequently-occurring rise of a representative government; which, as shown in a preceding chapter by another line of inquiry, is at once the product of industrial growth and the form proper to the industrial type. But in France none of these changes took place. Villanage remaining unmitigated, continued to comparatively late times; compounding for military obligation of vassal to suzerain was less general; and, when there arose tendencies toward the establishment of an assembly expressing the popular will, they proved abortive. Detailed comparisons of subsequent periods and their changes would detain us too long: it must suffice to indicate the leading facts. Beginning with the date at which, under the influences just indicated, parliamentary government was finally established in England, we find that for a century and a half, down to the Wars of the Roses, the internal disturbances were few and unimportant compared with those which took place in France; while at the same time (remembering that the wars between England and France, habitually taking place on French soil, affected the state of France more than that of England) we note that France carried on serious wars with Flanders, Castile, and Navarre, besides the struggle with Burgundy; the result being that, while in England popular power as expressed by the House of Commons became settled and increased, such power as the States-General had acquired in France dwindled away. Not forgetting that by the Wars of the Roses, lasting over thirty years, there was initiated a return toward absolutism, let us

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contemplate the contrasts which subsequently arose. For a century and a half after these civil conflicts ended, there were but few and trivial breaches of internal peace, while such wars as went on with foreign powers, not numerous, took place as usual out of England; and during this period the retrograde movement which the Wars of the Roses set up was reversed and popular power greatly increased; so that, in the words of Mr. Bagehot, "the slavish Parliament of Henry VIII grew into the murmuring Parliament of Queen Elizabeth, the mutinous Parliament of James I, and the rebellious Parliament of Charles I." Meanwhile France, during the first third of this period, had been engaged in almost continuous external wars with Italy, Spain, and Austria; while during the remaining two thirds it suffered from almost continuous internal wars, religious and political; the accompanying result being that, notwithstanding resistances from time to time made, the monarchy became increasingly despotic. To make fully manifest the different social types that had been evolved under these different conditions, we have to compare not only the respective political constitutions but also the respective systems of social control. Observe what these were at the time when there commenced the reaction which ended in the French Revolution. In harmony with the theory of the militant type, that the individual is, in life, liberty, and property, owned by the state, the monarch had come to be universal proprietor. Giving nothing in return, he took whatever houses and lands he pleased; and the burdens he imposed on land-owners were so grievous that some of them preferred abandoning their estates to paying. Then, besides the taking of property by the state, there was the taking of labor. One fourth of the working-days in the year went as *corvées*, due to the king and in part to the feudal lord. Such liberties as were allowed had to be paid for again and again; the municipal privileges of towns being seven times in twenty-eight years withdrawn and resold to them. Military services of nobles and people were imperative to whatever extent the king demanded; and conscripts were drilled under the lash. At the same time that the subjection of the individual to the state was pushed to such an extreme by exactions of money and services that the impoverished people cut the grain while it was green, ate grass, and died of starvation in millions, the state did little to guard their persons and homes. Contemporary writers enlarge on the multitudinous highway robberies, burglaries, assassinations, and torturings of people to discover their hoards; herds of vagabonds, levying black-mail, roamed about, and when, as a remedy, penalties were imposed, innocent persons denounced as vagabonds were sent to prison without evidence. There was no personal security either against the ruler or against powerful enemies: in Paris there were some thirty prisons where untried and unsentenced people might be incarcerated; and the "brigandage of justice" annually cost suitors forty to sixty millions of francs. While the state, aggressing on citizens to such

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extremes, thus failed to protect them against one another, it was active in regulating their private lives and labors. Religion was dictated to the extent that Protestants were imprisoned, sent to the galleys, or whipped, and their ministers hanged. The quantity of salt (on which there was a heavy tax) to be consumed by each person was prescribed; as were also the modes of its use. Industry of every kind was supervised. Certain crops were prohibited; and vines grown on soils considered unfit were destroyed. The wheat that might be bought at market was limited to two bushels; and sales took place in presence of dragoons. Manufacturers were regulated in their processes and products to the extent that there was destruction of improved appliances and of goods not made according to law, as well as penalties upon inventors. Regulations succeeded one another so rapidly that amid their multiplicity government agents found it difficult to carry them out; and with the increasing official orders came increasing swarms of public functionaries. Turning now to England at the same period, we see that along with progress toward the industrial type of political structure, carried to the extent that the House of Commons had become the predominant power, there had gone on a progress toward the accompanying social system. Though the subjection of the individual to the state was considerably greater than now, it was far less than in France. His private rights were not sacrificed in the same unscrupulous way; and he was not in danger of a *lettre de cachet*. Though justice was very imperfectly administered, still it was not administered so wretchedly; there was a fair amount of personal security, and aggressions on property were kept within bounds. The disabilities of Protestant dissenters were diminished early in the century; and, later on, those of Catholics. Considerable freedom of the press was acquired, showing itself in the discussion of political questions as well as in the publication of parliamentary debates; and, about the same time, there came free speech in public meetings. While thus the state aggressed upon the individual less and protected him more, it interfered to a smaller extent with his daily transactions. Though there was much regulation of commerce and industry, yet it was pushed to no such extreme as that which in France subjected agriculturists, manufacturers, and merchants, to an army of officials who directed their acts at every turn. In brief, the contrast between our state and that of France was such as to excite the surprise and admiration of various French writers of the time, from whom Mr. Buckle quotes numerous passages showing this.

Most significant of all, however, are the changes in England itself, first retrogressive and then progressive, that occurred during the war period which extended from 1775 to 1815, and during the subsequent period of peace. At the end of the last century and the beginning of this, reversion toward ownership of the individual by the society had gone a long way. "To statesmen, the state, as a unit, was all in all,

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and it is really difficult to find any evidence that the people were thought of at all, except in the relation of obedience." "The Government regarded the people with little other view than as a taxable and soldier-yielding mass." While the militant part of the community had greatly developed, the industrial part had approached toward the condition of a permanent commissariat. By conscription and by press-gangs was carried to a relatively vast extent that sacrifice of the citizen in life and liberty which war entails; and the claims to property were trenched upon by merciless taxation, weighing down the middle classes so grievously that they had greatly to lower their rate of living, while the people at large were so distressed (partly no doubt by bad harvests) that "hundreds ate nettles and other weeds." With these major aggressions upon the individual by the state went numerous minor aggressions. Irresponsible agents of the executive were empowered to suppress public meetings and seize their leaders; death being the punishment for those who did not disperse when ordered. Libraries and news-rooms could not be opened without license; and it was penal to lend books without permission. There were "strenuous attempts made to silence the press"; and booksellers dared not publish works by obnoxious authors. "Spies were paid, witnesses were suborned, juries were packed, and, the *habeas corpus* act being constantly suspended, the crown had the power of imprisoning without inquiry and without limitation." While the Government taxed and coerced and restrained the citizen to this extent, its protection of him was inefficient. It is true that the penal code was made more extensive and more severe: the definition of treason was enlarged, and many transgressions were made capital which were not capital before; so that there was "a vast and absurd variety of offenses for which men and women were sentenced to death by the score": there was "a devilish levity in dealing with human life." But at the same time there was not increase but rather decrease of security. As says Mr. Pike, in his "History of Crime," "It became apparent that the greater the strain of the conflict the greater is the danger of a reaction toward violence and lawlessness." Turn now to the opposite picture. After recovery from the prostration which prolonged wars had left, and the dying away of those social perturbations caused by impoverishment, there began a revival of traits proper to the industrial type. Coercion of the citizen by the state decreased in various ways. Voluntary enlistment replaced compulsory military service; and there disappeared some minor restraints over personal freedom, as instance the repeal of laws which forbade artisans to travel where they pleased, and which interdicted trades-unions. With these manifestations of greater respect for personal freedom may be joined those shown in the amelioration of the penal code: the public whipping of females being first abolished, then the long list of capital offenses being reduced until there finally remained but one, and eventually the pillory and impris-

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onment for debt being abolished. Such penalties on religious independence as remained disappeared; first by removal of those directed against Protestant dissenters, and then of those which weighed on the Catholics, and then of some which told specially against Quakers and Jews. By the Parliamentary Reform Bill and Municipal Reform Bill, vast numbers were removed from the subject classes to the governing classes. Interferences with the business-transactions of citizens were diminished by allowing free trade in bullion, by permitting joint-stock banks, by abolishing multitudinous restrictions on the importation of commodities—leaving eventually but few which pay duty. And, while by these and kindred changes, such as the removal of restraining burdens on the press, impediments to the free action of the citizen were decreased, the protective action of the state was increased. By a greatly-improved police system, by county courts, and so forth, personal safety and claims to property were better secured.

Not to elaborate the argument further by adding the case of the United States, which repeats with minor differences the same relations of phenomena, the evidence given adequately supports the proposition laid down. Amid all the complexities and perturbations, comparisons show us with sufficient clearness that, in actually-existing societies, those traits which we inferred must distinguish the industrial type show themselves clearly in proportion as the social activities are predominantly characterized by exchange of services under agreement.

As in the last chapter we noted the traits of character proper to the members of a society which is habitually at war, so here we have to note the traits of character proper to the members of a society occupied exclusively in peaceful pursuits. Already in delineating above, the rudiments of the industrial type of social structure as exhibited in certain small groups of unwarlike peoples, some indications of the accompanying personal qualities have been given; but it will be well now to emphasize these and add to them, before observing the kindred personal qualities in the more advanced industrial communities.*

Absence of a centralized coercive rule, implying as it does feeble political restraints exercised by the society over its units, is accompanied by a strong sense of individual freedom and a determination to maintain it. The amiable Bodo and Dhimáls, as we have seen, resist "injunctions injudiciously urged with dogged obstinacy."[1] The peaceful Lepchas "undergo great privations rather than submit to oppression or injustice."[2] The "simple-minded Santál" has a "strong natural sense of justice, and, should any attempt be made to coerce

* Though, as already explained, the references to authorities have been reserved until the final publication of these chapters, yet, as the facts quoted in the succeeding paragraphs are such as to excite surprise, or, it may be, doubt, I think it well to here give at once the means of verification: [1] Hodgson in "Journal Asiatic Society," Bengal, xviii, 746. [2] Campbell in "Journal Ethnological Society," for July, 1869. [3] Hunter's "Annals

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him, he flies the country."[3] And so of a tribe not before mentioned, the Jakuns of the South Malayan Peninsula, who, described as "entirely inoffensive," personally brave but peaceful, and as under no control but that of popularly appointed heads who settle their disputes, are also described as "extremely proud": the so-called pride being exemplified by the statement that their remarkably good qualities "induced several persons to make attempts to domesticate them, but such essays have generally ended in the Jakuns' disappearance on the slightest coercion."[4]

With a strong sense of their own claims, these unwarlike men display unusual respect for the claims of others. This is shown in the first place by the rarity of personal collisions among them. Hodgson says that the Bodo and the Dhimáls "are void of all violence toward their own people or toward their neighbors."[5] Of the peaceful tribes of the Neilgherry Hills, Colonel Ouchterlony writes, "Drunkenness and violence are unknown among them."[6] Campbell remarks of the Lepchas, that "they rarely quarrel among themselves."[7] The Jakuns, too, "have very seldom quarrels among themselves"; and such disputes as arise are settled by their popularly-chosen heads "without fighting or malice."[8] And similarly the Arafuras "live in peace and brotherly love with one another."[9] Further, in the accounts of these peoples we read nothing about the *lex talionis*. In the absence of hostilities with adjacent groups, there does not exist within each group that "sacred duty of blood-revenge" universally recognized in militant tribes and nations. Still more significantly, we find evidence of the opposite doctrine and practice. Says Campbell of the Lepchas: "They are singularly forgiving of injuries; . . . making mutual amends and concessions."[10]

Naturally, with respect for others' individualities thus shown, goes respect for their claims to property. Already, in the preliminary chapter, I have quoted testimonies to the great honesty of the Bodo

of Rural Bengal," i, 209; Sherville in "Journal Asiatic Society," xx, 554. [4] Rev. P. Favre in "Journal of Indian Archipelago," ii, 266, 267. [5] Hodgson in "Journal Asiatic Society," xviii, 746. [6] Colonel Ouchterlony, "Memoir of Survey of the N. H.," page 69. [7] Campbell in "Journal Ethnological Society," for July, 1869. [8] Rev. P. Favre in "Journal of Indian Archipelago," ii, 266. [9] Earl's translation of Kolff's "Voyages of the Dom-ga," page 161. [10] Campbell in "Journal Ethnological Society," of July, 1869. [11] Hooker's "Himalayan Journals," i, 175, 176. [12] Hunter's "Annals of Rural Bengal," i, 217. [13] Dalton's "Des. Ethnology," page 206. [14] Shortt's "Hill Ranges of S. S. India," part i, 9. [15] Ditto, part ii, 7, 8. [16] Favre in "Journal of Indian Archipelago," ii, 266. [17] Juke's "Voyage of Her Majesty's Ship Fly," i, 219, 220. [18] Hodgson in "Journal Asiatic Society," xviii, 745. [19] Hunter, "Annals of Rural Bengal," i, 209, 210. [20] Hooker's "Himalayan Journal," i, 175, 176; 129, 130. [21] Favre in "Journal of Indian Archipelago," ii, 266. [22] Earl's Kolff, 164. [23] Captain St. John's "The Wild Coasts of Nipon," 142. [24] Miss Bird's "Unbeaten Tracks in Japan," ii, 103; 74. [25] Hooker's "Himalayan Journal," i, 134. [26] Hunter's "Annals of Rural Bengal," i, 208. [27] Hodgson in "Journal Asiatic Society," xviii, 708. [28] Hunter's "Annals of Rural Bengal," i, 217. [29] Hodgson's "Essays," i, 150. [30] "Journal Ethnological Society," vii, 241.

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and the Dhimáls, the Lepchas, the Santáls, the Todas, and other peoples kindred in their form of social life; and here I may add further ones. Of the Lepchas, Hooker says, "In all my dealings with these people, they proved scrupulously honest."[11] "Among the pure Santáls," writes Hunter, "crime and criminal officers are unknown";[12] while of the Hos, belonging to the same group as the Santáls, Dalton says, "A reflection on a man's honesty or veracity may be sufficient to send him to self-destruction."[13] In like manner Shortt testifies that "the Todas, as a body, have never been convicted of heinous crimes of any kind";[14] and, concerning other peaceful tribes of the Shervaroy Hills, he states that "crime of a serious nature is unknown among them."[15] Again, of the Jakuns we read that "they are never known to steal anything, not even the most insignificant trifle."[16] And so of certain natives of Malacca who "are naturally of a commercial turn," Jukes writes: "No part of the world is freer from crime than the district of Malacca . . . a few petty cases of assault; or of disputes about property . . . are all that occur."[17]

Thus free from the coercive rule which warlike activities necessitate, and without that sentiment which makes the needful subordination possible—thus maintaining their own claims while respecting the like claims of others—thus devoid of the vengeful feelings which aggressions without and within the tribe generate—these peoples, instead of the bloodthirstiness, the cruelty, the selfish trampling upon inferiors, characterizing militant tribes and societies, display, in unusual degrees, the humane sentiments. Insisting on their amiable qualities, Hodgson describes the Bodo and the Dhimáls as being "almost entirely free from such as are unamiable."[18] Remarking that "while courteous and hospitable he is firm and free from cringing," Hunter tells us of the Santál that he thinks "uncharitable men" will suffer after death.[19] Saying that the Lepchas are "ever foremost in the forest or on the bleak mountain, and ever ready to help, to carry, to encamp, collect, or cook," Hooker adds, "They cheer on the traveler by their unostentatious zeal in his service"; and he also adds that "a present is divided equally among many, without a syllable of discontent or grudging look or word."[20] Of the Jakuns, too, Favre tells us that "they are generally kind, affable, inclined to gratitude and to beneficence": their tendency being not to ask favors but to confer them.[21] And then of the peaceful Arafuras we learn from Kolff that—

"They have a very excusable ambition to gain the name of rich men, by paying the debts of their poorer fellow-villagers. The officer [M. Bik], whom I quoted above, related to me a very striking instance of this. At Affora he was present at the election of the village chief, two individuals aspiring to the station of Orang Tua. The people chose the elder of the two, which greatly afflicted the other, but he soon afterward expressed himself satisfied with the choice the people had made, and said to M. Bik, who had been sent there on a commission, 'What reason have I to grieve? Whether I am Orang Tua or not, I still have it

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in my power to assist my fellow-villagers.' Several old men agreed to this, apparently to comfort him. Thus the only use they make of their riches is to employ it in settling differences." [22]

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And these various evidences may be enforced by yet others contained in works on Japan, published since these chapters were commenced. Giving a passing notice to the fact that Captain St. John, speaking of the "goodness and kindness" of the people in the "wild part of Japan," where they had not seen Europeans, says, "I always found, the farther from the open ports I went, the nicer in every way were the people," [23] I pass on to the testimony of Miss Bird concerning the Ainos. These appear to be an aboriginal race, who, like the Hill tribes of India, have retired before an invading race. According to this lady traveler, "they have no traditions of internecine strife, and the art of war seems to have been lost long ago." They are "truthful," "gentle," "considerate"; and when a house was burned down all the men joined to rebuild it. They are "punctiliously honest" in all their transactions; are very anxious to give; and when induced to sell would accept only a moiety of the amount offered. Describing generally their traits of nature she says, "I hope I shall never forget the music of their low sweet voices, the soft light of their mild brown eyes, and the wonderful sweetness of their smile." [24]

With these superiorities of the social relations in permanently peaceful tribes go superiorities of their domestic relations. As I have before pointed out, while the *status* of women is habitually very low in tribes given to war and in more advanced militant societies, it is habitually very high in these primitive peaceful societies. The Bodo and the Dhimáls, the Kocch, the Santáls, the Lepchas, are monogamic, as were also the Pueblos; and along with their monogamy habitually goes a superior sexual morality. Of the Lepchas Hooker says, "The females are generally chaste, and the marriage tie is strictly kept." [25] Among the Santáls, "unchastity is almost unknown" and "divorce is rare." [26] By the Bodo and the Dhimáls, "polygamy, concubinage, and adultery are not tolerated:" "chastity is prized in man and woman, married and unmarried." [27] Further it is to be noted that, among these peoples, the behavior to women is extremely good. "The Santál treats the female members of his family with respect;" [28] the Bodo and the Dhimáls "treat their wives and daughters with confidence and kindness: they are free from all out-door work whatever." [29] And even among the Todas, low as are the forms of their sexual relations, "the wives are treated by their husbands with marked respect and attention." [30] Moreover, we are told concerning sundry of these unwarlike peoples that the *status* of children is also high; and there is none of that distinction of treatment between boys and girls which characterizes militant tribes.*

* In a "Symposium" published in the "Nineteenth Century" for April and May, 1877, was discussed "the influence upon morality of a decline in religious belief": the ques-

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Of course, on turning to civilized peoples to observe the form of individual character which accompanies the industrial form of society, we encounter the difficulty that the personal traits proper to industrialism are, like the social traits, mingled with those proper to militancy. It is manifestly thus with ourselves. A nation which, besides its occasional serious wars, is continually carrying on small wars with uncivilized tribes; a nation which is mainly ruled in Parliament and through the press by men whose school-discipline led them during six days in the week to take Achilles for their hero, and on the seventh to admire Christ; a nation which at its public dinners habitually toasts its army and navy before toasting its legislative bodies—has not so far emerged out of militancy that we can expect either the institutions or the personal characters proper to industrialism to be shown with clearness. In independence, in honesty, in truthfulness, in humanity, its citizens

tion eventually raised being whether morality can exist without religion. Not much difficulty in answering this question will be felt by those who, from the conduct of these rude tribes, turn to that of Europeans during the Christian era, with its innumerable and immeasurable public and private atrocities, its bloody aggressive wars, its ceaseless family vendettas, its bandit barons and fighting bishops, its massacres, political and religious, its torturings and burnings, its all-pervading crime from the assassinations of and by kings down to the lyings and petty thefts of slaves and serfs. Nor do the contrasts between our own conduct at the present time and the conduct of these so-called savages leave us in doubt concerning the right answer. When, after reading police reports, criminal assize proceedings, accounts of fraudulent bankruptcies, etc., which, in our journals, accompany advertisements of sermons and reports of religious meetings, we learn that the "amiable" Bodo and Dhimáls, who are so "honest and truthful," "have no word for God, for soul, for heaven, for hell" (though they have ancestor-worship and some derivative beliefs), we find ourselves unable to recognize the alleged connection. If side by side with narratives of bank frauds, railway jobbings, turf chicaneries, etc., among people who are anxious that the House of Commons should preserve its theism untainted, we place descriptions of the "fascinating" Lepchas, who are so "wonderfully honest," but who "profess no religion, though acknowledging the existence of good and bad spirits" (to the latter of whom only they pay any attention), we do not see our way to accepting the dogma which our theologians think so obviously true; nor will acceptance of it be made easier when we add the description of the conscientious Santál, who "never thinks of making money by a stranger," and "feels pained if payment is pressed upon him" for food offered; but concerning whom we are told that "of a supreme and beneficent God the Santál has no conception." Admission of the doctrine that right conduct depends on theological conviction becomes difficult on reading that the Veddahs, who are "almost devoid of any sentiment of religion" and have no idea "of a Supreme Being," nevertheless "think it perfectly inconceivable that any person should ever take that which does not belong to him, or strike his fellow, or say anything that is untrue." After finding that, among the select of the select who profess our established creed, the standard of truthfulness is such that the statement of a minister concerning Cabinet transactions is distinctly falsified by the statement of a seceding minister, and after then recalling the marvelous veracity of these godless Bodo and Dhimáls, Lepchas, and other peaceful tribes having kindred beliefs, going to such extent that an imputation of falsehood is enough to make one of the Hos destroy himself, we fail to see that in the absence of a theistic belief there can be no regard for truth. When, in a weekly journal specially representing the university culture shared in by our priests, we find a lament over the moral degradation shown in our treatment of the Boers; when we are held degraded because we have

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are not likely to be the equals of the uncultured but peaceful peoples above described. All we may anticipate is an approach to these moral characteristics appropriate to a state undisturbed by international hostilities; and this we find.

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In the first place, with progress of the *régime* of contract has come growth of independence. Daily exchange of services under agreement, involving at once the maintenance of personal claims and respect for the claims of others, has fostered a normal self-assertion and consequent resistance to unauthorized power. The facts that the word "independence" in its modern sense was not in use among us before the middle of the last century, and that on the Continent independence is less markedly displayed, suggest the connection between this trait and a developing industrialism. The trait is shown in the multitudinousness of religious sects, in the divisions of political parties, and in minor

not slaughtered them for successfully resisting our trespasses; when we see that the "sacred duty of blood-revenge," which the cannibal savage insists upon, is insisted upon by those to whom the Christian religion was daily taught throughout their education; and when, from contemplating this fact, we pass to the fact that the unreligious Lepchas "are singularly forgiving of injuries"—the assumed relation between humanity and theism appears anything but congruous with the evidence. If with the ambitions of our church-going citizens, who (not always in very honorable ways) strive to get fortunes that they may make great displays, and gratify themselves by thinking that at death they will "cut up well," we compare the ambitions of the Arafuras, among whom wealth is desired that its possessor may pay the debts of poorer men and settle differences, we are obliged to reject the assumption that "brotherly love" can exist only as a consequence of divine injunctions, with promised rewards and threatened punishments; for of these Arafuras we read that, "of the immortality of the soul they have not the least conception. To all my inquiries on this subject they answered, 'No Arafura has ever returned to us after death, therefore we know nothing of a future state, and this is the first time we have heard of it.' Their idea was, when you are dead there is an end of you. Neither have they any notion of the creation of the world. They only answered, 'None of us were aware of this, we have never heard anything about it, and therefore do not know who has done it all.'" Once more, when, after indicating the Ainos' fear of ghosts and some allied superstitions, but saying that "it is nonsense to write of the religious ideas of a people who have none," Miss Bird tells us of these "kind and delightful savages" that for something she wished to buy they would accept only half what she offered; when by contrast we are reminded of Jews who, after three thousand years of monotheism, lend money at enormous rates of interest and ruin their clients by merciless enforcement of their claims—we are shown that the goodness which may exist without theistic belief is as remarkable as the badness which may exist along with it. That which the facts show us is that, so far as men's moral states are concerned, theory is almost nothing and practice is almost everything. No matter how high their nominal creed, nations given to political burglaries, to get "scientific frontiers" and the like, will have among their members many who "annex" others' goods for their own convenience; and with the organized crime of aggressive war will go criminality in the behavior of one citizen to another. Conversely, as these uncultivated tribes prove, no matter how devoid they are of religious beliefs, those who, generation after generation remaining unmolested, inflict no injuries upon others, have their altruistic sentiments fostered by the sympathetic intercourse of a peaceful daily life, and display the resulting virtues. We need teaching that it is impossible to join injustice and brutality abroad with justice and humanity at home. What a pity these heathens can not be induced to send missionaries among the Christians!

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ways by the absence of those "schools" in art, philosophy, etc., which, among Continental peoples, are formed by the submission of disciples to an adopted master. That in England men show, more than elsewhere, a jealousy of dictation, and a determination to act as they think fit, will not, I think, be disputed.

The diminished subordination to authority, which is the obverse of this independence, of course implies decrease of loyalty. Worship of the monarch, at no time with us reaching to the height it did in France early in the last century, or in Russia down to recent times, has now changed into a respect depending very much on the monarch's personal character. Our days witness no such extreme servilities of expression as were used by ecclesiastics in the dedication of the Bible to King James, nor any such exaggerated adulations as those addressed to George III by the House of Lords. The doctrine of divine right has long since died away; belief in an indwelling supernatural power (implied by the touching for king's evil, etc.) is named as a curiosity of the past; and the monarchical institution has come to be defended on grounds of expediency. So great has been the decrease of this sentiment which, under the militant *régime*, attaches subject to ruler, that nowadays the conviction commonly expressed is that, should the throne be occupied by a Charles II or a George IV, there would probably result a republic. And this change of feeling is shown in the attitude toward the Government as a whole. For not only are there many who dispute the authority of the state in respect of sundry matters besides religious beliefs, but there are some who passively resist what they consider unjust exercises of its authority, and pay fines or go to prison rather than submit.

As this last fact implies, along with decrease of loyalty has gone decrease of faith, not in monarchs only but in governments. Such belief in royal omnipotence as existed in ancient Egypt, where the power of the ruler was supposed to extend to the other world, as it is even now supposed to do in China, has had no parallel in the West; but still, among European peoples in past times, that confidence in the soldier-king essential to the militant type displayed itself, among other ways, in exaggerated conceptions of his ability to cure evils, achieve benefits, and arrange things as he willed. If we compare present opinion among ourselves with opinion in early days, we find a decline in these credulous expectations. Though, during the late retrograde movement toward militancy, state-power has been invoked for various ends, and faith in it has increased; yet, up to the commencement of this reaction, a great change had taken place in the other direction. After the repudiation of a state-enforced creed, there came a denial of the state's capacity for determining religious truth, and a growing movement to relieve it from the function of religious teaching, held to be alike needless and injurious. Long ago it had ceased to be thought that Government could do any good by regulating people's

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food, clothing, and domestic habits; and over the multitudinous processes carried on by producers and distributors, constituting immensely the larger part of our social activities, we no longer believe that legislative dictation is beneficial. Moreover, every newspaper, by its criticisms on the acts of ministers and the conduct of the House of Commons, betrays the diminished faith of citizens in their rulers. Nor is it only by contrasts between past and present among ourselves that we are shown this trait of a more developed industrial state. It is shown by kindred contrasts between opinion here and opinion abroad. The speculations of social reformers in France and in Germany prove that the hope for benefits to be achieved by state-agency is far higher with them than with us.

Along with decrease of loyalty and concomitant decrease of faith in the powers of governments has gone decrease of patriotism—patriotism, that is, under its original form. To fight "for king and country" is an ambition which nowadays occupies but a small space in men's minds; and though there is among us a majority whose sentiment is represented by the exclamation, "Our country, right or wrong!" yet there are large numbers whose desire for human welfare at large so far overrides their desire for national prestige that they object to sacrificing the first to the last. The spirit of self-criticism, which in sundry respects leads us to make unfavorable comparisons between ourselves and Continental nations, leads us more than heretofore to blame ourselves for wrong conduct to other peoples. The denunciations uttered by many on our dealings with the Afghans, the Zooloos, and the Boers, show that there is a large amount of the feeling reprobated by the "Jingo"-class as unpatriotic.

That adaptation of individual nature to social needs which, in the militant state, makes men glory in war and despise peaceful pursuits, has partially brought about among us a converse adjustment of the sentiments. The occupation of the soldier has ceased to be so much honored, and that of the civilian is more honored. During the forty years' peace, the popular sentiment became such that "soldiering" was spoken of contemptuously; and those who enlisted, habitually the idle and the dissolute, were commonly regarded as having completed their disgrace. Similarly in America before the late civil war, such small military gatherings and exercises as from time to time occurred, excited general ridicule. Meanwhile, we see that labors, bodily and mental, useful to self and others, have come to be not only honorable, but in a considerable degree imperative. In America the adverse comments on one who does nothing, almost force him into some active pursuit; and among ourselves the respect for industrial life has become such that men of high rank put their sons into business.

While, as we saw, the compulsory coöperation proper to militancy forbids, or greatly discourages, individual initiative, the voluntary coöperation which distinguishes industrialism gives free scope to

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individual initiative, and develops it by letting enterprise bring its normal advantages. Those who are successfully original in idea and act, prospering and multiplying in greater degrees than others, produce, in course of time, a general type of nature ready to undertake new things. The speculative tendencies of English and American capitalists, and the extent to which large undertakings, both at home and abroad, are carried out by them, sufficiently indicate this trait of character. Though, along with considerable qualification of militancy by industrialism on the Continent, there has occurred there, too, an extension of private enterprise, yet the fact that, while many towns in France and Germany have been supplied with gas and water by English companies, there is in England but little of kindred achievement by foreign companies, shows that, among the more industrially-modified English, individual initiative is more decided.

There is evidence that the decline of international hostilities, going as it does with the decline of hostilities between families and between individuals, is followed by a weakening of revengeful sentiments. This is implied by the fact that in our own country the more serious of these private wars early ceased, leaving only the less serious in the form of duels, which also have at length ceased: their cessation coinciding with the recent great development of industrial life—a fact with which may be joined the fact that in the more militant societies, France and Germany, they have not ceased. So much among ourselves has the authority of the *lex talionis* waned, that a man, whose actions are known to be prompted by the wish for vengeance on one who has injured him, is reprobated rather than applauded.

With decrease of the aggressiveness shown in acts of violence and consequent acts of retaliation has gone decrease of the aggressiveness shown in criminal acts at large. That this change has been a concomitant of the change from a more militant to a more industrial state can not be doubted by one who studies the history of crime in England. Says Mr. Pike in his work on that subject, "The close connection between the military spirit and those actions which are now legally defined to be crimes has been pointed out, again and again, in the course of this history." If we compare a past age in which the effects of hostile activities had been less qualified by the effects of peaceful activities than they have been in our own age, we see a marked contrast in respect of the numbers and kinds of offenses against person and property. We have no longer any English buccaneers; wreckers have ceased to be heard of; and travelers do not now prepare themselves to meet highwaymen. Moreover, that flagitiousness of the governing agencies themselves, which was shown by the venality of ministers and members of Parliament, and by the corrupt administration of justice, has disappeared. With decreasing amount of crime has come increasing reprobation of crime. Biogra-

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phies of pirate captains, suffused with admiration of their courage, no longer find a place in our literature; and the sneaking kindness for "gentlemen of the road" is, in our days, but rarely displayed. Many as are the transgressions which our journals report, they have greatly diminished; and, though in trading transactions there is much dishonesty (chiefly of the indirect sort), it needs but to read De Foe's "English Tradesman" to see how marked has been the improvement since his time. Nor must we forget that the change of character which has brought a decrease of unjust actions has brought an increase of beneficent actions; as seen in paying for slave emancipation, in nursing the wounded soldiers of our fighting neighbors, in philanthropic efforts of countless kinds.

As with the militant type, then, so with the industrial type, three lines of evidence converge to show us its essential nature. Let us set down briefly the several results, that we may observe the correspondences among them.

On considering what must be the traits of a society organized exclusively for carrying on internal activities, so as most efficiently to subserve the lives of citizens, we find them to be these: A corporate action, subordinating individual actions by uniting them in joint effort, is no longer requisite. Contrariwise, such corporate action as remains has for its end to guard individual actions against all interferences not necessarily entailed by mutual limitation: the type of society in which this function is best discharged being that which must survive, since it is that of which the members will most prosper. Excluding, as the requirements of the industrial type do, a despotic controlling agency, they imply, as the only congruous agency for achieving such corporate action as is needed, one formed of representatives who serve to express the aggregate will. The function of this controlling agency, generally defined as that of administering justice, is more specially defined as that of seeing that each citizen gains neither more nor less of benefit than his activities normally bring; and there is thus excluded all public action involving any artificial distribution of benefits. The *régime* of status proper to militancy having disappeared, the *régime* of contract which replaces it has to be universally enforced; and this negatives interferences between efforts and results by arbitrary appointment. Otherwise regarded, the industrial type is distinguished from the militant type as being not both positively regulative and negatively regulative, but as being negatively regulative only. With this restricted sphere for corporate action comes an increased sphere for individual action; and from that voluntary coöperation which is the fundamental principle of the type arise multitudinous private combinations, akin in their structures to the public combination of the society which includes them. Indirectly it results that a society of the industrial type is distinguished by plasticity; and also

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that it tends to lose its economic autonomy, and to coalesce with adjacent societies.

The question next considered was, whether these traits of the industrial type as arrived at by deduction are inductively verified; and we found that in actual societies they are visible more or less clearly in proportion as industrialism is more or less developed. Glancing at those small groups of uncultured people who, wholly unwarlike, display the industrial type in its rudimentary form, we went on to compare the structures of European nations at large in early days of chronic militancy with their structures in modern days characterized by progressing industrialism; and we saw the differences to be of the kind implied. We next compared two of these societies, France and England, which were once in kindred states, but of which the one has had its industrial life much more repressed by its militant life than the other; and it became manifest that the contrasts which, age after age, arose between their institutions, were such as answer to the hypothesis. Lastly, limiting ourselves to England itself, and first noting how recession from such traits of the industrial type as had shown themselves occurred during a long war period, we observed how, during the subsequent long peace beginning in 1815, there were numerous and decided approaches to that social structure which we concluded must accompany developed industrialism.

We then inquired what type of individual nature accompanies the industrial type of society; with a view of seeing whether, from the character of the unit as well as from the character of the aggregate, confirmation is to be derived. Certain uncultured peoples, whose lives are passed in peaceful occupations, proved to be distinguished by independence, resistance to coercion, honesty, truthfulness, forgivingness, kindness. On contrasting the characters of our ancestors during more warlike periods with our own characters, we see that, with an increasing ratio of industrialism to militancy have come a rising independence, a less-marked loyalty, a smaller faith in governments, and a more qualified patriotism; and while, by enterprising action, by diminished faith in authority, by resistance to irresponsible power, there has been shown a strengthening assertion of individuality, there has accompanied it a growing regard for the individualities of others, as implied by the diminution of aggressions upon them and the multiplication of efforts for their welfare.

To prevent misapprehension it seems needful, before closing, to explain that these traits are to be regarded less as the immediate results of industrialism than as the remote results of non-militancy. It is not so much that a social life passed in peaceful occupations is positively moralizing, as that a social life occupied in war is positively demoralizing. Sacrifice of others to self is in the one incidental only; while in the other it is necessary. Such aggressive egoism as accompanies the industrial life is extrinsic; whereas the aggressive egoism

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of the militant life is intrinsic. Though very generally unsympathetic, the exchange of services under agreement is now, to a considerable extent, and may be wholly, carried on with a due regard to the claims of others—may be constantly accompanied by a sense of benefit given as well as benefit received; but the slaying of antagonists, the burning of their houses, the appropriation of their territory, can not but be accompanied by vivid consciousness of injury done them, and a consequent brutalizing effect on the feelings—an effect wrought, not on soldiers only, but on those who employ them and contemplate their deeds with pleasure. This last form of social life, therefore, inevitably deadens the sympathies and generates a state of mind which prompts crimes of trespass; while the first form, allowing the sympathies free play, if it does not directly exercise them, favors the growth of altruistic sentiments and the resulting virtues.

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DETERIORATION OF AMERICAN OYSTER-BEDS.

By Lieutenant FRANCIS WINSLOW.

I.

A WRITER in a recent number of "Lippincott's Magazine" has called attention to the failure of the oyster-beds of the New England and Middle States, to the deterioration of those lying in Southern waters, and to the necessity for some effort, either upon the part of the national or State Governments or by individuals, to maintain the supply of oysters in sufficient numbers to satisfy the large and increasing demand of the consumers. This very desirable end, it is suggested, can be obtained by a system of oyster-culture similar to that adopted by the French Government and by various foreign oyster companies. The author's statements of facts, especially those relating to the foreign fisheries, are both interesting and in accordance with what is known by those interested in and possessing knowledge of the history of the oyster-fishery, either in the United States or abroad. The inferences drawn from the statistics collected can be accepted as just, inasmuch as they relate to the destruction or deterioration of the American beds; but that they logically lead to a belief that oyster-culture in the United States, if conducted as in France, can either supply the demand or be financially successful, is open to serious question.

There is no doubt, as stated in the article at present under review, that the natural beds of the North are practically exhausted; neither is there any doubt of the greatly diminished production of the Southern beds—that is, those of Maryland and Virginia. That the area of

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the latter has decreased is, however, improbable, the *estimates* of Governor Wise and of the officers of the "Merchants' and Mechanics' Exchange," of Norfolk, to the contrary, notwithstanding. Why the reduction of the area of the beds is considered improbable will be shown subsequently. The writer states various reasons for his belief in the early failure of the oyster-supply, none of which are sufficiently plausible to justify his assertion, unless supported by other facts of which he has made no mention. For instance, though the increased price of oysters may be, as he states, an indication of a diminished supply, yet an increase of the demand would have the same effect. Similarly with regard to the laws relating to the use of dredges and scrapes: the beds might be in their normal state, yet the increased demand or knowledge of the inhabitants of the fore-shores might call for protection of the beds. The action of natural enemies and of natural causes, also mentioned in the article in question, may be neglected. Such causes existed in the past as well as in the present, and yet the beds increased and multiplied as they have done nowhere else in the world.

"But the primary cause of the threatened destruction of this industry," says the author of Lippincott's article, "is the failure to cultivate the oyster." It would have been better had he said "the failure to protect the oyster-beds." Oyster-culture is one thing, no doubt an admirable one, but an expensive, laborious undertaking of doubtful financial success. Oyster protection is a matter easily achieved, with but small expenditure of money, and with but little distress to those depending upon the fishery for support.

It is presumable that our author was not aware of the contributions to the literature relating to oysters and oyster-beds, contained in the "Report of the Commissioners of Fisheries of Maryland," for 1880. Had he examined that report, he would have found matter which would more directly have supported his opinion regarding the deterioration of the Southern oyster-beds, and have suggested to him means of restocking the impoverished areas, other than by the expensive and laborious methods detailed in his paper. The tentative steps taken toward the latter end, by successfully propagating the oyster artificially, are detailed by Dr. Brooks, of the Johns Hopkins University, in the above-mentioned report, and the general condition of certain areas covered by oysters are described in extracts from official reports made by myself to the Superintendent of the Coast and Geodetic Survey. It is from those reports, the paper of Dr. Brooks, and the various works relating to oysters and oyster-culture here and abroad, that the material for this report is drawn.

While few will dispute the assertion that the Northern oyster-beds are practically exhausted and have become mere fattening-places for the transplanted Southern oyster, many will dispute the assertion that the beds of Maryland and Virginia are in a nearly similar condition, or

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in danger of soon becoming so. It rests with us, then, to determine that question with as much accuracy as possible, and, should we find the evil an existing one, to show the best means of removing it.

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First, are the beds of Maryland and Virginia deteriorating?

It is only possible to speak with entire accuracy of a limited portion of the entire area covered by oysters in these States, but, as the influences affecting the beds are very similar, it may be assumed with safety that the condition of the beds of one district will be, approximately, that of all; at least, it is certain that beds or localities presenting like peculiarities will be in a similar condition as regards reproduction. The only locality in this country which has been thoroughly studied lies on the eastern shore of Chesapeake Bay, opposite the mouth of the Potomac River. The investigation was carried on by the Coast and Geodetic Survey during the summers of 1878 and 1879, and included the survey of the beds of Tangier and Pocomoke Sounds, the measurement of the depth of water over the beds, and direction and force of currents; the ascertainment of the character of the bottom, the constituents and specific gravity of the water on both flood and ebb tides; the temperature during the summer months or spawning-season; the effect of gales, ice, and freshets; and of the fishery either with dredges or tongs. In general terms, as elaborate a study of the beds of the locality was made as was possible.

Tangier and Pocomoke Sounds were selected on account of the immense extent of their oyster-beds, and because they permitted the study of all the varying conditions affecting the oysters.

The two sounds are arms of Chesapeake Bay, and lie opposite the mouth of the Potomac River, on the eastern side of the bay. Tangier Sound extends north from Watt's Island, at its entrance, about thirty-six miles, and is separated from the bay by a chain of low, marshy islands; it receives from the eastern peninsula the waters of several creeks and rivers, all of considerable importance. The shoals on each side of the channel are covered with oyster-beds, and, where the beds do not exist, the oysters are scattered either in groups or singly. They are also found as continuations of the beds, or scattered in the straits separating the different islands and joining the waters of the sound to those of the bay. On each side of the channels of the tributaries of the sound oyster-beds are also found, and, generally speaking, it may be said that throughout Tangier, in depths between one and six fathoms, oysters may be taken in varying numbers. The entrance to Tangier Sound is also the entrance to Pocomoke Sound, Watt's Island lying between the two at their confluence. Pocomoke stretches to the northward and eastward, extending into the peninsula, while Tangier lies along its western boundary.

Pocomoke Sound is twelve and a half miles long and about nine miles broad near the middle, decreasing in breadth near the head and entrance. The channel is narrow and tortuous, and the main body

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of the sound is shoal, and these shoals covered with oysters scattered singly and in small groups, or existing in large, well-defined beds. Several small creeks empty their waters into this sound, and one large river, the Pocomoke, discharges into it also. The majority of the beds were found on the eastern side of the sound, and the largest were about the middle and near the mouths of the creeks. The beds in both sounds were located and defined during the summer of 1878, and the area upon which oysters were scattered was also ascertained approximately. The entire area in both sounds upon which oysters were found amounts to fifty-four square miles. The area covered by oysters, but only very thinly, they being scattered in small groups or singly, comprises in Tangier Sound fourteen square miles, and in Pocomoke Sound twenty-nine square miles. The area of the beds proper, or those grounds where the oysters are to a great extent uniformly spread and where the majority of the dredging-vessels work, amounts to six square miles in Tangier Sound and to four square miles in Pocomoke Sound.

The information obtained in 1878, so far as it related to the condition of the beds, may be summarized as follows: The number of oysters on the beds had been very much diminished since the commencement of the fishery, or during the last thirty years. The area of the beds had been greatly increased since the commencement of the fishery. There had been during the period alluded to no change of the usual natural conditions to which the animals are subjected.

Before attempting to draw any conclusions from the above, it will be well to see if the extension in area of the beds and diminution of the number of oysters can be accounted for by the action of natural, unassisted causes.

After the original formation and growth of the beds, they would at some time, the same conditions continuing to operate, cease their development, neither increasing in size nor in number of oysters, there being a natural limit to expansion in either direction. Suppose, then, a bed to have extended itself as far as the conditions of bottom and water or other natural limit would allow, all future expansion could be only in the number of oysters on the bed, and this is limited by the amount of food and room for development, the question of enemies not being considered, as, there being no increase, if they were not in sufficient numbers to prevent the growth of the bed and number of oysters, they would not be sufficient to cause its destruction or deterioration. The number of oysters on a limited bed would then steadily increase, as long as there were sufficient room and food supplied them, until they had reached their limit, a rather undefinable one, in that direction. Having reached that point, the number of oysters would to all intents remain the same as long as the conditions under which they had previously lived were not changed. To cause, then, either an increase or diminution of the number of oysters or the size of the

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bed, a new factor must be brought into operation, when, all conditions being changed, the life of the animals begins anew and progresses differently.

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As already stated, the character of both beds and oysters in the locality under consideration has undergone great changes during the last thirty years, and the causes for those changes must be sought among such as it is known would produce like effects. Disregarding for the present the agency of man in the matter, the question is, What natural cause or causes would both expand the beds and diminish the number of oysters?

A bed is extended, naturally, by the drifting "spat" or young brood attaching themselves to any appropriate "cultch" contiguous to the bed. This manner of extending the area is much assisted by the current, and consequently natural extension is greatest in the direction of the currents. The principal expansion of the beds, so far as could be effected by Nature, must, however, have been accomplished long ago, for as far back as can be remembered the beds have been surrounded by soft bottoms of a character most destructive to the young brood. Unless, then, some substance is interposed between this soft bottom and the drifting "spat," they will sink into it and be destroyed. Nature has no means of offering such a substance except to a very small extent, and consequently the great expansion of the beds could not have been the result of natural causes, but must be assigned to other agents.

The diminution of the number of oysters might have been effected by several natural causes. An increased deposit of earthy or vegetable matter upon the beds would, if in sufficient quantities to bury the oyster, effect the destruction of old and young. No such deposit has been noticed, nor could it well occur without showing its presence in other ways, principally by changing the channels and causing shoals, but no such changes have occurred; the deviations in channels, shoals, and character of bottom, from those established by the first hydrographic survey of the locality, being very slight indeed.

A change in the character of the water and bottom which would probably follow a change of channel, and possibly occur without such change, might, by depriving the animals of their proper food, cause their deterioration and destruction; but such a change, though it would certainly diminish the number of oysters, would do so suddenly, and the evil effects would be noticed in the oysters remaining, their quality, flavor, and vitality being very much impaired. No such impairment has been observed, however, the animals being at present much larger and finer than when the beds were first discovered.

That fact alone will eliminate many quantities from the equation, for any natural cause injurious to all the oysters on a bed would show its effects upon those remaining, and an examination of a few specimens would be sufficient to determine the question. If, however, the

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destruction of the mature oysters or the non-production of the young is accomplished by means that are harmful only to those individuals directly affected, a cause for the diminution is discovered in harmony with the existing facts.

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Considering first the destruction of young, large numbers, immense when compared with the production of the higher orders of animals, are annually destroyed by the falling of the "spat" upon unfavorable ground, the prevalence of heavy freshets which would drive the brood into the bay and probably cause its loss, the ravages of various enemies, and unusual changes of the temperature and density of the water. But all these causes have been in operation continually since the first discovery of the beds, and the animals have survived and increased while contending with them. Therefore, some increase of power must be assigned to one or all of these causes, in order to account for the diminished number of oysters, and there is no reason to suppose that there has been such increase. Thus, by reviewing all the natural causes which affect the beds, we can assign to none of them the destruction of either young or old oysters, or the extension of the beds which has been coincident with the diminution of the number of animals. Remaining, then, as the only other operating cause, is the agency of man.

The oyster-fishery in these localities is carried on in two ways, either by "tonging" or "dredging." The first method, being confined to small areas and to a limited number of fishermen, and susceptible of use but in shoal water, need not be considered. The second method of taking the oysters is as follows: the implement used is called a dredge, or scrape, and resembles a large iron claw, the nails representing the teeth of the dredge. To the back of this claw, or the dredge, is fastened a bag of iron mesh-work, large enough to hold two or three bushels. When the dredge is dragged along the bottom the teeth or claws dig up the oysters and shells, which pass between them and into the network behind. The action is somewhat like that of a harrow. The dredges vary greatly in size, being from two to five feet across the mouth, and of greater or less weight, according to the depth of water in which it is intended to use them. The dredging-vessels vary in size from five to thirty tons, and all use two dredges. When on the oyster-ground the dredges are dropped one from each side, and a sufficient amount of line paid out to insure the "taking" of the teeth; the vessel is then kept under easy sail and at a moderate speed until the dredges are full, that being indicated by the strain on the dredging-line and by other signs known to the fishermen. The instrument is then hauled in by means of a small winch, the contents emptied on the deck, and the dredge put over again. This is continued until the vessel is near the edge of the bed, when the dredges are recovered, the vessel put about, and the dredging resumed in an opposite course. While the dredges are in the water, the mud, sand, sponge, grass, or other *débris* brought up are separated from the oysters, and,

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together with all oysters unfit for market, thrown back into the water. The limits of the dredging-grounds are not accurately defined, and the vessels frequently drag large numbers of shells and oysters some distance beyond the boundary of the beds. The dredge, especially when full, acts as a scrape, and carries before it much that would be collected in the network attached to it, had that receptacle been open. After "culling" the oysters, or separating them from the old shells, those shells are thrown back again and with them many young oysters. Should they fall on suitable ground, and any which is sufficiently consistent to support them is suitable, they form a small colony which, by action of natural causes, or the dredges, soon becomes attached to the main bed and the area of the latter is thus enlarged. The exposure of suitable "cultch" on bottoms contiguous to the bed is effected by the dredges in the above manner, and they are thus mainly instrumental in extending the area, especially by their direct action in raking down the bed and spreading the shells and oysters. Will the dredging also account for the diminution of the oysters?

Without, for the present, going into the question of propagation, which will be subsequently discussed, it may be stated here that both male and female of the American variety of oyster expel the generative matter into the water, where the eggs must meet the male fluid in order to be fertilized. That being the case, it is evident that the more compact the bed, the more closely settled the community of oysters, the greater the chance the ova and spermatozoa have of coming in contact; or the chance of fertilization of the eggs is inversely proportional to the distance separating the oysters. Hence, should the mature, spawn-bearing oysters on any bed become very much diminished in number or widely separated from each other, there would be but a slight chance of contact of ova and spermatozoa, and a consequent failure of reproduction. Should the bed be so situated that the currents passing over it did not also pass over other more plentifully stocked beds, it would receive no outside support, and the mutual assistance generally rendered would not be obtained. This is the case with one of the largest beds in Pocomoke Sound, and, as would be inferred, the most extensive deterioration was noticed on that bed.

The removal of mature brood-oysters would, then, cause a diminished fecundity, and, should this removal continue, the fecundity will naturally diminish, until there is virtually no reproduction on the bed. But the removal of brood-oysters is not the sum total, by any means, of the effects of the dredging. Millions of young oysters, unfit for market, are carried off sticking to the shells of the mature oysters, and with those shells find a final resting-place on the shell-heaps of the packing-houses. Nearly as many young are destroyed by being thrown from the dredging-vessels upon soft or unfavorable bottoms, no care being exercised, in the hurry and press of work, to see that the young are returned to the beds or other suitable ground.

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Theoretically, then, the dredging would—1. Extend the beds; 2. Destroy their fecundity by removing the brood-oysters and by destroying their progeny. Practically, has this been the case?

In the absence of previous surveys of the beds, the testimony of the fishermen must be accepted with regard to the extension of area, and the testimony was unanimous to that effect, some of the beds having doubled in size during the last thirty years. The testimony was also to the effect that all the beds in question had materially deteriorated, the general opinion being that, with the improved appliances now in use, there could have been taken twenty-five years ago from two to seven times as many oysters as at present! But we are not compelled to rely solely upon these statements. A comparison of the results obtained from an investigation of newly discovered beds in the Chesapeake Bay with those beds in the sounds that had long been subjected to the dredging influence shows marked differences, and affords more certain methods of proving the deterioration of old beds. In 1879 areas were discovered in the bay upon which oysters existed, and the locality of which was known to but few of the fishermen; the beds were thus practically in a natural state. The following differences were observed between them and the beds in the sounds: On the new beds in the bay the oysters were generally found in clusters of from three or four to twelve and fifteen; the shells were clean and white, and free from worms; the spaces between the larger oysters were filled with the young growth and barnacles; usually the clusters had a large tuft of red sponge attached to them, and sponges were very plentiful over the beds; the mature oysters were long and narrow, with the lower valve very deep and bills very thin and sharp; the animal itself was much larger and thinner than those of the same age on the worked beds in the sounds; and this last difference is probably due to the difference of water and to the fact that, growing as they do in clusters, food is not so readily obtained. The oysters taken from a bed which has been worked for some time are usually single or in clusters of two or three; they are larger than the corresponding class on the unworked beds—that is, broader in comparison to their length and of greater thickness; the valves are blunt and thick about the lips; and the animal fatter and thicker than those of the same age in the new beds. The shells are dirty, with much mud or sand clinging to them. There is but little sponge attached to the shells; but they are covered with worms, and bored in many places by the boring pholad; and the older the bed and oysters, the larger the number of worms and the less healthy is the appearance of the shell.

The new beds were hard, and the clusters seemed more firmly attached to the bottom, and required greater force to detach them than was necessary on the beds in the sounds. There was comparatively but a small number of broken shells, and the bottom was usually too hard to be penetrated by an iron probe. The beds in the sounds were

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soft and easily penetrated. The dredge took the oysters readily, and without great effort. There was much mud among the oysters, and the amount of old broken shells and other *débris* was quite large. It is evident that in any community there must be in the life of a given generation a depletion of number in each successive stage of existence, or, in other words, as the age of the generation increases, the number of individuals decreases. Therefore, on an oyster-bed we should have a larger number of young than mature oysters, provided that we include as "young" the offspring of a sufficient number of spawning-seasons to guard against irregular production in any one season; and, if, having taken that precaution, we find the number of mature oysters to exceed the number of young growth, we may safely decide that there is a deficient production due to some cause, natural or otherwise.

On a natural bed which has not been worked, and which has had no abnormal conditions to contend with, the number of young oysters should, then, exceed the number of those mature. Let us see if this was actually the case on the unworked beds in Chesapeake Bay.

All the oysters examined during the season of 1879 were measured and distributed into four classes. The first two classes comprised the mature oysters; the last two, the young growth. During the season several areas which had never been dredged over were carefully examined, with the following result: Over twenty thousand oysters were measured and classified, and the ratio of young growth to mature oysters was found to be as three to two, or one and five tenths of the former class to one of the latter. This ratio was accepted as a standard, and the ratios of young oysters to mature on all the beds in the sounds were compared with it separately and collectively. Over one hundred thousand oysters were taken from those beds, measured and classified in a similar manner to that adopted for the oysters from the beds in the bay, and the ratio of young growth to mature oysters was found to be as three to six, or five tenths of the former class to one of the latter. Thus, on the new beds the young growth outnumbered the mature, while on the worked beds in the sounds the mature oysters outnumbered the young growth.

The action of the dredge is very destructive to the oysters remaining on the bed. They are not only roughly detached from each other and from the different objects to which they cling, but are, no doubt, frequently left in such positions as will prevent the opening of the valves without allowing the entrance of mud or sand, and thus insuring destruction. The teeth of the dredge also break the lips of the valves, and thus prevent their complete closure, which is the only defense of the oyster against its numerous enemies. Thus, the dredge causes the destruction indirectly of a large number of oysters that remain after its passage, and hence the number of old empty shells should be greater upon a bed that has been dredged than upon one

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that has not; and, if that number is very large, it shows that the population of the bed has been destroyed. Upon an unworked bed the number of old shells will show approximately the number of oysters perishing from natural causes; and, should the number on any worked bed exceed this on the undredged one, it may be concluded that Nature is being assisted in her work of destruction.

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The quantity of matter brought up in the dredge was measured in all cases during the season of 1879, as was also the quantity of oysters and of *débris*. On the unworked beds in the bay this *débris* was found to equal thirty per cent. of the whole amount of matter brought up. On nearly every bed in the sounds the percentage of *débris* was greater than that on the unworked beds, and in Pocomoke Sound it was extraordinarily large, amounting in some of the beds to as much as ninety-seven per cent.!

During the season of 1878 a method was devised by which the number of oysters to the square yard could be determined approximately; and, though this number was not near the true one, yet, as the measurements were always made in the same manner, it was useful as affording a standard for comparing the results of subsequent seasons or of different localities.

The number of oysters to the square yard obtained by this method depended mainly upon the number of oysters brought up by the dredge; and, as already explained, the difficulty of obtaining the animals was much greater on the new and unworked beds than upon those which had been dredged for many years; therefore, the number to the square yard, other things being equal, should be much greater on the old beds than upon those recently discovered. To make this plainer, a very simple illustration will suffice: Any person knows that the plowing or harrowing of a field frequently subjected to that process is much easier than the breaking up of entirely new ground, and the dredging of an oyster-bed is very similar to the harrowing of a field.

The number of oysters to the square yard, as shown by the method used, should then be greater upon the old beds than upon the new, and, comparing the results of successive seasons on the same bed, if it is found that the number of oysters to the square yard is decreasing, it may be concluded that too large a number of the animals is annually removed. The investigation of the beds in 1879 showed that on sixty per cent. of the beds in Tangier Sound there was a decrease in the number of oysters during the season of 1878–'79, and that on sixty per cent. of the beds the number of oysters to the square yard was *less* than on the newly discovered beds in the bay, and in no case was the number much greater. In Pocomoke Sound, *on every bed* the number of oysters to the square yard was *considerably less* than in 1878, and also *much below* the number on the new beds in the bay.

On several of the beds in the sounds the ratio of young growth to

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mature oysters was found to be considerably larger than that on the unworked beds, and there was thus, apparently, a much increased production upon the former areas, or the ratio apparently indicated that, instead of deteriorating, the beds were improving, though all other indications were the reverse.

It is evident that, if the number of young growth falls below the number of mature oysters, the fecundity of the bed is impaired; but it does not follow that, if the young greatly outnumber the mature, it is a sign of increased production, for, though the ratio may be increased by increasing the antecedent, or the number of young, it may also be increased by diminishing the consequent, or number of mature oysters. We know that from the beds in question many millions of oysters are annually removed, and that a large percentage of them are mature; and, if this removal of one class is excessive, it might show itself in the increased ratio of young oysters to mature. Supposing this to be the case, the young would then greatly outnumber the mature for about three years, or the period necessary to pass from youth to maturity. During this period there is a constant removal of the brood-oysters, and, as the reproduction depends upon them principally, the number of young spawned during that period will constantly decrease, so that at the end of three years the mature oysters would probably outnumber the young, and the ratio be as abnormally small as it was abnormally large. Now, with the large number of mature oysters there would be an increased production, and at the end of the second period of three years the ratio would again change, and in this way will increase and diminish alternately, while the number of oysters will constantly diminish. In time, however, the brood-oysters will become so scarce and so widely separated that the fertilization of the eggs will be more and more improbable, and the young will consequently remain in the minority, and, the fishing continuing, the entire destruction of the breeding power will be but a matter of time.

During both seasons of the investigation of the question here discussed, every effort was made to collect statistics of the oyster-fishery, and from these statistics has been estimated the number of oysters removed in a day and in the season. In 1878 this number was over 1,500,000 per day; in 1879, over 700,000 per day. In the sounds the dredging continues throughout the year, though comparatively little is done during the summer months. As the law sanctions the working of the beds only from October 1st until May 1st, in order that any error may be in under- rather than in over-estimation, I will consider the dredging to be confined to that period, and will make the very liberal allowance of three days in each week for bad weather which would prevent work. The dredging-season would then be one of one hundred and twenty days, and in that time there would be removed from the beds, by the estimate of 1878, over

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184,000,000 oysters; and by the estimate of 1879, over 89,000,000 oysters. The number of young growth removed would be, by the first estimate, 148,000,000; by the second, 36,000,000. The statistics collected in 1879, when compared with those collected in 1878, show that there were twice as many vessels at work in 1878 as in 1879, which accounts to a great extent for the difference of 95,000,000 mature oysters, as shown by the estimates for each season. The difference in the yield of young growth is due to the fact that, owing to the variations in temperature during the spawning-season, the summer of 1879 was a bad one for the "spat," and consequently there was a failure of "young."

So far as can be at present ascertained, the mortality among the young after attachment is about fifty per cent., and consequently only about 74,400,000 of the young removed in 1878–'79 would have attained an age of one year, and perhaps the number would not reach even that figure. If none of the oysters had been removed from the beds during the dredging-season of 1878–'79, we would have had, when the last season's investigation was in progress, about 259,000,000 more oysters on the beds than was actually the case, and of that number seventy-one per cent. were mature and spawn-bearing. Now, as sixty-five per cent. of those in the beds are mature, the addition of the 250,000,000 would increase the percentage to sixty-eight, or the young growth would be in a more hopeless minority than before.

To prove more conclusively the effect of the fishery upon the ratio of young to mature oysters, I will take as examples the condition of two of the largest beds in Tangier Sound, where the number of young growth was much in excess of the number of mature oysters. The beds are known as the "Great Rock" and "Woman's Marsh." On the former the ratio of young growth to mature oysters was as three to one, or twenty-four per cent. were mature; on the latter the ratio was as one and seventy-four hundredths to one, or thirty-six per cent. were mature. By consulting the statistics collected, I find that of the oysters removed from the Great Rock in one year, sixty-four per cent. were mature, and of those removed from the Woman's Marsh sixty-nine per cent. were of the same class. If these oysters had not been removed, we would have on the Great Rock forty-four per cent. of the community mature, or the ratio of young growth to mature oysters would be as one and one tenth to one; and on the Woman's Marsh the percentage would be fifty-two instead of thirty-six, and the ratio would be as nine tenths to one. It is evident from the foregoing that a very large ratio of young growth to mature oysters is not an indication of an increased production, but, as explained, is due to the removal of too large a number of brood-oysters.

We have, then, three indications of the deterioration of the beds: the number of young is either much smaller or larger than the number

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of mature oysters, and in the latter case it is so large as to be abnormal; the amount of *débris* found on the beds is much greater than in the newly discovered areas; and the number of oysters to the square yard not only falls below what it should be, but has decreased since the first examination in 1878. The testimony of all persons living in the vicinity of the sounds is to the effect that there has been a marked deterioration of the beds since they were first discovered and worked, and it is the general opinion that, had the improved implements and appliances now used in the fishery been available when the beds were first discovered, from three to five times as many oysters as are taken at present could have been obtained in Tangier Sound, and about seven times as many in Pocomoke Sound; that even with the insufficient implements then in use more oysters were taken, *per sail*, in the same time than was possible at present.

Considering this testimony, and the results of the comparison of the worked beds in the sound with the unworked ones in the bay, it may be concluded that the former areas are much impaired in productive power, and, the same causes continuing to operate, there will be a constant deterioration until that productive power is entirely destroyed. As there is no indication of any natural cause influencing the beds in the sounds and not the contiguous ones in the bay, we are compelled to assign, as the cause for the deterioration and impaired fecundity of the beds in Tangier and Pocomoke Sounds, the excessive and exhaustive fishery peculiar to them, and from which the beds in the bay have heretofore been free.

The fishery in the sounds is not more extensive than it is in many other localities in Chesapeake Bay: the conditions under which the beds exist are nearly the same; the laws governing the fishery are the same; and about the same amount of attention is paid to them. It is probable, then, that were the remaining beds of the Chesapeake examined carefully, they would present indications of deterioration similar to those shown by the Tangier and Pocomoke beds.* That this deterioration is due to the severe fishing can not be doubted. That in time it will amount to utter exhaustion is a fact well known to those who have given any attention to the matter. To those who have not, the following information may be interesting. Only a few of many cases are cited, but enough, it is hoped, to show that the experience is not confined to small areas or one country; that one result follows invariably upon the heels of over-fishing, and that result is, exhaustion.

The records of the production of the beds of Cancale Bay, on the northwest coast of France, which extend over a period of sixty-eight years, from 1800 to 1868, are perhaps the most instructive:

The beds in the bay comprise an area of about one hundred and fifty acres, and, from 1800 to 1816, produced annually from 400,000 to

* Recent investigations by the Coast and Geodetic Survey confirm this opinion.

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2,000,000 oysters. This, however, was the period of the Napoleonic wars, and the fishery was much disturbed by the English cruisers. During this time the beds became so thickly stocked that the oysters were in some places a yard thick. After the close of the war the fishery improved, and the oysters were removed in larger and increasing numbers until 1843.

From 1823 to 1848 it is supposed that the dredgers were living upon the animals accumulated during the period of enforced rest, from 1800 to 1816. In 1817 the number of oysters produced was 5,600,000, and until 1843 there was a constant increase, the number taken in that year being 70,000,000. In 1848 it was 60,000,000, and thenceforward there was a constant decrease. From 1850 to 1856 the decrease was from 50,000,000 to 18,000,000, and was supposed to be the effect of over-dredging. From 1859 to 1868 the decrease was from 16,000,000 to 1,079,000, the oysters having almost entirely disappeared from the beds, *though on account of the suffering condition of the inhabitants of the shores* it was impossible to prevent it or restrict the fishery. In 1870 there was a *complete wreck of the bottom*, which could only be remedied by a total prohibition of the fisheries for several years.

From the beds of the districts of Rochefort, Marennes, and Isle d'Oléron, on the west coast of France, there were taken, in 1853–'54, 10,000,000 oysters; in 1854–'55, 15,000,000. On account of exhaustive fishing, in 1863–'64 only 400,000 could be obtained.

According to Mr. Webber, Mayor of Falmouth, England, about seven hundred men, working three hundred boats, were employed in a profitable oyster-fishery in the neighborhood of Falmouth until 1866, when the old laws enforcing a close-time were repealed, under an impression that, owing to the great productive powers of the oyster, it would be impossible to remove a sufficient number to prevent the restocking of the beds. Since 1866 the beds have become so impoverished, from the excessive and continual fishery, that in 1876 only forty men and less than forty boats could find employment, and, small as that number is, they could not take more than sixty or one hundred oysters a day, while formerly, in the same time, one boat could take from ten to twelve thousand.

According to the statement of Mr. Messum, an oyster-dealer and secretary of an oyster company in Emsworth, England, there were in the harbor of Emsworth, between the years 1840 and 1850, so many oysters that one man in five hours could take from twenty-four to thirty-two thousand. In consequence of over-fishery in 1858, scarcely ten vessels could find loads, and in 1868 a dredger, *in five hours, could not find more than twenty oysters!*

The oyster-fisheries of Jersey, in the English Channel, afforded employment to four hundred vessels. In six or seven years the dredging became so extensive and the beds so exhausted that only three or

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four vessels could find employment, and the crews of them had to do additional work on shore in order to support themselves, the returns from the beds being so inadequate.

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The evil of excessive fishery then exists, and, continuing, can have but one effect, and we have seen how disastrous is that result. Our oyster-beds are, however, so extensive, the animals are so widely distributed, and are so easily transported and transplanted, that the total failure of the American oyster-beds must be postponed for some time. But the failure of the beds of different localities may occur at any time, and it is more than probable that those of Chesapeake Bay will be practically exhausted before many years. The deterioration and final exhaustion of the beds, either of particular localities or of the whole country, would, however, cause far greater distress, discomfort, and inconvenience in the United States than the failure of the foreign beds caused abroad. With us the oyster is no luxury, but a means of subsistence to a large number of people. Oysters are consumed from Maine to Texas, and from the Atlantic to the Pacific, and immense numbers are also annually exported. In supplying this great demand numbers of the poorer classes of citizens find a constant and profitable employment, and thus the deterioration of the beds, or extinction of the oysters, would not only be felt by the consumer in the much-increased price of a desirable and nutritious article of food, but by the producer, in a loss of employment, and that loss occurring in localities where there is hardly any other resource.

[The natural history of the oyster with especial reference to the process of reproduction and the conditions influencing its rate of increase will form the subject of a concluding article.—Ed.]

VOLCANOES, THEIR ACTION AND DISTRIBUTION.*

"WHAT is a volcano?" This is a familiar question, often addressed to us in our youth, which "Catechisms of Universal Knowledge" and similar school manuals have taught us to reply to in some such terms as the following: "A volcano is a burning mountain, from the summit of which issue smoke and flames." This description, says Professor Judd, is not merely incomplete and inadequate as a whole, but each individual proposition of which it is made up is grossly inadequate and, what is worse, perversely misleading. In the first place, the action which takes place at volcanoes is not "burning," or combustion, and bears, indeed, no relation whatever to that well-known

* Volcanoes, what they Are, and what they Teach. By John W. Judd, F.R.S. With Ninety-six Illustrations. "International Scientific Series." In press of D. Appleton & Co.

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process. Nor are volcanoes necessarily "mountains" at all; essentially, they are just the reverse—namely, holes in the earth's crust, or outer portion, by means of which a communication is kept up between the surface and the interior of our globe. When mountains do exist at centers of volcanic activity, they are simply the heaps of materials thrown out of these holes, and must, therefore, be regarded not as the causes but as the consequences of volcanic action. Neither does this action always take place at the "summits" of volcanic mountains when such exist, for eruptions occur quite as frequently on their sides or at their base. That, too, which popular fancy regards as "smoke" is really condensing steam or watery vapor, and the supposed raging "flames" are nothing more than the glowing light of a mass of molten material reflected from these vapor-clouds. The name of volcano has been borrowed from the mountain Vulcano, in the Lipari Islands, where the ancients believed that Hephæstus, or Vulcan, had his forge. Volcanic phenomena have been at all times regarded with a superstitious awe, which has resulted in the generation of such myths as the one just mentioned, or of that in which Etna was said to have been formed by the mountains under which an angry god had buried the rebellious Typhon. These stories changed their form, but not their essence, under a Christian dispensation, and Vulcano became regarded as the place of punishment of the Arian Emperor Theodosius, and Etna as that of Anne Boleyn, who had sinned by perverting the faith of King Henry VIII.

Volcanic phenomena can be studied to great advantage in Stromboli, whose crater, the edge of which is easily accessible, is in a state of constant moderate action, and can be watched for hours together without having the judgment warped either by an excited imagination or the sense of danger. It is an island of rudely circular outline and conical form, and rises to the height of three thousand and ninety feet above the level of the Mediterranean (Fig. 1). From a point on the side of the mountain masses of vapor are seen to issue, which unite to form a cloud over the summit, the outline of which varies continually according to the hygrometric state of the atmosphere and the direction and force of the wind. At the time the sketch was made, April 20, 1874, the vapor-cloud was spread in a great horizontal stratum overshadowing the whole island, but was clearly seen to be made up of a number of globular masses, each of which was a product of a distinct outburst of the volcanic forces.

The mountain is visible over the sea for a hundred miles. When it is watched from the deck of a vessel anywhere within this distance, "a glow of red light is seen to make its appearance from time to time above the summit of the mountain; this glow of light may be observed to increase gradually in intensity, and then as gradually to die away. After a short interval the same appearances are repeated, and this goes on till the increasing light of the dawn causes the phenome-

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non to be no longer visible. The resemblance presented by Stromboli to a 'flashing-light' on a most gigantic scale is very striking, and the mountain has long been known as the 'lighthouse of the Mediterranean.'"

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The island appears, if we land upon it, to be entirely built up of such materials as we know to be ejected from volcanoes; "indeed, it

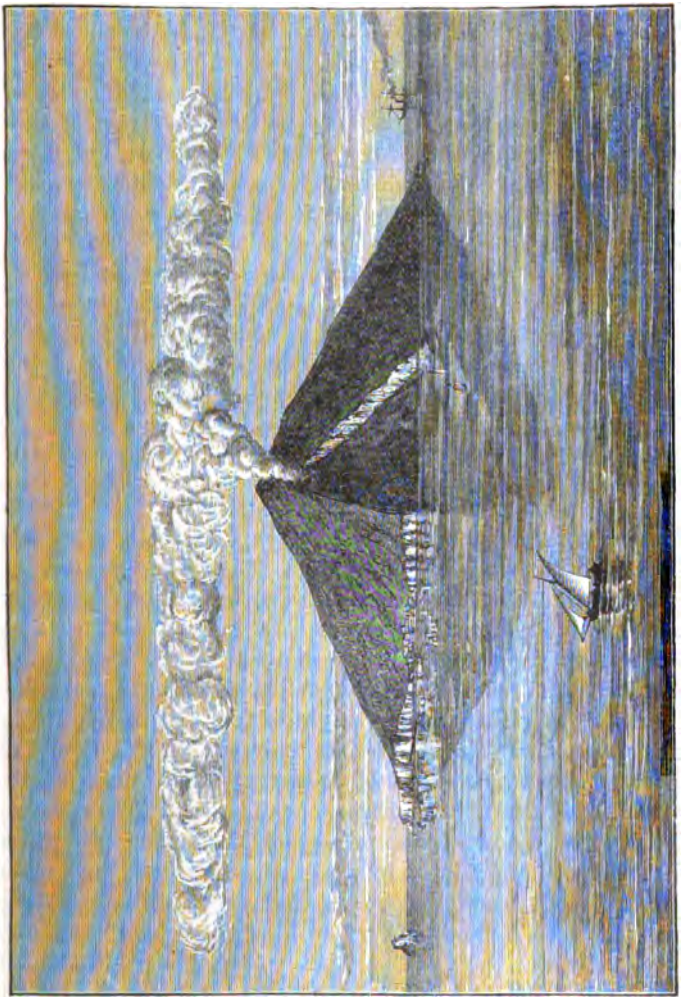


FIG. 1.—STROMBOLI, VIEWED FROM THE NORTHWEST, APRIL, 1874.

resembles, on a gigantic scale, the surroundings of an iron-furnace, with its heaps of cinders and masses of slag. The irregularity in the form of the island is at once seen to be due to the action of the wind, the rain, and the waves of the surrounding sea, which have removed the loose, cindery materials at some points, and left the hard, slaggy masses standing up prominently at others." This pile stands in a sea

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of about six hundred fathoms depth; as it rises to more than three thousand feet above the surface, it represents a conical mass of cinders and slaggy materials, six thousand feet high and more than four miles in diameter at the base. The crater may be approached by a flat slope called the Sciarra, which rises at an angle of 35° with the horizon, and ends abruptly at its edge. The accompanying sketch (Fig. 2) was



FIG. 2.—THE CRATER OF STROMBOLI AS VIEWED FROM THE SIDE OF THE SCIARRA DURING AN ERUPTION ON THE MORNING OF APRIL 24, 1874.

made from this point at the moment of an outburst. "Before the outburst, numerous light, curling wreaths of vapor were seen ascending from fissures on the sides and bottom of the crater. Suddenly, and without the slightest warning, a sound was heard like that produced when a locomotive blows off its steam at a railway-station; a great volume of watery vapor was at the same time thrown violently into the atmosphere, and with it there were hurled upward a number of dark fragments, which rose to the height of four or five hundred feet above the crater, describing curves in their course, and then falling back upon the mountain. Most of these fragments tumbled into the crater with a loud, rattling noise, but some of them fell outside the crater, and a few rolled down the steep slope of the Sciarra into the sea."

Spallanzani and other later investigators carried on their observations from a point whence they could look down into the bottom of the crater, and, with a wind that would blow the vapors away, sit and watch for hours the wonderful scene. From this point, the black, slaggy bottom of the crater is seen to be traversed by many fissures or cracks, from most of which curling jets of vapor issue quietly and gradually mingle with and disappear in the atmosphere. Besides, there are several larger openings, varying in number and position at different periods, from some of which "steam is emitted with loud, snorting puffs, like those produced by a locomotive-engine, but far less regular and rhythmical in their succession"; from others, masses of

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molten material well out and sometimes flow outside of the crater, with steam escaping, often in considerable quantities; in some a viscid or semi-liquid substance is seen seething, swelling up and forming gigantic bubbles, which burst under occasional great rushes of steam, carrying fragments of the scum-like surface of the liquid high up into the atmosphere, almost precisely as takes place in a pot of boiling mush. At night, "the smaller cracks and larger openings glow with a ruddy light. Every time a bubble bursts, and the crust is broken up by the escape of steam, a fresh, glowing surface of the incandescent material is exposed. If at these moments we look up at the vapor-cloud covering the mountain, we shall at once understand the cause of the singular appearances presented by Stromboli when viewed from a distance at night; for the great masses of vapor are seen to be lit up with a vivid, ruddy glow, like that produced when an engine-driver opens the door of the furnace and illuminates the stream of vapor issuing from the funnel of his locomotive."

These phenomena differ only in degree from those presented by volcanoes which, like Vesuvius, are spasmodically more active. Occasionally, the violence of the outbursts at Stromboli is temporarily increased; and at Vesuvius a series of small explosions, quite similar to those occurring at Stromboli, were observed for some months before the great eruption of 1872. French geologists, in fact, define the conditions of activity of volcanoes by speaking of the "Strombolian" and the "Vesuvian" stage as two degrees between which the passage is by insensible gradations. The eruption of 1872, of which the accompanying view (Fig. 3) is from a photograph, afforded a fine example of the intense Vesuvian stage. The activity of the forces at work within the mountain had been on the increase for more than a year, and reached its climax on the day the photograph was taken. During the eruption the bottom of the crater was entirely broken up, and the sides of the mountain were rent by fissures in all directions whence liquid matter appeared to be oozing as from every part of the surface, or as Professor Palmieri expressed it, "Vesuvius sweated fire." Enormous volumes of steam rushed out from the crater and from some of the fissures, to the height, as shown by the picture, of twenty thousand feet, or nearly four miles, with a prodigious roaring sound that frightened the inhabitants of Naples into leaving their houses and seeking refuge in the streets. The roaring was produced by explosions or detonations rapidly following one another, each of which sent up a globe of white vapor, out of a mass of which globes the overhanging cloud was formed. Lava, or molten rock, rushed down the sides of the mountain in great streams, whence enormous volumes of steam continually rose, forcing the congealing rock as it escaped from it into great bubbles and blisters, thus giving rise to the formation of innumerable miniature volcanoes.

Other phenomena accompanying this eruption were the prevalence

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of earthquake-shocks in the country around, the vivid lightnings and thunders arising from the electrical action engendered by the column of steam, and the excessive rainfall which followed the condensation of the steam.

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In both these volcanoes the active cause of all the phenomena exhibited is found to be the escape of steam from the midst of masses



FIG. 8.—VESUVIUS IN ERUPTION, AS SEEN FROM NAPLES, APRIL 26, 1872. (From a Photograph.)

of incandescent liquefied rock. The violence, the grandeur, and the destructive effects of an eruption depend upon the abundance and tension of this escaping steam.

The manner in which volcanic cones are built up is ascertained

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from the examination of sections of them. This was first attempted at the suggestion of Goethe, in the case of the Kammerbühl, a small hill in Bohemia, concerning which it was disputed whether its materials had been derived from the combustion of coal or from aqueous precipitation, or whether they were of volcanic origin. An excavation to the core of the hill, finished in 1837, showed that the center of the mass was filled with a plug of basalt, which was connected with a small lava-stream flowing down the side of the hill; while the bulk of the hill was composed of volcanic scoriæ and lapilli (Fig. 4). Nat-

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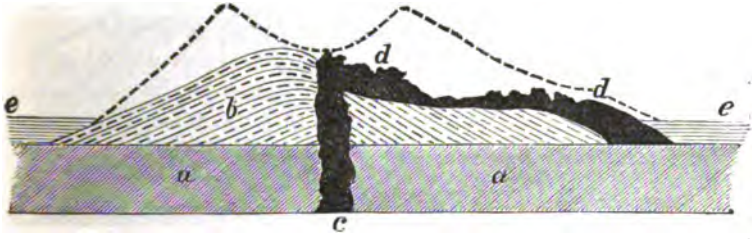


FIG. 4.—SECTION OF THE KAMMERBÜHL, IN BOHEMIA. *a a*, metamorphic rocks; *b*, basaltic scoriæ; *c*, solid plug of basalt rising through the center of the volcanic pile; *d d*, lava-stream composed of the same rock; *e e*, alluvial matter surrounding the old volcano. (The dotted lines indicate the probable former outline of the volcano.)

ural sections are not rare. A very fine one is afforded by the peninsula of Vulcanello, in the Island of Vulcano (Fig. 5). The peninsula consists of three volcanic cones, united at their base, with the lava-

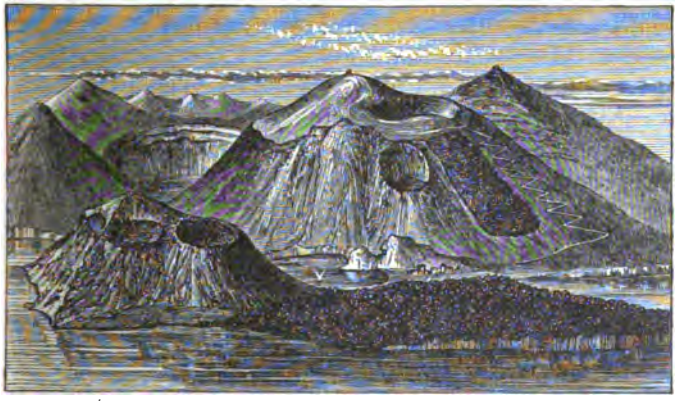


FIG. 5.—VIEW OF VULCANO, WITH VULCANELLO IN THE FOREGROUND, TAKEN FROM THE SOUTH END OF THE ISLAND OF LIPARI.

streams which have flowed from them. One half the cone on the left side of the picture has been completely washed away by the sea, so that a perfect section of the internal structure is exposed, as in the accompanying figure (Fig. 6). This section shows—1. The loose scoriæ and lapilli, *d*, which, in falling through the air, have arranged themselves in tolerably regular layers on the sides of the cone; 2. Lava-

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streams, *b*, which have been ejected from the crater or from fissures, and flowed down the sides of the cone; and, 3. Masses of lava, *c*, filling up cracks in the cone, called "dikes." Most volcanic mountains are built up of these three kinds of material, but with varying arrangement and proportions. One kind very often predominates

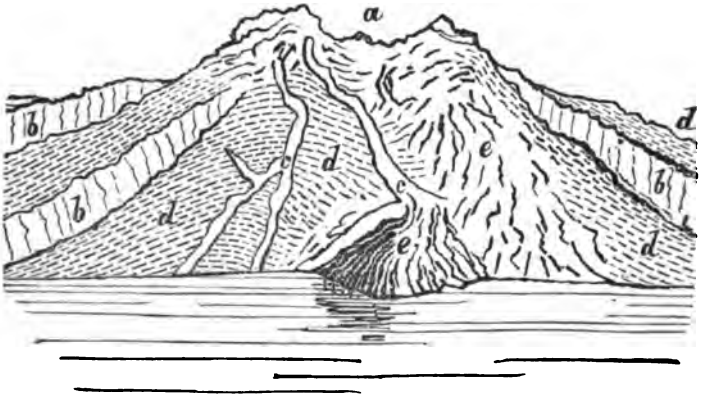


FIG. 6.—NATURAL SECTION OF A VOLCANIC CONE IN THE ISLAND OF VULCANO. *a*, crater; *b b*, lava-streams; *c*, dikes which have clearly formed the ducts, through which the lava has risen to the crater; *d d*, stratified volcanic scoriæ; *e*, talus of fallen materials.

almost to the exclusion of the others. The materials falling through the air upon the surface of the mountain assume a stratified arrangement, in which the finer matters are sorted out and carried to a greater distance than the others, the same as when the deposit is made from water. When materials of a different character are thrown out by different eruptions, the distinctions are very plainly marked.

An opportunity was given for observing the formation of a volcanic cone through all its stages in the case of the eruption of Monte Nuovo, or New Mountain, on the shores of the Bay of Naples, in 1538 (Fig.



FIG. 7.—MONTE NUOVO (440 FEET HIGH), ON THE SHORES OF THE BAY OF NAPLES.

7). After the neighborhood had been affected by earthquakes for more than two years, on the 29th of September, at eight o'clock in the morning, to be exact, water, first cold, afterward becoming tepid, was observed to issue from a depression which was noticed on the site of the future hill. Four hours afterward the ground was seen to swell

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up and open, forming a gaping fissure, within which incandescent matter was visible. Masses of stone and vast quantities of pumice and mud were then thrown up to a great height for two days and nights, and, falling on the sides of the vent, formed a great mound, which was climbed up by adventurous persons on the third day, a quiet one. The ejections were resumed on the next day, when several persons who undertook to climb the hill were killed or injured, but ceased on the seventh or eighth day. The mass of the hill, which is four hundred and forty feet above the sea, was chiefly composed of the materials which were thrown out during the first two days and nights. It consists of scoriæ, lapilli, and dust, and is now covered with a thick growth of pines. The crater is marked by a steep, cup-shaped depression, the bottom of which is but little above the level of the sea. The district in which this mountain is situated contains a great number of hills, strikingly resembling it, some of which are larger, some smaller than it, but all so similar that "no stranger visiting the district, without previous information on the subject, would suspect the fact that, while all the other hills of the district have existed from time immemorial, and are constantly mentioned in the works of Greek and Roman writers, this particular hill of Monte Nuovo came into existence less than three hundred and fifty years ago."

The form of the cones is modified by the character of the materials thrown out, by the action of the weather, and by repeated eruptions. Loose material, scoriæ and lapilli, roll till they reach a position of rest, and leave a more or less regular cone. Very liquid lavas flow to great distances, resting at a very slight slope, as in the volcanoes of Hawaii, where, with a slope of only six or eight degrees, the mountains have a diameter of seventy miles at their base, and reach a height of

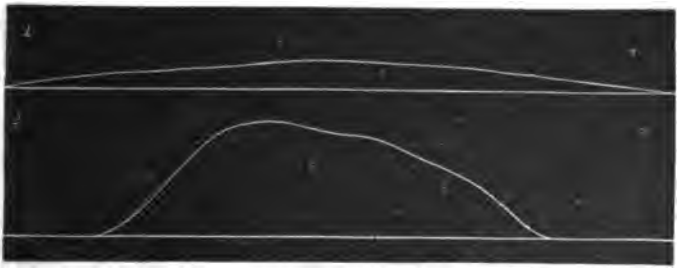


FIG. 8.—OUTLINES OF LAVA-CONES. 1. Mauna Loa, in Hawaii, composed of fluid lava; 2. The Schlossberg of Teplitz, Bohemia, composed of very imperfectly fluid or viscid lava.

fourteen thousand feet. If, on the other hand, the lava is only imperfectly liquid, it tends to accumulate around the vent and form a more or less steep-sided bulbous mass, as in number two of the figure (Fig. 8). The shape of the cone may undergo changes during an eruption, as in the accompanying outlines of Vesuvius (Fig. 9). Most of the great volcanic mountains belong to the class of "composite cones," and are built

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up by alternate ejections of fluid lava and fragmentary materials. The slopes of their sides are subject to a wide range of variation, corresponding with the varying character and degree of liquidity of these materials. The sides of the cones are liable to be rent asunder and traversed with fissures, through which liquid lava forces its way and

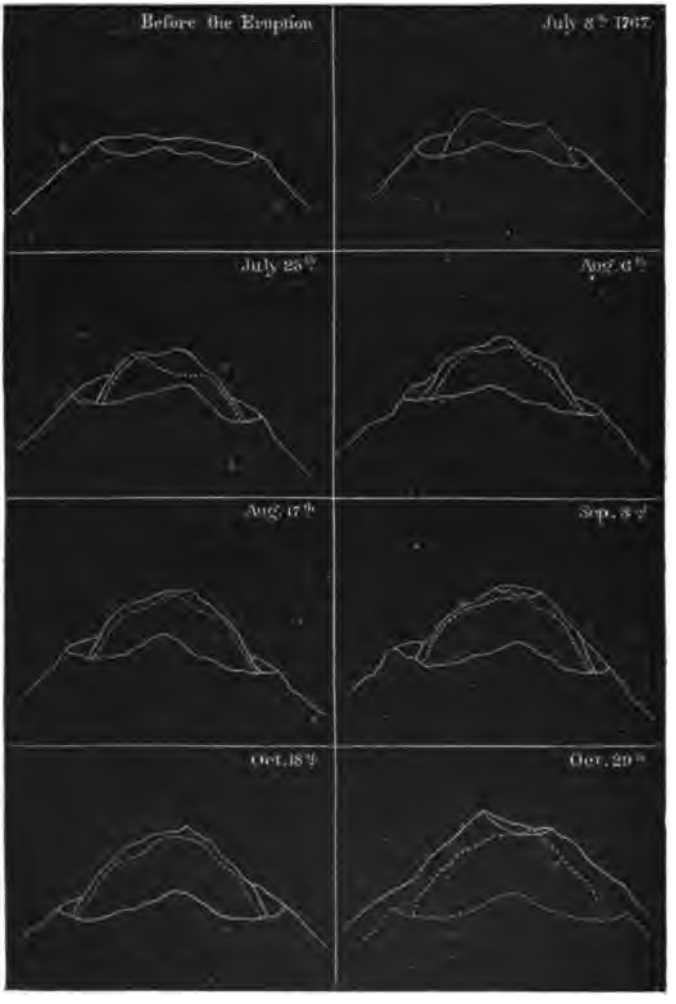


FIG. 9.—OUTLINES OF THE SUMMIT OF VESUVIUS DURING THE ERUPTION OF 1767.

gives rise to new subsidiary cones, or series of cones, along the lines of the clefts. These cones are called parasitic cones, and frequently attain considerable dimensions, some of those on the flanks of Etna being nearly eight hundred feet high. A typical example of a group of such cones is given in the Island of Ischia, where several parasitic

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cones have been formed around the main cone. Another example is furnished on the slopes of Etna, where the scoria-cones raised in 1865 along a fissure were so close together as to make a long, irregular ridge (Fig. 10). Seven of these cones were formed along this fissure,

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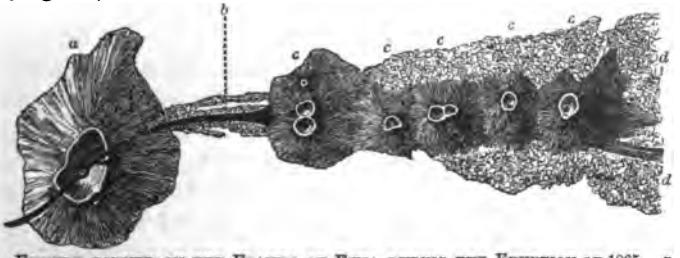


FIG. 10.—FISSURE FORMED ON THE FLANKS OF ETNA DURING THE ERUPTION OF 1865. *a*, Monte Frumento, an old parasitic cone; *b*, line of fissure; *c c c*, new scoria-cones thrown up on the line of fissure; *d*, lava from the same.

thirty-six along another fissure during the eruption of 1874. Similar phenomena were witnessed upon the slopes of Vesuvius in 1760, when a fissure opened on the south side of the mountain, and fifteen scoria-cones, which are still visible, were thrown up along it.

The center of eruption has sometimes shifted itself along a line of fissure, as has taken place at Etna, where the present center is four miles from the old one, and in the Island of Vulcano with the peninsula of Vulcanello, which affords the best possible example of such a shifting. Whole systems of volcanoes appear to be built up along the lines of such fissures, as is shown by the linear arrangement of volcanoes in different parts of the earth, and strikingly in the Lipari Islands, where the volcanoes are arranged along a series of lines which doubtless mark rents in the earth's crust, and which radiate from a center at which we have proofs of the former existence of a volcano of enormous dimensions.

There is also good ground for believing that the great linear bands of volcanoes which, as we shall see, stretch for thousands of miles over the earth, have had their positions determined by great lines of fissure in the earth's crust. While, however, the smaller fissures, upon which rows of scoria-cones are thrown up, seem to have been in many cases opened by a single effort of the volcanic forces, the enormous fissures which traverse so large a portion of the surface of the globe are doubtless the result of numerous manifestations of energy extending over vast periods of time.

It is very hard accurately to estimate the number of volcanoes in the world. They vary in size from immense mountains like Chimborazo and Cotopaxi to mere holes in the ground, letting escape barely perceptible columns of vapor. The history of a large proportion of them has been known only for a brief period, and many which are considered extinct because they have never been seen in action may be merely dormant, ready to burst out at any time, as Vesuvius did in

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the year 79. If we include only habitual vents of considerable importance, which we have reason to believe may still be in active condition, the number may be put at between three hundred and three hundred and fifty. Most of these are marked by more or less considerable mountains formed of the matters ejected from them. If we include the mountains which exhibit the main features of volcanoes, but concerning the activity of which we have no record or tradition, the number will not fall much short of one thousand. Then there are other "ruined volcanoes," the cones of which have been worn away and of which the "ground-plans" only are left, still more numerous. The smaller temporary openings, usually subordinate to the habitual vents, known to ancient and modern history and tradition, may be counted by thousands and tens of thousands. The still feebler manifestations—steam-jets, geysers, thermal and mineral waters, fumaroles, mud-volcanoes, and the like—must be numbered by millions. The latter class seem to play a small part as we contemplate them singly, but their force in the aggregate probably far exceeds that of all the great habitual vents. These volcanoes, in all their classes, are very unequally distributed over the globe. Vesuvius is the only habitual vent on the Continent of Europe, and it is on the shores of the Mediterranean; the Mediterranean islands contain six; Africa has ten—four on the western, six on the eastern coast; Asia, so far as is known, twenty-four, twelve of which are on the peninsula of Kamtchatka. None are known in Australia. North America has twenty volcanoes, Central America twenty-five, and South America thirty-seven. In all, one hundred and seventeen volcanoes are situated on the great continental lands, leaving nearly twice that number distributed over the islands of the oceans.

In nearly all cases, the volcanoes are either close to the shores of the continent or at no very great distance from them. The only known exceptions are in the Central Asian plateau and Chinese Mantchooria, concerning which more accurate information is needed. All the oceanic islands that are not coral reefs are of volcanic origin, and many of them contain active volcanoes. A ridge running through the midst of the Atlantic Ocean and embracing the Islands of Jan Mayen, Iceland, the Azores, Canaries, and West Indies, contains forty active volcanoes and a greater number of extinct ones. A similar line in the Pacific Ocean, including the group of islands southeast of the Asiatic Continent, "the grandest focus of volcanic activity on the globe," contains no less than one hundred and fifty active volcanoes; and, if we include those on lines branching from the main one, half the habitually active vents of the globe. A third series of volcanoes starts from near the last one in the neighborhood of Behring Strait, and stretches along the whole western coast of the American Continent, with about eighty active vents.

The volcanoes of the globe thus usually assume a linear arrange-

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ment, and are nearly all situated along three well-marked bands and the branches proceeding from them. The volcanoes of the eastern coast of Africa, with Mauritius, Bourbon, Rodriguez, and the vents along the line of the Red Sea, may be regarded as forming a fourth and subordinate band. Nearly all of them are situated near the limits which separate the great land and water masses of the globe, either on the parts of continents not far removed from their coast-lines, or on islands in the ocean not very distant from the shores. Two conspicuous exceptions to this rule are the volcanoes of the Thian-Shan range in Asia, in the center of the largest unbroken land-mass of the globe; and the group of the Sandwich Islands, almost in the center of the largest ocean, and rising almost from the greatest depths of that ocean. Geological researches have, however, shown that the Thian-Shan Mountains in Pliocene times stood on the southern borders of a great inland sea. A regular parallelism seems to exist between volcanic bands and the great mountain-chains; and the researches of Mr. Darwin have shown that "nearly all the active volcanoes are situated upon rising areas, and that volcanic phenomena are conspicuously absent from those parts of the earth's crust which can be proved at the present day to be undergoing depression."

Inferences are sometimes hastily drawn from the fact that most volcanoes are near the ocean which the facts themselves will hardly warrant. Thus, it is frequently assumed that we may refer all the phenomena of volcanic action to the penetration of sea-water to a mass of incandescent lava in the earth's crust and to the chemical and mechanical actions which result from the meeting. This argument, however, as Mr. Scrope has shown, involves a reasoning in a circle. "It is assumed, on the one hand, that the heaving subterranean movements which give rise to the fissures by which steam and other gases escape to the surface are the result of the passage of water to the heated masses in the earth's crust. But, on the other hand, it is supposed that it is the production of these fissures which leads to the influx of waters to the heated materials. If it is the passage of water through these fissures which produces the eruptions, it may be fairly asked, What is it gives rise to the fissures? And if, on the other hand, there exist subterranean forces competent to produce the fissures, may they not also give rise to the eruptions through the openings which they have originated?"

Many of the various theories which have been proposed to account for volcanic action—depending upon the supposed presence of active forces within the earth; upon the contact of water with the hot solid or liquid matter of the interior of the globe; upon the chemical actions that may be taking place within the earth; upon the heat that may be developed by the contraction of the earth's crust; or upon the occlusion of gases by the metallic elements of which many suppose the core of the earth to be composed—have a certain probability. They

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are not definitely contradicted by anything that we know, but are as yet still further from being fully sustained by facts; and they all prove to be beset by difficulties when they are subjected to a critical analysis. Thus, "it must be admitted that we do not at present appear to have the means for framing a complete and consistent theory of volcanic action, but we may hopefully look forward to the time when further observation and experiment shall have removed many of the existing difficulties which beset the question, and when by the light of such future researches untenable hypotheses shall be eliminated and the just ones proved and established."

Modern speculation, recognizing that the worlds of our system are bound by the same laws and had the same origin, now tends to look to the study of what is going on in the sun and planets as a valuable aid in ascertaining the reason of the operations to which our planet is and has been subjected.

PHYSICAL EDUCATION.

By FELIX L. OSWALD, M. D.

HYGIENIC PRECAUTIONS.

"Dangers we can not avoid we must learn to defy."—Lessing.

CREATURES in a state of nature can almost dispense with sanitary precautions; Providence has secured their safety in that respect. Animals are born with the instinct that enables them to distinguish wholesome from injurious plants. In the wilderness, where the neighborhood of man does not tempt them to brave the winter of the higher latitudes, most birds emigrate in time to avoid its rigors; those that stay can rely on their feather-coats; natural selection has adapted their utmost power of endurance to the possible extremes of the atmospheric vicissitudes. The sexual instinct of wild animals is limited to certain seasons and months that preclude the possibility of their young being born at any but the most favorable time of the year. From birth to death the children of Nature can trust themselves to the guidance of their hereditary inclinations; all the contingencies of their simple lives have been amply provided for.

These provisions do not apply exclusively to a state of affairs which the agency of man has in so many ways modified or even reversed; still, it would seem as if Nature had failed to make adequate allowance for the possibility of certain perils incident to our artificial mode of life. This fact is perhaps most strikingly illustrated by the treacherous *non-repulsiveness* of certain mineral poisons. The offensive taste of poisonous plants seems to be proportioned to the degree of their noxiousness; hemlock, strychnine, and opium are forbiddingly

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nauseous, even in the smallest quantities. A drop of prussic acid fills a whole room with its bitter aroma. But arsenious acid is tasteless and odorless, and so unsuspicious to the most wary animals that its name has become a synonym of ratsbane. The reason is apparently this: that Providence (*or* "natural selection") has endowed animals with a protective antipathy against all poisons they could possibly mistake for comestibles, but not against such *out-of-the-way* things as arsenic or sugar of lead, nor against the mixtures by which the art of man has disguised the taste of naturally unpalatable substances. Coffee, without sugar and milk, "straight and strong," as the Turks drink it, would hardly tempt a Christian schoolboy; mixed, it can be made seductive enough to deceive even the *ex-officio* opponents of the stimulant-habit. In such commixtures as milk-punch, beer-soup, "Scutari sherbet," the taste—though not the effect—of alcohol almost disappears; the Algeria trappers catch monkeys with a *mélange* of rum and manna-sirup. A famous cook of the "Frères Provençeaux" used to boast his ability of compounding delightful ragouts from meat in *any* state of decomposition. Early habits and the influence of evil examples also tend to corrupt the integrity of that physical conscience whose arbitrations form the health-code of our dumb fellow-creatures. In large cities the panders of vice vie in the art of making their poisons attractive, and, where such dangers can not be avoided, it is always the safest plan to meet and master them in time.

Early impressions are very enduring, and can make useful habits as well as evil ones a sort of second nature. In order to forestall the chief danger of in-door life, make your children love-sick after fresh air; make them associate the idea of fusty rooms with prison-life, punishment, and sickness. Open a window whenever they complain of headache or nausea; promise them a woodland excursion as a reward of exceptionally good behavior. Save your best sweetmeats for out-door festivals. By the witchery of associated ideas a boy can come to regard the lonely shade-tree as a primary requisite to the enjoyment of a good story-book. "*Or, mes pensées ne veulent jamais aller qu' avec mes jambes,*" says Rousseau ("Only the movement of my feet seems to set my brains a-going"), and it is just as easy to think, debate, rehearse, etc., walking as sitting; the peripatetic philosophers derived their name from their pedestrian proclivities, and the Stoic sect from their master's predilection for an open porch. Children who have been brought up in hygienic homes not rarely "feel as if they were going to be choked" in unventilated rooms, and I would take good care not to cure them of such salutary idiosyncrasies.

Every observant teacher must have noticed the innate hardiness of young boys, their unaffected indifference to wind and weather. They seem to take a delight in braving the extremes of temperature, and, by simply indulging this *penchant* of theirs, children can be made weather-proof to an almost unlimited degree; and in nothing else can

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they be more safely trusted to the guidance of their protective instincts. Don't be afraid that an active boy will hurt himself by voluntary exposure, unless his chances for out-door play are so rare as to tempt him to abuse the first opportunity. Weather-proof people are almost sickness-proof; a merry hunting-excursion to the snow-clad highlands will rarely fail to counteract the consequences of repeated surfeits; even girls who have learned to brave the winter storms of our Northwestern prairies will afterward laugh at "draughts" and "raw March winds." Winter is the season of lung-affections, the larger part of them induced by long confinement in a vitiated atmosphere; the part caused by light winter clothes is smaller than most people imagine. I have weathered a good many winters without fur caps and woolen shawls, and I ascribe my immunity to the circumstance that my guardian made it a rule never to force us to wear such things. The Moslems rarely eat before they have washed their hands, and a rather unscrupulous frontier Turk assured me that in his case the practice had nothing to do with superstition; it had become a physiological habit, whose omission, he had found, would produce a fit of very realistic nausea. In the same way more comprehensive ablutions may become a physiological necessity: there are people who owe their sound sleep and other sound things to their inability to go to bed without a sponge-bath. The habit can be formed in one summer.

The dietetic instincts of a rationally educated person should obviate the necessity of special precautions, but in large cities, where temptations walk in disguise, the welfare of inexperienced children may require additional safeguards. In the first chapter of this series I have enumerated the chief arguments of the vegetarian school. Among the incidental advantages of their system it might be mentioned that a purely vegetable diet is the most effectual precaution against a danger which only in one of its exceptional forms was lately brought home to us by the trichina panic. Flesh-eaters always run a risk of inoculating themselves with the germs of the various diseases which both beef- and man-flesh is heir to, consumption especially, and several disorders arising from the corruption of the humors, by the use of decayed or fermented food. Sausage-makers, like trance-mediums, never divulge their trade-secrets, but it is a suggestive fact that, in the Anglo-German cities of this continent, the scrofulous and decrepit old females of the bovine race are known by the name of Bologna cows. Abstinence from *Wurst*, boarding-house hash, and mince-pies, may diminish the danger, but abstinence from all animal food is the safer plan and the easier one. If children were restricted to a vegetable or semi-animal diet (milk, eggs, etc.), I doubt if many of them would afterward choose to overcome that instinctive repugnance to flesh-food expressed in the original meaning of the word *frugality*. The Romans of the Cincinnatian era, though entirely free from Buddhistic scruples, seem

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to have eschewed animal food for sanitary reasons. Children with a phthisical taint are certainly better off without it. Give them eggs and all the available vegetable fat they can digest, but no flesh nor milk of anyways doubtful origin. Two or three families of moderate means might rent a bit of pasture-land, and divide the milk of a healthy country cow. The sanitary condition of a single animal could be ascertained by any competent farrier, but the control of a wholesale meat-market will always be more or less perfunctory.

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Principiis obsta is probably the wisest maxim ever expressed in two words, and I believe that the poison-problem will be ultimately solved on that principle. The work of reform must begin in the nursery; and, under circumstances where we can not keep temptations from our door, we must make our children temptation-proof, inspire them with an indelible abhorrence of drunkenness and poison-slavery of every kind.

"I still find the Laconic method the shortest," writes a friend of mine, alluding to the Spartan plan of warning boys by the example of a drunken Helot. He used to interest his boy in the *modus operandi* of alcohol, opium, etc., and then take him out, and, under some pretext or other, drop into a slum-saloon on Saturday night, or a police-court on Monday morning, to give him a practical illustration of his theory. Whenever they saw the poison displayed in an attractive form, on ornamental sign-boards or in the gorgeous bottles of druggists and hotel-keepers, they would study the well-baited trap with a peculiar interest, and go their way rejoicing, as in the possession of an invaluable secret. The result was that the boy became "aggressively virtuous," and used to button-hole visitors in order to lecture them on the causes and consequences of the popular delusion.

Even city boys do not often contract the nicotine habit till after their twelfth year, and a fit of tobacco-nausea before that time generally induces a forbidding reaction not easy to outgrow. I remember the case of a brutal tavern-keeper who tried to accustom his son to the fumes of Alsatian leaf-tobacco (*vulgo Stinkewitz*), and the unexpected result of his last experiment. He took the lad on a stage-coach trip from Colmar to Metz, and induced the postillion to take in a few extra passengers, whom he treated to clay pipes and Stinkewitz. He then closed the windows, and in less than twenty minutes his son turned deadly pale, and would have fainted if he had not found relief in a violent fit of retching. If he had loathed Stinkewitz before, he now dreaded it, and six years after, when he was apprenticed to a tanner, he surprised his master by asking, as for a special favor, that they would not force him to smoke leaf-tobacco. Frederick the Great, too, ascribed his abhorrence of the weed to the choking tobacco-fumes of the Wusterhauser club-room, where the boon companions of his awful parent used to indulge from 5 to 12 P. M. It is not necessary to suffocate a child with nicotine-fumes, but it can do no harm to take him

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once in a while to a smoker's den, to sniff the "pestilent and penal fires," and let him glory in his blest exemption.

Coffee and tea temptations, pungent spices, etc., may be forestalled in the same way; much is gained if the dietetic innocence of a child has been preserved to the end of the fourteenth year, the age when routine habits first become physiologically confirmed. The habits of the last years of growth become ingrained, as it were, with the constitution of the body, and will bias the physical inclinations of all after-years; circumstances may oblige a man to conform to the customs of a foreign country, the rules of a regimental mess, etc., but, upon the first opportunity of regulating his own regimen, the habits of his boyhood will reassert themselves, even in regard to the time and number of his daily meals. I know from personal experience the unspeakable advantage of having a constitutional predilection for postponing the principal meal till the day's work is done. It was the plan of the ancient Greeks, and to their followers every day is its own reward—the symposium, and the long, undisturbed *siesta* a daily festival. It almost doubles a man's working capacity, by saving him the dire daily struggle between duty and the after-dinner drowsiness. Children who have tried the two methods will rarely hesitate in their choice. Give them a lunch at twelve o'clock, and for breakfast a crust of sweet bran-bread, the coarser the better. A hard crust is the best possible dentifrice. I never could get myself to believe in the natural necessity of a tooth-brush. The African nations, the Hindoos, the natives of Southern Europe, the South-Sea Islanders, the Arabs, the South American vegetarians, in short, three fourths of our fellow-men, besides our next relatives, the frugivorous animals, have splendid teeth without sozodont. I really believe that ours decay from sheer disuse; the boarding-house *homo* lives chiefly on pap—wants all his meats soft-boiled, and growls at cold biscuit or an underdone potato; in other words, he delegates to the cook the proper functions of his teeth. We hear occasionally of old men getting a second, or rather third, set of teeth. I met one of them in northern Guatemala, and ascertained that he had become toothless during a twelve years' sojourn in a seaport town, and that he got his new set upon his return to his native village, where circumstances obliged him to resume the hard corn-cake diet of his boyhood years. His teeth had reappeared, as soon as their services were called for, and would probably never have absented themselves if a pap-diet had not made them superfluous. An artificial dentifrice will certainly keep the teeth white, but that does not prevent their premature decay; disuse gradually softens their substance, till one fine day the hash-eater snaps his best incisor upon an unexpected piece of bone. Every old dentist knows hundreds of city customers whom the daily use of a tooth-brush did not save from the necessity of applying, before the end of the fortieth year, for a complete "celluloid set." I do not say that a soft tooth-brush and such dentifrices

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as oatmeal or burned arrow-root can do any harm, but, for sanitary purposes, such precautions must be supplemented by *dental exercise*. Let a child invigorate its teeth by chewing a hard crust, or, better yet, a handful of "St. John's bread" or carob-beans, the edible pod of the *Mimosa siliqua*. Children and whole tribes of the northern races seem to feel an instinctive desire to exercise their teeth upon some solid substance, as pet squirrels will gnaw the furniture if you give them nut-kernels instead of nuts. Thus Kohl tells us that the natives of southern Russia are addicted to the practice of chewing a vegetable product which he at first supposed to be pumpkin or melon seeds, but found to be the much harder seed of the Turkish sunflower (*Helianthus perennis*). Their national diet consists of milk, *kukuruz* (hominy, with butter, etc.), and boiled mutton, and they seem to feel that their Turkoman jaws need something more substantial. The schoolboy habit of gnawing pen-holders, finger-nails, etc., may have a similar significance. The *Mimosa siliqua* would yield abundantly in our Southern States, and its sweet pods would make an excellent substitute for chewing-gum. Our practice of sipping ice-cold and steaming-hot drinks, turn about, has also a very injurious effect upon the brittle substance that forms the enamel of our teeth; no porcelain-glaze would stand such abuse for any length of time, and experience has taught hunters and dog-fanciers that it destroys even the bone-crushing fangs of the animal from which our canine teeth derive their name.

Various diseases of the eye, including myopia, strumous and catarrhal ophthalmia, are due to a scrofulous diathesis, and sometimes to a general debility, and can be radically cured only by out-door exercise and a more nutritious diet. But a transient "weak-sightedness" (*Schwach-sichtigkeit*, as the Germans call it), is eminently a disease of the school-room, caused by a persistent abuse of the eyes, poring for hours together over a spelling-book or writing by the light of a flickering candle (much worse than twilight), as well as by the wretched print of our modern dictionaries and cheap cyclopædias. It should be kept in mind that reading and writing, even under the most favorable circumstances, require an effort to which the eye can only very gradually accustom itself. Hereditary influences and the preliminary exercises of the infant's eye, as, in examining picture-books, the first graphic essays with a slate-plencil, etc., may help to smooth the difficulty; for it is a fact, attested by the experience of all school-teaching missionaries, that the eyes of an adult, sharp-sighted savage begin to smart and water at the first attempt to decipher the hieroglyphics of his primer. The rudiments ought to be taught in half-hour lessons, with liberal intervals of rest and out-door play; and scrofulous children should never be sent to a public school till after a novitiate of at least six months of home studies. Instruct them never to pore over a book, but to keep the head erect, and, at the first symptoms of dim-sighted-

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ness, to let the eyes rest upon some distant object, till the optic nerve has recovered from the short-range strain. The hues of the forest have a wonderfully strengthening influence upon weak eyes, almost like its air upon weak lungs; a woodland excursion is like a return to our native element, the birth-land to whose life-conditions the organs of our ancestors were originally adapted.

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Accidents can not be avoided by keeping a boy in his nurse's arms or in a padded family coach. Sooner or later he will have to rely on his own limbs, and it is best that time should find him well prepared. Let him rough it, barefoot and bareheaded; let him climb hills and take short cuts over fences and ravines; every fall, every skinned elbow and bumped head, will impart a lesson in the art of locomotion. Without apprentice-fees of that sort he will never get to be a master. I would even connive at an occasional rough-and-tumble fight with a wild comrade; it will acquaint him with what Talleyrand used to call the "esoteric reason for preserving the peace." Constructiveness, too, often the redeeming propensity of a young scapegrace, has its dangers which had better be mastered than avoided. Instead of lecturing a lad or taking away his pocket-knife for cutting his finger, engage a carpenter to teach him the proper use of edge-tools. Let him have a little workshop of his own, with a lot of scrap-tin, boards, nails, and a five-dollar tool-box. Ten to one that those five dollars will save ten cents a week for dime-novels, and, by-and-by, ten dollars a month for beer and tobacco. If your son should manifest symptoms of the collecting-mania, try to direct it to objects of natural history—herbs, beetles, or butterflies. It may lead to deeper studies, and the love of nature in general. A passion for the study of natural history has often turned the scales in a choice between a farm and a dry-goods prison.

"On a visit to Paris," says Carl Weber ("Democritos," vol. ix, p. 166), "the Mentor of a young man, after a trip to the Jardin des Plantes, should not fail to take him to Bertrand Rival's Anatomical Waxwork Museum. It is no misnomer if Bertrand calls his collection '*Musée physiologique, historique et morale*'—intended not only to instruct but to warn the visitor. *Salus tota illa sapere est.*" As a last resort, perhaps, but hardly before the twentieth year. Precocious prurience is due to causes which can generally be avoided. If you can educate the younger children at home and select their playmates, there is no real danger before the eleventh year of a boy and the ninth of a girl. After that, the following precautions will suffice in all but the unluckiest cases: Let your children have plenty of out-door play, especially in the evening. Wait till they are really sleepy before you send them to bed. Let every child have its own bed, or at least its own bedclothes. Keep your small boys out of the servants' room, and your girls after their tenth year; with girls under ten there is less danger: they are quite sure to tell about any improper thing they see

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or hear, and the servants seem to know that instinctively. Do not leave them alone with elder children—not even with their own neighbors' and relatives'—till you have satisfied yourself about the character of their new friends. No need of a phrenologist to settle that point: the indications of a child's propensities are not confined to the cranium. Vary the child's diet with the season; put the flesh-pots aside when the approach of the summer solstice threatens the land with the temperatures and temptations of southern Italy. Let them avoid all greasy-made dishes when it is too warm to take much out-door exercise. And, if possible, cultivate their literary taste to the degree that enables them to appreciate the wit or the common-sense of an author, as well as his imagination, and consequently to loathe unmitigated absurdities. That alone will be an effectual safeguard against ninety-nine dime-novels out of a hundred.

In conclusion, I will add a short miscellany of hygienic rules and aphorisms.

The first thing a child should learn is to ask for a drink of water. I have seen hand-fed children scream and fidget for hours together, as if troubled by some unsatisfied want, but at the same time rejecting the milk-bottle and pap-dish with growing impatience. In nine such cases out of ten the nurse will either resort to paregoric or try the effect of a lullaby. I need not say that the poison-expedient would be wrong under all circumstances, but, before you try anything else, offer the child a cup of cold water. To a young nursling the mother's breast supplies both food and drink, but farinaceous paps require a better diluent than milk.

If I should name the greatest danger of childhood, I would unhesitatingly say, Medicine. A drastic drug as a remedial agent is Beelzebub in the *rôle* of an exorcist.

Our nursery system, after all reforms, is still far from being the right one—how far, we may infer from the fact that we have not yet learned to make our babies behave as well as young animals.

Tight-swaddling, strait-jacket gowns, and trailing petticoats—restraint, in short, makes our infants so peevish. If we would give them a chance to use their limbs they would have no time to scream.

It would prevent innumerable diseases if people would learn to distinguish a morbid appetency from a healthy appetite. One diagnostic rule is this, that the gratification of the latter is not followed by repentance; another, that the former has to be artificially and painfully acquired: our better nature resists the incipience of a morbid "second nature." After acquitting Nature from all responsibility for such factitious appetites, it may be justly said that a man can find a road to health and happiness by simply following his instincts.

The supposed danger of cold drinks on a hot day is a very expensive superstition. It deprives thousands of people of the most pleasurable sensation the human palate is capable of. It is worth a two hours'

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anabasis in the dog-days to drink your fill at the coldest rock-spring of the mountains.

Bathing in flannel!—I would as soon take ice-cream in capsules. The price of the flannel suit would buy you a season-ticket to a lonely beach.

A disposition to excessive perspiration is often due to general debility, but there is a specific remedy for it. Fill your knapsack with substantials and take a pedestrian trip in midsummer, up-hill, if possible, and without loitering under the shade-trees; in short, give your body something worth perspiring for. After that it will be less lavish of gratuitous performances of that sort. The soldiers of the Legion Étrangère are mostly northmen—Poles, Belgians, and Russians—but upon their return from a year's service in Algiers it takes a long double-quick under a Mediterranean sun to drill them into a sweat.

"A catarrh is the beginning of a lung-disease." It would be the end of it if we did not aggravate it with nostrums and fusty sick-rooms.

Somehow or other we must have abused our teeth shamefully before Nature had to resort to such a veto as toothache.

A tooth pulled in time saves nine.

"If you doubt whether a contemplated act is right or wrong," says Zoroaster, "it is the safest plan to omit it." Let dyspeptics remember that when they hesitate at the brink of another plateful.

The digestion of superfluous food almost monopolizes the vital energy; hence the mental and physical indolence of great eaters. Strong-headed business-men manage to conquer that indolence, but only by an effort that would have made the fortune of a temperate eater.

A glutton will find it easier to reduce the number of his meals than the number of his dishes.

Highland children are the healthiest, and, even starving, the happiest. "There is no joy the town can give like those it takes away."

Paracelsus informs us that the composition of his "triple panacea" can be described only in the language of alchemistic adepts. Nature's triple panacea is less indescribable—fasting, fresh air, and exercise.

A banquet without fruit is a garden without flowers.

The best stuff for summer-wear: one stratum of the lightest mosquito-proof linen.

"Do animals ever go to the gymnasium?" asks an opponent of the movement cure. Never: they have no time—they are too busy practicing gymnastics out-doors.

Descent from a long-lived race is not always a guarantee of longevity. A far more important point is the sanitary condition of the parents at the birth of the child. Pluck, however, is hereditary, and has certainly a prophylactic, a "health-compelling" influence.

The first gray hairs are generally a sign of *dear-bought* wisdom.

The "breaking-up" of a pulmonary disease could often be accomplished by breaking the bedroom-windows.

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Death, formerly the end of health, is nowadays the end of a disease.

Dying a natural death is one of the lost arts.

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There seems to be a strange *fatum* in the association of astronomy with humbug: formerly in horoscopes, and now in patent-medicine almanacs.

A patent-medicine man is generally the patentee of a device for selling whisky under a new name.

A "chronic disease," properly speaking, is nothing but Nature's protest against a chronic provocation. To say that chronic complaints end only with death, means, in fact, that there is generally no other cure for our vices.

Every night labors to undo the physiological mischief of the preceding day—at what expense, gluttons may compute if they compare the golden dreams of their childhood with the leaden torpor-slumbers of their pork and lager-beer years.

If it were not for calorific food and superfluous garments, midsummer would be the most pleasant time of the year.

A HALF-CENTURY OF SCIENCE.*

By Sir JOHN LUBBOCK.

I.

IN the name of the British Association, which for the time I very unworthily represent, I beg to tender to you, my Lord Mayor, and through you to the city of York, our cordial thanks for your hospitable invitation and hearty welcome. We feel, indeed, that in coming to York we were coming home: gratefully as we acknowledge and much as we appreciate the kindness we have experienced elsewhere, and the friendly relations which exist between this Association and most—I might even say all—our great cities, yet Sir R. Murchison truly observed, at the close of our first meeting in 1831, that to York, "as the cradle of the Association, we shall ever look back with gratitude; and whether we meet hereafter on the banks of the Isis, the Cam, or the Forth, to this spot we shall still fondly revert." Indeed, it would have been a matter of much regret to all of us if we had not been able on this, our fiftieth anniversary, to hold our meeting in our mother city.

My Lord Mayor, before going further, I must express my regret, especially when I call to mind the illustrious men who have preceded

* Presidential address before the York Meeting of the British Association for the Advancement of Science.

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me in this chair, that it has not fallen to one of my eminent friends around me to preside on this auspicious occasion. Conscious, however, as I am of my own deficiencies, I feel that I must not waste time in dwelling on them, more especially as in doing so I should but give them greater prominence. I will, therefore, only make one earnest appeal to your kind indulgence.

The connection of the British Association with the city of York does not depend merely on the fact that our first meeting was held here. It originated in a letter addressed by Sir D. Brewster to Professor Phillips, as Secretary to your York Philosophical Society, by whom the idea was warmly taken up. The first meeting was held on September 26, 1831, the chair being taken by Lord Milton, who delivered an address, after which Mr. William Vernon Harcourt, chairman of the Committee of Management, submitted to the meeting a code of rules which had been so maturely considered and so wisely framed, that they have remained substantially the same down to the present day. The constitution and objects of the Association were so ably described by Mr. Spottiswoode, at Dublin, and are so well known to you, that I will not dwell on them this evening. The excellent President of the Royal Society, in the same address, suggested that the past history of the Association would form an appropriate theme for the present meeting. The history of the Association, however, is really the history of science, and I long shrank from the attempt to give even a panoramic survey of a subject so vast and so difficult; nor should I have ventured to make any such attempt, but that I knew I could rely on the assistance of friends in every department of science.

Certainly, however, this is an opportunity on which it may be well for us to consider what have been the principal scientific results of the last half-century, dwelling especially on those with which this Association is more directly concerned, either as being the work of our own members or as having been made known at our meetings. It is, of course, impossible within the limits of a single address to do more than allude to a few of these, and that very briefly. In dealing with so large a subject, I first hoped that I might take our annual volumes as a text-book. This, however, I at once found to be quite impossible. For instance, the first volume commences with a Report on Astronomy by Sir G. Airy; I may be pardoned, I trust, for expressing my pleasure at finding that the second was one by my father, on the Tides, prepared, like the preceding, at the request of the council; then comes one on Meteorology by Forbes; Radiant Heat by Baden Powell; Optics by Brewster; Mineralogy by Whewell, and so on. My best course will therefore be to take our different sections one by one, and endeavor to bring before you a few of the principal results which have been obtained in each department.

The Biological Section is that with which I have been most intimately associated, and with which it is, perhaps, natural that I should

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begin. Fifty years ago it was the general opinion that animals and plants came into existence just as we now see them. We took pleasure in their beauty; their adaptation to their habits and mode of life in many cases could not be overlooked or misunderstood. Nevertheless, the book of Nature was like some richly illuminated missal, written in an unknown tongue; the graceful forms of the letters, the beauty of the coloring, excited our wonder and admiration; but of the true meaning little was known to us; indeed, we scarcely realized that there was any meaning to decipher. Now glimpses of the truth are gradually revealing themselves; we perceive that there is a reason —and in many cases we know what that reason is—for every difference in form, in size, and in color; for every bone and every feather, almost for every hair. Moreover, each problem which is solved opens out vistas, as it were, of others perhaps even more interesting. With this great change the name of our illustrious countryman, Darwin, is intimately associated, and the year 1859 will always be memorable in science as having produced his great work on "The Origin of Species." In the previous year he and Wallace had published short papers, in which they clearly state the theory of natural selection, at which they had simultaneously and independently arrived. We can not wonder that Darwin's views should have at first excited great opposition. Nevertheless, from the first they met with powerful support, especially in this country, from Hooker, Huxley, and Herbert Spencer. The theory is based on four axioms:

"1. That no two animals or plants in nature are identical in all respects. 2. That the offspring tend to inherit the peculiarities of their parents. 3. That of those which come into existence, only a small number reach maturity. 4. That those which are, on the whole, best adapted to the circumstances in which they are placed are most likely to leave descendants."

Darwin commenced his work by discussing the causes and extent of variability in animals, and the origin of domestic varieties; he showed the impossibility of distinguishing between varieties and species, and pointed out the wide differences which man has produced in some cases—as, for instance, in our domestic pigeons, all unquestionably descended from a common stock. He dwelt on the struggle for existence (which has since become a household word), and which, inevitably resulting in the survival of the fittest, tends gradually to adapt any race of animals to the conditions in which it occurs. While thus, however, showing the great importance of natural selection, he attributed to it no exclusive influence, but fully admitted that other causes—the use and disuse of organs, sexual selection, etc.—had to be taken into consideration. Passing on to the difficulties of his theory, he accounted for the absence of intermediate varieties between species, to a great extent, by the imperfection of the geological record. But, if the geological record be imperfect, it is still very instructive. The

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further paleontology has progressed, the more it has tended to fill up the gaps between existing groups and species; while the careful study of living forms has brought into prominence the variations dependent on food, climate, habitat, and other conditions, and shown that many species, long supposed to be absolutely distinct, are so closely linked together by intermediate forms that it is difficult to draw a satisfactory line between them.

The principles of classification point also in the same direction, and are based more and more on the theory of descent. Biologists endeavor to arrange animals on what is called the "natural system." No one now places whales among fish, bats among birds, or shrews with mice, notwithstanding their external similarity; and Darwin maintained that "community of descent was the hidden bond which naturalists had been unconsciously seeking." How else, indeed, can we explain the fact that the framework of bones is so similar in the arm of a man, the wing of a bat, the foreleg of a horse, and the fin of a porpoise—that the neck of a giraffe and that of an elephant contain the same number of vertebræ?

Strong evidence is, moreover, afforded by embryology; by the presence of rudimentary organs and transient characters, as, for instance, the existence in the calf of certain teeth which never cut the gums, the shriveled and useless wings of some beetles, the presence of a series of arteries in the embryos of the higher vertebrata exactly similar to those which supply the gills in fishes, even the spots on the young blackbird, the stripes on the lion's cub; these, and innumerable other facts of the same character, appear to be incompatible with the idea that each species was specially and independently created; and to prove, on the contrary, that the embryonic stages of species show us more or less clearly the structure of their ancestors.

Darwin's views, however, are still much misunderstood. I believe there are thousands who consider that according to his theory a sheep might turn into a cow, or a zebra into a horse. No one would more confidently withstand any such hypothesis, his view being, of course, not that the one could be changed into the other, but that both are descended from a common ancestor. No one, at any rate, will question the immense impulse which Darwin has given to the study of natural history, the number of new views he has opened up, and the additional interest which he has aroused in, and contributed to, biology. When we were young, we knew that the leopard had spots, the tiger was striped, and the lion tawny; but why this was so it did not occur to us to ask; [and, if we had asked], no one would have answered. Now we see at a glance that the stripes of the tiger have reference to its life among jungle-grasses; the lion is sandy, like the desert; while the markings of the leopard resemble spots of sunshine glancing through the leaves.

The science of embryology may almost be said to have been cre-

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ated in the last half-century. Fifty years ago it was a very general opinion that animals which are unlike when mature were dissimilar from the beginning. It is to Von Baer, the discoverer of the mammalian ovum, that we owe the great generalization that the development of the egg is in the main a progress from the general to the special; in fact, that embryology is the key to the laws of animal development. Thus the young of existing species resemble in many cases the mature forms which flourished in ancient times. Huxley has traced up the genealogy of the horse to the Miocene Anchitherium. In the same way Gaudry has called attention to the fact that, just as the individual stag gradually acquires more and more complex antlers—having at first only a single prong, in the next year two points, in the following three, and so on—so the genus, as a whole, in Middle Miocene times had two pronged horns; in the Upper Miocene, three; and that it is not till the Upper Pliocene that we find any species with the magnificent antlers of our modern deer. It seems to be now generally admitted that birds have come down to us through the Dinosaurians, and, as Huxley has shown, the profound break once supposed to exist between birds and reptiles has been bridged over by the discovery of reptilian birds and bird-like reptiles; so that, in fact, birds are modified reptiles. Again, the remarkable genus *Peripatus*, so well studied by Moseley, tends to connect the annulose and articulate types.

Again, the structural resemblances between Amphioxus and the Ascidians had been pointed out by Goodsir; and Kowalevsky in 1866 showed that these were not mere analogies, but indicated a real affinity. These observations, in the words of Allen Thomson, "have produced a change little short of revolutionary in embryological and zoölogical views, leading as they do to the support of the hypothesis that the Ascidian is an earlier stage in the phylogenetic history of the mammal and other vertebrates."

The larval forms which occur in so many groups, and of which the insects afford us the most familiar examples, are, in the words of Quatrefages, embryos, which lead an independent life. In such cases as these, external conditions act upon the larvæ as they do upon the mature form; hence we have two classes of changes, adaptational or adaptive, and developmental. These and many other facts must be taken into consideration; nevertheless, naturalists are now generally agreed that embryological characters are of high value as guides in classification, and it may, I think, be regarded as well established that, just as the contents and sequence of rocks teach us the past history of the earth, so is the gradual development of the species indicated by the structure of the embryo and its developmental changes. When the supporters of Darwin are told that his theory is incredible, they may fairly ask why it is impossible that a species in the course of hundreds of thousands of years should have passed through changes which occupy only a few days or weeks in the life-history of each individual.

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The phenomena of yolk-segmentation, first observed by Prevost and Dumas, are now known to be in some form or other invariably the precursors of embryonic development; while they reproduce, as the first stages in the formation of the higher animals, the main and essential features in the life-history of the lowest forms. The "blastoderm," as it is called, or first germ of the embryo in the egg, divides itself into two layers, corresponding, as Huxley has shown, to the two layers into which the body of the *Cœlenterata* may be divided. Not only so, but most embryos at an early stage of development have the form of a cup, the walls of which are formed by the two layers of the blastoderm. Kowalevsky was the first to show the prevalence of this embryonic form, and subsequently Lankester and Haeckel put forward the hypothesis that it was the embryonic repetition of an ancestral type, from which all the higher forms are descended. The cavity of the cup is supposed to be the stomach of this simple organism, and the opening of the cup the mouth. The inner layer of the wall of the cup constitutes the digestive membrane, and the outer the skin. To this form Haeckel gave the name *Gastræa*. It is perhaps doubtful whether the theory of Lancaster and Haeckel can be accepted in precisely the form they propounded it; but it has had an important influence on the progress of embryology. I can not quit the science of embryology without alluding to the very admirable work on "Comparative Embryology" by our new general secretary, Mr. Balfour, and also the "Elements of Embryology" which he had previously published in conjunction with Dr. M. Foster.

In 1842 Steenstrup published his celebrated work on the "Alternation of Generations," in which he showed that many species are represented by two perfectly distinct types or broods, differing in form, structure, and habits; that in one of them males are entirely wanting, and that the reproduction is effected by fission, or by buds, which, however, are in some cases structurally indistinguishable from eggs. Steenstrup's illustrations were mainly taken from marine or parasitic species, of very great interest, but not generally familiar, excepting to naturalists. It has since been shown that the common *Cynips*, or gall-fly, is also a case in point. It had long been known that in some genera belonging to this group males are entirely wanting, and it has now been shown by Bassett, and more thoroughly by Adler, that some of these species are double-brooded; the two broods having been considered as distinct genera. Thus, an insect known as *Neuroterus lenticularis*, of which females only occur, produces the familiar oak-spangles so common on the under sides of oak-leaves, from which emerge, not *Neuroterus lenticularis*, but an insect hitherto considered as a distinct species, belonging even to a different genus (*Spathegaster baccarum*). In Spathegaster both sexes occur; they produce the currant-like galls found on oaks, and from these galls Neuroterus is again developed. So also the King Charles oak-apples produce a species known as *Teras terminalis*,

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which descends to the ground, and makes small galls on the roots of the oak. From these emerge an insect known as *Biorhiza aptera*, which again gives rise to the common oak-apple.

It might seem that such inquiries as these could hardly have any practical bearing. Yet it is not improbable that they may lead to very important results. For instance, it would appear that the fluke which produces the rot in sheep, passes one phase of its existence in the black slug; and we are not without hopes that the researches, in which our lamented friend Professor Rolleston was engaged at the time of his death, which we all so much deplore, will lead, if not to the extirpation, at any rate to the diminution, of a pest from which our farmers have so grievously suffered.

It was in the year 1839 that Schwann and Schleiden demonstrated the intimate relation in which animals and plants stand to each other, by showing the identity of the laws of development of the elementary parts in the two kingdoms of organic nature.

As regards descriptive biology, by far the greater number of species now recorded have been named and described within the last half-century. Dr. Günther has been good enough to make a calculation for me. The numbers, of course, are only approximate, but it appears that, while the total number of animals described up to 1831 was not more than 70,000, the number now is at least 320,000.

Lastly, to show how large a field still remains for exploration, I may add that Mr. Waterhouse estimates that the British Museum alone contains not fewer than 12,000 species of insects which have not yet been described, while our collections do not probably contain anything like one half of those actually in existence. Further than this, the anatomy and habits even of those which have been described offer an inexhaustible field for research, and it is not going too far to say that there is not a single species which would not amply repay the devotion of a lifetime.

One remarkable feature in the modern progress of biological science has been the application of improved methods of observation and experiment, and the employment in physiological research of the exact measurements employed by the experimental physicist. Our microscopes have been greatly improved. The use of chemical reagents in microscopical investigations has proved most instructive, and another very important method of investigation has been the power of obtaining very thin slices by imbedding the object to be examined in paraffine or some other soft substance. In this manner we can now obtain, say, fifty separate sections of the egg of a beetle or the brain of a bee.

At the close of the last century Sprengel published a most suggestive work on flowers, in which he pointed out the curious relation existing between these and insects, and showed that the latter carry the pollen from flower to flower. His observations, however, attracted little notice until Darwin called attention to the subject in 1862. It

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had long been known that the cowslip and primrose exist under two forms, about equally numerous, and differing from one another in the arrangements of their stamens and pistils; the one form having the stamens on the summit of the flower and the stigma half-way down, while in the other the relative positions are reversed, the stigma being at the summit of the tube and the stamens half-way down. This difference had, however, been regarded as a case of mere variability; but Darwin showed it to be a beautiful provision, the result of which is that insects fertilize each flower with pollen brought from a different plant; and he proved that flowers fertilized with pollen from the other form yield more seed than if fertilized with pollen of the same form, even if taken from a different plant.

Attention having been thus directed to the question, an astonishing variety of most beautiful contrivances has been observed and described by many botanists, especially Hooker, Axel, Delpino, Hildebrand, Bennett, Fritz Müller, and, above all, Hermann Müller and Darwin himself. The general result is that to insects, and especially to bees, we owe the beauty of our gardens, the sweetness of our fields. To their beneficent though unconscious action flowers owe their scent and color, their honey—nay, in many cases, even their form. Their present shape and varied arrangements, their brilliant colors, their honey, and their sweet scent are all due to the selection exercised by insects. In these cases the relation between plants and insects is one of mutual advantage. In many species, however, plants present us with complex arrangements adapted to protect them from insects; such, for instance, are in many cases the resinous glands which render leaves unpalatable; the thickets of hairs and other precautions which prevent flowers from being robbed of their honey by ants. Again, more than a century ago our countryman, Ellis, described an American plant, *Dionœa*, in which the leaves are somewhat concave, with long lateral spines and a joint in the middle; close up with a jerk like a rat-trap the moment any unwary insect alights on them. The plant, in fact, actually captures and devours insects. This observation also remained as an isolated fact until within the last few years, when Darwin, Hooker, and others have shown that many other species have curious and very varied contrivances for supplying themselves with animal food.

Some of the most fascinating branches of botany—morphology, histology, and physiology—scarcely existed before 1830. In the two former branches the discoveries of Von Mohl are preëminent. He first observed cell-division in 1835, and detected the presence of starch in chlorophyl-corpuscles in 1837, while he first described protoplasm, now so familiar to us, at least by name, in 1846. In the same year Amici discovered the existence of the embryonic vesicle in the embryo sac, which develops into the embryo when fertilized by the entrance of the pollen-tube into the micropyle. The existence of sexual repro-

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duction in the lower plants was doubtful, or at least doubted by some eminent authorities, as recently as 1853, when the actual process of fertilization in the common bladderwrack of our shores was observed by Thuret, while the reproduction of the larger fungi was first worked out by De Bary in 1863.

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As regards lichens, Schwendener proposed, in 1869, the startling theory, now, however, accepted by some of the highest authorities, that lichens are not autonomous organisms, but commensal associations of a fungus parasitic on an alga. With reference to the higher cryptogams it is hardly too much to say that the whole of our exact knowledge of their life-history has been obtained during the last half-century. Thus, in the case of ferns, the male organs, or antheridia, were first discovered by Nägeli in 1844, and the archegonia, or female organs, by Suminski in 1848. The early stages in the development of mosses were worked out by Valentine in 1833. Lastly, the principle of alternation of generations in plants was discovered by Hofmeister. This eminent naturalist also, in 1851–'54, pointed out the homologies of the reproductive processes in mosses, vascular cryptogams, gymnosperms, and angiosperms.

Nothing could have appeared less likely than that researches into the theory of spontaneous generation should have led to practical improvements in medical science. Yet such has been the case. Only a few years ago bacteria seemed mere scientific curiosities. It had long been known that an infusion—say, of hay—would, if exposed to the atmosphere, be found, after a certain time, to teem with living forms. Even those few who still believe that life would be spontaneously generated in such an infusion, will admit that these minute organisms are, if not entirely, yet mainly, derived from germs floating in our atmosphere; and, if precautions are taken to exclude such germs, as in the careful experiments especially of Pasteur, Tyndall, and Roberts, every one will grant that in ninety-nine cases out of a hundred no such development of life will take place. These facts have led to most important results in surgery. One reason why compound fractures are so dangerous, is because, the skin being broken, the air obtains access to the wound, bringing with it innumerable germs, which too often set up putrefying action. Lister first made a practical application of these observations. He set himself to find some substance capable of killing the germs, without being itself too potent a caustic, and he found that dilute carbolic acid fulfilled these conditions. This discovery has enabled many operations to be performed which would previously have been almost hopeless.

The same idea seems destined to prove as useful in medicine as in surgery. There is great reason to suppose that many diseases, especially those of a zymotic character, have their origin in the germs of special organisms. We know that fevers run a certain definite course. The parasitic organisms are at first few, but gradually multiply at the

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expense of the patient, and then die out again. Indeed, it seems to be thoroughly established that many diseases are due to the excessive multiplication of microscopic organisms, and we are not without hope that means will be discovered by which, without injury to the patient, these terrible though minute enemies may be destroyed, and the disease thus stayed. The interesting researches of Burdon-Sanderson, Greenfield, Koch, Pasteur, Toussaint, and others, seem to justify the hope that we may be able to modify these and other germs, and then by appropriate inoculation to protect ourselves against fever and other acute diseases.

The history of anæsthetics is a most remarkable illustration of how long we may be on the very verge of a most important discovery. Ether, which, as we all know, produces perfect insensibility to pain, was discovered as long ago as 1540. The anæsthetic property of nitrous oxide, now so extensively used, was observed in 1800 by Sir H. Davy, who actually experimented on himself, and had one of his teeth painlessly extracted when under its influence. He even suggests that, "as nitrous oxide gas seems capable of destroying pain, it could probably be used with advantage in surgical operations." Nay, this property of nitrous oxide was habitually explained and illustrated in the chemical lectures given in hospitals, and yet for fifty years the gas was never used in actual operations.

Few branches of science have made more rapid progress in the last half-century than that which deals with the ancient condition of man. When our Association was founded, it was generally considered that the human race suddenly appeared on the scene, about six thousand years ago, after the disappearance of the extinct mammalia, and when Europe, both as regards physical conditions and the other animals by which it was inhabited, was pretty much in the same condition as in the period covered by Greek and Roman history. Since then the persevering researches of Layard, Rawlinson, Botta, and others have made known to us, not only the statues and palaces of the ancient Assyrian monarchs, but even their libraries ; the cuneiform characters have been deciphered, and we can not only see, but read in the British Museum, the actual contemporary records, on burned-clay cylinders, of the events recorded in the historical books of the Old Testament and in the pages of Herodotus. The researches in Egypt also seem to have satisfactorily established the fact that the pyramids themselves are at least six thousand years old, while it is obvious that the Assyrian and Egyptian monarchies can not suddenly have attained to the wealth and power, the state of social organization, and progress in the arts, of which we have before us, preserved by the sand of the desert from the ravages of man, such wonderful proofs.

In Europe, the writings of the earliest historians and poets indicated that, before iron came into general use, there was a time when bronze was the ordinary material of weapons, axes, and other cutting

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implements, and though it seemed *a priori* improbable that a compound of copper and tin should have preceded the simple metal iron, nevertheless, the researches of archæologists have shown that there really was in Europe a "bronze age," which at the dawn of history was just giving way to that of "iron." The contents of ancient graves, buried in many cases so that their owner might carry some at least of his wealth with him to the world of spirits, left no room for doubt as to the existence of a bronze age; but we get a completer idea of the condition of man at this period from the Swiss lake-villages, first made known to us by Keller. Along the shallow edges of the Swiss lakes there flourished, once upon a time, many populous villages or towns, built on platforms supported by piles, exactly as many Malayan villages are now. Under these circumstances innumerable objects were one by one dropped into the water; sometimes whole villages were burned, and their contents submerged; and thus we have been able to recover, from the waters of oblivion in which they had rested for more than two thousand years, not only the arms and tools of this ancient people, the bones of their animals, their pottery and ornaments, but the stuffs they wore, the grain they had stored up for future use, even fruits and cakes of bread.

But this bronze-using people were not the earliest occupants of Europe. The contents of ancient tombs give evidence of a time when metal was unknown. This also was confirmed by the evidence then unexpectedly received from the Swiss lakes. By the side of the bronze-age villages were others, not less extensive, in which, while implements of stone and bone were discovered literally by thousands, not a trace of metal was met with. The shell-mounds, or refuse-heaps, accumulated by the ancient fishermen along the shores of Denmark, fully confirmed the existence of a "stone age."

No bones of the reindeer, no fragment of any of the extinct mammalia, have been found in any of the Swiss lake-villages or in any of the thousands of tumuli which have been opened in our own country, or in Central and Southern Europe. Yet the contents of caves and of river-gravels afford abundant evidence that there was a time when the mammoth and rhinoceros, the musk-ox and reindeer, the cave-lion and hyena, the great bear and the gigantic Irish elk wandered in our woods and valleys, and the hippopotamus floated in our rivers; when England and France were united, and the Thames and the Rhine had a common estuary. This was long supposed to be before the advent of man. At length, however, the discoveries of Boucher de Perthes in the valley of the Somme, supported as they are by the researches of many Continental naturalists, and in our own country of MacEnery and Godwin-Austen, Prestwich and Lyell, Vivian and Pengelly, Christy, Evans, and many more, have proved that man formed a humble part of this strange assembly. Nay, even at this early period there were at least two distinct races of men in Europe; one of them—as

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Boyd Dawkins has pointed out—closely resembling the modern Esquimau in form, in his weapons and implements, probably in his clothing, as well as in so many of the animals with which he was associated.

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At this stage man appears to have been ignorant of pottery, to have had no knowledge of agriculture, no domestic animals, except, perhaps, the dog. His weapons were the axe, the spear, and the javelin; I do not believe he knew the use of the bow, though he was probably acquainted with the lance. He was, of course, ignorant of metal, and his stone implements, though skillfully formed, were of quite different shapes from those of the second stone age, and were never ground. This earlier stone period, when man coexisted with these extinct mammalia, is known as the Palæolithic or Early Stone Age, in opposition to the Neolithic or Newer Stone Age. The remains of the mammalia which coëxisted with man in prehistoric times have been most carefully studied by Owen, Lartet, Rütimeyer, Falconer, Busk, Boyd Dawkins, and others. The presence of the mammoth, the reindeer, and especially of the musk-ox, indicates a severe, not to say an arctic climate, the existence of which, moreover, was proved by other considerations; while, on the contrary, the hippopotamus requires considerable warmth. How, then, is this association to be explained?

While the climate of the globe is, no doubt, much affected by geographical conditions, the cold of the glacial period was, I believe, mainly due to the eccentricity of the earth's orbit, combined with the obliquity of the ecliptic. The result of the latter condition is a period of twenty-one thousand years, during one half of which the northern hemisphere is warmer than the southern, while during the other ten thousand five hundred years the reverse is the case. At present we are in the former phase, and there is, we know, a vast accumulation of ice at the south pole. But when the earth's orbit is nearly circular, as it is at present, the difference between the two hemispheres is not very great; on the contrary, as the eccentricity of the orbit increases, the contrast between them increases also. This eccentricity is continually oscillating within certain limits, which Croll and subsequently Stone have calculated out for the last million years. At present, the eccentricity is ·016, and the mean temperature of the coldest month in London is about 40°. Such has been the state of things for nearly one hundred thousand years; but before that there was a period, beginning three hundred thousand years ago, when the eccentricity of the orbit varied from ·26 to ·57. The result of this would be greatly to increase the effect due to the obliquity of the orbit; at certain periods the climate would be much warmer than at present, while at others the number of days in winter would be twenty more, and of summer twenty less than now, while the mean temperature of the coldest month would be lowered 20°. We thus get something like a date for the last glacial epoch, and we see that it was not simply a period of cold, but rather one of extremes, each beat of the pendulum

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of temperature lasting for no less than twenty-one thousand years. This explains the fact that, as Morlot showed in 1854, the glacial deposits of Switzerland, and, as we now know, those of Scotland, are not a single uniform layer, but a succession of strata indicating very different conditions. I agree also with Croll and Geikie in thinking that these considerations explain the apparent anomaly of the coexistence in the same gravels of arctic and tropical animals; the former having lived in the cold, while the latter flourished in the hot, periods.

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It is, I think, now well established that man inhabited Europe during the milder periods of the glacial epoch. Some high authorities, indeed, consider that we have evidence of his presence in pre-glacial and even in Miocene times, but I confess that I am not satisfied on this point. Even the more recent period carries back the record of man's existence to a distance so great as altogether to change our views of ancient history. Nor is it only as regards the antiquity and material condition of man in prehistoric times that great progress has been made. If time permitted, I should have been glad to dwell on the origin and development of language, of custom, and of law. On all of these the comparison of the various lower races, still inhabiting so large a portion of the earth's surface, has thrown much light; while even in the most cultivated nations we find survivals, curious fancies, and lingering ideas, the fossil remains, as it were, of former customs and religions imbedded in our modern civilization, like the relics of extinct animals in the crust of the earth.

In geology the formation of our Association coincided with the appearance of Lyell's "Principles of Geology," the first volume of which was published in 1830, and the second in 1832. At that time the received opinion was that the phenomena of geology could only be explained by violent periodical convulsions, and a high intensity of terrestrial energy culminating in repeated catastrophes. Hutton and Playfair had indeed maintained that such causes as those now in operation would, if only time enough were allowed, account for the geological structure of the earth; nevertheless, the opposite view generally prevailed, until Lyell, with rare sagacity and great eloquence, with a wealth of illustration and most powerful reasoning, convinced geologists that the forces now in action are powerful enough, if only time be given, to produce results quite as stupendous as those which science records.

As regards stratigraphical geology, at the time of the first meeting of the British Association at York, the strata between the carboniferous limestone and the chalk had been mainly reduced to order and classified, chiefly through the labors of William Smith. But the classification of all the strata lying above the chalk and below the carboniferous limestone respectively, remained in a state of the greatest confusion. The year 1831 marks the period of the commencement of the joint labors of Sedgwick and Murchison, which resulted in the estab-

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lishment of the Cambrian, Silurian, and Devonian systems. Our pre-Cambrian strata have recently been divided by Hicks into four great groups of immense thickness, and implying, therefore, a great lapse of time; but no fossils have yet been discovered in them. Lyell's classification of the tertiary deposits, the result of the studies which he carried on with the assistance of Deshayes and others, was published in the third volume of the "Principles of Geology" in 1833. The establishment of Lyell's divisions of eocene, miocene, and pliocene, was the starting-point of a most important series of investigations, by Prestwich and others, of these younger deposits, as well of the post-tertiary, quaternary, or drift-beds, which are of special interest from the light they have thrown on the early history of man.

As regards the physical character of the earth, two theories have been held: one, that of a fluid interior covered by a thin crust; the other, of a practically solid sphere. The former is now very generally admitted, both by astronomers and geologists, to be untenable. The prevailing feeling of geologists on this subject has been well expressed by Professor Le Conte, who says, "The whole theory of igneous agencies—which is little less than the whole foundation of theoretic geology—must be reconstructed on the basis of a solid earth."

In 1837 Agassiz startled the scientific world by his "Discours sur l'ancienne Extension des Glaciers," in which, developing the observation already made by Charpentier and Venetz, that bowlders had been transported to great distances, and that rocks far away from, or high above, existing glaciers, are polished and scratched by the action of ice, he boldly asserted the existence of a "glacial period," during which Switzerland and the north of Europe were subjected to great cold and buried under a vast sheet of ice.

The ancient poets described certain gifted mortals as privileged to descend into the interior of the earth, and have exercised their imagination in recounting the wonders there revealed. As in other cases, however, the realities of science have proved more varied and surprising than the dreams of fiction. Of the gigantic and extraordinary animals thus revealed to us, by far the greatest number have been described during the period now under review. For instance, the gigantic cetiosaurus was described by Owen in 1838, the dinornis of New Zealand by the same distinguished naturalist in 1839, the mylodon in the same year, and the archæopteryx in 1862.

In America, a large number of remarkable forms have been described, mainly by Marsh, Leidy, and Cope. Marsh has made known to us the titanosaurus, of the American (Colorado) Jurassic beds, which is, perhaps, the largest land animal yet known, being a hundred feet in length, and at least thirty feet in height, though it seems possible that even these vast dimensions were exceeded by those of the atlantosaurus. Nor must I omit the hesperornis, described by Marsh in 1872, as a carnivorous, swimming ostrich, provided with teeth, which he re-

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gards as a character inherited from reptilian ancestors; the ichthyornis, stranger still, with biconcave vertebræ, like those of fishes, and teeth set in sockets.

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As giving, in a few words, an idea of the rapid progress in this department, I may mention that Morris's "Catalogue of British Fossils," published in 1843, contained 5,300 species; while that now in preparation by Mr. Etheridge enumerates 15,000. But, if these figures show how rapid our recent progress has been, they also very forcibly illustrate the imperfection of the geological record, and give us, I will not say a measure, but an idea, of the imperfection of the geological record. The number of all the described recent species is over 300,000, but certainly not half are yet on our lists, and we may safely take the total number of recent species as being not less than 700,000. But in former times there have been at the very least twelve periods, in each of which by far the greater number of species were distinct. True, the number of species was probably not so large in the earlier periods as at present; but, if we make a liberal allowance for this, we shall have a total of more than 2,000,000 species, of which about 25,000 only are as yet upon record; and many of these are only represented by a few, some only by a single specimen, or even only by a fragment.

The progress of paleontology may also be marked by the extent to which the existence of groups has been, if I may so say, carried back in time. Thus, I believe that in 1830 the earliest known quadrupeds were small marsupials belonging to the Stonesfield slates; the most ancient mammal now known is *Microlestes antiquus* from the Keuper of Würtemberg; the oldest bird known in 1831 belonged to the period of the London Clay, the oldest now known is the archæopteryx of the Solenhofen slates, though it is probable that some at any rate of the footsteps on the Triassic rocks are those of birds. So, again, the Amphibia have been carried back from the Trias to the Coal-measures; fish from the Old Red Sandstone to the Upper Silurian; reptiles to the Trias; insects from the Cretaceous to the Devonian; Mollusca and Crustacea from the Silurian to the Lower Cambrian. The rocks below the Cambrian, though of immense thickness, have afforded no relics of animal life, if we except the problematical *Eozoön Canadense*, so ably studied by Dawson and Carpenter. But, if paleontology as yet throws no light on the original forms of life, we must remember that the simplest and the lowest organisms are so soft and perishable that they would leave "not a wrack behind."

Passing to the science of geography, Mr. Clements Markham has recently published an excellent summary of what has been accomplished during the half-century. But the progress in our knowledge of geography is, and has been, by no means confined to the improvement of our maps, or to the discovery and description of new regions of the earth, but has extended to the causes which have led to the present configuration of the surface. To a great extent, indeed, this

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part of the subject falls rather within the scope of geology, but I may here refer, in illustration, to the distribution of lakes, the phenomena of glaciers, the formation of volcanic mountains, and the structure and distribution of coral islands.

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The origin and distribution of lakes is one of the most interesting problems in physical geography. That they are not scattered at random, a glance at the map is sufficient to show. They abound in mountain districts, are comparatively rare in equatorial regions, increasing in number as we go north, so that in Scotland and the northern parts of America they are sown broadcast. Perhaps *a priori* the first explanation of the origin of lakes which would suggest itself, would be that they were formed in hollows resulting from a disturbance of the strata, which had thrown them into a basin-shaped form. Lake-basins, however, of this character are, as a matter of fact, very rare; as a general rule, lakes have not the form of basin-shaped synclinal hollows, but, on the contrary, the strike of the strata often runs right across them. My eminent predecessor, Professor Ramsay, divides lakes into three classes: 1. Those which are due to irregular accumulations of drift, and which are generally quite shallow; 2. Those which are formed by moraines; and, 3, those which occupy true basins scooped by glacier-ice out of the solid rock. To the latter class belong most of the great Swiss and Italian lakes. Professor Ramsay attributes their excavation to glaciers, because it is of course obvious that rivers can not make basin-shaped hollows surrounded by rock on all sides. Now, the Lake of Geneva, 1,230 feet above the sea, is 984 feet deep, the Lake of Brienz is 1,850 feet above the sea, and 2,000 feet deep, so that its bottom is really below the sea-level. The Italian lakes are even more remarkable. The Lake of Como, 700 feet above the sea, is 1,929 feet deep. Lago Maggiore, 685 feet above the sea, is no less than 2,625 feet deep. It will be observed that these lakes, like many others in mountain regions, those of Scandinavia, for instance, lie in the direct channels of the great old glaciers. If the mind is at first staggered at the magnitude of the scale, we must remember that the ice, which scooped out the valley in which the Lake of Geneva now reposes, was once at least 2,700 feet thick; while the moraines were also of gigantic magnitude, that of Ivrea, for instance, being no less than 1,500 feet in height. Professor Ramsay's theory seems, therefore, to account beautifully for a large number of interesting facts.

Passing from lakes to mountains, two rival theories with reference to the structure and origin of volcanoes long struggled for supremacy. The more general view was that the sheets of lava and scoriæ which form volcanic cones—such, for instance, as Etna or Vesuvius—were originally nearly horizontal, and that subsequently a force operating from below, and exerting a pressure both upward and outward from a central axis toward all points of the compass, uplifted the whole stratified mass, and made it assume a conical form, giving rise at the same

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time, in many cases, to a wide and deep circular opening at the top of the cone, called by the advocates of this hypothesis a "crater of elevation."

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This theory, though, as it seems to us now, it had already received its death-blow from the admirable memoirs of Scrope, was yet that most generally adopted fifty years ago, because it was considered that compact and crystalline lavas could not have consolidated on a slope exceeding 1° or 2°. In 1858, however, Sir Charles Lyell conclusively showed that in fact such lavas could consolidate at a considerable angle, even in some cases at more than 30°, and it is now generally admitted that, though the beds of lava, etc., may have sustained a slight angular elevation since their deposition, still, in the main, volcanic cones have acquired their form by the accumulation of lava and ashes ejected from one or more craters.

The problems presented by glaciers are of very great interest. In 1843 Agassiz and Forbes proved that the center of a glacier, like that of a river, moves more rapidly than its sides. But how and why do glaciers move at all? Rendu, afterward Bishop of Annecy, in 1841 endeavored to explain the facts by supposing that glacier-ice enjoys a kind of ductility. The "viscous theory" of glaciers was also adopted and most ably advocated by Forbes, who compared the condition of a glacier to that of the contents of a tar-barrel poured into a sloping channel. We have all, however, seen long, narrow fissures, a mere fraction of an inch in width, stretching far across glaciers—a condition incompatible with the ordinary idea of viscosity. The phenomenon of regelation was afterward applied to the explanation of glacier-motion. An observation of Faraday's supplied the clew. He noticed in 1850 that, when two pieces of thawing ice are placed together, they unite by freezing at the place of contact. Following up this suggestion, Tyndall found that, if he compressed a block of ice in a mold, it could be made to assume any shape he pleased. A straight prism, for instance, placed in a groove and submitted to hydraulic pressure, was bent into a transparent semicircle of ice. These experiments seem to have proved that a glacial valley is a mold through which the ice is forced, and to which it will accommodate itself, while, as Tyndall and Huxley also pointed out, the "veined structure of ice" is produced by pressure, in the same manner as the cleavage of slate-rocks.

It was in the year 1842 that Darwin published his great work on "Coral Islands." The fringing reefs of coral presented no special difficulty. They could be obviously accounted for by an elevation of the land, so that the coral, which had originally grown under water, had been raised above the sea-level. The circular or oval shape of so many reefs, however, each having a lagoon in the center, closely surrounded by a deep ocean, and rising but a few feet above the sea-level, had long been a puzzle to the physical geographer. The favorite theory was, that these were the summits of submarine volcanoes on which the

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coral had grown. But, as the reef-making coral does not live at greater depths than about twenty-five fathoms, the immense number of these reefs formed an almost insuperable objection to this theory. The Laccadives and Maldives, for instance—meaning literally the "lac of islands" and the "thousand islands"—are a series of such atolls, and it was impossible to imagine so great a number of craters, all so nearly of the same altitude. Darwin showed, moreover, that, so far from the ring of corals resting on a corresponding ridge of rock, the lagoons, on the contrary, now occupy the place which was once the highest land. He pointed out that some lagoons, as, for instance, that of Vanikoro, contain an island in the middle; while other islands, such as Tahiti, are surrounded by a margin of smooth water, separated from the ocean by a coral-reef. Now, if we suppose that Tahiti were to sink slowly, it would gradually approximate to the condition of Vanikoro; and, if Vanikoro gradually sank, the central island would disappear, while on the contrary the growth of the coral might neutralize the subsidence of the reef, so that we should have simply an atoll, with its lagoon. The same considerations explain the origin of the "barrier reefs," such as that which runs, for nearly one thousand miles, along the northeast coast of Australia. Thus Darwin's theory explained the form and the approximate identity of altitude of these coral islands. But it did more than this, because it showed us that there were great areas in process of subsidence, which, though slow, was of great importance in physical geography.*

Much information has also been acquired with reference to the abysses of the ocean, especially from the voyages of the Porcupine and the Challenger. The greatest depth yet recorded is near the Ladrone Islands, where a sounding of 4,575 fathoms was obtained. Ehrenberg long ago pointed out the similarity of the calcareous mud now accumulating in our recent seas to the chalk, and showed that the greensands of the geologist are largely made up of casts of foraminifera. Clay, however, had been looked on, until the recent expeditions, as essentially a product of the disintegration of older rocks. Not only, however, are a large proportion of silicious and calcareous rocks either directly or indirectly derived from material which has once formed a portion of living organisms, but Sir Wyville Thomson maintains that this is the case with some clays also. In that case, the striking remark of Linnæus, that "fossils are not the children but the parents of rocks," will have received remarkable confirmation. I should have thought it, I confess, probable that these clays are, to a considerable extent, composed of volcanic dust.

It would appear that calcareous deposits resembling our chalk do not occur at a greater depth than 3,000 fathoms; they have not been met with in the abysses of the ocean. Here the bottom consists of

* I ought to mention that Darwin's views have recently been questioned by Semper and Murray.

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exceedingly fine clay, sometimes colored red by oxide of iron, sometimes chocolate by manganese oxide, and containing with Foraminifera occasionally large numbers of siliceous Radiolaria. These strata seem to accumulate with extreme slowness: this is inferred from the comparative abundance of whales' bones and fishes' teeth, and from the presence of minute spherical particles, supposed by Mr. Murray to be of cosmic origin—in fact, to be the dust of meteorites, which in the course of ages have fallen on the ocean. Such particles no doubt occur over the whole surface of the earth, but on land they soon oxidize, and in shallow water they are covered up by other deposits. Another interesting result of recent deep-sea explorations has been to show that the depths of the ocean are no mere barren solitudes, as was until recent years confidently believed, but, on the contrary, present us many remarkable forms of life. We have, however, as yet but thrown here and there a ray of light down into the ocean abysses:

"Nor can so short a time sufficient be,
To fathom the vast depths of Nature's sea."

(*Concluded in the December number.*)

THE DISCOVERY OF ORGANIC REMAINS IN METEORIC STONES.

By FRANCIS BIRGHAM.

THE great problem, whether or not other celestial bodies besides our own planet are or in past ages have been inhabited by animate beings, must be a subject of the deepest interest to every thinking being. This question has for some time past been answered in the affirmative with great probability. The complete analogy of physical conditions which has been proved to exist in some other planets of our solar system, and which without doubt must also occur in innumerable planets of other solar systems, allowed the very probable deduction that not only on our own earth a higher organic process of evolution has taken place. Still, this conclusion by analogy had hitherto remained a simple, unproved hypothesis, although supported by good evidence.

But now at last it seems that we have obtained a direct answer to this question, and that we are able to see with our own eyes the *veritable remains of animate beings from another celestial body.*

It has been conclusively demonstrated that the meteoric stones which from time to time drop down on the earth have at no time formed a part of this planet, and it is now generally conceded that they are the remains of other celestial bodies—probably those of a destroyed planet.

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In such meteoric stones, and especially in the class called *chondrites*, on account of the peculiar spherical inclosures found in them, the eminent German geologist, Dr. Hahn, has recently discovered *an entire series of organic remains*. By a laborious process of grinding down and polishing these fragments he succeeded in producing a large number of thin laminæ or delicate stone shavings, which he subjected to a careful series of investigations under the most powerful microscopes. He has recently published a book on this subject, containing on thirty-two plates more than one hundred representations of these laminæ of meteorites, every one of which contains different forms and figures, which Dr. Hahn positively identifies *not as mineralogical* but as *organic*, and, in fact, *as zoölogical formations* belonging to the different classes of *sponges*, *corals*, and *crinoids*. These pictures, which have been reproduced from the original laminæ by photography, without any alterations or additions by a draughtsman, must cause great surprise to every geologist and paleontologist, who will at once recognize the structure of well-known coral types on several of the plates. The majority of the meteorites containing these forms are part of the celebrated great meteoric fall of Knyahinya in Hungary, which took place on the 9th of June, 1866.

Dr. Hahn, having sent the whole of his original shavings, comprising over three hundred specimens, to the noted zoölogist Dr. Weinland for examination and determination, the latter has also published a report on this subject in a German scientific journal, and the present article is based on the statements of these two scientists.

The result of a thorough examination of these specimens, with a complete comparison of his own great collection of corals, fully convinced Dr. Weinland that a large number of the formations in question are without doubt *remains of coral* belonging to the class of the *favositines*, which on the earth are now to be found only in a fossil state, and then only in the oldest, or palæolithic, stratum.

The terrestrial polypous branches of these favositines are composed of polypary tubes running parallel to each other. At the top, where the cups (*calyx*) open and the then living polyps are sitting, the coral branches of the favosite present a more or less regular *network*, composed of the walls of the different polyps. Besides, this class is especially characterized by the *cross-partitions* in the polypous tubes, as well as by the regular rows of minute holes in these walls, which facilitate the connection between each tube with its neighbors.

Now these polyparies (i. e., bundles of tubes entirely similar to those of the earth's favositines) can be found in a large number of Dr. Hahn's meteoric laminæ, which originated not from a single but from many separate falls of meteorites. Many of them show with perfect clearness the very same cross-partitions and rows of holes at fixed intervals from each other with so much regularity that it is impossible to admit a coincidence. At the same time, no geologist would attempt

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to offer a mineralogical determination of these minute structures, partitions, and holes, which are already visible under a microscope magnifying two hundred times, but which may even still be traced *up to four hundred and eighty times.* It is, therefore, perfectly evident that the objects in question are organic remains, and, in fact, those of a class nearly related to our favosite corals.

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Unfortunately, most of the laminæ are cut parallel to the length of the polypary tubes, because the huge meteoric stones had to be broken up in order to obtain these shavings, whereby they generally split with the length of the coral-branches. Only one remarkably fine lamina, a perfect unicorn, in the whole collection, and also a part of the fall at Knyahinya, affords a full view from the top of the branch into the calyx of the polyparium and into the arrangement of the cups themselves. This specimen alone must bring conviction to every connoisseur of corals. It is represented on Plate X, Figs. 3 and 4, of Dr. Hahn's book, but the yellowish tint of the lamina prevented the object from coming out as clearly on the photograph as it can be seen on the original under a good microscope.

This object is evidently a complete small coral-branch of roundish shape, which stands with a broad base on another coral formation. The whole network of the calyx can here be seen with the greatest clearness. The cups are quite dark in the center, being filled with a black substance ; then follows a whitish filling around this dark center, and then, plainly visible, the wall of each tube always as *a sharply defined line*, which is already visible with a low magnifying power. This network of lines, separating the single cups from each other, presents a variety of sizes and forms of the calyx, which, just like those of a great number of our corals, and especially of those of the Devonian *favosites polymorphus*, are very irregular, often larger or smaller than the average, with rounded or straight side-walls or smaller cups formed by the partition of one larger one. This ex-terrestrial coral has been named by Dr. Weinland, in honor of its discoverer, *Hahnia meteoritica.* All these coral structures in the meteorites are petrified, having taken the form of silicates of magnesia.

Another very notable peculiarity of these ex-terrestrial corals is *their extreme smallness*, for, in comparison with those of the earth's fauna, they represent *a veritable pygmy animal kingdom.* The just-described coral-branch of *Hahnia meteoritica* is but a white dot in the meteoric shaving, barely visible to the naked eye. Its greatest diameter measures but 0·90 millimetre, and the single cups average but 0·05 millimetre. These are dimensions quite unknown in any terrestrial corals, where a calyx of one millimetre diameter may already be called small. But we must still be prepared for yet quite different things in these ex-terrestrial organisms, for it is very possible that there may yet be found *formations for which we can absolutely find no place in our systems of zoölogy.* In fact, it is rather startling that the

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above-mentioned structures present forms of coral so nearly related to those of the earth, and we must, therefore, accept this fact as important evidence that an organic evolution of great similarity to that on our own earth has taken place on whatever planet from which these meteorites originated.

Besides corals, Dr. Weinland has also succeeded in finding a number of other organic remains in Dr. Hahn's specimens. The material for this investigation was very large, for the greater part of the specimens has evidently been fused together from organic fragments. This is especially the case with the great meteoric stone of Knyahinya, which weighed over two hundred pounds. Well-preserved forms, however, are scarce, for the meteoric material was principally composed of fragments and detritus, which greatly resembled, for instance, the youngest marine chalk in the Gulf of Mexico. But, after comparing a great number of laminæ and attaining some practice in this work, Dr. Weinland succeeded in restoring certain often-repeated formations. The *sponges* especially were highly developed, and of these Dr. Weinland succeeded in actually determining three different genera. Of one characteristic bluish sponge, which occurred in several favorable shavings both as young and old specimens, he was able to make a drawing of its interior construction as easily as from a living specimen. He also thinks that he has discovered *vegetable traces;* at least, a remarkable, arched form, divided into two halves by a cross-partition, and measuring 0·8 millimetre in diameter, greatly resembles the shield-algæ (*cocconeis*). But he is yet unable to decide whether the formations, claimed by Dr. Hahn as *crinoids*, really belong to this class, for some of them are certainly *spongiæ*.

So far, not a single trace has been found of *higher animal forms* (*mollusca*, *arthrozoa*), but all the discovered organisms evidently indicate the *primary formation* of the celestial body from which they came. Then, again, this entire ex-terrestrial fauna hitherto discovered, which already comprises about fifty different species, and which originates from different meteoric falls, even from some during the last century, conveys the impression that it doubtlessly once formed part of *a single ex-terrestrial-celestial body* with a unique creation, which in bygone ages seems to have been overtaken by a grand catastrophe, during which it was broken up into fragments.

Perhaps some readers of this article will ask why this remarkable discovery has not been made before, considering the great number of meteorites already collected in our mineralogical collections and the considerable number of scientists who have investigated them.* Dif-

* Probably the largest collection of meteoric stones is in the possession of Mr. Shephard, of New Haven, Connecticut. It contains over 500 specimens, weighing together 1,200 pounds. The largest fragment, which weighs 436 pounds, comes from Colorado, and the smallest, of half an ounce only, from Otsego County, New York. The largest complete stone (56 pounds) fell in Muskingum County, Ohio, the smallest (less than 50

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ferent circumstances will explain this question. Firstly, meteoric stones are always rare and costly objects, which are not easily sacrificed by their possessors, so that hitherto but very few of them have been broken up in order to obtain laminæ suitable for microscopic investigation. Then, again, the latter have only been manufactured in limited numbers, so that the probability of discovering a favorable object in them could consequently be but very small. Dr. Hahn, however, has made extraordinary sacrifices, both in time and money, to obtain his specimens, of which he now possesses no less than six hundred. It must also be mentioned that hitherto the investigations of a few specimens have been made with a magnifying-glass only, and but seldom with powerful microscopes, such as Dr. Hahn employs.

Besides thus affording positive proof of the fact that other worlds are or have been inhabited by organic beings, this important discovery has also solved another interesting problem, which has long perplexed the scientific world. By the newest theory of the celebrated astronomer Schiaparelli regarding meteorites, the latter were supposed to emanate from incandescent comets and their tails. Now all the petrified organisms discovered by Dr. Hahn have been proved to belong to *the subaqueous classes of animals*, and indeed have lived in water *which never froze entirely*, and for which we would certainly have to look in vain in comets, which are now generally admitted to be in a state of active combustion.

This affords but another proof of the transcendent importance of this new and great discovery, the general results of which we have now placed before the readers of this journal.

THE AVAILABLE ENERGY OF NATURE.*

By Sir WILLIAM THOMSON.

DURING the fifty years' life of the British Association, the advancement of science, for which it has lived and worked so well, has not been more marked in any department than in one which belongs very decidedly to the Mathematical and Physical Section—the science of energy. The very name energy, though first used in its present sense by Dr. Thomas Young about the beginning of this century, has only come into use practically after the doctrine which defines it had,

grains) in Sweden. The specimens forming this collection have been brought together from all parts of the world, and belong to meteoric falls during several centuries. The first specimen in the catalogue fell on the 7th of November, 1492, in Alsace, and the last on the 12th of February, 1875, in Iowa.

* Opening address before Section A, at the York Meeting of the British Association for the Advancement of Science.

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during the first half of the British Association's life, been raised from a mere formula of mathematical dynamics to the position it now holds of a principle pervading all nature and guiding the investigator in every field of science.

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A little article, communicated to the Royal Society of Edinburgh a short time before the commencement of the epoch of energy, under the title "On the Sources available to Man for the Production of Mechanical Effect," * contained the following:

"Men can obtain mechanical effect for their own purposes by working mechanically themselves, and directing other animals to work for them, or by using natural heat, the gravitation of descending solid masses, the natural motions of water and air, and the heat, or galvanic currents, or other mechanical effects produced by chemical combination, but in no other way at present known. Hence the stores from which mechanical effect may be drawn by man belong to one or other of the following classes:

"I. The food of animals.

"II. Natural heat.

"III. Solid matter found in elevated positions.

"IV. The natural motions of water and air.

"V. Natural combustibles (as wood, coal, coal-gas, oils, marsh-gas, diamond, native sulphur, native metals, meteoric iron).

"VI. Artificial combustibles (as smelted or electrically-deposited metals, hydrogen, phosphorus).

"In the present communication, known facts in natural history and physical science, with reference to the sources from which these stores have derived their mechanical energies, are adduced to establish the following general conclusions:

"1. *Heat radiated from the sun* (sunlight being included in this term) *is the principal source of mechanical effect available to man.*† From it is derived the whole mechanical effect obtained by means of animals working, water-wheels worked by rivers, steam-engines, galvanic engines, windmills, and the sails of ships.

"2. The motions of the earth, moon, and sun, and their mutual attractions, constitute an important source of available mechanical effect. From them all, but chiefly, no doubt, from the earth's motion of rotation, is derived the mechanical effect of water-wheels driven by the tides.

"3. The other known sources of mechanical effect available to man are either terrestrial—that is, belonging to the earth, and available without the influence of any external body—or meteoric—that is, belonging to bodies deposited on the earth from external space. Ter-

* Read at the Royal Society of Edinburgh, on February 2, 1852 ("Proceedings" of that date).

† A general conclusion equivalent to this was published by Sir John Herschel in 1833. See his "Astronomy," edition 1849, § 399.

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restrial sources, including mountain quarries and mines, the heat of hot springs, and the combustion of native sulphur—perhaps, also, the combustion of inorganic native combustibles—are actually used; but the mechanical effect obtained from them is very inconsiderable, compared with that which is obtained from sources belonging to the two classes mentioned above. Meteoric sources, including only the heat of newly-fallen meteoric bodies, and the combustion of meteoric iron, need not be reckoned among those available to man for practical purposes."

Thus, we may summarize the natural sources of energy as tides, food, fuel, wind, and rain.

Among the practical sources of energy thus exhaustively enumerated, there is only one not derived from sun-heat—that is, the tides. Consider it first. I have called it *practical*, because tide-mills exist. But the places where they can work usefully are very rare, and the whole amount of work actually done by them is a drop to the ocean of work done by other motors. A tide of two metres' rise and fall, if we imagine it utilized to the utmost, by means of ideal water-wheels doing with perfect economy the whole work of filling and emptying a dock-basin in infinitely short times at the moments of high and low water, would give just one metre-ton per square metre of area. This work, done four times in the twenty-four hours, amounts to $\frac{1}{1650}$ of the work of a horse-power. Parenthetically, in explanation, I may say that the French metrical equivalent (to which, in all scientific and practical measurements, we are irresistibly drawn, notwithstanding a dense barrier of insular prejudice most detrimental to the islanders)—the French metrical equivalent of James Watt's "horse-power" of 550 foot-pounds per second, or 33,000 foot-pounds per minute, or nearly two million foot-pounds per hour, is seventy-five metre-kilogrammes per second, or four and a half metre-tons per minute, or two hundred and seventy metre-tons per hour. The French ton of one thousand kilogrammes, used in this reckoning, is 0·984 of the British ton.

Returning to the question of utilizing tidal energy, we find a dock area of 162,000 square metres (which is a little more than 400 metres square) required for 100 horse-power. This, considering the vast costliness of dock-construction, is obviously prohibitory of every scheme for economizing tidal energy by means of artificial dock-basins, however near to the ideal perfection might be the realized tide-mill, and however convenient and non-wasteful the accumulator—whether Faure's electric accumulator or other accumulators of energy hitherto invented or to be invented—which might be used to store up the energy yielded by the tide-mill during its short harvests about the times of high and low water, and to give it out when wanted at other times of the six hours. There may, however, be a dozen places possible in the world where it could be advantageous to build a sea-wall across the

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mouth of a natural basin or estuary, and to utilize the tidal energy of filling it and emptying it by means of sluices and water-wheels. But, if *so* much could be done, it would in many cases take only a little more to keep the water out altogether, and make fertile land of the whole basin. Thus, we are led up to the interesting economical question, whether is forty acres (the British *agricultural* measure for the area of 162,000 square metres) or 100 horse-power more valuable. The annual cost of 100 horse-power, night and day, for 365 days of the year, obtained through steam from coals, may be about ten times the rental of forty acres at £2 or £3 per acre. But the value of land is essentially much more than its rental, and the rental of land is apt to be much more than £2 or £3 per acre in places where 100 horse-power could be taken with advantage from coal through steam. Thus, the question remains unsolved, with the possibility that in one place the answer may be *one hundred horse-power*, and in another *forty acres*. But, indeed, the question is hardly worth answering, considering the rarity of the cases, if they exist at all, where embankments for the utilization of tidal energy are practicable.

Turning, now, to sources of energy derived from sun-heat, let us take the wind first. When we look at the register of British shipping and see 40,000 vessels, of which about 10,000 are steamers and 30,000 sailing-ships, and when we think how vast an absolute amount of horse-power is developed by the engines of those steamers, and how considerable a proportion it forms of the whole horse-power taken from coal annually in the whole world at the present time, and when we consider the sailing-ships of other nations, which must be reckoned in the account, and throw in the little item of windmills, we find that, even in the present day of steam ascendency, old-fashioned wind still supplies a large part of all the energy used by man. But, however much we may regret the time when Hood's young lady, visiting the fens of Lincolnshire at Christmas, and writing to her dearest friend in London (both sixty years old now if they are alive), describes the delight of sitting in a bower and looking over the wintry plain, not desolate, because "windmills lend revolving animation to the scene," we can not shut our eyes to the fact of a lamentable decadence of wind-power. Is this decadence permanent, or may we hope that it is only temporary? The subterranean coal-stores of the world are becoming exhausted surely, and not slowly, and the price of coal is upward bound—upward bound on the whole, though no doubt it will have its ups and downs in the future as it has had in the past, and as must be the case in respect to every marketable commodity. When the coal is all burned, or long before it is all burned, when there is so little of it left, and the coal-mines from which that little is to be excavated are so distant and deep and hot that its price to the consumer is greatly higher than at present, it is most probable that windmills or wind-motors in some form will again be in the ascendant, and that

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wind will do man's mechanical work, on land at least, in proportion comparable to its present doing of work at sea.

Even now it is not utterly chimerical to think of wind superseding coal in some places for a very important part of its present duty—that of giving light. Indeed, now that we have dynamos and Faure's accumulator, the little want to let the thing be done is cheap windmills. A Faure cell containing twenty kilogrammes of lead and minium, charged and employed to excite incandescent vacuum-lamps, has a light-giving capacity of sixty-candle hours (I have found considerably more in experiments made by myself, but I take sixty as a safe estimate). The charging may be done uninjuriously, and with good dynamical economy, in any time from six hours to twelve or more. The drawing-off of the charge for use may be done safely, but somewhat wastefully, in two hours, and very economically in any time of from five hours to a week or more. Calms do not last often longer than three or four days at a time. Suppose, then, that a five days' storage-capacity suffices (there may be a little steam-engine ready to be set to work at any time after a four-days' calm, or the user of the light may have a few candles or oil-lamps in reserve, and be satisfied with them when the wind fails for more than five days). One of the twenty kilogramme-cells, charged when the windmill works for five or six hours at any time, and left with its sixty candle-hours' capacity to be used six hours a day for five days, gives a two-candle light. Thus, thirty-two such accumulator-cells so used would give as much light as four burners of London sixteen-candle gas. The probable cost of dynamo and accumulator does not seem fatal to the plan, if the windmill could be had for something comparable with the prime cost of a steam-engine, capable of working at the same horse-power as the windmill when in good action. But windmills as hitherto made are very costly machines, and it does not seem probable that, without inventions not yet made, wind can be economically used to give light in any considerable class of cases, or to put energy into store for work of other kinds.

Consider, lastly, rain-power. When it is to be had in places where power is wanted for mills or factories of any kind, water-power is thoroughly appreciated. From time immemorial, water-motors have been made in large variety for utilizing rain-power in the various conditions in which it is presented, whether in rapidly-flowing rivers, in natural waterfalls, or stored at heights in natural lakes or artificial reservoirs. Improvements and fresh inventions of machines of this class still go on, and some of the finest principles of mathematical hydrodynamics have, in the lifetime of the British Association, and, to a considerable degree, with its assistance, been put in requisition for perfecting the theory of hydraulic mechanism, and extending its practical applications.

A first question occurs: Are we necessarily limited to such natural sources of water-power as are supplied by rain falling on hill-country,

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or may we look to the collection of rain-water in tanks placed artificially at sufficient heights over flat country to supply motive power economically by driving water-wheels? To answer it: Suppose a height of one hundred metres, which is very large for any practical building, or for columns erected to support tanks; and suppose the annual rainfall to be three quarters of a metre (thirty inches). The annual yield of energy would be seventy-five metre-tons per square metre of the tank. Now, one horse-power for 365 times twenty-four hours is 236,500 foot-tons; and, therefore (dividing this by 75), we find 3,153 square metres as the area of our supposed tank, required for a continuous supply of one horse-power. The prime cost of any such structure, not to speak of the value of the land which it would cover, is utterly prohibitory of any such plan for utilizing the motive power of rain. We may or may not look forward hopefully to the time when windmills will again "lend revolving animation" to a dull, flat country; but we certainly need not be afraid that the scene will be marred by forests of iron columns taking the place of natural trees, and gigantic tanks overshadowing the fields and blackening the horizon.

To use rain-power economically on any considerable scale we must look to the natural drainage of hill-country and take the water where we find it either actually falling or stored up and ready to fall when a short artificial channel or pipe can be provided for it at moderate cost. The expense of aqueducts, or of underground water-pipes, to carry water to any great distance—any distance of more than a few miles or a few hundred yards—is much too great for economy when the yield to be provided for is *power;* and such works can only be undertaken when the *water itself* is what is wanted. Incidentally, in connection with the water-supply of towns, some part of the energy due to the head at which it is supplied may be used for power. There are, however, but few cases (I know of none except Greenock) in which the energy to spare over and above that devoted to bringing the water to where it is wanted, and causing it to flow fast enough for convenience at every opened tap in every house or factory, is enough to make it worth while to make arrangements for letting the water-power be used without wasting the water-substance. The cases in which water-power is taken from a town supply are generally very small, such as working the bellows of an organ, or "hair-brushing by machinery," and involve simply throwing away the used water. The cost of energy thus obtained must be something enormous in proportion to the actual quantity of the energy, and it is only the smallness of the quantity that allows the convenience of having it when wanted at any moment, to be so dearly bought.

For anything of great work by rain-power, the water-wheels must be in the very place where the water-supply with natural fall is found. Such places are generally far from great towns, and the time is not yet come when great towns grow by natural selection beside waterfalls,

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for power, as they grow beside navigable rivers, for shipping. Thus, hitherto, the use of water-power has been confined chiefly to isolated factories which can be conveniently placed and economically worked in the neighborhood of natural waterfalls. But the splendid suggestion made about three years ago by Mr. Siemens in his presidential address to the Institution of Mechanical Engineers, that the power of Niagara might be utilized, by transmitting it electrically to great distances, has given quite a fresh departure for design in respect to economy of rain-power. From the time of Joule's experimental electro-magnetic engines developing ninety per cent. of the energy of a voltaic battery in the form of weights raised, and the theory of the electro-magnetic transmission of energy completed thirty years ago on the foundation afforded by the train of experimental and theoretical investigations by which he established his dynamical equivalent of heat in mechanical, electric, electro-chemical, chemical, electro-magnetic, and thermo-elastic phenomena, it had been known that potential energy from any available source can be transmitted electro-magnetically by means of an electric current through a wire, and directed to raise weights at a distance, with unlimitedly perfect economy. The first large-scale practical application of electro-magnetic machines was proposed by Holmes in 1854, to produce the electric light for lighthouses, and persevered in by him till he proved the availability of his machine to the satisfaction of the Trinity House and the delight of Faraday in trials at Blackwall in April, 1857, and it was applied to light the South Foreland Lighthouse on December 8, 1858. This gave the impulse to invention, by which the electro-magnetic machine has been brought from the physical laboratory into the province of engineering, and has sent back to the realm of pure science a beautiful discovery, that of the fundamental principle of the dynamo, made triply and independently, and as nearly as may be simultaneously, in 1867 by Dr. Werner Siemens, Mr. S. A. Varley, and Sir Charles Wheatstone—a discovery which constitutes an electro-magnetic analogue to the fundamental electrostatic principle of Nicholson's revolving doubler, resuscitated by Mr. C. F. Varley in his instrument "for generating electricity," patented in 1860; and by Holtz in his celebrated electric machine; and by myself in my "replenisher" for multiplying and maintaining charges in Leyden jars for heterostatic electrometers, and in the electrifier for the siphon of my recorder for submarine cables.

The dynamos of Gramme and Siemens, invented and made in the course of these fourteen years since the discovery of the fundamental principle, give now a ready means of realizing economically on a large scale for many important practical applications the old thermo-dynamics of Joule in electro-magnetism; and, what particularly concerns us now in connection with my present subject, they make it possible to transmit electro-magnetically the work of waterfalls through long, insulated conducting wires, and use it at distances of fifties or hun-

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dreds of miles from the source, with excellent economy—better economy, indeed, in respect to proportion of energy used to energy dissipated than almost anything known in ordinary mechanics and hydraulics for distances of hundreds of yards instead of hundreds of miles.

In answer to questions put to me in May, 1879,* by the Parliamentary Committee on Electric Lighting, I gave a formula for calculating the amount of energy transmitted, and the amount dissipated by being converted into heat on the way, through an insulated copper conductor of any length, with any given electromotive force applied to produce the current. Taking Niagara as example, and with the idea of bringing its energy usefully to Montreal, Boston, New York, and Philadelphia, I calculated the formula for a distance of 300 British statute miles (which is greater than the distance of any of those four cities from Niagara, and is the radius of a circle covering a large and very important part of the United States and British North America), I found almost to my surprise that even with so great a distance to be provided for, the conditions are thoroughly practicable with good economy, all aspects of the case carefully considered. The formula itself will be the subject of a technical communication to Section A in the course of the meeting on which we are now entering. I therefore at present restrict myself to a slight statement of results:

1. Apply dynamos driven by Niagara to produce a difference of potential of 80,000 volts between a good earth connection and the near end of a solid copper wire of half an inch (1·27 centimetres) diameter, and 300 statute miles (483 kilometres) length.

2. Let resistance by driven dynamos doing work, or by electric lights, or, as I can now say, by a Faure battery taking in a charge, be applied to keep the remote end at a potential differing by 64,000 volts from a good earth-plate there.

3. The result will be a current of 240 webers through the wire taking energy from the Niagara end at the rate of 26,250 horse-power, losing 5,250 (or twenty per cent.) of this by the generation and dissipation of heat through the conductor and 21,000 horse-power (or eighty per cent. of the whole) on the recipients at the far end.

4. The elevation of temperature above the surrounding atmosphere, to allow the heat generated in it to escape by radiation and be carried away by convection is only about 20° centigrade; the wire being hung freely exposed to air like an ordinary telegraph-wire supported on posts.

5. The striking distance between flat metallic surfaces with difference of potentials of 80,000 volts (or 5,000 Daniell's) is (Thomson's "Electrostatics and Magnetism," § 340) only eighteen millimetres, and therefore there is no difficulty about the insulation.

* Printed in the "Parliamentary Blue-Book Reports of the Committee on Electric Lighting," 1879.

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6. The cost of the copper wire, reckoned at eight pence per pound, is £37,000; the interest on which at five per cent. is £1,900 a year. If 5,250 horse-power at the Niagara end costs more than £1,900 a year, it would be better economy to put more copper into the conductor; if less, less. I say no more on this point at present, as the economy of copper for electric conduction will be the subject of a special communication to the section.

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I shall only say, in conclusion, that one great difficulty in the way of economizing the electrical transmitting power to great distances (or even to moderate distances of a few kilometres) is now overcome by Faure's splendid invention. High potential, as Siemens, I believe, first pointed out, is the essential for good dynamical economy in the electric transmission of power. But what are we to do with 80,000 volts when we have them at the civilized end of the wire? Imagine a domestic servant going to dust an electric lamp with 80,000 volts on one of its metals! Nothing above 200 volts ought on any account ever to be admitted into a house or ship or other place where safeguards against accident can not be made absolutely and for ever trustworthy against all possibility of accident. In an electric workshop 80,000 volts is no more dangerous than a circular saw. Till I learned Faure's invention I could but think of step-down dynamos, at a main receiving-station, to take energy direct from the electric main with its 80,000 volts, and supply it by secondary 200 volt dynamos or 100 volt dynamos, through proper distributing wires, to the houses and factories and shops where it is to be used for electric lighting, and sewing-machines, and lathes, and lifts, or whatever other mechanism wants driving power. Now the thing is to be done much more economically, I hope, and certainly with much greater simplicity and regularity, by keeping a Faure battery of 40,000 cells always being charged direct from the electric main, and applying a methodical system of removing sets of fifty, and placing them on the town-supply circuits, while other sets of fifty are being regularly introduced into the great battery that is being charged, so as to keep its number always within fifty of the proper number, which would be about 40,000 if the potential at the emitting end of the main is 80,000 volts.

THE DURATION OF HUMAN LIFE.

By M. DE SOLAVILLE.

CAN man reach and pass the age of a hundred years? is a question concerning which physiologists have different opinions. Buffon was the first one in France to raise the question of the extreme limit of human life. In his opinion, man, becoming adult at sixteen, ought

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to live to six times that age, or to ninety-six years. Having been called upon to account for the phenomenal ages attributed by the Bible to the patriarchs, he risked the following as an explanation: "Before the flood, the earth was less solid, less compact, than it is now. The law of gravitation had acted for only a little time; the productions of the globe had less consistency, and the body of man, being more supple, was more susceptible of extension. Being able to grow for a longer time, it should, in consequence, live for a longer time than now."

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The German Heusler has suggested on the same point that the ancients did not divide time as we do. Previous to the age of Abraham, the year, among some people of the East, was only three months, or a season; so that they had a year of spring, one of summer, one of fall, and one of winter. The year was extended so as to consist of eight months after Abraham, and of twelve months after Joseph. Voltaire rejected the longevity assigned to the patriarchs of the Bible, but accepted without question the stories of the great ages attained by some men in India, where, he says, "it is not rare to see old men of one hundred and twenty years." The eminent French physiologist, Flourens, fixing the complete development of man at twenty years, teaches that he should live five times as long as it takes him to become an adult. According to this author, the moment of a completed development may be recognized by the fact of the junction of the bones with their apophyses. This junction takes place in horses at five years, and the horse does not live beyond twenty-five years; with the ox, at four years, and it does not live over twenty years; with the cat at eighteen months, and that animal rarely lives over ten years. With man, it is effected at twenty years, and he only exceptionally lives beyond one hundred years. The same physiologist admits, however, that human life may be exceptionally prolonged under certain conditions of comfort, sobriety, freedom from care, regularity of habits, and observance of the rules of hygiene; and he terminates his interesting study of the last point ("De la Longévité humaine") with the aphorism, "Man kills himself rather than dies."

Another physiologist, Dr. Huferand, wrote in 1841 in the "Journal de la Société de Statistique universelle": "There is nothing to prevent our considering the most remote terms which the known examples of longevity offer to us as forming the extreme limit of human life, or as the ideal of perfection, as a model, finally, of what the nature of man is capable of under favorable circumstances. Experience attests that one may live to one hundred and fifty and even to one hundred and sixty years. More than this, the autopsy of Thomas Parr, who died at one hundred and fifty-two years, which showed that all his viscera were perfectly sound, proves that he might have lived still longer, if the new kind of life that he led in consequence of a change in his conditions of existence had not determined a mortal

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plethora in him. There is, then, nothing improbable in the affirmation that the organization of man may endure and his vital force act during two centuries." Dr. Berthelot, adopting the doctrine that the duration of human life is proportioned to the time required for reaching maturity, cites as a well-known fact that the traveler Delahaye, who was born with a robust constitution and led a regular life, was not matured till long after the common time, married and became a father at seventy, and lived till he was a hundred and twenty years old.

The German physiologists have paid the greatest attention to this subject. Haller maintained that man might live to two hundred years. Hufeland, in his "Art of prolonging Life," teaches that the age of the world has to this day had no influence on the duration of human life, and that it may be prolonged to the length of the lives of the patriarchs computed according to the actual divisions of time; assuming that the animal lives eight times as long as it takes it to reach maturity, he calculates that man becoming an adult at twenty-five years, should live to be two hundred years old. This opinion is shared by Professor Karup, Dr. Buschner, of Darmstadt, and others who have written with reference to life insurance. Dr. Gardner, an English physiologist, has also published a work on the means of prolonging life, and has likewise adopted the doctrine of a ratio of the whole duration to the period required for full development. He believes, however, that the latter period is not fixed, but that it varies from eighteen to twenty-one years, and consequently the whole length of life should be between ninety and one hundred and five years. But he does not hesitate to affirm that the latter age has never been passed, if it has been reached. Sir George Cornewall Lewis is still more skeptical, and does not believe that the existence even of a centenarian can be demonstrated. Mr. J. Thomes, in "Notes and Queries," while he contests ultra-centenarianism as impossible, cites as entirely authentic the fact of a client of an English life-assurance company having died in 1879, at the proved age of one hundred and two years and some months. But this case, he adds, "is the only one which an open inquiry among the oldest life-assurance companies of England has brought to light." According to Mr. Thompson, however ("Curiosities of Longevity"), nothing decisive is involved in the extreme rarity of centenarians in the annals of insurance companies, for the highest ages are found in the lower classes of society, and notably among agriculturists, who do not insure their lives.

So far as to doctrines; we now come to examine the facts. In this we must exercise considerable restraint, for the data we have personally gathered and those which we have found in books, memoirs, medical dictionaries, etc., form a considerable collection, the reproduction of which would require a volume; we shall have to make a very limited choice from among the numerous documents.

The ancient Greek writers, especially Lucian, have left biographi-

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cal notices concerning several centenarians of their country, and mention philosophers, moralists, poets, and artisans who reached and even passed one hundred years, among them the following: Solon, Thales, Pittacus, Epimedes, four of the seven wise men of Greece, lived more than a hundred years according to Lucian, who fixed the date of their death at about B. C. 600. Epimenides, poet and historian, according to Pliny, died at one hundred and fifty-four; Aristarchus, the tragic poet of Tegea in Arcadia, at one hundred years, about B. C. 460 (Lucian). The comic poet, Cratinus, of Athens, died at ninety-nine, B. C. 405. According to Valerius Maximus, Sophocles wrote his "Œdipus Tyrannus" when nearly a hundred years old, B. C. 405. The satirical poet Democritus died at one hundred and nine, B. C. 361; Gorgias, of Leontes, at one hundred and eight, B. C. 400. The great orator Isocrates perished from hunger at ninety-nine years, B. C. 338. Hippocrates, the father of medicine, died at the same age, B. C. 361. The philosopher Theophrastus died at one hundred and seven, about B. C. 254. Cleanthes, of Epirus, the celebrated disciple of Zeno, died nearly one hundred years old, B. C. 240. The historian, Hieronymus, of Rhodes, died at one hundred and four, B. C. 254. The immortal Galen died, like his great predecessor Hippocrates, almost a centenarian, B. C. 193. The philosopher Demonax, of Crete, perished from hunger at one hundred years, in the reign of Hadrian.

The Romans also had their centenarians, but the dates of their deaths are often not given. Juvenal was a hundred years old when he died, B. C. 120. Terentius Varro died at ninety-eight, B. C. 28. Quintus Fabius Maximus, augur for sixty-two years, died a centenarian, B. C. 107. Perennius Tutus died at Cornelia, at one hundred and eleven, A. D. 117.

Women also reached a very advanced age. It is notorious, for example, that Terentia, the divorced wife of Cicero, died at between one hundred and three and one hundred and twelve, after having been remarried three times, about B. C. 62. The poet Martial gives an epitaph in verse of a woman who died in his time at the fabulous age of two hundred years. The juggler Galeria practiced at her profession till she was a hundred years old, and died at one hundred and four, A. D. 9. According to Pliny, the comedian Luccia also played till the same age as Galeria, and died at one hundred and fifteen. Phlegon, in his book "De Rebus Mirabilibus" and "De Longævis," mentions the names and places of origin of one hundred and seventeen centenarians who died at different periods of the Roman Empire. On the taking of the census under Vespasian, A. D. 74, fifty-four of the inhabitants of the eighth administrative circumscription declared themselves to be one hundred years old, one hundred and fourteen between one hundred and one hundred and ten, two between one hundred and ten and one hundred and twenty-five, four between one hundred and twenty-five and one hundred and thirty, four between one hundred

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and thirty and one hundred and thirty-five, and three between one hundred and thirty-five and one hundred and forty. It is questionable whether these old persons may not have had some interest in claiming such great ages.

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In modern times, we have for France documents relatively worthy of faith only from the beginning of the eighteenth century. Except in a small number of cases, where the ages have been authenticated by extracts from baptismal registers, these ages have no other guarantee of exactitude than the declarations of the interested parties and contemporaries.

Documents which we have before us—necessarily very incomplete—attribute to France, during the eighteenth century, a few more than a hundred centenarians. The majority of these were men, but women appear to have reached the most advanced ages. Agriculturists figure largely in the number, while industrial workers and inhabitants of cities are few among them. A certain degree of probability is given to the statements by the fact that the number of extraordinary ages claimed is very small. Instances of fecundity at advanced ages are not rare. Contemporaneous writers mention examples of rejuvenation which must be regarded as probably legendary, although they have been recorded without protestation in grave scientific works. A much more serious fact, and one that may be more reasonably admitted, is that of hereditary longevities, of which there are numerous examples. Most of these centenarians appear to have been temperate, only two instances of drunkards being known among them. Many of them were indefatigable walkers, traversing every day considerable distances to go to their work; and, according to the custom of the day, they all went to bed and rose early.

Among the most distinguished of them were the following, whose cases are given in the order of their dates: The diplomat De Vignancourt died at one hundred and three, in the exercise of his functions; the Marchioness of Luxemburg and the Maréchal d'Estrées died at one hundred; the three advocates, Larroque, of Agen; Coster, of Bordeaux; and William Grévin, of Pont l'Eveque, the first two at a hundred and eleven, and the last at a hundred and seven. The master-saddler Philip Herbelot died in 1714, at the verified age of one hundred and fourteen years. M. Lefèbre de Lezeau still attended the councils of the king when a hundred years old, and died in 1715. Charles Colbert, brother of the great Minister, died at a hundred and four. Jacques Poncy, dean of the surgeons of Paris, performed operations in his hundredth year, and died at a hundred and two. The Count de Bethune, an old superior officer, died in Paris, at a hundred and five. Fontenelle died at a hundred, on the 9th of January, 1757. Dom Jean Mabillon, of the Academy of Inscriptions and Belles-Lettres, died in Paris at a hundred and six, in 1778. Anne Marie Brideau died at a hundred, in the enjoyment of a tontine fund that brought her 55,625

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livres of revenue in return for an outlay of three hundred livres. The Marchioness of Balestrin died at a hundred years, famous for her wit and her satirical verses. Françoise Pinel, a pauper, died at the Charité in Lyons, at a hundred and four, in January, 1754; and Marie Nauserine, another pauper, at the Hospital of Dinan, at a hundred and five, in March, 1756. The Baron de Lavaur died in 1764, at a hundred and five. Madame Marie Jahan, widow of M. de Villeneuve, lieutenant-general, died at a hundred and eight. Madame Lullin, having reached a hundred years, received a bouquet with a complimentary verse from Voltaire. The most advanced age seems to have been attained by a patriarch of the Jura, named Jacob, who was presented to the National Assembly on the 28th of October, 1789, at the age, as attested by his baptismal record, of one hundred and twenty years. Two invalids, one a hundred and six, the other a hundred and seven years old, dined with the First Consul on the tenth anniversary of the capture of the Bastile, July 14, 1799. Facts concerning centenarianism are still more abundant in the nineteenth century, for more attention has been paid to collecting and publishing them, especially since the athenticity of such cases has been disputed. Dr. François de Beaupin, who died at Chateaubriand in 1805, a hundred and seventeen years old, was married a second time at eighty, and had sixteen children by each marriage. Dr. Dufournet, who died at Paris in 1810, aged a hundred and ten, married a girl of twenty-six at eighty, by whom he had two children. On the occasion of the inauguration of the equestrian statue of Louis XIV in 1822, Pierre Huet, who was called dean of the French army, and was a hundred and seventeen years old, was placed in a chair in front of the statue, and was decorated in the name of the King by the Prefect of the Seine. M. d'Ornois, of the Academy of Rouen, died at St. George's in 1834, at a hundred and five. Alexandre Mongeot, formerly Professor of Mathematics in the Polytechnic School, died at Passy in 1807, at a hundred and five, with all his faculties sound. Madame Foulon, sister of the unfortunate manufacturer of that name who was murdered by the populace in 1789, died in Paris at a hundred and four. A robust old man, M. Desquersonnières, formerly commissary of the armies, was still living in Paris in 1842 at the authenticated age of a hundred and fourteen years; we do not know the date of his death. We were personally acquainted with M. Verron, who died in 1860 at the well-authenticated age of a hundred years. He had administered the commune of Montmartre for more than fifty years, and was still its mayor at the time of his death. Baron de Posant, former prefect, died in Paris in 1872, at a hundred and two; the Count Jean Frédéric de Waldeck on the 29th of November, 1875, at a hundred years and some months. The latter was in his youth a military and diplomatic figure of considerable importance; he published a book of travels in North and South America in 1838, and was a painter of considerable distinction. M. Duroy, a retired officer,

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being a hundred and four years old, attended the marriage of his great-granddaughters in 1877, sang, and opened the ball. M. Kennoux, Mayor of Plermeux-Gontier for fifty-three years, died in the same year at a hundred years and eight months. François Pelpel, a distiller of Paris, announced in the newspapers in 1878 that he had reached his one hundredth year, and was enjoying good health. Louis Etienne Mirvault, a former diplomat, who had served in the American war with Lafayette and Rochambeau, died at Ransay in the same year, aged a hundred and two years and six months. The celebrated physicist Becquerel was more than a hundred years old when he died.

Mr. Thompson, in his "Curiosities of Longevity," has related numerous cases of centenarianism in England. One of the most remarkable is that of a peasant who died near the middle of the seventeenth century at the hyperbolical age of one hundred and seventy-two years, and is said to have received the honor of being buried at Westminster. Another is that of Henry Jenkins, who is said to have lived to one hundred and seventy-five. Lord Bacon, of Verulam, in his book "De Vita et Morte," speaks of the deaths of contemporaries at the ages of one hundred and fifty and even of one hundred and sixty years, ages that were proved, he said, by judicial documents quite worthy of faith. The family of Thomas Parr, who died in his hundred and fifty-second year, incontestably enjoyed the privilege of a very great length of life. Parr left three grandsons, who died, one at one hundred and twenty-four, the second at one hundred and twenty-five, the third at one hundred and twenty-six years. William Parr died at Birmingham in 1770, one hundred and twenty years old, after having had forty-four children, grandchildren, and great-grandchildren die. John Tice died in 1770, after a troubled life of one hundred and twenty-six years. Mr. Thompson cites also, as entirely worthy of faith, the death of one Gordon at Edinburgh in 1775, at the age of one hundred and thirty-one years. According to Dr. Isidore Bourdon, Greenwich Hospital had in 1806 one hundred and twenty centenarians, thirteen of whom were bachelors. A man applied at a life-insurance office in London, in 1875, for insurance, who said, in answer to questions, that on his father's side his grandfather had died at one hundred and ten and his grandmother at ninety-five, and the same ancestors on the mother's side at one hundred and at ninety-nine years; his mother, still living, was one hundred and five, and his father had died at one hundred and eight. A man who presented himself at the police-office of Doncaster in 1872, said that he was one hundred and eight years old, and had had twenty-two children, and that his wife had died in 1870 at ninety-nine. The Rev. Mr. Bradon, of Southampton, was congratulated by the Queen on the occasion of his hundredth birthday in 1877. The Rev. James Hingham died at Unst in February, 1879, aged one hundred and three. He had learned Hebrew and German after he was ninety; his father died at one hundred and his grandfather at one hundred and five. It

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would lengthen our list too much to quote from the records of centenarians in other countries. Taking the mean of the censuses from 1869 to 1872, we find that Europe (except Russia, Turkey, and a few small states in the south) had in a population of 212,940,376, 17,313,715 persons more than sixty, 79,850 more than ninety, and 3,108 more than one hundred years old; or one person in twelve over sixty, one in 2,669 over ninety, and one in 62,503 over a hundred. According to a table we have calculated for fifteen countries of Europe, more women than men attain an extreme old age, and the difference increases with the age. The greatest number of persons over sixty years of age is found in France, but not the greatest number of centenarians. Calculating upon the given age at death, we have found the percentage of those among the deceased who were ninety years old and more to be, in Great Britain, 9·73; in Sweden, 7·39; in France, 6·58; in Belgium; 6·07; in Switzerland, 6; in Holland, 4·47; in Italy, 3·76; in Bavaria, 3·42; in Prussia, 3·06; in Austria, 2·61.

As to whether the proportion of great longevities is increasing or diminishing, we have information only for France. During the fourteen years, from 1823 to 1837, the mean annual number of persons dying centenarians was 152, or one for 217,105 inhabitants; during the eight years, from 1852 to 1860, the mean was 111 in a population that had increased twenty per cent. But, although the great ages seem to have diminished, the mean length of life has very sensibly increased, and this is much better.

A number of centenarians have made their regimen known. Notwithstanding some rare examples to the contrary, temperance, sobriety, and regularity of habits, are of the first importance; then follow heredity, a relatively comfortable condition, freedom from strong and frequent emotions, residence as far as possible in the country, exercise, and a healthy and quiet business. The celebrated but humorous German physiologist, Hoffmann, summarizes the means of reaching a great age as follows: "Avoid excess in everything, respect old habits, even bad ones, breathe a pure air, adapt your food to your temperament, shun medicines and doctors, keep a quiet conscience, a gay heart, a contented mind."—*Revue Scientifique.*

WORRY.

By Dr. J. MORTIMER GRANVILLE.

WHEN a strong and active mind breaks down suddenly, in the midst of business, it is worn out by worry rather than overwork. Brain-labor may be too severe, or ordinary exercise prolonged until it produces serious exhaustion; but the mere draining of re-

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sources, however inexpedient, is not disease, and seldom inflicts permanent injury. A temporary collapse of the mental powers may be caused by excessive or too continuous exertion, just as a surface-well may be emptied by pumping it out more rapidly than it is refilled, but the apparatus is not thereby disorganized, and time will remedy the defect. When rest is not followed by recovery, the recuperative faculty itself, an integral part of the intellectual organism, must be impaired or disabled. This is not unfrequently the case when the possessor of a worried and weakened brain in vain seeks refuge from the supposed effects of "overwork" in simple idleness. Something more than exhaustion has occurred, and rest alone will not cure the evil. The faculty of repair is not in a condition to restore the equilibrium between potential energy and kinetic force. Divers hypotheses have been suggested to explain this state of matters. The mind has been compared to a muscle overstrained by a too violent effort, or paralyzed by excessive exertion. The two phenomena have little similarity, and no new light is thrown on the nature of mental collapse by the comparison. Perhaps a closer parallel might be found in the state which ensues when the tension of a muscular contraction is so high that spasm passes into rigidity, and molecular disorganization ensues. Meanwhile, however interesting these speculations may prove to the physiologist, they bring no relief to the sufferer. It is easy to see that a worse evil than simply using up his strength too rapidly has befallen him, but no one knows precisely *what* has happened. To cover the enigma, without solving it, "overwork" is taken to mean more than work *over* the normal, in quantity, quality, and time, but no attempt is made to determine how excess, in either or all of these particulars, can bring about the disability and decrepitude we bewail. It is to the investigation of this mystery that attention needs to be directed. If it should be possible to ascertain why a mind previously healthy, and still apparently intact, breaks down instantly and thoroughly under a strain not exceptionally great, and, collapse having once occurred, recovery follows tardily and is rarely complete, it will probably be within the scope of common-sense to draw some practical conclusions as to the prevention, and it may be the cure, of what is in truth becoming a scourge of mental industry already almost decimating the ranks of the army of progress, in every field of intellectual enterprise at home and abroad.

A certain degree of tension is indispensable to the easy and healthful discharge of mental functions. Like the national instrument of Scotland, the mind drones wofully and will discourse most dolorous music, unless an expansive and resilient force within supplies the basis of quickly responsive action. No good, great, or enduring work can be safely accomplished by brain-force without a reserve of strength sufficient to give buoyancy to the exercise, and, if I may so say, rhythm to the operations of the mind. Working at high-pressure may be bad,

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but working at low-pressure is incomparably worse. As a matter of experience, a sense of weariness commonly precedes collapse from "overwork"; not mere bodily or nervous fatigue, but a more or less conscious distaste for the business in hand, or perhaps for some other subject of thought or anxiety which obtrudes itself. It is the offensive or irritating burden that breaks the back. Thoroughly agreeable employment, however engrossing, stimulates the recuperative faculty while it taxes the strength, and the supply of nerve-force seldom falls short of the demand. When a feeling of disgust or weariness is not experienced, this may be because the compelling sense of duty has crushed self out of thought. Nevertheless, if the will is not pleasurably excited, if it rules like a martinet without affection or interest, there is no *verve*, and, like a complex piece of machinery working with friction and heated bearings, the mind wears itself away and a breakdown ensues. Let us look a little closely at this matter.

The part which "a stock of energy" plays in brain-work can scarcely be exaggerated. Reserves are of high moment everywhere in the animal economy, and the reserve of mental force is in a practical sense more important than any other. It may happen that mere strength of mind carries a body with scarcely a vestige of power in reserve through some crisis of extraordinary difficulty, but the mental exploit is full of danger. The residual air in a lung is the basis of the respiratory process; the sustained tension of the smaller arteries transforms the pulsating current of blood thrown into the system by the heart to a continuous circulation; the equilibriated tonicity of opposing muscles gives stability to the apparatus of motion, and renders specific combinations of movement possible. What is true of the physical is also true of the mental constitution; the residual force, the tension, the tonicity, of mind, form the basis of intellectual action. It is not necessary to discuss the relations of mind and matter; even if the mental being is no more than a formulated expression of the physical organism, the continuity is so complete that the same laws govern both. For the purposes of the present argument it is sufficient to assert that, without a reserve of energy, healthy brain-work is impossible. Pain, hunger, anxiety, and a sense of mind-weariness, are the warning tokens of exhaustion extending to the reserves. When these indications are disregarded, or destroyed, as they may be, by stupefying drugs, an inordinate use of stimulants, a strong effort of the will, or the anæsthetic effect of excessive exhaustion, the consumption of energy goes on unobserved. The feats of intellectual or physical strength, the surprising exploits of special sensation and mind-power, performed by individuals under the influence of any condition which suspends the sense of pain, weakness, or fatigue, are explained by the circumstance that unsuspected reserves of power and endurance are placed at the disposal of the will. These resources were there before, but jealously guarded by the sensations. Martyrdom is possible under the influence of an over-

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powering abstraction. Passion may produce a similar immunity from pain, and give ability to endure even self-inflicted injury. The daily experience of lunatic asylums will abundantly attest the truth of this last assertion.

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How does all this bear upon the subject? It seems rather to strengthen the position assailed, by showing that "overwork" may exhaust the reserves, thereby arresting the function, and possibly destroying the integrity, of the mental organism! That is undoubtedly the surface view of the case, and it is the popular explanation of what occurs. To controvert the received hypothesis is the object of the present paper. The argument, opposed to the theory of work itself exhausting the stock of energy, may be simply stated thus: the reserves, physical and mental, are too closely guarded to be invaded by *direct* encroachment. Pain is not suspended by the persistent infliction of injury unless the mechanism of sensation is disabled or destroyed. Hunger does not cease until starvation has assailed the seat of nutrition. The sense of extreme weariness is not allayed by increased activity, but the longing for rest may subside, because it has been stifled by some overwhelming influence. The natural safeguards are so well fitted for their task that neither body nor mind is exposed to the peril of serious exhaustion so long as their functions are duly performed. In brief, overwork is *impossible* so long as the effort made is natural. When energy, of any kind, takes a morbid form of action, some force outside itself must be reacting upon it injuriously; and the seat of the injury, so far as the sinister influence on energy is concerned, will be found in close proximity to the sensation which under normal conditions guards the reserve. The use of stimulants in aid of work is, perhaps, one of the commonest forms of collateral influence suspending the warning sense of exhaustion. When the laborious worker, overcome with fatigue, "rouses" himself with alcohol, coffee, tea, or any other agent which may chance to suit him, he does not add a unit of force to his stock of energy, he simply narcotizes the sense of weariness, and, the guard being drugged, he appropriates the reserve. In like manner, when the dreamer and night-watcher, worn out by sleeplessness, employs opium, chloral, or some other poison to produce the semblance of repose, he stupefies the consciousness of unrest, but, except in cases where it is only a *habit* of sleeplessness, which has been contracted, and, being interrupted, may be broken by temporary recourse to a perilous artifice, the condition is unrelieved. Not unfrequently the warning sense is stifled by the very intensity of the motive power or impulse. Ambition, zeal, love, sometimes fear, will carry a man beyond the bounds set by nature. No matter what suspends the functions of the guard set at the threshold of the reserve, if the residual stock is touched, two consequences ensue—waste and depreciation. It is important to recognize both of these evils. The former is generally perceived, the latter is commonly overlooked. The

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reserve, as we have seen, plays a double part in the economy: it is a stock in abeyance, and it is the base of every present act. Without a reserve of mental energy, the mind can no more continue the healthful exercise of its functions than a flabby muscle without tonicity can respond to the stimulus of strong volition and lift a heavy weight or strike a heavy blow.

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The cause, or condition, which most commonly exposes the reserve of mental energy to loss and injury is *worry*. The tone and strength of mind are seriously impaired by its wearing influence, and, if it continue long enough, they will be destroyed. It sets the organism of thought and feeling vibrating with emotions which are not consonant with the natural liberation of energy in work. The whole machinery is thrown out of gear, and exercise, which would otherwise be pleasurable and innocuous, becomes painful and even destructive. It is easy to see how this must be. The longest note in music, the most steady and persistent ray of light—to use an old-fashioned expression—the tonic muscular contraction, are all, we know, produced by a rapid succession of minute motive impulses or acts, like the explosion and discharge of electricity from alternately connected and separated points in a circuit; in fact, a series of vibrations. Mental energy doubtless takes the same form of development. If a disturbing element is introduced by the obtrusion of some independent source of anxiety, or if, out of the business in hand, the mind makes a discord, confusion ensues, and for the time being harmonious action ceases. Working under these conditions in obedience to the will, the mental organism sustains injury which must be great, and may be lasting. The function of the warning sense is suspended; the reserve is no longer a stock in abeyance, and it ceases to give stability to the mind; the rhythm of the mental forces is interrupted; a crash is always impending, and too often sudden collapse occurs. The point to be made clear is this: overwork is barely possible, and seldom, if ever, happens, while the mind is acting in the way prescribed by its constitution, and in the normal modes of mental exercise. The moment, however, the natural rhythm of work is broken and discord ensues, the mind is like an engine with the safety-valve locked, the steam-gauge falsified, the governing apparatus out of gear; a breakdown may occur at any instant. The state pictured is one of worry, and the besetting peril is not depicted in too lurid colors. The victim of worry is ever on the verge of a catastrophe: if he escape, the marvel is not at his strength of intellect so much as his good fortune. Worry is disorder, however induced, and disorderly work is abhorred by the laws of nature, which leave it wholly without remedy. The energy employed in industry carried on under this condition is lavished in producing a small result, and speedily exhausted. The reserve comes into play very early in the task, and the faculty of recuperation is speedily arrested. Sometimes loss of appetite announces the cessation of nutrition; otherwise

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the sense of hunger, present in the system, is for a time preternaturally acute, and marks the fact that the demand is occasioned by loss of power to appropriate, instead of any diminution of supply. The effort to work becomes daily more laborious, the task of fixing the attention grows increasingly difficult, thoughts wander, memory fails, the reasoning power is enfeebled; prejudice—the shade of defunct emotion or some past persuasion—takes the place of judgment; physical nerve or brain disturbance may supervene, and the crash will then come suddenly, unexpected by on-lookers, perhaps unperceived by the sufferer himself. This is the history of "worry," or disorder produced by mental disquietude and distraction, occasionally by physical disease.

The first practical inference to be deduced from these considerations is that brain-work in the midst of mental worry is carried on in the face of ceaseless peril. Unfortunately, work and worry are so closely connected in daily experience that they can not be wholly separated. Meanwhile the worry of work—that which grows out of the business in hand—is generally a needless though not always an avoidable evil. In a large proportion of instances this description of disorder is due to the lack of education in brain-work. Men and women, with minds capacious and powerful enough but untrained, attempt feats for which training is indispensable, and, being unprepared, they fail. The utilitarian policy of the age is gradually eliminating from the educationary system many of the special processes by which minds used to be developed. This is, in part at least, why cases of sudden collapse are more numerous now than in years gone by. It is not, as vanity suggests, that the brain-work of to-day is so much greater than that exacted from our predecessors, but we are less well prepared for its performance. The treatment of this form of affection, the break-down from the worry of work, must be preventive; the sole remedy is the reversal of a policy which substitutes results for processes, knowledge for education. It is a serious cause of discomfiture and sorrow in work that so much of the brain-power expended is necessarily devoted to the removal of extraneous causes of worry. Labor is so fatal to life, because it is so difficult to live. The deadly peril of work in the midst of worry must be confronted, because the disturbing cause can only be got rid of by persistent labor. This is the crux of the difficulty, and, in the attempt to cure the evil, the struggling mind finds its fate involved in a vicious circle of morbid reactions. Nevertheless, it is the fact that work in the teeth of worry is fraught with peril, and whenever it can be avoided it should be, let the sacrifice cost what it may.

The second deduction must be, that there is no excuse for idleness in the pretense of fear of "overwork." There is some reason to apprehend that the attention recently directed to this alleged cause of mental unsoundness has not been free from a mischievous influence on

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minds only too ready to take refuge in any excuse for inactivity. If the private asylums of the country were searched for the victims of "overwork," they would nearly all be found to have fallen a prey to "worry," or to that degeneracy which results from lack of purpose in life and steady employment. This is a grave assertion, but it points to an evil it is especially needful to expose. Weak minds drift into dementia with wondrous celerity when they are not carried forward to some goal, it matters little what, by the impulse of a strong motive. The bugbear of "overwork" is, it may be feared, deterring parents and friends from enforcing the need of sedulous industry on the young. The pernicious system of "cram" slays its thousands, because *uneducated*, undeveloped, inelastic intellects are burdened and strained with information adroitly deposited in the memory, as an expert valet packs a portmanteau, with the articles likely to be first wanted on the top. Desultory occupation, mere play with objects of which the true interest is not appreciated, ruins a still larger number; while worry, that bane of brain-work and mental energy, counts its victims by tens of thousands, a holocaust of minds sacrificed to the demon of discord, the foe of happiness, of morality, of success. The enemy takes many shapes and assumes bewildering disguises. Sometimes he comes in like a flood, hurrying everything before him; with heaps of work to be done in less than adequate time. Now the victim is hurried from task to task with a celerity fatal to sanity. Then he is chained like a galley-slave to some uncongenial labor without respite. Again, a buzz of distracting and irritating mental annoyances seem let loose to distress and distract him. Under each and all of these guises it is *worry* that molests, and, unless he be rescued, will ruin him. Meanwhile, the miseries of "overwork," pure and simple, are few and comparatively insignificant. Those who bewail their infliction most loudly are weak of mind or torpid of brain. Of such lame and maimed mortals we are not now thinking. Their lot may be humiliating or pitiable, as their condition is due to neglect or misfortune; but our concern is with the multitude of strong and able-minded workers who fail at their task. These are the victims not of overwork but of worry, a foe more treacherous and merciless than all besides. The mind-cure for the malady to which "worry" gives rise, and from which so many suffer, is not idleness, or "rest," in the ordinary sense of that term, but orderly and persistent work. The work by which they have been injured has not been excessive, but bad of its kind and badly done. The palsied faculties must be strengthened and incited to healthy nutrition by new activity, at first, perhaps, administered in the form of passive mental movement, and then induced by appropriate stimuli applied to the mind.—*Nineteenth Century.*

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AMERICAN CLIMATE AND CHARACTER.

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By EDWARD C. TOWNE.

THE statements given under this head at pages 705 and 706 of "The Popular Science Monthly" for September, 1880, are not borne out by a careful study of facts on English soil, where alone popular American and foreign ideas in regard to the English climate and character can be duly corrected. I have given special attention to the subject in the way of study for very many years, and in the way of observation in England during the past four years, and my conclusion is that the only English and American facts which present a contrast are exceptional ones, and that for the several statements of Mr. Young and the authorities quoted by him there is scarce any foundation at all. Study led me to the conviction long since that the general American or Yankee type, in all its varieties, belonged to England as truly as to America, and that the John Bull type is an exceptional one in England, and exclusively English, partly because it never emigrates, and partly because its characteristics are due to English eating and drinking habits. Observation has shown me that the facts are even more in this direction than I had expected to find them, and that statements such as those of Mr. Young and his authorities could hardly be more wide of the mark.

For more than thirty years I have had a habit of studying the looks of people upon every opportunity, and was most familiar when I came to England with American characteristics in Boston, New York, Philadelphia, Baltimore, Cincinnati, Chicago, and the Northern States generally, and to a considerable extent in the South. In England I have seen the crowds of London, Liverpool, Manchester, Sheffield, and other places, and have many times made a special study of large companies (one to four thousand) of people where I could walk about among them by the hour together. On one occasion, for example, I made a series of visits to a fair which brought together a large number of the titled ladies of the north of England. I saw there one lady of the type which made Hawthorne write as he did of the beef-eating bigness of English women—a duchess who must have frequently crossed Hawthorne's vision. The duke, her husband, reminded me of my own father, spare and dark, and no way a John Bull. The other ladies of quality had exactly the look in every way of the ladies one sees in the best company in Boston. The company generally, apart from the titled ladies, made no approach to a Boston company, but strikingly lacked quality, whether beauty, refinement, or taste. But there was no such contrast as Mr. Young asserts. There is no ground worth speaking of for his statement as to the contrast between English and American women. It is not at all true. I can compare a country vil-

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lage in Massachusetts with one in Yorkshire, and what Mr. Young says of American women lacking or losing form and beauty is more true of the English example than the American. There are numbers of English women, it is true, who show the type, at one extreme, to which Mr. Young refers, but as you go from that extreme to the other you find the middle type as much the rule in England as in America, and the worn, thin, nervous type fully as common in England as in America, and often more extreme here than in America. It is life more than climate which produces this extreme, and life for Englishwomen is worse than American in the whole lower range of society, and in many sections higher up.

It is quite erroneous for Mr. Young to talk of the drying, irritating effect of American climate as compared with English. The drying, irritating, corrosive effect of the east wind in the streets of London is very much worse than anything known in America. It is a strong, steady Siberian wind, which blows for weeks together, with a biting power which I have seen entirely blacken the early leaves of the horse-chestnut. In many seasons, judging by what I have seen myself, and by many statements made by English writers, I should say that, in bad seasons at least, the irritating effects of the English climate are more than twice as bad as those of the American. At any rate, there is no ground whatever for saying that American women are made thin and English are not. More English women than American are made very thin by the greater cruelty to women of English care and toil and suffering. And, if more are kept stout, it is largely because the stout type have stuck to the home soil, and very largely because of beer added to beef.

Mr. Young's conclusion as to America, that "the dry air produces nervous, energetic, large-jointed skeletons, which have little or nothing in common with the stout, fresh, rosy, phlegmatic inhabitants of the mother-country," could not well be more wide of the mark. The type which Mr. Young says is American was produced hundreds of generations ago; and if Mr. Young chooses he can see in the north of England a larger proportion of this type than he can find anywhere in America, except those parts of the South where English and Scotch of this type were numerous in the early colonies. Typical skeletons are not made in a day, nor in seven or eight generations. I should say that, across England by Manchester and Sheffield, the "nervous, energetic, large-jointed," not stout, not rosy, and most emphatically not phlegmatic men, are ten to one as numerous as anywhere in America. One supposes that he has seen nervous energy in Chicago, but only in England have I ever had my attention drawn to nervous energy almost gone mad. The impression that the English are phlegmatic is a false inference from peculiar appearances.

The exterior calm is very often that of suppressed temper, and the outbreak of violent temper is very much worse and much more fre-

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quent in England than in America. It is common to find gentlemen, who are such in character and position, delightfully genial at one time and violently passionate at another. I met in America a gentleman of the best standing in his English home, the winning charm of whose manners awakened in me the desire to study character in the old country. One of my friends was dining with this gentleman after his return, and was asked, as an American, to state what the case was between the North and the South in the civil war. My friend made a moderate statement of his view as a Northern man, and, when he had concluded, his host, his face white and his lips trembling with passion, replied, "I have been several weeks in your country, in the North and in the South, and there isn't a word of truth in what you have said!" There was a second English gentleman present, who insisted that Mr. Garrison and other American friends had given the same account, and that it must be true. This second gentleman is physically what Mr. Young would call an American, and he has no more reserve of temper than the typical Boston gentleman.

Extreme passion is very much more common in England than in America, and especially in the north of England. But I doubt whether the very strong air and the intense vital vigor which it tends to produce explain it. It seems to me rather a moral survival, one of the signs of barbarism holding on which one so often encounters in England. The habit which many of the working-class have of brutally kicking their wives in the abdomen, and many other forms of British masculine energy, would disappear without reference to climate if education and other moral influences were such as they are in America.

Mr. Young singularly errs in stating that Britons have a stout, fresh, rosy habit, which they directly lose in American air. I am writing where there is a country population of four thousand, and I should make money by giving Mr. Young a dollar for every rosy Briton he could find if he would give me a cent each for every "peculiarly American" member of the population. In the towns, Mr. Young's Britons can be more easily found; but the type is more conspicuous than it is numerous. Of course, the style of dress, the cut of the beard, and the puff and color given to the face by drink, are not due to climate and are not race-characteristics; yet many not sufficiently instructed observers fail to see that, if they were to deduct these characteristics in the case of many who seem strikingly English, the type would look quite American. The last large company of Englishmen whom I have seen showed very many of the "nervous, energetic, large-jointed skeletons" of Mr. Young's peculiarly American type, and I have personal knowledge which enables me to say that nowhere in America could an equal number be found of men violently excitable and explosive. Temper, in fact, and nerves, are generally very much worse in England than in America. There is no approach in America

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to the passion of an English crowd. A throng pressing to get at the doors of a public hall are violent and dangerous to a degree unknown in America. But it is the native barbarism, not the climate. In figure, stature, and aspect, a body of men in England met for intellectual purposes will rarely suggest any contrast between England and America. At the Royal Academy Exhibition in London on my first visit, when I studied the people rather than the pictures, and at the opening of the new Town Hall in Manchester, where four thousand people in full dress were wandering through the hall, corridors, and state apartments of the vast structure, the great mass of the people were not different from American in any of the respects named by Mr. Young. There is a marked difference, which an Englishman living in America expressed by saying that English women are dowdy compared with American. I should not say this, for it is not true; but it is true that, while cultivated and attractive refinement and taste are the same with women of the superior class in both countries, there is much less diffusion of the influence of this class in England than in America; and, so far from Mr. Young's view being true, it is rather the fact that a general crowd is much less good-looking in England than in America, and in no respect will American women suffer in comparison with English.

My first year in England took me over the region from London to Oxford, and I used every opportunity to observe both men and women, with the result that I hardly at all saw Mr. Young's British type. I did see it in a few gentlemen pampered with port and in farmers rosy with beer, but commonly I saw the American type, as Mr. Young would call it. In a society of thirty gentlemen with whom I met weekly, the type was much more American than it would have been in Plymouth, Massachusetts—figures slighter and temperament more nervous. The authorities quoted by Mr. Young have spoken much more from hasty theory than from any real facts. Dr. Reich has no warrant whatever for asserting a great difference between English and American physical types. The differences are not so much physical as moral, and they are not, with some exceptions, so much differences of type as differences superficially established by habits. If England had had American education and abstinence for the past fifty years, and could learn freedom, equality, and humanity as Americans do, it would be hard to see any great difference between the two peoples. What Dr. Reich says of the dryness and heat of America is said ignorantly. Is American air so dry along the Atlantic coast, and within reach of the great line of Northern lakes? The truth is, not that America is too dry, but that England is often not dry enough, and at other times is more dry than America. Dr. Reclam is out of sight of the facts completely when he compares the air of America and its effects to those of heights where lightness and dryness prevail, and thinks Americans characterized by peculiarities such as in Europe

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he supposes due to the dry northeast wind. This wind, from which England and the Continent suffer so much, is very much worse than any wind known to that chief part of America which extends from the Atlantic to the far side of the Mississippi Valley; and, so far as it produces results in exaggerated nervous activity and excesses of the national character, England and Germany are much worse off than America. In England especially, exaggerated nervous activity and excesses of national character are very much worse than they are in America, and, if northeast wind really causes such things, the atrocious blast certainly rages across England as it never does in America. What Matthew Arnold calls the effusion and the confusion and the vulgarity of the middle-class Englishman, that is, of the average Englishman, is something very much worse than any American development, and, so far as climate plays upon and excites this, England has ten days of irritating rawness, dryness of cold wind, and poison of dust, to one that America has.

As for heat, the mistake is no less complete. England suffers more from 78° than America from 98°. There is never a chance to change to summer dress with any security, and heat, when it does come, has to be undergone without preparation. It commonly, moreover, comes with excess of moisture, and has an effect more dangerous than twenty degrees more of American heat. Dr. von Pettenkofer has not done wisely in comparing the case of a person living in dry air with that of one living in damp air. Americans do not live in dry air, and Englishmen, with excess of damp much of the time, do not develop fat, or phlegmatically nervous temperament, or a sluggish want of intense energy. The mad chase after the material things of the world is more mad and feverish and violent in Manchester and its cotton-spinning neighbors than it is in Chicago and the Northwest of America. I think circumstances and not climate chiefly explain it, but for climate the American is much less likely than the English to produce the effect. The European hygienists, who are dealing with the subject by means of speculative observations, ought to try a winter and spring in Oldham, Blackburn, Bolton, or Wigan, and see what a cold wind can do, with dust and coal-smut, to create dry torment, and to sting the bony, skinny, fierce operative into communistic madness. If they would study a Lancashire mob and an English east wind, and would read the tale of speculation, fierce competition, and fraud in manufacture, which the Manchester men know so well, there would be an end of the shallow philosophy into which a totally wrong report of the facts has betrayed them.

Dr. Büchner could not have gone more astray than in his astonishing conclusion that Americans are tending toward the Indian type, not only in the face and form, but in the gestures and movements. The inference can not rest with Dr. Büchner on any adequate observation, either of Indians or of Americans, and its extravagance is wild

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and ridiculous in any just view of the real facts. It does not follow that gestures and movements, due to, we will say, acute tactical sensitiveness, indicate community of race. Some which I have had myself, I remark in my English housekeeper, and no doubt I might see them in an Indian or a negro. But one decisive fact disposes of Dr. Büchner's inference. The English much oftener suggest the Indian type than the Americans do, and there is much less extravagance in imagining, baseless as the notion would be, that England is turning Indian than in supposing that America shows such a tendency. In America I never saw a markedly Indian type without Indian blood, but I have seen it in England again and again; in one case a lady with the dirty-black skin, straight, intensely black hair, high, fierce temper, indifference to grime and smut on her hands, and habitually very bad breath of a savage, and yet purely English, and as much a lady and a Christian as her peculiarities permitted. America is much further than England from the Indian type, and is not tending toward it, but the contrary. In the earliest American days the opinion was at one time general in England that the climate of Virginia turned the colonists into blacks, and that, besides going black, a man was there harnessed into the plow and the cart and made to do the work of a beast. The like notions, only not quite so outrageous, form now a large part of English and foreign supposed knowledge of America, and Dr. Büchner's notion that Americans tend toward the Indian type is about the worst item of this *pseudo*-knowledge. English ignorance about America seems to me the worst ignorance anywhere existing. It is largely due to the greed of the general English mind for mean ideas of America. Unfortunately, many Americans unwittingly feed this greed, either from lacking correct comparative knowledge of England and America, or from making assertions or admissions which will be entirely misunderstood by the English mind. It requires a good deal of varied residence and reading for an American to know accurately and adequately his own country, and to know it in comparison with England requires residence in England, and that among the people. The most rural parts of England are best for knowledge calculated to throw light on America. The peculiar Yankee characteristics, as of guessing and questioning and cute getting to know all about a person or matter, I have actually seen in England, in their native seats. They are all old rural English, and have nothing to do with either climate or character in America. In America they have dwindled and been effaced more than they have in England.

But what I would particularly emphasize is the twofold fact that the character and the climate which are said to be American are both English a good deal more than they are American. The nervous temperament; the excess of energy; the exaggerations and intensities of character; the vulgarities and madness of selfish getting; the fierce resort to sham and shoddy as a short cut to profit; and all the forms

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of headlong service of the devil to which unregenerate, raw, brute humanity can be tempted, are very much worse in England than they are in America. And the air said to favor such characters is much more found in England than in America. I was myself under the impression, before I lived in England, that we had in America more electrical excitement than is known in England. But now I find that it shuts down on you more in England, and that while you see more in America, at a great height above the earth, you feel more of it in England, and have it dropping on you more; and that, although the climate is characteristically damp, there occur more and longer times of irritating dryness and electrical aggravation than are known in America. I am fortunately able to cite a testimony which will make clear what I mean, and prove that I do not imagine my facts. In "Nature" for September 9th, page 437, Professor Tait quotes from an account given him by an Irish correspondent, who tells how the dryness I speak of may come out of the same quarter from which at other times moist air comes, and who expressly says that the same dryness comes with the east wind which is such a curse to the British Isles. Professor Tait's correspondent wrote as follows:

"At the commencement of the present unprecedentedly long and severe storm the wind blew from southwest, and was very warm. After blowing about two days it became, without change of direction, exceedingly bitter and cold, and the rain was from time to time mixed with sleet and hail, and lightning was occasional. This special weather is common for weeks together in March or early April. The air is (like what an east wind brings in Edinburgh) cold, raw, dry, and in every way uncomfortable, especially to people accustomed to the moist Atlantic winds. During these weeks a series of small clouds seem to start at regular intervals from the peaks of hills in Connemara and Mayo. They are all more or less charged with electricity. I have at one time seen such a cloud break into lightning over the spire of the Jesuits' church. At another, I have seen such a cloud pour down in a thin line of fire, and fall into the bay in the shape of a small, incandescent ball. On one occasion I was walking with a friend, when I remarked: 'Let us turn and make a run for it. We have walked unwittingly right underneath a little thunder-cloud.' I had scarcely spoken, when a something flashed on the stony ground at our very feet, a tremendous crash pealed over our heads, and the smell of sulphur was unmistakable."

This sort of greater nearness of the electrical demonstrations is the rule in Great Britain; and the horrid dryness, rawness, and aggravation spoken of in the above account, as due to the east wind when that blows, as it does for weeks together, and also due for weeks together to other wind, are a greater and a more grievous infliction in Great Britain than anything known in America over the chief settled region.

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I think the general facts in regard to the English race in England and America and elsewhere should be referred to a history going back, not for the seven American generations, nor even for the forty British generations, but for at least a thousand generations. This great race, whose tongue is now spoken by a quarter of civilized mankind, was not made yesterday, and will not be unmade to-morrow. Its great essential lines are precisely the same in England and in America. New England in America was settled by English of picked moral and intellectual quality, and with the enormous double advantage of freedom to educate everybody and give everybody a chance, and of entire absence of the vile, pauper, and prostitute class which Old-World circumstances had created. The result has been that America, without some superlative advantages possessed by England, has on the broad level done more and done better than England in the direction of mind and quality, character and achievement—truly English in the higher sense of race; and that the British English type mainly differs from the American English by backward relation to barbarism, the Old-World use of war, monarchy and aristocracy, privilege oppressive of the people, as of lords and landlords, priests, pensioners, and publicans, and other forms of grievous denial of the rights and injury to the welfare of man as man. It would take a volume to tell the story of English barbarism. The English race has won on American soil stages of advance not yet won in England; and, when all the facts are discriminated, it will appear that climate in America is anything but unfavorable to this advance, although the opinion is a superficial error that climate has much to do with character in an age when circumstances dominate in the environment of a highly civilized race. As soon as English circumstances overtake American, there will cease to be any marked difference between the English in England and the English in America. And, when verified knowledge shall take the place of speculative, there will be no more Americo-German attempts to describe American climate as dry and damaging as compared with English. The climate of America is as much better than that of England as American civilization is more advanced on the broad level of the common people. It would double the value of England in every respect to have the climate of America. And certainly character would gain more than it would lose by the change.

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SKETCH OF GEORGE JARVIS BRUSH.

By Professor T. R. LOUNSBURY.

PROFESSOR GEORGE J. BRUSH was born in Brooklyn, New York, on the 15th of December, 1831. His father was a merchant in that city, but in 1835, retiring from business, took up his residence in Danbury, Connecticut. There the family remained till 1841, when they returned to Brooklyn; and in the schools of these two places Mr. Brush received his early education. It was not, however, until 1846, when he was sent to a school in West Cornwall, Connecticut, that he had an opportunity to pay any special attention to science. This school was kept by Mr. Theodore S. Gold, who was an enthusiastic student of mineralogy, botany, and of various other departments of natural history; and he not only gave instructions to his pupils in these subjects, but succeeded in inspiring them with a taste for them. Although young Brush was at this place only six months, he remained long enough to acquire a fondness for natural science, which in the end resulted in changing his course in life. He intended to pursue a business career; and, accordingly, on leaving the school at West Cornwall, entered, in the latter part of 1846, the counting-house of a merchant in Maiden Lane, New York City. There he remained for nearly two years, but the taste for scientific study already acquired did not desert him, and, in particular, he took advantage of every opportunity that came in his way to go off upon mineralogical excursions. A severe illness that befell him in 1848 rendered it necessary that he should abandon the mercantile profession, and it was decided that he should take up in its place the life of a farmer.

Just about this time Professor John P. Norton returned from Germany, and in conjunction with Professor Silliman, Jr., opened at Yale College a laboratory for the purpose of practical instruction in the applications of science to the arts and to agriculture. At the same time he began a course of lectures on agriculture and agricultural chemistry. To attend these lectures, to fit himself as thoroughly as possible for the life of a farmer, Professor Brush, not as yet seventeen years old, repaired to New Haven in October, 1848. This event changed his career. He came to attend a single course of lectures on agriculture. He remained two years as a student of chemistry and mineralogy. In October, 1850, he went to Louisville, Kentucky, as assistant to Benjamin Silliman, Jr., who had been elected Professor of Chemistry in the university of that city. There he remained the following winter, and in March, 1851, made one of the party who accompanied the elder Silliman on a somewhat extended tour in Eu-

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rope. Returning to Louisville in the autumn of that year, he continued acting in his old capacity until the spring of 1852. Then he returned to New Haven. At the time he was a student, no degrees were granted by the college merely for proficiency in science. There was a general feeling that the pursuit of it, like the pursuit of virtue, was its own reward. But through the exertions of Professor Norton the corporation of the college voted to create the degree of Bachelor of Philosophy, and to grant it to those of the old students in the department of science who would come back and pass a satisfactory examination. Accordingly, Mr. Brush returned, and, after undergoing examination, received, with six others, at the commencement of 1852, the degree of Ph. B., the first time it was given by the college.

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The academic year 1852–'53 was now spent by him at the University of Virginia, where he was employed as assistant in the chemical department. Here he was associated with Professor J. Lawrence Smith in a series of special studies, the object of which was to reëxamine a number of American minerals which had been described as new species. The results of their joint investigations were published in the fifteenth and sixteenth volumes of the "American Journal of Science," second series. At the end of the academic year Professor Brush went to New York, where he was associated with Professor Silliman, Jr., in charge of the mining and mineral departments of the Universal Exposition held that year in the city. But he now began to feel the necessity of pursuing his studies to an extent which he was not able to do in this country, especially at that time. Accordingly, in 1853, he sailed for Europe, and, during one year at the University of Munich, devoted himself to chemistry and mineralogy under Liebig, Von Kobell, and Pettenkofer. The year following—that of 1854–'55—he spent at the Royal Mining Academy in Freiburg, Saxony.

Just about this time an effort was being made at New Haven to put the scientific department of Yale College in a more satisfactory position than it had previously held. To the building of it up Professor Norton had sacrificed time and money, and, at last, his life ; and, after the loss it sustained in his early death, it for a while continued to exist rather than to live. Outside of a very small circle, nobody cared for it, and it might at any moment have dropped entirely out of being, and the larger portion of the academic world would not have known enough of it even to regret its death. Modern science is so aggressive, it occupies so prominent a position both in the theory and practice of education, that it is hard for us now to realize how low was the estimation in which it was held in this country, even less than thirty years ago. The academic department of Yale College numbered at that period among its faculty the names of some men of science who were held in honor throughout the country. Their reputation, in fact, rather overshadowed that of most of their colleagues in other branches. Still, so strong was the influence of ancient tradition, that the prevail-

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ing college sentiment reflected the views and feelings of the past, and very little those of the present; it did not begin to have even a conception of what was in store in the future. The student might or might not learn Latin and Greek; but, whichever was the case, he left the institution with a profound respect for them both, and usually the degree of his respect was fairly proportioned to the degree of his ignorance. It was not at all so in the case of the natural sciences, in spite of the eminence of some of its professors. Nor in the academic body as a whole was there then the least comprehension of what may be termed the solidarity of studies—that community of honor and dishonor in which they share, which renders it impossible for any one of them to be unduly depreciated without having some injurious effect upon the development of all the rest.

Still, the necessity of doing something more than had been done was beginning to be felt; and in a feeble way efforts were put forth to prepare for what the blindest could not fail to see was the inevitable. In 1854 an attempt was made at organization. The scattered instruction given by individual professors was brought together in the catalogue, though nowhere else; and an institution under the somewhat imposing name of the Yale Scientific School existed at least on paper. There was then no money with which to endow it; it is safe to say that, had there been, none would have been voted. But in one respect the corporation did a service to the new department they had created greater than could have been rendered by any pecuniary assistance that lay in their power. At the commencement of 1855 they elected Mr. Brush to a professorship.

He was first offered the chair of mining and metallurgy; but this he declined as embracing too much, and the title was limited to that of metallurgy alone. This, several years after, was exchanged for that of mineralogy. To qualify himself still further for the position, the newly-elected Professor went, in the autumn of 1855, to London, where he pursued his studies in the Royal School of Mines. The following year he made an extended tour through the mines and smelting-works of England, Scotland, Wales, Belgium, Germany, and Austria. In December, 1856, he returned to this country, and, in January, 1857, he entered upon the duties of his professorship.

From this time on the history of Professor Brush has been the history of the special scientific department of Yale College, which, in 1860, owing to the liberal benefactions of Mr. Joseph E. Sheffield, received the name of the Sheffield Scientific School. He came to it while it was not only without reputation, but without appreciation or expectation. He came to it while it was poor beyond even that decent poverty which apparently belongs, in the nature of things, to institutions of learning—while it was in a state so unorganized that as a whole it could hardly be said to have a being at all. It exhibited, indeed, a good deal of life in the college catalogue, but beyond that

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its vitality did not extend. There was vigor enough in certain of its departments, especially in that of civil engineering, under the charge of Professor William A. Norton; but in such cases it was a vigor due to the energy of the individual instructor, and therefore almost certain to disappear whenever he disappeared. To bring these scattered units into an organic whole, to build up a complete and consistent scheme of scientific education, which should have both definite and lofty aims, which should train men thoroughly in scientific methods, and which should continue to exist by its own inherent vitality after the men who established it should have passed away—all this became by degrees a main work of Professor Brush's life. His energy, his judgment, his executive capacity, and his devotion, soon gave him the leading direction in the affairs of the institution. He was for a long period its secretary; he has always been its treasurer; and when, in 1872, a more formal organization of its faculty was felt to be desirable, he was elected as its presiding officer, a position which he still retains. Others have done their part toward developing various departments of the school, but its growth, as a whole, the position which it has acquired among scientific institutions, whatever that position may be, has been due to him very much more than to any other one man connected with it. None are more willing to admit this than the colleagues who have coöperated with him; and it is a gratification for them to have an opportunity of saying here, without his knowledge, what would never be suffered to be printed were it submitted to his inspection.

Nor has Professor Brush been idle in his special work, in spite of the exhausting demands made upon his time and thought by the management of the Sheffield Scientific School. The series of investigations made by him on American minerals, in conjunction with Professor J. Lawrence Smith, has already been mentioned. He coöperated with Professor Dana in the preparation of the fifth edition of his treatise on "Descriptive Mineralogy," published in 1868, and an account of his special services in connection with that work will be found stated in the author's preface. To the two editions preceding, as well as to this one, he contributed analyses of minerals. He also edited the eighth, ninth, and tenth supplements to this fifth edition, as well as the appendix to it published in 1872. In 1875 he brought out also a "Manual of Determinative Mineralogy and Blowpipe Analysis." In addition to these he has been a constant contributor to the "American Journal of Science," as will be seen by the following list of articles furnished by him to that periodical:

Second Series.

Vol. x, p. 370: "Analyses of American Spodumene."

Vol. xviii, p. 407: "On the Chemical Composition of Clintonite (Seybertite)"; p. 415: "On a new test for Zirconia."

Vol. xx, p. 273: "On Prosopite."

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Vol. xxiv, p. 128: "On the Chemical Composition of Antigorite"; p. 116: "On Dechenite and Eusynchite"; p. 124: "Note on Parathorite."

Vol. xxv, p. 198: "Chemical Composition of Chalcodite."

Vol. xxvi, p. 64: "Analyses of Gieseckite (?) from Diana, Compact Pyrophillite, Unionite, Danbury Feldspar."

Vol. xxvii, p. 395: "Chemical Examination of Boltonite."

Vol. xxxii, p. 94: "On Crystalline Hydrate of Magnesia."

Vol. xxxiv, p. 243: "On Amblygonite from Maine"; p. 402: "On Triphyline from Norwich, Massachusetts."

Vol. xxxvi, pp. 122, 257: "On Childrenite from Hebron, Maine"; p. 152: "On the Tucson Meteoric Iron."

Vol. xxxvii, p. 66: "On Tephroite."

Vol. xxxix, p. 132: "On Artificial Diopside."

Vol. xli, p. 246: "On Cookeite and Jefferisite."

Vol. xliv, p. 219: "On Native Hydrates of Iron."

Vol. xlvi, pp. 140, 240: "On Sussexite."

Vol. xlviii, p. 17: "On Hortonolite"; p. 17: "On Durangite"; p. 179: "On a Meteoric Stone from Frankfort, Alabama"; p. 360: "On Magnetite in the Pennsville Mica."

Third Series.

Vol. i, p. 28: "On Gahnite from New Jersey."

Vol. ii, p. 30: "On Ralstonite."

Vol. v, p. 421: "On Compact Anglesite."

Vol. xi, p. 464: "On Durangite."

Vol. xxi, p. 312: "On American Sulposelenides of Mercury."

In 1878 a new and remarkable mineral locality at Branchville, Fairfield County, Connecticut, was discovered; and, in connection with Professor Edward S. Dana, Professor Brush produced a series of papers on the new minerals there found. These papers are contained in the "American Journal of Science," third series, vol. xv, pp. 398, 481; vol. xvi, pp. 33, 114; vol. xvii, p. 359; vol. xviii, p. 45, and vol. xix, p. 316; and in them are described the new phosphates—Eosphorite, Triploidite, Dickinsonite, Lithiophilite, Reddingite, Fairfieldite, and Fillowite. In conjunction also with Professor E. S. Dana he contributed to the same journal a memoir on "Spodumene and its Alterations" (xx, 257), and a paper on "Crystallized Danburite from Russell, New York" (xxi).

In 1862 Professor Brush was made a corresponding member of the Royal Bavarian Academy of Sciences; in 1866 a member of the Imperial Mineralogical Society of St. Petersburg; and in 1877 a foreign correspondent of the Geological Society of London. He is also a member of the American Philosophical Society, of the National Academy of Sciences, and of various other scientific bodies in this country. In 1880, at the meeting of the American Association for the Advancement of Science, held at Boston, he was elected its president for the following year, and in that capacity presided over the meeting held in August, 1881, at Cincinnati.

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CORRESPONDENCE.

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THE COPPER-MINES OF ISLE ROYALE.

Messrs. Editors.

I HAVE read with much pleasure Professor Winchell's paper on the "Ancient Copper-Mines of Isle Royale," in "The Popular Science Monthly" for September. As the Professor's very laudable object is undoubtedly "to make a little history" respecting the wonderful copper-mines of Lake Superior, and as no narrative (with the exception of some occasional geological reports) respecting the late working of them has to my knowledge been published, and as he has inadvertently made some quite important omissions, with your leave I will endeavor to supply the deficiency. On page 602 he says: "The finding of these thin chips of copper is the first indication of the proximity of a large mass. In the summer of 1874 the first of these large masses was discovered."

In the summer of 1822, fifty-two years *before* "the summer of 1874," General Cass, at that time the United States Territorial Governor of what now constitutes the States of Michigan, Wisconsin, and Minnesota, and *ex-officio* Superintendent of Indian Affairs for the Northwest, made his celebrated trip from Detroit to the head of Lake Superior, with his party, "in birchen canoes," and thence overland to the Mississippi River. He stopped at the mouth of the Ontonagon River, on the south shore of Lake Superior, two or three days to recruit his *voyageurs* after a "canoe-paddle" of nearly one thousand miles from Detroit. Knowing what the "early Jesuits" had said about copper in that country, in the published memoirs of their operations in the "Great Lake country," nearly two hundred years before, he naturally sought information of the Indians he found there respecting it. They took him to a mass of copper which was lying on the bank of the Ontonagon River, some eight miles from its mouth. It was found to be, apparently, *pure native copper*. In 1845, I think it was, *Julius Eldred*, of Detroit, by permission of the Government, took it to Washington, for the purpose of its being eventually put into the Washington Monument, as a contribution showing the mineral resources of Michigan. It weighed something like six thousand pounds. In 1848 the Minnesota Mining Company commenced work on their mine, in the range of hills some twenty-one miles (by the course of the stream) up the Ontonagon River. They began work in what are called the "*ancient diggings*." This "digging" was simply an *open trench*, some ten to twelve feet wide, running on the course of a mineral vein that had been excavated by the "ancients" in the "country rock" to uncover the vein. I do not now recollect the length of that particular trench. The country is full of them.

I give you what Mr. William Hickok, one of the owners and originators of the Minnesota mine—which mine, by-the-way, has produced several million dollars' worth of copper—and who now resides at Tarrytown in this State, says of their work and what they found. In reply to a note I addressed him respecting it on the 25th ultimo, he writes: "The mass of copper discovered by Mr. Knapp in the Minnesota mine in 1848, of which you inquire, was found in the vein, resting upon skids about twenty-five feet from the surface. It weighed 12,480 pounds. All the rock had been cleaned from its surface, giving it the appearance of being as pure as *refined copper*. There were found in the excavation a large number of 'stone hammers,' weighing from one to forty pounds each, and encircled by a 'groove' cut undoubtedly for the purpose of receiving a hickory 'withe,' to be used as a handle. There were also several copper implements, such as chisels, etc., found, that showed, from the manner they had been used—the battered heads of the chisels, for instance—that the '*art*' of hardening and welding that metal (an art now lost) was known by those who had made them. There was at that time growing in that excavation (which was filled with alluvial soil) over the vein and the mass of copper a hemlock-tree, of about three hundred and seventy-five years' growth, judging from the number of its concentric rings. We must, I think, go back to the 'stone age' to find the workers of these copper-mines. The discovery of the mass of copper in the vein of the Minnesota mine entirely free from rock, ready to be moved, unlocks the mystery of those 'floating masses'—that seen by General Cass was one of them—found in various places on the surface, showing that they had all been mined and taken from the veins, and had been abandoned while being transported to the lake, for some cause to us unknown."

It occurs to me that, if the foregoing is added to Professor Winchell's very valuable paper, the account of those remarkable min-

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eral deposits will be somewhat more complete. Yours very truly,

C. A. TROWBRIDGE.

NEW YORK, *September* 6, 1881.

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NUMBER-FORMS AND COLORS.

Messrs. Editors.

IN "The Visions of Sane Persons," in the "Monthly" for August, the author, Francis Galton, speaks of a certain proportion of people (five per cent.) to whom the thought of a series of consecutive numbers invariably brings the vision of them arranged in a perfectly defined and constant position.

From my earliest recollection, numbers have always appeared to me arranged in a straight line of regularly increasing height, extending from north to south: 1 is flat on the ground; 2 close to it, but a little higher and a little farther to the south, and so on. The row of figures extends upward at an angle of about forty degrees. I said that 1 was flat on the ground. I do not mean the literal ground, for the whole vision appears surrounded by and outlined against that brownish-red light which falls through our closed lids upon our eyes, when we shut them in the full glare of sunlight. I meant that 1 is at the feet of the imaginary person who, wishing to read these numbers, stands with his back to the north, looking southward and upward at this regularly ascending row.

Not only do they have position; they also have color—that is, nearly all of them. The conception of color or non-color is associated with them all: 1 is transparent, like glass or water; 2 has a reddish tinge; 3 is a bluish-green (I have in mature years seen the exact shade that my childish imagination invested this number with—in shallow bays, and waters of the tropical Pacific); 4 is also red, but a different shade from 2—more of a crimson; 5 is a very pretty, delicate gray, always spotless—a Quaker woman's dress reminds me of 5; 6 is a deeper shade of 3, a deeper blue-green; 7 I always disliked. It is a yellowish brown, the hue of withered fields and bare earth in winter, when there is no snow on the ground; 8 is black; 9 is a decided green, a darker shade of 3 and 6. Whether this is because it combines them I can not say; 10 is colorless, being composed of two numerals that are colorless, though, as previously indicated, the conception of non-color is associated with it.

The 'teens likewise have colors, but not individual ones. The numeral in the units' column gives color to the whole, though it is somewhat diluted by the colorless quality of the 1 by which it stands. It is as if an equal quantity of clear water had been poured into a colored liquid. In the numbers above twenty, sometimes one numeral, sometimes another, gives color to the number, but this is done in an arbitrary manner, and I can perceive no rule. These higher numbers, too, are somewhat confused, not so clear as those of lower denomination. The only ones that are distinct are 22, 33, 44, 55, etc. I will add, in conclusion, that there is connected with them no conception beyond form, position, and color.

Will some chemist, or some one well read in history, please explain the allusions and references in this passage from Victor Hugo's "Les Misérables"? It will be found in Chapter CCXLIX, of Lascelles Wraxall's translation: "It was from the drain of Münster that John of Leyden produced his false moon; and it was from the cesspool-well of Kekhscheb that his Oriental Menæchmus, Mokannah, the veiled prophet of Khorassan, brought his false sun."

LOUISE COFFIN JONES.

OSKALOOSA, IOWA, *August* 5, 1881.

EDITOR'S TABLE.

BALANCE AND COMPENSATION OF INORGANIC FORCES.

IT was some forty years ago that the organic chemists, represented by such masters as Dumas and Liebig, worked out the beautiful idea of the balance of organic nature. They showed that the vegetable and animal kingdoms carry on antagonist processes—each for ever undoing the work of the other. The atmosphere is the arena of this subtile conflict, being poisoned by the animal world and purified by the vegetable world; while these opposing processes so effectually counteract each other, that the air is automatically maintained in a condition fitted for the preservation of the living races.

A corresponding balance of forces is displayed on a grand and still more striking scale in the inorganic world, by which the varied configuration of the earth's surface and the continued habitability of the globe are maintained.

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In his new and very interesting book on "Volcanoes," Professor J. W. Judd, of London, has taken up this subject, and his chapter on "The Part played by Volcanoes in the Economy of Nature" impresses us like a powerful sermon on the old problem of good and evil—and that has also something *new* in it. Professor Judd does not dwell upon the moral aspect of the subject, but we can not better introduce his view to our readers than by a reference to its ethical implications.

Nothing, of course, can have less claim upon the attention of men whose intelligence, however considerable of its sort, has never been directed to the understanding of nature, than what goes on in the interior of the earth. That, says a representative of this class, belongs to scientific speculation, and is no concern of his. He knows, indeed, of earthquakes and volcanoes as deadly agencies by which great numbers of lives are often ruthlessly destroyed; and he regards them as conspicuous examples of diabolism in nature; and when he hears it said that "volcanoes are the safety-valves of the globe," he is very glad to know that they have some possible use, however remote.

Now, ethics—the science of right and wrong, of good and bad—is certainly not an exact science; and yet it has a quantitative basis. In the constitution of this world, good and evil are inextricably mixed up, and the problem of their proportions is therefore fundamental in ethical inquiries. There is always more or less of each, and there are degrees of both. We are familiar with the terms small and great in their applications to evil and good, and we labor to diminish the former and increase the latter. It is natural that the estimates of the relative amounts of good and evil should vary, especially as so much depends upon the subjective condition of the estimator. The pessimist admits that there may be hours and perhaps places in which good prevails; but he maintains that, on the whole, evil so greatly predominates that life is not worth living. The optimist holds on the contrary that, while evil may be supreme at times, good is ascendant in the large view. The question between them, therefore, is mainly one of relative quantities.

If, now, it can be shown that in any given case good prevails over evil, say in the ratio of one hundred thousand to one, it is obvious that the pessimist will not have much margin left upon which to make a stand; and, if it can be further proved that this ratio holds on a stupendous scale, and, moreover, that it includes just those malign manifestations of Nature that are most cited as evidence of her vicious spirit, the pessimist will be left in a still worse predicament. This position may be familiarly illustrated. A certain considerable amount of life is violently destroyed each year by lightnings, storms, and floods; yet these effects are only the calamitous incidents of a great system of circulation of water and air over our globe by which all life is maintained. That system of movements gives good and evil, but, compared with their beneficence, the disastrous results they produce are absolutely insignificant. If we say that the good prevails over the evil at the rate of a million to one, the estimate is still very far within the limits of truth.

Professor Judd has shown that the same principle holds in regard to volcanoes and earthquakes. We know that by these agencies dwellings, villages, and even entire cities are reduced to heaps of ruins, often with the direct destruction of multitudes of people, and furthermore that famines, pestilences, and social disorganizations frequently follow. But these catastrophes, terrible as they may be, are the results of a system of overwhelming beneficence. The subterranean energies, of which earthquakes and volcanoes are the striking manifestations, are necessary to

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the continued existence of our earth as a place fitted for the habitation of living beings, and they must be credited with the total amount of benefit implied by the existence and preservation of the life of the globe in all its forms and gradations. We quote enough of the argument of Professor Judd, in his elaborate chapter upon this subject, to substantiate the view here taken:

We have had frequent occasion in the preceding pages to refer to the work—slow but sure, silent but effective—wrought by the action of the denuding forces ever operating upon the surface of our globe. The waters condensing from the atmosphere and falling upon the land in the form of rain, snow, or hail, are charged with small quantities of dissolved gases, and these waters, penetrating among the rock-masses of which the earth's crust is composed, give rise to various chemical actions of which we have already noticed such remarkable illustrations in studying the ancient volcanic products of our globe. By this action the hardest and most solid rock-masses are reduced to a state of complete disintegration, certain of their ingredients undergoing decomposition, and the cementing materials which hold their particles together being removed in a state of solution. In the higher regions of the atmosphere this work of rock-disintegration proceeds with the greatest rapidity; for there the chemical action is reënforced by the powerful mechanical action of freezing water. On high mountain-peaks the work of breaking up rock-masses goes on at the most rapid rate, and every craggy pinnacle is swathed by the heaps of fragments which have fallen from it. The Alpine traveler justly dreads the continual fusillade of falling rock-fragments which is kept up by the ever-active power of the frost in these higher regions of the atmosphere; and fears lest the vibrations of his footsteps should loosen, from their position of precarious rest, the rapidly accumulating piles of detritus. No mountain-peak attains to any very great elevation above the earth's surface, for the higher we rise in the atmosphere the greater is the range of temperature and the more destructive are the effects of the atmospheric water. The moon, which is a much smaller planet than our earth, has mountains of far greater elevation; but the moon possesses neither an atmosphere nor moisture on its surface, to produce those leveling effects which we see everywhere going on around us upon the earth.

The disintegrated materials, produced by chemical and mechanical actions of the atmospheric waters upon rock-masses, are by floods, rivers, and glaciers, gradually transported from higher to lower levels; and sooner or later every fragment, when it has once been separated from a mountain-top, must reach the ocean, where these materials are accumulated and arranged to form new rocks.

Over every part of the earth's surface these three grand operations of the disintegration of old rock-masses, the transport of the materials so produced to lower levels, and the accumulation of these materials to form new rocks, are continually going on. It is by the varied action of these denuding agents upon rocks of unequal hardness, occupying different positions in relation to one another, that all the external features of hills, and plains, and mountains owe their origin.

It is a fact, which is capable of mathematical demonstration, that by the action of these denuding forces the surface of all the lands of the globe is being gradually but surely lowered; and this takes place at such a rate that in a few millions of years the whole of the existing continents must be washed away and their materials distributed over the beds of the oceans.

It is evident that there exists some agency by which this leveling action of the denuding forces of the globe is compensated; and a little consideration will show that such compensating agency is found in the subterranean forces ever at work within the earth's crust. The effects of these subterranean forces which most powerfully arrest our attention are volcanic outbursts and earthquake-shocks, but a careful study of the subject proves that these are by no means the most important of the results of the action of such forces. Exact observation has proved that almost every part of the earth's surface is either rising or falling, and the striking and destructive phenomena of volcanoes and earthquakes probably bear only the same relation to those grand and useful actions of the subterranean forces which floods do to the system of circulating waters and hurricanes to the system of moving air-currents. . . .

We establish the fact of the movement of portions of the earth's crust by noticing the changing positions of parts of the earth's surface in relation to the constant level of the ocean. When this is done we find abundant proof that, while some parts of the earth's crust are rising, others are as undoubtedly undergoing depression.

We shall be able to form some idea of the vastness of the effects produced by the sub-

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terranean forces, by a very simple consideration. It is certain that during, the enormous periods of time of which the records have been discovered by the geologist, there have always been continents and oceans upon the earth's surface, just as at present, and it is almost equally certain that the proportions of the earth's surface occupied by land and water respectively have not varied very widely from those which now prevail. But, at the same time, it is an equally well-established fact that the denuding forces ever at work upon the earth's surface would have been competent to the removal of existing continents many times over, in the vast periods covered by geological records. Hence we are driven to conclude that the subterranean movements have in past times entirely compensated for the waste produced by the denuding forces ever at work upon our globe. But this is not all. The subterranean forces not only produce upheaval; in a great many cases the evidences of subsidence are as clear and conclusive as are those of upheaval in others. Hence we are driven to conclude that the forces producing upheaval of portions of the earth's crust are sufficient, not only to balance those producing subsidence, but also to compensate for the destructive action of denuding agents upon the land-masses of the globe.

It is only by a careful and attentive study and calculation of the effects produced by the denuding agents at work all around us, aided by an examination of the enormous thicknesses of strata formed by the action of such causes during past geological times, that we are able to form any idea of the reality and vastness of the agents of change which are ever operating to modify the earth's external features. When we have clearly realized the grand effects produced on the surface of the globe by these external forces, through the action of its investing atmosphere and circulating waters, then, and only then, shall we be in a position to estimate the far greater effects resulting from the internal forces, of which the most striking, but not the most important, results are seen in the production of volcanic eruptions and earthquake-shocks.

Another series of facts which serves to convince the geologist of the reality and potency of the forces ever at work within the earth's crust, and the way in which these have operated during past geological periods, is found in the disturbed condition of many of the stratified rock-masses of which it is composed. Such stratified rock-masses, it is clear, must have been originally deposited in a position of approximate horizontality; but they are now often found in inclined and even vertical positions; they are seen to be bent, crumpled, puckered, and folded in the most remarkable manner, and have not unfrequently been broken across by dislocations — "faults" — which have sometimes displaced masses, originally in contact, to the extent of thousands of feet. The slate-rocks of the globe, moreover, bear witness to the fact that strata have been subjected to the action of lateral compression of enormous violence and vast duration; while in the metamorphic rocks we see the effects of still more extreme mechanical strains, which have been in part transformed into chemical action. No one who has not studied the crushed, crumpled, fractured, and altered condition of many of the sedimentary rocks of the globe, can form the faintest idea of the enormous effects of the internal forces which have been in operation within the earth's crust during earlier geological periods. And it is only by such studies as these that we at last learn to regard the earthquake and volcanic phenomena of our globe, not as the grandest and most important effects of these forces, but as their secondary and accidental accompaniments.

Professor Judd here passes to a very lucid presentation of the later views of geologists in regard to the mode of origin and development of mountains. This is an important part of his discussion, but we have no room for it here. He concludes:

From what has been said, it will be seen that mountain-chains may be regarded as cicatrized wounds in the earth's solid crust. A line of weakness first betrays itself at a certain part of the earth's surface by fissures, from which volcanic outbursts take place; and thus the position of the future mountain-chain is determined. Next, subsidence during many millions of years permits of the accumulation of the raw materials out of which the mountain-range is to be formed; subsequent earth-movements cause these raw materials to be elaborated into the hardest and most crystalline rock-masses, and place them in elevated and favorable positions; and lastly, denudation sculptures from these hardened rock-masses all the varied mountain forms. Thus the work of mountain-making is not, as was formerly supposed by geologists, the result of a simple upheaving force, but is the outcome of a long and complicated series of operations.

The careful study of other mountain-chains, especially those of the American Con-

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tinent, has shown that the series of actions which we have described as occurring in the Alps took place in the same order in the formation of all mountain-masses. It is doubtful whether the line of weakness is always betrayed in the first instance by the formation along its course of volcanic fissures. But in all cases we have evidence of the production of a geosynclinal, which is afterward, by lateral pressure, converted into a geanticlinal, and from this the mountain-chains have been carved by denudation. Professor Dana has shown that the geosynclinal of the Appalachian chain was made up of sediments attaining a thickness of forty thousand feet, or eight miles; while Mr. Clarence King has shown that a part of the geosynclinal of the Rocky Mountains was built up of no less than sixty thousand feet, or twelve miles of strata.

It has thus been established that a very remarkable relation exists between the forces by which continental masses of land are raised and depressed and mountain-ranges have been developed along lines of weakness separating such moving continental masses and those more sudden and striking manifestations of energy which give rise to volcanic phenomena. It is in this relation between the widespread subterranean energies and the local development of the same forces at volcanic vents that we must in all probability seek for the explanation of those interesting peculiarities of the distribution of volcanoes upon the face of the globe which we have described in a former chapter. The parallelism of volcanic bands to great mountain-chains is thus easily accounted for; and in the same way we may probably explain the position of most volcanoes with regard to coast-lines. . . .

Terrible and striking, then, as are the phenomena connected with volcanic action, such sudden and violent manifestations of the subterranean energy must not be regarded as the only, or indeed the chief, effects which they produce. The internal forces continually at work within the earth's crust perform a series of most important functions in connection with the economy of the globe, and, were the action of these forces to die out, our planet would soon cease to be fit for the habitation of living beings. . . .

It is by no means a difficult task to calculate the approximate rate at which the various continents and islands are being leveled down, and such calculations prove that in a very few millions of years the existing forces operating upon the earth's surface would reduce the whole of the land-masses to the level of the ocean. . . .

But, by the admirable balancing of the external and internal forces on our own globe, the conditions necessary to animal and vegetable existence are almost constantly maintained, and those interruptions of such conditions, produced by hurricanes and floods, by volcanic outbursts and earthquakes, may safely be regarded as the insignificant accidents of what is, on the whole, a very perfectly working piece of machinery.

LITERARY NOTICES.

The Ancient Bronze Implements, Weapons, and Ornaments of Great Britain and Ireland. By John Evans, D. C. L., LL. D., F. R. S., F. S. A., F. G. S., President of the Numismatical Society, etc. New York: D. Appleton & Co. 1881. Pp. 509. Price, $5.

A few years ago there appeared a portly volume, profusely illustrated, and entitled "The Ancient Stone Implements and Ornaments of Great Britain." It was a monument of careful observation and painstaking labor in a new field, with not many enthusiastic explorers, and was at once accepted as a trustworthy and, authoritative work upon the subject, which, although chiefly confined to Great Britain, was an important contribution to the general science of archæology. Mr. John Evans, the author of that work, has continued to devote himself to the field of archaic research, and now publishes a corresponding volume on "The Ancient Bronze Implements, Weapons, and Ornaments of Great Britain and Ireland."

We have here a history more ancient than written history, and which reveals the social state, the conditions of culture and development of prehistoric man. These are determined by the evidences of what he did, the relics that remained and have been found, of what he invented and constructed to meet his wants. His first tools and weapons were of stone, and the period when he employed them is the earliest of which we have any trace, and is called the "Stone Age." But there was an education in these rude constructions which led to progress, so that this most ancient period has been divided into two stages, the Palæolithic or the very earliest, and the Neolithic or later stone age, which exhibits a marked advancement in the art of producing stone implements.

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The next step of prehistoric progress consisted in entering upon the use of metal instead of stone for the construction of weapons and implements of industry. It is probable that gold, which commonly occurs native and brilliant, was the first metal that attracted the attention of mankind; and it is likely that the next metal discovered was copper, which also occurs native, and has many points of resemblance to gold. It was found in sufficient abundance to be available for working, and was probably the material out of which the first metallic utensils were manufactured. The State of Wisconsin alone has furnished upward of one hundred axes, spear-heads, and knives formed of copper. On the shores of Lake Superior native copper occurs in great abundance, and no doubt attracted the attention of the early occupants of the country. Dr. Evans remarks that, "accustomed to the use of stone, they would at first regard the metal as a stone of peculiarly heavy nature, and on attempting to chip it or work it into shape would at once discover that it yielded to a blow instead of breaking, and that in fact it was a malleable stone." The great majority of these copper instruments hitherto found, if not all, have been hammered and not cast, so that the working of metal into shape by melting it was probably a later acquisition. There is reason to believe that there was what may be called a "Copper Age," in parts of North America, but in Europe the traces of it are feeble, if not totally wanting.

Bronze is formed by the admixture or alloy of tin with copper in the molten state, and the effect of this mixture results in hardening the product, so that the resulting bronze becomes much more useful for many mechanical purposes than copper. There is overwhelming evidence that bronze greatly predominated for these purposes before iron was employed; the passage to iron and steel constituting a further step of advancement, and leading to a subsequent "Iron Age." Bronze abounded in ancient Egypt, while iron was but little used, and there are only thirteen references to iron in the Pentateuch, while bronze is mentioned forty-four times.

Dr. Evans's volume contains 540 illustrations of hatchets, chisels, gouges, hammers, sickles, knives, razors, daggers, halberds, maces, swords, scabbards, spear-heads, shields, trumpets, bells, pins, bracelets, rings, clasps, buttons, buckles, and vessels of all kinds, that are formed of bronze, and that have been collected and classified with the view of throwing light upon the history of the "Bronze Period." And in regard to their scientific significance the author remarks: "It may by some be thought that a vast amount of useless trouble has been bestowed in figuring and describing so many varieties of what were, after all, in most cases, the ordinary tools of the artificer, or the common arms of the warrior or huntsman, which differed from each other only in apparently unimportant particulars. But as in biological studies minute anatomy often affords the most trustworthy evidence as to the descent of any given organism from some earlier form of life, so these minor details in the form and character of ordinary implements, which to the cursory observer appear devoid of meaning, may, to a skillful archæologist, afford valuable clews by which the march of the bronze civilization over Europe can be traced to its original starting-place. I am far from saying that this has as yet been satisfactorily accomplished, and to my mind it will only be by accumulating a far larger mass of facts than we at present possess that comparative archæology will be able to triumph over the difficulties with which its path is still beset."

THE JOURNAL OF PHYSIOLOGY. Edited by Gamgee, Rutherfurd, Burdon-Sanderson, Bowditch, Martin, Wood, and Michael Foster.

WE have received numbers I and II of Volume III of this important periodical, together with the supplement of Volume III, and we again call attention to it as having high claims upon the medical profession and all interested in the progress of physiological science. It is conducted by the very ablest men in England and this country, and, by their labors and the contributions of other investigators, it thoroughly represents the advance of research in this fruitful field of inquiry. The papers in number I, "On the Antagonism of Poisons," "The Influence of Quinine upon the Reflex Excitability of the Spinal Cord," "The Rate of Propagation of the Arterial Pulse-Wave,"

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"The Tonicity of the Heart and Blood-Vessels"; and the articles in number II, "On the Proteid Substances contained in the Seeds of Plants," "The Influence of Season and of Temperature on the Action and the Antagonisms of Drugs," and "The Elastic Properties of the Arterial Wall," are especially noteworthy, and their conclusions of much scientific interest. The supplement gives an extensive list of titles of books and papers upon physiological questions, in all the modern languages, that have appeared in 1880. Six numbers form a volume of about 500 pages, the American subscription of which is $5, and may be remitted to Mr. W. T. Sedgwick, Johns Hopkins University, Baltimore, Maryland. The American edition of the Journal now appears under the auspices of that institution.

INTERNATIONAL SCIENTIFIC SERIES.—NO. XXXV.

VOLCANOES: WHAT THEY ARE AND WHAT THEY TEACH. By JOHN W. JUDD, F. R. S., Professor of Geology in the Royal School of Mines. With 96 Illustrations. New York: D. Appleton & Co. Pp. 381. Price, $1.75.

IN no field has modern research been more fruitful than in that of which Professor Judd gives a popular account in the present volume. The great lines of dynamical, geological, and meteorological inquiry converge upon the grand problem of the interior constitution of the earth, and the vast influence of subterranean agencies. The subject was first comprehensively dealt with in the light of modern scientific views by the late Mr. Poulett Scrope, who published two systematic treatises upon different divisions of it in the years 1825 and 1827. Professor Judd was a student and disciple of this master, who, before he died, committed to him the task of preparing a popular exposition of the present condition of our knowledge on volcanoes. Since the time of Scrope's publication many important additions have been made to the subject, and these the author has faithfully incorporated in the book now issued. The plan and spirit of the work are thus indicated in his preface:

"In order to keep the work within the prescribed limits, and to avoid unnecessary repetitions, I have confined myself to the examination of such selected examples of volcanoes as could be shown to be really typical of all the various classes which exist upon the globe; and I have endeavored from the study of these to deduce those general laws which appear to govern volcanic action. But it has, at the same time, been my aim to approach the question from a somewhat new standpoint, and to give an account of those investigations which have in recent times thrown so much fresh light upon the whole problem. In this way I have been led to dwell at some length upon subjects which might not at first sight appear to be germane to the question under discussion—such as the characters of lavas revealed to us by microscopic examination; the nature and movements of the liquids inclosed in the crystals of igneous rocks; the relations of minerals occurring in some volcanic products to those found in meteorites; the nature and origin of the remarkable iron-masses found at Ovifak in Greenland; and the indications which have been discovered of analogies between the composition and dynamics of our earth and those of other members of the family of worlds to which it belongs. While not evading the discussion of theoretical questions, I have endeavored to keep such discussions in strict subordination to that presentation of the results attained by observation and experiment, which constitutes the principal object of the work."

We are not acquainted with any other work of Professor Judd, but he is an experienced and very agreeable writer, and is evidently a master of the art of statement. His book is very far from being a mere dry description of volcanoes and their eruptions; it is rather a presentation of the terrestrial facts and laws with which volcanic phenomena are associated. We give an extract in our editorial pages which well represents the quality of the book. The illustrations are numerous, well chosen, and especially fine in execution; and the volume is among the best of the series to which it belongs.

THE BIBLE AND SCIENCE. By T. LAUDER BRUNTON, M. D., D. S. C., F. R. S. With Illustrations. Macmillan & Co. 1881. Pp. 415. Price, $2.50.

THIS book is an example on a small scale of the common remark that "history

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repeats itself." It belongs to the literature of reconciliation of religion and science, and does over again what had been so often done before that its repetition should be superfluous—that is, if people were not so stupid.

When the laws of planetary motion were discovered, devout Bible-believers took the alarm and denounced the doctrine as destructive of religion. A war arose between the new science and the old Church, which was at length composed by a reinterpretation of Scripture passages, and everybody has become reconciled except Brother Jaspar.

But no sooner was the Bible brought into harmony with astronomy, than the same difficulty broke out in another place. Geologists found that the earth and the life upon it are a good deal older than have been supposed; but this was vehemently declared to be in conflict with the text of the old Hebrew oracles. The geologists were charged with being subverters of religion, and there was a long battle about it. But a way was discovered to reconcile Genesis with the new views of the earth's history, and the alarmed believers found not only that they had been a good deal more scared than hurt, but, greatly to their gratification, that Moses was the true founder of geological science.

One would think that by this time something might have been learned, and very much indeed has been learned, but there are multitudes of religious people who are still exactly where stood the religious people of three centuries ago. Another religious panic is upon us, from the same old cause. Science has proclaimed evolution as an established law of nature, and the believers in the killing letter of Scripture see another crusade of infidelity which, cloaking itself with the name of science, aims at the subversion of Christianity. Dr. Brunton's work grows out of this crisis, and is devoted to the old task of reconciliation.

There are many nominally religious people upon whom this sort of labor is quite thrown away. There must be some sincere solicitude for truth before there can be much concern about its agreements. It is not to be expected that those who are religious in obedience to the requirements of Mrs. Grundy will greatly trouble themselves about the conflicts of their faith. Then there are others, not wanting perhaps in sincerity, to whom religion is a mere safeguard against future life-dangers, and these, of course, will care little about the relations of their religion to knowledge. They have nothing to reconcile, nothing to be explained away. They have merely a system of supernaturalism to be professed, with divers accompaniments, as a means of escaping from everlasting perdition. But there are still many conscientious people who, having arrived at no general principles to govern the case, are perplexed at the disagreements between the accepted tenets of religious belief and the progressive doctrines of science. Dr. Brunton's book is written for this order of minds, and with reference to the new issues between the Bible and science which have arisen in our own age. But it is best to let the author speak for himself in regard to his purpose. He says: "Many people consider the doctrine of evolution, or, as it is not unfrequently termed, Darwinism, as necessarily atheistic, and regard it with horror mingled with fear. They look upon it with horror, because they think that its spread will be injurious to religion and morality; and they fear it, because they see that every year its adoption is becoming more general, and that, notwithstanding their dislike to it, they are unable to stop its progress. In addition to this, some have a lurking dread that the doctrine may be true, and that they may by-and-by be forced, in spite of themselves, to acknowledge its truth, and to give up the cherished religious beliefs which have been their joy and strength. Feelings of this sort induce some people to remain willfully ignorant both of what the doctrine of evolution really is, and the arguments that may be adduced in support of it, while others refuse to see the force of the arguments; and others, again, are rendered most unhappy by their inability to deny their truth. The objects of the present work are to give a brief and popular sketch of the data on which the doctrine is founded, and to show that instead of being atheistic it is the very reverse, and is no more opposed to the Biblical account of the creation than those geological doctrines regarding the structure and formation of the earth's crust which were once regarded as

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heretical and dangerous, but are now to be found in every class-book and are taught in every school."

Dr. Brunton's volume is not at all of the controversial form, and is quiet in tone and most conciliatory in spirit. It is besides a very instructive book, his plan being not so much to argue his questions in a formal way as to give the information and illustrate the facts that will enable the reader to draw his own conclusions.

The method of the book is somewhat novel. It is divided into two parts, which are so separate and so different that the reader is left long in doubt as to their connection or what they have to do with each other. The three introductory chapters are devoted to an account of Bible lands, or the countries of Egypt and Palestine, and the Exodus of the Hebrews. This part of the work is of extreme interest, because of the freshness of its restatement of old facts in the light thrown upon them by later knowledge. The countries of Egypt and Palestine are regarded as typical specimens of regions where the climatic conditions were entirely different, so that abundance prevailed in one while famine desolated the other, and drove a starving people to one of those wholesale migrations which have played so important a part in the world's history. Ancient Egyptian life has been dwelt upon to fix attention upon an old civilization as a landmark of the world's progress, so that the long centuries which have since intervened might introduce to the conception of geological time. The influence of circumstances upon character and the law of the hereditary transmission of qualities are variously exemplified by the Israelitish race.

Fifty pages of the work are consumed in this preliminary discussion, and then the next 286 pages are devoted to such a general survey of the vegetable and animal kingdoms, in the present structures and affinities of living species and in the relations of the earth's historic life displayed by fossils, as brings out in an impressive manner the truth of the doctrine of evolution. This portion of the work is highly instructive, from the richness of its facts and the copiousness of the pictorial illustrations which help their interpretation. But it is mainly valuable, of course, as showing the extent, the variety, and the harmony of the proofs that can be given of the law of development. This law being established, the author proceeds in Lecture XVI to consider "The Mosaic Record and Evolution." There is here no straining after effect, but it is shown how the honest believer in the Scriptures need have no real difficulty in interpreting the Biblical text in harmony with evolutional truth. A rigorous literalism can, of course, make a stand here, as it did in the times of the astronomical and geological controversy; but there is a good deal less difficulty with the reconciliation now than there was in the preceding cases. The closing lecture is devoted to individual development, and gives occasion to some practical conclusions and reflections suggested by the subject, which are full of instructive interest.

REPORT OF ANALYTICAL AND OTHER WORK DONE ON SORGHUM AND CORN-STALKS BY THE CHEMICAL DIVISION OF THE DEPARTMENT OF AGRICULTURE. By PETER COLLIER, Chemist. Washington: Government Printing-Office. 1880. Pp. 101, with Twenty-seven Plates.

THE object of the work reviewed in this report is to ascertain as many facts as possible in relation to the development and actual composition of the stalks and juices of the different varieties of sorghum and corn which can be successfully grown in the United States. The experiments were generally directed to the demonstration of the period at which the juice of each particular variety of sorghum or corn contained the most crystallizable sugar which could be profitably separated. Large sheet plates present graphically the results of 3,601 analyses of thirty-eight varieties of sorghum, eleven varieties of corn-stalks, and a few outside samples of sugar and sirup.

NASO-PHARYNGEAL CATARRH. By MARTIN F. COOMES, M. D., Professor in the Kentucky School of Medicine. Louisville, Kentucky: Bradley & Gilbert. Pp. 165. Price, $2.

THIS book, the author tells us, was prepared by request, as a practical treatise for the use of general practitioners of medicine. It treats of the anatomy of the parts

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liable to catarrhal affections, the examination of the pharynx, the value and method of local and constitutional medication, and the remedies used, the effect of climate on hay-fever, and the pathology and treatment of catarrh, and acute sporadic catarrh, with descriptions of many cases.

THE HYSTERICAL ELEMENT IN ORTHOPÆDIC SURGERY. By NEWTON M. SHAFFER, M. D., Surgeon in charge of the New York Orthopædic Dispensary and Hospital, etc. New York: G. P. Putnam's Sons. Pp. 66. Price, $1.

CASES of knee-joint disease, hip-joint disease, Pott's disease, lateral curvatures, and club-foot, have come before the author in his practice, which were not real, but the result of hysterical affection, or what he calls nervous mimicry. Some of them existed in persons who had never seen a genuine case of the disease with which they presumed they were afflicted. The present volume gives the diagnosis of such cases, with accounts of the method and results of treatment.

BRIEF REVIEW OF THE MOST IMPORTANT CHANGES IN THE INDUSTRIAL APPLICATIONS OF CHEMISTRY WITHIN THE LAST FEW YEARS. By J. W. MALLET, F. R. S. Pp. 98.

THIS work hardly needs any other notice than the transcription of its title, which fully defines its purpose and scope. It is full of instructive facts, valuable for practical application in nearly every department of the arts. The improved chemical processes and applications which it describes in classified detail, when brought together and considered in the aggregate, are significant of the great and wonderful advance that has been made in all that contributes to the economy and comfort of life.

EDUCATIONAL JOURNALISM. An Address before the New York State Teachers' Association, at its Thirty-sixth Annual Meeting, Saratoga Springs, August 7, 1881. By C. W. BARDEEN. Syracuse, New York: C. W. Bardeen. Pp. 30.

THIS address gives the history of the older and of some of the most famous educational journals of the country, with remarks on the value of publications of that class.

A FATAL FORM OF SEPTICÆMIA IN THE RABBIT PRODUCED BY THE SUBCUTANEOUS INJECTION OF HUMAN SALIVA. An Experimental Research. By GEORGE M. STERNBERG, Surgeon United States Army. Baltimore: John Murphy & Co. 1881. Pp. 22.

IN this interesting research the author discovered that the injection of his saliva into the subcutaneous connective tissue of a rabbit infallibly produced the death of the animal, usually within forty-eight hours. Experiments with the saliva of other persons resulted variously; some salivas appearing to be more virulent than others. These facts afford an interesting commentary on the discovery announced by Pasteur of a "new disease" produced by the injection of the saliva of infants which have died from hydrophobia. The experiments are described in detail, and photographs of the septic organisms developed after the injections are also given.

WHAT SHALL WE DO WITH THE INEBRIATE? By T. D. CROTHERS, M. D. Pp. 24.

THE author of this pamphlet, who is superintendent of a home for the treatment of inebriates and opium cases at Hartford, Connecticut, and who may therefore be supposed to know something of the subject about which he writes, controverts the theory that drunkenness is a vice to be counteracted by moral and penal influences only. He regards it as a disease requiring peculiar treatment, and divides inebriates into three classes, to whose condition the method of treatment requires to be specially adapted. Thus managed, he believes inebriety to be as curable as other forms of disease.

FIFTH ANNUAL REPORT OF THE STATE BOARD OF HEALTH OF WISCONSIN. 1880. Madison, Wisconsin: David Atwood, State Printer. Pp. 156.

BESIDES the accounts of the operations of the Board and the condition of health of the State, this report contains a number of special papers prepared for the information of the people, on such subjects as "General Hygienic Knowledge a Necessity for the People," "Recreation as a Sanitary Agent," "School Hygiene," "The Management of Contagious Diseases in the City of Milwaukee," "Diseased Meat and its Relations to Health," and "Kerosene."

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SYNOPSIS OF THE FRESH-WATER RHIZOPODS. A Condensed Account of the Genera and Species, founded upon Professor Joseph Leidy's "Fresh-Water Rhizopods of North America." Compiled by ROMYN HITCHCOCK, F. R. M. S. New York: Romyn Hitchcock, 51 and 53 Maiden Lane. Pp. 56.

RHIZOPODS form a division of the *Protozoa*, and consist, essentially, of a soft mass of clear or granular protoplasm, usually colorless, with one or more nuclei and contractile vesicles. They are mostly microscopic, are quite common, and may be found in the settlings of still water, in the slime of submerged rocks, stems, and leaves, and in similar situations. The author hopes, by means of this work, which is devoted to the description of genera and species, to facilitate the study of these interesting organisms.

THE MINERAL RESOURCES OF THE HOCKING VALLEY; BEING AN ACCOUNT OF ITS COALS, IRON-ORES, BLAST-FURNACES, AND RAILROADS. By T. STERRY HUNT, LL. D. With a Map. Boston: S. E. Cassino. Pp. 152.

THE Hocking Valley coal-field of Ohio occupies an area of about two hundred and fifty square miles, in the region drained by the Hocking River, and is characterized by the exceptional thickness and value of its coal-beds. It contains, also, extensive beds of good iron-ores and quarries of limestone, and thus combines rare advantages to encourage the establishment of iron-works. It is well supplied with railroads connecting it with important commercial centers which can be supplied with coal more conveniently from it than from any more distant source. All of these points are set forth clearly and in detail in the present report.

BUTTERFLIES: THEIR STRUCTURE, CHANGES, AND LIFE-HISTORIES, with Special Reference to American Forms. Being an Application of the "Doctrine of Descent" to the Study of Butterflies, with an Appendix of Practical Instructions. By SAMUEL H. SCUDDER. New York: Henry Holt & Co. Pp. 322. Price, $3.

A BOOK intended to awaken interest in the study of butterflies, and to assist in intelligent observation. It begins with the life-history of the insect, from the egg through the stages of the caterpillar, the chrysalis, and the perfect insect; describes its internal organs, with careful illustrations of its anatomy, its habits in all its stages, its seasonal changes and histories, and its coloring, "with further histories," and discusses the diversity of the sexes in coloring and structure, the origin and development of ornamentation, the ancestry and classification and geographical distribution of butterflies, and suggests a theory of the way in which New England was colonized with the insects. In the appendix are given instructions for collecting, rearing, preserving, and studying butterflies, the bibliography of the subject, and a systematic list of butterflies mentioned in the text. The whole is fully illustrated, generally from American specimens.

PRIMITIVE INDUSTRY; OR, ILLUSTRATIONS OF THE HAND-WORK, IN STONE, BONE, AND CLAY, OF THE NATIVE RACES OF THE NORTHERN ATLANTIC SEABOARD OF AMERICA. By CHARLES C. ABBOTT, M. D. Salem, Massachusetts: George A. Bates. 1881. Illustrated. Pp. 560. Price, $3.

THE title of this book describes in the fullest manner its contents. Dr. Abbott has wisely chosen to limit his work to that portion of the continent in which he has collected and studied, and to which he has added so many valuable contributions. In the preface he expresses the hope that the book will "induce others to explore such localities as they have opportunity of doing, and to preserve such traces of early man as they may find *by placing them in public museums*." Dr. Abbott has strictly adhered to this advice. He has no private collection. The immense mass of material he has gathered in his State now enriches the museums of Cambridge and Salem, where at all times it is open to inspection. In the light of the author's exhaustive study of the Trenton gravels, and the various beds superimposed upon them, we think he is justified in taking exception to the views expressed by Professor Whitney that "it is evident that there has been no unfolding of the intellectual faculties of the human race on this continent which can be parallelized with that which has taken place in Central Europe. We can recognize no palæolithic, neolithic, bronze, or iron ages." Dr. Abbott shows conclusively that the evidences of a

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true palæolithic and neolithic age are as marked in that section of the country he has examined as can be found in the valley of any European river.

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The chapter on "Palæolithic Implements," and the contributions of Professor H. C. Lewis on "The Antiquity and Origin of the Trenton Gravels," with which the volume closes, will be of great value to those interested in this question.

It is impossible to do justice to this work in the limited space of a book notice. It is sufficient to say that the work as a contribution to the archæology of Eastern North America is by far the most important of any that has appeared in this country. The student will be greatly aided by the careful way in which the various implements are classified and named.

How Persons afflicted with Bright's Disease ought to live. By Joseph F. Edwards, M. D. Philadelphia: Presley Blakiston. Pp. 87. Price, 75 cents.

The author believes that, in many instances, persons afflicted with Bright's disease may, by proper management, enjoy comfort and comparative good health for many years, and even outlive thousands around them who are in vigorous health. The object of his treatise is to define the conditions of the proper life with which this may be accomplished. These conditions are summed up in the avoidance of whatever will irritate the kidneys and attention to keeping up the general health. The skin should be kept in good condition by regular bathing, a proper degree but no excess of exercise should be practiced, the food should be suitable and abundant, the clothing always comfortable; alcohol and tobacco and other stimulants should be avoided.

The Figure of the Earth. An Introduction to Geodesy. By Mansfield Merriman, Professor of Civil Engineering in Lehigh University. New York: John Wiley & Sons. Pp. 88. Price, $1.50.

This work embraces the substance of "familiar talks" on the size and figure of the earth which were delivered, in 1879, to the students of civil engineering in Lehigh University. They were afterward published, with considerable extensions and improvements, and this is another revision. Its aim is to give the history of scientific investigation and opinion concerning the figure of the earth, and at the same time furnish an introduction to the science of geodesy that will possess desirable qualities for engineering students and engineers. The illustrative examples are generally from American surveys.

Rugby, Tennessee. By Thomas Hughes. London: Macmillan & Co. Pp. 168. Price, $1.

This book is put forth as the best answer which the founders of the Rugby colony can make to the questions that are asked them, chiefly in the United Kingdom, concerning their settlement. The first part answers questions respecting the class of persons for whom the place is intended. They are young men of good education and small capital. The second part consists of the letters written by Mr. Hughes last fall to the London "Spectator," reprinted without alteration. The third part, Mr. Killebrew's report, describes the natural situation and condition of the land without coloring, apparently hiding no defects. The glossary answers questions definitely and in short.

Pharmacology and Therapeutics; or, Medicine Past and Present. The Goulstonian Lectures, delivered before the Royal College of Physicians and Surgeons in 1877. By T. Lauder Brunton, M. D., F. R. S. London: Macmillan & Co. Pp. 212.

The object of these lectures was to show how the progress of therapeutics is aided by an exact knowledge of drugs obtained by experiments. The history of medicine in the past, with the course of the empiric and dogmatic systems, is reviewed, and the development described of rational and scientific methods of study, culminating in the application of the systematic investigation of the properties of drugs as illustrated especially in the case of strychnia, curare, casca, and other remedies, the adoption of which has given a new aspect to modern pharmacology and therapeutics. The *rationale* of the operation of many remedies, as brought out by the new methods of investigation, is also briefly discussed.

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PUBLICATIONS RECEIVED.

Further Notes on the Pollination of Yucca and on Pronuba and Prodoxus. By C. V. Riley. Pp. 33.

Fourteenth Annual Report of the Trustees of the Peabody Museum of American Archæology and Ethnology. Vol. III, No. 1. Cambridge. 1881. Pp. 41.

Noxious and Beneficial Insects of the State of Illinois. Fifth Annual Report. By Cyrus Thomas, Ph. D., State Entomologist. Springfield, Illinois. 1881. Pp. 282.

Report on the Statistics of Grape-Culture and Wine-Production in the United States for 1880. By William McMurtrie, Ph. D. Washington: Government Printing-Office. 1881. Pp. 104.

The Nature of the Existence of Matter. By Edward Randall Knowles. Pascoag, R. I. 1881. Pp. 7.

The Manuscript Troano. By Professor Cyrus Thomas. Reprint from "The American Naturalist." Pp. 16.

Free Trade *vs.* Protection. By Henry J. Philpott. Des Moines, Iowa, State Leader Co. 1881. Pp. 21.

Ethylene Bichloride as an Anæsthetic Agent, pp. 12; and Convulsions due to Depression of Spinal Reflex-Inhibitory Centers, pp. 5. By Edward T. Reichert, M. D. Reprints from the Philadelphia "Medical Times," 1881.

Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Indiana. By Professor Charles R. Barnes. Crawfordsville, Indiana. 1881. Pp. 38.

"Journal of the American Chemical Society," Vol. III, Nos. 1-6, January to June, 1881. New York: The American Chemical Society.

Bacteria. By Dr. Ferdinand Cohn. Translated by Charles S. Dolley. Rochester, New York. 1881. Pp. 30.

Remarkable Change in the Color of the Hair in a Patient under Treatment by Pilocarpin, etc.; and Case of Membranous Croup treated Successfully by Pilocarpin. By D. W. Prentiss, M. D. Philadelphia: J. B. Lippincott & Co. 1881. Pp. 15.

A Dictionary of Music and Musicians, A. D. 1450-1881. Edited by George Grove, D. C. L. London and New York: Macmillan & Co. 1881. Part XIV. Richter to Schoperlechner. Price per part, $1.

Subjects and Questions pertaining to Political Economy, Constitutional Law, Current Politics, etc. New York: The Society for Political Education. 1881. Pp. 24. 10 cents.

A Short History of the Bible. By Bronson C. Keeler. Chicago: The Century Publishing Co. 1881. Pp. 126.

Elements of Geometry. By Simon Newcomb. Pp. 299. $1.75. English History for Students. By Samuel R. Gardiner, LL. D. Pp. 424. $2.25. The Wandering Jew. By Moncure D. Conway. Pp. 200. $1.50. New York: Henry Holt & Co. 1881.

Report of the Commissioner of Education for 1879. Washington: Government Printing-Office. 1881. Pp. 757.

Manual of Sugar Analysis. By J. H. Tucker, Ph. D. New York: D. Van Nostrand. 1881. Pp. 353. $3.50.

The Harrogate Waters. By George Oliver, M. D. London, Eng.: H. K. Lewis. 1881. $1.50.

The Land of the White Elephant. By Frank Vincent, Jr. New York: Harper & Brothers. 1881. $3.50.

An Artistic Treatise on the Human Figure. By Henry Warren, K. L. Edited by Susan N. Carter. Pp. 82. 50 cents. Animal Physiology for Schools. By J. Milner Fothergill. Pp. 112. 75 cents. The Autobiography of Mark Rutherford. Edited by Reuben Sharpcott. Pp. 218. $1. Bacon. By Thomas Fowler, M. A., etc. Pp. 206. $1.25. New York: G. P. Putnam's Sons. 1881.

Principles of Chemical Philosophy. By Josiah Parsons Cooke. Boston: John Allen. 1881. Pp. 623. $3.50.

The Publishers' Trade List Annual for 1881. New York: F. Leypoldt. September, 1881. $1.50.

POPULAR MISCELLANY.

Gesture-Speech.—Colonel Garrick Mallory, of the United States Army, delivered a lecture on "The Gesture-Speech of Man," at the last meeting of the American Association, in which he remarked that North America had showed more favorable conditions for the development of gesture-signs than any other thoroughly explored part of the civilized world. Its aboriginal population was scanty, and so dialectically subdivided, with sixty-five families of languages, some comprising twenty languages each, that few bands could readily converse with each other. The Alaskan tribes generally used signs not more than a generation ago. The use of gestures could not be accounted for by any theory of the poverty of Indian languages, for no such theories were true, neither was it correct to suppose that a gesture-language was originated by a certain tribe, or in a particular region, and thence spread. The sign-language among the Indians is not uniform, and it is no argument in favor of uniformity that the signs used by any of the tribes are generally understood by others, for signs might be understood without being identical with any before seen. Regarding the question, whether the signs were conventional or instructive, Colonel Mallory was of the opinion that sign-language, as a product of evolution, had been developed rather than invented, and yet it seemed probable that each of the separate signs had a definite origin arising out of some appropriate occasion, and the same sign might in this manner have had many independent origins, due to indentity in the circumstances, or, if lost, might have been reproduced. The studies so far pursued led to the conclusion that at the time of the discovery of North America all its inhabitants practiced sign-language, though with different degrees of expertness. The language has been disused with some, but with oth-

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ers, particularly with those which have become nomadic, it has been cultivated to a high degree of development. The signs have their birth, growth, development, changes, and death, and those which are in general use must be of great antiquity. Colonel Mallory's researches during several years showed a surprising number of signs for the same ideas which were substantially identical, not only among savage tribes, but among all peoples that used gesture-signs with any freedom. Indians who have been brought to the Eastern States have often had happy intercourse by signs with white deaf-mutes; many of their signs were identical, and all sooner or later were mutually understood. The so-called sign-language of the Indians is not, properly speaking, one language, but it and the gesture systems of deaf-mutes and all people together constitute one language—the gesture-speech of mankind—of which each system is a dialect. Colonel Mallory next showed how this language of gestures aided archæological research. The Indian signs, as well as their myths and customs, form a part of the paleontology of humanity, to be studied in the history of the latter, as the geologist, with similar object, studies all the strata of the physical world.

The Origin of Lake Erie.—In a paper, read at the recent Cincinnati meeting, on the evidence from the drift of Ohio in regard to the origin of Lake Erie, Professor E. W. Claypole endeavored to show that the theory that the lake-bed was excavated by local glaciers at the oncoming and passing away of the ice age was not competent to account for the depth of the basin. A careful examination of the drift of Ohio in various parts of the State had convinced the author that the average depth of the erosion performed by the great continental glacier did not exceed fifty-six feet. If this was the limit of the effect produced by this immense mass of ice during its whole duration, it was idle to ascribe to a small local glacier the removal of many hundred feet deep of rock which was involved in the excavation of the bed of Lake Erie. Moreover, if the lake-basin had been so formed, the material taken out would have been found piled up like a mountain around the southwest end of the lake, but it is not so found, and the drift in that region is not perceptibly deeper than in other places. Furthermore, no local glaciers could have been formed unless the lake-beds had previously existed in their present form and size, and to ascribe the beds to the action of such a glacier is to mistake cause for effect. Observations of the drift in Indiana and Illinois go to confirm this view. The glacial theory being held to be untenable, the only alternative is to ascribe the formation of the lake-bed to the action of an ancient pre-glacial river, to which Lakes Erie and Ontario would be a broad, open valley, worn out where the rocks were soft, and connected by deep channels where they were hard, and this river he proposed to call the Ontario River. Mr. Holley replied to Professor Claypole's arguments, by exhibiting sections of the lakes and their rivers, and pointing to the fact in respect to the Niagara River, unique among American rivers, that while the descent of the river is in one direction the rise of its banks is in an opposite direction; the elevation anciently formed a dam which set the waters back to Lake Michigan, causing the constitution of an immense inland lake, which emptied its waters through the Illinois and Mississippi Rivers. In this theory, Professor Claypole might find a way to get rid of his drift.

Ancient and Modern Shells.—Professor E. S. Morse presented at the last meeting of the American Association some observations on changes of form which shells of the genera *Mya* and *Lunatia* seem to have undergone since the New England shell-heaps were deposited. This had been ascertained by comparing the shells of the ancient deposits and living shells of the same species, in New England and Japan, where similar changes were found to have taken place. It appeared, from measurements that he had made of the common clam (*Mya*), at Goose Island, Maine, and at Ipswich and Marblehead, Massachusetts, that the ancient specimens were higher in proportion to their length than the recent specimens. A comparison of the common beach-cockle (*Lunatia*) from the shell-heaps of Marblehead, Massachusetts, showed that the present form living on the shore to-day had a more de-

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pressed spine than the ancient form. In another paper, Professor Morse, after referring to the fact that, although worked shells were not uncommon in the shell-heaps of Florida and California, none had been found in the New England and Japanese shell-heaps, exhibited specimens of the large beach-cockle (*Lunatia*) from Marblehead, Massachusetts, which had unmistakably been worked by cutting out a part of the outer whorl near the suture. To show that this could not have been artificially broken, he exhibited naturally broken shells of the same species, both ancient and recent, in which the fractures were essentially unlike those of the worked shells.

Who were the Mound-Builders?—Dr. W. De Haas, after a careful examination of the supposed connection between the "mound-builders" and the ancient races of Mexico, has come to the conclusion that it does not exist. He considers that the former people were but little advanced beyond the modern Indians, but that they were different. In the discussion that followed the reading of Dr. De Haas's paper in the American Association, Judge Henderson objected to the use of the term "mound-builder," as one that conveyed a false idea. There is no evidence, he said, which will justify us in separating the ancient and more modern races, not a single feature peculiar to the so-called mound-builders. The speaker had started out in the study of American archæology with the impression that these people were distinct and separate from the Indians, but he had been compelled by the force of facts to relinquish the theory. It was improper to talk about these people as mysterious, for they were no more mysterious than the Shawnees, the Natchez, the Tensas, and other tribes. The cloth found in their works was like that made by every tribe from the Lakes to the Gulf, even less fine than some, and their pottery was no better. In short, the speaker said, in his judgment, the mound-builders were the ancestors of the Indians.

M. Trouvé's Electric Canoe.—"La Nature" gives the details of a series of experiments made upon the Seine, at Paris, in the latter days of May, with the electric canoe and motor invented by M. G. Trouvé. The motor is composed of an improved Siemens coil, which acts through a Vaucasson chain and a Galle chain upon a three-bladed screw fitted into an opening cut out of the rudder to receive it. It is fixed to the upper part of the rudder, so that it, as well as the screw, follows all its movements. The motor employed in the experiments was composed of two coils, and, with its accessories, did not weigh more than five kilogrammes (twelve and a half pounds). It was placed in the stern of a canoe, the Telephone, which measured seventeen feet ten inches by three feet ten inches, and weighed one hundred and eighty pounds. Two cup batteries of bichromate of potassa, composed of six elements each, and weighing together sixty pounds, were placed in the middle of the canoe. They were connected with the motors by two cords, which served at the same time as envelopes for the conducting wires and as tiller-ropes, and which were furnished with appurtenances for applying or shutting off the current at will. The motor is independent, and can be applied to any boat. The first experiments were made on the 26th of May, when the boat was worked for about forty-five minutes by M. Trouvé and M. Tissandier, in the afternoon, and by M. Trouvé and others for about the same time in the evening. A third experiment was made on the 31st of May, in the presence of M. G. Berger, commissioner-general of the Universal Electrical Exposition, M. A. Breguet, of the "Revue Scientifique," M. Hospitalier, M. Fricéro, of the Russian navy, and others. The Telephone, with three persons in it, easily went up the Seine six times for a distance of two hundred metres, or six hundred and fifty feet, at the rate of one metre in a second, and descended at the rate of two and a half metres in a second. Other experiments were made on the 2d of June, in presence of the Russian Admiral Likhatchof and a number of spectators interested in science or navigation. These experiments recall a similar attempt made on the Neva in 1839, by Jacobi. He used on the occasion two Grove batteries, each composed of sixty-four couples of zinc and platinum, and presenting a surface of sixteen square feet. The

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boat, propelled by paddle-wheels, and carrying twelve persons, sailed upon the river for several hours against the current, and in spite of a violent wind; but the operators were greatly inconvenienced by the nitrous gas, which escaped in great quantities, and the spectators on the banks were obliged, by the suffocating fumes, to leave the place. Electric navigation may be considered to have originated with this experiment.

The Kafirs of Kafiristan.—The Kafirs, who inhabit the country called Kafiristan, which lies south and southeast of the Hindoo-Koosh Mountains, are so called by their Mohammedan neighbors after a term signifying unbeliever, because they are not of the Mohammedan faith. They are an Aryan people of unknown origin and history, divided into a number of tribes speaking as many tongues; they are ethnically distinct from any of their neighbors; their religion is pagan, but neither Hindoo nor Buddhist, and they are in constant hostility with the Mohammedans. Possibly they represent the Aryan race in the nearest to the primitive state in which it can now be found. They have never been visited by a European. Colonel H. C. Tanner, who has furnished an account of them to the Royal Geographical Society, has been nearer to them than any other Englishman, having been invited by influential Kafirs to visit the country as their guest, but he was prevented by sickness from getting any farther than the country of the Chugáni, a Kafir tribe who have embraced Mohammedanism, living on the borders of Kafiristan. The Chugáni live in the highest habitable parts of the Kund range. They are of the Suni faith, and are the only Mohammedans in the region who allow their women European freedom. One of the principal towns is Aret, a village of six hundred houses, which are built on the face of a very steep slope, and arranged in terraces one above the other. The view from below presents a vast amphitheatre of carvings, with which the wood-work of the houses is covered. Inside, the furniture consists of cots (*kát*), stools (*stá*), and earthen vessels with Grecian-looking ears, cheese-making utensils, and agricultural implements—wooden shovels, rakes, etc.—stuck between the blackened rafters; and the impression on the whole is one of superiority to most Indian habitations. The burial-places are scattered among the rocks in any spots not too steep for them, and the graves are built with stones and covered with slabs, so that the bodies shall not come in contact with the earth. Highly ornamented and fantastically carved posts stand at the head and foot of the graves. The posts of a new grave were painted red and adorned with pegs, representing the number of enemies the deceased had killed during his lifetime. The Sanu Kafirs are a merry people, fond of dancing, music, and wine, who shake hands in the English fashion. Their religion is simple. Men call on the gods for aid in battle, and pay offerings to them if successful in the fight, storing the offerings in the temples, some of which contain the accumulations of hundreds of years. They do not bury their dead, but place them in wooden coffins and stow them away in caves in the mountains. The country probably contains interesting antiquities, for stones are told of with ancient writing engraved upon them; ruins exist at Islámabad and at Bimbakot, the reputed capital of the Hindoo Bim Raja; and the petrified remains of Noah's Ark are said to rest on the shores of a lake on the summit of Kund, while the legendary tomb of Lamech, Noah's father, is in the plain below, and the name of Noah seems to be very common. Colonel Tanner found an exact representation of a Kafir knife in one of the *topes*, and dug up a number of small, well-executed pictures from the life of Buddha, in limestone, at the same place.

The Coal Production of the World.—Professor von Neumann, of Vienna, estimates, in his "Review of the Production, Traffic, and Commerce of the World's Economy," that the annual product of coal in the whole world increased from 136,000,000 tons in 1860 to 294,000,000 tons in 1877. Great Britain was the leading producer, during the whole period, and returned an output of 137,000,000 tons in 1878. The United States, which stands next, returned 55,200,000 tons in 1877. Germany, France, Belgium, and Austro-Hungary follow in

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their order. The drain upon the earth's stock of coal has hardly begun yet. The known fields of China, still almost unbroken, are supposed to have an area of 200,000 square miles; those of the United States of 193,870; the East Indian fields of 35,000; the British fields of 9,000; Germany, France, and Belgium have small fields; one field in Russia covers 13,600 square miles; Japan has coal-fields in fifteen of its thirty-eight provinces; Australia has excellent coal to supply the lands of the Pacific. Great Britain consumes coal at the rate of 3·6, the United States of 1·06, Germany of 1·1, France of 0·64, Belgium of 1·96, Austro-Hungary of 0·33 ton per inhabitant. In England about one third of the coal is used in the manufacture of iron and steel, more than one fifth in the large industries, more than one sixth for domestic purposes, and the rest is consumed by gas-works, water-works, mines, railways, and steamers. In France, the metallurgical, industrial, and gas works consume 72 per cent., the household 18 per cent., the transporting industries 10 per cent., and the mines 4 per cent. of the whole amount. The coal-mines of the world employ about 1,100,000 men, viz., 514,500 men in England, 210,000 in Germany, 97,000 in France, 101,000 in Belgium, more than 100,000 in the United States, and 63,000 in Austro-Hungary.

Intellectual Condition of the Savage Negro.—M. de Rouvre gives, in the "Bulletin de la Société de Géographie," a darkly-colored view of the mental and moral capacity of the negroes of southern Guinea. The black, he says, has no initiative, and is completely destitute of metaphysical conception and abstract ideas. The seat of the intellectual functions appears to be paralyzed or atrophied; the comprehension is inert. He receives no impression of the beautiful, of the grand; feels no love, no other passion than the bestial instinct; knows no distinction between good and evil, except that which is imposed by the fear of punishment. Therefore, he experiences no satisfaction over a good deed, no remorse over a wicked one. His enjoyments lie in eating, drinking, and sleeping. He has no conception of property beyond that of an infant that prizes what it has without thinking of its real value, and has no scruples against taking what is another's if the notion strikes it. The black, from sheer unintelligence, is unmoved by the sight of our machines. The crew of M. de Rouvre's pirogue, when he visited the frigate Bellona, were taken through the ship and shown it by a quartermaster, but paid more attention to the biscuit and rum that were offered them than to any feature of the vessel or its equipment. M. de Rouvre showed some of them a photograph of a friend who had a long beard and with whom they were well acquainted; they remarked, after looking at it in every aspect, "You have a very pretty wife in Europe." As a rule, when anything is shown them, they look at the person who points it out rather than at the object, try to divine what he thinks about it, and repeat that. It is impossible to convince them that anything can be different from what it is; but they regard everything with a mixture of superstition, incapacity, and perversity. They have never thought of digging wells in their towns in time of drought, though they suffer greatly from the want of water, and have often seen how the Europeans provide it in their factories. Some of them have visited Europe, without having received any permanent improvement. One young man went to Paris and learned to speak French and dress in the European style, but resumed his natural life as soon as he returned home, reserving only a kind of varnish to cover the duplicity with which an incomplete education had endowed him. All the traces that were left of his education were an increased power of discovering what was really wicked, and of putting what he had learned to the service of his unrestrained instincts.

Action of the Different Rays of the Spectrum. — Assuming that the rays of the spectrum vary simply by their wave-length, or quantitatively, M. Lermantoff, of St. Petersburg, believes it probable that their mode of action on bodies is really the same. The dark heat-rays produce a sensible heating of the entire body; but each superficial molecule that receives directly the energy of the ray is heated much more than the rest of the body, and communi-

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cates its excess of heat by conductivity. The luminous and ultra-violet rays produce a similar effect; but the motion which they communicate to the molecules is distinguished by greater velocity, corresponding to a higher temperature. Such an hypothesis of molecular heating is sufficient to explain most of the effects produced by light on bodies. The incandescence of the superficial molecules, under the influence of the most refrangible rays emanating from a source at high temperature, must persist for a finite time after the cessation of the action of light. In this, perhaps, lies the direct explanation of the phosphorescence of short duration which M. Ed. Becquerel has observed in nearly all solid bodies. Fluorescence is also explained by the same hypothesis, if we regard it as a phosphorescence of short duration sufficiently intense to be seen during the action of the light. In general, moderate elevation of temperature favors the reactions of combination, while in the highest temperatures all known combinations undergo dissociation or decomposition. Thus, according to M. Lermantoff's hypothesis, the less refrangible parts of the spectrum should produce principally reactions of combination, and the more refrangible parts decompositions. This is precisely what M. Chastaing has proved for the particular case of oxidations.

Metallic Anti-Resonators.—It is known that resonances in public halls can be modified or prevented by stretching wires across the ceilings; and the principle has been rudely applied in a number of instances with fairly satisfactory results. Mr. A. C. Engler, of London, has invented a plan for a systematic arrangement of steel plates, or wires, which promises to accomplish the object more completely. The effect of the plates is to take up the most gentle vibrations and greatly to increase the speed of transmission. Wires have a similar property, and are more convenient. In the most advantageous application of Mr. Engler's invention, one or more layers of steel wires are stretched along the length of the room, a few feet below the ceiling, connected by cross-wires and spiral springs, and properly tuned, so that the vibration may be absorbed and conveyed from one wire to another, and instantaneously spread over the whole building; and the words of the speaker or the notes of the singer are so accelerated that they reach the audience about fifteen times more quickly than under ordinary arrangements. The effect is improved and the tone enriched by using steel plates. The system has been applied—imperfectly, for the wires had to stop short of the wall at one end—in a lecture-room at the South Kensington Museum of notoriously bad acoustic properties. Twenty-eight lengths of steel wire were stretched across a distance of sixty feet, and connected at the end by steel-wire springs. Above them were three other steel wires, connected with the lower group, so as to form a perfect network of wires. The effect was a complete distribution of the sound, so that a speaker at the lecturer's table could be heard distinctly in any part of the theatre, and all the acoustic defects of the hall were considerably mitigated.

Decline of Country Population in England.—The returns of the new English census show that the growth of the towns at the expense of the rural villages and the agricultural districts, which has been remarked in previous censuses, still continues; and it is not certain that the process of depletion of the country is not progressive. The younger people are leaving their rural homes so rapidly that in some parts of the kingdom the difference is sufficient to strike even casual travelers. The causes of the decline of the agricultural population are supposed to be attributable partly to the increasing use of machinery, which reduces the demand for hands; partly to reduction of wages; but chiefly to an increase in the dislike for agricultural labor under existing conditions. The towns offer better pay, more steady employment, better protection from the weather, and more hope of reaching an improved condition, than the farms; and work in towns, if it is hard, is more lively and gregarious than agricultural labor. The remedy suggested for the evil, if one is to be applied, is peasant proprietorship, under which the man who works may, as on the Continent and in the United States, feel that he is laboring for himself.

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The English Mile.—M. Faye has explained why it takes sixty-nine and a half English miles to make a degree instead of sixty, as was probably intended when the mile was established. The English geographers deduced their mile from Ptolemy, and Ptolemy refers to Eratosthenes. Eratosthenes measured the arc of the meridian on the basis of the distance between Syene and Alexandria, in Egypt, which gave seven hundred stadia to the degree. Ptolemy says that he verified the measurements of Eratosthenes, and found the same result, which he gives, however, as five hundred stadia to the degree. The discrepancy arises from a change which took place in the standard of the foot—of which six hundred went to the stadium—during the four hundred years between Eratosthenes and Ptolemy. Eratosthenes used the ancient Egyptian foot, which is shorter than ours, while Ptolemy used the Phileterian foot, which is longer than ours. Making allowance for this difference, the two measurements agree. The English geographers, in making their calculation, believed that Ptolemy had used still another foot, the Greek foot, which is one and a half hundredths longer than ours, but shorter than the one he did actually use. If the English geographers of the sixteenth century had strained this valuation ever so little, and had carried it to five one-hundredths, they would have found 630 English feet for the stadium, which they believed to be 600 Greek feet, and these 630 feet, or 210 yards, multiplied by 500, would give them 105,000 yards for the degree, and exactly 1,760 yards for the mile.

The International Electrical Exhibition.—The International Exhibition of Electricity at Paris was satisfactorily opened August 11th, though the preparations still lacked something of being completed. The exhibition represents, in two distinct divisions—first, appliances of electric lighting; and, second, the other applications of electricity. In the second division, England and Germany have the first places on the left of the entrance, with one thousand square metres of space each; after them follow, in order of the size of their exhibits, Belgium, America, Austro-Hungary, Russia, Sweden and Norway, Italy, Spain, Switzerland, Holland, and Denmark. Japan exhibits a table of porcelain vases and jars of lacquered stuff for insulators. The French exhibits are on the right, and in the center of the palace is an electric lighthouse, surrounded by a basin, in which a boat propelled by electricity moves around. The twenty-eight rooms of the first floor are each lighted by a different system of electric lighting. One room, lighted by the sun-lamp, contains pictures and works of art to show the application of electricity to the lighting of museums. Another room is a completely furnished theatre, lighted by the Werdemann system. Two other rooms, furnished as a suite, contain the applications of electricity to domestic and social life. In the next rooms electrical playthings are collected, and in the rooms adjoining are telephones, by means of which visitors are brought within hearing of the Opéra and the Théâtre Français. Other rooms are devoted to electropathy, electric photography, testing instruments, a retrospective exhibition of historical apparatus, and, lastly, Mr. Edison's inventions. Visitors are brought from the Place de la Concorde to the door of the exhibition on an electric tramway, and a little electric railway for the transmission of letters and telegrams traverses the south gallery.

Propagating Sponges by Cuttings.—The Austrian Government has made some successful experiments in the propagation of sponges from cuttings in the Adriatic Sea, accounts of which have been published by Dr. Emil von Marenzeller, in the "Transactions of the Zoölogical-Botanical Society of Vienna." The most suitable season for undertaking the propagation is the winter; for, although the growth of the sponges and the healing of the cut surfaces takes place more slowly then than in the summer, the sponges are much less liable to be spoiled by putrefaction. The suitableness of a spot for the cultivation is surely indicated by the freshness and liveliness of the marine algæ growing in it. It demands a bay sheltered from strong waves and currents, but not quite still, a rocky bottom, clothed with living algæ, and a moderate ebb and flow of the tide. In all cases the neighborhood of the mouths of brooks, rivers, and sub-

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terranean springs, must be avoided. The worst enemy of sponge-culture is mud. The sponges chosen for cutting must be gathered by experienced hands, with all possible gentleness, so as to avoid tearing them. They should be cut up rapidly, with a common knife, or, better, a saw-like blade, being laid for the purpose on a smooth wooden board, moistened with sea-water, into pieces of about one cubic inch each; and it is well that each cutting should have the greatest possible area of uninjured outer skin. A healthy piece of sponge firmly attaches itself to any surface with which it comes into intimate contact, in a short time. Preference is given to stone as a foundation, because it is the natural ground and is not attacked by the teredo, which seems to be a dangerous enemy to the culture. The Austrian culturists generally attached their cuttings by pegs to a kind of wooden apparatus, taking care to avoid lacerating the sponge, and forcing and squeezing, which cause a loss of sarcode, and metals, which cause rot, and sink it into the water. Too much light and too little light must be avoided; the sponges must be kept constantly moist with sea-water during the preparation, especially in warm weather; and all wood-work must be tarred, to delay (for it does not prevent) the ravages of the pile-worm. If the cuttings hold fast after three or four weeks, the propagation is regarded as secure. A characteristic feature is the tendency of the cuttings to assume a round form, and the apparatus for planting them is shaped to promote this. The period of growth varies considerably, but generally a term of seven years is required to produce a marketable and profitable article. The question whether this mode of cultivation is profitable appears to have two sides. Dr. Marenzeller considers it doubtful whether it is advantageous to cut in pieces a sponge which, uncut, would have more quickly reached the same size and height as the collective cuttings, and thinks that attention may be better directed to the development of ill-shaped ones into good-shaped ones.

Experiments in Vision.—MM. Macé and Nicati have found that persons with normal vision, when looking at the solar spectrum, form considerably different estimates of the distribution of light in it. They have since experimented with four Daltonians, or color-blind persons, and observed that in three of them the vision of red was very feeble, that of yellow was normal, and that of green appeared to be even sharper than in normal-eyed persons, while in the fourth the conditions were reversed. Between Daltonians who could not perceive red, differences were noticed in the powers of vision of blue and violet, similar to those met in normal eyes. M. Charpentier has experimented by looking in darkness at an opaque screen perforated by a number of minute holes, which were distinguishable in a moderate light, and learned that a very faint light merely produces a diffuse luminous sensation; a greater quantity of light gives the notion of color, if color is present; and a still greater quantity is required to produce the perception of form.

The Interstellar Ether.—Professor T. Sterry Hunt, at the recent meeting of the American Association, explained his peculiar views of the nature of the interstellar ether. Having referred to the theories of different philosophers respecting the extent of the earth's atmosphere and the nature of the ethereal fluid, he said that processes have been going on from the earliest ages which have absorbed and evolved enormous quantities of gases. For instance, in the manufacture of the limestone rocks of the earth alone over two hundred times the amount of the carbonic dioxide now in our atmosphere have been consumed. This must have been borrowed from space. Professor Hunt then discussed the probability of a chemically compound ether, exceedingly attenuated, existing in the interstellar space, and pervading the universe just as the atmosphere surrounds the earth.

Vaccination for the Anthrax.—After a long series of experiments M. Pasteur has found a method of attenuating the virus of the carbuncle, or *anthrax*, of cattle and sheep, and of vaccinating animals with it so as to give them an effective protection against the disease. The sufficiency of the remedy was attested by inoculating with the active virus sixteen sheep, taken as they came from the flock, and nineteen

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sheep which had been previously vaccinated. Three days afterward fifteen of the sixteen unvaccinated sheep were dead, while the nineteen vaccinated ones were perfectly healthy. M. Toussaint has discovered that a female animal which has been inoculated for this disease transmits her immunity to her offspring, and that equally well whether the inoculation was made before conception or afterward.

NOTES.

PROFESSOR T. J. BURRILL, in the "American Naturalist," refers certain blights and diseases of plants to the agency of bacteria. Those organisms appear to be an active cause of the blight in pear and apple trees. The cells of blighted pear-trees are destitute of the starch-grains with which the healthy cells are filled, but traces of fermentation have been discovered in them, and bacteria have been uniformly observed in the juices of diseased pear and apple trees. The death of patches of bark on the trunk and larger limbs of apple-trees is ascribed by Professor Burrill to the same cause. The yellows of the peach-tree have been shown by the discovery of bacteria under the microscope to be caused by a similar organism, as are also the blights of the Lombardy poplar and the aspen.

MR. E. E. FISH, in the "Bulletin" of the Buffalo Society of Natural Sciences collates several instances to show that the power of repeating from imitation other sounds than their own notes, which has been noticed in only a few species, is common to many birds. He has observed the sparrow singing clearly the song of the chewink or towhee bunting and of the pewit; the robin interspersing the notes of a phebe-bird with each song, "with such exactness as to deceive any one who might not see the bird while singing"; another robin utter the notes of the oriole; the red-eyed vireo whistle the "Bob White" of the quail, deceiving those who heard it and did not see it.

How fallible is a name as a guide to any fact in respect to the article to which it is applied is curiously shown in the case of the "Jordan almonds," which even Philip Miller, in Bailey's Dictionary, said were so called because the best of them grew near the river Jordan. In fact, no almonds come, or ever did come, from the Jordan. An old work, however, mentions "Jardyne almaunde, *Amigdalum jardinum*," and solves the doubt. Jordan is a corruption of jarden; the Jordan almond is simply a garden or cultivated almond.

MR. JAMES B. FRANCIS, President of the American Society of Civil Engineers, endeavoring to account for the origin of anchor or ground-ice, shows that it is formed in streams where the water is much disturbed, rising and falling in upward and downward currents. The ice-needles in course of formation, having nearly the same specific gravity, are carried down with the descending currents, and many of them become attached to the bottom by regelation. Of the immense number of needles that are formed, enough thus adhere together at the bottom to form a mass of ice there. The essential conditions to the formation of ground-ice are, that the temperature of the water must be at the freezing-point, and that of the air below it; that the surface of the water must be exposed to the air, and there must be a current in the water—all of which are in harmony with this theory. The adherence of the ice to the bottom is always down-stream from where the needles are found, and in large streams it is many miles below.

PROFESSOR ALEXANDER HOGG, in an address, at Marshall University, Texas, illustrated the extent to which the English language has spread, by referring to the time when Mary Beatrice, of Modena, about to marry the Duke of York, afterward King James II, did not know where England was; then to one hundred years ago, when French was spoken by twice as many native Frenchmen as there were English-speaking people, while German was the language of at least an equal number, and Spanish had a wider geographical range than either German, French, or English; and, comparing these periods with the present, when English is the language of one hundred million people, and bids fair, before another hundred years, to be that of ten times as many.

MR. RHEES'S biography of Smithson, published by the Smithsonian Institution, states that the precise date and place of his nativity are unknown. Mr. Joseph L. Chester states, in the "Academy," that the matriculation register of the University of Oxford shows that Smithson matriculated as James Lewis Macie, from Pembroke College, on May 7, 1782, at the age of seventeen, and that he was a native of London. As the age at the last birthday was always required, it follows that he was born between May 7, 1764 and May 7, 1765. The date, about 1754, given by Mr. Rhees as that of Smithson's birth, is, then, ten years too early.

M. SCHLUMBERGER, describing the powerful antiseptic qualities of salicylic acid, says that, employed in infinitely small doses, it hinders the action of nitrogenous ferments, and forms stable combinations with them. In hygiene, it is a valuable disinfecting and

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sanitary agent. The French railway companies have for some time used it as a wash to cleanse their cattle-cars. In some countries it is employed as a remedy for certain affections of animals, and as a prophylactic against contagious diseases. These services, important as they are, are surpassed by those which this substance is made to render in the preservation of food. The quantities of the acid which are required for this purpose are very minute, and no case of injury to any person has been traced to it during the six years in which it has been in increasing use; yet some physicians have expressed the apprehension lest the continuous daily consumption of salicylized food may eventually produce derangement in the system. The subject deserves careful examination.

M. G. HAYEM, having studied the physiological and medical effects of inhalations of oxygen, reports that when taken regularly, mingled with an indeterminate quantity of common air, oxygen produces an energetic stimulation of the nutritive faculties. It is especially beneficial to chlorotic patients, in whom it restores the appetite, stops vomiting, revives the movement of assimilation, and causes increase of weight. Inhalations of oxygen form a useful auxiliary in the treatment of chlorosis with iron, especially when gastric troubles make the application of this treatment more difficult. The inhalations are especially characterized by the control they exercise over vomiting, which is often suspended after one or two applications. They have also been observed to promote an increased elimination of urea.

MR. G. S. JOHNSON has effected the synthesis of ammonia by passing a mixture of hydrogen and pure nitrogen over spongy platinum at a low red heat, when ammonia was produced at the rate of 5·9 milligrammes per hour. The experiment was varied in different ways, under one of which ammonia was produced at the rate of twenty-four, under another of three, milligrammes per hour, while in others none was produced. From all the experiments, Mr. Johnson has concluded that nitrogen, like phosphorus, may exist in two states, active and inactive, the latter being brought on by exposure to heat.

CATHERINE C. HOPLEY suggests in "Land and Water" a new theory of the so-called fascination of birds by snakes. It is that the bird mistakes the snake's tongue, which the animal keeps in constant motion, while it otherwise remains perfectly still, for a lively worm, and gazes at it with the expectation of making food of it. The idea was suggested by observations at the Zoölogical Gardens, where the birds were frequently seen watching the tongues of the snakes.

ATTEMPTS have been made in England, applying the principle of the Bessemer process, to facilitate the extraction of copper from the sulphuret by blowing air into the pyrites, in order to consume the sulphur and make it at the same time a source of heat for the continuance of the process of reduction. They have failed, because the bath would lose its heat as soon as the sulphur was consumed. The discovery has been made in a factory at Lyons, France, that the presence of a compound containing phosphorus will protract the continuance of the required temperature till the process is completed. The order of the combustion appears to be, first of the sulphur, next of the metallic impurities, lastly of the phosphorus.

THE French Minister of Public Instruction has appointed a commission on hygiene of the eyes in schools, for the purpose of investigating the influence of the material conditions of the arrangement and furnishings of the school-room—the seats, desks, position of the light, etc., on the progress of myopia, and of looking for means of opposing them. Dr. Gavarret is president of the committee, and Dr. Javal is one of the members; and, in order that questions of typography may not be overlooked, it includes two publishers and a printer.

M. E. BOUCHUT has suggested the use of the digestive juice, papaine, which we have recently described, for the dissolution and digestion of the false membranes of diphtheria. He has, in his experiments, seen a thick, resisting, and elastic false membrane from the trachea which he had placed in a tube with one third part of the juice of the papaya, dissolved in a few hours when cold, and in a few minutes when the tube was warmed. Since beginning his studies on this subject he has treated thirty-two cases of infants or adults, two of which were very severe, and lost only four.

M. GLEY, a French physiologist, has, from experiments made upon himself respecting the effect of attention and intellectual work upon cerebral circulation, confirmed the results of M. Mosso and added some new observations. He finds that the rhythm of the heart suffers an acceleration which is increased in a direct proportion with the intensity of the attention. Thus the pulse was quicker when he studied geometry than when he studied philosophy, with which he was more at home. The carotid artery is also dilated during cerebral work, and the carotidian pulse becomes dicrotic, but the radial pulse becomes smaller and less ample. The phenomena of congestion observed in the brain persist for a certain time after cerebral activity.

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PAUL BROCA.

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DETERIORATION OF AMERICAN OYSTER-BEDS.

By Lieutenant FRANCIS WINSLOW.

II.

AN oyster-bed, in its natural and undisturbed state, consists of a long, narrow ridge of shells and oysters, lying generally in brackish water, on and surrounded by sticky bottoms, a mixture similar to clay and mud being the most favorable.

The form and area of the bed are variable, but, naturally, the length is greater than the breadth, and the greatest dimension is usually in the direction of the current. The bed itself is made up of masses of shells and oysters, covering areas of different sizes, and separated from each other by mud or sand-sloughs, though frequently it is unbroken, and the animals spread evenly and continuously over the entire area. This separation and detachment of the groups of animals are much more noticeable upon a bed which has been much worked. Upon an unworked bed, or one in its natural state, the oysters grow in clusters, and are firmly cemented to the bottom. Upon a bed which has been frequently dredged, the animals are single, and have no hold upon the bottom.

The fauna of the bed varies with the locality; in the Chesapeake it is somewhat sparse.

The bottom is usually of clay or mud, and of sufficient consistency to support the oysters; certain varieties of bottom are more favorable than others, but, except within wide limits, the character of the bottom does not appear to be of great importance, so long as it is sufficiently firm to prevent the animal from sinking into it and thus smothering.

The oyster thrives best in slightly brackish water, and the finest varieties are usually found in water of a lower specific gravity than

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that of the sea, but the density is not important, except within wide limits, though the specific gravity should not fall below 1·01 at 60° Fahr., distilled water being represented by 1·00. The main necessity is that the water should contain a sufficient amount of lime to furnish the animal with the principal constituent of its shell.

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The mature marketable oyster is so well known that it is unnecessary to describe it; but the following will assist the reader, who is not acquainted with the anatomy of the animal, to a correct appreciation of the facts stated and terms used in subsequent pages:

That part of the oyster usually known as the heart is a muscle, called the abductor muscle; its office is to keep the valves (or shell) closed, and prevent the ingress of deleterious matter.

The two valves are hinged at the round, blunt end of the shell, and between this hinge and the abductor muscle lies the body of the oyster or *visceral mass*, which is made up of the light-colored reproductive organs and the dark-colored digestive ones, packed together in one continuous mass. The mouth of the oyster is that part nearest the hinge, and what is usually called the "beard" of the animal is known as the "gills."

The oyster lies on its side in the shell, and the minute animal and vegetable organisms contained in the water, and which form the food of the animal, are passed along between the gills to the mouth by the action of myriads of small vibrating hairs, called *cilia*. These cilia cover the surface of the gills, and, by a rapid and simultaneous motion in one direction and a slow one in the opposite, cause a strong current to set into the lips of the valves, bringing in not only what is suitable for food, but many other minute organisms and particles which thus come in contact with the gills and what they may hold.

The European oyster (*Ostrea edulis*) and the American oyster (*Ostrea Virginiana*) are varieties of the same family, and, though differing in several particulars, are not so dissimilar but that the conditions favorable to the growth and life of one may be considered as equally so for the other. With each variety the formation of the generative matter is gradual, and the spawning-season of both is during the early summer months, its advent depending probably upon the temperature, the higher temperature hastening and the lower retarding that event. No particular temperature can be assigned, as it depends greatly upon the locality, but departures from the normal temperature of the spring and summer months will have the effect described. In the same way an increased or diminished density of the water, whether due to change of temperature or to the addition of water of greater or less specific gravity than that usually surrounding the animals, has probably a similar accelerating or reverse effect upon the spawning, though as yet we can not speak with certainty upon this point.

Generally, both in Europe and America, the spawning-season may be said to be from June 1st until August 15th, though variations of

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the temperature and density of the surrounding waters may expand or contract that period considerably.

All authorities upon the early stages of the European variety concur in the statement that the young oyster or "spat" is formed by the fertilization of the eggs of the female while within the shell of that animal, and that the "spat" is held between the gills, and thus protected by the parent until the shell has formed. Many authorities are also of the opinion that the parents are hermaphrodites, and it is here that the first difference between the European and American varieties is noticed. Professor W. K. Brooks, in his recent paper upon the embryology of the American oyster, states that, though he has during the past two years examined a very large number of oysters, he has never found any evidence of a union of the two sexes in the same animal; and my own more limited observations have likewise failed to discover any such indication.

The second and most material difference is in the manner of impregnating the eggs of the female. According to the best authorities the fertilization of the eggs of the European variety is accomplished by the passage of the male fluid into the water, and thence between the valves and gills of the female, where the eggs, having been expelled from the ovaries, are lying ready for fertilization. The young resulting from the union of the ova and spermatozoa are held and protected within the gills of the female until the shells have formed and until they are quite well advanced in development, having at the time of their expulsion locomotive powers of their own, which enable them to swim about and seek an appropriate place for attachment.

The American variety, according to the observations of Dr. Brooks, differs in this, that the young oyster is not found within the gills of either parent, nor does the fertilization take place within the shell, but the contents of the generative organs of both sexes are expelled into the water, there to stand the chance of coming into contact. My own observations support this theory, inasmuch as relates to the presence of young within the gills, I having examined those parts of a large number of oysters very carefully, and with an utter failure to discover an embryo oyster, even during the height of the spawning.*

It is evident that a large measure of protection is afforded the young of the European variety by the inclosing shells of the parent, and that this protection is given during the most precarious stages of their existence, while the ova and spermatozoa of the American oyster are not only left to a happy chance for their successful union, but the

* At least one variety of the European oyster is reproduced in a manner similar to our own. During the summer of 1880 I successfully impregnated the eggs of several female oysters, taken from the Bay of Cadiz, Spain. The embryo were maintained alive for eight days, and their development was entirely similar to that of the American variety.

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resulting young are exposed, unprotected, to all the vicissitudes of climate and to the ravages of all enemies.

After the formation of the shell, and the development of the locomotive powers, the young of both varieties begin their search for a permanent resting-place or point of attachment. The swimming period is of short duration, and the powers of locomotion are not very great; consequently, such points of attachment must soon be obtained, or the young oyster perishes. Any moderately rough, hard substance, provided that the surface is clean, is suitable for attachment, and such objects, when exposed for the purpose of attracting the young brood, are called "cultch." Pieces of wood, boughs of trees, planks, stones, old shells, tiles, and fagots, have all been successfully used. It is only necessary that the surface should be hard and clean, and, if dark-colored, so much the better. Upon finding the "cultch," the "spat" attaches itself firmly, and is thenceforward, so far as its own power is concerned, located for ever; all future movement and change of position are due to causes, natural or otherwise, over which it has no control.

The development now is one of ordinary growth, the animal having passed through its embryonic life; its organs are formed and are in active operation; it is but immature. The increase in size and the development of the different parts, or, in other words, the growth, are much more rapid with the American variety than with the European. Though we have no record extending over any length of time, and none of different localities, yet the observations during the summer of 1879 in Chesapeake Bay show that in the first three months of existence the oyster in that locality increases in size from a hardly visible speck to an average length of one and a quarter inch, and a few were over two inches long. The lower and attached side grows the most rapidly, and during this first period the growth is mainly in length; there is, of course, a development in all directions, but the greatest is toward the lips of the shell. After the first year, the increase in size is not so rapid, and oysters of two or three years of age are about two inches broad and three inches long, though those dimensions will vary considerably in different localities on account of the different conditions to which the animals are subjected; in three years at the most the American oyster is considered mature, and will present all the characteristics of those found in the markets. With the European variety the growth is much slower, and at maturity they are very much smaller than the American oyster: but this difference is immaterial to the question under consideration, and all that is necessary to notice is the consequence of the different methods of propagation.

With all animals Nature strives to provide against the destruction of the young after birth by insuring a sufficient number to allow for all ravages; and the greater the dangers to which the immature of any species is exposed, the larger will be the number provided to meet

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those dangers. Hence, as the embryo European oyster receives some protection and the American none, it is inferred that the number of American embryos in any community will be subjected to greater danger, and consequently it is probable that a larger number of eggs and spermatozoa are provided, that the production may not be less. If this is not the case, then the reproduction upon the European beds is much greater than upon our own. Let us see if the investigations, conducted both in this country and abroad, support this conclusion.

Professor Möbius, in his work upon the oyster and oyster-culture, estimates the number of eggs spawned by the European variety as about 1,800,000, and his estimate is supported by Eyton, in his "History of the Oyster and Oyster-Fisheries."

Professor Brooks estimates the possible number of eggs spawned by the American variety to be as large as sixty millions, and the average number to be over nine millions, or the American oyster spawns about nine times as many eggs as the European. The number of male cells is so great that, even if it were possible, it would be unnecessary to estimate them; but, from the comparison of the numbers of eggs spawned, it will be seen that Nature supplies with the American variety a much larger number of eggs, in order that the deficient protection afforded them after fertilization may, as far as possible, be remedied.

It would seem that the growth of a bed and increase in the number of oysters would be immense did we not know that the greater the production of the germs in all forms of life the greater the mortality among those germs; and, therefore, any conclusions as to the impossibility of destroying the fecundity of the oyster-beds, when such conclusions are based upon the large number of eggs spawned, must be erroneous. The number of embryos surviving and maturing can not be accurately stated for either variety, as we have but four data from abroad bearing upon the question, and, until the last year, none at all from this country. Professor Möbius has collected the results of the official examinations of the Schleswig-Holstein beds, and from their inspection has come to certain conclusions, and, as these results are the only ones known to us, it may be interesting to briefly describe the method of arriving at them.

The observations were made on the beds by officials of the Government from 1730 to 1852, and were conducted in the following manner: Each bed was dredged over in three or six places, according to its size, and the oysters taken were divided into three classes and carefully counted. The classes were denominated "marketable," "medium," and "young growth." The "marketable" oysters were those full-grown and mature, from seven to nine centimetres in length and breadth, and eighteen millimetres thick. The "medium" were half-grown oysters, from sixteen to eighteen millimetres thick, and less

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than nine centimetres in breadth; the "young growth" were those one or two years old.

From these observations, which were made annually, Professor Möbius discovers that there was on an average 421 medium oysters to every 1,000 marketable ones—that is, out of every 1,421 oysters 1,000 were full grown. The average of all observations differed very little from the number given by each, and consequently shows that there was but a slight fluctuation in the proportion in one hundred and twenty-two years. The "medium" oysters are considered by Professor Möbius to be those descendants of the "marketable" ones that have survived their most precarious years of existence and escaped their principal enemies, and are consequently likely to reach their full growth. They thus represent the total number of oysters spawned which have survived in the struggle for existence. From his experiments Möbius decides that about one million eggs are spawned by each oyster, and that about forty-four per cent. of the oysters on a bed spawn each season.

It is evident from the above that in an assemblage of one thousand oysters four hundred and forty million eggs would be voided every season, and of the resulting embryos four hundred and twenty-one would survive; or, 1,045,000 eggs would perish where one survived. But the "medium" oysters also spawn, though they send forth a much smaller number of eggs, and Möbius estimates that four hundred and twenty-one in the community would produce about sixty million, or the fourteen hundred and twenty-one would spawn together about five hundred million eggs, and from these five hundred million only four hundred and twenty-one oysters would be produced; or, where one oyster arrived at maturity, about 1,185,000 eggs or oysters perished!

As heretofore no examinations of the oyster-beds of this country have been made, there is no data similar to the foregoing upon which to base an estimate. As already pointed out, the mortality among the American embryo oysters must be much greater than among the European, and, in order that there might be some idea of the decrease in number and increase in size of our own variety when in the natural beds, there were deposited at various points in Tangier and Pocomoke Sounds, Maryland and Virginia, during the summer of 1879, a number of earthenware tiles as "spat"-collectors. Many of these were removed or destroyed, but from those left in place, by carefully counting at intervals the number of oysters attached, we have been able to estimate the decrease in numbers during the early months of existence.

The inspections of the "spat" collectors showed that the oysters continued attaching until about the 20th of August, and that the largest number attached about the first of that month; between the 23d of August and 10th of October the mortality was shown to be fully fifty per cent.; future examinations of the "spat"-collectors will

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probably show a diminished mortality, as the animal will be better able to protect itself as it increases in size, but the destruction among the unprotected, delicate embryos must be immense, and, as it is as great as fifty per cent. after attachment, it must be much more serious prior to that event.

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From observations made during the summer of 1879, I find that, on a natural, unworked bed, the ratio of young oysters, or those over one and under two years of age, to those mature and over that age, is as one to two, or in a community of fifteen hundred there would be one thousand mature and five hundred young oysters.

There is no reason to suppose that, circumstances being favorable, this entire number does not spawn, for, of all those I have examined, I have never in the spawning-season found an animal that did not contain the generative matter, or that had not recently expelled it. Numbers send forth the products of generation at unfavorable times and in either an unripe or overripe condition, and some fail to void the fluids at all, but only unfortunate combinations of natural causes have those effects; and it is probable, if not absolutely certain, that in most spawning-seasons all the animals spawn. Dr. Brooks estimates the number of eggs voided by the American oyster at from nine to sixty millions; for convenience, we may take ten millions as the average number, which is probably less than what is actually the case. The thousand mature oysters in the community would, then, spawn ten billion eggs, and, as the young European oyster has been found to spawn about one third as many eggs as the mature animal, we will consider the same to be true for the American variety. The five hundred young would, then, spawn 1,600,000,000 eggs, or the total number in the community would spawn 11,600,000,000 eggs, from which would result five hundred oysters, or about twenty million eggs or oysters would perish where one was preserved!

It is evident, then, that the vast number of eggs spawned by the oyster is no assurance that even a small proportion of them will reach maturity, or that any external or abnormal agency, natural or unnatural, may not be sufficient to destroy the beds by removing either young or old oysters, or in other ways preventing them from reproducing their kind.

My personal observations convince me that the beds of Pocomoke Sound at least are in a condition very similar to the French beds before they were subjected to the action of protective laws; and, as the French beds have, by a wise and efficient protection, been made to yield again a profitable return, it will be instructive to see how that protection is afforded. Artificial cultivation in any way is not considered, as not being pertinent, and because, in however bad a condition our own fisheries may be, the time has not yet arrived when we will be reduced to those laborious and expensive methods of obtaining a supply of oysters.

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The French Government assumes control of all oyster-beds and fore-shores. As occasion may seem to require, an entire bed or part of it may be reserved from dredging for a certain time, that time being decided by the local commission. The general practice seems to be, to buoy off a third or fourth of a bed each year, which portion is only sufficiently dredged to remove weeds, mud, vermin, etc. The remainder of the bed is open to all licensed persons for a certain specified time. The following year another part of the bed is reserved, and occasionally portions are reserved for longer periods than usual. The local commission decides all matters pertaining to the beds in their vicinity, and is composed of the following officers: the inspector of the fisheries, the commander of the fishery guard, two *gardes maritimes*, and one fisherman, master of a boat.

The following are the most important regulations, made for the guidance of the commission by the Minister of Marine: The beds should not be opened for fishing until the "spat" has acquired strength to resist the action of the dredge—until the end of January, for example. When a bed has well-established breeding qualities, a fourth or fifth part of its entire area should be set apart as a reserve, and dredging over such part entirely prohibited. A fishery guard-boat should, whenever practicable, take part in the working of each bed. When a bed is foul, or encumbered with weeds or other matter noxious to the development or adherence of the "spat," it should be opened for dredging until cleaned. Beds on which there is never any production of "spat" should be opened all through the season. After the working of any bed is over, it should be carefully examined, and, if necessary, the "cultch" replenished. The close-time is between the 1st of May and 31st of August, and is strictly observed.

The above regulations and their strict observance have caused a great improvement of all the beds on the French coasts; but one instance will be sufficient to show the effects of a protective policy when understandingly conceived and rigidly enforced. In 1870, through over-fishing, the beds in the Bay of Arcachon had become entirely exhausted; but, by the strict protection afforded them, their fecundity has once more become so great (in 1876) that the waters of the bay from June until August are filled with the young swarm. On a bed, when dry at low spring ebbs, and comprising 26·7 acres, there were taken by forty or fifty persons, in some two and a half hours, about sixty thousand oysters. That part of the bed was immediately buoyed, and no more fishing allowed during the season.

Having seen what protection has been afforded the French beds, and with what success, let us see how that experience can be best used, together with such knowledge on the subject of our own fisheries as the investigations conducted during the past two years have given us. The deterioration of an oyster-bed and its impaired fecundity will be shown:

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1. By the general appearance and condition of the beds and animals, the former being broken up with mud and sand among the shells, and but little healthy, growing sponge; the oysters will be large and single, the shells covered with worms, and much broken and bored in many places. Very few barnacles will be found, and the general appearance of the shells will be one of decay. 2. The ratio of "young" to "mature" oysters will be abnormally large or small; should it be greater than as two to one, or less than as one to one, it may, until we have more information on the subject, be considered abnormal. 3. The amount of *débris* in the bed will be very large, and, should it exceed fifty per cent. of the contents of the dredges, it would be unusually large. 4. The number of oysters on the beds will be found to decrease each year, though slight improvements may from time to time occur. 5. The discovery of unusual inhabitants of the beds, other than the oysters, or the disappearance of those usually found, or, in general terms, marked changes of the fauna of the beds, are an indication of deterioration.

If a bed or any number of beds present these peculiarities, in order to prevent their entire destruction it will be necessary to insure the animals some adequate protection. The best remedy for any evil is the removal of the cause; and, should the deterioration of the beds be due to excessive fishery, the prohibition of such fishery would be the readiest and most certain means of arresting the deterioration: but, as a large number of the poorer class of people is dependent, in one way or another, upon the beds, or the oyster industry, for support, it would be impossible to prohibit all fishing of any extensive area without causing great distress, and the working of the beds can consequently be only restricted and not prohibited.

As the number of dredging-vessels employed directly in the fishery is, for a time at least, constant, it follows that, the larger the area open to these workers, the less exhaustive will be the fishery of any particular locality, for the fishermen will naturally seek the most productive fields for labor, and leave old and worn-out beds for those newly discovered and well stocked. Therefore, one of the best means of affording protection to the overworked beds is the discovery of new ones, as thus without prohibitory laws the fishery will be transferred from the former to the latter. Fortunately, the area covered by oysters along the coast of the United States is so great that at present, when any bed or locality ceases to give an adequate return, the fishery is transferred to other points—as, for instance, those vessels accustomed to work in Tangier and Pocomoke Sounds have left that locality for the Potomac River and the beds in the Chesapeake bay.

In time, however, the areas covered by oysters will be known, and all future extension of the fishing-ground must be an artificial one of those known areas.

In searching for new beds they will probably be found off the

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mouths of creeks or rivers, and not distant from beds already known. They generally exist as long, narrow ridges, very thickly stocked and having their greatest dimension in the direction of the current. Those areas where the bottom is sticky and the change from deep water sudden are most likely to reward a search.

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The extension of the old beds can be effected by depositing suitable "cultch" upon the bottoms contiguous to the bed, and thus afford a place for the attachment of the drifting "spat." Stones, ballast, old pieces of earthenware, water-pipes, and old shells form excellent cultch, and, if any of these are scattered about the beds, a good catch may be confidently expected. Care must be taken to deposit the cultch upon those bottoms sufficiently consistent to support it, and also to make the deposit upon such areas as lie in the direction of the tidal currents, so that the young brood, rising from the natural beds, may be carried over the newly exposed cultch. If a number of mature oysters are deposited with the shells, they will materially assist in the extension of the beds. The cultch should be exposed late in the spring, so as to insure its cleanliness, as that is very desirable.

The consumption of the oyster is constantly increasing, and as the demand increases so will the disposition to fish the beds, and, should there be any failure of the supply, the increased price consequent upon that failure will induce even more exhaustive fishery; and it will become so great, if it has not already, that only strict protective laws, rigidly enforced, will be sufficient to protect the beds, and prevent the destruction of the industry.

There is, however, another means of maintaining the fecundity of the beds, which merits consideration.

During the summer of 1879, Professor W. K. Brooks was successful in securing, by artificial means, the fertilization of the eggs of the female, and in protecting the offspring for some time. Though, owing to various unforeseen combinations of natural causes, and to the accidents incidental to all tentative work, he has not been successful in maintaining the embryos until such a time as they could be deposited upon the beds with a certainty of survival, yet he has accomplished sufficient to show that the impregnation of the female cells can be easily and certainly achieved by a very simple process; and, as probably the greatest loss of the young is due to the failure of the ova to meet the male fluid at the proper time, any method which will insure such contact and protect the embryos, for even a limited period, is of great value, and well worthy of the attention of those interested in the preservation of the oyster-fishery.

Any protection afforded the young oyster assures the maturity of a greater number, and, as the beds are failing from a want of reproduction, due to the absence of mature oysters, any method which will insure the maturity of an abnormal number should be brought, if possible, to a point of practical benefit.

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It would be useless to give a synopsis of the laws of the several States, so far as they relate to the oyster-fishery, as long as we are ignorant both of the condition of the beds and of the amount of observance of the law. In the locality which has been investigated an inefficient law is entirely disregarded. An oyster-guard exists, but pays no attention to the duties assigned it, and the fishery is governed solely by the demands of the market and the necessities of the oystermen. What should be done in this locality, now that the condition of the beds is known, will be apparent to any one; and the sooner other localities are subjected to a similar examination and the condition of the beds determined, the better.

So far as it is possible to give an opinion which is suitable to all localities, it would seem that any legislation looking to the protection of the oyster-beds should comprise the following:

An organized and systematic effort to discover new beds and to extend the old ones. Continued experiments, in order to ascertain the possibility of artificially raising the oysters in sufficient numbers to restock impoverished areas. The maintenance of a commission to have charge of all matters pertaining to the fishery—the commission to be composed of intelligent men, having special knowledge of the subject and allowed considerable power, and to be so appointed and constituted that their acts will be influenced by no considerations other than those for the good of the beds. Under the control of the commission should be a fishery-guard, of sufficient power and importance to enforce the regulations of the commission.

The regulations of the commission should have in view the following desired results: The prevention of exhaustive dredging. The reservation of those beds or parts of beds upon which there is a large number of young growth. The prevention of the removal of the young growth from the beds. The close observance of the close-time, which should include the outer limits of the spawning-season. The cleansing of the beds before the advent of the young brood. The exposure of suitable "cultch" when a bed has been long worked, and the destruction of starfish, drills, or other enemies that may exist on the beds.

While I am unable to say with certainty that the beds of other localities than the one I have examined have been overworked, yet I should infer that such was probably the case; and, considering the surprising results of the investigation of one locality, and one which was supposed to be the most productive in the country, if not in the world, the investigation of others can not be too soon undertaken.

The probability of all our beds arriving in time at the forlorn condition of the European oyster-banks has been foreseen, and Professor Möbius warns us of the consequence of our exhaustive fishery in the following words: "In North America the oysters are so fine and so cheap that they are eaten daily by all classes; hence they are now,

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and have been for a long time, a real means of subsistence for the people. This enviable fact is no argument against the injuriousness of a continuous and severe fishing of the beds. . . . But as the number of consumers increases in America the price will also surely advance, and then there will arise the desire to fish the beds more severely than hitherto; and, if they do not accept in time the unfortunate experience of the oyster-culturists of Europe, they will surely find their oyster-beds impoverished for having defied the *bioconotic** laws."

How nearly correct he has been in his prophecy I have attempted to show, and it is with the intention of seconding his advice, and with the hope that it will be heeded, that this article has been written.

PHYSICAL EDUCATION.

By FELIX L. OSWALD, M. D.

POPULAR FALLACIES.

"A national superstition is a national misfortune. No pious fraud has ever advantaged the world, for every popular delusion becomes the mother of a noxious and numerous progeny."—HELVETIUS.

LOGICIANS distinguish between inferential and presumptive fallacies, the first being founded upon illogical conclusions from correct premises, the second upon logical conclusions from incorrect premises. With few exceptions the most mischievous popular delusions of all ages have arisen from the latter—the "presumptive" fallacies. Where their own interests are involved, men seem gifted with an instinctive faculty for looking through the tricks by which a word-juggler appears to support his sophisms with axioms known to be true, but, where that knowledge itself has been falsified (by repeating fictions till they assume the semblance of truisms), all thus biased will accept as sound whatever logical superstructure dupes or impostors may choose to erect upon such sham facts. If a man had been persuaded that cold is a panacea, he would naturally conclude that Siberia must be the healthiest country in the world. In Hindostan, where the sanctity of horned cattle is an established dogma, no true believer would hesitate to indict an irreverent bull-driver for blasphemy, or to preserve a beefsteak as a sacred relic. As long as the Bible passed for infallible, it seemed perfectly logical to ascribe diseases to witchcraft and their cure to prayer, to regard a man's natural instincts as his natural foes, to deny the difference between one and three, and treat mathematicians as enemies of the human race. The systematic application of spurious principles has led to strange

* Derived from *bioconosm*, a word signifying complete within itself.

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results, and latterly to still stranger disputes concerning the propriety of acknowledging the failure, and the best way of compromising the consequences; but such controversies could often be simplified by tracing the effects to their causes. Ill-founded buildings are naturally shaky. Still, people dislike to be lectured on the chronic dilapidation of their parlor-walls. But he who succeeds in exposing the rottenness of the foundation-timbers will need no specious arguments to demonstrate the expediency of removing the household goods to a safer place.

For many centuries the training of the young was almost monopolized by the propagandists of that most terrible of all delusions, the natural-depravity dogma, and our whole system of practical education is still interwoven with the following fallacies, all more or less deeply-rooted upshots of that dogma:

1. The Leading-Strings Fallacy.—From the moment a child is born, he is treated on the principle that all his instincts are essentially wrong, that Nature must be thwarted and counteracted in every possible way. He is strapped up in a contrivance that he would be glad to exchange for a strait-jacket, kept for hours in a position that prevents him from moving any limb of his body. His first attempts at locomotion are checked; he is put in leading-strings, he is carefully guarded from the out-door world, from the air that would invigorate his lungs, from the sports that would develop his muscles. Hence, the peevishness, awkwardness, and sickliness of our young aristocrats. Poor people have no time to imitate the absurdities of their wealthy neighbors, and their children profit by what the model nurse would undoubtedly call neglect. Indian babies are still better off. They are fed on bull-beef, and kicked around like young dogs; but they are not swaddled, they are not cradled, and not dosed with paregoric; they crawl around naked, and soon learn to keep out of the way; they are happy, they never cry. If we would treat our youngsters in the same way, only substituting kisses and bread for kicks and beef, they would be as happy as kids in a clover-field, and moreover they would afterward be hardier and stronger. Every week the newspapers tell us about ladies tumbling down-stairs and breaking both arms; boys falling from a fence and fracturing their collar-bones. From what height would a young Comanche have to fall to break such bones—not to mention South-Sea Island children and young monkeys? The bones of an infant are plastic: letting it tumble and roll about would harden the bony tissue; guarding it like a piece of brittle crockery makes its limbs as fragile as glass. Christian mothers reproach themselves with neglecting their duty to their children if they do not constantly interfere with their movements, but they forget that in points of physical education Nature herself is such an excellent teacher that the apparent neglect is really a transfer of the pupil to a more efficient school.

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2. The Nostrum Fallacy.—When a child complains of headache, lassitude, or want of appetite, the nurse concludes that he must "take something." If the complexion of a young lady grows every day paler and pastier, her mother will insist that she must "get something" to purify her blood. If the baby squeals day and night, a doctor is sent for, and is expected to "prescribe something." What that something should be, the parents would be unable to define, but they have a vague idea that it should come from the drug-store, and that it can not be good for much unless it is bitter or nauseous. Traced to its principles their theory would be about this: "Sickness and depravity are the normal condition of our nature; salvation can come only through abnormal agencies; and a remedy, in order to be effective, should be as anti-natural as possible." Perfectly logical from a Scriptural point of view. But Nature still persists in following her own laws. Her physiological laws she announces by means of the instincts which man shares with the humblest of his fellow-creatures, and health is her free gift to all who trust themselves to the guidance of those instincts. Health is not lost by accident, nor can it be repurchased at the drug-store. It is lost by physiological sins, and can be regained only by sinning no more. Disease is Nature's protest against a gross violation of her laws. Suppressing the symptoms of a disease with drugs means to silence that protest instead of removing the cause. We might as well try to extinguish a fire by silencing the fire-bells; the alarm will soon be sounded from another quarter, though the first bells may not ring again till the belfry breaks down in a general conflagration. For the laws of health, though liberal enough to be apparently plastic, are in reality as inexorable as time and gravitation. We can not bully Nature, we can not defy her resentment by a fresh provocation. Drugs may change the form of the disease—i. e., modify the terms of the protest—but the law can not be baffled by complicating the offense: before the drugged patient can recover, he has to expiate a double sin—the medicine and the original cause of the disease. But shall parents look on and let a sick child ask in vain for help? By no means. Something is certainly wrong, and has to be righted. The disease itself is a cry for help. But not for drugs. Instead of "*taking* something," something ought to be *done*, and oftener something habitually done ought to be *omitted*. If the baby's stomach has been tormented with ten nursings a day, omit six of them; omit tea and coffee from the young lady's *menu;* stop the dyspeptic's meat-rations, and the youngster's grammar-lessons after dinner. But open the bedroom-windows, open the door and let your children take a romp in the garden, or on the street, even on a snow-covered street. Let them spend their Sundays with an uncle who has a good orchard; or, send for a barrel of apples. Send for the carpenter, and let him turn the nursery or the wood-shed into a gymnasium. In case you have nothing but your bedroom and kitchen, there will still be room

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for a grapple-swing; the Boston Hygienic Institute has patented a kind that can be fastened without visible damage to the ceiling. If the baby won't stop crying, something ought to be done about it. Yes, and as soon as possible: remove the strait-jacket apparatus, swaddling-clothes, petticoat, and all, spread a couple of rugs in a comfortable corner, and give the poor little martyr a chance to move his cramped limbs; let him roll, tumble, and kick to his heart's content, and complete his happiness by throwing the paregoric-bottle out of the window.

3. The Stimulant Fallacy.—Eight hours of healthy sleep are sufficient to restore the energy expended in an ordinary day's work. Extraordinary efforts, emotional excitement, sensual excesses, or malnutrition (either by insufficient food or dyspeptic habits), induce a general lassitude—a warning that the organism is being overtasked. Repose and a healthier or more liberal diet will soon restore the functional vigor of the system. But during such periods of their diminished activity the vital powers can be rallied by drastic drugs or tonic beverages—in other words, by poisons. The prostrate vitality rises against a deadly foe, as a weary sleeper would start at the touch of a serpent; and, as danger will momentarily overcome the feeling of fatigue, the organism labors with restless energy till the poison is expelled. This feverish reaction, dram-drinkers (patent dram-drinkers especially) mistake for a sign of returning vigor, persistently ignoring the circumstance that the excitement is every time followed by a prostration worse than that preceding it. Feeling the approach of a relapse the stimulator then resorts to his old remedy, thus inducing another sham revival, followed by an increased prostration, and so on; but before long the dose of the stimulant, too, has to be increased, the stimulator becomes a slave to his poison, and passes his life in a round of morbid excitements and morbid exhaustions—the former at last nothing but a feeble flickering-up of the vital flame, the latter soon aggravated by sick-headaches, "vapors," and hypochondria.

The stimulant habit in all its forms—"exhilarating beverages," "tonic medicines," "prophylactic bitters," etc.—is a dire delusion. A healthy man needs no artificial excitants; the vital principle in its normal vigor is an all-sufficient stimulus; the inspiration bought at the rum-shop is but a poor substitute for the spontaneous exaltations of a healthy mind in a healthy body. Playing with poisons is a losing game; the sweetness of the excitement is not worth the bitter reaction. In sickness stimulants can not further the actual recovery by a single hour. There is a strong progressive tendency in our physical constitution; Nature needs no prompter: as soon as the remedial process is finished, the normal functions of the organism will resume their work as spontaneously as the current of a stream resumes its course after the removal of an obstruction. A "prophylactic" brandy is Old Scratch in the *rôle* of an exorcist. Fevers can be prevented by

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other means; and at any rate the possible danger of a climatic disease is preferable to the sure evils of the poison-drug. But how can noxious stimulants be distinguished from wholesome drinks? Tonic medicines, stimulating beverages, and poisons, are synonymous terms. Every known poison can become a lusted-after stimulant by forcing it repeatedly upon the (at first) reluctant stomach. It is true that the hankering of an old *habitué* after his tipple resembles the craving of a hungry man for food, but that constitutes no reproach against Nature, for the taste of the first drink betrayed the poison. To the palate of a child narcotic stimulants are bitter, alcohol is burning-acrid, tobacco nauseous, mineral poisons either bitter or insipid. By a liberal admixture of sugar and milk the repulsiveness of various narcotic decoctions can be diminished, but in no disguise could they be possibly mistaken for nourishing substances if the natural-depravity dogma had not weakened our confidence in the testimony of our instincts.

4. The Cold-Air Fallacy.—The influence of anti-naturalism is most strikingly illustrated in our superstitious dread of fresh air. The air of the out-door world, of the woods and hills, is, *par excellence*, a product of Nature—of wild, free, and untamable Nature—and therefore the presumptive source of innumerable evils. Cold air is the general scapegoat of all sinners against Nature. When the knee-joints of the young debauchee begin to weaken, he suspects that he has "taken cold." If an old glutton has a cramp in the stomach, he ascribes it to an incautious exposure on coming home from a late supper. Toothache is supposed to result from "draughts"; croup, neuralgia, mumps, etc., from the "raw March wind." When children have been forced to sleep in unventilated bedrooms till their lungs putrefy with their own exhalations, the *materfamilias* reproaches herself with the most sensible thing she has been doing for the last hundred nights—"opening the windows last August when the air was so stiflingly hot." The old dyspeptic, with his cupboards full of patent nostrums, can honestly acquit himself of having yielded to any natural impulse; after sweltering all summer behind hermetically closed windows, wearing flannel in the dog-days, abstaining from cold water when his stomach craved it, swallowing drugs till his appetite has given way to chronic nausea, his conscience bears witness that he has done what he could to suppress the original depravity of Nature; only once the enemy got a chance at him: in rummaging his garret for a warming-pan he stood half a minute before a broken window—to that half-minute, accordingly, he attributes his rheumatism. For catarrh there is a stereotyped explanation: "Catched cold." That settles it. The invalid is quite sure that her cough came on an hour after returning from that sleigh-ride. She felt a pain in the chest the moment her brother opened that window. There is no doubt of it—it's all the night-air's fault.

The truth is, that cold air often reveals the existence of a disease. It initiates the reconstructive process, and thus apparently the disease

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itself, but there is a wide difference between a proximate and an original cause. A man can be too *tired* to sleep and too *weak* to be sick. Bleeding, for the time being, may "break up" an inflammatory disease; the system must regain some little strength before it can resume the work of reconstruction. The vital energy of a person breathing the stagnant air of an unventilated stove-room is often inadequate to the task of undertaking a restorative process—though the respiratory organs, clogged with phlegm and all kinds of impurities, may be sadly in need of relief. But, during a sleigh-ride, or a few hours' sleep before a window left open by accident, the bracing influence of the fresh air revives the drooping vitality, and Nature avails herself of the chance to begin repairs, the lungs reveal their diseased condition, i. e., they proceed to rid themselves of the accumulated impurities. Persistent in-door life would have aggravated the evil by postponing the crisis, or by turning a temporary affection into a chronic disease. But in a plurality of cases Nature will seize even upon a transient improvement of the external circumstances: a cold night that disinfects the atmosphere of the bedroom in spite of closed windows, a draught of cool air from an adjoining room, or one of those accidental exposures to wind and weather which the veriest slave of the cold-air superstition can not always avoid. For, rightly understood, the external symptoms of a disease constitute a restorative process that can not be brought to a satisfactory issue till the cause of the evil is removed. So that, in fact, the air-hater confounds the cause of his recovery with the cause of his disease. Among nations who pass their lives out-doors, catarrh and scrofula are almost unknown; not fresh air, but the want of it, is the cause of countless diseases, of fatal diseases where people are in the habit of *nailing down* their windows every winter to keep their children from opening them. "In one such den," says Dr. Bock, "I was so overcome with nausea that I could not speak till I had knocked out a pane of glass. That is about the best thing one could do in most sick-rooms"—except knocking out the whole window. The only objection to a "draught" through a defective window is, that the draught is generally not strong enough. An influx of fresh air into a fusty sick-room is a ray of light into darkness, a messenger of Vishnu visiting an abode of the damned. Cold is a disinfectant, and under the pressure of a high wind a modicum of oxygen will penetrate a house in spite of closed windows. This circumstance alone has preserved the lives of thousands whom no cough-sirup or cod-liver oil could have saved.

5. The Fever Fallacy.—Fever-and-ague, being eminently a summer disease, could not very well be ascribed to cold air; but the anti-naturalists, still resolved to find an extraneous cause, have selected as their scapegoat the only kind of natural food and drink most Christians ever touch in summer-time—fruits and cold water. The police of fever-stricken towns prohibit the sale of fresh fruit; fever-patients

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are kept in sweat-boxes, asking in vain for water and fresh air; illustrated almanacs implore us to fortify our constitutions with patent brandy—"a reliable febrifuge, and in malarious districts the only safe beverage."

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Considering the problem from a purely inductive standpoint, we shall find that fruits and fevers are not necessarily concomitant. Some two hundred millions of our fellow-men stick to a frugal diet in the swampiest districts of the intertropical regions, and yet enjoy a greater immunity from periodical fevers than the inhabitants of our Northern seaport towns. Siam, the Punjaub, the Brazilian forest-province of Entre-Rios, and the swampy peninsula of Yucatan, would be the healthiest regions of this planet if the absence of what we call malarial diseases could be accepted as a safe criterion; but the accounts of former travelers show that the same diseases were entirely unknown in regions which are now justly dreaded—by visitors from the North. In the valley of the Amazon, and on the larger islands of the West Indian archipelago, fevers made their first appearance with the advent of European colonists. The natives of Sierra Leone, Dr. Schweinfurth tells us, call swamp-fever the "English sickness"—a disease confined to foreigners. The Portuguese and Italians, people with a natural predilection for a frugal diet, survive where beef-eaters die by hundreds. In Mexico, where several coast-towns have become international seaports, vegetarians are almost the only permanent foreign residents; native domestics, who share the flesh-pots of their foreign employers, die by scores every summer. But the necessity of such a result might have been inferred from an *a priori* axiom which seems to have been no secret to the ancient inhabitants of Southern Europe, viz., that in a warm climate calorific food is incompatible with the constitution of the human body. The word *fever* (Latin *febris*) and its equivalents in several other languages (Greek πύρεξις, Spanish and Italian *calentura*) are derived from adjectives meaning *fervid*—hot or heated—thus indicating the chief characteristic, and, according to the ancient Greek and modern Spanish theory, also the chief cause, of all pyrexial disorders. Man is a native of the tropics, and like our next relatives, the anthropoid four-handers, our primogenitor subsisted probably on fruits and water—i. e., on a refrigerating diet. In subsequent ages several tribes of the human race emigrated to regions whose climate requires calorific food and warm clothing. On returning to the birth-land of their race these wanderers often persist in habits compatible only with a low temperature: the combined influence of a warm climate, warm clothing, and calorific food overcomes the vital power of resistance; the inability of the system to preserve its due mean temperature induces the blood-changes which characterize the symptoms of climatic fevers—the overheated blood ferments. Humid heat accelerates the disintegrating process; but that humidity is only an adjuvant and not even a necessary adjuvant cause, is

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proved by the immunity of fruit-eaters in the swampiest regions of the equatorial coast-lands, as well as by the frequency of yellow-fever epidemics in such places as Vera Cruz and Pernambuco, whose neighborhood rivals that of Persepolis in sandy aridity. In other words, fevers are caused by the folly of aggravating the influence of the summer heat by superfluous clothing and calorific food (meat, greasy-made dishes, and ardent spirits), and not by fruit or cold water.

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6. The Spa Fallacy.—According to the theory of the anti-naturalists, a man's instincts conspire for his ruin; whatever is pleasant to our senses must be injurious; repulsiveness and healthfulness are synonymous terms. To every poison known to chemistry or botany they attribute remedial virtues; to sweetmeats, fruits, fresh air, and cold spring-water all possible morbific qualities. But, for consistency's sake, they make an exception in favor of mineral springs. Spas, impregnated with a sufficient quantity of iron or sulphur to be shockingly nauseous, must therefore be highly salubrious. Solitary mountain-regions afflicted with such spas become the favorite resort of invalids; dyspeptics travel thousands of miles to reach a spring that tastes like a mixture of rotten eggs and turpentine. Faith does wonders, but the cure of a large proportion of the many thousands who annually visit such watering-places as Ems, Carlsbad, and White Sulphur Springs, need not be ascribed to the effects of imagination alone. The motion and the excitement of traveling exert a beneficial influence on many disorders. Mountain-air is almost a panacea. Woodland rambles, changes of diet and of general habits, conversation, and even music, are not unimportant co-agents of materia medica. But the spa itself —in the case of *bona fide* health-seekers, at least—is a decided drawback upon such advantages. Saline and sulphur springs are purgative; the system hastens to rid itself of an injurious substance. A very small dose might operate as a moderate aperient; but the trouble is that the digestive organs come to rely on such excitants as they would upon alcoholic tonics, hence the chronic constipations that so often follow upon the return from a watering-place trip: the stimulant being withdrawn, the organs become remiss in their functions. From a hygienic standpoint a sanitarium without a spa is therefore by no means a Hamlet-drama minus the Prince; the mountain-air of Meran in the Tyrol or the sweet grapes of a Rhenish *Trauben-Kur* are worth a million sulphur-springs; and, if people knew half the value of up-hill pedestrian exercise, there would be a "Hygienic Home" wherever a steep mountain overlooks a populous plain.

7. The Ascetic Fallacy.—The origin of asceticism is widely different from that of the frugal philosophy which consoles itself with the reflection that the reduction of our wants is equivalent to the enlargement of our means. A man of simple habits may be both happier and healthier than the lover of artificial luxuries, but the anti-naturalists make war upon earthly enjoyments as such; they try to suppress

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harmless as well as vicious pleasures; their aim is not the reduction but the destruction of our natural desires. The joy-loving Greeks deified even the aberrations of our natural instincts; the ascetic condemns even their legitimate gratifications. In the world of the mind as well as in the wonders of the visible creation, in streams and passions, in woods and dreams, wherever the children of Nature sought a god, the anti-naturalists feared a devil; to the exponents of asceticism life is a penalty, and earth the devil's vanity-fair, "a fleeting show, for man's illusion given." They make joy a crime, they tell us that God delights in the mortification of his creatures, in the suppression of their natural affections: "If any man hate not his father and mother and wife and children and brothers and sisters, yea, and his own life, he can not be my disciple."

But this war against Nature is the pendulum's struggle against the law of gravitation; it is the schoolboy's attempt to obstruct the sources of the Danube. Swinging left, swinging right, the pendulum must return to the middle; the stream will find its way to the valley athwart all dams, in spite of all obstructions. We can not suppress the sources of a natural instinct; all we can achieve by such attempts is to divert the stream from its normal course—to turn a natural into an unnatural passion. Education, i. e., *guidance*, does not deserve its name where it is nothing but a blind struggle against Nature. Few parents know how much easier it is to *guide* than to suppress the natural propensities of a child. Obstinate vices are often merely instincts astray, perverted energies that might be made innocuous by guiding them back to their proper sphere—perverted faculties whose abuse might have been prevented by encouraging their right use. The enemies of Nature seem to believe that an instinct can be deadened by stifling its symptoms, but the history of the last eighteen centuries has demonstrated the fallacy of that principle. They tried to stop the stream: they have only succeeded in turning it from its natural course. The attempt to suppress the pursuit of natural sciences led to the pursuit of *pseudo*-sciences—to supernaturalism, demonism, and all sorts of hideous chimeras. The monastic exiles from human society peopled their solitude with phantoms. The suppression of healthful pastimes begot a passion for vicious pastimes, and made the fancied identity of sin and pleasure a sad reality. The suppression of rational freedom has led to anarchy: the pendulum swings in the opposite direction to re-establish the due equilibrium. The ordinance of celibacy became the mother of secret vices; intolerance is the parent of hypocrisy. Wherever asceticism has trampled the flowers of this earth, the soil has produced a rich crop of weeds. The pent-up well-springs of Nature have found new outlets through dark, underground currents that could not fertilize the fields, and have undermined the foundations of many useful buildings before they could regain the light of day. Whatever liberties we now enjoy had thus to force their way through

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unnatural obstructions, and the rise of our new civilization is merely the reappearance of a river which once flowed with a less turbulent and less turbid current. Yet it must flow on; all opposition has proved in vain, for each re-enforcement of the mole has also re-enforced the pressure of the waters.

Shall we persist in a hopeless endeavor? The dam-builders are still at work, but the rising stream surges with ominous eddies, constantly threatening to burst through all obstructions and cover the valley with wreck and ruin. There is only one remedy: We must reopen the natural channel. We must repair and improve its ancient banks—remove the dam that obstructs the stream, and build a dike along the shore.

The religion of the ancients exalted vice as well as Nature. Our present religion suppresses Nature as well as vice. The religion of the future will teach us to distinguish between vice and Nature.

THE RISE AND PROGRESS OF PALEONTOLOGY.*

By Professor T. H. HUXLEY, F.R.S.

THAT application of the sciences of biology and geology which is commonly known as paleontology took its origin in the mind of the first person who, finding something like a shell or a bone naturally imbedded in gravel or in rock, indulged in speculations upon the nature of this thing which he had dug out—this "fossil"—and upon the causes which had brought it into such a position. In this rudimentary form, a high antiquity may safely be ascribed to paleontology, inasmuch as we know that, five hundred years before the Christian era, the philosophic doctrines of Xenophanes were influenced by his observations upon the fossil remains exposed in the quarries of Syracuse. From this time forth, not only the philosophers, but the poets, the historians, the geographers of antiquity occasionally refer to fossils; and after the revival of learning lively controversies arose respecting their real nature. But hardly more than two centuries have elapsed since this fundamental problem was first exhaustively treated; it was only in the last century that the archæological value of fossils—their importance, I mean, as records of the history of the earth—was fully recognized; the first adequate investigation of the fossil remains of any large group of vertebrated animals is to be found in Cuvier's "Recherches sur les Ossemens Fossiles," completed in 1822; and so modern is stratigraphical paleontology, that its founder, William Smith,

* Discourse given at the York meeting of the British Association. Revised by the author.

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lived to receive the just recognition of his services by the award of the first Wollaston medal in 1831.

But, although paleontology is a comparatively youthful scientific specialty, the mass of materials with which it has to deal is already prodigious. In the last fifty years the number of known fossil remains of invertebrated animals has been trebled or quadrupled. The work of interpretation of vertebrate fossils, the foundations of which were so solidly laid by Cuvier, was carried on with wonderful vigor and success by Agassiz in Switzerland, by Von Meyer in Germany, and, last but not least, by Owen in this country, while, in later years, a multitude of workers have labored in the same field. In many groups of the animal kingdom the number of fossil forms already known is as great as that of the existing species. In some cases it is much greater; and there are entire orders of animals of the existence of which we should know nothing except for the evidence afforded by fossil remains. With all this it may be safely assumed that, at the present moment, we are not acquainted with a tithe of the fossils which will sooner or later be discovered. If we may judge by the profusion yielded within the last few years by the Tertiary formations of North America, there seems to be no limit to the multitude of mammalian remains to be expected from that continent, and analogy leads us to expect similar riches in Eastern Asia whenever the Tertiary formations of that region are as carefully explored. Again, we have as yet almost everything to learn respecting the terrestrial population of the Mesozoic epoch—and it seems as if the Western Territories of the United States were about to prove as instructive in regard to this point as they have in respect of Tertiary life. My friend Professor Marsh informs me that, within two years, remains of more than one hundred and sixty distinct individuals of mammals, belonging to twenty species and nine genera, have been found in a space not larger than the floor of a good-sized room; while beds of the same age have yielded three hundred reptiles, varying in size from a length of sixty or eighty feet to the dimensions of a rabbit.

The task which I have set myself to-night is to endeavor to lay before you, as briefly as possible, a sketch of the successive steps by which our present knowledge of the facts of paleontology and of those conclusions from them which are indisputable has been attained; and I beg leave to remind you at the outset that, in attempting to sketch the progress of a branch of knowledge to which innumerable labors have contributed, my business is rather with generalizations than with details. It is my object to mark the epochs of paleontology, not to recount all the events of its history.

That which I just now called the fundamental problem of paleontology, the question which has to be settled before any other can be profitably discussed, is this: What is the nature of fossils? Are they, as the healthy common-sense of the ancient Greeks appears to have led

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them to assume without hesitation, the remains of animals and plants? Or are they, as was so generally maintained in the fifteenth, sixteenth, and seventeenth centuries, mere figured stones, portions of mineral matter which have assumed the forms of leaves and shells and bones, just as those portions of mineral matter which we call crystals take on the form of regular geometrical solids? Or, again, are they, as others thought, the products of the germs of animals and of the seeds of plants which have lost their way, as it were, in the bowels of the earth, and have achieved only an imperfect and abortive development? It is easy to sneer at our ancestors for being disposed to reject the first in favor of one or other of the last two hypotheses; but it is much more profitable to try to discover why they, who were really not one whit less sensible persons than our excellent selves, should have been led to entertain views which strike us as absurd. The belief in what is erroneously called spontaneous generation—that is to say, in the development of living matter out of mineral matter, apart from the agency of pre-existing living matter, as an ordinary occurrence at the present day—which is still held by some of us, was universally accepted as an obvious truth by them. They could point to the arborescent forms assumed by hoar-frost and by sundry metallic minerals as evidence of the existence in nature of a "plastic force" competent to enable inorganic matter to assume the form of organized bodies. Then, as every one who is familiar with fossils knows, they present innumerable gradations, from shells and bones which exactly resemble the recent objects, to masses of mere stone which, however accurately they repeat the outward form of the organic body, have nothing else in common with it; and, thence, to mere traces and faint impressions in the continuous substance of the rock. What we now know to be the results of the chemical changes which take place in the course of fossilization, by which mineral is substituted for organic substance, might, in the absence of such knowledge, be fairly interpreted as the expression of a process of development in the opposite direction—from the mineral to the organic. Moreover, in an age when it would have seemed the most absurd of paradoxes to suggest that the general level of the sea is constant, while that of the solid land fluctuates up and down through thousands of feet in a secular ground-swell, it may well have appeared far less hazardous to conceive that fossils are sports of Nature than to accept the necessary alternative, that all the inland regions and highlands, in the rocks of which marine shells had been found, had once been covered by the ocean. It is not so surprising, therefore, as it may at first seem, that, although such men as Leonardo da Vinci and Bernard Palissy took just views of the nature of fossils, the opinion of the majority of their contemporaries set strongly the other way; nor even that error maintained itself long after the scientific grounds of the true interpretation of fossils had been stated, in a manner that left nothing to be desired, in the latter half of the sev-

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enteenth century. The person who rendered this good service to paleontology was Nicholas Steno, professor of anatomy in Florence, though a Dane by birth. Collectors of fossils at that day were familiar with certain bodies termed "glossopetræ," and speculation was rife as to their nature. In the first half of the seventeenth century, Fabio Colonna had tried to convince his colleagues of the famous Accademia dei Lincei that the glossopetræ were merely fossil sharks' teeth, but his arguments made no impression. Fifty years later Steno reopened the question, and, by dissecting the head of a shark and pointing out the very exact correspondence of its teeth with the glossopetræ, left no rational doubt as to the origin of the latter. Thus far, the work of Steno went little further than that of Colonna, but it fortunately occurred to him to think out the whole subject of the interpretation of fossils, and the result of his meditations was the publication, in 1669, of a little treatise with the very quaint title of "De Solido intra Solidum naturaliter contento." The general course of Steno's argument may be stated in a few words. Fossils are solid bodies which by some natural process have come to be contained within other solid bodies—namely, the rocks in which they are imbedded; and the fundamental problem of paleontology, stated generally, is this: "Given a body endowed with a certain shape and produced in accordance with natural laws, to find in that body itself the evidence of the place and manner of its production."* The only way of solving this problem is by the application of the axiom that "like effects imply like causes," or as Steno puts it, in reference to this particular case, that "bodies which are altogether similar have been produced in the same way."† Hence, since the glossopetræ are altogether similar to sharks' teeth, they must have been produced by shark-like fishes; and since many fossil shells correspond, down to the minutest details of structure, with the shells of existing marine or fresh-water animals, they must have been produced by similar animals; and the like reasoning is applied by Steno to the fossil bones of vertebrated animals, whether aquatic or terrestrial. To the obvious objection that many fossils are not altogether similar to their living analogues, differing in substance while agreeing in form, or being mere hollows or impressions, the surfaces of which are figured in the same way as those of animal or vegetable organisms, Steno replies by pointing out the changes which take place in organic remains imbedded in the earth, and how their solid substance may be dissolved away entirely, or replaced by mineral matter, until nothing is left of the original but a cast, an impression, or a mere trace of its contours. The principles of investigation thus excellently stated and illustrated by Steno in 1669, are those which have, consciously or un-

* "De Solido intra Solidum," p. 5. "Dato corpore certâ figurâ prædito et juxta leges naturæ producto, in ipso corpore argumenta invenire locum et modum productionis detegentia."

† "Corpora sibi invicem omnino similia simili etiam modo producta sunt."

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consciously, guided the researches of paleontologists ever since. Even that feat of paleontology which has so powerfully impressed the popular imagination, the reconstruction of an extinct animal from a tooth or a bone, is based upon the simplest imaginable application of the logic of Steno. A moment's consideration will show, in fact, that Steno's conclusion that the glossopetræ are sharks' teeth implies the reconstruction of an animal from its tooth. It is equivalent to the assertion that the animal of which the glossopetræ are relics, had the form and organization of a shark; that it had a skull, a vertebral column, and limbs similar to those which are characteristic of this group of fishes; that its heart, gills, and intestines presented the peculiarities which those of all sharks exhibit; nay, even that any hard parts which its integument contained were of a totally different character from the scales of ordinary fishes. These conclusions are as certain as any based upon probable reasonings can be. And they are so, simply because a very large experience justifies us in believing that teeth of this particular form and structure are invariably associated with the peculiar organization of sharks, and are never found in connection with other organisms. Why this should be we are not at present in a position even to imagine; we must take the fact as an empirical law of animal morphology, the reason of which may possibly be one day found in the history of the evolution of the shark tribe, but for which it is hopeless to seek for an explanation in ordinary physiological reasonings. Every one practically acquainted with paleontology is aware that it is not every tooth nor every bone which enables us to form a judgment of the character of the animal to which it belonged, and that it is possible to possess many teeth, and even a large portion of the skeleton of an extinct animal, and yet be unable to reconstruct its skull or its limbs. It is only when the tooth or bone presents peculiarities which we know by previous experience to be characteristic of a certain group that we can safely predict that the fossil belonged to an animal of the same group. Any one who finds a cow's grinder may be perfectly sure that it belonged to an animal which had two complete toes on each foot, and ruminated; any one who finds a horse's grinder may be as sure that it had one complete toe on each foot and did not ruminate; but, if ruminants and horses were extinct animals of which nothing but the grinders had ever been discovered, no amount of physiological reasoning could have enabled us to reconstruct either animal, still less to have divined the wide differences between the two. Cuvier, in the "Discours sur les Révolutions de la Surface du Globe," strangely credits himself, and has ever since been credited by others, with the invention of a new method of paleontological research. But if you will turn to the "Recherches sur les Ossemens Fossiles," and watch Cuvier, not speculating but working, you will find that his method is neither more nor less than that of Steno. If he was able to make his famous prophecy from the jaw which lay upon the surface

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of a block of stone to the pelvis of the same animal which lay hidden in it, it was not because either he, or anybody else, knew, or knows, why a certain form of jaw is, as a rule, constantly accompanied by the presence of marsupial bones—but simply because experience has shown that these two structures are co-ordinated.

The settlement of the nature of fossils led at once to the next advance of paleontology—viz., its application to the deciphering of the history of the earth. When it was admitted that fossils are remains of animals and plants, it followed that, in so far as they resemble terrestrial or fresh-water animals and plants, they are evidences of the existence of land or fresh water, and, in so far as they resemble marine organisms, they are evidences of the existence of the sea at the time at which they were parts of actually living animals and plants. Moreover, in the absence of evidence to the contrary, it must be admitted that the terrestrial or the marine organisms implied the existence of land or sea at the place in which they were found while they were yet living. In fact, such conclusions were immediately drawn by everybody, from the time of Xenophanes downward, who believed that fossils were really organic remains. Steno discusses their value as evidence of repeated alteration of marine and terrestrial conditions upon the soil of Tuscany in a manner worthy of a modern geologist. The speculations of De Maillet in the beginning of the eighteenth century turn upon fossils, and Buffon follows him very closely in those two remarkable works, the "Théorie de la Terre" and the "Époques de la Nature," with which he commenced and ended his career as a naturalist.

The opening sentences of the "Époques de la Nature" show us how fully Buffon recognized the analogy of geological with archæological inquiries. "As in civil history we consult deeds, seek for coins, or decipher antique inscriptions in order to determine the epochs of human revolutions and fix the date of moral events, so, in natural history, we must search the archives of the world, recover old monuments from the bowels of the earth, collect their fragmentary remains, and gather into one body of evidence all the signs of physical change which may enable us to look back upon the different ages of nature. It is our only means of fixing some points in the immensity of space, and of setting a certain number of way-marks along the eternal path of time."

Buffon enumerates five classes of these monuments of the past history of the earth, and they are all facts of paleontology. In the first place, he says, shells and other marine productions are found all over the surface and in the interior of the dry land; and all calcareous rocks are made up of their remains. Secondly, a great many of these shells which are found in Europe are not now to be met with in the adjacent seas; and, in the slates and other deep-seated deposits, there are remains of fishes and of plants of which no species now exist in

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our latitudes, and which are either extinct or exist only in more northern climates. Thirdly, in Siberia and in other northern regions of Europe and of Asia, bones and teeth of elephants, rhinoceroses, and hippopotamuses occur in such numbers that these animals must once have lived and multiplied in those regions, although at the present day they are confined to southern climates. The deposits in which these remains are found are superficial, while those which contain shells and other marine remains lie much deeper. Fourthly, tusks and bones of elephants and hippopotamuses are found not only in the northern regions of the Old World, but also in those of the New World, although, at present, neither elephants nor hippopotamuses occur in America. Fifthly, in the middle of the continents, in regions most remote from the sea, we find an infinite number of shells, of which the most part belong to animals of those kinds which still exist in southern seas, but of which many others have no living analogues; so that these species appear to be lost, destroyed by some unknown cause. It is needless to inquire how far these statements are strictly accurate; they are sufficiently so to justify Buffon's conclusions that the dry land was once beneath the sea; that the formation of the fossiliferous rocks must have occupied a vastly greater lapse of time than that traditionally ascribed to the age of the earth; that fossil remains indicate different climatal conditions to have obtained in former times, and especially that the polar regions were once warmer; that many species of animals and plants have become extinct; and that geological change has had something to do with geographical distribution.

But these propositions almost constitute the framework of paleontology. In order to complete it but one addition was needed, and that was made, in the last years of the eighteenth century, by William Smith, whose work comes so near our own times that many living men may have been personally acquainted with him. This modest land-surveyor, whose business took him into many parts of England, profited by the peculiarly favorable conditions offered by the arrangement of our secondary strata to make a careful examination and comparison of their fossil contents at different points of the large area over which they extend. The result of his accurate and widely extended observations was to establish the important truth that each stratum contained certain fossils which are peculiar to it; and that the order in which the strata, characterized by these fossils, are superimposed one upon the other is always the same. This most important generalization was rapidly verified and extended to all parts of the world accessible to geologists; and now it rests upon such an immense mass of observations as to be one of the best established truths of natural science. To the geologist this discovery was of infinite importance, as it enabled him to identify rocks of the same relative age, however their continuity might be interrupted or their composition altered. But to the biologist it had a still deeper meaning, for it demonstrated

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that, throughout the prodigious duration of time registered by the fossiliferous rocks, the living population of the earth had undergone continual changes, not merely by the extinction of a certain number of the species which at first existed, but by the continual generation of new species, and the no less constant extinction of old ones.

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Thus, the broad outlines of paleontology, in so far as it is the common property of both the geologist and the biologist, were marked out at the close of the last century. In tracing its subsequent progress I must confine myself to the province of biology, and indeed to the influence of paleontology upon zoölogical morphology. And I accept this limitation the more willingly as the no less important topic of the bearing of geology and of paleontology upon distribution has been luminously treated in the address of the President of the Geographical Section.

The succession of the species of animals and plants in time being established, the first question which the zoölogist or the botanist had to ask himself was, "What is the relation of these successive species one to another?" And it is a curious circumstance that the most important event in the history of paleontology which immediately succeeded William Smith's generalization was a discovery which, could it have been rightly appreciated at the time, would have gone far toward suggesting the answer, which was in fact delayed for more than half a century. I refer to Cuvier's investigation of the mammalian fossils yielded by the quarries in the older Tertiary rocks of Montmartre, among the chief results of which was the bringing to light of two genera of extinct hoofed quadrupeds, the *Anoplotherium* and the *Palæotherium*. The rich materials at Cuvier's disposition enabled him to obtain a full knowledge of the osteology and of the dentition of these two forms, and consequently to compare their structure critically with that of existing hoofed animals. The effect of this comparison was to prove that the *Anoplotherium*, though it presented many points of resemblance with the pigs on the one hand, and with the ruminants on the other, differed from both to such an extent that it could find a place in neither group. In fact, it held, in some respects, an intermediate position, tending to bridge over the interval between these two groups, which in the existing fauna are so distinct. In the same way, the *Palæotherium* tended to connect forms so different as the tapir, the rhinoceros, and the horse. Subsequent investigations have brought to light a variety of facts of the same order, the most curious and striking of which are those which prove the existence, in the Mesozoic epoch, of a series of forms intermediate between birds and reptiles—two classes of vertebrate animals which at present appear to be more widely separated than any others. Yet the interval between them is completely filled, in the mesozoic fauna, by birds which have reptilian characters on the one side, and reptiles which have ornithic characters on the other. So, again, while the group of

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fishes termed ganoids is at the present time so distinct from that of the dipnoi or mud-fishes that they have been reckoned as distinct orders, the Devonian strata present us with forms of which it is impossible to say with certainty whether they are dipnoi or whether they are ganoids.

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Agassiz's long and elaborate researches upon fossil fishes, published between 1833 and 1842, led him to suggest the existence of another kind of relation between ancient and modern forms of life. He observed that the oldest fishes presented many characters which recall the embryonic conditions of existing fishes; and that, not only among fishes, but in several groups of the invertebrata which have a long paleontological history, the latest forms are more modified, more specialized, than the earlier. The fact that the dentition of the older tertiary ungulate and carnivorous mammals is always complete, noticed by Professor Owen, illustrated the same generalization.

Another no less suggestive observation was made by Mr. Darwin, whose personal investigations during the voyage of the Beagle led him to remark upon the singular fact that the fauna which immediately precedes that at present existing in any geographical province of distribution presents the same peculiarities as its successor. Thus, in South America and in Australia, the later tertiary or quaternary fossils show that the fauna which immediately preceded that of the present day was, in the one case, as much characterized by edentates and in the other by marsupials as it is now, although the species of the older are largely different from those of the newer fauna.

However clearly these indications might point in one direction, the question of the exact relation of the successive forms of animal and vegetable life could be satisfactorily settled only in one way—namely, by comparing, stage by stage, the series of forms presented by one and the same type throughout a long space of time. Within the last few years this has been done fully in the case of the horse, less completely in the case of the other principal types of the ungulata and of the carnivora, and all these investigations tend to one general result—namely, that in any given series the successive members of that series present a gradually increasing specialization of structure. That is to say, if any such mammal at present existing has specially modified and reduced limbs or dentition and complicated brain, its predecessors in time show less and less modification and reduction in limbs and teeth and a less highly developed brain. The labors of Gaudry, Marsh, and Cope furnish abundant illustrations of this law from the marvelous fossil wealth of Pikermi, and the vast uninterrupted series of tertiary rocks in the Territories of North America.

I will now sum up the results of this sketch of the rise and progress of paleontology. The whole fabric of paleontology is based upon two propositions: the first is, that fossils are the remains of animals and plants; and the second is, that the stratified rocks in which

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they are found are sedimentary deposits; and each of these propositions is founded upon the same axiom that like effects imply like causes. If there is any cause competent to produce a fossil stem, or shell, or bone, except a living being, then paleontology has no foundation; if the stratification of the rocks is not the effect of such causes as at present produce stratification, we have no means of judging of the duration of past time, or of the order in which the forms of life have succeeded one another. But, if these two propositions are granted, there is no escape, as it appears to me, from three very important conclusions. The first is, that living matter has existed upon the earth for a vast length of time, certainly for millions of years. The second is that, during this lapse of time, the forms of living matter have undergone repeated changes, the effect of which has been that the animal and vegetable population at any period of the earth's history contains some species which did not exist at some antecedent period, and others which ceased to exist at some subsequent period. The third is that, in the case of many groups of mammals and some of reptiles, in which one type can be followed through a considerable extent of geological time, the series of different forms by which the type is represented at successive intervals of this time is exactly such as it would be if they had been produced by the gradual modification of the earliest form of the series. These are facts of the history of the earth guaranteed by as good evidence as any facts in civil history.

Hitherto I have kept carefully clear of all the hypotheses to which men have at various times endeavored to fit the facts of paleontology, or by which they have endeavored to connect as many of these facts as they happened to be acquainted with. I do not think it would be a profitable employment of our time to discuss conceptions which doubtless have had their justification and even their use, but which are now obviously incompatible with the well-ascertained truths of paleontology. At present these truths leave room for only two hypotheses. The first is that, in the course of the history of the earth, innumerable species of animals and plants have come into existence, independently of one another, innumerable times. This, of course, implies either that spontaneous generation on the most astounding scale, and of animals such as horses and elephants, has been going on, as a natural process, through all the time recorded by the fossiliferous rocks; or it necessitates the belief in innumerable acts of creation repeated innumerable times. The other hypothesis is, that the successive species of animals and plants have arisen, the later by the gradual modification of the earlier. This is the hypothesis of evolution; and the paleontological discoveries of the last decade are so completely in accordance with the requirements of this hypothesis that, if it had not existed, the paleontologist would have had to invent it.

I have always had a certain horror of presuming to set a limit upon the possibilities of things. Therefore, I will not venture to say that

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it is impossible that the multitudinous species of animals and plants may have been produced one separately from the other by spontaneous generation, nor that it is impossible that they should have been independently originated by an endless succession of miraculous creative acts. But I must confess that both these hypotheses strike me as so astoundingly improbable, so devoid of a shred of either scientific or traditional support, that even if there were no other evidence than that of paleontology in its favor, I should feel compelled to adopt the hypothesis of evolution. Happily, the future of paleontology is independent of all hypothetical considerations. Fifty years hence, whoever undertakes to record the progress of paleontology will note the present time as the epoch in which the law of succession of the forms of the higher animals was determined by the observation of paleontological facts. He will point out that, just as Steno and as Cuvier were enabled from their knowledge of the empirical laws of coexistence of the parts of animals to conclude from a part to the whole, so the knowledge of the law of succession of forms empowered their successors to conclude, from one or two terms of such a succession, to the whole series, and thus to divine the existence of forms of life, of which, perhaps, no trace remains, at epochs of inconceivable remoteness in the past.

STUDIES OF VORTEX-RINGS.

By ADRIEN GUÉBHARD.

MAKING skip-rings in the water, and gazing at the vapors in the air, furnish common expressions for complete inactivity and vacuity. Yet, in these occupations may be found subjects of profound and worthy studies. Nothing is vulgar to one who knows how to see, nothing indifferent to one who knows how to observe; and the fall of a drop of water, insignificant as we may regard it, may bring us into the neighborhood of the ultimate mysteries of those regions to which the fall of an apple once transported the immortal genius of Newton. As profitable subjects for study may be found in those common rings, simple wrinkles on the surface of the water, in which the physicist sees many things and the clown few; or, in those turbid clouds of smoke which every day float toward the sky from our fires here below.

Everybody has seen some adroit smoker throw from his mouth or his pipe pretty, white wreaths, whose whirling vapors it was a pleasure to follow in the air.* It is a fact of daily observation that

* Fig. 1 has been designed after the celebrated picture of Brauwer in the Lacaze Gallery of the Louvre. In the original, the picture only represents a spiral of smoke. But the form of the mouth and the convergence of the eyes sufficiently indicate the helpless effort of the drunken man. The subject seems to have been a favorite one with the

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a drop of soap and water dropping from the end of the fingers spreads out in the basin into the form of a perfect ring that gradually increases as it descends toward the bottom.

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Why do the light particles, instead of scattering promiscuously in the liquid or gaseous medium, take this special state of mobile equilibrium and regular grouping? Why this form so fragile in appearance, instead of any other more simple and possibly more stable? Is it by pure chance or by pure direction? And, if the latter is the case, what is the secret of it? It will not be difficult to detect the secret in a short time, and a few words will show that we have here, not an exceptional and rare case, but a general law of nature, common examples of which exist under our eyes.



FIG. 1.—WREATHS OF TOBACCO-SMOKE. (From Brauwer's picture in the Lacaze Gallery, Louvre.)

Wreaths of the same shape are often seen to issue from the mouths of cannon when they are fired off; I have seen them following the locomotive of an express-train. Any one who has pursued a course in chemistry may remember the beautiful experiments in which bubbles of phosphoretted hydrogen take fire spontaneously as they rise to the surface of the basin, and develop superb wreaths of white fumes.

old Flemish painters, for it recurs under all sorts of forms, either as a detail or as the principal motive in ten, at least, of Teniers's pieces, and in another Brauwer in the gallery at Madrid.

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Nature herself sometimes produces this phenomenon without any human intervention, and shows us the vortices of the *ignis fatuus*, to which the middle ages attached so many poetical legends, rising on summer evenings from the stagnant waters of marshes. The craters of volcanoes also frequently give off smoke in the form of magnificent ring-clouds.

Huygens observed, with one of the first telescopes, the annular form of those curious satellites of Saturn, the singular equilibrium of which is still a subject of discussion. The periodical November meteors form a real ring of planetary fragments around the earth; everything seems to prove that the milky way is nothing but a gigantic ring of cosmic dust, of which our sun and its satellites are only a few grains; the question of the form of the zodiacal light is hardly doubtful; and, finally, among the infant worlds that we call nebulæ, the annular figure recurs with such frequency that it can no longer be considered exceptional; and the inspiration of genius which caused Laplace to see in the fracture of such a ring the whole origin of our solar system is reflected in the broken rings which are found among some of these nebulæ.

The laws of nature, however, frequently reveal themselves best in the infinitely little; and I have made my first observations toward a new study in watching the filiform currents produced during the osmotic interchange of two liquids through the pores of a membrane.*

While intimately regarding the curious phenomena with which Ducrochet sought to connect all the laws of life, I devised a way to observe the current of osmose, if I may so speak, in the act. This is not easily done with alcohol or water, but, by carefully taking advantage of the refracting and magnifying properties of cylindrical glasses, I succeeded, at last, in distinguishing before either very dark or very light grounds, slight, thin trains indicative of movement; and it was really a curious phenomenon to see two liquids of so strong affinities for each other, brought into intimate contact through a permeable membrane, obeying the laws of gravity almost without mixing, and taking their course across each other in the form of distinct threads, which presented at the same time the sharpness and the apparent fixity of a fiber of pure glass. The figure of these threads is not constantly stationary, but is subject to a regular movement, in which periodically, while still preserving its individuality, it seems to undergo alternate swellings and attenuations that give it the appearance from a certain distance of shafts of columns put one upon the other, of larger and larger capitals, or of pointed parasols, or Chinese hats with several crowns. If we look at them from above, we may perceive, in these spirals and expansions, the profiles of real circular rings, slightly attached by an invisible cord to a central stalk which bears them

* "Études sur l'osmose de l'alcool à travers la gutta-percha" (C. R. de l'Assoc. France, Montpellier, 1879).

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in groups of two or three, and animated by special movements. A section of the chain along its axis of revolution gives the forms represented in Fig. 2, A. The superposed forms of the figure, A, are evidently only the successive phases of a single drop as emitted at each pulsation; and all our efforts should be directed to isolating the drops and retarding their descent, so as to make them

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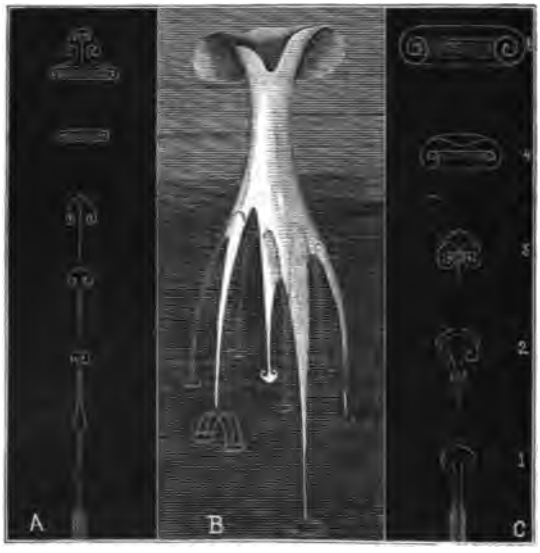


FIG. 2.—FORMS OF A COLORED DROP PENETRATING A COLORLESS LIQUID.

more visible under their different aspects. This is easily done. A variety of colored liquids are at our disposal, and, with a little alcohol, or a trace of glycerine or sugar, we may modify insensibly the density of the liquids, reduce the action of gravity to a minimum, and have at will ascending or descending currents. The last are generally easiest to obtain. Fig. 3 represents a simple apparatus for the experiment, the operation of which is dependent on the familiar principle of the siphon: we have only to raise the level of the colored liquid in the glass to change the rate of flow as we may wish. Certain manual difficulties in handling this apparatus may be obviated by using a system of communicating vessels, such as may be made by taking a common lamp-chimney, corking up the lower part and putting it in communication, by means of a pipe inserted in the cork and an India-rubber tube, with the bottom of a similar vessel or the nozzle of a vertical funnel. A string around the tube, or a pair of nippers, may serve to regulate the flow of the colored liquid, which should be only a little less dense than the other; and by inclosing a bubble of air above this liquid and covering the top of the chimney with a membrane, we may vary the pressure without changing the level of the liquid. If we have

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not a glass tube at hand, we may make the communication by means of a fine bird's-quill, or a thin straw of grass, or even by a pinhole pierced in a piece of membrane. Having brought the orifice and the surface of separation of the two liquids to the same level, if we give a gentle push, we may see issue a kind of swelled fungus with a short



FIG. 3.—ARRANGEMENT OF AN APPARATUS FOR THE STUDY OF VORTICAL VEINS IN LIQUIDS.

stem (Fig. 2, C 1), on the edges of which a backward rotation is immediately manifested, an evident sign of the resistance and friction of the ambient mass. Hardly is the drop detached from the tube before we see it widening on its stem and becoming hollow below (Fig. 2, C 2); the edges fold back and soon take the motion of a winding scroll, which seems to attract to itself the lingering part of the colored filament (Fig. 2, C 3). Once begun, this whirling motion is continually kept up by the friction, which, upon the exterior contours, exhausts a little of the acquired velocity. The whole substance of the drop will pass into it, and with it numerous molecules of the uncolored liquid, the interposed layers of which will assist in supporting the geometrical rolling up of the steadily growing spirals. It is really an endless reeling, a stretching out into a surface of the whole of a little liquid mass; so that finally (Fig. 2, C 4) the line of the front appears as only a minutely fine thread, which is destined to burst under the strain of the

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tension of the whole contour. At length (Fig. 2, C 5) we find ourselves in the face of that curious form of mobile equilibrium of fluids of which we have noticed so many examples, and of which we have in a manner just studied the genesis and the anatomy. These singular wreaths have a still more singular constitution than we conceive; they are not full rings, nor even such simple hollow rings as we might make by bringing together the ends of an India-rubber tube. We have to



FIG. 4.—A LAMP-CHIMNEY, closed by a membrane at its lower end, with a perforated disk in the middle, and half filled with tobacco-smoke; a push of the thumb on the membrane causes rings of smoke to issue through the orifice of the disk in the middle.

imagine a continuous necklace of watch-springs locked one to another along a circle, by which all their ends are joined; or, to speak geometrically, the figure of revolution which would be produced by a plane spiral turning round an asymptotic axis. Observation shows, together with a delicacy of design in the shaft, and a transparency which nothing can excel, fine horizontal striæ passing from one volute to another, and marking with exceeding neatness the number and divergence of the rollings. In water, effects of exquisite beauty may be produced directly without passing through the intermediate phases, by means of taps on the membrane of the apparatus. The experiment may again be simplified by forming with the membrane itself the bottom of the vessel, and using for an orifice a hole pierced in a disk which has been

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forced down tight into the middle of the tube. This instrument gives at each expulsion of the colored ring a corresponding return ring, a kind of negative ring, that descends clear in the interior of the colored liquid, or *vice versa*, if it is the liquid in the upper part that has been colored. The same phenomena appear when smoke is used, as in Fig. 4. We may dispense with all apparatus and let fall from the height of about an inch a lightly tinted drop into a still colorless mass. From this experiment chemists learned, even before Trowbridge explained the theoretical reason for it, that it was best to employ liquids differing but little from each other, or at least such as were easily diffusible in each other. Reusch, however, has described some very unstable rings of oil in water that may be produced with an apparatus similar to ours. It is interesting, in view of the cosmic examples to which we have referred, that after the oil of the upper compartment has been replaced with water, each jet carries along from the borders of the tubing myriads of little oily drops, the drift of which renders visible in the interior of the clear water the annular constitution of the vortex formed by the irruption of a mass of absolutely identical liquid. The generality of the fact may be verified with an emulsion of ginger, or simply with superficial dust on the brightly lighted bottom of a white porcelain plate.

Imperceptible grains of coloring substance, put upon the surface of the water, immediately give rise to fine descending trains, which permit us to detect in the phenomena of solution the same character of intermittence and discontinuity that marks that of osmose. A penful of ink, a bit of sugar, a thousand simple means of observing the development of vortices, may be suggested. A piece of thread, hanging from a glass filled to the brim, makes an excellent capillary siphon, and furnishes perfect continuous movements, so that, unless the liquid is superficially stirred, or the lower glass is shaken, we obtain trains of provoking fixity, that follow their determined route without giving a pulsation to betray their interior motion. Of this character are the upright columns of mist that rise from the calm plain of the desert. So a flexible thread, carried by a balloon, revolves in the breath of the wind without breaking. The direction of a straight line is not an essential one; and, if the density of the liquid happens to be variable, the thread takes the form of an elongated spiral, the curves of which are alternately narrower and wider, and end in scrolls resembling foliage or florescence. These phenomena are not transient, but may last for days, although the rings we have been considering continue only for a few moments, and, while they present a real elasticity of form as long as they are in motion, never survive the loss of the impulse that produced them. Most frequently denser nuclei appear in their interior, which take the lead, and descend as if suspended from elastic arches, of which they draw out long branches (Fig. 2, B). Each of these nuclei appears to undergo, in its interior, the different transformations

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of Fig. 2, C, till a little secondary ring is formed, which sometimes remains attached, is at other times separated and divided into several others, that will, if they are small enough, continue for a long time suspended in the liquid.

All of these little rings, with the curved filaments supporting them, form in the water a very marked figure—a kind of diadem, a fantastic hydra, or a diaphanous cup (Fig. 2, B)—the singular figure of which causes us to neglect at first certain less visible details in which the real mechanism of the phenomenon is revealed; and a very light or a very dark ground, according to the character of the colored liquid, is required in order to discover the frame-work and the processes of the formation.

Rings of vapor are capable of attaining considerable dimensions without breaking. If we take a box, make a hole in it, substitute a stretched cloth or plate of metal for one of its sides, and develop in it vapors of phosphoric acid or muriate of ammonia, we can easily by



Fig. 5.—The same experiment, performed with a box made of playing-cards. The box is filled from the mouth at the hole in the upper side.

means of a slight blow cause wreaths several inches in diameter, exhibiting the structural details of the liquid rings, to shoot out to a considerable distance. A soap-bubble filled with smoke produces similar effects when it bursts; and a cubic box made of playing-cards

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(Fig. 5) will enable us to study, with the help of tobacco-smoke, how little influence the shape of the opening has upon the rings which we drive out through the hole at which we have filled the box. We may make the hole square or rectangular; or, if we cut certain combinations of long slits or several holes, those composite forms which Thomson has described as vibrating rings will be produced.

If two rings are sprung in succession, they will constantly tend to overtake each other and cross each other alternately in a curious play of approaches and withdrawals, but always with some damage to each other if they are large; and this property is best studied in liquids. Two equal vortices shot from different boxes will play with each other indefinitely, and the same happens when they strike the wall. But, if they pass each other, only grazing their edges, they will merely change shape without breaking and without getting out of the way, and then immediately bound back to their original form like an India-rubber spring. This power of resistance, or power of annular elasticity, is the most striking characteristic of these singular forms, real magazines of energy, in which all the living primitive force collects itself under the influence of external friction. Theoretically, the vortical movement, in a perfect fluid, can neither be created nor destroyed; eternal as matter itself, it has neither beginning nor end. The vortex-ring is indivisible. Attack it as quickly as you will, says Professor Tait, cut at it with the sharpest knife, you can never sever it or mar it; but, flying away or enveloping the material object, it remains whole, always itself; and, when we consider its wonderful properties, we need hardly be surprised that philosophers have aspired to build up upon it theories of the constitution of matter, and of the origin of all the physical forces, from gravitation to electricity.

We conclude with the citation of an extremely simple experiment described by Helmholtz: If we draw the rounded end of a spoon or a knife over the surface of a liquid, we may produce all around a vortical agitation giving the form of a vertical half-ring, the internal contour of which corresponds with the semicircular edge of the solid object, while on the right and left, on the surface of the liquid, appear two portions of the same diametrical section, which should reproduce the schemes of Fig. 2, C. Quite plain, in effect, are the scrolls designed on the dark surface of a cup of coffee by the white trains of the cream; and it is very easy to study thus all the mutual reactions of these vortices, similar as they are to those which the waterman sees running along the edge of his oar, and which can be reproduced of satisfactory dimensions on the surface of a bath-tub. Such experiments are within the reach of every one.—*La Nature.*

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EQUALITY AND INEQUALITY IN SEX.

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By G. DELAUNEY.

THE sentimental pretensions put forward by a political school which holds that woman is intellectually the equal of man, give a character of actuality to the question of the comparison of the sexes. This question, which it has been the custom to treat from a metaphysical point of view, is to us purely anthropological, or rather zoölogical; for we propose to show by characteristic examples borrowed from the whole animal kingdom that sexuality undergoes the same evolution in all species, including the human species. The female surpasses the male in certain inferior species. The males are smaller than the females among many cephalopods, and among some cirripeds. With a few exceptions, the superiority of the females prevails among the annelids, and among certain articulates, as bees, hornets, wasps; and female butterflies are larger and heavier than males, a difference being observable even among the larvæ. A like superiority of females may be observed in many fishes, as in the cyprinoids, and in reptiles. This is, however, no longer the case among the superior vertebrates. The males of birds and mammals are nearly always superior to the females.

To sum up, the two sexes, at first unequal in consequence of the superiority of the female over the male characterizing the lowest species, become equal among species a little more elevated in the animal scale, and become unequal again in consequence of the pre-eminence of the male over the female, which is observed in all the higher species. The supremacy of the female is, then, the first term of the evolution which sexuality undergoes, while the supremacy of the male is the last term. Let us now see wherein the superiority of the male is manifested.

The nutritive phenomena in birds and mammals, including the human species, are more intensive in the male than in the female. The blood is denser, redder, contains more red globules and hemiglobine (Quinquand, Korniloff), fewer white globules, and less water. M. Malassez has found a million more red globules in a cubic millimetre of man's than of woman's blood. Man eats more than woman. Public charities recognize that it costs more to feed a boy than a girl. But, though she eats less, woman is more of a gourmand (Brillat-Savarin), and eats more frequently, being oftener pressed by hunger. Women in the cities eat between-meals, like children. In asylums for the aged, where women are not allowed more meals than men, they abstract food from each meal to eat in the intervals, so as to double the number of their meals.

The respiratory phenomena of men are also stronger than those of women. The pulmonary capacity of a woman is a pint less than that

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of a man of the same size. The thoracic index of woman is less than that of man (Weisgerber). The man absorbs more oxygen, although he does not breathe as often. According to Quetelet, the woman, from fifteen to fifty years of age, makes one more inspiration a minute than the man. At all ages man exhales more carbonic acid than woman (Andral and Gavarret). The temperature of man is higher than that of woman. In the circulation, the pressure of the blood is stronger in the male, although the pulse is less frequent. The difference amounts to eighteen pulsations a minute in the lion, ten in cattle, twelve in sheep, and ten to fourteen in man.

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The relative weight of the skeleton to the total weight of the body is less with woman; Topinard says that in the physical characters of her skeleton woman is intermediate between the infant and the masculine adult. M. Milne-Edwards has found the bones of the male a little richer in inorganic matter than those of the female, and that at thirty years the bones of the man contain more mineral matter, less organic matter, more carbonate of lime, less phosphate of lime, than those of the woman. The prevalence of the right side over the left is less with the woman (Harting). Broca has found that the clavicle of the woman is longer in proportion to the humerus; similar differences are observed between inferior and superior races.

The male individual is always larger than the female. This is observable in our domestic animals. M. Topinard fixes the average difference in height between man and woman at twelve centimetres (four and two thirds inches). Woman is also lighter than man, although she often appears larger on account of the greater development of her adipose system. Topinard says that in the whole Indo-European series woman is more prognathous than man. According to my researches the foot of woman is flatter and less arched than that of man, a fact which women of fashion try to hide by means of high heels. The female voice is always higher than that of the male, in animals and in man. Woman's voice is an octave higher than man's.

The muscular system of the male is better developed and more vigorous than that of the female. This may be observed in wild and domestic animals. The muscular force of a woman from twenty-five to thirty years of age, measured in the dynamometer, is a third less than that of a man of the same age. The movements of man are more precise than those of woman. Thus men make the best pianists. The skull of the male is more voluminous than that of the female (Sömmering, Parchappe, Broca, Morselli). Huschke estimates the difference in Europeans at two hundred and twenty cubic centimetres, Dr. Weisbach makes the relative measurement as 1,000 to 878; Morselli, 100 to 85. The shape of the skull also varies with the sex, that of the man being lower and longer than that of the woman. The brain of the male is heavier than that of the female, in a proportion for man fixed by Broca at 1,323 to 1,210 grammes (46¾ to 42¾ ounces).

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Parchappe makes the difference as 109·34 to 100, Broca ; Rudolph, and Wagner, as 111 to 100 ; Huschke, as 112 to 100 ; Meyner, as 100 to 90. That this difference in weight does not depend upon the relatively smaller size of woman is shown by the statement of Parchappe, that while the stature of woman is to that of man as 927 to 1,000, the relative weight of the brains of the two sexes is as 909 to 1,000. M. Le Bon has found, on comparing the average weight of the brains of seventeen men of about five feet in height with that of the brains of seventeen women of corresponding size, a difference of one hundred and seventy-two grammes (six and one quarter ounces) in favor of the masculine brain. Diagrams of the feminine brains of different races show that even in the most intelligent populations, as among contemporary Parisians, the skulls of a notable proportion of women more nearly approach the volume of the skulls of certain gorillas than that of the better developed skulls of the male sex.

Other differences between the brains of the two sexes relate to the conformation. According to Broca, Wagner, and Huschke, and Wight, of New York, the frontal lobes, the seat of the highest intellectual faculties, are less developed in woman than in man. The occipital lobes, the seat of the sentiments, are more voluminous in woman. According to Professor Wagner, the brain of woman as a whole is always in a more or less embryonic condition. Huschke says that woman is only a child in growth, and belies her infantine type no more by her brain than by the other parts of her body. Some anatomists allege that the right side of the brain is superior in women and the left side in men ; hence women pass to the left and men to the right. I have observed that man performs certain motions, as those of striking and buttoning the clothes, centrifugally, and woman centripetally—another sign of inferiority in woman.

The differences in the relative prominence of the lobes of the brain may explain why woman is more given to the life of the heart and man to that of the mind, a point in which all authors are agreed.

The question of the relative morality of the sexes has been debated by thousands of authors. Without going over their ground, we will endeavor to show what light has been cast upon it by recent facts in demography. Women incontestably commit a smaller proportion of crimes against persons than men. Quetelet suggests that they are more restrained by shame and modesty, by their condition of dependence, their more retired habits, and their physical weakness. When they do thus offend, they are more apt to adopt poisoning, the weapon of cowards. It is universally admitted, again, that woman is more devout and more charitable than man. Her charity is, however, it may be said, often narrow and intolerant, and exercised for the sake of proselytism.

We now come to the consideration of the intellectual faculties. The male is more intelligent than the female in all the superior species.

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Trainers of trick-dogs prefer males. Regarding the human species, all known systems of legislation recognize an intellectual inferiority of the female sex to the male, and treat woman as a minor not able to take care of herself, and needing a guide and tutor. The allotment of this position to woman has been determined chiefly by her levity and frivolity, and the Roman law constantly invokes *fragilitatem sexus* in justification of its statutes. The partisans of equality meet this fact by alleging that the laws have sacrificed woman because they were made by men. Moralists have also noticed that women are merrier, more changeable, and more capricious than men; they are likewise more heedless and less circumspect. All philosophers and moralists admit that women are more superstitious, more prepossessed, more imitative, and more addicted to routine, more talkative, and more timid, than men. Some men of science also hold that women are less intelligent than men. Broca says they are a little less so. Darwin remarks that men go further than women in all that they undertake where profound thought, reason, imagination, or the application of the senses and the hands are concerned, and that if we should draw up a list of the dozen men and a similar list of the dozen women most distinguished in poetry, painting, sculpture, science, and philosophy, the two lists would bear no comparison. We might also cite the opinion of manufacturers and merchants who, employing both sexes, have been able to compare their faculties. All those whom we have consulted think women are more assiduous but less intelligent than men. In printing-offices, for example, women work minutely, mechanically, without knowing very well what they are doing. They succeed well in reprint, which does not exact intelligence, and poorly in manuscript.

In the evolution of tastes and ideas, woman marches about a century behind man. One might say that she is in the course of going through the phases that we have passed in arts, letters, science, and philosophy. The artistic and literary paths which man is abandoning for the scientific road are now taken possession of by the female sex. According to the librarians and the directors of reading-rooms, while the men are interested in the study of history, philosophy, and science, the women are still inquiring for novels. It is, however, just to add that Europe and America possess a few doctresses, and that a day will perhaps come when scientific careers will be disputed by women. We are not authorized to conclude, from the fact that they have not yet figured as inventors, that they will always be incapable of discovering anything. The future only can tell whether woman is simply an imitator, or whether she is a creator in the same sense as man.

It results as a whole from this parallel between the sexes that, among the superior species, the male excels the female not only in the intensity of the nutritive phenomena, but also in muscular force and intellectual development; because man, more strongly nourished than woman, fabricates more force than she, he is correspondingly stronger

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in physical and intellectual qualities than she. It may be added that more biological differences are found between the males than between the females of the same race. If, for example, we take ten Crèvecœur cocks, we shall find that they differ much more from each other in size and the development of the locomotive organs than ten hens of the same variety. So, in the human species, regarding the stature, color of hair, muscular strength, voice, tastes, ideas, and even handwriting, we shall find a great resemblance among women and a great diversity among men. Although, as we have seen, man excels woman among the European races, this is not the case in certain inferior races, where the feminine sex is more vigorous and more intelligent than the masculine. The women are equal or superior among certain African tribes—as in Dahomey, where they are the soldiers and have a higher official rank—among some of the hill tribes of India, among the Pueblos of North America, in Kamtchatka according to Meiners, among some Afghan tribes in Java, and among the Morotokos of South America. The Patagonian women, according to De Rochas, are almost as large and as brave as the men, and a woman is chief; and when in an inferior race the man surpasses the woman, his pre-eminence is always less than it is among the superior races. This is shown by different anthropologists to be the case with reference to the length of the radius (Broca), the dimensions of the shoulder-blades (Dr. Livon), and the general stature. The two sexes are of the same size among the Bushmen and the Patagonians (De Rochas). The difference in favor of the man among the Europeans averages eighty-six millimetres according to Quetelet, and twelve centimetres according to M. Topinard (4·68 inches). A similar diversity in differences of cranial capacity is indicated by the measurements of Broca, and by the observations of M. Huschke and Mr. J. B. Davis, that the difference in this respect in favor of the man increases as the race is more elevated. The same rule is applied to the general external aspect by M. Pruner Bey, whose conclusion is supported by his own observations of the Druses and those of M. G. Pouchet among the Arabs of Upper Nubia. We need not go as far as this, for some anthropologists tell us that the difference is less noticeable between Russian than between French men and women.

What we have noticed relative to living inferior tribes is equally observed among ancient inferior races. Some of the peoples of antiquity were governed by women, of whom Semiramis, Dido, Athalia, Cleopatra, Zenobia, etc., are examples. Diodorus speaks of the equality of the sexes among the ancient Scythians. According to the Roman historians, the Teutonic, Cimbrian, and Gallic women fought with as much courage as the men. Among some of the Pelasgian peoples and the Ibero-Ligurians, women decided concerning war and peace. The physical and intellectual predominance of the men was, on the other hand, considerable among the Greeks and Romans. The pre-eminence

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of the men of the higher races grows at a rate corresponding with the progress of evolution. According to Broca's investigations, the superiority of the man's cranial capacity is fifty per cent. more among the French in general, and a hundred and twenty-one per cent. more among the Parisians, than it was in the Cro-Magnon race. Very curiously, the cranial capacity of the prehistoric women was greater than that of the women of to-day. It appears demonstrated, says Broca, that the women participating more actively in the labors of the men had at the same time a more considerable cranial capacity than in our days. Zametti, of Sardinia, and Le Bon announce the same view on this point, and Le Bon says that the difference in the average cranial capacity of modern Parisian men and women is nearly double what is observed between the masculine and feminine skulls of Egypt.

Thus the superiority of women appears everywhere among ancient and modern inferior races, but is never observed among superior races, which are, on the contrary, always characterized by the pre-eminence of the man. Whether we regard species or races, we see evolution constantly advancing from the supremacy of the female to that of the male.

The same appears to take place in respect to age. Girls grow faster than boys till they are seventeen, after which the man keeps on growing and the woman remains at a stand-still. So, in the intellectual point, teachers in mixed schools observe that girls hold the first rank till they are twelve years old, and a lower rank afterward. Woman is, therefore, physically, intellectually, and morally, more precocious than man. Buffon believes that this difference bears a relation to the more solid development of the tissues of men; but precocity itself, according to the investigations I have reported to the Société de Biologie, is a character of inferiority—for it is always followed by an arrest of development—observable among all females of animals and of men. As a rule, man differs from woman more at the age of maturity than during youth or old age, in such a manner that the maximum of masculine pre-eminence corresponds with the climax of his evolution.

Whether we consider the organism in general or the several organs separately, we shall find that the differences, null during fetal life and slight at birth, go on increasing till they reach their sum at adult age, then diminish during old age. This is the case in respect to stature, where, according to Quetelet and M. Topinard, the difference of one centimetre at birth grows to one of twelve centimetres at maturity, after which a tendency to return to equality manifests itself; it is so in case of the difference in weight, which increases from three hundred and fifty grammes (or about twelve and one-sixth ounces) at birth to five, eight, or eleven kilogrammes (twelve and a half to twenty-seven pounds), according to different authors, at maturity, and falls off again with advancing age. The heads of boys measure a

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centimetre (four tenths of an inch) more at birth than those of girls (Liharzic). The difference increases by reason of the girl's head ceasing to grow much earlier than the man's. The difference in favor of the male in the weight of the brain about triples itself in the course of the first twenty years, and amounts, according to Broca, to seven per cent. between twenty-one and thirty years, to eleven per cent. between thirty-one and forty, then falls to ten per cent. between forty-one and fifty, and to eight per cent. between fifty-one and sixty years. After sixty years the weight diminishes, and the man's brain loses eighty-four grammes (three ounces), and the woman's fifty-nine grammes (about two and a half ounces) from the mean weight it attained at maturity. These anatomical differences bring on intellectual and moral differences that explain why in higher societies the two sexes, after sharing each other's sports in infancy, become separated during the age of maturity, and become again more alike in old age. The same facts are established in regard to the general aspect. Till the time of puberty, says M. Topinard, the skeletons hardly differ appreciably, the features are rather feminine. The man begins to be traceable only at puberty. At about forty-five years the distinctions begin to attenuate, and the sexes end by resembling each other in advanced age, when, however, the characteristics are rather masculine.

The same is the case in respect to the nutritive phenomena, to the amount of carbonic acid produced, to the volume of the lungs, to the quantity of salt in the blood, and to the pulse.

We gather from this review that the female sex surpasses the male in certain points during the first twelve years; then the male gains upon the female and acquires a pre-eminence that increases till the age of maturity, after which it falls off during old age. This pre-eminence is parallel with the progress of evolution, for its maximum corresponds with the apogee of evolution, which, we know, occurs at between forty and fifty years.

The pre-eminence of man over woman is more considerable in the case of large than of small persons. M. Verneau says that the differences in the size of the pelvis of the two sexes vary according to the general stature. The pre-eminence is greater among the inhabitants of the cities than with countrymen, among Parisians than among provincials. Broca assigns a difference of one hundred and fifty cubic centimetres in cranial capacity between French men and women in general, and of two hundred and twenty-one cubic centimetres between Parisians. M. Pruner Bey having remarked that among non-civilized races the women have masculine forms approaching that of a man, adds that the same phenomenon exists, although in a smaller degree, among the "inferior classes" of civilized races. It is easy to observe in our cities how much more the men differ from the women among the richer than among the poorer classes. And it is often the case in the latter classes that the woman is more intelligent than the man who

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has been brutalized by manual labor and drink. The advocates of Paris who are accustomed to plead for the workmen have remarked that the women are able to put their cases much better than their husbands, and often say to the latter, "Send me your wife."

The biological considerations we have adduced explain to us why the two sexes tend to diverge from each other as we proceed from the lower to the higher classes. Both sexes among peasants and working-people having nearly the same moral and intellectual faculties, they can sympathize with each other, and have no reason for becoming estranged. It is different among the intelligent classes, where the two sexes, in consequence of the increasing pre-eminence of man, not having the same ideas, the same sentiments, nor the same tastes, can not understand each other, and form separate coteries. Moralists have long taken notice of the separation, which is of force in the family and in the meetings of men and of women, which seem to be increasing from year to year.

According to M. Le Bon's researches, the different social classes should be ranked by their cranial capacity as follows: literary and scientific men, middle-class men (*bourgeois*), nobles, servants, peasants. The separation of which we speak widens as we rise from the peasant to the man of science, passing the servant, the noble, and the middle-class man. It appears, then, like the pre-eminence of man over woman, to be measured proportionately to the cranial capacity and the development of intelligence.

It might be thought that the physical and intellectual inferiority of woman is a consequence of her muscles and brain being less exercised than those of man. This is not correct. As to bodily strength, it readily appears in the circus, where the two sexes receive the same physical education, that the boy is always more vigorous than the girl, and constantly maintains his superiority over her. Some difficult feats which the men perform regularly are forbidden to the women. The view that the intellectual superiority of man and inferiority of woman are due to differences in education is likewise not just. In former ages, when the mass of the people were groping in ignorance, neither sex was better instructed than the other; and now, in the France of to-day, there are still six hundred thousand children of both sexes who never set foot in a school, and receive absolutely no education. We can, then, say with Professor Bischoff, of Munich, that "women have suffered no other hindrances to the exercise and evolution of their brains and their intellect than those that are derived from their constitution and their faculties of development." The pretense that woman never receives the same education as man is, moreover, false. Female pupils receive precisely the same musical instruction at the music-schools as male pupils. How comes it then that, although there are incomparably more women than men following music as a profession, women furnish good performers but no composers? The same

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observation is applicable to painting and the culinary art. Why is it that, while all the men who devote themselves to the latter art become good cooks, there are among the thousands of women who exercise it as a profession so few of the first quality?

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We have already seen that in mixed schools, where children of both sexes receive precisely the same education till they are fifteen years old, the girls at first are ahead by virtue of their natural precocity, but, on passing twelve years, fall behind the boys. The arrest in the development that takes place in woman at about this time is the real cause of the growing pre-eminence of man, who continues to develop till an advanced age. If the girl begins thus to fall behind the boy at a certain point after having enjoyed the same training, it must be that her inferiority is real, and can not be ascribed to a difference in education that does not exist.

Thus equality in the instruction of individuals of the two sexes, the equal working of the brain, instead of re-establishing equality between them, increases the pre-eminence of the males, and this explains why woman is less perfectible than man. The equality of the sexes dreamed of by the philosophers is, then, not near being realized. On the contrary, that equality which existed among the primitive races, and still exists among some savages, is tending more and more to disappear with the progress of civilization. The pre-eminence of man over woman, which is a product of the evolution of individuals and races, is rather increased by instruction, the effect of which, far from re-establishing the equality of the sexes, is to assure definitively the supremacy of man.

It would be interesting to investigate the effect of the environment on the differences between the sexes. I am inclined to believe that the differences diminish as we go south. In Italy, for example, according to statistics covering a period of fourteen years, published by the Minister of Agriculture, the excess in the height of men over women falls from forty-two millimetres (1·63 inch) in the northern provinces to twenty-nine millimetres (1·13 inch) in the southern provinces. According to Broca, women are more nearly of the same size as men in mountainous than in flat countries. To summarize our argument, the pre-eminence of the female sex over the male, occurring only in certain inferior species and races, and in children of the superior races, marks an inferior degree of evolution. The same may be said of equality of the sexes, which is observable only among individuals little advanced in evolution: inferior races and species, youth, aged persons, and the lower classes. On the contrary, the pre-eminence of the male over the female represents a superior phase of evolution, for it characterizes superior species and races, the adult age, and the higher classes. In the moral as in the physical point of view, evolution appears to me, then, to advance from the pre-eminence of the female sex to that of the male sex; equality of the sexes would thus be a stage in the natural transition between the two opposite phases of evolution.

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A HALF-CENTURY OF SCIENCE.*

By Sir JOHN LUBBOCK.

II.

IN astronomy, the discovery in 1845 of the planet Neptune, made independently and almost simultaneously by Adams and by Le Verrier, was certainly one of the very greatest triumphs of mathematical genius. Of the minor planets, four only were known in 1831, while the number now on the roll amounts to 220. Many astronomers believe in the existence of an intra-Mercurial planet or planets, but this is still an open question. The solar system has also been enriched by the discovery of an inner ring to Saturn, of satellites to Mars, and of additional satellites to Saturn, Uranus, and Neptune.

The most unexpected progress, however, in our astronomical knowledge, during the past half-century, has been due to spectrum analysis. The dark lines in the spectrum were first seen by Wollaston, who noticed a few of them; but they were independently discovered by Fraunhofer, after whom they are justly named, and who, in 1814, mapped no fewer than 576. The first steps in "spectrum analysis," properly so called, were made by Sir J. Herschel, Fox Talbot, and by Wheatstone, in a paper read before this Association in 1835. The latter showed that the spectrum emitted by the incandescent vapor of metals was formed of bright lines, and that these lines, while, as he then supposed, constant for each metal, differed for different metals. "We have here," he said, "a mode of discriminating metallic bodies more readily than that of chemical examination, and which may hereafter be employed for useful purposes." Nay, not only can bodies thus be more readily discriminated, but, as we now know, the presence of extremely minute portions can be detected, the $\frac{1}{5000000}$ of a grain being in some cases easily perceptible.

It is also easy to see that the presence of any new simple substance might be detected, and in this manner already several new elements have been discovered, as I shall mention when we come to chemistry.

But spectrum analysis has led to even grander and more unexpected triumphs. Fraunhofer himself noticed the coincidence between the double dark line D of the solar spectrum and a double line which he observed in the spectra of ordinary flames, while Stokes pointed out to Sir W. Thomson, who taught it in his lectures, that in both cases these lines were due to the presence of sodium. To Kirchhoff and Bunsen, however, is due the independent conception and the credit of having first systematically investigated the relation which exists between

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Fraunhofer's lines and the bright lines in the spectra of incandescent metals. In order to get some fixed measure by which they might determine and record the lines characterizing any given substance, it occurred to them that they might use for comparison the spectrum of the sun. They accordingly arranged their spectroscope so that one half of the slit was lighted by the sun, and the other by the luminous gases they proposed to examine. It immediately struck them that the bright lines in the one corresponded with the dark lines in the other—the bright line of sodium, for instance, with the line or rather lines D in the sun's spectrum. The conclusion was obvious. There was sodium in the sun! It must indeed have been a glorious moment when that thought flashed across them, and even by itself well worth all their labor.

But why is the bright line of a sodium-flame represented by a black one in the spectrum of the sun! To Angstrom is due the theory that a vapor or gas can absorb luminous rays of the same refrangibility only which it emits when highly heated; while Balfour Stewart independently discovered the same law with reference to radiant heat.

This is the basis of Kirchhoff's theory of the origin of Fraunhofer's lines. In the atmosphere of the sun the vapors of various metals are present, each of which would give its characteristic lines, but within this atmospheric envelope is the still more intensely heated nucleus of the sun, which emits a brilliant continuous spectrum, containing rays of all degrees of refrangibility. When the light of this intensely-heated nucleus is transmitted through the surrounding atmosphere, the bright lines which would be produced by this atmosphere are seen as dark ones.

Kirchhoff and Bunsen thus proved the existence in the sun of hydrogen, sodium, magnesium, calcium, iron, nickel, chromium, manganese, titanium, and cobalt; since which Angstrom, Thalén, and Lockyer have considerably increased the list. But it is not merely the chemistry of the heavenly bodies on which light is thrown by the spectroscope; their physical structure and evolutional history are also illuminated by this wonderful instrument of research. It used to be supposed that the sun was a dark body enveloped in a luminous atmosphere. The reverse now appears to be the truth. The body of the sun, or photosphere, is intensely brilliant; round it lies the solar atmosphere of comparatively cool gases, which cause the dark lines in the spectrum; thirdly, a chromosphere—a sphere principally of hydrogen, jets of which are said sometimes to reach to a height of 100,000 miles or more, into the outer coating or corona, the nature of which is still very doubtful.

Formerly the red flames which represent the higher regions of the chromosphere could be seen only on the rare occasions of a total solar eclipse. Janssen and Lockyer, by the application of the spectroscope, have enabled us to study this region of the sun at all times. It is,

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moreover, obvious that the powerful engine of investigation afforded us by the spectroscope is by no means confined to the substances which form part of our system. The incandescent body can thus be examined, no matter how great its distance, so long only as the light is strong enough. That this method was theoretically applicable to the light of the stars was indeed obvious, but the practical difficulties were very great. Sirius, the brightest of all, is, in round numbers, a hundred millions of millions of miles from us; and, though as big as sixty of our suns, his light when it reaches us, after a journey of sixteen years, is at most one two-thousand-millionth part as bright. Nevertheless, as long ago as 1815 Fraunhofer recognized the fixed lines in the light of four of the stars, and in 1863 Miller and Huggins in our own country, and Rutherfurd in America, succeeded in determining the dark lines in the spectrum of some of the brighter stars, thus showing that these beautiful and mysterious lights contain many of the material substances with which we are familiar. In Aldebaran, for instance, we may infer the presence of hydrogen, sodium, magnesium, iron, calcium, tellurium, antimony, bismuth, and mercury; some of which are not yet known to occur in the sun. As might have been expected, the composition of the stars is not uniform, and it would appear that they may be arranged in a few well-marked classes, indicating differences of temperature, or, in other words, of age. Some recent photographic spectra of stars obtained by Huggins go very far to justify this view. Thus we can make the stars teach us their own composition with light which started from its source before we were born—light older than our Association itself.

Until 1864, the true nature of the unresolved nebulæ was a matter of doubt. In that year, however, Huggins turned his spectroscope on to a nebula, and made the unexpected discovery that the spectra of some of these bodies are discontinuous—that is to say, consist of bright lines only, indicating that, "in place of an incandescent solid or liquid body, we must probably regard these objects, or at least their photo-surfaces, as enormous masses of luminous gas or vapor. For it is from matter in a gaseous state only that such light as that of the nebulæ is known to be emitted." So far as observation has yet gone, nebulæ may be divided into two classes: some giving a continuous spectrum, others one consisting of bright lines. These latter all appear to give essentially the same spectrum, consisting of a few bright lines. Two of them, in Mr. Huggins's opinion, indicate the presence of hydrogen: one of them agrees in position with a line characteristic of nitrogen.

But spectrum analysis has even more than this to tell us. The old methods of observation could determine the movements of the stars so far only as they were transverse to us; they afforded no means of measuring motion either directly toward or away from us. Now, Döppler suggested in 1841 that the colors of the stars would assist us in this respect, because they would be affected by their motion to and

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from the earth, just as a steam-whistle is raised or lowered as it approaches or recedes from us. Every one has observed that if a train whistles as it passes us, the sound appears to alter at the moment the engine goes by. This arises, of course, not from any change in the whistle itself, but because the number of vibrations which reach the ear in a given time are increased by the speed of the train as it approaches, and diminished as it recedes. So, like the sound, the color would be affected by such a movement; but Döppler's method was practically inapplicable, because the amount of effect on the color would be utterly insensible; and even if it were otherwise, the method could not be applied, because, as we did not know the true color of the stars, we have no datum-line by which to measure.

A change of refrangibility of light, however, does occur in consequence of relative motion, and Huggins successfully applied the spectroscope to solve the problem. He took in the first place the spectroscope of Sirius, and chose a line known as F, which is due to hydrogen. Now, if Sirius was motionless, or rather if it retained a constant distance from the earth, the line F would occupy exactly the same position in the spectrum of Sirius as in that of the sun. On the contrary, if Sirius were approaching or receding from us, this line would be slightly shifted either toward the blue or red end of the spectrum. He found that the line had moved very slightly toward the red, indicating that the distance between us and Sirius is increasing at the rate of about twenty miles a second. So also Betelgeux, Rigel, Castor, and Regulus are increasing their distance; while, on the contrary, that of others, as for instance of Vega, Arcturus, and Pollux, is diminishing. The results obtained by Huggins on about twenty stars have since been confirmed and extended by Mr. Christie, now Astronomer-Royal in succession to Sir G. Airy, who has long occupied the post with so much honor to himself and advantage to science.

To examine the spectrum of a shooting-star would seem even more difficult; yet Alexander Herschel has succeeded in doing so, and finds that their nuclei are incandescent solid bodies; he has recognized the lines of potassium, sodium, lithium, and other substances, and considers that the shooting-stars are bodies similar in character and composition to the stony masses which sometimes reach the earth as aërolites.

Some light has also been thrown upon those mysterious visitants, the comets. The researches of Professor Newton on the periods of meteoroids led to the remarkable discovery by Schiaparelli of the identity of the orbits of some meteor-swarms with those of some comets. The similarity of orbits is too striking to be the result of chance, and shows a true cosmical relation between the bodies. Comets, in fact, are in some cases at any rate groups of meteoric stones. From the spectra of the small comets of 1866 and 1868, Huggins showed that part of their light is emitted by themselves, and reveals the presence

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of carbon in some form. A photographic spectrum of the comet recently visible, obtained by the same observer, is considered by him to prove that nitrogen, probably in combination with carbon, is also present.

No element has yet been found in any meteorite, which was not previously known as existing in the earth, but the phenomena which they exhibit indicate that they must have been formed under conditions very different from those which prevail on the earth's surface. I may mention, for instance, the peculiar form of crystallized silica, called by Maskelyne, asmanite ; and the whole class of meteorites, consisting of iron generally alloyed with nickel, which Daubrée terms holosiderites. The interesting discovery, however, by Nordenskjöld, in 1870, at Ovifak, of a number of blocks of iron alloyed with nickel and cobalt, in connection with basalts containing disseminated iron, has, in the words of Judd, "afforded a very important link, placing the terrestrial and extra-terrestrial rocks in closer relations with one another."

We have as yet no sufficient evidence to justify a conclusion as to whether any substances exist in the heavenly bodies which do not occur in our earth, though there are many lines which can not yet be satisfactorily referred to any terrestrial element. On the other hand, some substances which occur on our earth have not yet been detected in the sun's atmosphere. Such discoveries as these seemed, not long ago, entirely beyond our hopes. M. Comte, indeed, in his "Cours de Philosophie Positive," as recently as 1842, laid it down as an axiom regarding the heavenly bodies, that "nous concevons la possibilité de déterminer leurs formes, leurs distances, leurs grandeurs et leurs mouvements, tandis que nous ne saurions jamais étudier par aucun moyen leur composition chimique ou leur structure minéralogique." Yet within a few years this supposed impossibility has been actually accomplished, showing how unsafe it is to limit the possibilities of science.

It is hardly necessary to point out that, while the spectrum has taught us so much, we have still even more to learn. Why should some substances give few, and others many, lines? Why should the same substance give different lines at different temperatures? What are the relations between the lines and the physical or chemical properties? We may certainly look for much new knowledge of the hidden actions of atoms and molecules from future researches with the spectroscope. It may even, perhaps, teach us to modify our views of the so-called simple substances. Prout long ago, struck by the remarkable fact that nearly all atomic weights are simple multiples of the atomic weight of hydrogen, suggested that hydrogen must be the primordial substance. Brodie's researches also naturally fell in with the supposition that the so-called simple substances are in reality complex, and that their constituents occur separately in the hottest regions

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of the solar atmosphere. Lockyer considers that his researches lend great probability to this view. The whole subject is one of intense interest, and we may rejoice that it is occupying the attention, not only of such men as Abney, Dewar, Hartley, Liveing, Roscoe, and Schuster in our own country, but also of many foreign observers.

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When geology so greatly extended our ideas of past time, the continued heat of the sun became a question of greater interest than ever. Helmholtz has shown that, while adopting the nebular hypothesis, we need not assume that the nebulous matter was originally incandescent; but that its present high temperature may be, and probably is, mainly due to gravitation between its parts. It follows that the potential energy of the sun is far from exhausted, and that with continued shrinking it will continue to give out light and heat, with little, if any, diminution for several million years.

Like the sand of the sea, the stars of heaven have ever been used as effective symbols of number, and the improvements in our methods of observation have added fresh force to our original impressions. We now know that our earth is but a fraction of one out of at least 75,000,000 worlds. But this is not all. In addition to the luminous heavenly bodies, we can not doubt that there are countless others, invisible to us from their greater distance, smaller size, or feebler light; indeed, we know that there are many dark bodies which now emit no light, or comparatively little. Thus, in the case of Procyon, the existence of an invisible body is proved by the movement of the visible star. Again, I may refer to the curious phenomena presented by Algol, a bright star in the head of Medusa. This star shines without change for two days and thirteen hours; then, in three hours and a half, dwindles from a star of the second to one of the fourth magnitude; and then, in another three and a half hours, reassumes its original brilliancy. These changes seem certainly to indicate the presence of an opaque body, which intercepts at regular intervals a part of the light emitted by Algol.

Thus the floor of heaven is not only "thick inlaid with patines of bright gold," but studded also with extinct stars; once, probably, as brilliant as our own sun, but now dead and cold, as Helmholtz tells us that our sun itself will be, some seventeen million years hence.

The connection of astronomy with the history of our planet has been a subject of speculation and research during a great part of the half-century of our existence. Sir Charles Lyell devoted some of the opening chapters of his great work to the subject. Haughton has brought his very original powers to bear on the subject of secular changes in climate, and Croll's contributions to the same subject are of great interest. Last, but not least, I must not omit to make mention of the series of massive memoirs (I am happy to say, not yet nearly terminated) by George Darwin on tidal friction, and the influence of tidal action on the evolution of the solar system. I may, per-

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haps, just mention, as regards telescopes, that the largest reflector, in 1830, was Sir W. Herschel's, of four feet; the largest at present being Lord Rosse's, of six feet; as regards refractors, the largest then had a diameter of eleven and a quarter inches, while your fellow-townsman, Cooke, carried the size to twenty-five inches, and Mr. Grubb, of Dublin, has just successfully completed one of twenty-seven inches for the Observatory of Vienna. It is remarkable that the two largest telescopes in the world should both be Irish.

The general result of astronomical researches has been thus eloquently summed up by Proctor: "The sidereal system is altogether more complicated and more varied in structure than has hitherto been supposed; in the same region of the stellar depths coexist stars of many orders of real magnitude; all orders of nebulæ, gaseous or stellar, planetary, ring-formed, elliptical, and spiral, exist within the limits of the galaxy; and, lastly, the whole system is alive with movements, the laws of which may one day be recognized, though at present they appear too complex to be understood."

We can, I think, scarcely claim the establishment of the undulatory theory of light as falling within the last fifty years; for though Brewster, in his "Report on Optics," published in our first volume, treats the question as open, and expresses himself still unconvinced, he was, I believe, almost alone in his preference for the emission theory. The phenomena of interference, in fact, left hardly any—if any—room for doubt, and the subject was finally set at rest by Foucault's celebrated experiments in 1850. According to the undulatory theory, the velocity of light ought to be greater in air than in water, while if the emission theory were correct the reverse would be the case. The velocity of light—186,000 miles in a second—is, however, so great that, to determine its rate in air, as compared with that in water, might seem almost hopeless. The velocity in air was, nevertheless, determined by Fizeau in 1849, by means of a rapidly revolving wheel. In the following year Foucault, by means of a revolving mirror, demonstrated that the velocity of light is greater in air than in water—thus completing the evidence in favor of the undulatory theory of light.

The idea is now gaining ground that, as maintained by Clerk Maxwell, light itself is an electro-magnetic disturbance, the luminiferous ether being the vehicle of both light and electricity.

Wünsch, as long ago as 1792, had clearly shown that the three primary colors were red, green, and violet; but his results attracted little notice, and the general view used to be that there were seven principal colors—red, orange, yellow, green, blue, indigo, and violet; four of which—namely, orange, green, indigo, and violet—were considered to arise from mixtures of the other three. Red, yellow, and blue were therefore called the primary colors, and it was supposed that in order to produce white light these three colors must always be present.

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Helmholtz, however, again showed, in 1852, that a color to our unaided eyes identical with white was produced by combining yellow with indigo. At that time yellow was considered to be a simple color, and this, therefore, was regarded as an exception to the general rule, that a combination of three simple colors is required to produce white. Again, it was, and indeed still is, the general impression that a combination of blue and yellow makes green. This, however, is entirely a mistake. Of course, we all know that yellow paint and blue paint make green paint; but this results from absorption of light by the semi-transparent solid particles of the pigments, and is not a mere mixture of the colors proceeding unaltered from the yellow and the blue particles; moreover, as can easily be shown by two sheets of colored paper and a piece of window-glass, blue and yellow light, when combined, do not give a trace of green, but if pure would produce the effect of white. Green, therefore, is after all not produced by a mixture of blue and yellow. On the other hand, Clerk Maxwell proved in 1860 that yellow could be produced by a mixture of red and green, which put an end to the pretension of yellow to be considered a primary element of color. From these and other considerations it would seem, therefore, that the three primary colors—if such an expression be retained—are red, green, and violet.

The existence of rays beyond the violet, though almost invisible to our eyes, had long been demonstrated by their chemical action. Stokes, however, showed in 1852 that their existence might be proved in another manner, for that there are certain substances which, when excited by them, emit light visible to our eyes. To this phenomenon he gave the name of fluorescence. At the other end of the spectrum Abney has recently succeeded in photographing a large number of lines in the infra-red portion, the existence of which was first proved by Sir William Herschel.

From the rarity, and in many cases the entire absence, of reference to blue, in ancient literature, Geiger—adopting and extending a suggestion first thrown out by Mr. Gladstone—has maintained that, even as recently as the time of Homer, our ancestors were blue-blind. Though for my part I am unable to adopt this view, it is certainly very remarkable that neither the "Rigveda," which consists almost entirely of hymns to heaven, nor the "Zendavesta," the Bible of the Parsees or fire-worshipers, nor the Old Testament, nor the Homeric poems, ever allude to the sky as blue.

On the other hand, from the dawn of poetry, the splendors of the morning and evening skies have excited the admiration of mankind. As Ruskin says, in language almost as brilliant as the sky itself, the whole heaven, "from the zenith to the horizon, becomes one molten, mantling sea of color and fire; every black bar turns into massy gold, every ripple and wave into unsullied, shadowless crimson, and purple, and scarlet, and colors for which there are no words in language, and

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no ideas in the mind—things which can only be conceived while they are visible; the intense hollow blue of the upper sky melting through it all, showing here deep, and pure, and lightness; there, modulated by the filmy, formless body of the transparent vapor, till it is lost imperceptibly in its crimson and gold."

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But what is the explanation of these gorgeous colors? why is the sky blue? and why are the sunrise and sunset crimson and gold? It may be said that the air is blue; but, if so, how can the clouds assume their varied tints? Brücke showed that very minute particles suspended in water are blue by reflected light. Tyndall has taught us that the blue of the sky is due to the reflection of the blue rays by the minute particles floating in the atmosphere. Now, if from the white light of the sun the blue rays are thus selected, those which are transmitted will be yellow, orange, and red. Where the distance is short the transmitted light will appear yellowish. But as the sun sinks toward the horizon the atmospheric distance increases, and consequently the number of the scattering particles. They weaken in succession the violet, the indigo, the blue, and even disturb the proportions of green. The transmitted light under such circumstances must pass from yellow through orange to red, and thus, while we at noon are admiring the deep blue of the sky, the same rays, robbed of their blue, are elsewhere lighting up the evening sky with all the glories of sunset.

Another remarkable triumph of the last half-century has been the discovery of photography. At the commencement of the century Wedgwood and Davy observed the effect produced by throwing the images of objects on paper or leather prepared with nitrate of silver, but no means were known by which such images could be fixed. This was first effected by Niepce, but his processes were open to objections which prevented them from coming into general use, and it was not till 1839 that Daguerre invented the process which was justly named after him. Very soon a further improvement was effected by our countryman Talbot. He not only fixed his "Talbotypes" on paper—in itself a great convenience—but, by obtaining a negative, rendered it possible to take off any number of positive, or natural, copies from one original picture. This process is the foundation of all the methods now in use; perhaps the greatest improvements having been the use of glass plates, first proposed by Sir John Herschel; of collodion, suggested by Le Grey, and practically used by Archer; and, more lately, of gelatine, the foundation of the sensitive film now growing into general use in the ordinary dry-plate process. Not only have a great variety of other beautiful processes been invented, but the delicacy of the sensitive film has been immensely increased, with the advantage, among others, of diminishing greatly the time necessary for obtaining a picture, so that even an express-train going at full speed can now be taken. Indeed, with full sunlight, $\frac{1}{600}$ of a second is

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enough, and in photographing the sun itself $\frac{1}{60000}$ of a second is sufficient.

We owe to Wheatstone the conception that the idea of solidity is derived from the combination of two pictures of the same object in slightly different perspective. This he proved in 1833 by drawing two outlines of some geometrical figure or other simple object, as they would appear to either eye respectively, and then placing them so that they might be seen, one by each eye. The "stereoscope," thus produced, has been greatly popularized by photography.

For two thousand years the art of lighting had made little if any progress. Until the close of the last century, for instance, our lighthouses contained mere fires of wood or coal, though the construction had vastly improved. The Eddystone Lighthouse, for instance, was built by Smeaton in 1759; but for forty years its light consisted in a row of tallow candles stuck in a hoop. The Argand lamp was the first great improvement, followed by gas, and in 1863 by the electric light.

Just as light was long supposed to be due to the emission of material particles, so heat was regarded as a material, though ethereal, substance, which was added to bodies when their temperature was raised.

Davy's celebrated experiment of melting two pieces of ice by rubbing them against one another in the exhausted receiver of an air-pump, had convinced him that the cause of heat was the motion of the invisible particles of bodies, as had been long before suggested by Newton, Boyle, and Hooke. Rumford and Young also advocated the same view. Nevertheless, the general opinion, even until the middle of the present century, was that heat was due to the presence of a subtile fluid known as "caloric," a theory which is now entirely abandoned.

Melloni, by the use of the electric pile, vastly increased our knowledge of the phenomena of radiant heat. His researches were confined to the solid and liquid forms of matter. Tyndall studied the gases in this respect, showing that differences greater than those established by Melloni existed between gases and vapors, both as regards the absorption and radiation of heat. He proved, moreover, that the aqueous vapor of our atmosphere, by checking terrestrial radiation, augments the earth's temperature, and he considers that the existence of tropical vegetation—the remains of which now constitute our coal-beds—may have been due to the heat retained by the vapors which at that period were diffused in the earth's atmosphere. Indeed, but for the vapor in our atmosphere, a single night would suffice to destroy the whole vegetation of the temperate regions.

Inspired by a contemplation of Graham Bell's ingenious experiments with intermittent beams on solid bodies, Tyndall took a new and original departure; and regarding the sounds as due to changes

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of temperature, he concluded that the same method would prove applicable to gases. He thus found himself in possession of a new and independent method of procedure. It need, perhaps, be hardly added that, when submitted to this new test, his former conclusions on the interaction of heat and gaseous matter stood their ground.

The determination of the mechanical equivalent of heat is mainly due to the researches of Mayer and Joule. Mayer, in 1842, pointed out the mechanical equivalent of heat as a fundamental datum to be determined by experiment. Taking the heat produced by the condensation of air as the equivalent of the work done in compressing the air, he obtained a numerical value of the mechanical equivalent of heat. There was, however, in these experiments, one weak point. The matter operated on did not go through a cycle of changes. He assumed that the production of heat was the only effect of the work done in compressing the air. Joule had the merit of being the first to meet this possible source of error. He ascertained that a weight of one pound would have to fall 772 feet in order to raise the temperature of one pound of water by 1° Fahr. Hirn subsequently attacked the problem from the other side, and showed that if all the heat passing through a steam-engine was turned into work, for every degree Fahr. added to the temperature of a pound of water, enough work could be done to raise a weight of one pound to a height of 772 feet. The general result is that, though we can not create energy, we may help ourselves to any extent from the great storehouse of nature. Wind and water, the coal-bed and the forest, afford man an inexhaustible supply of available energy.

It used to be considered that there was an absolute break between the different states of matter. The continuity of the gaseous, liquid, and solid conditions was first demonstrated by Andrews in 1862. Oxygen and nitrogen have been liquefied independently and at the same time by Cailletet and Raoul Pictet. Cailletet also succeeded in liquefying air, and soon afterward hydrogen was liquefied by Pictet under a pressure of 650 atmospheres, and a cold of 170° Cent. below zero. It even became partly solidified, and he assures us that it fell on the floor with "the shrill noise of metallic hail." Thus, then, it was shown experimentally that there are no such things as absolutely permanent gases.

The kinetic theory of gases, now generally accepted, refers the elasticity of gases to a motion of translation of their molecules, and we are assured that, in the case of hydrogen at a temperature of 60° Fahr., they move at an average rate of 6,225 feet in a second; while, as regards their size, Loschmidt, who has since been confirmed by Stoney and Sir W. Thomson, calculates that each is at most $\frac{1}{\text{00000000}}$ of an inch in diameter.

We can not, it would seem, at present hope for any increase of our knowledge of atoms by any improvement in the microscope. With

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our present instruments we can perceive lines ruled on glass of $\frac{1}{90000}$ of an inch apart. But, owing to the properties of light itself, the fringes due to interference begin to produce confusion at distances of $\frac{1}{44000}$, and in the brightest part of the spectrum at little more than $\frac{1}{90000}$ they would make the obscurity more or less complete. If, indeed, we could use the blue rays by themselves, their waves being much shorter, the limit of possible visibility might be extended to $\frac{1}{120000}$; and, as Helmholtz has suggested, this perhaps accounts for Stinde having actually been able to obtain a photographic image of lines only $\frac{1}{100000}$ of an inch apart. It would seem, then, that, owing to the physical characters of light, we can, as Sorby has pointed out, scarcely hope for any great improvement so far as the mere visibility of structure is concerned, though in other respects, no doubt, much may be hoped for. At the same time, Dallinger and Royston Pigott have shown that, so far as the mere presence of simple objects is concerned, bodies of even smaller dimensions can be perceived.

Sorby is of opinion that in a length of $\frac{1}{80000}$ of an inch there would probably be from 500 to 2,000 molecules—500, for instance, in albumen and 2,000 in water. Even, then, if we could construct microscopes far more powerful than any we now possess, they would not enable us to obtain by direct vision any idea of the ultimate molecules of matter. Sorby calculates that the smallest sphere of organic matter which could be clearly defined with our most powerful microscopes would contain many millions of molecules of albumen and water, and it follows that there may be an almost infinite number of structural characters in organic tissues, which we can at present foresee no mode of examining.

The science of meteorology has made great progress; the weather, which was formerly treated as a local phenomenon, being now shown to form part of a vast system of mutually dependent cyclonic and anti-cyclonic movements. The storm-signals issued at our ports are very valuable to sailors, while the small weather-maps, for which we are mainly indebted to Francis Galton, and the forecasts, which any one can obtain on application, either personally or by telegraph, at the Meteorological Office, are also of increasing utility.

Electricity, in the year 1831, may be considered to have just been ripe for its adaptation to practical purposes; it was but a few years previously, in 1819, that Oersted had discovered the deflective action of the current on the magnetic needle, that Ampère had laid the foundation of electro-dynamics, that Schweigger had devised the electric coil or multiplier, and that Sturgeon had constructed the first electro-magnet. It was in 1831 that Faraday, the prince of pure experimentalists, announced his discoveries of voltaic induction and magneto-electricity, which, with the other three discoveries, constitute the principles of nearly all the telegraph instruments now in use; and in

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1834 our knowledge of the nature of the electric current had been much advanced by the interesting experiment of Sir Charles Wheatstone, proving the velocity of the current in a metallic conductor to approach that of the wave of light.

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Practical applications of these discoveries were not long in coming to the fore, and the first telegraph-line on the Great Western Railway, from Paddington to West Drayton, was set up in 1838. In America, Morse is said to have commenced to develop his recording instrument between the years 1832 and 1837, while Steinheil, in Germany, during the same period, was engaged upon his somewhat super-refined ink-recorder, using for the first time the earth for completing the return circuit; whereas in this country Cooke and Wheatstone, by adopting the more simple device of the double-needle instrument, were the first to make the electric telegraph a practical institution. Contemporaneously with, or immediately succeeding these pioneers, we find in this country Alexander Bain, Breguet in France, Schilling in Russia, and Werner Siemens in Germany, the latter having first, in 1847, among others, made use of gutta-percha as an insulating medium for electric conductors, and thus cleared the way for subterranean and submarine telegraphy. Four years later, in 1851, submarine telegraphy became an accomplished fact through the successful establishment of telegraphic communication between Dover and Calais. Submarine lines followed in rapid succession, crossing the English Channel and the German Ocean, threading their way through the Mediterranean, Black, and Red Seas, until in 1866, after two abortive attempts, telegraphic communication was successfully established between the Old and New Worlds, beneath the Atlantic Ocean.

In connection with this great enterprise, and with many investigations and suggestions of a highly scientific and important character, the name of Sir William Thomson will ever be remembered. The ingenuity displayed in perfecting the means of transmitting intelligence through metallic conductors, with the utmost dispatch and certainty as regards the record obtained, between two points hundreds and even thousands of miles apart, is truly surprising. The instruments devised by Morse, Siemens, and Hughes have also proved most useful.

Duplex and quadruplex telegraphy, one of the most striking achievements of modern telegraphy, the result of the labors of several inventors, should not be passed over in silence. It not only serves for the simultaneous communication of telegraphic intelligence in both directions, but renders it possible for four instruments to be worked irrespectively of one another, through one and the same wire connecting to distant places.

Another more recent and perhaps still more wonderful achievement in modern telegraphy is the invention of the telephone and microphone, by means of which the human voice is transmitted through the electric conductor, by mechanism that imposes through its extreme sim-

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plicity. In this connection the names of Reiss, Graham Bell, Edison, and Hughes, are those chiefly deserving to be recorded.

While electricity has thus furnished us with the means of flashing our thoughts by record or by voice from place to place, its use is now gradually extending for the achievement of such quantitative effects as the production of light, the transmission of mechanical power, and the precipitation of metals. The principle involved in the magneto-electric and dynamo-electric machines, by which these effects are accomplished, may be traced to Faraday's discovery in 1831 of the induced current, but their realization to the labors of Holmes, Siemens, Pacinotti, Gramme, and others. In the electric light, gas-lighting has found a formidable competitor, which appears destined to take its place in public illumination, and in lighting large halls, works, etc., for which purposes it combines brilliancy and freedom from obnoxious products of combustion, with comparative cheapness. The electric light seems also to threaten, when subdivided in the manner recently devised by Edison, Swan, and others, to make inroads into our dwelling-houses.

By the electric transmission of power we may hope some day to utilize at a distance such natural sources of energy as the Falls of Niagara, and to work our cranes, lifts, and machinery of every description by means of sources of power arranged at convenient centers. To these applications the brothers Siemens have more recently added the propulsion of trains by currents passing through the rails, the fusion in considerable quantities of highly refractory substances, and the use of electric centers of light in horticulture as proposed by Werner and William Siemens. By an essential improvement by Faure of the Planté secondary battery, the problem of storing electrical energy appears to have received a practical solution, the real importance of which is clearly proved by Sir W. Thomson's recent investigation of the subject. It would be difficult to assign the limits to which this development of electrical energy may not be rendered serviceable for the purposes of man.

As regards mathematics, I have felt that it would be impossible for me, even with the kindest help, to write anything myself. Mr. Spottiswoode, however, has been so good as to supply me with the following memorandum :

In a complete survey of the progress of science during the half-century which has intervened between our first and our present meeting, the part played by mathematics would form no insignificant feature. To those, indeed, who are outside its enchanted circle it is difficult to realize the intense intellectual energy which actuates its devotees, or the wide expanse over which that energy ranges. Some measure, however, of its progress may perhaps be formed by considering, in one or two cases, from what simple principles some of the great recent developments have taken their origin.

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Consider, for instance, what is known as the principle of signs. In geometry we are concerned with quantities such as lines and angles; and in the old systems a proposition was proved with reference to a particular figure. This figure might, it is true, be drawn in any manner within certain ranges of limitation; but if the limits were exceeded, a new proof, and often a new enunciation, became necessary. Gradually, however, it came to be perceived (e. g., by Carnot, in his "Géometrie de Position") that some propositions were true even when the quantities were reversed in direction. Hence followed a recognition of the principle (of signs) that every line should be regarded as a directed line, and every angle as measured in a definite direction. By means of this simple consideration, geometry has acquired a power similar to that of algebra, viz., of changing the signs of the quantities and transposing their positions, so as at once, and without fresh demonstration, to give rise to new propositions.

To take another instance. The properties of triangles, as established by Euclid, have always been considered as legitimate elements of proof; so that, when in any figure two triangles occur, their relations may be used as steps in a demonstration. But, within the period of which I am speaking, other general geometrical relations, e. g., those of a pencil of rays, or of their intersection with a straight line, have been recognized as serving a similar purpose. With what extensive results this generalization has been attended, the "Géometrie Supérieure" of the late M. Chasles, and all the superstructure built on Anharmonic Ratio as a foundation, will be sufficient evidence.

Once more, the algebraical expression for a line or a plane involves two sets of quantities, the one relating to the position of any point in the line or plane, and the other relating to the position of the line or plane in space. The former set alone were originally considered variable, the latter constant. But as soon as it was seen that either set might at pleasure be regarded as variable, there was opened out to mathematicians the whole field of duality within geometry proper, and the theory of correlative figures which is destined to occupy a prominent position in the domain of mathematics.

Not unconnected with this is the marvelous extension which the transformation of geometrical figures has received very largely from Cremona and the Italian school, and which in the hands of our countrymen Hirst and the late Professor Clifford has already brought forth such abundant fruit. In this, it may be added, there lay—dormant, it is true, and long unnoticed—the principle whereby circular may be converted into rectilinear motion, and *vice versa*—a problem which, until the time of Peaucillier, seemed so far from solution, that one of the greatest mathematicians of the day thought that he had proved its entire impossibility. In the hands of Sylvester, of Kempe, and others, this principle has been developed into a general theory of link-work, on which the last word has not yet been said.

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If time permitted, I might point out how the study of particular geometric figures, such as curves and surfaces, has been in many instances replaced by that of systems of figures infinite in number, and, indeed, of various degrees of infinitude. Such, for instance, are Plücker's complexes and congruencies. I might describe also how Riemann taught us that surfaces need not present simple extension without thickness, but that, without losing their essential geometric character, they may consist of manifold sheets; and that our conception of space, and our power of interpreting otherwise perplexing algebraical expressions, become immensely enlarged.

Other generalizations might be mentioned, such as the principle of continuity, the use of imaginary quantities, the extension of the number of the dimensions of space, the recognition of systems in which the axioms of Euclid have no place. But as these were discussed in a recent address, I need not now do more than remind you that the germs of the great calculus of quaternions were first announced by their author, the late Sir W. R. Hamilton, at one of our meetings.

Passing from geometry proper to the other great branch of mathematical machinery, viz., algebra, it is not too much to say that within the period now in review there has grown up a modern algebra, which to our founders would have appeared like a confused dream, and whose very language and terminology would be as an unknown tongue.

Into this subject I do not propose to lead you far. But, as the progress which has been made in this direction is certainly not less than that made in geometry, I will ask your attention to one or two points which stand notably prominent.

In algebra we use ordinary equations involving one unknown quantity; in the application of algebra to geometry we meet with equations, representing curves or surfaces, and involving two or three unknown quantities respectively; in the theory of probabilities, and in other branches of research, we employ still more general expressions. Now, the modern algebra, originating with Cayley and Sylvester, regards all these diverse expressions as belonging to one and the same family, and comprises them all under the same general term "quantics." Studied from this point of view, they all alike give rise to a class of derivative forms, previously unnoticed, but now known as invariants, covariants, canonical forms, etc. By means of these, mathematicians have arrived not only at many properties of the quantics themselves, but also at their application to physical problems. It would be a long and perhaps invidious task to enumerate the many workers in this fertile field of research, especially in the schools of Germany and of Italy; but it is perhaps the less necessary to do so, because Sylvester, aided by a young and vigorous staff at Baltimore, is welding many of these results into a homogeneous mass in the classical memoirs which are appearing from time to time in the "American Journal of Mathematics."

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In order to remove any impression that these extensions of algebra are merely barren speculations of ingenious intellects, I may add that many of these derivative forms, at least in their elementary stages, have already found their way into the text-books of mathematics; and one class in particular, known by the name of determinants, is now introduced as a recognized method of algebra, greatly to the convenience of all those who become masters of its use.

In the extension of mathematics it has happened more than once that laws have been established so simple in form, and so obvious in their necessity, as scarcely to require proof. And yet their application is often of the highest importance in checking conclusions which have been drawn from other considerations, as well as in leading to conclusions which, without their aid, might have been difficult of attainment. The same thing has occurred also in physics; and notably in the recognition of what has been termed the "law of the conservation of energy."

Energy has been defined to be "the capacity, or power, of any body, or system of bodies, when in a given condition, to do a measurable quantity of work." Such work may either change the condition of the bodies in question, or it may affect other bodies; but in either case energy is expended by the agent upon the recipient in performance of the work. The law then states that the total amount of energy in the agents and recipients taken together remains unaltered by the changes in question.

Now, the principle on which the law depends is this—"that every kind of change among the bodies may be expressed numerically in one standard unit of change," viz., work done, in such wise that the result of the passage of any system from one condition to another may be calculated by mere additions and subtractions, even when we do not know how the change came about. This being so, all work done by a system may be expressed as a diminution of energy of that system, and all work done upon a system as an accession of energy. Consequently, the energy lost by one system in performance of work will be gained by another in having work done upon it, and the total energy, as between the two systems, will remain unchanged.

There are two cases, or conditions, of energy which, although substantially the same, are for convenience regarded separately. These may be illustrated by the following example: Work may be done upon a body, and energy communicated to it, by setting it in motion, e. g., by lifting it against gravity. Suppose this to be done by a spring and detent; and suppose, further, the body, on reaching its highest point, to be caught so as to rest at that level on a support. Then, whether we consider the body at the moment of starting, or when resting on the support, it has equally received an accession of energy from the spring, and is therefore equally capable of communicating energy to a third body. But in the one case this is due to the motion

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which it has acquired, and in the other to the position at which it rests, and to its capability of falling again when the support is removed. Energy in the first of these states is called "Energy of Motion," or "Kinetic Energy," and that in the second state, "Energy of Position," or "Potential Energy." In the case supposed, at the moment of starting, the whole of the energy is kinetic; as the body rises, the energy becomes partly potential and partly kinetic; and when it reaches the highest point the energy has become wholly potential. If the body be again dropped, the process is reversed.

The history of a discovery, or invention, so simple at first sight, is often found to be more complicated the more thoroughly it is examined. That which at first seems to have been due to a single mind proves to have been the result of the successive action of many minds. Attempts more or less successful in the same direction are frequently traced out; and even unsuccessful efforts may not have been without influence on minds turned toward the same object. Lastly, also, germs of thought, originally not fully understood, sometimes prove in the end to have been the first stages of growth toward ultimate fruit. The history of the law of the conservation of energy forms no exception to this order of events. There are those who discern even in the writings of Newton expressions which show that he was in possession of some ideas which, if followed out in a direct line of thought, would lead to those now entertained on the subjects of energy and of work. But, however this may be, and whosoever might be reckoned among the earlier contributors to the general subject of energy, and to the establishment of its laws, it is certain that within the period of which I am now speaking, the names of Séguin, Clausius, Helmholtz, Mayer, and Colding, on the Continent, and those of Grove, Joule, Rankine, and Thomson, in this country, will always be associated with this great work.

I must not, however, quit this subject without a passing notice of a conclusion to which Sir William Thomson has come, and in which he is followed by others who have pursued the transformation of energy to some of its ultimate consequences. The nature of this will perhaps be most easily apprehended by reference to a single instance. In a steam-engine, or other engine, in which the motive power depends upon heat, it is well known that the source of power lies not in the general temperature of the whole, but merely on the difference of temperature between that of the boiler and that of the condenser. And the effect of the condenser is to reduce the steam issuing from the boiler to the same temperature as the condenser. When this is once done, no more work can be got out of the engine, unless fresh heat be supplied from an outside source to the boiler. The heat originally communicated to the boiler has become uniformly diffused, and the energy due to that difference is said to have been dissipated. The energy remains in a potential condition as regards other bodies; but as regards the engine, it is of no further use. Now, suppose that we

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regard the entire material universe as a gigantic engine, and that after long use we have exhausted all the fuel (in its most general sense) in the world; then all the energy available will have become dissipated, and we shall have arrived at a condition of things from which there is no apparent escape.

Professor Frankland has been so good as to draw up for me the following account of the progress of chemistry during the last half-century: Most of the elements had been discovered before 1830, the majority of the rarer elements since the beginning of the century. In addition to these the following five have been discovered, three of them by Mosander, viz.: lanthanum in 1839, didymium in 1842, and erbium in 1843. Ruthenium was discovered by Claus in 1843, and niobium by Rose in 1844. Spectrum analysis has added five to the list, viz.: cæsium and rubidium, which were discovered by Bunsen and Kirchhoff in 1860; thallium, by Crookes in 1861; indium, by Reich and Richter in 1863; and gallium, by Lecoq de Boisbaudran in 1875.

As regards theoretical views, the atomic theory, the foundation of scientific chemistry, had been propounded by Dalton (1804–1808). The three laws which have been chiefly instrumental in establishing the true atomic weights of the elements—the law of Avogadro (1811), that equal volumes of gases, under the same conditions of temperature and pressure, contain equal numbers of molecules; the law of Dulong and Petit (1819), that the capacities for heat of the atoms of the various elements are equal; and Mitscherlich's law of isomorphism (1819), according to which equal numbers of atoms of elements belonging to the same class may replace each other in a compound without altering the crystalline form of the latter—had been enunciated in quick succession; but the true application of these three laws, though in every case distinctly stated by the discoverers, failed to be generally made, and it was not till the rectification of the atomic weights by Cannizzaro, in 1858, that these important discoveries bore fruit.

In organic chemistry the views most generally held about the year 1830 were expressed in the radical theory of Berzelius. This theory, which was first stated in its electro-chemical and dualistic form by its author in 1817, received a further development at his hands in 1834, after the discovery of the benzoyl-radical by Liebig and Wöhler. In the same year (1834), however, a discovery was made by Dumas, which was destined profoundly to modify the electro-chemical portion of the theory, and even to overthrow the form of it put forth by Berzelius. Dumas showed that an electro-negative element, such as chlorine, might replace, atom for atom, an electro-positive element like hydrogen, in some cases without much alteration in the character of the compound. This law of substitution has formed a necessary portion of every chemical theory which has been proposed since its discovery,

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and its importance has increased with the progress of the science. It would take too long to enumerate all the theoretical views which have prevailed at various times during the past fifty years; but the theory which along with the radical theory has exercised most influence on the development of the views now held, is the theory of types, first stated by Dumas (1839), and developed in a different form and amalgamated with the radical theory by Gerhardt and Williamson (1848–1852). It is, however, the less necessary to refer in detail to these views, seeing that in the now prevailing theory of atomicity we possess a generalization which, while greatly extending the scope of chemical science in its power of classifying known and predicting unknown facts, includes all that was valuable in the generalizations which preceded it. The study of the behavior of organo-metallic compounds in chemical reactions led to the conclusion that various metallic elements possess a definite capacity of saturation with regard to the number of atoms of other elements with which they can combine, and demonstrated this regularity of atom-fixing power in the case of zinc, tin, arsenic, and antimony. A serious obstacle, however, in the way of determining the true atomicities of the elements was the general employment of the old so-called equivalent weights, which were by most chemists confounded with the atomic weights. This difficulty was removed by the rectification of the atomic weights, which, though begun by Gerhardt as early as 1842, met for a long time with but little recognition, and was not completed till the subject was taken up by Cannizzaro in 1858. The law of atomicity has given to chemistry an exactness which it did not previously possess, and since its discovery and recognition chemical research has moved very much on the lines laid down by this law.

Chemists have been engaged in determining, by means of decompositions, the molecular architecture, or *constitution* as it is called, of various compounds, natural and artificial, and in verifying by synthesis the correctness of the views thus arrived at.

It was long supposed that an impassable barrier existed between inorganic and organic substances: that the chemist could make the former in his laboratory, while the latter could only be produced in the living bodies of animals or plants—requiring for their construction not only chemical attractions, but a supposed "vital force." It was not until 1828 that Wöhler broke down this barrier by the synthetic production of urea, and since his time this branch of science in the hands of Hofmann, Wurtz, Berthelot, Butlerow, and others, has made great strides.

Innumerable natural compounds have thus been produced in the laboratory—ranging from bodies of relatively simple constitution, such as the alcohols and acids of the fatty series, to bodies of such complex molecular structure as alizarine (the principal coloring-matter of madder), coumarine (the odoriferous principle of the Tonka bean), vanilline,

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and indigo. The problem of the natural alkaloids has also been attacked, in some cases with more than partial success. Methylconine, which occurs along with conine in the hemlock, has been recently prepared artificially by Michael and Gundelach, this being the first instance of the synthesis of a natural alkaloid. A proximate synthesis of atropine, the alkaloid of the deadly nightshade, has been accomplished by Ladenburg. It seems further probable that at no distant date the useful alkaloids, such as quinine, may also be synthesized, inasmuch as quinoline, one of the products of the decomposition of quinine and of some of the allied bases, has recently been prepared by Skraup by a method which admits of its being obtained in any quantity.

Much also has been done in the way of building up compounds the existence of which was predicted by theory. Indeed, the extent to which hitherto undiscovered substances can be predicated is doubtless the greatest triumph achieved by chemists during the past fifty years.

As yet, however, only the statical side of chemistry has been developed. While the physicist has been engaged in tracing, for the gaseous condition at least, the paths of the molecules and calculating their velocities, the chemist, whose business is with the atoms within the molecule, can point to no such scientific conquests. All that he knows concerning the intramolecular atoms and all that he expresses in his constitutional formulæ is, the particular relation of union in which each of these atoms stands to the others—which of them are directly united (as he expresses it) to other given atoms, and which of them are in indirect union. Of the relative positions in space occupied by these atoms, and of their modes of motion, he is absolutely ignorant. In like manner, in a chemical reaction, the initial and final conditions of the reacting substances are known, but the intermediate stages—the modes of change—are for the most part unexplained.

Owing to a feeling that no number, however great, of successfully solved problems of constitutional chemistry (as at present understood), and no number of syntheses, however brilliant, of natural compounds could raise chemistry above the statical stage—that the solution of the dynamical problem can not be arrived at by purely chemical means—has led many chemists to approach the subject from the physical side. The results which the physico-chemical methods, as exemplified in the laws already alluded to of Dulong and Petit, Avogadro, and Mitscherlich, have yielded in the past, offer the best guarantee of their success in the future. And the advantages of many of the physical methods are obvious. Every purely chemical examination—whether proximate or ultimate—of a compound, presupposes the destruction of the substance under examination: the chemist "murders to dissect." But observations on the action of a substance on the rays of light, on the relative volumes occupied by molecular quantities of a substance, on its velocity of transpiration in the liquid or gaseous state—these

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teach us the habits of the living substance. The rays of light which have threaded their way between the molecules of a body have undergone, in contact with these molecules, various specific and measurable changes, the nature and amount of which are assuredly conditioned by the mass, form, and other properties of the molecules: the plane of polarization has been caused to rotate; a particular degree of refraction has been imparted; or rays of certain wave-lengths have been removed by absorption, their absence being manifested by bands in the absorption spectrum of the substance. The volumes occupied by molecular quantities are dependent partly on the size of the molecules and partly on that of the intermolecular spaces.

The duty of the physical chemist is to endeavor to co-ordinate his physical observations with the known constitution of compounds as already determined by the pure chemist. This endeavor has in various branches of physical chemistry been to some extent successful. Le Bel has found that among organic compounds those only possess action on the plane of polarized light which contain at least one *asymmetric carbon-atom*—that is to say, a carbon-atom which is united to four *different* atoms or groups of atoms. The researches of Landolt, of Gladstone, and of Brühl on the specific refraction of organic liquids, have shown that from the known constitution of a liquid organic compound it is possible to calculate its specific refraction. Noel Hartley, in an examination of the absorption spectra of organic liquids for the ultra-violet rays, has demonstrated that certain molecular groupings are represented by particular absorption bands, and this line of inquiry has been extended with very interesting results to the ultra-red rays by Abney and Festing. It is obvious that these methods may in turn be employed to determine the unknown constitution of substances. The same holds true of the investigations of Kopp with regard to the molecular volumes of liquids at their boiling-points, in which he has established the remarkable fact that some elements always possess the same atomic volume in combination, whereas, in the case of certain other elements, the atomic volume varies in a perfectly definite manner with the mode of combination. This investigation has lately been extended with the best results by Thorpe and by Ramsay. Thermo-chemistry, also, which for a long time, at least as regards that portion which relates to the heat of formation of compounds, consisted chiefly of a collection of single equations, each containing three unknown quantities, is beginning to be interpreted by Julius Thomsen, whose experimental work in this field is well known. Many other methods of physico-chemical research are being successfully prosecuted at the present day, but it would go beyond the bounds of this summary even to enumerate these.

The concordant results obtained by these widely differing methods show that those chemists who have devoted themselves, frequently amid the ridicule of their more practical brethren, to ascertaining by

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purely chemical methods the constitution of compounds, have not labored in vain. But the future doubtless belongs to physical chemistry.

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In connection with the rectification of the atomic weights it may be mentioned that a so-called natural system of the elements has been introduced by Mendelejeff (1869), in which the properties of the elements appear as a periodic function of their atomic weights. By the aid of this system it has been possible to predict the properties and atomic weights of undiscovered elements, and in the case of known elements to determine many atomic weights which had not been fixed by any of the usual methods. Several of these predictions have been verified in a remarkable manner. A periodicity in the atomic weights of elements belonging to the same class had been pointed out by Newlands about four years before the publication of Mendelejeff's memoir.

In mechanical science the progress has not been less remarkable than in other branches. Indeed, to the improvements in mechanics we owe no small part of our advance in practical civilization, and of the increase of our national prosperity during the last fifty years. This immense development of mechanical science has been to a great extent a consequence of the new processes which have been adopted in the manufacture of iron, for the following data with reference to which I am indebted to Captain Douglas Galton. About 1830, Neilson introduced the hot blast in the smelting of iron. At first a temperature of 600° or 700° Fahr. was obtained, but Cowper subsequently applied Siemens's regenerative furnace for heating the blast, chiefly by means of fumes from the black furnace, which were formerly wasted; and the temperature now practically in use is as much as 1,400°, or even more: the result is a very great economy of fuel and an increase of the output. For instance, in 1830, a blast-furnace with the cold blast would probably produce 130 tons per week, whereas now 600 tons a week are readily obtained.

Bessemer, by his brilliant discovery, which he first brought before the British Association at Cheltenham in 1856, showed that iron and steel could be produced by forcing currents of atmospheric air through fluid pig-metal, thus avoiding for the first time the intermediate process of puddling iron, and converting it by cementation into steel. Similarly, by Siemens's regenerative furnace, the pig-metal and iron-ore are converted directly into steel, especially mild steel for ship-building and boilers; and Whitworth, by his fluid compression of steel, is enabled to produce steel in the highest condition of density and strength of which the metal is capable. These changes, by which steel can be produced direct from the blast-furnace instead of by the more cumbersome processes formerly in use, have been followed by improvements in manipulation of the metal.

The inventions of Cort and others were known long before 1830, but we were then still without the most powerful tool in the hands of

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the practical metallurgist, viz., Nasmyth's steam-hammer. Steel can be produced as cheaply as iron was formerly; and its substitution for iron, as railway material and in ship-building, has resulted in increased safety in railway-traveling, as well as in economy, from its vastly greater durability. Moreover, the enlarged use of iron and steel, which has resulted from these improvements in its make, has led to the adoption of mechanical means to supersede hand-labor in almost every branch of trade and agriculture, by which the power of production has been increased a hundred-fold, while at the same time much higher precision has been obtained. Sir Joseph Whitworth has done more than any one else to perfect the machinery of this country by the continued efforts he has made, during nearly half a century, to introduce accuracy into the standards of measurement in use in workshops. He tells us that, when he first established his works, no two articles could be made accurately alike or with interchangeable parts. He devised a measuring apparatus, by which his workmen in making standard gauges are accustomed to take measurements to the $\frac{1}{20000}$ of an inch.

In its more immediate relation to the objects of this Association, the increased importance of iron and steel has led to numerous scientific investigations into their mechanical properties and into the laws which govern their strength; into the proper distribution of the material in construction; and into the conditions which govern the friction and adhesion of surfaces. The names of Eaton Hodgkinson, Fairbairn, Barlow, Rennie, Scott Russell, Willis, Fleeming Jenkin, and Galton, are prominently associated with these inquiries.

The introduction of iron has, moreover, had a vast influence on the works of both the civil and military engineer. Before 1830, Telford had constructed an iron suspension turnpike-road bridge of 560 feet over the Menai Straits; but this bridge was not adapted to the heavy weights of locomotive-engines. At the present time, with steel at his command, Mr. Fowler is engaged in carrying out the design for a railway-bridge over the Forth, of two spans of 1,700 feet each—that is to say, of nearly one third of a mile in length. In artillery, bronze has given place to wrought-iron and steel; the 68-pound shot, which was the heaviest projectile fifty years ago, with its range of about 1,200 yards, is being replaced by a shot of nearly a quarter-ton weight, with a range of nearly five miles; and the armor-plates of ships are daily obtaining new developments.

But it is in railroads, steamers, and the electric telegraph, that the progress of mechanical science has most strikingly contributed to the welfare of man. To the latter I have already referred. As regards railways, the Stockton and Darlington Railway was opened in 1825; but the Liverpool and Manchester Railway, perhaps the first truly passenger line, dates from 1830; while the present mileage of railways is over 200,000 miles, costing nearly £4,000,000,000 sterling. It was

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not until 1838 that the Sirius and Great Western first steamed across the Atlantic. The steamer, in fact, is an excellent epitome of the progress of the half-century; the paddle has been superseded by the screw; the compound has replaced the simple engine; wood has given place to iron, and iron in its turn to steel. The saving in dead weight, by this improvement alone, is from ten to sixteen per cent. The speed has been increased from nine knots to fifteen, or even more. Lastly, the steam-pressure has been increased from less than five pounds to seventy pounds per square inch, while the consumption of coal has been brought down from five or six pounds per horse-power to less than two. It is a remarkable fact that not only is our British shipping rapidly on the increase, but it is increasing relatively to that of the rest of the world. In 1860 our tonnage was 5,700,000 against 7,200,000; while it may now be placed as 8,500,000 against 8,200,000; so that considerably more than half the whole shipping of the world belongs to this country.

If I say little with reference to economic science and statistics, it is because time, not materials, is wanting.

I scarcely think that, in the present state of the question, I can be accused of wandering into politics if I observe that the establishment of the doctrine of free trade as a scientific truth falls within the period under review.

In education some progress has been made toward a more rational system. When I was at a public school, neither science, modern languages, nor arithmetic formed any part of the school system. This is now happily changed. Much, however, still remains to be done. Too little time is still devoted to French and German, and it is much to be regretted that even in some of our best schools they are taught as dead languages. Lastly, with few exceptions, only one or two hours on an average are devoted to science. We have, I am sure, none of us any desire to exclude or discourage literature. What we ask is that, say, six hours a week each should be devoted to mathematics, modern languages, and science, an arrangement which would still leave twenty hours for Latin and Greek. I admit the difficulties which schoolmasters have to contend with; nevertheless, when we consider what science has done and is doing for us, we can not but consider that our present system of education is, in the words of the Duke of Devonshire's commission, little less than a national misfortune.

In agriculture the changes which have occurred in the period since 1831 have been immense. The last half-century has witnessed the introduction of the modern system of subsoil drainage founded on the experiments of Smith, of Deanston. The thrashing and drilling machines were the most advanced forms of machinery in use in 1831. Since then there have been introduced the steam-plow; the mowing-machine; the reaping-machine, which not only cuts the corn but binds it into sheaves; while the steam-engine thrashes out the grain and

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builds the ricks. Science has thus greatly reduced the actual cost of labor, and yet it has increased the wages of the laborer.

It was to the British Association, at Glasgow, in 1841, that Baron Liebig first communicated his work "On the Application of Chemistry to Vegetable Physiology," while we have also from time to time received accounts of the persevering and important experiments which Mr. Lawes, with the assistance of Dr. Gilbert, has now carried on for more than forty years at Rothamsted, and which have given so great an impulse to agriculture by directing attention to the principles of cropping, and by leading to the more philosophical application of manures.

I feel that, in quitting Section F so soon, I owe an apology to our fellow-workers in that branch of science, but I doubt not that my shortcomings will be more than made up for by the address of their excellent President, Mr. Grant-Duff, whose appointment to the governorship of Madras, while occasioning so sad a loss to his friends, will unquestionably prove a great advantage to India, and materially conduce to the progress of science in that country.

Moreover, several other subjects of much importance, which might have been referred to in connection with these latter sections, I have already dealt with under their more purely scientific aspect.

Indeed, one very marked feature in modern discovery is the manner in which distinct branches of science have thrown, and are throwing, light on one another. Thus the study of geographical distribution of living beings, to the knowledge of which our late general secretary, Mr. Sclater, has so greatly contributed, has done much to illustrate ancient geography. The existence of high northern forms in the Pyrenees and Alps points to the existence of a period of cold when Arctic species occupied the whole of habitable Europe. Wallace's line—as it has been justly named after that distinguished naturalist—points to the very ancient separation between the Malayan and Australian regions; and the study of corals has thown light upon the nature and significance of atolls and barrier-reefs.

In studying the antiquity of man, the archæologist has to invoke the aid of the chemist, the geologist, the physicist, and the mathematician. The recent progress in astronomy is greatly due to physics and chemistry. In geology the composition of rocks is a question of chemistry; the determination of the boundaries of the different formations falls within the limits of geography; while paleontology is the biology of the past.

And now I must conclude. I fear I ought to apologize to you for keeping you so long, but still more strongly do I wish to express my regret that there are almost innumerable researches of great interest and importance which fall within the last fifty years (many even among those with which our Association has been connected) to which I have

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found it impossible to refer. Such for instance are, in biology alone, Owen's memorable report on the homologies of the vertebrate skeleton; Carpenter's laborious researches on the microscopic structure of shells; the reports on marine zoölogy by Allman, Forbes, Jeffreys, Spence Bate, Norman, and others; on Kent's Cavern by Pengelly; those by Duncan on corals; Woodward on crustaceæ; Carruthers, Williamson, and others on fossil botany, and many more. Indeed, no one who has not had occasion to study the progress of science throughout its various departments can have any idea how enormous—how unprecedented—the advance has been.

Though it is difficult, indeed impossible, to measure exactly the extent of the influence exercised by this Association, no one can doubt that it has been very considerable. For my own part, I must acknowledge with gratitude how much the interest of my life has been enhanced by the stimulus of our meetings, by the lectures and memoirs to which I have had the advantage of listening, and, above all, by the many friendships which I owe to this Association.

Summing up the principal results which have been attained in the last half-century we may mention (over and above the accumulation of facts) the theory of evolution, the antiquity of man, and the far greater antiquity of the world itself; the correlation of physical force and the conservation of energy; spectrum analysis and its application to celestial physics; the higher algebra and the modern geometry; lastly, the innumerable applications of science to practical life—as, for instance, in photography, the locomotive-engine, the electric telegraph, the spectroscope, and most recently the electric light and the telephone.

To science again we owe the idea of progress. The ancients, says Bagehot, "had no conception of progress; they did not so much as reject the idea; they did not even entertain it." It is not, I think, now going too far to say that the true test of the civilization of a nation must be measured by its progress in science. It is often said, however, that great and unexpected as the recent discoveries have been, there are certain ultimate problems which must ever remain unsolved. For my part, I would prefer to abstain from laying down any such limitations. When Park asked the Arabs what became of the sun at night, and whether the sun was always the same, or new each day, they replied that such a question was childish, and entirely beyond the reach of human investigation. I have already mentioned that, even as lately as 1842, so high an authority as Comte treated as obviously impossible and hopeless any attempt to determine the chemical composition of the heavenly bodies. Doubtless there are questions, the solution of which we do not as yet see our way even to attempt; nevertheless the experience of the past warns us not to limit the possibilities of the future.

But, however this may be, though the progress made has been so rapid, and though no similar period in the world's history has been

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nearly so prolific of great results, yet, on the other hand, the prospects of the future were never more encouraging. We must not, indeed, shut our eyes to the possibility of failure: the temptation to military ambition; the tendency to over-interference by the state; the spirit of anarchy and socialism—these and other elements of danger may mar the fair prospects of the future. That they will succeed, however, in doing so, I can not believe. I can not but feel confident hope that fifty years hence, when perhaps the city of York may renew its hospitable invitation, my successor in this chair—more competent, I trust, that I have been to do justice to so grand a theme—will have to record a series of discoveries even more unexpected and more brilliant than those which I have, I fear so imperfectly, attempted to bring before you this evening. For one great lesson which science teaches is, how little we yet know, and how much we have still to learn.

CATHOLICISM, PROTESTANTISM, AND SUICIDE.*

By HENRY MORSELLI, M. D.

THE influences of religion are, together with the influence of race, the strongest motive powers which act on the will of man. The discussion as to whether the growth of suicide is to be accounted for by the decrease of religious sentiment scarcely finds place in a work like this. It is a thesis generally put forward by moralists whose opinion approaches our own on this subject. On the other hand, the theme of the special influence of the various faiths, which statisticians have sought to dispute, presents itself to us, two kinds of proof being deduced therefrom. The first is furnished by the indication of the form of worship to which suicides belong; but, unfortunately, this is represented in very few statistics of Central Europe, and is not always adapted to each case in particular. The second is the approximate relation between the number of violent deaths and the predominant form of worship in given countries; and here the most fertile in results are the statistics of the states having inhabitants of various forms of worship, as Prussia, Germany, Austria, Holland, and Switzerland. The countries of the south, Italy, Spain, and France, have so small a number of non-Catholics that little or no comparative result could be obtained from it. We notice again that, in the comparisons based on the religion of suicides, Judaism figures, in which the influence of religious bonds is complicated with that of race. This is perhaps the only religion bound up in the fate of a single people, whether on account of the exclusiveness of the Mosaic laws, or be-

* From advance sheets of Dr. Morselli's new book on suicide. As the tables can not be here well given, the references to them are omitted.

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cause no other race is so jealous of its own purity, its own customs, and especially of the faith of its fathers, as the Jewish. In every country where the *chosen* people has been spread, it has always preserved the moral Semitic character, while it has sometimes modified its physical characteristics, as when becoming fair where formerly dark-skinned; the religion of the God of Abraham is the only bond which now unites its scattered members. This strong influence of race obliges one to proceed cautiously in attributing to the Mosaic religion the little tendency of Jews toward suicide. In the most ancient history of Palestine not more than ten suicides are mentioned, and their greatest number belongs to a less pure Jewish period, when, through the Babylonish captivity and through the false prophets, they lost all trace of the ancient law. Already, among the last Jews who had to struggle against the invading Roman power, suicide had become more frequent (Josephus); but, while dispersing themselves among other nations over the face of the earth, the descendants of Abraham have always shown and still show among their moral characteristics an habitual resistance to suicide, although the same can not be said with regard to madness.

The influence of other religions may be studied without being perplexed with the question of race. It is true that the people called Latins have remained faithful to Catholicism, while the reform of religious thought was the exclusive work of the Anglo-Germans; but it is likewise true that, in countries of mixed religions, statistics have always shown the hurtful or beneficial effect of each. At first sight it is indeed perceived that the purely Catholic nations, Italy, Spain, and Portugal, stand on the last step of the scale of suicide, while those exclusively or mostly Protestant take the first grade; it suffices to cite Saxony, Denmark, Scandinavia, and Prussia. In countries of mixed religions, then, the inclination toward suicide diminishes in direct ratio to the predominance of Catholicism. Looking at the aggregate of statistics collected by us for the most recent years, it is inferred that the frequency of suicide is, in states of Catholic religion, on an average of 58 per million; in Protestant states, 190; in the United or non-united Greek, 40; where there is a mixture of Catholic, Protestant, and other sects, 96 per million. Countries of the Greek religion, then, give the smallest proportion; but here comes in the great influence of Slavism, which would be sufficient to neutralize all others, as we already found was the case with regard to climate and anthropological characteristics. With our results, those of Wagner, Oettingen, and Legoyt agree; this latter author having calculated, on the statistical documents of Bavaria, Prussia, Würtemberg, and Austria, that the tendency to suicide is, among Protestants, 102·7 per million individuals; among Catholics, 62·3; among other Christians (Greeks, United and the Orthodox) 36·2; and lastly, among the Jews, 48·4 per million.

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But much more correct than this comprehensive comparison is that between the proselytes of different religions in the same country, because then the political and social conditions do not vary, and the due homogeneity of comparative data remains the same. Statistics, however, are liable to another error; in most cases the religion of the suicide is not registered, and the column of the unknown always predominates over the others. It is sufficient to cite the Prussian statistics of the two years 1871–'72, in which, out of 5,673 registered suicides, quite 3,703 (65 per cent.) can give no answer to the question of the religion professed by the suicides. Nevertheless, we have been able to ascertain the frequency of suicide among individuals of different religions in thirty-seven countries, as our tables show.

In these thirty-seven comparisons of different countries and periods, hardly four show the Catholics superior in numbers of suicides to Protestants, Jews, and Greeks (Galicia, Buckowina, Military Frontiers, and Transylvania), and one only, also with doubts as to its being an error, gives the higher number to the Jews (? Lower Austria); but in the remainder the larger proportions are always offered by the Protestant religion, whether Lutheran or Reformed. The most frequent order in which the various religions follow each other is this: *Protestants*, *Catholics*, and *Jews;* and next in order of frequency come *Protestants*, *Jews*, and *Catholics*. Looking next at the position held by the Oriental Christians, it will be found that once only, and then it was among the Greek Catholics or Uniates, they gave the largest proportion to suicide (Military Frontiers); as a rule, their proportion is always lower than that of the Protestants, often also than that of the Catholics of the West. The inferiority in numbers of the Greeks is most apparent in Transylvania, where the Catholics occupy the first place, followed by the Uniates, then by the Lutherans and Calvinists, and lastly, at a long interval, by the United or non-united Greeks. The peculiar position occupied by Jews in relation to Catholics deserves attentive investigation. Jews are in general more subject to mental alienation than either Catholics or Protestants. In Bavaria, for instance, we find one insane in every 908 Catholic inhabitants, in every 967 Protestants, and every 514 Jews. In Hanover the reports give respectively one in 527 Catholics, in 641 Protestants, and in every 337 Jews. In Würtemberg one in every 2,006 Catholics, in 2,022 Protestants, and in 1,544 Jews; and in Denmark in like manner, while there is one insane person in every 1,750 among the Jewish population, there is one in every 2,000 of other religions. In Italy also, since the asylums have been opened to Jews, their contingent has been very considerable (Lambroso, Livi). Is the explanation to be sought in their race, their religion, or their customs? Dr. Martini (of Leubus) would refer it to their frequent consanguineous marriages; but in truth the supposed evils arising from the consanguinity of parents have yet to be proved. To us it seems more

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correct to regard it as the consequence of the mode of life and habits of the Hebrew people, who are always to be found living in crowded cities (excepting, perhaps, the numerous Jewish population of Galicia, Poland, and Buckowina); and the professions they follow are more liable than others to commercial crises and the constant vicissitudes of trade.

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With regard to suicide, on the other hand, the Jews of various countries differ more among themselves than Catholics from Protestants, who maintain a certain relative proportion with little variation. Great anthropological and social diversities are indeed to be observed between the Jews of Poland, Galicia, and Russia of the Dnieper, where they are very numerous and exercise an important influence on public affairs, and those of Central Europe, and in general of Catholic or mixed Catholic countries, where they have had to struggle through so many centuries against religious intolerance.

The very high average of suicides among Protestants is another fact too general to escape being ascribed to the influence of religion. Protestantism, denying all materialism in external worship and encouraging free inquiry into dogmas and creeds, is an eminently mystic religion, tending to develop the reflective powers of the mind and to exaggerate the inward struggles of the conscience. This exercise of the thinking organs, which, when they are weak by nature, is always damaging, renders them yet more sensible and susceptible of morbid impressions. Protestantism in the German states further exercises this exciting influence on the cerebral functions in yet another manner: it originated those philosophical systems which are based on the naturalistic conception of human existence, and put forward the view that the life of the individual is but a simple function of a great whole. These philosophical ideas are harmless enough to strong minds and those stored with a fit provision of scientific culture, but in the democratic atmosphere of our times the heart is not educated *pari passu*. The religious apathy with which the present generation is afflicted does not arise from a reasoned inquiry into the laws of nature or a scientific appreciation of its phenomena; it is not, in short, a deep conviction of the mind, but springs from a physical inertia, and from the little hold obtained by any ideas but such as are directed to material improvement and the gratification of ambition. To our mind, therefore, the great number of suicides is to be attributed to the state of compromise which the human mind occupies at the present time between the metaphysical and the positivist phase of civilization, and as this transition is more active in countries of marked mystic and metaphysical tendencies, such as is the case with Protestantism, it is natural that in them suicide should have the greatest number of victims.

It is obvious that a great difference generally exists between Catholic and Protestant countries only, not between the Catholic and

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Protestant inhabitants of the same country. Where the tendency to suicide is great among the latter, it will be found to be also high among the former, as may be observed from the statistics already quoted of Baden, Würtemberg, Franconia, Galicia, Bavaria, etc. This follows from the moral and social condition of the various religionists being rendered locally identical. Wagner, Oettingen, and Legoyt reckon that they have established, from their study of the influence of religion on this matter, that "*the inclination toward suicide in the inhabitants belonging to any particular worship, in any given country, will diminish in direct ratio with their numerical inferiority.*" According to Legoyt, suicide more rarely occurs in those persuasions which are numerically weak, because the struggle with the hostility and intolerance of the population in the midst of whom they live exercises on them a sort of moral coercion, making them desirous to avoid the harsh judgment held over them. As a matter of theory we can not deny the truth of this conclusion of Legoyt, as we well know how the spirit of association and the earnestness of religious convictions increase in proportion to the isolation into which any given congregation is cast when in the minority in a country. This influence of the surrounding atmosphere on religion is proved by the persistence and tenacity of the transmission of the Mosaic law through so many ages and migrations, and may explain the small tendency toward suicide among Jews. But at the same time an attentive examination of facts does not altogether bear out Legoyt's conclusion; for we find that it is scarcely ever that minorities furnish the smallest contingent to the register of suicide. For example, in Lower Bavaria, where Protestants are barely $\frac{8}{100}$ of the population, we find one hundred and forty-eight suicides in a million among them, whereas among Catholics, who compose nine tenths of the population, the number of suicides amounts to hardly twenty-eight in a million. In Brandenburg, where the Catholics are scarcely $\frac{8}{100}$ of the population, they show a threefold greater inclination for suicide than in Saxony, where they form *half the population.* And in Austria the Catholics, although in a minority in Galicia, Buckowina, the Military Frontiers, and Transylvania, yet show a greater tendency to suicide than either Greeks, Uniates, or Jews. The exceptions to the rule, therefore, are more numerous than the examples which should establish it. So far from it, if we consider the aggregate of the various countries of Europe, and that at the *latest statistical period*, it is easy to perceive that, where religious toleration has made more way, minorities begin to approximate the general average of their religion, the moral coercion of which Legoyt speaks is fast disappearing, and the unmixed influence of religion begins to tell with full force. The same thing happens with the Protestants of Baden, Würtemberg, and Austria, and in fact everywhere; notwithstanding that they form the minority, and in some cases a very considerable minority, the average of suicide is everywhere higher than that of the

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Catholics. If a numerical inferiority were to operate at the present time in reproducing the tendency to suicide, we should not find it, as we do, much more frequent among the Jews of Bavaria, and especially in Lower Franconia and the Archduchy of Austria, than among the Catholics, although they form but a small fraction of the population.

With regard to the influence of religion in this matter, the only one fact which as yet has been well proved is the higher rate of suicides among Protestants than among Catholics, as appears from our tables, in which, along with the average of various states and provinces, we have given the proportions of the inhabitants belonging to the two faiths. A very considerable difference will be found, particularly in countries of mixed creeds, where those in which Protestants predominate are always visited with the greatest number of violent deaths. It needs but to compare the mixed Cantons of Switzerland, the Circles of Prussia, Hanover, and Baden, and the provinces of Holland. And it is observable that, while there certainly are Catholic countries which supply a high average (such as the departments of the Ile de France and the Orleannais), no Protestant country has figures that will bear comparison with the lowest of those of certain Catholic countries of the south of Europe. The influence of Paris is such as altogether to neutralize that of religion; but, for so considerable a rise in the average of the northeast of France, we must take into account the introduction of the Germanic ethnical element, for there the religious apathy which springs from the habits of our times has not yet taken sufficient effect to tell upon statistics.

A MAP REVIEW.

By FRANK D. Y. CARPENTER, C. E.

EVERY new scientific book is duly noticed, and every meritorious painting or other work of art receives its critical mention, but we have yet to see, in this country, any review of that combination of science and art—a geographical map. Such a map, worthy in more ways than one of the attention of engineer and artist, has just been completed in the Washington office of the geographical surveys of the United States Engineer Bureau, and as a posthumous publication of these surveys, now discontinued, its appearance may awaken a sense of regret over the end of an organization which was capable of producing such excellent results. It has already won the highest honors at the Geographical Congress of Venice, where the original drawing and a photo-lithographic proof were exhibited in September last.

This sheet was designed by Captain Wheeler, in charge of this work, to illustrate the methods of map-making, peculiarly American

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and adapted to our extensive territory, which have been developed in this country within the last quarter of a century, through the successive mediums of the itineraries of exploring parties, the various boundary surveys, Whitney's California Survey, Clarence King's Fortieth-Parallel Survey, Hayden's and Powell's geological surveys, and the geographical surveys and other frontier operations of the Engineer Bureau. The methods in question combine the rapid reconnaissance, the mountain sketch, and the barometrical height upon a precise geodetic basis, incorporating all reliable information attainable from other sources, especially the land-surveys, which give certain points in roads and streams, and the perimeters of valleys and areas of water. In the end we have a map of which the error is, in general, inappreciable, and the cost in time and money is comparatively insignificant. Yet so faithfully may the features of a country be portrayed in this way, that the map of Lake Tahoe, the subject of this note, is sufficient to guide the engineer in his projects, the geologist in his studies, the tourist on his travels, the soldier on his march, and the emigrant in his search for a home.

So much for its usefulness, which is the first and principal mission of a map. As a work of art, graphically delineating the configuration of a district of surpassing beauty and variety of scenery, it will, perhaps, possess greater interest to the ordinary observer than any scientific value of accuracy and completeness could give it. If a person were called upon to construct an ideal map which should group together specimens of all types of topographical form and the conventional signs known to the draughtsman, he could hardly derive from his imagination a chart more comprehensive than this. There is certainly nowhere else in our country an area of equal extent so diversified and broken. Extending from latitude 38° 45′ to 39° 32′, and from longitude 119° 33′ to 120° 22′, it reaches from the desert inland basin of Nevada to the timbered and grassy mountain-spurs—embraced by the multitudinous forks of the American River—with which the Sierra Nevada range descends into the Sacramento Valley of California.

Lake Tahoe is a sheet of water some ten by twenty miles in extent, situated high up in the heart of the Sierras. The mountain-range divides to receive the lake, forming a cup-like space in which its clear waters are gathered. On the map the lake is given the place of honor, in the center. Its surface, being six thousand two hundred feet above sea-level, is not far below the rim of mountains which inclose it, but which, however, slope to great depths in the Carson Valley on the east and toward the Pacific coast on the west. The range in altitude, from the lowest to the highest point on the map, is more than seven thousand feet, there being three mountains—Freel's Peak, Pyramid Peak, and Mount Rose—standing at three corners of the lake, which are upward of ten thousand feet in height. Thus the subject, taken as a whole, is an admirable one for cartographical expression and

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effect, the surrounding valleys and the blank expanse of water in the center constituting a ground from which the mountains rise in bold relief.

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Nor, taken in detail, is it less worthy of study. The agricultural district with its checker-work of farms, the great round hills which cover the Comstock lode, the barren edge of the desert, the sharp and ragged peaks which are the *sierras* proper, the easy grades of the forest-clad slopes about the lake, the rocky shore, the sandy beach, the angular course of the mountain-torrent as it dashes between cañon-walls, and its winding bed through the alluvial soil of the valley, are all given true to nature.

The draughtsman to whom this map owes its realistic appearance is Mr. John E. Weyss, a veteran of thirty years' continuous service as a topographer for our Government. In order to catch and preserve those characteristic traits of form and surface which it is so hard for one draughtsman to transmit to another, he visited the ground in person, and, from the summits of lofty peaks and other advantageous points, accumulated a series of sketches with the aid of which to restore a natural effect to the construction-plots of contour-lines as they came to his hands from the surveyors. The map is finished in hachures, a method which is more intelligible to the unprofessional eye than that of contours, and which, in this case, is made especially effective by a free and artistic handling of the subject. As that is the best map for popular use which, in its true proportions, presents the most exact picture of the country for which it stands, there is room, in a district accidented as this is, for many a felicitous touch and extra bit of shading not provided for in any of the schools of topographical drawing. In fact, the draughtsman who adheres too closely and conscientiously to Lehmann's or any other conventional diapason of shades is likely to construct a map whose geographical features are stiff, unnatural, and almost mechanical in their geometrical regularity, just as the writer who checks up every sentence by his text-books of grammar and rhetoric produces an essay with none but negative merits to recommend it.

Mr. Weyss accompanied General Michler, of the Engineer Corps, on his recent official mission to the different geodetic institutions of Europe, and, having seen the best that the Old World has to show, he still maintains that this is the finest geographical map ever made. Taking into consideration both the subject and the manner of its treatment, this claim is not an extravagant one. In one respect this has an advantage over the maps of the thickly settled European countries, upon which the utilitarian features of roads, villages, and other works of man are so numerous as to obscure the natural attractions of the land, and to give it the uninteresting appearance of a city plot; for too many right angles detract from the beauty of a map as well as from the charm of a landscape. While the advancing wave of civili-

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zation has touched the region around Lake Tahoe, it has not yet covered it, and there are districts near its borders which are still as wild and secluded as in the days of the first explorer. There is the Devil's Basin, impassable and almost unapproachable, a great area of rock, rent with chasms and dotted with myriads of lakes. On every hand tower peaks upon whose summits, on a cloudy day, the traveler can feel as lonely as on the tops of the Alps or the Andes. And toward the northern limit of the map lies the historic Donner Lake, where, in the early days, a band of emigrants starved to death in the snows of winter.

But the practical pioneer is setting his seal upon this land, and claiming it as his own. Already the mountain-sides are marked with road, flume, ditch, and saw-mill, and scarred with mine and tunnel, and this lovely tract, fittest of all for a national park, is becoming the home of lumbermen and stock-raisers. The track of the plow is seen in the fertile valleys. The excavated ground of the Virginia City mines shows in the distance. Along the Carson River, at regular intervals, the quartz-mills lie. Log-slide, flume, and railroad carry the lumber from the heart of the forest to the outer world. The Pacific Railway winds between the high cañon-walls of the Truckee River and then follows its circuitous course, through miles of snow-shed and tunnel, across the Sierra Nevadas. Westward from Lake Tahoe runs the old Placerville road, once the main route of travel between California and Nevada, and down the eastern side of the range, in and out with many an escalop, winds the stage-road of the famous Hank Monk. From Virginia northward runs the Geiger Grade, the subject of one of Bret Harte's poems. In Emerald Bay is the little island with the empty grave which old Captain Dick carved for himself in the solid rock before he sunk in the deep water of the lake, to rise no more. Upon the cliff which bears the great poet's name the natural portrait of Shakespeare, done in weather-stain and lichen, is plainly visible. So there is enough of man's interference within the borders of this map to lend human interest and topographical variety to the scene.

It is a subject of common remark among travelers that nowhere else have they found a spot at once so easily reached and containing so great a variety of the interesting, the beautiful, and the grand, as here adjacent to Lake Tahoe, and this map will accomplish a not unimportant mission if it serves to call attention to a region too often overlooked. Leaving the Pacific Railway at Truckee or Reno, a circuit of one hundred miles will include not only this district, but the silver-mines of Virginia City and the mineral waters of Steamboat Springs as well. Then, from the south end of the lake, it is an easy *détour* of but a few miles to the crest of Tallac Peak, which, as if for the especial convenience of the tourist, is surrounded by an epitome of all types of Western scenery, from the placid beauty of Fallen-Leaf Lake, reposing at his feet, to the desolate wastes of rock which extend in chaotic piles behind him.

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The map of Lake Tahoe was begun in the summer of 1876, in which season a survey of the shores of the lake and the mountains immediately outlying was made by Lieutenant M. M. Macomb, of the army, and the writer. Dr. F. Kampf, Mr. Gilbert Thompson, Lieutenant S. E. Tillman, Mr. William A. Cowles, Mr. Frank O. Maxson, Mr. Anton Karl, and other engineers have contributed to the work at different times. In one respect it is still incomplete, and it is to be hoped that provision may yet be made for a series of soundings with which to illustrate the very remarkable configuration of the bottom of the lake. It is scarcely to be doubted that the geographical map of the future, and especially the geological chart, will portray surfaces below as well as above water. These could be drawn in contour-lines, either faint, broken, or in blue color, so as to indicate their submarine position. The "ripple-lines" with which shores are now sometimes represented are arranged at regular intervals, in curves which are regularly concentric, and they give no idea of the additional character which a map would derive from a real plot of its surface below water.

Since the interest and effect of a plot increase with the irregularity of the surface of which it is a copy, no known body of water excels Lake Tahoe in the instruction to be gained from such a survey. It is very deep in comparison with its narrow superficial extent, the few random soundings already taken showing a depth of over sixteen hundred feet, with indications that there are other crater-like depressions beyond any yet discovered. The absence of currents and other subsurface agencies of disturbance has probably left the cliffs and cañons beneath the lake as rugged and unworn as those above it. The western bank is apparently abrupt and even precipitous, while the eastern shore is more gentle in its descent. Thus these declivities correspond to the two mountain-slopes of which they are respectively prolongations. A hydrographic survey would trace them in their descent, fathom the unknown depths to which they go, and furnish information which would not only be of general scientific and perhaps economical interest, but would also reveal the geological secret of the structure of this wonderful basin in the mountain-top.

NORTH AMERICA IN THE ICE PERIOD.

By C. H. HITCHCOCK,
PROFESSOR OF GEOLOGY IN DARTMOUTH COLLEGE.

FEW geological subjects have been discussed so much as the nature, extent, and cause of the glacial period. At first, the speculations of such men as Dr. Buckland upon the ice-markings excited derision, and led to the publication of caricatures. Next, when its claims

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could not be set aside, some thought it the same with the flood of Noah, and others believed it to represent the chaos supposed to have pervaded space just before the advent of man. Then it was fashionable to believe in a submergence of the land by an ocean freighted with enormous icebergs, floating southerly from the pole. After this the battle raged fiercely between the advocates of icebergs and glaciers, the odds resulting in favor of the glacialists. Agassiz, with his polar-cap theory, advocated the view of a globe entirely encircled by ice, thickest at the poles, but covering the tropics with sufficient thickness to destroy the Tertiary life. Since these days of controversy, geologists have been accumulating facts in all glaciated countries; extreme views are being modified by their holders; and the time has come for consistent, reasonable generalizations in respect to the origin and extent of glacial phenomena.

Where the glacial markings have been most studiously investigated, it appears that an ice-sheet invariably occupies a definite area; that a *mer de glace* accumulates in the higher central portions, from which glaciers move outwardly in all directions, extending as far as the descending ground will permit, or the oceanic currents can convey the icebergs broken off from the frozen mass without melting; and that these ice-streams carry with them fragments of rock scoring the ledges as they pass along, thus affording the means for determining the exact dimensions of the glaciated areas, even after the climate has moderated and melted the ice. In Europe, the familiar Alpine district is constantly quoted as an illustration of the nature of a glaciated region, with its center of dispersion. Small ice-tributaries now cover the slopes of the Rhône Valley, where formerly the solid mass pressed down from the Bernese Oberland and the region of Mont Blanc, over Lake Geneva and the broad valley of Switzerland to the flanks of the Jura, forming an ice surface fifty miles wide, one hundred and fifty miles long, and two thousand feet deep. On the south, other streams have conveyed morainic materials equally far into the valley of the river Po. Hence we can assign to this area, with its center of dispersion, a definite number of square miles, linking together the actual glaciers with the traces of their former greater extension. No one will question the correctness of the generalizations enlarging the limits of the Alpine glaciated area.

We proceed next to consider the proper extent of the *Scandinavian district*, which will furnish an example more nearly analogous to that of Eastern America. Erdmann's map in Geikie's "Ice Age" represents striæ pushing northerly into the Arctic Ocean from Finland; southeast toward the White Sea and the Gulf of Finland; southerly in the south part of Sweden, turning to southwesterly toward the Cattegat; west, southwest, and northwest in Norway. Croll, in his work on "Climate and Time," supplements this map by drawing lines to indicate the direction taken by the ice after leaving Finland and

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Scandinavia. The more eastern lines penetrate the edges of Russia and Prussia. Those passing into the Gulf of Bothnia and the Baltic Sea curve westerly so as to extend over the North Sea, English Channel, southern England, and the north of Scotland. England and Scotland are made to send off additional currents; and the limit of the ice-sheet reaches to west longitude 14°, or where the shallow water begins to deepen. The chart is designed to show the probable path of the ice in Northwestern Europe during the period of maximum glaciation. This area is about seventeen hundred miles wide and fifteen hundred from north to south, and will hence compare favorably in size with that of Eastern America. The phenomena of dispersion are explicable upon the theory of the origin of the current from the central Scandinavian ridge, supplemented by radial streams from the Scotch and Welsh highlands; and there is no evidence, unless upon the outermost Hebrides, of any flow of polar ice into the European district. The ice-masses have proceeded from higher to lower levels for the most part, rising somewhat to pass over Denmark and southern England; and there is no essential difference between the Alpine and Scandinavian areas save in size.

All the glaciated districts can now be referred to definite areas, separate from one another, and exhibiting grooves radiating from central points and lines. They are, first, the small Alpine district; second, the Scandinavian, with the British additions; third, the paleocrystic sea of the polar regions; fourth, Greenland; fifth, Eastern America, concerning which more will be said in the sequel; sixth, the Rocky Mountain areas, in which there were several groups of glaciers, confluent north of the Columbia River.

Maps will show how the several glaciated regions stand related to one another. They are isolated, disconnected, though all situated upon one hemisphere. Each was a center by itself. The ice moving from the central highlands made its way radially in all directions, carrying detritus and scouring the ledges. The larger ones do not vary greatly in their territorial dimensions. That of Eastern America exceeds the others, especially if we add to it the Arctic archipelago, where, owing to the high latitude, the *mer de glace* is nearly universal with no great amount of motion. But we do not discover from this delineation any confirmation of the notion of a general polar ice-cap, which has furnished the ice for both the European and American glacial sheets. The Scandinavian, Greenland, and American regions seem to have been entirely independent of each other—separated by deep ocean-water. All of them must have undergone their intense frigid conditions in post-Tertiary times, because of some astronomical cause affecting the northern hemisphere equally throughout. We do not find distinct glaciated areas upon the Asiatic side of the pole, because the relations of land and water are unfavorable to the formation of ice-sheets, but the temperature is and has been low enough.

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We know but little respecting the ice-sheet about the pole. It has been fashionable to speak of an open polar sea, but no one has yet penetrated into it. The impression derived from the latest Arctic voyages of the American, English, Austrian, and Swedish expeditions is unfavorable to the existence of permanent open water. Yet there may not be an accumulation of a thick, frozen sheet, as the ice-rafts floating away from this northern waste are floes rather than bergs. Nares concludes that this ice is of great antiquity—that it is a paleocrystic rather than an open sea. We need additional observations to satisfy us that the climate is not more severe at the pole than on either side, and whether the meteorological dogma of two poles of cold is correct.

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GREENLAND.—The study of the Greenland glaciers takes us a step further toward the understanding of the American ice-sheet. We have hardly appreciated the size of this island—it being larger than the Alpine glaciated tract. It is over twelve hundred miles long, and four hundred broad, or as far as from Boston to the Missouri River. The interior is covered by a field of ice never crossed in a direct line by any civilized being. From three points attempts have been made to learn something of its nature. In 1830 Keilsen went eighty miles inland from Holsteinberg—latitude 67°—reaching the edge of the ice-sheet, which could not be climbed. In 1870 Nordenskiöld went in a distance of thirty miles, reaching the altitude of twenty-two hundred feet. He observed that the ice rose gradually toward the interior. The outer edge is a high, precipitous wall. Once entered upon the broad surface of the ice, it is like traveling upon the sea, away from all sight of land. From north Greenland, Dr. Hayes penetrated to a distance of seventy miles. It was a day's journey from the sea to the wall of ice. The second day was spent in climbing to the table-land; the third day allowed a progress of thirty miles, the angle of ascent falling from six to two degrees. On the fourth day an altitude of five thousand feet was attained, and the ice still continued to rise, but, because of inclement weather, no further progress was practicable. The view was that of a frozen Sahara, immeasurable to the human eye.

It is probable that Greenland slopes westerly in general, having its main axis of elevation near the eastern border. It may be compared to a broad platter inclined westerly, with occasional chinks in the sides through which the ice discharges itself as if it were a viscous body. The principal discharge of icebergs is upon the western side into Baffin's Bay. Not less than thirteen glaciers are found upon the western side to the south of Upernavik, about 73° north latitude, and the largest ones occur farther north. Some of the bergs are three thousand feet thick. The Humboldt glacier empties into Smith's Sound with a width of sixty miles, and showing ice-cliffs from fifty to three hundred feet high above the water. The rock-cliffs adjoining are

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from five hundred to one thousand feet high. At Polaris Bay a northward transportation is indicated, where Dr. Bessel found numerous granitic blocks containing peculiar garnets, such as abound in south Greenland, resting upon silurian limestones. Other glaciers have been mentioned farther north. Some have suggested that a series of islands will be found underneath the ice. Little is known of the eastern side, because it is practically inaccessible.

The general trend of Greenland is northwesterly. Hence the south end is farther east than any part of the western coast-line. The oversight of this simple fact has led to confusion among historians and statesmen. The island was discovered by Gunnibjörn in 872. In 983 Eric the Red, banished from Iceland, established a colony near the south end of Greenland, on its western shore, and gave to the island its name. The settlement prospered, and the indications of civilization left behind by these Norsemen exist as far north as Upernavik, or as far as the stoutest ships of modern times can sail without encountering serious risk. The population increased sufficiently to require the services of a bishop, and a list of seventeen terms of clerical office, from 1126 to 1406, has been preserved. A change of political relations led to the destruction of the commerce between Greenland and Scandinavia. Deserted by their friends, pirates and the Skraellings, or Esquimaux, completely exterminated the inhabitants. A record has been preserved in the Icelandic annals of the murder of the very last family in the fifteenth century. For some reason the Danes misunderstood the history after the removal of the restrictions upon the commerce, and many expeditions are said to have been sent out by the Government in search of their old colony in east Greenland, looking for it upon the coast facing Iceland rather than Baffin's Bay. It was thought that the descendants of the original settlers might still be found there, though for many years shut out from communication with Europe; but every ship returned baffled in its attempt to reach the eastern coast. Modern antiquarians have discovered the buildings erected by the Norsemen, read the inscriptions upon the churches and tombstones, and, by a study of the Icelandic sagas, deciphered the whole history, of which an outline has been already given. The facts have also been brought out prominently by Dr. Hayes in a small book describing some recent summer experiences in Greenland with a party of tourists.

All the Greenland glaciers become confluent in the interior, so that it is not a typical *mer de glace*, but a sheet of ice, which overspreads the highest mountains. It is only near the edge that the several streams manifest their independent existence. Thence the usual phenomena of Alpine glaciers manifest themselves. The sub-glacial streams pouring into the sea produce certain peculiarities. Immense supplies of heat penetrate the ice from the sun's rays, which melt very much ice and discharge muddy torrents of great size. As all water

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seeks the lowest levels attainable, these currents will find a place at the bottom of the ice-sheet, and wear away the ground-moraines and other *débris*. Hence banks of earth or clay will be found continuous from the ice-cliff to as great a distance toward deep water as the currents have power to transport the material. Marine animals live in and upon these banks, and leave their remains in them. Hence the deposit is analogous to that series of marine clays called Champlain by me in 1861, and occurring so plentifully up to three hundred feet in the St. Lawrence Valley, and to one hundred and sixty feet along the coast of northern New England and the Provinces. It is obvious that they were contemporaneous with the glacial moraines upon the land, and not entirely consecutive, as so many have supposed. This was the position assumed by the late Professor Agassiz, and confirmed by our own published observations in the "Geology of New Hampshire," describing the occurrence of fossiliferous beds between the lower and upper till of Portland, Maine.

THE EASTERN AMERICAN ICE AREA.—The latest generalizations indicate that some part of the Labrador Peninsula may be considered as the center from which the ice has radiated over the Dominion of Canada and the northern United States east of the Rocky Mountains. By regarding the Greenland and polar areas as independent of the Labrador sheet, though possibly confluent at the time of maximum glaciation, a multitude of difficulties are removed, and our American glaciers are seen to have been subjected to the same laws as the several ice-fields of other parts of the world. This area extends from Baffin's Bay to Dakota, and from Hudson's Bay, or the Arctic Archipelago, to a line drawn from the Great Banks of Newfoundland through New Jersey, southern Ohio, etc., to the plains east of the Rocky Mountains.

Most of this territory exhibits a southwesterly course of glaciation. This is well shown over the highlands between Hudson's Bay and the St. Lawrence Valley, the valley itself, western New York, Ohio, Iowa, Minnesota, Manitoba, and so on to the extreme western limits. It is very prominent from Lake Superior, near the international boundary, westward to the Rocky Mountains. In eastern New York and the Champlain and Hudson Valleys the course is southerly. In New England the dominant direction is southeasterly, and the same is true of New Brunswick and Nova Scotia. The exceptional deviations are due to local influences, exerted in the decline of the age. The facts in hand for Newfoundland are too few for a satisfactory delineation, while not in disagreement with these generalizations. On the east coast of Labrador there are several fiords, as if there had been an ice-sheet upon the upper part of the peninsula, moving northeast and east. Professor O. M. Lieber's sketches in the Coast Survey report suggest a local glaciation, and not such a general smoothing as would be manifested in case the ice had come from the opposite Greenland coast.

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Packard describes glacial markings in the Hamilton Inlet fiord running to the northeast, and thinks that the movement was to the southeast on the southern coast, or toward Newfoundland.

Farther north, the *Meta incognita* just north of Hudson's Straits shows an extensive *mer de glace*, with southerly-moving glaciers. McClintock describes bowlders at Leopold Harbor (North Somerset) and at Graham Moore Bay (Bathurst Island), which have been transported one hundred and one hundred and ninety miles northeast and northwest. Glaciated conditions are mentioned by various explorers to the west of Hudson's Bay, but we have no facts to indicate the direction of the movement. Several statements made in Franklin's second voyage imply a westerly movement.

There is a marked difference in the distances to which bowlders have been transported by the southwest and southeast currents. The average distance of the transportation in New England is from twelve to fifteen miles, and no bowlders, so far as known, have been carried more than one hundred miles. At the extreme north edge of Maine, as well as near the north line of Vermont, west of the Connecticut water-shed, are a few bowlders that have come from beyond the St. Lawrence, thus indicating a southeast movement across the St. Lawrence Valley, at right angles to what is supposed to be the common course. In Ohio many stones have been transported more than one hundred miles. In Iowa and Wisconsin bowlders of native copper occur from three hundred to four hundred and sixty-five miles away from their supposed source in Michigan. From the Lake of the Woods G. M. Dawson has described a transportation toward the Rocky Mountains of seven hundred miles. At Baton Rouge, Louisiana, are fossils, perhaps transported by floating ice, that seem to have come from Canada West, as much as twelve hundred miles; and at Natchez, Mississippi, there has been found auriferous quartz, supposed to have come from Montana, eighteen hundred miles. The southwest direction has therefore afforded the examples of the greatest distance traveled by the bowlders. Perhaps topography has aided the result, and the St. Lawrence valley is directly continuous with the Western prairies and Mississippi bottoms, and the New England mountains have intercepted the material brought from the Laurentian highlands.

The evidence is clear, however, of the passage of the ice-sheet directly over all the higher New England summits in a southeasterly direction. The facts illustrative have been specifically given for the Green Mountains, as Mounts Mansfield, Camel's Hump, Pico, Eolus, etc.; for Greylock, the highest of the Massachusetts mountains; for Mount Washington, and others of the White Mountains, in New Hampshire; and for Katahdin, in Maine, in the several geological reports of those States. The most important case is that of Mount Washington, both because of its greater altitude and because it has been generally supposed to have been an exception to the rule, and most geologists

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have spoken of it as an island in the ice age.* I have fully stated elsewhere† the facts proving the presence of the ice-sheet there. They are, briefly, the usual glaciated appearance of the ledges, striæ, and transported bowlders, two of them weighing nearly one hundred pounds, and distinctly identical with ledges several miles distant. All the surface rocks above five thousand feet have been riven into angular fragments by the long-continued action of frost, insomuch that the embossment and striation have been nearly obliterated, and the fragments so covered by lichens that extraordinary care is required to discover any dissimilarity among them. Washington is the highest peak southeast from the St. Lawrence Valley; hence, if that has been glaciated by ice moving from the northwest, then every part of New England has been covered by the same sheet.

Assuming it well established that the center of dispersion for the Eastern American drift was in the west part of Labrador, we are met by the difficulty that the land beneath this central *mer de glace* is not so much elevated as the New England mountains which have been covered by the ice originating in those Laurentian highlands. As to the facts, they are indisputable—the glacier has moved over slopes higher than the mountains at its source; and it may be that we have something new to learn from these facts about ice accumulation and movement. Professor Dana has proposed the theory of a change of level in the land since the ice period. Assuming the starting-point to have been in the Laurentian highlands, if a descent of ten feet per mile be allowed, the sheet must have been at least thirteen thousand feet high to have allowed it to slide over Mount Washington; or, the land must have been four thousand five hundred feet higher than now.‡ The distance from these highlands to the base of the Rocky Mountains along which the ice is known to have moved southwesterly is about fifteen hundred miles, requiring, on the basis of Professor Dana's data, an elevation of certainly four miles. A change of level to that extent seems improbable.

Recent writers have developed a molecular theory of glacier motion; and in connection with it mention such possibilities of ice-accumulation as to suggest a method of relief from the difficulty of understanding how the ice can move up an elevation. The mere weight of the ice does not cause it to slide downward. According to Canon Moseley, from thirty to forty times its weight is required to shear the ice; the motion is proportional to the amount of heat present. The melted ice is very susceptible to the action of gravity, and the motion is greatest where the most heat is manifested, or upon the south side of the glacier.

* E. Hitchcock, "Proceedings of the American Association of Geologists," 1841, p. 182. L. Agassiz, "Geological Sketches," Second Series, p. 98.

† "Geology of New Hampshire," vol. iii, p. 203.

‡ "American Journal of Science," III, vol. ii, p. 327.

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The writings of Moseley and Croll recall the utterances of Agassiz as respects the motion of the glacier. He himself modestly avows his physical researches upon the glacier as inferior to those of his successors, Forbes, Tyndall, etc.; yet he could not shut his eyes to the fact that those physicists had not satisfactorily solved the problem. While ascribing the motion to expansion by freezing, Agassiz insisted that heat was largely concerned, asserting that its presence was more consequential than that there should be an inclined plane—that the ice might move up-hill toward the sun; and particularly that a great thickness of it could make its way over such level territory as the prairies of Indiana and Illinois. The ice along the southern melting edge would be charged with moisture percolating through the pores and capillaries, descending the icy slopes obedient to gravity, and no longer requiring the shearing force. The amount of motion would in these circumstances be like that of the Greenland sheet, sixty feet per diem, rather than the sluggish crawl of one to three feet in the same time of the comparatively poorly developed Alpine glaciers. In agreement with these views we find the motion northward toward the pole to be very slight, though the land may be inclined northerly as in Grinnell Land.

Now, if we apply these principles to the territory in question, we would say that the ice began to accumulate in Canada from an unusual precipitation of moisture, gradually filling up the St. Lawrence Valley, and at first moving southwesterly. But, the supply still continuing plentiful, the valley fills up and runs over. It does not need to accumulate to the thickness of several miles upon the Laurentian highlands so as to have a downward slope all the way to Mount Washington. A mass only a few thousands—possibly hundreds—of feet thick might soften before the southern sun and the influence of the Atlantic Ocean off our coast, and lead the plastic material southeasterly over the Montalban water-shed. Once started upon the seaward slope, the ice could not fail to reach its destination. The southwest motion would likewise continue, and accomplish greater results, transporting blocks much farther because commencing earlier, continuing longer, and pushing forward in a thicker sheet. This Canadian ice would have resembled the present *mer de glace* of Greenland, confluent over hill, valley, and island, dragging the reluctant erratics up hill and down, accumulating ground moraines and lenticular hills, hollowing out pot-holes and discharging clouds of mud into the edge of the sea. Hence, instead of saying that the land rose three or four miles above its present level in Labrador in order to give the required impetus to the ice-movement in New England, it is easy to see how the same work could be accomplished by the action of much simpler causes.

Messrs. Torell and Dana have advocated the notion that the Greenland and Eastern American areas are one, and that Greenland was the source of the ice that has covered the eastern part of our continent.

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One can not see that this view better suits the facts than to suppose there were two centers of dispersion, one for Greenland and the other for the continent. From Greenland to the southwest edge of the glaciated area the distance is twenty-five hundred miles, two fifths greater than from the Laurentian highlands, and requiring a descent of over seven miles of vertical elevation from the center to the circumference. It seems unnecessary to add to the difficulties of height incurred in the shorter distance. Provided there has been no great elevation of the land, Davis' Strait seems to contain enough ocean-water to carry off all the glacial products poured into it from either side. The facts of ice-movement already stated for Labrador and the Arctic Archipelago show motion easterly and northerly in the teeth of this imagined current from Greenland. Hence, as we find phenomena of glaciation in agreement with our view of radial dispersion from Labrador, whose existence was unknown to Torell, it seems as if it were altogether unnecessary to look so far as Greenland for the source of the ice-flow.

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TERMINAL MORAINES.—Years ago, those who believed icebergs would explain glaciation triumphantly asked the glacialists, Where are the terminal moraines which must have accumulated at the lower edge of the great ice-sheet? It is very strange their existence was not suspected by the early glacialists; and, as we now show their lines of distribution upon our maps, we remove another obstacle to the acceptance of the glacial theory.

Writers now generally employ the word *till* to denominate the materials accumulated by the ice, including the moraines and bowlder clays. The ground-moraine is that form of the till least noticed in the examination of active glaciers, because situated in the nearly impenetrable abysses between ice and earth. In the continental glacier, where the surface had the unbroken white snow for its covering, this form of moraine accumulation must have been the most abundant. In middle New England the ground-moraine is developed into the *lenticular hill*—an oblong rounded hummock, sometimes two hundred feet high, mostly composed of lower till, with a trend corresponding to the direction of the ice-current in the neighborhood, varying from nearly southeast near Newburyport to south 10° west in the Connecticut Valley. This lower till is compact, sometimes clayey, full of small, scratched, far-traveled stones in a forced position, with the iron coloring matter in the ferrous or protoxide condition. The capping of the hill or upper till is loose, the fragments are rough, not far removed from their source, commonly lying naturally, and the color is yellowish red from the presence of ferric oxide. These characteristics suggest the derivation of the upper till from the materials held in the ice at the time of its melting; they falling promiscuously upon the surface of the ground-moraine, compacted by the great weight of the glacier.

The moraines regarded by us as terminal are in all respects like

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the upper till, as would be expected, considering that the fragments in front of the glacier principally consist of extensive tracts of that deposit crowded into a small compass. In connection with it one often sees sloping plains of gravel and sand deposited by streams of melted ice acting upon the moraine, or, if the supply of water has been copious, the unstratified drift has all been modified. Some authors think the upper till is only the surface portion of the ground-moraine acted upon and oxidized by atmospheric agencies. If the difference in the angularity, roughness, and distance traveled of the stones is not sufficient to justify our definitions, then these writers must explain why our terminal moraines should show the oxidation throughout their whole mass, hundreds of feet thick, while the upper till is usually very thin, often no deeper than the roots of large trees.

There are two lines of terminal moraines more conformable to each other than to the extreme southern limit of the glacier. East of Cape Cod this line is supposed to have passed over the St. George's and Great Newfoundland Banks, while the icebergs carried *débris* from the land to unknown distances southerly over the Atlantic Ocean. The outermost series of terminal moraines commences upon the Island of Nantucket, and is traceable thence across Martha's Vineyard, Block, Long, and Staten Islands; whence, according to Professor Cook, "the whole line of the moraine [across New Jersey] is remarkably plain and well defined." The line across Pennsylvania has been traced out recently by Mr. H. C. Lewis. This whole series, as far west as Ohio, occupies the outer margin of the glaciated area; and Professor Cook thinks the same moraines will be found conterminous with the extreme southern limit of the ice-sheet to its remotest bound in Montana.

The inner line of moraines starts at the middle of the east coast of Cape Cod, follows the curved shore to old Plymouth, thence south to the Elizabeth Islands on the border of Buzzard's Bay. After passing under water for several miles, it comes to the surface along the south shore of Rhode Island west of Narragansett Bay, touches Plum and Fisher's Islands, continues to the northeast angle of Long Island, passes through the greater part of Brookhaven, Riverhead, and Southold, where it disappears.

The outer moraine determines the topography of Long Island, as it constitutes a marked ridge, or "backbone," as sometimes called, from Montauk Point to Fort Hamilton. The highest point is three hundred and eighty-four feet, and the base of the moraines is usually more than fifty feet above tide-water. The southern slope is a gently inclined sandy plain, made of the ruins of the terminals; the northern slope terminates in cliffs, because so largely consisting of cretaceous clays. The eastern and middle portions of this ridge consist of modified drift, containing few or rare bowlders. The western portions represent the typical constitution of terminal moraines, and are well

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shown in the numerous excavations made for building purposes about Brooklyn. The bowlders upon Long Island have all been brought from the northwest, and those familiar with the ledges in Connecticut and up the Hudson can readily recognize the fragments in the various parts of the island—the Palisade traps in Brooklyn, and the New Haven red sandstones to the southeast of their place upon the mainland.

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We can recognize the inner moraine in Ohio, while its remnants may be found in New York State by future investigators. Dr. Newberry describes a line of kames occupying the water-shed between the affluents of the Ohio and Lake Erie, which can be easily correlated with the modified drift fringing our terminal moraine. This line extends entirely through Ohio, and bends sharply at Fort Wayne, Indiana, following St. Joseph's River northeasterly, so that its whole course is parallel to the shore of Lake Erie. N. H. Winchell thinks there are several of these moraines in the northwest part of Ohio. Professor T. C. Chamberlin has generalized the facts about the course of these moraines between Pennsylvania and Minnesota, and supposes there are two morainic lines parallel to the shore of Lake Erie, the outer reaching to middle Indiana. Likewise there appear moraines in the form of loops following the course of the shores of Lake Michigan, Green Bay, Keweenaw Bay, and the southwest end of Lake Superior. The glaciers seem to have followed the several valleys, continuing to flow as long as the material lasted. The Green Bay and Lake Superior streams did not cover the area in the lee of the highlands of northern Wisconsin; and hence there was a large tract of land, occupying essentially what is known as the "Lead-region of the Northwest," over which we search in vain for erratics or glaciated surfaces. Mr. Warren Upham has communicated to us many facts for Minnesota, Dakota, and Iowa. They indicate two looped moraines west of the Mississippi: one reaching nearly to Yankton, Dakota, having the celebrated *Coteau de Missouri* for its western border, and part of the *Coteau de Prairie* for its eastern; the other taking the eastern line of the *Coteau de Prairie* for one side, and pointing east of south to Des Moines, Iowa. An inner loop connecting the Wisconsin moraine with that of the Leaf Hills may have been pushed there by the Lake Superior stream, and the more southern loops may have had some connection with glaciers starting in the Dominion portions of the Rocky Mountains. Hence the Labrador and Rocky Mountain sheets may have been confluent, and, owing to the great masses of ice thus accumulated along the upper part of the tributaries of the Mississippi basin, we may understand why the glacier extended so much farther south in the interior than upon either coast.

ELEVATION OF THE LAND IN THE GLACIAL AGE.—The earlier writers accounted for the glacial cold by supposing the land had been elevated sufficiently to lower the temperature, and subsequently de-

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pressed to its original level. Later authors suggest that the formation of ice-caps at the poles would draw away enough water from the lower latitudes to increase the amount of land in the north. Either view would afford conditions adequate to produce the results; but the evidences of such an oscillation, from the nature of the case, are very difficult to obtain. The most obvious are derived from the existence of ancient river-channels now submerged beneath the ocean. Upon the south sides of Long Island* and Cape Cod† there are several ravines channeled out of the till and modified drift, too large to have been excavated by the present drainage system. They are fiords, and many of them are filled by linear fresh-water lakes, kept in position by bars of beach-sand near the ocean's level. Similar facts have been reported in connection with the former entrances of tributary streams into the Great Lakes.‡ In all these cases the excavations must have been made in connection with the disappearance of the ice-sheet.

A more extensive series of excavations occurred in the larger rivers, though it is not so easy to fix their date. By studying the submarine contours off the mouths of the Connecticut and Hudson Rivers, we can follow the outlines of their valleys for many miles out to sea. The first named flowed around the east end of Long Island, leaving the Housatonic to join the Hudson just below Manhattan Island, as shown by Professor Newberry. The Hudson continued southerly for seventy or eighty miles, as first pointed out by Professor Dana. As no deltas appear in connection with the present mouths of these streams, their submergence must have been comparatively recent, while they may have existed as channels of erosion for millions of years.

A further examination of coast-charts reveals the fact that there is a belt of shallow land bordering the continent from New Jersey to Newfoundland, and that it is as wide as the extensions of the Hudson and Connecticut. Hence, if there has been a submergence off New York, the same oscillation occurred along the whole coast; and thus a tract of land, as large as Pennsylvania, New York, and the maritime provinces combined, has been lost to the continent, probably since the glacial period. The corresponding area in Northern Europe, which seems to have been elevated at the same time, may be found indicated in Geikie's "Ice Age."

More impressive proofs of a former elevation of the continent appear from a careful study of the lower Mississippi. The contour-line of one thousand feet depth suggests the continuance of the river-bed for a distance of forty miles into the Gulf of Mexico. The Tertiary rocks of the river-basin have been excavated to the depth of two

* "American Journal of Science," III, vol. xiii, p. 142 (Lewis).

† "American Naturalist," vol. xiii, p. 555 (Upham).

‡ The discovery of the pre-glacial outlet of Lake Erie by Professor J. W. Spencer, and the former northerly drainage of the tributaries of the Alleghany River by the Pennsylvania geologists, have been published since this article was written.

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hundred to five hundred feet, and then unconformably overlaid by the orange sand—a deposit coeval with the glacial drift. Borings in lower Louisiana show first the Port Hudson group or post-glacial deposits; second, the orange sand; and, third, the underlying eroded Tertiaries with their characteristic fossils. This excavation could not have been made unless the waters of the Gulf had been at least five hundred feet lower than at present.

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Other facts further illustrate these former elevations. Upon the Atlantic border between New Orleans and New York we find a low, broad plain, largely consisting of marshy or drowned lands. On reaching Virginia this land begins to disappear, but the plain holds the same relation to the continent, as it continues to exist in the submarine banks east of Massachusetts. Curiously enough, we now dredge from the George's and Great Banks Tertiary fossils similar to those occurring in the unsubmerged parts of this plain. Their existence beneath the ocean had never been suspected till the possible identity of the Atlantic plain with the eastern shoals had been suggested, subject to the crucial test of dredging.

These facts authorize us to believe that the eastern half of the continent has been elevated certainly six hundred feet in the glacial period. As this elevation included Northern Europe, and consequently the polar districts, so as to unite the Old and the New Worlds, we may be able to follow the older writers, and find in this land-mass the conditions adequate to produce the glacial cold. Such a cause will explain the facts more satisfactorily than the invocation of the eccentricity of the earth's orbit, or the precession of the equinoxes. If we can combine the two classes of causes, we can certainly explain all the phenomena, besides obtaining the data for the chronology of the ice age.

THE MELTING OF THE GLACIAL SHEET.—Time fails us to describe the marvelous facts connected with the melting of the ice. The numerous kames, elevated sand-plains, and river-terraces, found everywhere in Northern America, came into existence with the copious floods of water resulting from the dissolution of the ice. The history of the ice age is incomplete without a discussion of the events occurring in this great continental freshet; but this sketch must be deferred for the present.

AN EXPERIENCE IN SCIENCE-TEACHING.

BY STANLEY M. WARD.

FOR the past two years I have had charge of a public school in Pennsylvania, and have endeavored to awaken in the minds of my pupils a love for and an interest in science, with especial reference to the truths and lessons of physiology and zoölogy. Perhaps my

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experience may not prove valueless or uninteresting to teachers and others.

The summer of 1878 was spent at Salem, at the Summer School of Biology connected with the Peabody Academy of Science, and, while there, the ideas on teaching gathered from Huxley, Mill, Bain, and Spencer, took a tangible shape; and I determined that classes in physiology that came under my charge should have the benefit of practical work so far as lay in my power to give it. In September of that year I organized a class in physiology, made up of young ladies and gentlemen between the ages of sixteen and twenty-one. With this material I went to work. My plan was briefly this: Teach as many facts in this study and those connected with it as possible; then for direct use have the pupils get some idea, if but slight, of the progress of science, and develop mental discipline by pursuing the work according to the scientific method, so far as time and material will permit. To accomplish these results seemed to be worth striving for; and, without making any pretensions to exhaustive work, I followed a programme substantially as follows: A suitable text was provided, and, with this in hand and a human skeleton, we considered the location, use, form, structure, articulation, etc., of the bones; the same was done with many of the muscles, being aided in this by an excellent series of plates; the skin next claimed attention, and in succession followed the circulatory, respiratory, and digestive systems. During this time there were no regular recitations, but each scholar was free to ask any question on the preceding lesson to any member of the class he saw fit; in this way we took a cursory view of the human frame outside of the nervous and reproductive systems. After we had seen something of the mechanism in its entirety, and had a general idea of it, I chloroformed a cat and dissected it before the class; this was not performed in my regular school-room, but in a small room off, which had been used for recitations by one of my teachers. During the operation the class asked questions, and were at perfect liberty to discuss any topic connected with the subject, or to ask explanations concerning the structure or use of any part examined. The dissection did not aim to be exhaustive, the idea being more to clinch the facts which had before been given, and to present in a clearer light the form of the body interiorly. After this dissection the class recited from the text, and were aided with plates, specimens, and informal talks, through the whole course. After finishing the work another animal was procured, and several members of the class took turns in dissecting, sometimes several working at once and sometimes one only; here I endeavored to give the pupils their own way, the object being not to make skilled dissections, but to teach them to study nature at first hand. In this work they followed Foster and Langley as closely as possible. We then made a thorough review of the whole text, this work being supplemented by bringing

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before the class a few birds, some insects, a fish, some frogs, and a few tadpoles. The remainder of the term was spent in studying comparative physiology and anatomy. I followed out this course, with few modifications, with a number of classes, and never failed to interest them. There was but little attention paid to the nervous system, as I considered it too abstruse for the students. I will say, however, that, after spending some little time on the brain and spinal column of a cat and dog, a few of the pupils of their own accord worked out the nervous system of a crawfish in quite an admirable manner. The work done was, of course, far from thorough, and will bear no comparison to that performed in more pretentious institutions: it will be remembered that I was working under a school system which does not require physiology to be taught, that I had nothing to work with except what I myself furnished, and that, worse than all, I had a tremendous prejudice to combat.

Whether I was successful or not may be judged by the fact that some members of the class who went over the ground in this way now occupy their spare time in summer in making collections of the flora and fauna in their vicinity. I further noticed that in Latin and mathematics those pupils who were most interested in physiology were quicker and clearer observers, more accurate reasoners, and more just and keen in their criticisms, than those of equal caliber who had not taken the course.

I give this experience for what it is worth, hoping that, if it meets the eye of one teacher who has a class in physiology, and is teaching by the old method of exclusiveness, he will try the process above described (which is far from original), confident that he will meet with success beyond his most sanguine expectations.

DISEASE-GERMS.

By Dr. WILLIAM B. CARPENTER.

AMONG the distinguished men who came together at the recent International Medical Congress—a gathering altogether unexampled for its combination of great and varied ability, and worthily representative of almost every country in which medicine is studied—there was no one whose presence was more universally or more cordially welcomed than a quiet-looking Frenchman, who is neither a great physician nor a great surgeon nor even a great physiologist, but who, originally a chemist, has done more for medical science than any *savant* of his day; and this, not only (probably not so much) through the results already attained by Pasteur himself and by others working on his ideas—great though these results are—but through the entirely

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new direction he has given to scientific inquiry, the number of new paths of research he has opened out, and of new clews he has afforded to those who will follow them up, and, last but by no means least, by the admirable example he has afforded, in the strictness and severity of his own methods (which have made him almost unerring in his predictions, and have given his conclusions the force of demonstrations), to those who would carry on the same lines of inquiry.

And here I would stop to note, as honorable to the disinterested character of a profession which has been lately the object of violent abuse for its (alleged) selfish and mercenary spirit, that this unique welcome was given, not to a great physician who had discovered a cure for gout, cancer, or consumption, by the use of which it would be enriched—not to a bold surgeon who had brought into vogue some wonderful operation, the success of which would tend to its renown—but to the scientific investigator of the *causes* of disease, whose work belongs altogether to the domain of *preventive* medicine, and thus, so far from being likely to benefit its members pecuniarily, tends only to diminish their remunerative employment. I never felt so proud of belonging to the body which still does me the honor to recognize me as one of its members as I did when Sir James Paget, the President of the Congress, paused in his opening address to point out on the platform behind him the greatest living exemplar of the truths he was so admirably enforcing, and when the whole of his vast audience—the like of which had never before been gathered in St. James's Hall, and perhaps never will be again—enthusiastically cheered, not once only, but again and again, the scientific veteran whose renown has spread from his quiet Parisian laboratory over the whole civilized world.

In order that the last of Pasteur's great achievements—which, with some of the ideas it suggests, it is my object now to bring before the readers of "The Nineteenth Century"—may be properly appreciated, it will be well for me to sketch out briefly what has been the nature of his life-work from the time when the singular beauty of some of his chemico-physical researches (which obtained for him in 1856 the Rumford Medal of the Royal Society) marked him out as one likely to attain further distinction.

It seems to have been by his special interest in the chemistry of organic substances that he was early led to examine into the question of fermentation, which had come to present an entirely new aspect through the discovery of Cagniard de la Tour that yeast is really a *plant* belonging to one of the lowest types of fungi, which grows and reproduces itself in the fermentable fluid, and whose vegetative action is presumably the cause of that fermentation, just as the development of mold in a jam-pot occasions a like change in the upper stratum of the jam, on whose surface and at whose expense it lives and reproduces itself. Chemists generally—especially Liebig, who

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had a fermentation-theory of his own—pooh-poohed this idea altogether; maintaining the presence of the yeast-plant to be a mere concomitant, and refusing to believe that it had any real share in the process. But, in 1843, Professor Helmholtz, then a young, undistinguished man, devised a method of stopping the passage of organic germs from a fermenting into a fermentable liquid, without checking the passage of fluids; and, as no fermentation was then set up, he drew the inference that the "particulate" organic germs, not the soluble material of the yeast, furnish the *primum mobile* of this change—a doctrine which, though now universally accepted, had to fight its way for some time against the whole force of chemical authority.*

A little before Cagniard de la Tour's discovery, a set of investigations had been made by Schulze and Schwann to determine whether the exclusion of air was absolutely necessary to prevent the appearance of living organisms in decomposing fluids, or whether these fluids might be kept free from animal or vegetable life by such means as would presumably destroy any germs which the air admitted to them might bring in from without, such as passing it through a red-hot tube or strong sulphuric acid. These experiments, it should be said, had reference rather to the question of "spontaneous generation," or "abiogenesis," than to the cause of fermentation and decomposition, its object being to determine whether the living things found by the microscope in a decomposing liquid exposed to the air spring from germs brought by the atmosphere or are generated *de novo* in the act of decay—the latter doctrine having then many upholders. But the discovery of the real nature of yeast and the recognition of the part it plays in alcoholic fermentation gave an entirely new value to Schulze's and Schwann's results, suggesting that putrefactive and other kinds of decomposition may be really due, not (as formerly supposed) to the action of atmospheric oxygen upon unstable organic compounds, but to a new arrangement of elements brought about by the development of germinal particles deposited from the atmosphere.

It was at this point that Pasteur took up the inquiry, and, for its subsequent complete working-out, science is mainly indebted to him; for, although other investigators—notably Professor Tyndall—have confirmed and extended his conclusions by ingenious variations on his mode of research, they would be the first to acknowledge that all those main positions which have now gained universal acceptance—save on the part of a few obstinate "irreconcilables"—have been established by Pasteur's own labors. These positions may be briefly summarized as follows:

1. That no organic fluid undergoes *spontaneous* fermentation or

* It was, I remember, in or about that year that Professor Liebig's visit to England gave me the opportunity of showing him some yeast under a high power of the microscope. He said that he had not before seen its component cells so distinctly.

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decomposition, even in the presence of atmospheric air, any such action being originated and maintained only by the developmental action of definite organic germs.

2. That different kinds of fermentation (using that term in its large sense) are produced by organic germs of different species. Thus, while *torula* sets going the alcoholic fermentation in a saccharine wort, other fungoid germs will set up the acetous, and others, again, the putrefactive fermentation, when introduced into fluids of the same kind.

3. That many different kinds of germs—notably those of the *bacteria*, which induce putrefactive fermentation—are constantly floating in the ordinary atmosphere, so as to be almost certainly self-sown in any organic fluid freely exposed to it.

4. That, if these germs be removed by mechanical filtration, or be got rid of by subsidence, or be deprived of their potency by chemical agents which destroy their vitality, the most readily decomposable organic fluid may be subjected to the freest contact with the air from which the germs have been thus eliminated without undergoing any change.

5. That, as there is no such thing as fermentation without the presence of germ-particles, so there is no such thing as the spontaneous origination of such germs, each kind, when sown in the liquid, reproducing itself with the same regularity as in higher plants, and thus continuously maintaining its own type.

6. That such germ-particles, when dried up, can not only maintain their germinal power for unlimited periods, starting into renewed activity so soon as the requisite conditions are supplied, but that, in this state of dormant vitality, they can be subjected to influences which would destroy the life of the growing plants—such as very high or very low temperatures, the action of strong acid or alkaline solutions, and the like.*

The first application of these doctrines to the study of disease in the living animal was made in a very important investigation, committed to Pasteur by his old master in chemistry (the eminent and eloquent Dumas), into the nature of the *pébrine*, which was threatening to extinguish the whole silk-culture of France and Italy. It had been previously ascertained that the bodies of the animals affected with this disease (whether in the worm, chrysalis, or moth stage) swarm with peculiar minute corpuscles, which even pass into the undeveloped eggs of the female moth, but there was no evidence that these corpuscles were independent, self-developing organisms introduced from without, many regarding their presence as a mere expression or concomitant of the disorder, not as its cause. It would be too long to detail the steps of this most complicated and difficult inquiry, and I must satisfy myself with the mere statement that it not only

* The evidence on which these conclusions rest is fully stated in Professor Tyndall's recently published treatise on the "Floating Matter of the Air."

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proved completely successful as to what may be termed its commercial object, but that, though it concerned only a humble worm, it laid the foundation of an entirely new system and method of research into the nature and causes of a large class of diseases in man and the higher animals, of which we are now only beginning to see the important issues.

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Among the most *immediately* productive of its results may be accounted the "antiseptic surgery" of Professor Lister, of which the principle is the careful exclusion of living bacteria and other germs alike from the natural internal cavities of the body and from such as are formed by disease, whenever these may be laid open by accident or may have to be opened surgically. This exclusion is effected by the judicious use of carbolic acid, which kills the germs without doing any mischief to the patient; and the saving of lives, of limbs, and of severe suffering, already brought about by this method, constitutes in itself a glorious triumph alike to the scientific elaborator of the germ-doctrine and to the scientific surgeon by whom it has been thus applied.

A far wider range of study, however, soon opened itself. The revival by Dr. Farr of the doctrine of *zymosis* (fermentation), long ago suggested by the sagacity of Robert Boyle, and practically taken up in the middle of the last century by Sir John Pringle (the most scientific physician of his time), as the expression of the effect produced in the blood by the introduction of a specific poison (such as that of small-pox, measles, scarlatina, cholera, typhus, etc.), had naturally directed the attention of thoughtful men to the question (often previously raised speculatively) whether these specific poisons are not really organic germs, each kind of which, a real *contagium vivum*, when sown in the circulating fluid, produces a definite *zymosis* of its own, in the course of which the poison is reproduced with large increase, exactly after the manner of yeast in a fermenting wort. Pasteur's success brought this question to the front as one not to talk about but to work at, the lead being taken, I believe, by M. Chauveau, the distinguished Professor of Medicine at Lyons, but other investigators (among them our own Professor Burdon-Sanderson) followed closely in his wake. Pasteur's own attention seems at that time to have been chiefly directed to what may be termed the pathology of beer, wine, and vinegar, and to the fight he had still to maintain with the advocates of abiogenesis. I shall not stop to describe the valuable improvements he has introduced into the manufacture of alcoholic and acetous liquors, with a view of preventing those injurious fermentations which often interfere with the normal processes, and sometimes ruin their results, but shall keep to the object I have specially in view, the exposition of those more recent contributions to "preventive medicine," which constitute him the greatest public benefactor of his time.

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An epizoötic malady extensively prevails on the Continent of Europe, though fortunately but little known in this country, which is sometimes designated "splenic fever," and sometimes "anthrax" or "carbuncular" disease, while it is known in France as "charbon" or "pustule maligne." In its most malignant form, it causes the death of the horses, cattle, and sheep affected by it, in the course of four-and-twenty hours. In the less severe form of anthrax disease, it occasions great and prolonged suffering, even when final recovery takes place. Both forms seem propagable to man. Between the years 1867 and 1870, above 56,000 deaths from this disease are recorded as having occurred among horses, cattle, and sheep, and 528 deaths among the human population, in the single district of Novgorod in Russia. It appears to be scarcely ever absent from France, and is estimated to involve an annual loss of many millions of francs on the part of breeders in that country, whole flocks and herds being carried off at once, and their proprietors ruined. A mild epizoötic of this type seems to have prevailed in this country between 1850 and 1860; while the "plague of boils," under which many of our human population (my unhappy self among the rest) suffered during some part of that decennium, was probably brought on us by infection from animals. Attention has lately been drawn to a severe and often fatal malady occurring among the "wool-sorters" at Bradford, which is pretty certainly a modification of "splenic fever," communicated by the wool of sheep infected with that disease.

As far back as 1850 it was observed by two distinguished French pathologists, MM. Rayer and Davaine, that the blood of animals affected with splenic fever contained minute, transparent rods; but their fungoid nature and life-history were first worked-out a few years since by a young German physician named Koch, whose account of it was soon confirmed by Cohn, the eminent Botanical Professor of Breslau, and afterward in this country by Mr. Ewart, all of whom "cultivated" the plant in aqueous humor, or some other organic liquid of suitable character, kept at nearly blood-heat. They found the "rods" to be produced by progressive extension from germ-particles of extreme minuteness. At first they are simple tubes divided at intervals by transverse partitions, but after a time minute dots are seen within these tubes, which gradually enlarge into ovoid bodies that lie in rows within the rods, and at last the rods fall to pieces, liberating the germ-particles they included. The minutest drop of the fluid containing these germs, if conveyed into another portion of cultivated fluid, initiates the same process of growth and reproduction, and this may be repeated many times without any impairment of the potency of the germs, which, when introduced by inoculation into the bodies of rabbits, Guinea-pigs, and mice, develop in them all the characteristic phenomena of splenic fever. Koch further ascertained that the blood of animals that succumbed to this disease might be dried and kept for

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four years, and might be even pulverized into dust, without losing its power of infection.

Here I would stop to cite the prophetic words used by Professor Tyndall, when giving an account to a Glasgow audience, in 1876, of Koch's then recent researches: "The very first step toward the extirpation of those contagia is the knowledge of their nature; and the knowledge brought to us by Dr. Koch will render as certain the stamping out of splenic fever as the stoppage of the plague of *pébrine* by the researches of Pasteur."

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It was but fitting that the complete verification of this prediction should be the direct result of the labors of the illustrious man on whose previous work it was based, although others were at work, more or less successfully, in the same direction.

One of the first questions examined by Pasteur was the cause of outbreaks of "charbon" in its most deadly form among flocks of sheep feeding in what appeared to be the healthiest pastures, far removed from any obvious source of infection. Learning by the inquiries he instituted that special localities seemed haunted, at distant intervals, by this plague, he inquired what had been done with the bodies of the animals that had died of it, and learned that it had been customary to bury them deep in the soil, and that such interments had been made, it might have been ten years before, beneath the surface of some of the very pastures in which the fresh outbreaks took place. Notwithstanding that the depth (ten or twelve feet) at which the carcasses had been buried seemed to preclude the idea of the upward traveling of the poison-germs, the divining mind of Pasteur found in *earth-worms* a probable means of their conveyance, and he soon obtained an experimental verification of his idea, which satisfied even those who were at first disposed to ridicule it. Collecting a number of worms from these pastures, he made an extract of the contents of their alimentary canals, and found that the inoculation of rabbits and Guinea-pigs with this extract gave them the severest form of "charbon," due to the multiplication in their circulating current of the deadly *anthrax-bacillus*, with which their blood was found after death to be loaded.

Another mode in which the disease-germs of anthrax may be conveyed to herds of cattle widely separated from each other and from any ostensible source of infection was discovered by the inquiries prosecuted, a few years ago, by Professor Burdon-Sanderson at the Brown Institution, in consequence of a number of simultaneous outbreaks which occurred in different parts of the country. It was found that all the herds affected had been fed with brewers' grains supplied from a common source; and, on examining microscopically a sample of these grains, they were seen to be swarming with the deadly *bacillus*, which, when it has once found its way among them, grows and multiplies with extraordinary rapidity.

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The next important step in this investigation was the discovery of the modification in the potency of the poison, which can be produced by the "cultivation" of this *bacillus*. Every one knows that some of our most valued esculent plants and fruits are the "cultured" varieties of types which man would scarcely care to use in their original state, on account of the unpleasantness of their flavor or their semi-poisonous qualities. And, now that we know that these disease-germs are really humble types of vegetation, the idea naturally suggests itself whether they, too, may not be so far modified, by the "environment" in the midst of which they are developed, as to undergo some analogous modification. Two modes of such "culture" suggest themselves: the introduction of the germs into the circulating current of animals of a different type, and its repeated transmission from one such animal to another; and cultivation carried on out of the living body, in fluids (such as blood-serum or meat-juice) which are found favorable to its growth, the temperature of the fluid in the latter case being kept up nearly to blood-heat. Both these methods have been used by Pasteur himself and by Professor Burdon-Sanderson; and the latter especially by M. Toussaint, of Toulouse, who, as well as Pasteur, has experimented also on another *bacillus* which he had found to be the disease-germ of a malady termed "fowl-cholera," which proves very fatal among poultry in France and Switzerland.* It has been by Pasteur that the conditions of the mitigation of the poison by culture have been most completely determined, so that the disease produced by the inoculation of his "cultivated" virus may be rendered so trivial as to be scarcely worth notice. His method consists in cultivating the bacillus in meat-juice or chicken broth, to which access of air is permitted while dust is excluded, and then allowing a certain time to elapse before it is made use of in inoculation experiments. If the period does not exceed two months, the potency of the *bacillus* seems but little diminished; but, if the interval be extended to three or four months, it is found that, though animals inoculated with the organism take the disease, they have it in a milder form, and a considerable proportion recover; while, if the time be still further prolonged, say to eight months, the disease produced by it is so mild as not to be at all serious, the inoculated animals speedily regaining perfect health and vigor.†

* I have seen notices of its serious prevalence during this very summer in some of the localities most frequented by tourists.

† It is not a little curious that as culture of one kind can mitigate the action of the poison-germs, so culture of another kind may restore, or even increase, their original potency. It has been found by Pasteur that this may be effected by inoculating with the mitigated virus a new-born Guinea pig, to which it will prove fatal; then using its blood for the inoculation of a somewhat older animal; and repeating this process several times. In this way a most powerful virus may be obtained at will—a discovery not only practically valuable for experimental purposes, but of great scientific interest, as throwing light upon the mode in which mild types of other diseases may be converted into malignant.

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Thus, then, it becomes possible to affect sheep and cattle with a form of anthrax-disease so mild as to bear much the same relation to the severer forms that cow-pox bears to small-pox; and for this artificial affection with the mitigated disorder, Pasteur uses the term "vaccination." The question that now arises—to which the whole previous investigation has led up—is the most important of all: Does this "vaccination" with the mild virus afford the same protection against the action of the severe, that is imparted by cow-pox vaccination against small-pox? To this question affirmative answers were last year obtained by Professor Greenfield (on Professor Burdon-Sanderson's suggestion) in regard to bovine animals, and by M. Toussaint in regard to sheep and dogs; the former, when "vaccinated" from rodents, and the latter from fluids "cultivated" outside the living body after a method devised by M. Toussaint, proving themselves incapable of being infected with any form of anthrax-disease, though repeatedly inoculated with the malignant virus, and remaining free from all disorder, either constitutional or local. The same result having been obtained from experiments made by Pasteur himself, probably about the same date, with charbon-virus cultivated in the manner previously described, it was deemed expedient by one of the Provincial Agricultural Societies of France that this important discovery should be publicly demonstrated on a great scale. Accordingly, a farm and a flock of fifty sheep having been placed at M. Pasteur's disposal, he "vaccinated" twenty-five of the flock (distinguished by a perforation of their ears) with the *mild* virus on the 3d of May last, and repeated the operation on the 17th of the same month. The animals all passed through a slight indisposition, but at the end of the month none of them were found to have lost either fat, appetite, or liveliness. On the 31st of that month, all the fifty sheep, without distinction, were inoculated with the *strongest* charbon-virus, and M. Pasteur predicted that on the following day the twenty-five sheep inoculated for the first time would all be dead, while those protected by previous "vaccination" with the mild virus would be perfectly free from even slight indisposition. A large assemblage of agricultural authorities, cavalry-officers, and veterinary surgeons having met at the field the next afternoon (June 1st), *the result was found to be exactly in accordance with M. Pasteur's predictions.* At two o'clock *twenty-three* of the "unprotected" sheep were dead; the *twenty-fourth* died within another hour, and the *twenty-fifth* an hour afterward. But the twenty-five "vaccinated" sheep were all *in perfectly good condition;* one of them, which had been designedly inoculated with an extra dose of the poison, having been slightly indisposed for a few hours, but having then recovered. The twenty-five carcasses were then buried in a selected spot, with a

By Dr. Grawitz, indeed, it has been recently asserted that even some of the most innocent of our domestic microphytes may be changed by artificial culture into disease-germs of deadly infectiveness.

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view to the further experimental testing of the poisonous effect produced upon the grass which will grow over their graves. But the result, says the reporter of the "Times" (June 2d), "is already certain; and the agricultural public now know that an infallible preventive exists against the charbon-poison, which is neither costly nor difficult, as a single man can inoculate a thousand sheep in a day." I have since learned that this protection is being eagerly sought by the French owners of flocks and herds; and, if any severe epidemic of the same kind were to break out in this country, our own agriculturists would probably show themselves quite ready to avail themselves of it. To the "wool-sorters" of Bradford it must prove a most important boon, if they can be led to understand its value.

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That this is not to remain an isolated fact, but will be the first of a series of discoveries of surpassing importance (some of them already approaching maturity), is shown by the fact that Pasteur has found himself able to impart a like protection against fowl-cholera by "vaccinating" chickens with its cultivated *bacillus*.

These wonderful results obviously hold out an almost sure hope of preventing the ravages, not merely of the destructive animal plagues that show themselves from time to time among us, but of doing that for some of the most fatal forms of human infectious disease which Jennerian vaccination has already done—as shown by Sir Thomas Watson in these pages—for what was once the most dreaded of them —small-pox. It is unfortunately too true that, with the reduction of small-pox mortality, there has been an increase in the mortality from measles and scarlatina exceeding that which increase of population would account for, the number of deaths in England and Wales from the former of these diseases frequently exceeding 10,000 in the year, while the annual mortality from the latter averages nearly 20,000, sometimes exceeding 30,000. It scarcely seems too much to expect that before long, as Professor Lister last year suggested, "an appropriate 'vaccine' may be discovered for measles, scarlet fever, and other acute specific diseases in the human subject"; for already, as I have been informed by one of the most distinguished of the United States members of our Congress, researches have been there made, with very promising results, on the "cultivation" of the *diphtheritic* virus—the mortality from which, in England and Wales, during the last decade, has averaged nearly 3,000 annually, being, for the seven years, 1873–'79, *half as great again* as the mortality from small-pox during the same period.

Another important line of inquiry, which was supposed by many able pathologists to have been closed by the negative results of previous investigations, has now to be reopened under the new light shed upon it by Pasteur's discoveries: I refer to the relation between cow-pox and small-pox. It is well known that Jenner himself, struck with the fact that the protective influence of successful vaccination against

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the *oc*currence of small-pox is about the same as that of a first attack of small-pox against its *re*currence, suspected that cow-pox might really be small-pox modified by passing through the living body of the cow; and attempts have been made, at different times and in various places, to test the truth of this hypothesis. Before proceeding, however, to discuss that question, it will be advantageous to consider what new light is cast, by recent scientific discovery, on the *nature* of the protection afforded by successful vaccination.

Notwithstanding the "strong assurance of faith," on the part of Jenner and his immediate disciples, in regard to the permanent efficacy of vaccination, it is certain that, as time went on, a suspicion grew up among vaccinators of long experience, that vaccinia has a tendency to degenerate—i. e., to lose its protective power—in proportion to the remoteness of its derivation from the original (cow) stock. During my own early professional life (1830–'40) in Bristol, this conviction was prevalent among the older practitioners, who recollected the early Jennerian cow-pock. The vesicle (they said) was smaller than the original, and ran its course more quickly; and the want of the slight constitutional disturbance formerly observable at its maturity showed that the body of the subject was not thoroughly affected by the disorder. Hearing in 1838 of a renewed outbreak of cow-pox among cows at Berkeley, Mr. J. B. Estlin (whose pupil I had been) went down thither, and brought back a supply of original vaccine lymph, which (with the assistance of his brother practitioners) was soon diffused through Bristol and its neighborhood, and proved to reproduce the characteristic Jennerian vesicle. The circumstances attending this reintroduction of an original *vaccinia*, which I have recently detailed elsewhere,* strongly impressed me with the idea that the vaccine virus became "tempered" (so to speak) by passing through the human body, its original potency suffering diminution with the increase in the number of subjects through which it had been transmitted; while, at the same time, the proportion of subjects in whom the vaccination "took," which had been small with the original "vaccine," increased when it had (so to speak) become "humanized." This gradual modification we now understand to be the natural result of the continued "cultivation" of vaccinia in the human body; so that the diminution of the protective power of vaccination by such "cultivation" through a long succession of generations is just what might be scientifically expected. A most curious proof of the modification which *vaccinia*, thus humanized, has undergone, is afforded by the experiments of Dr. Martin (of Foxborough, Massachusetts), who states that, while there is no difficulty in keeping up an *original* vaccinia for any length of time by continuous transmission through heifers, the *humanized* vaccinia, if recommunicated to heifers, soon dies out, this retro-vaccination (as

* See the "Lancet," May 10th.

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Dr. Martin terms it) *never succeeding beyond the third remove* from the human into the bovine subject.

There can now, therefore, be no reasonable doubt that a very large proportion of the failures, triumphantly adduced by anti-vaccinationists as proofs that the alleged protective power of vaccination is a mere assumption, are attributable to this degeneration, the protection diminishing with the "humanization" of the virus employed, and this being proportional to the remoteness of its derivation from the bovine stock.

During the war between the Northern and Southern States, Dr. Martin (who had previously acquired a reputation for special knowledge of this subject) was specially employed by the Government of the North to proceed to the various localities in which severe outbreaks of small-pox were from time to time taking place, and he most commonly found that there had either been no previous vaccination at all or vaccination with degenerate virus. Armed with a supply of good lymph, and with military authority (which enabled him to practice a really *compulsory* vaccination and revaccination), he always found himself able to control these outbreaks, and to prevent their recurrence. Anxious, however, to obtain (if possible) a fresh primary stock of vaccine, he advertised extensively for information as to any *original* case of cow-pock, but could hear of none. And he then imported from France some dried lymph of what is known as the "Bougival" stock, which had been continuously transmitted, through a long succession of heifers, from its original bovine parentage in that place. This transmission he has himself kept up in the neighborhood of Boston (New England) for the last ten years; and he assures me—1. That vaccination from this heifer-stock, if practiced according to his instructions, is quite as successful (in regard to the proportion of cases in which it "takes") as vaccination from the human arm; 2. That the vesicle produced by it is always of the true old Jennerian type, no deterioration having taken place in its long descent from the original stock, such as is produced by "humanization"; 3. That he has never seen either erysipelas or any other of the "accidents" which sometimes (as in my own Bristol experience in 1838) attend the direct vaccination from the *original* cow-stock; and, 4. That, having offered a considerable reward in all the principal towns of the Union for information as to the occurrence of any case of small-pox within ten years after thorough vaccination with his heifer-lymph, this reward has never been claimed; although, since its introduction, the United States have been traversed (in the years 1874–'76) by an epidemic of small-pox, which will be long remembered there for its peculiar virulence and the wide-spread mortality it occasioned.*

* The distinguished American physicians, whose attendance at the recent Congress gave me the opportunity of conversing with them on this subject, entirely confirmed Dr. Martin's account of the severity of that epidemic, which, in some respects, bore such a

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This epidemic was clearly the same as that which had prevailed, with somewhat of the same severity, not only in this country, but also over the greater part of the Continent of Europe, two years previously; and hence there can be little doubt that the high rate of mortality by which it was everywhere characterized must have been due to general rather than to local causes. It had the good effect of frightening many of our local health authorities into a more efficient observance of their duty in regard to vaccination; and the result has been that, during the last two years, the reports of the Registrar-General show an *almost complete extinction* of small-pox in the nineteen great towns, whose aggregate population (about three and three quarter millions) equals that of the metropolis. The fresh outbreak which has taken place during the first half of the present year has been almost entirely restricted to the London area, and evidently points to the importance of a more strict enforcement of the vaccination law, which is at present rendered nugatory, as regards no inconsiderable proportion of the metropolitan population, by the migration of families from one district to another.

The prolonged experience of Dr. Martin, in regard to the facility of keeping up heifer-vaccination continuously from the original stock, altogether confirmatory as it is of what has been reported on this subject from France, Belgium, and St. Petersburg, seems to me to justify the demand that our Government should maintain the requisite establishment on a sufficient scale to meet the requirements of the whole country, so that every vaccination and revaccination may be performed (if desired) with lymph derived from the original cow-stock, without any humanization whatever.* The vaccinia of Jenner may be thus maintained in its original efficacy, without the impairment of its protective influence by prolonged "cultivation" in the human subject, and thus only can it be secured against the contaminating influence of human disease, the liability to which furnishes the anti-vaccinationists with their strongest weapon.

No benefit can be reasonably expected from the adoption of any system which is based on the induction of vaccinia in a calf or

resemblance to the "Black Death" that carried off what was estimated at *one third* of the population of Europe in the fourteenth century, as to suggest that the latter may have been really a peculiarly malignant small-pox. My friends greatly regretted the want in the United States of a system of "compulsory" vaccination; but said that, when outbreaks of small-pox occurred in their towns, the municipal authorities took the matter in hand, and insisted on the immediate vaccination and revaccination of all dwellers in the infected localities, by which means these outbreaks were brought under control. As there is no registration system in the American Union, I could not obtain any definite information as to the amount of its small-pox mortality; but no one seemed to entertain the least doubt as to the preventive efficacy of vaccination.

* I am assured by Dr. Martin that vaccination with heifer-lymph dried on ivory "points" succeeds in as large a proportion of cases as vaccination with fresh human lymph, provided that it be practiced according to the method which his large experience has led him to adopt as the most effective.

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heifer, by inoculation with lymph which has been "humanized" by long transmission through a succession of human beings. For, as is proved by Dr. Martin's experiments on this *retro*-vaccination, such lymph has been so altered by "humanization" that the germs it contains do not properly reproduce themselves in the system of the calf, thus showing that it no longer possesses the attributes of true vaccinia. And, although the liability to contamination from human disease may be thus greatly diminished, it can not be certainly said to have been destroyed.

We now come to the bearing of Pasteur's researches on the question of the fundamental identity of small-pox and cow-pox, originally mooted by Jenner. Attempts at its solution were made, early in the present century, by the inoculation of bovine animals with small-pox virus; and it was asserted that in this way true vaccinia had been artificially produced. But the evidence in support of this assertion did not command general assent; and it was not until Dr. Thiele, of Kazan, published, about forty years ago, an account of his experiments, that the doctrine obtained any considerable amount of acceptance. According to the citations given by Mr. Simon, in his valuable "Report on Small-pox and Vaccination," issued under Government authority, in 1857, Dr. Thiele not only repeatedly succeeded in producing a genuine vaccinia by inoculating bovine animals with small-pox virus, but himself used this artificial vaccine largely and successfully in human vaccination, and propagated it extensively by the instrumentality of other vaccinators, its protective power being found to be fully equal to that of the natural vaccinia. But, further, Dr. Thiele asserted that he could produce this artificial vaccine without the use of the cow at all, by *diluting the small-pox virus with warm milk*, or, as we should now term it, "cultivating" its living germs in that fluid. I can scarcely help thinking that the great improbability—as it *then* seemed—of such a conversion has thrown a discredit upon the whole of Dr. Thiele's statements, which has caused them to be ignored by most subsequent workers on this subject. But, should that part of his results be ever confirmed, he must be accorded the credit of having anticipated in a most remarkable way one of the most important of Pasteur's methods, though, it is pretty certain, without knowing, or even guessing, their true *rationale*; for it must have been not by *dilution* of the virus (like that of a chemically acting fluid), but by a *modification in the character of the disease-germs* resulting from their development in milk, that this part of Thiele's results (supposing them to be genuine) was produced.

Simultaneously with those of Dr. Thiele, a set of experiments of the same kind was being carried on in our own country by Mr. Ceely, of Aylesbury; the results of which, however, were not equally satisfactory. He did, it is true, produce an eruption in cows inoculated with small-pox virus, which was transmissible by inoculation to the

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human subject, but this eruption seems to have had rather the character of a modified *variola* than that of a true *vaccinia;* and, as its transmission by inoculation through a succession of human subjects did not produce what the best judges considered a genuine cow-pock, it was allowed to die out. The case was very different, however, with another set of experiments made a few years afterward (in ignorance of Mr. Ceely's) by Mr. Badcock, a druggist at Brighton, who was led to institute them through having himself suffered an attack of small-pox, though vaccinated in early life, and having been thus led to suspect that the protective power of vaccination had undergone deterioration. From the account he gave of his work in a small pamphlet published in 1845 (for a sight of which I am indebted to his son), it appears—1. That he inoculated his cows with small-pox virus furnished to him from an unquestionable source; * 2. That this inoculation produced vesicles which were pronounced by some of the best practitioners of Brighton to have the characters of genuine vaccinia; 3. That lymph drawn from these vesicles, and introduced by inoculation into the arms of children, produced in them vaccine vesicles of the true Jennerian type; 4. That free exposure of some of these children to small-pox infection showed them to have acquired a complete protection; and, 5. That this new stock of "vaccine" had been extensively diffused through the country, and had been fully approved by the best judges of true *vaccinia*, both in London and the provinces.

Mr. Simon, writing in 1857, stated that, from the new stock thus obtained by Mr. Badcock (not once only, but repeatedly), more than 14,000 persons had been vaccinated by Mr. Badcock himself, and that he had furnished supplies of his lymph to more than 4,000 medical practitioners. And I learn from Mr. Badcock, junior, who is now a public vaccinator at Brighton, that this stock is still in use in that town and neighborhood.

Against these *positive* results are to be set the *negative* results of attempts made in the same direction by many other able experimenters, such as Professor Chauveau and his coadjutors, the recent Belgian Commission, and Professor Burdon-Sanderson, as well as the unsatisfactory results obtained by Ceely. But I can not see that their *non*-successes are in any way contradictory of the *absolute* and *complete* successes which, if testimony is to be trusted, were obtained by Thiele and Badcock. The lesson taught by the failures appears to me to be the careful imitation of the conditions under which the successes were obtained; and, as Mr. Badcock, senior, is still living, and is said to be both able and willing to give all needful information, it is the inten-

* The only possible fallacy in these experiments, as it seems to me, might lie in his medical friend, Mr. (afterward Sir J.) Cordy Burrows, having supplied him with vaccine lymph, instead of with variolous virus. But, though this might have been the case once or twice, it could scarcely have happened several times, except by *design*, which is scarcely to be thought of.

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tion of Professor Burdon-Sanderson and myself to take an early opportunity of personally obtaining this from him, with a view to a careful and thorough testing of his experiments, with every precaution that experience can devise.

The recent meeting of the Medical Congress has given me the opportunity of personal communication on this subject both with M. Pasteur and M. Chauveau. From the former I learned that his use of the term "vaccination" in connection with his employment of the mitigated virus of "charbon" and "chicken-cholera," as a protective against the malignant forms of those diseases, was intended rather as a compliment to Jenner than as expressive of any belief in the identity of vaccinia and variola. This question, he said, was one which he had not himself investigated, and on which he did not feel himself justified in forming an opinion. But, when I asked him whether he considered it to have been already decided in the negative, and further informed him of the positive evidence afforded by Mr. Badcock's experiments, he expressed himself strongly in favor of regarding the question as still *open*, to be decided by further researches carried on under the new light afforded by the results of his own recent investigations. I found M. Chauveau himself not less willing to admit the force of the strong analogy between the protective agency of the Jennerian and what I may term the Pastorian "vaccination," and not less ready to accept the results of any thorough reinvestigation of the subject. Such a reinvestigation I hope shortly to see carried out at the Brown Institution by the accomplished young successor to Professor Greenfield, under the superintendence and with the co-operation of Professor Burdon-Sanderson, in whose great knowledge, long experience, and wise judgment, all who know him and his pathological work have the fullest confidence.

Now, putting altogether on one side the purely scientific interest of this investigation, let us see in what position we shall be, if it should issue in the confirmation of Jenner's view of the fundamental identity of *vaccinia* and *variola*, proving cow-pox to be not a disease *sui generis*, but small-pox modified by passing through the cow.

In the first place, we shall have the *scientific basis* for the practice of vaccination, which it has never yet possessed; for it will be then clear that the protective power of vaccination is exactly the same in *kind*—as it has long been known to be about the same in *degree*—as that of a first attack of small-pox.

Secondly, the "common-sense" argument in favor of vaccination will be greatly strengthened by the proof that we are not poisoning the blood of our children with a new disease (which some of the most vehement of the anti-vaccinationists maintain to be already destroying the vitality of the nation), but are merely imparting to them in its mildest form a disease which every one is liable, without such protec-

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tion, to take at any time. Those who would hasten to protect their flocks and herds by Pastorian "vaccination" against a deadly "charbon" raging in their neighborhood—as who would not?—can not, in common consistency, refuse Jennerian vaccination for their children.

And, thirdly, we shall be furnished with the means of obtaining, at any time, an original stock of *vaccinia*, the continuous transmission of which through a succession of heifers will at the same time secure the maintenance of its potency, and exclude the chance of human contamination.

Among the numerous other researches now being followed out on the Pastorian lines, I may notice two as likely to prove of the highest practical importance: those which, in the hands of Drs. Klebs and Tommasi Crudeli, seem likely to demonstrate that *marsh-malaria* derive their potency from organic germs (an idea that singularly harmonizes with the *periodicity* which is the special character of the varied forms of disease they induce), and those which, based on the original discovery of Villemin (in 1865) as to the communicability of *tubercle* by inoculation, are rendering it probable that this terrible scourge (including not only pulmonary consumption, but scrofulous disease in all its varied forms) really depends on the presence of a microphyte, which may be introduced into the body, not merely by direct passage into the blood-current (as in inoculation), but also through the alimentary canal, or even through the lungs. This doctrine, which was first advanced by Professor Klebs four years ago, has lately been the subject of most careful research by Dr. Schüller, of Greifswald, who has shown that every form of tuberculosis can thus be artificially induced, the characteristic micrococcus spreading rapidly in the blood and tissues of the animal inoculated with it; and that if, in an animal so infected, any joint is experimentally injured, that joint at once becomes a place of preferential resort to the micrococcus, and the special or exclusive seat of characteristic tubercular changes—a fact of the utmost practical interest in its relation to human joint-diseases. Another line of inquiry, which has obviously the most important bearing upon human welfare, is the propagability of the micrococcus of tubercle by the milk of cows affected with tuberculosis, a question in regard to which some very striking facts were brought before the Medical Congress by a promising young pathologist, Dr. Creighton.

Well might Mr. Simon conclude his admirable address as President of the Public Health Section of the Congress with these pregnant words: "I venture to say that in the records of human industry it would be impossible to point to work of more promise to the world than these various contributions to the knowledge of disease, and of its cure and prevention; and they are contributions which, from the nature of the case, have come, and could only have come, from the performance of experiments on living animals."—*Nineteenth Century.*

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M. PAUL BROCA.

M. BROCA, says his friend Jacques Bertillon, worked all his life, and at tasks of very different sorts. "Rarely has there been a mind so active, so equally open to all kinds of knowledge, and so equally fond of all kinds. M. Elisée Reclus, who was his associate in college, tells that he said to him very early in life: 'I do not believe in vocations; a man may select a career almost at random, he will always make a place for himself in it according to his cut.' M. Broca judged others according to himself, and in that went too far, but, as concerned himself, he judged aright." M. Verneuil, pronouncing a funeral eulogy upon him before the Faculty of Medicine, remarked that his life might be shown up as a model to those who desired to become in that profession first pupils, then assistants, and at last masters. In whatever station he was placed, the eulogist added, M. Broca always fulfilled his commission with exemplary exactness and zeal, and, rather than think of avoiding the most trifling item in his programme, he was inclined to charge himself unnecessarily in the fear that he might not be carrying a load proportioned to his strength.

PAUL BROCA was born at Sainte-Foy-la-Grande, in the Gironde, June 28, 1824. The Brocas were of an old Huguenot family, which had included several of the famous brave "pastors of the desert," who suffered in the times of persecution. Broca's father had served in the Spanish wars, and had contracted a profound hatred of the spirit of despotism in which they originated, and were waged; and young Broca was vividly impressed with the reality of the principles of civil and religious liberty, at six years of age, when the Catholics of Sainte-Foy rose against the Government of July, 1830. In 1832 he entered the Communal College of Sainte-Foy, an institution which was then frequented by all the Protestant youth of France, and at which most of the distinguished men of the Reformed Churches were educated. Broca's father wished him to study medicine. He, having a taste for mathematics, preferred the Polytechnic School. He secretly prepared a baccalaureate in science, and having taken the degree of Bachelor in Letters, first in rank, in 1840, when only sixteen years old, he gained permission from his father to be examined for the bachelor's degree in mathematical sciences. Having gained this, he began to prepare himself for the Polytechnic, teaching in the day-time in the college where he had been a student, studying the calculus at night. His plans were suddenly changed by the death of his sister. He was now an only child, and would not embrace a profession that would call him away from his parents. He resolved to study medicine, and share his father's practice at Sainte-Foy.

He was enrolled in the Faculty of Medicine at Paris in November,

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1841, and passed successfully through the several competitive examinations, till he became Anatomy Assistant of the Faculty in 1846, Prosector of the Faculty in 1848, and Doctor of Medicine in 1849; and while waiting the aggregate competition, which would not take place for several years, he gave lectures on surgery and operative medicine at the Practical School. Numerous works already gave promise of what the future had in store for him. The bulletins of the Anatomical Society contain several papers which are still in repute on various difficult subjects of pathology. "There is hardly one of these subjects," says his biographer, Dr. Pozzi, "in which he did not at the first stroke make a discovery great or small; there is not one, at any rate, in which he has not left the mark of his originality." At the aggregate competition, which he had been awaiting, Broca displayed an amount of knowledge and an erudition with which the judges were strongly impressed. His thesis was a finished work on one of the most difficult subjects in surgery. He was named first in promotion. At the same time he received, at the competition of the Central Bureau, the title of Surgeon of the Hospitals. He formed many and solid friendships, and exercised, through the superiority of his mind and his integrity, a real intellectual and moral authority.

Till 1859, Broca's labors were exclusively anatomical and surgical. His treatises on "Aneurisms and their Treatment" and on "Tumors" have become celebrated. About two hundred studies on the most various subjects, among which may be mentioned especially his researches on articular cartilages and their pathology, belong to this period.

In the preface to his work on aneurisms, Broca makes an exposition of the principles by which he was guided, which Dr. Pozzi regards as worthy of being made the confession of faith of a scientific writer. "I have desired," he says, "to submit received doctrines and opinions to an independent criticism, knowing well that real science is still hardly in its dawn, and that the most undisputed assertions are frequently the most assailable; I have aimed to set classic descriptions in the face of positive observations, appealing to the experience of surgeons of all countries, profiting by ancient and modern facts, checking one with another, despising none, and seeking before everything the reality, although authority may suffer for it. And I have made it my duty to go back to the origin of our knowledge, to follow ideas and discoveries from their birth to their complete development, and to consecrate the rights often slighted of the true inventors. This alliance of criticism and observation, of clinics and history, is destined gradually to regenerate surgery by delivering it at the same time from tradition and empiricism, from the spirit of routine and the spirit of system, from the sterile erudition of those who look only at the past, and the convenient ignorance of those who are occupied only with the present."

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Broca had a high opinion of the value of statistics, and employed them extensively in his researches, as constituting a sure basis for sound conclusions. He uttered a very expressive appreciation of them when he said once in the Academy of Medicine: "Statistics are the anatomy and physiology of the social body. Without them, we grasp only little groups, our judgments are mere impressions, and, even if these impressions do not deceive us, they make us but imperfectly acquainted with facts that are only partial, and the laws of which escape us." Applying the method of means derived from statistics to anatomy, he renovated and almost created anthropology.

After 1859, Broca pursued a double purpose. Without neglecting any of his manifold medical duties, he undertook the considerable task of founding a new society, and almost of a new science. The incidents which led to this step date from 1847, when Broca, as medical assistant, was appointed for the study of the bones, upon a special commission charged with making a report on the excavations in the Church of the Celestins. In preparing to draw up his report, he was led to read the works in which craniology was discussed; and thenceforth, although his competitions drew him to different studies, he continued to read with a lively interest the books, then rare, which treated of man and the human races. The ethnology of the day tended to contract its programme around the then overshadowing question of monogeny or polygeny, and the Ethnological Society of Paris had so exhausted itself with the reiteration of its narrow debates that it had ceased to meet in 1848. Ten years afterward, Broca, having brought out certain facts in hybridity, desired to communicate them to the Society of Biology. He had not foreseen the pusillanimity of some of his colleagues. Some of his positions were contradictory of the doctrine of the monogenists, and Rayer, president of the society, alarmed at the views contained in it, asked Broca to withhold his communications on the subject. He accordingly sought another channel for the publication of his memoir.

This incident, which greatly disturbed the Biological Society, suggested the necessity of founding a new society, in which questions relating to mankind could be given free scope. The project had to make its way against difficulties. Broca wanted to obtain twenty members, but, after a whole year of effort, he had to begin with nineteen. Then there was trouble in getting an authorization for the meeting of the society. The Government officers were afraid of its name, apprehending that the strange word "anthropology" might cover some political or social scheme. Finally, the prefect of the police, judging that a meeting of one short of twenty persons did not require special authorization, gave Broca permission to meet with his friends, on condition that he should be personally responsible for all that might be said against society, religion, or the Government, and that an agent of police should always be present in citizen's dress to

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see that no harm was done. Broca, says M. E. W. Brabrock, of the Anthropological Institute, "liked to tell an amusing anecdote on the subject of this supervision: The police officer acquitted himself of his mission with so great regularity, and had got so much the habit of sitting among the members, that he seemed soon to have forgotten that he was there in a special capacity. Wishing one day to be able to take a holiday with a clear conscience, he approached the officers with an amiable smile, and addressed Broca: 'There will be nothing interesting to-day, I suppose? May I go?' 'No, no, my friend,' Broca immediately replied, 'you must not go for a walk; sit down and earn your pay.' He returned to his place very unwillingly, and never after ventured to ask a holiday from those he was set to look after."

The society held its first meeting May 19, 1859. When it was seen at work, adhesions came fast; and after it had published the first volume of its "Bulletins," and shown the exclusively scientific character of its labors, the suspicions which it had excited before its birth began to subside. The Minister of Public Instruction deigned at last to authorize it in 1861, and three years afterward it was recognized as a society of public utility. M. Broca, all agree, was the soul of this society. Having founded it, he kept it alive during its perilous early years by the prepondering interest of his incessant labors, and the communicative ardor of his devotion to the young science. He had the faculty of grouping the most diverse, and, apparently, the most discordant, elements around his person; the power to excite the zeal of some, restrain the passion of others, and to exercise over all an authority that was incontestable and uncontested, simply because it rested solely upon his real superiority freely recognized by all. This influence of Broca, visible particularly at the beginning, continued no less real till the last days of his life, notwithstanding he took pains to avoid everything that might give him the appearance of a personal direction. He was secretary of the society for the first three years, and was accustomed to record its debates from memory after the meetings were over, in a manner that heightened their original interest and gave prominence to the central point of the debate. In 1863 the growth of the society had made the office of a general secretary necessary. Broca was elected to the position, and held it till his death.

In 1861 Broca began his admirable researches on the brain. In a series of four memoirs he gave reasons for the belief that the brain was not, as many at the time thought, "an undivided organ in which the different faculties have no determined seat," but that the fundamental convolutions of the cerebral hemispheres are distinct organs, each having distinct functions. Performing an autopsy upon a man who had been deprived of the faculty of speech for twenty years, he was led, by a careful examination of the condition of his brain, to the conviction that the primary seat of his affection was in the third con-

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volution of the left frontal lobe. Other facts came in to confirm his view, and this part of the organ, now generally known as the "convolution of Broca," has been determined to be the center of the faculty of speech.

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In the two manuals which Broca published as guides to the studies of general anthropology and craniology, he condensed in a few pages the work of several years. He insisted especially on the importance of accurate measurements, and of having conclusions supported by the averages of a large number of experimental cases. For these purposes he invented more than thirty simple, accurate, and convenient instruments of measurement. His anthropological memoirs are numerous, and pertain to all branches of the science, prehistorical, historical, ethnographical, and linguistic, and repeatedly illustrate the activity and encyclopedic comprehension of his intellect. He had begun to collect them in a series of volumes, of which three have been published and a fourth is in preparation. During the later years of his life he was chiefly interested in cerebral morphology; and he was engaged, when he was surprised by death, in a complete work on the morphology of the brain, to constitute a masterly summary of the result of his studies. Though it is unfinished, this valuable manuscript will not be lost to science. Its scattered leaves have been collected, and will be eventually published.

Broca intermitted his anthropological labors during the Franco-German War, in order to serve his country as one of the three directors of Public Assistance. Here it was his privilege, by the exercise of considerable prudence and tact, to save the funds of the department, amounting to 75,000,000 francs (or $15,000,000), from plunder by the Communists. While others were ready to boast of their services, and claim recognition for them after order was restored, Broca made no allusion to what he had done. He resumed his studies during the second siege, occupying himself in the formation of the collection of cerebral models in the laboratory. He founded the "Revue d'Anthropologie" in January, 1872, and in the same year took part in the formation of the French Association for the Advancement of the Sciences, in which he became the leading spirit in the Anthropological Section.

The foundation of the Anthropological School, and its installation in rooms dependent on the Faculty of Medicine, was due to Broca's personal influence and zeal. The period of preparation for the opening of the institution was fraught with perils to it arising from the opposition of the clerical party and the timidity of the Government. The school, the laboratory, and the Anthropological Society, meeting in the same place, are now together known as the Anthropological Institute.

At the beginning of 1880 M. Broca was elected Senator for life. Shortly afterward he wrote in reply to the congratulations of an English club over his new advancement: "In choosing their candidate for

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the first time from outside the political world, the 'Left' of the Senate have wished to manifest their good disposition toward the sciences; and, if I am happy in having been chosen on that ground, I am especially happy that anthropology should have acquired so much importance in public opinion as to be called to have its representative in the Senate." A banquet was given him by his friends in honor of his nomination, when he made a remark which had a singular bearing in connection with his sudden death: "My friends, I am too happy. . . . Yes, I am too happy. If I was superstitious, I should regard my nomination to the Senate as the presage of some great misfortune, perhaps as the presage of death." On the 6th of July, 1880, he was seized with a fainting-fit at his place in the Senate. He resumed his work on the two following days, but was attacked again at midnight on the 8th, and died in ten minutes. His organs were found to be all sound, and his death was attributed to cerebral exhaustion arising from overwork.

For forty years Broca lived a life of persistent work. While still a student, he would pass his nights reading scientific works and journals pen in hand, to note down what he found most interesting. For three years, although he was otherwise the busiest of the professors, he delivered his lectures twice a week, while his colleagues were satisfied to give a single lesson. He was accustomed to spend much time every day at the laboratory, dissecting, drawing, or superintending the modeling and classification of new specimens; and he also devoted most of his evenings to anthropology. The pressure of his duties finally became so great that he could only afford one hour an evening for his favorite work, and he took from eleven o'clock till midnight, promising his family that he would not study later.

As a teacher, says M. Bertillon, he was clearness itself. His passion for truth spoke in his lectures, and he would never leave a subject till he could see the understanding of it reflected in the face of every hearer down to the simplest child. He was always ready to ignore the interests of his own ambition for the sake of those of science, and insisted on retiring from the presidency of the Anthropological Section of the French Association in 1876, so that the honor might be open to others. His style was simple and elegant, and combined the graces of the man of taste and the lover of poetry with the preciseness of the scientific student. In his personality his features were less important than the expression that animated them. In personal intercourse his vivacity, his originality, his fertile memory, and his inexhaustible resources in quotations and anecdotes, made him a charming talker. He was as familiar with questions of æsthetics and literature as with those of politics and science; was interested in everything, and had his own well-reasoned views on everything. In all things love of truth was the great passion of his life.

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CORRESPONDENCE.

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WHERE DO THE MEMBERS OF THE AMERICAN SCIENTIFIC ASSOCIATION COME FROM?

Messrs. Editors.

HAVING had a curiosity to know, in something more than a general way, how the various sections of the country contribute to the attendance at the meetings of the American Association for the Advancement of Science, I have analyzed the "registers of arrivals" of the Boston and Cincinnati meetings. The results, which may be of interest to others as well, are embodied in the following tables. In checking off so many names, there is, of course, liability to error, but some pains have been taken to make the statement correct. E.

TABLE I.—ATTENDANCE BY STATES.

STATES.	Boston meeting, 1880.	Cincinnati meeting, 1881.
Maine	14	2
New Hampshire	17	0
Vermont	7	0
Massachusetts	221*	28
Rhode Island	17	1
Connecticut	89—315	11—37
New York	170	45
New Jersey	36	8
Pennsylvania	47	18
Delaware	1—254	0—66
Wisconsin	4	8
Michigan	7	10
Indiana	8	29
Illinois	21	27
Ohio	22	61†
Kentucky	9	25
West Virginia	1	3
Virginia	3	2
Maryland	16	18
District of Columbia	71—162	80—208
Tennessee	6	8
North Carolina	2	2
Georgia	2	4
Florida	1	3
Alabama	1	2
Mississippi	0—12	3—22
Louisiana	1	2
Missouri	32	18
Iowa	9	8
Minnesota	4	3
Kansas	2	1
Colorado	0	3
Arizona	3	0
Nebraska	0	1
California	1—52	3—39
British Provinces	21	4
England	5	0
Cuba	3	0
Boston ‡	164	0
Cincinnati ‡	0	155
	988	581

* Excluding Boston.
† Excluding Cincinnati.
‡ The two or three names without addresses have been credited to the entertaining city.

TABLE II.—ATTENDANCE BY SECTIONS.

SECTIONS.	BOSTON MEETING.		CINCINNATI MEETING.	
	No.	Per ct.	No.	Per ct.
From New England	315	31·9	37	7·0
From the Middle States	254	25·7	66	12·4
From the Western States east of the Mississippi, and as far south as Kentucky and Virginia	162	16·4	203	39·2
From the Southern States east of the Mississippi	12	1·2	22	4·2
From west of the Mississippi	52	5·3	39	7·3
From the British Provinces and beyond the sea	29	2·9	4	0·7
From the entertaining city	164	16·6	155	29·2
Totals	988	100·0	581	100·0

IDENTITY OF THE INDIANS AND THE MOUND-BUILDERS.

Messrs. Editors.

IN 1875 I read a paper before the Iowa Academy of Science, on "The Mounds and Mound-Builders," in which I took the same grounds and came to the same conclusion as Professor Winchell, in his recent article on the "Ancient Copper-Mines of Isle Royale." My article was suggested by the examination of some mounds on the bank of the Mississippi, in Whitesides County, Illinois.

Among other things exhumed were one or two skeletons with anchyloses of the first and second vertebræ, and quite a number with *flattened shin-bones*, and also a flattened or deformed skull. In 1864–'65 there was a large number of Sioux Indians, concerned in the massacre at New Ulm, Minnesota, in the prison-camp at Davenport, Iowa. Dr. R. J. Farquharson, of that place, two or three years ago disinterred several skeletons of the prisoners who died there. He found one with the first and second vertebræ anchylosed, and several with flattened tibia, showing that *platycnemism* still exists among the modern tribes, and connects them with the mound-builders.

Very respectfully,
P. J. FARNSWORTH.

CLINTON, IOWA, *September* 1, 1881.

A CORRECTION.

Messrs. Editors.

IN your sketch of Edward D. Cope in the May number of "The Popular Science Monthly," the following statement occurs

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on page 111: "His Western explorations were begun in 1870, when he visited the cretaceous region of Western Kansas." Is not this date a mistake? Professor Marsh, of Yale College, in November, 1870, fitted out an expedition at Fort Wallace, and explored the cretaceous deposits of Western Kansas during November and December of that year. In June, 1871, he again started with an expedition from the same fort, and spent about two months in exploring the same region.

I am quite sure that Professor Cope did not visit Western Kansas until after Professor Marsh's second season's work was completed.

There are some other similar errors in this sketch which should perhaps be noticed, but the one mentioned I can correct of my own knowledge. M. D.

MANHATTAN, KANSAS, *October* 25, 1881.

INFLUENCE OF TEMPERATURE ON THE CHIRP OF THE CRICKET.

Messrs. Editors.

SOME years ago my attention was called to the crickets which chirp so incessantly every summer evening, and it was thought by a friend that they varied in the number of their chirps per minute — at a higher temperature vibrating much faster. At that time a single observation was made, but for some reason was not repeated.

Recently, a writer in the "Salem Gazette," signing himself W. G. B., gives the following rule for estimating the temperature of the air by the number of chirps made by the crickets per minute: "Take seventy-two as the number of strokes per minute at 60° temperature, and for every four strokes more add 1°, and for every four strokes less deduct the same." After seeing this I determined to make a number of observations, to find out if this were an invariable rule. I tried it, with one or two exceptions, every night that the crickets chirped, from September 30th to October 17th. During this period a heavy frost occurred, when the crickets were not heard, but as soon as the weather grew warmer they began again. The lowest temperature at which they were heard was 50°. By the observations given, it will be seen that the temperature as estimated from the number of the crickets' chirps varies a degree or more from that recorded by the thermometer, but it must be remembered that no standard thermometer was used, and that the crickets were chirping in the trees, in many cases sheltered from the wind, while the thermometer hung near a window in a more exposed position; also, that on cool evenings it was very difficult to count the strokes, as they were feeble and interrupted. Below are given the observations for twelve evenings:

Date of observation.	Rate of vibration.	Temperature as computed by the rate of vibration.	Temperature as recorded by the thermometer.
Sept. 30.....	122	73°	70°
Oct. 3.....	115	71	70
" 7.....	67	59	59
" 8.....	104	68	67
" 9.....	74	61	59
" 9.....	64	58	57
" 10.....	42	52	50
" 12.....	66	58	56
" 13.....	118	72	70
" 16.....	81	63	63
" 16.....	73	60	60
" 17.....	57	56	54

It will be seen, by the above, that there is a remarkable accordance between the number of vibrations and the temperature of the air. With more accurate observations doubtless a closer agreement would be proved. MARGARETTE W. BROOKS.

SALEM, MASSACHUSETTS, *October* 22, 1881.

EDITOR'S TABLE.

FURTHER LESSONS OF THE YORKTOWN CENTENNIAL.

THE recent centennial proceedings at Yorktown, and the event they commemorated, have been so fully discussed in all quarters and in all aspects, that the topic is now pretty well exhausted. We certainly can not add anything to it in the way of novelty, but among the lessons that have been drawn from it there are some which deserve greater emphasis than they seem to have received. The orators of this occasion have expatiated much on the Yorktown surrender as a great step in the progress of human liberty: it is worth while to inquire to what extent and in what sense this is true.

The capture of Cornwallis ended a protracted war, and by the success of the insurgents turned the infamy of a rebellion into the glory of a revolution. It secured political independence, and

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gave origin to a new nation. Yet the revolt was against the freest constitutional government in the world, and the communities that rose against the mother-country had been nurtured in the spirit of independence under British influence and British institutions. The justifying principle of the war was simply that the people on the spot, knowing their own circumstances and wants, could govern themselves better than they could be governed through agents by a people three thousand miles away. In reconstituting the government, various things deemed useless or injurious—hereditary monarchy, hereditary aristocracy, and a state Church—were lopped away as excrescences. But the constitution of the English law-making body was imitated, and the old common law of England, with its recognitions and guarantees of personal rights, and its machinery of justice, to which the people were accustomed, remained in substantial force. The bulwarks of civil liberty were a heritage from the parent country. In the declaration of political independence there was an affirmation of the natural and equal rights of all men. But it was little more than a "rhetorical flourish," as its reduction to living practice was scarcely thought of. There was a servile class stripped of all rights who sorely needed the benefit of this pretentious declaration, but it did not get it. In fact, the insurgent colonies were nothing less than slave-holding and slave-trading communities, and, when they deliberately proceeded to form a Constitution, human slavery was fortified in its provisions, and the foreign slave-trade was guaranteed for twenty years.

But if the Constitution of the new government left a weak and defenseless class a prey to its oppressors, was nothing gained for the superior race? Much, undoubtedly. There was a relief from monarchical, aristocratic, and hierarchical burdens, a simplification of political machinery, and an experiment in the direction of popular self-government. There was a transference of power into the hands of the people more complete than ever before. It was the boldest venture in representative government that had ever been made; yet, if we are to trust the official Yorktown orator, after the retrospect of a century, the problem is not yet solved, and we can not look forward to the next hundred years without profound solicitude.

But there was one grand stroke for the promotion of human liberty made in organizing the republic, the far-reaching consequences of which were neither appreciated by those who made it nor are they yet well comprehended by our people. We here refer to the liberty of commercial transactions, to the establishment of absolute free trade between the citizens of all the States of our political Union. An immense step was here taken in the progress of liberty. All the liberties—liberty of conscience, liberty of thought and speech, and liberty of exchange—have been slow growths; but no one has grown so slowly or against such resistance, or is still so immature, as that full liberty of action that is involved in the free exchange of property. It is here, in oppressive exactions upon exchange, that the most grinding tyranny takes effect; upon this point rapacious government is the first to fasten and the last to let go. Men may think and say what they like, and go where they like, but, if they can not dispose, unhindered, of the property which they have produced, and which is their own, their liberty is a delusion. Great progress has unquestionably been made in modern times in freeing exchange from its burdens, and all that had been gained was secured by the organic law of the new republic. It was decreed that Americans within the national limits shall be let alone—shall enjoy immunity from vexatious trade

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restrictions—that is, shall be left free in all their industrial and commercial pursuits. Whatever may be the strength of local interests, whatever the advantages or drawbacks of States, they are for ever forbidden to interfere with the mutual liberties of exchange between citizens by tariffs, imposts, or any form of trade restrictions. No pretext of developing resources, diversifying industry, fostering weak interests, or protecting labor, could be made an excuse for commercial restrictions. It was ordained that business shall be left to voluntary enterprise, to the spontaneous impulses of private effort, and to stand upon the stable basis of its natural laws rather than upon the artificial support of regulative State legislation.

The good effects of this policy no man can now be found to question. A hundred years of experience has attested the practical wisdom and established the solid and permanent beneficence of this great constitutional measure. With trade as free as the winds, the result has been an unparalleled activity in the development of all resources, and a general prosperity such as the world has never before seen; while the open liberty of interchange, resulting in active and intimate intercourse, has favored political unity and strengthened amicable feeling between distant and diverse communities.

One has but to picture what the consequences would have been of applying protective theories to Northern and Southern, Eastern and Western States, to understand how vast has been the advantage of the free-trade policy. With the general ignorance that prevailed in regard to economical principles, the restrictive policy, if permitted at all, would have been driven to its last results. To have let State politicians loose upon our internal commerce would not only have abolished it, but would have aggravated local prejudice, narrowness of feeling, rivalries and jealousies, and engendered alienations and irritations that would have made national unity impossible. The fathers built wiser than they knew, and did the noblest service to human freedom which it was in their power to render when they united the American States on the basis of free trade.

This great lesson has not been lost, though it has not yet borne its full and final fruits. The policy which has proved of such immense benefit at home has not been trusted beyond the national borders. We adopt a partial practice with immense benefit, and then repudiate the principles it involves. Internal trade is free, but external trade is still shackled. A New-Yorker trades with a Pennsylvanian without restriction under the principle that they are the best judges of their own business affairs. They are free to buy and to sell as they like, and for the sufficient reason that the thing they will do is the best for both. But if a New-Yorker undertakes to trade with a Canadian, Government declares that the transaction shall not be free, the parties shall not do as they like with their own, and this for no other reason under heaven than because the Canadian is a foreigner. If Canada were "annexed," presto! these traders would at once know their own business best, and could exchange with perfect freedom.

We have here, in this surviving prejudice about the "foreigner," an illustration of the vicious potency of militant conceptions. The foreigner is our virtual enemy, one whom it is our patriotic duty to hate and not to help. The term is redolent of international antagonism and the pursuit of war which is the curse of civilization. This spirit, identified with the love of country, and fortified in long tradition, is slow to yield to the influence of humanizing and pacific agencies; but yield it must, and it has already greatly yielded, as witness the doings at Yorktown. That demonstration commemorated a military exploit; but ev-

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erybody has seen that it was awkward, anomalous, and embarrassing. There was a great flaunting of military parade, suggestive of fighting; but, apart from the historic reminiscences, the speeches contradicted the whole spirit of the occasion. It was by no means devoted to unalloyed rejoicing over a military triumph, but was much more a tribute to the interests of peace and international friendliness. A hundred years makes a great difference nowadays, and the Yorktown utterances were significant registers of the progress of ideas. The new President spoke with wise discretion, and gave voice to the wishes of the American people by ordering that the commemorative services close with a salute to the British flag by the assembled forces of the army and navy, "in recognition of the friendly relations so long and so happily subsisting between Great Britain and the United States, in the trust and confidence of peace and good-will between the two countries for all the centuries to come, and especially as a mark of the profound respect entertained by the American people for the illustrious sovereign and gracious lady who sits upon the British throne."

Nothing could be more significant, as showing the growth of liberal ideas with reference to our external relations. It signalized the hope that time will secure in the family of nations what we have secured in the family of States. We can not expect peace "for all the centuries to come" except by cherishing the ideas and strengthening the sentiments and confirming the practices upon which peace depends. We can not have exemption from war if we cultivate the spirit of international antagonism—antagonism that tends to war. Nations must be knit together by closer links of mutual interest if peace is to be permanent. War isolates, destroys commercial intercourse, and drives nations into the policy of producing everything for themselves; and the feeling thus engendered by military domination in time of peace maintains barriers and repulsions between nations, on the plea that "we must not be dependent upon foreigners." The curses of war thus become perpetual. Its baneful influence lives on in the so-called "protective" policy which strangles foreign commerce, and compels a nation to shape all its internal affairs with a view, not to the interests of industry which demand the widest liberty of commercial expansion, but to the future contingencies of war.

MILITANCY AND INDUSTRIALISM IN VIRGINIA.

No better illustration can be desired of these views than that offered by the State of Virginia. Her citizens were certainly to be pardoned for their enthusiasm over the Yorktown pageant. The Revolution was consummated upon her soil, and she has a natural pride in all its reminiscences. But what a monument is that great State to-day of the scourge of war-ideas! Settled early as a colony, favorably situated in regard to climate, and with varied and boundless resources, she is nevertheless poor, incompetent, and backward in all the elements of public prosperity. If it be said that these calamities are due to slavery, we reply that slavery is only chronic and subdivided war. Slavery and war are kindred agencies, grown up together in a common barbarism, and both are despotisms of violence. Their one idea is the brute-force control of men—in war for the destruction of life and property, and in slavery for better ends. It was the cherishing of ideas common to slavery and war that drew Virginia with such facility into the vortex of domestic war. It was declining militancy rebelling against growing industrialism. How intense was the barbaric spirit is seen in the persistence of obsolete war-usages. Where militant ideas are ascendant, as in Germany and

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France, dueling is habitual. And so, at the very height of the Yorktown celebration, one of Virginia's "captains," who had got a national reputation as a candidate for an office in the United States Senate, was principal in two duels in a single day; and when he returned to Richmond the same evening, instead of being "publicly flogged by a nigger," as he ought to have been, he received an "enthusiastic reception." Will the honor of its "chivalry" save the State from the disgrace of repudiation?

Militant ideas being opposed to business ideas, Virginia presents a case of arrested development. The world's beneficent work is mainly done by private enterprise; Virginia ideas have not favored this, and so she has been left behind in the race of State development. Legislation has been invoked to bring out her splendid resources, but there has still been wanting that vigor of private effort which can alone give effect to legislative measures. This is well shown in the history of one of her great public works. The project of opening commercial communication with the West was early entertained by sagacious Virginians. The distance of the Atlantic from the Ohio River through the valleys of the James and the Kanawha, which almost connect at their head-waters in the Alleghanies, is shorter than by any other route. It was a favorite idea of Washington to open this communication, and he strongly advocated a bill, passed by the Virginia Legislature in 1784, for the improvement of the James River, with a view to developing a Western water-communication. This project was worked at in an ineffectual way for a number of years, and in 1832 the James River and Kanawha Company was chartered to construct a canal up the James Valley, and this was opened between Richmond and Lynchburg in 1840. It was further extended to Buchanan, a distance of one hundred and ninety-seven miles from Richmond, in 1851. Some further work was begun beyond this point, to secure an avenue for through Western trade, but the sections beyond were not completed. The work as far as constructed was inadequate, only very small canal-boats being available; and so, in 1873, Congress was urged to assume, enlarge, and extend the work, which, in this era of developing railroads, it wisely declined to do. And then, after a hundred years of State efforts and the expenditure of ten million dollars, the undertaking completely broke down, and the dilapidated and useless canal property was offered to anybody gratuitously who would take it and pay its debts.

A couple of years ago a private company of Northern capitalists came forward and took the concern off the hands of the State, and proposed to see what could be done toward carrying out the original plan. They organized the Richmond and Alleghany Railroad Company, and, under the stimulus of intelligent business enterprise, and without a dollar of State aid, two hundred and fifty miles of solid road-bed, laid on the old tow-path as far as it went, with heavy steel rails and numerous iron bridges, were constructed through the valley of the James River to its head-waters in the Alleghanies *in eighteen months*. Seventy miles more will soon be built, connecting the new line with the Ohio Central, which terminates at Toledo—and the aspiration of Washington will be fulfilled.

While the military doings at Yorktown were at their height, absorbing the attention of Virginians, the formal opening of this railroad, replete with all modern improvements and appointments, took place. It was not so striking as the war-show, but it was of far greater moment to the prosperity of the Commonwealth. It was a *foreign* enterprise, made possible by free commerce, and inspired solely by the mercenary purpose of making money out of poor old Virginia; yet it was an ele-

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ment of new life to that community, and will be to it even a greater source of wealth and advantage than to the speculators who carried out the work. Sordid commerce creates manufactures, advances agriculture, and, by increasing the occupations and remunerations of industry, increases all the benefits of civilization. Locomotives are missionaries without moral intentions. There was no patriotism, no philanthropy, no public spirit at the bottom of this movement, yet it will promote all these ends. Millions of Northern capital were poured out solely that they might be augmented, but in doing this they will develop a vast productive region, and aid in giving Virginia a new start in a new direction; and not the least advantage will be to compel the adoption of a new order of ideas.

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OUR POLICY RESPECTING THE PANAMA CANAL.

THE letter of Secretary Blaine to Minister Lowell, of London, as to the policy of the United States in regard to the neutrality of the Panama Canal, deserves attention. Being a diplomatic document, it may not be easy to say what or how much meaning there is in it; but, as read by common-sense, it is a missive of intimidation, and contains a virtual threat of war. Mr. Blaine is, at any rate, playing with fire, and it is therefore well to watch him.

The canal, which opens a ship communication between the Atlantic and Pacific Oceans, being of vital moment to the commerce of the world, it is of the first importance to all nations that its neutrality be preserved inviolate; but as, in the rivalries and hostilities of nations, there would be danger that this neutrality might be violated, there arises the need of some strong arrangement to secure it. The United States of Colombia, across whose territory the canal passes, and which is therefore the rightful controller of it, is a weak power, and unable to protect the property from foreign interference. She consequently meets the necessity of the case and the requirements of nations by entering into treaty stipulations for guaranteeing the neutrality of the canal, or securing its equal benefits for all countries and at all times.

Now, Mr. Blaine informs whomsoever it may concern that this country has already attended to all this. He says, "The United States recognizes a proper guarantee of neutrality as essential to the construction and successful operation of any highway across the Isthmus of Panama," and that in 1846 it entered into a treaty with Colombia for that purpose.

But that treaty was made under no immediate expectation of the construction of a canal: it was shaped in the light of history by which this country was on record as friendly to the project. Yet, when the undertaking begins first to take practical shape, and the desideratum of centuries promises to be realized, it turns out that the United States is no longer anxious about it. In fact, there was recently developed throughout the country an unmistakable hostility to it. We would neither build it ourselves nor help others to build it, and did all we could to discourage the work by trying to alarm foreign capitalists and prevent them from furnishing the funds for its construction. In this state of things—this sudden abandonment of a clearly defined historic policy—Colombia very naturally began to query as to the satisfactoriness of the guarantee of a power that had ceased to care about the legitimate objects of the work, and had, in fact, developed a feeling inimical to it. They, therefore, began to raise the question of securing the neutrality of the canal by treaty with European powers; and these, it is apprehended, entertain the idea of re-enforcing the American guarantee. Mr. Blaine says, in behalf of this Government, that such a course is inadmissible; and he instructs Mr. Low-

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ell to inform Lord Granville, on the part of the English Government, "that any movement in the sense of supplementing the guarantee contained therein" (that is, in the treaty with Colombia) "would necessarily be regarded by this government as an uncalled-for intrusion into a field where the local and general interests of the United States of America must be considered before any other power, save those of the United States of Colombia alone"; any such movement "would be an extraordinary procedure, and would necessarily be viewed by this Government with the gravest concern"; and, moreover, "would partake of the nature of an alliance against the United States, and would be regarded by this Government as an indication of unfriendly feeling."

Now, if a guarantee in this case is the right thing, and if a valid guarantee of neutrality is really wanted, common-sense fails to see how it can be so well secured as by treaty compact on the part of all the powers from whom there may ever be danger of its violation. If desired at all, the stronger it can be made the better; and, if this strengthening is objected to, what else can it mean than that the objector has a sinister object, and does not want a *bona fide* guarantee? The plain import of Mr. Blaine's letter is this: There shall be no comprehensive and efficacious international guarantee of the neutrality of the interoceanic canal; the United States will give such a guarantee as it thinks "proper"; it will take exclusive possession of the canal, regardless of the nation within whose territory it is, and it will itself violate its neutrality whenever its own interests may dictate such a course.

And what are those interests? They are not the bonds of commerce. The nation has gone far to put itself outside the pale of civilization by the destruction of its outside commercial relations. It has "protected" what commerce it had to death, and insanely persists in the policy by which it can never be restored to life. As a consequence, it had no need of a Panama Canal, and has no concern about it now, except to get exclusive possession of it for use in the contingency of war.

The New York "Evening Post" undoubtedly gives us the point of Mr. Blaine's letter when it remarks, "We can not say too plainly that we mean to protect the canal ourselves exclusively." But what, then, can be Mr. Blaine's meaning, when he says to Mr. Lowell:

> You will be careful, in any conversations you may have, not to represent the position of the United States as the development of a new policy, or the inauguration of any advanced aggressive steps to be taken by this Government; it is nothing more than the pronounced adherence of the United States to principles long since enunciated by the highest authority of the Government, and now, in the judgment of the President, firmly inwoven as an integral and important part of our national policy.

If not diplomatic, this is certainly strange. In the view of common-sense, which is of course our only guide in interpreting the case, what Mr. Blaine says is not true; it is squarely contradicted by all the facts; and, as Lord Granville is presumably not a fool, it would be interesting to know what kind of a time Mr. Lowell had in carrying out his very curious instructions. The policy now advocated is emphatically a "new policy"—a policy that has taken shape only when there began to be some danger that the canal would be made; and it is not merely a change in our course of action, but it is an entire inversion of the historic policy of the Government. This nation has again and again explicitly proclaimed, and is now under solemn covenant, that it will not do exactly the thing it is now proposed to do. If the "new policy" is not in the teeth of an existing treaty, why are its advocates so frantic to have that treaty "torn up"—abrogated and got out of the way?

If it be said that our policy is that

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of the old "Monroe doctrine," the reply is that this doctrine does not touch the case, and the action of the Government proves it. The doctrine was proclaimed by Mr. Monroe to prevent European powers from "oppressing" or "controlling" in any way the young American republics, and it has been construed only as against the attempts of those powers to found new colonies or make territorial acquisitions on this side of the Atlantic. That it was not held by the Government to exclude foreign participation in the construction and protection of such a work as the Isthmus Canal, is attested by the fact that in 1835, long after its promulgation, the Congress of the United States resolved, and four years later the Senate of the United States re-resolved, "that the President be requested to open negotiations with other nations" for the purpose of "ascertaining the practicability of effecting a communication between the Atlantic and Pacific Oceans by the construction of a ship-canal across the Isthmus, and of securing for ever, *by suitable treaty stipulations, the free and equal right of navigating such canal to all nations.*" This view was, moreover, embodied more than thirty years ago in a treaty of our Government with England, in which both parties agreed, with reference to any possible future ship communication across the Isthmus, that "*they will guarantee the neutrality thereof, so that the said canal may be for ever open and free*"; that "*vessels of the United States or Great Britain traversing the said canal, shall, in case of war between the contracting parties, be exempted from blockade detention or capture by either of the belligerents*"; and furthermore, "*that neither the one nor the other will obtain or maintain for itself any exclusive control over said ship-canal; agreeing that neither will ever erect or maintain any fortifications commanding the same or in the vicinity thereof.*"

Are we to understand, then, that there neither has been, nor is there intended to be, any departure from this deliberate, long-established, and honorable policy of the Government of the United States?

M. DELAUNEY, a French *savant*, has been studying the problem of woman from an anthropological point of view to determine her intellectual status, which he maintains to be inferior to that of man. He intimates that "sentimental pretensions" being now made the basis of a political movement, it is necessary to deal with the subject scientifically. The investigation is of course a proper and an important one; but it has had a somewhat curious reception from the press—or those editors, perhaps, who suspect that the women may yet vote, and will remember things. These declare this article to be most horrible, but contrive, with a good deal of deprecation, to get as much of it before their readers as they seem to dare. We have had it translated for the benefit of such dauntless souls as are prepared to take their lives in their hands, and go through with it. Our own special trouble is, that in about six weeks we shall get a bushel, more or less, of answers to it, written very much alike, all in "hair-marks," and with very pale ink.

LITERARY NOTICES.

INTERNATIONAL SCIENTIFIC SERIES, NO. XXXVI.

SUICIDE: AN ESSAY ON COMPARATIVE MORAL STATISTICS. By HENRY MORSELLI, M. D., Professor of Psychological Medicine in Royal University, Turin; Physician-in-Chief to the Royal Asylum for the Insane. New York: D. Appleton & Co. Pp. 388. Price, $1.75.

SOME two or three years since, the author of this book contributed quite an elaborate work in Italian to the "International Scientific Series." It at once took high rank as an authoritative presentation of the subject,

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and was largely drawn upon by Continental and English periodicals in the discussions that followed its publication. Dr. Morselli has revised and abridged the original, expressly for the English version now issued in London and New York; and the work in its present form supplies a long-recognized want in our literature.

There are, however, those who will ask: "What has suicide to do with science? or, What place has such a work in the 'International Scientific Series'? People commit suicide," they will say, "because they are tired of life; it is a matter of morals; an act of volition originating in the will, which is free, and therefore not amenable to the methods of science."

To this, the simple reply is, that it is the office of science to investigate the regularities and the conditions, or, in other words, the laws of phenomena. The voluntary destruction of life is a social phenomenon, the investigation of which falls just as much within the scope of science as an inquiry into the conditions of combustion, the classification of minerals, or the laws of plant-growth. Dr. Morselli's book is a systematic and comprehensive inquiry into the phenomena, the conditions, and the laws of suicide. It is, therefore, a legitimate and important contribution to the science of sociology; and is, moreover, the most practical exemplification we have seen of the real significance of law in what are called the higher spheres of its application. In a notice like this we can only give a few illustrative results of his method.

In the first place, it has been found, by a long course of extensive and careful observation, as shown by statistics, which are simply numerical records of facts, that the phenomena of suicide occur with great regularity. The psychical laws, in fact, work with more uniformity than the physiological or organic laws. Suicides are more regular than births, deaths, and marriages; and it has also been established that it is on the increase in the most enlightened countries, so as to compel the conclusion that this result is due to advancing civilization. Dr. Morselli states this general result in the following form: "*In the aggregate of the civilized states of Europe and America, the frequency of suicide shows a growing and uniform increase, so that generally voluntary death since the beginning of the century has increased and goes on increasing more rapidly than the geometrical augmentation of the population and of the general mortality.*" Extensive tables are given, confirming this statement in a large number of countries.

But, though there is great regularity in the phenomena of suicide, this regularity is only under uniform conditions. Suicide varies as the conditions vary. Moreover, a large number of conditions are acting together, so that the result is a highly complex one. It is the work of the investigator to disentangle these conditions, so as to show the proper value of each. The general problem presents itself in this way. Suicide is a phenomenon occurring in all states of society. But in some countries its rate falls as low as twenty or thirty to a million inhabitants in a year, while in others it rises to perhaps one hundred and seventy to the million, and others show rates that are intermediate. In some cases, the figures from year to year are comparatively stationary, but fluctuate at different times of the year. In other instances, the annual figures fluctuate; and in all cases a variety of causes are at work to determine the result. The task of the statistician is to find out and express by numbers and averages the relation of the rates of suicide to these numerous accompanying conditions that are found to influence voluntary death. The task is an especially difficult one, but it has been accomplished with such success as to afford new and striking proof of the validity of sociological science. Dr. Morselli first considers the influence of the physical environment or the agencies of nature, as they affect the practice of self-destruction.

Men do not kill themselves in all climates alike. The influence of different regions is not great, but it is real. It has long been supposed that suicide is much more frequent in the north of Europe than in the south; and it has been found that it is more common in the northern than in the southern parts of France and Italy. But the old notion that Northern Europe is the "classic ground" of suicide is modified by later researches, which indicate that the excess is rather in the central region. Dr. Morselli says: "If of all the countries, dis-

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tricts, provinces, and circles of Europe we form five groups, which we will call the North, West, Central, East, and South, we shall perceive the predominance of the central over the other four according to the method in which the countries indicated are placed in the scale of averages per million. In the center *two thirds* of the countries exceed the proportion of one hundred and fifty on the million; to the North about *three quarters* stand between fifty and one hundred and fifty, and in the South more than *three quarters* do not exceed the proportion of fifty suicides per million of inhabitants in the year."

But the influence of seasons over suicide is powerful. It varies greatly in different times of the year, and this variation is so regular that the number of those who will destroy themselves in the different months is predictable in each country. Many things about suicide are difficult to ascertain and more or less uncertain, but there is no doubt about the time of year; and it is entirely established that the maximum of suicide occurs in the hot season, and the minimum in the cold season. Fig. 1 is a copy of one of Morselli's diagrams showing the comparative monthly variation of suicide in five countries. By tracing each line representing a country, its height at each month indicates the proportion given in the left-hand column.

We can not say anything here of the influence of geology or of meteorology, or of the moon, or of the days of the month, or

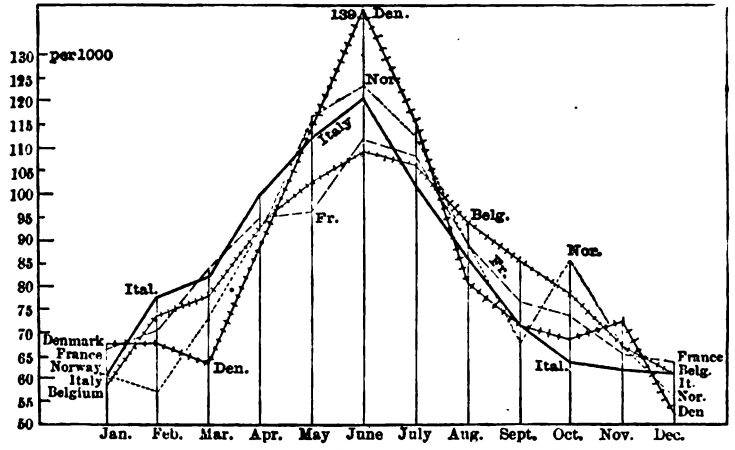


FIG. 1.—MONTHLY CURVE OF SUICIDE IN FRANCE, ITALY, NORWAY, BELGIUM, AND DENMARK. (Maximum in June.)

of the hours of day or night, by all of which the rates of suicide are shown to be affected.

Under the title "Ethnological Influences," Dr. Morselli treats of races, stocks, nationalities, anthropological characteristics, and customs. As regards ethnic influences it is shown that the Germanic race is most addicted to suicide, while the two stocks, German and Scandinavian, divide this supremacy; the Jews, on the other hand, stand lowest in the scale. There seems to be a relation between suicide and anthropological characters, of which the following example is given: "*The frequency of suicide in the various parts of Italy generally is in a direct ratio with stature, and the inclination to self-destruction increases from south to north as the stature of the Italians gradually increases.*"

The social environment, or social influences, affecting suicide are treated in a chapter of the work of great interest and instruction. The topics dealt with are the nature and effect of civilization; the influence of different forms of religious worship and creed; the effect of culture and instruction; the influence of public morality; general economical and political conditions; the density of population; and city and country life.

Chapter V is devoted to "The Influence

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of Individual Conditions," such as sex, age, vocation, profession, and individual status in government and society. Here also, as in the former chapter, we are tempted to give results which space forbids. But in regard to sex it may be remarked that, so

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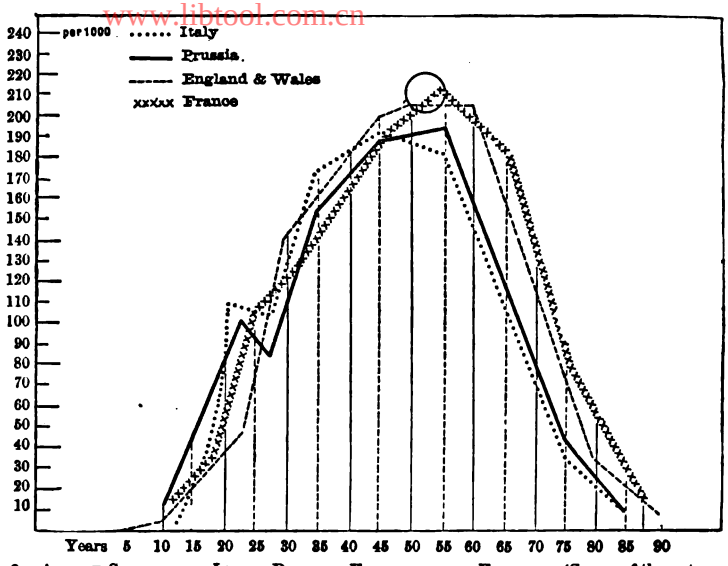


FIG. 2.—AGE OF SUICIDES IN ITALY, PRUSSIA, ENGLAND, AND FRANCE. (Curve of the returns per 1,000 of the actual numbers.)

profoundly different are the characteristics of the sexes, we might expect a great difference in their proneness to suicide, and such is the fact. But the result is different from what we should expect if we accept the statements of reformers, who tell us

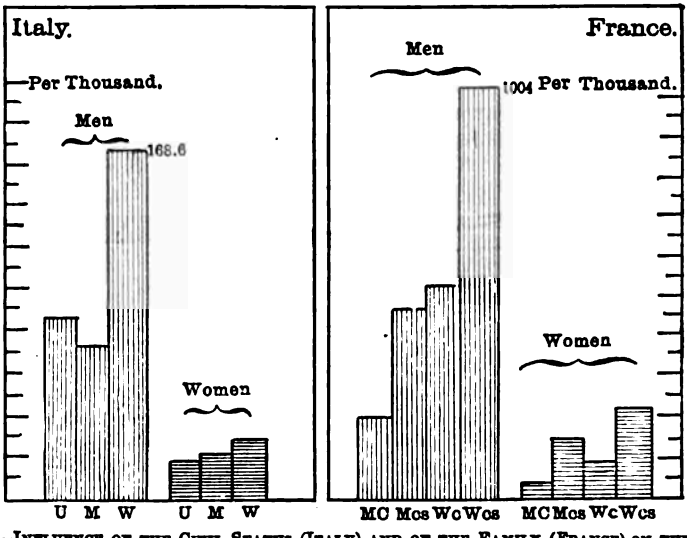


FIG. 3.—INFLUENCE OF THE CIVIL STATUS (ITALY) AND OF THE FAMILY (FRANCE) ON THE TENDENCY TO SUICIDE. *U* unmarried, *M* married, *W* widowed; *Mc* married with children, *Mcs* married childless, *Wc* widowed with children, *Wcs* widowed childless.

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that women have hitherto been the sufferers from a systematic oppression which has made life a burden, while tyrannical men have made existence pleasant by abusing the weaker sex. Yet suicide is everywhere three or four times more frequent among men than among women. It is remarked that suicide is more frequent among Spanish women than those of any other country; and, curiously enough, that the proportion is generally found to decline with the greater preponderance of women in any country. Age also powerfully influences suicide, and nearly equally so in both sexes. The time of life most favorable to suicide is from twenty to fifty years of age; but the greatest proportion happens between forty and fifty. Dividing life into periods of ten years, it will be found that the fifth decennial period stands highest, and curves have been constructed to represent graphically to the eye the rate of increase and decline. Fig. 2 illustrates this for four countries.

Under the head of civil and social status, Dr. Morselli considers the influence of celibacy, marriage, widowhood, and the presence or absence of children. Those conditions are very different and marked in their effects. In Italy, France, and Switzerland, suicides are less numerous among single than among married women. In Italy, if the suicides among single women are represented at 90, those of married women will be 100, and of widows 147; and in France, if the probability of suicide among married men is represented by 100, that of single men will be 111·4, and of widowers, astonishing to say, 256. Fig. 3 brings out some of these results very strikingly.

There are many other points of interest in the volume which we can not even name. The discussion of the philosophy of the subject, its moral aspects, and under what condition the suicidal practice is to be diminished in future, is clear, sagacious, and instructive. The subject has always a mysterious fascination, but as here considered it has also a rational and scientific interest that will command the attention of all thinking people.

In a chapter on the modes and instruments of self-destruction, it is shown that even here there is a predictable regularity.

THE FOREIGNER IN CHINA. By L. N. WHEELER, D. D. With an Introduction by Professor W. C. Sawyer, Ph. D. Chicago: S. C. Griggs & Co. Pp. 268. Price, $1.25.

DR. WHEELER has here given us an extremely readable little volume, treating various aspects of matters in the "Flowery Kingdom." He was a Methodist missionary in China from 1865 until 1873. He preached to the natives in their own language, and devoted himself actively to missionary work through the preparation of many English and Chinese publications. His familiarity with the native written and spoken language gave him advantages in studying the character of that people, of which he seems to have well availed himself. There are more candor and fairness in his pages than might be expected of one, under the powerful bias of religious partisanship, who goes to a distant country for the avowed purpose of overturning its system of faith. His chapters on Chinese history, diplomatic intercourse, and on the origin and effect of the various wars—external and internal—in which the empire has been involved in modern times, are most interesting and instructive. As between the peaceable pagans, who are content to be let alone, and the aggressive Christian nations, who have been bent upon opening the Celestial Kingdom to the benefits of civilization, Dr. Wheeler does not fail to recognize that the heathen have much the better showing. After giving an account of the Chinese policy, and the wars and their results, in the first eight chapters, the author passes to the subject of the religious conversion of the Chinese people. An account of the Roman Catholic missions is followed by that of the Protestant missions, and a discussion of the hindrances to evangelism, after which he devotes a chapter to proving that Protestant missions are not a failure. He points out the great difficulties of the work, and gets a standard of what constitutes success in dealing with such a nation by showing that all other efforts to influence the Chinese—diplomatic, commercial, and military—have been anything but successful. Judged "by the same tests as we apply to more mundane undertakings," missionary work, he thinks, is not to be pronounced a failure. But Dr. Wheeler's ideas of success are certainly

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large, if not peculiar. He says, "Were there not a single convert to Christianity in the Chinese Empire to-day, it would still be too early to pronounce unfavorably on missions." When we remember, as the author tells us, that the Christian gospel was introduced among the Chinese as early as A. D. 300; that Nestorian Christian missionaries began work there in A. D. 639; that the Catholic Church entered upon this missionary field more than six hundred years ago; and that the Protestant Church began its missionary labors there early in the present century—the statement that, if there were not a single convert to Christianity in the Chinese Empire to-day, it would still be too early to draw an unfavorable inference as to future prospects, shows that faith pays but very little regard to the inductions of experience. The doctor, moreover, interprets success in a very liberal way, considering it rather a problem of spiritual dynamics than of mere numbers. He says, "As each idolater was held fast by the entire force of native superstition, the conversion of one was a triumph over the whole might of paganism."

As to Confucianism, the religion of China, Dr. Wheeler has no hesitation in declaring that to be a "stupendous failure," leaving the people in a wretched spiritual condition, notwithstanding its long and undisturbed ascendency. He quotes the Rev. William Ashmore, who describes the prevalence of the precepts of Confucius as follows: "The roads to honor, to wealth, and to official preferment all start out from the skill displayed in stating and applying the maxim of the sage and his expounders. The most powerful social class is composed of those who have been covered with literary honors for their proficiency in the knowledge of Confucius. Confucianism is really the state constitution; it is the state religion; it is the state etiquette. Confucius and his teachings are worshiped by three hundred million people. The words that fell from his lips form the thesis of all the literary tournaments of the empire. They are graven deep on granite monuments. They are posted on the doorways of pavilions and rest-houses every year. They are written on fans that are ever in hand. They are painted on bed-curtains. They are gilded on rolls and hung up to adorn their temples and dwelling-houses. They furnish the phraseology with which men of polite learning exchange amenities with each other; and they may be heard falling from the lips of the common people in the markets when chaffering about the price of shrimps and snails."

And yet, notwithstanding all this, the moral condition of the Chinese is anything but satisfactory. The virtues of benevolence, integrity, propriety, wisdom, sincerity, with filial piety, are so far exemplified in the daily life of the people as to explain their remarkable longevity as a nation; their love of fixed and orderly modes of life; their thrifty habits; and their general tendency to practice the arts of peace. But the people are untruthful and dishonest, and, notwithstanding their ostentatious politeness, are coarse and brutal under the surface, and are loose, lewd, and polygamous.

Professor Sawyer's introduction to the volume is a brief essay on the present American aspects of the Chinese question. He considers it from the point of view of the recent treaties with China negotiated by the American envoys, Angel, Swift, and Prescott, the text of these treaties being given at the close of the volume. Professor Sawyer takes what may be called the liberal or anti-Californian view of the subject. He shows the futility of the reasons commonly offered for excluding the Chinese from the country, and in this connection remarks: "We have long endured the immigration of Celts and Teutons at a rate fifty times more rapid than the coming of the Celestials, and no political economist would dare to say that we should be better off without them, although they have made it almost impossible to govern New York and some other cities even respectably. Strange to say, these very Celts and Teutons are the men whose minds are most exercised lest we should be overrun by an inferior race; and their hoodlum sons, not the Chinese, are the disturbing element in San Francisco."

A HAND-BOOK OF VERTEBRATE DISSECTION. By H. NEWELL MARTIN, D. S. C., and WILLIAM A. MOALE, M. D. Part I. How to dissect a Chelonian. New York: Macmillan & Co. 1881. Pp. 94. Price, 75 cents.

THE multiplication of special monographs for guidance in practical scientific study is

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an excellent sign of the times, as it becomes an index of activity in the field of experimental work. But these little manuals of practice are generally prepared with no other view than to serve as convenient helps in manipulation, and are but rarely steps in a broad, well-defined educational plan. The little book before us is of a different character, and has its place as part of a comprehensive system of biological study.

Professor Martin, who has charge of biology in Johns Hopkins University, has organized his department of teaching on a rational basis, and this book is the first installment of a series of small hand-books which has had its origin in his experience and necessities as a teacher. His theory of the method of study, which is hardly new, but has not been before reduced to a working system, is that students should first acquire some general idea of the elements and relations of their subject before concentrating study upon special divisions of it. In accordance with this idea, he some years ago, in connection with Professor Huxley, issued a volume called "Practical Biology," which was designed to introduce students to this science by observations of the structure and life-history of a number of typical plants and animals. It assumed that there is properly a science of living beings, as such, quite apart from any division of them into animals and plants. The course of study prescribed was experimental and thorough, and designed to lay a firm foundation for the further pursuit of the subject. Being thus grounded in general biology, the student is prepared to take up botany, or animal anatomy and physiology, and proceed with them to the greatest advantage. The present hand-book comes in at this point when it is proposed to enter upon the scientific investigation of vertebrates, and it shows him "how to dissect a chelonian." The *Chelonia* are reptiles of the tortoise kind, and among these Professor Martin selects the Red-bellied Slider Terrapin for dissection, and adapts his book to the details of its structure. But, if students can not find this species, Professor Martin says that it is quite as well, and even in some respects better, to obtain species slightly different from the one described; the attention of students being kept more alert when they find they can not altogether rely on the description in the book, but have to look at everything carefully for themselves.

The present monograph will shortly be followed by two others, containing directions for the dissection of a pigeon and a rat, both of which are nearly ready for publication. The series will ultimately include a bony and a cartilaginous fish, a lizard, and one of the large-tailed amphibia, and when completed the series will form a Hand-book of Vertebrate Dissection.

ALGEBRA FOR SCHOOLS AND COLLEGES. By SIMON NEWCOMB, Professor of Mathematics, U. S. Navy. New York: Henry Holt & Co. 1881. Pp. 454. Price, $1.90.

A CHARACTERISTIC of this book is that, for the convenience of teachers, it is divided into two parts: the first adapted to well-prepared beginners, and comprising about what is commonly required for admission to college; and the second designed for the more advanced general student.

In the preparation of his work, Professor Newcomb recognizes two important principles in education which are much overlooked, and are novelties in their application to algebra. The first is that, in the acquisition of knowledge, an idea can not be very fully grasped by the youthful mind unless it is presented under a concrete form. This requires that, whenever possible, an abstract idea should be embodied in some visible representation, and all general theorems presented in a variety of special forms. In accordance with this principle, numerical examples of nearly all algebraic operations and theorems have been given. Algebraic operations with pure numbers are made to precede the use of symbols, and the latter are introduced only after the pupil has had a certain amount of familiarity with the distinction between algebraic and numerical operations. The second principle is the importance of time in mental processes. All mathematical conceptions require time to become ingrafted upon the mind, and the greater their abstruseness the more time is needed. The author is of the opinion that the backward state of mathematical instruction in this country, as compared with Europe, is due to a neglect of

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this principle. He says: "Let us take, for instance, the case of the student commencing the calculus. On the system which was so universal among us a few years ago, and which is still widely prevalent, he is confronted at the outset with the number of entirely new conceptions, such as those of variables, functions, increments, infinitesimals, and limits. In his first lesson he finds these all combined with a notation so entirely different from that to which he has been accustomed, that before the new ideas and forms of thought can take permanent root in his mind he is through with the subject, and all that he has learned is apt to vanish from his memory in a few months. To meet this difficulty, the author has not scrupled to deviate from strict logical order to introduce the more advanced conceptions, disguised, perhaps, under some simple form at the earliest practicable period in the course. Some familiarity with ideas is thus acquired before their more formal enunciation. The practical feature of the work subsidiary to this principle consists in subdividing each subject as minutely as possible, and exercising the pupil on the details preparatory to combining them into a whole. Exercises in the use of algebraic language have been made to precede any solution of problems. In general, each principle which is to be presented or used is stated singly, and the pupil is practiced upon it before proceeding to another."

These features of the work certainly conform to sound educational philosophy, and they justify the conclusion that it has been executed throughout in a similar spirit. Professor Newcomb's reputation as a mathematician will be sure to commend his work to the favorable regard of teachers, and experience with it will test the fidelity with which he has applied the principles we have referred to, and others of perhaps equal importance which we have not space to notice.

MAN'S ORIGIN AND DESTINY, SKETCHED FROM THE PLATFORM OF THE PHYSICAL SCIENCES. By G. P. LESLEY, State Geologist of Pennsylvania. Boston: George H. Ellis. Pp. 442.

THE chief portion of this volume was prepared as a series of lectures, and delivered at the Lowell Institute, Boston, in 1866. They were published in a volume under the present title in 1868, and, the work continuing to be called for, some slight corrections were made in the plates, and a new edition is now issued, to which six more lectures are added.

It was the author's aim in his lectures "to attempt to show how far the sciences, as they are now advanced, succeed in throwing light upon the early history of our race"; or "to stimulate one class of minds by certain new suggestions respecting the correlation of the physical sciences with the history of mankind." His book is in no sense the systematic exposition of a theory which he claims as his own, but is rather a free, discursive interpretation and criticism of some of the leading doctrines and tendencies of modern scientific thought. The purpose and quality of the work are sufficiently indicated in the following prefatory passage: "The author never contemplated anything beyond a general sketch of the present bearings of science upon the vexed question of the origin and early history of man. But the question has many subdivisions. He intended the several lectures to be separate sketches of those subdivisions of the field of discussion—mere introductions to their proper study. His views are stated, therefore, in round terms. Nothing is closely reasoned out. Much is left to the logical instinct, and more to the literary education, of the reader. Reference is everywhere made to the sources of information within easy reach of all. Even the style of an essay has been avoided. The book is merely a series of familiar conversations upon the current topics of interest in the scientific world."

We have gone through Mr. Lesley's book with interest and profit—pleased with its brilliant and forcible passages, which are frequent; instructed by its learning and its abounding facts, and stimulated by its incisive observations and its forcible arguments. But the work is strongly stamped with the author's individuality, and its supplementary chapters especially, fresh and breezy as they are, contain various opinions to which we find it impossible to subscribe. The view taken of sociology, in the lecture on "The Social Destiny of the Race," appears to us inadequate and not up to the times; and in the lecture on "The Future

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Economics of Mankind" we seem to hear the voice of a Pennsylvania official rather than the scientific master of economical principles. But, notwithstanding its faults, the work is original, helpful, and invigorating, and those who are concerned to note the drifts of modern inquiry will be sure to find it serviceable.

THE MICROSCOPE AND ITS REVELATIONS. By WILLIAM B. CARPENTER, M. D., F. R. S. Sixth edition. Illustrated by Twenty-six Plates and Five Hundred Wood-Engravings. Philadelphia: P. Blakiston & Co. 1881. Pp. 882. Price, $5.50.

THE admirers of the veteran physiologist Dr. William B. Carpenter will be gratified to learn that his surrender of the registrarship of the University of London, to which he had given nearly a quarter of a century of his life, was not the signal of retirement from scientific labor. On the contrary, liberation in one field has only led to greater activity in another. His elaborate work on the microscope has long been a standard for practical students, and has well kept up with microscopical improvement and progress. In preparing the fifth edition the pressure of official duties upon his time made it necessary to call in assistance in getting ready certain parts of the work. But, being recently more at liberty, he has rewritten those parts, and has devoted himself to the task of thoroughly revising and much extending the whole treatise in this sixth edition. We have spoken of former editions of the book in terms of strong commendation, and an examination of the present has only served to heighten our estimate of its excellence. It is encyclopedic in scope, and profusely and elegantly illustrated. The ease and clearness of Dr. Carpenter's style are well known, and no book that he has written better illustrates these qualities than "The Microscope." There is another feature of the work that adds greatly to its popular value—the large amount of interesting information in each department of natural history, which is made a subject of microscopical study. While 266 pages are devoted strictly to the construction, forms, properties, and manipulation of the instrument, more than 600 pages are given to its applications in the living world. This greatly enhances the interest of the work, and gives it a completeness possessed by no other microscopical manual. Every one who has a microscope will need also Dr. Carpenter's book to get the most out of his instrument; and every one who has the book will be certain to want a microscope.

PUBLICATIONS RECEIVED.

The Mechanic's Slide Rule and how to use it. By Frederick T. Hodgson. New York Industrial Publication Co. 1881. Pp. 29. 25 cents.

The New Botany. A Lecture on the Best Method of Teaching. By W. J. Beal, Ph. D., Professor of Botany in the Agricultural College, Lansing, Michigan. Pp. 15.

The New Ethics. An Essay on the Moral Law of Use. By Frank Sewall. New York: G. P. Putnam's Sons. 1881. Pp. 61. 75 cents.

Quarterly Report of the Chief of the Bureau of Statistics for the Three Months ended June 30, 1881. Washington: Government Printing-Office. Pp. 107.

Contributions to the Study of the Toxicology of Cardiac Depressants. I. Carbolic Acid. A Summary of Fifty-six Cases of Poisoning, with a Study of its Physiological Action. By Edward T. Reichert, M. D. Pp. 25.

Thirty-ninth Missouri University Catalogue, 1880-'81. Including Report to the Governor. Pp. 176.

Tertiary Lake Basin of Florissant, Colorado. By Samuel H. Scudder. Washington. 1881. Pp. 22. With Map.

Ottawa Field Naturalists' Club. Transactions No. 2. Ottawa, Canada. 1881. Pp. 44.

On some Mammalia of the Lowest Miocene Beds of New Mexico. By E. D. Cope. 1881. Pp. 12.

On the Origin of the Iron-Ores of the Marquette District, Lake Superior, pp. 10; and On the Age of the Copper-bearing Rocks of Lake Superior, pp. 2. By M. E. Wadsworth. Cambridge, Massachusetts.

The Hessian Fly. Its Ravages, Habits, Enemies, and Means of preventing its Increase. By A. S. Packard, Jr., M. D. Washington: Government Printing-Office. 1880. Pp. 43.

General Index and Supplement to the Nine Reports on the Insects of Missouri. By Professor C. V. Riley. Washington: Government Printing-Office. 1881. Pp. 177.

On the Conidæ of the Loup Fork Epoch, pp. 4; and Review of the Rodentia of the Miocene Period of North America, pp. 26. By E. D. Cope. Washington. 1881.

Osteology of Lanius Ludovicianvs Excubitorides, pp. 9; and Osteology of the North American Tetraonidæ, pp. 4. With Nine Plates. By Dr. R. W. Shufeldt, U. S. A. Washington. 1881.

The President's Report to the Board of Regents of the University of Michigan, for the Year ending June 30, 1880. Ann Arbor. 1880. Pp. 76.

Annotated List of the Birds of Nevada. By W. J. Hoffman, M. D. Extracted from the Bulletin of the United States Geological and Geographical Survey. Washington. 1881. Pp. 54. With Map.

Astronomical Papers. Vol. I, Part 5. On Gauss's Method of computing Secular Perturbations. Washington. 1881. Pp. 44.

"American Journal of Mathematics." Vol. III, No. 4. Cambridge: University Press. December, 1880.

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American Juvenile Speaker and Songster. By C. A. Fyke. Cincinnati: F. W. Helmick. Pp. 127. 40 cents.

The Mother's Guide in the Management and Feeding of Infants. By John M. Keating, M. D. Philadelphia: H. C. Lea's Son & Co. 1881. Pp. 118. $1.

Florida, for Tourists, Invalids, and Settlers. By George M. Barbour. With Maps and Illustrations. New York: D. Appleton & Co. 1882. $1.50.

The Labor Question, or an Exact Science of Equivalents. Chicago: Legal News Co., Printers. 1881. Pp. 186.

Celestial Objects for Common Telescopes. By Rev. T. W. Webb, F. R. A. S. New York: Industrial Publication Co. 1881. Pp. 493.

First Annual Report of the United States Geological Survey. By Clarence King, Director. Washington: Government Printing-Office. 1880. Pp. 79. With Map.

Antiseptic Surgery. The Principles, Modes of Application, and Results of the Lister Dressing. By Dr. Just Lucas-Championnière. Translated and edited by F. H. Gerrish, M. D. Portland: Loring, Short & Harmon. 1881. Pp. 289. $2.25.

An Introduction to the Science of Comparative Mythology and Folk-Lore. By Rev. Sir George W. Cox, M. A. New York: Henry Holt & Co. 1881. Pp. 330. $1.75.

POPULAR MISCELLANY.

The Mammoth Cave.—Professor H. C. Hovey made some interesting statements at the last meeting of the American Association concerning recent discoveries, measurements, and temperature observations in the Mammoth Cave. No exact measurements of the cave have ever been given, and most of the statements that have been published rest upon the representations, seldom accurate, of guides and proprietors. Even after Professor Hovey had received permission to make his observations, he was requested by the manager of the cave not to make any of the facts he had gained public. This is for the fear that other land-owners near the cave may learn where to look to find a rival entrance to the one that is now known. A fairly correct survey was made about forty years ago, the results of which, after they had been purposely confused to some extent, were embodied in the map of "Stephen Bishop, the Guide," but the map gave too correct information to suit the jealous proprietors, and was destroyed. Only one copy of it is now known to exist. Dr. Forwood's map, published in 1870, was declared to contain several deviations from accuracy. Dr. Blackall, of Chicago, made a careful survey, several years ago, on the basis of which he prepared a lecture, but was prevented from delivering it by an injunction. Another survey was made by Jeffreys, but the person who had possession of the notes has died, and they can not be found. Mr. Klett, the manager of the cave, is making a thorough survey, the results of which, it is hoped, the proprietors may be induced to allow to be published. Professor Hovey is himself trying to collect all the descriptions of American caverns, and has accumulated quite a voluminous mass of cave literature, embracing more than a hundred distinct treatises of greater or less importance. The cave is stated in Owen's "Geological Report of Kentucky" to include two hundred and twenty-three avenues. Professor Hovey visited fifty-three avenues, and could get accounts of only eighty. A curious property was observed in Echo Hall, in that at a point about midway in the stream, when the notes of a full chord are sounded in slow succession, they are repeated by the arched wall overhead in *arpeggio*, and accompanied by a wonderful deep undertone. In regard to the question whether carnivorous animals accustomed to living in the open air would make their abode in caves, a dog, which had made repeated trips to the cave, finally staid at a point beyond Echo River, seemingly happy and contented, and refused to go out. The highest temperature of the cave in the hottest season does not exceed 56° Fahr. The lowest temperature was 33°. Professor Hovey spoke of the extensive saltpeter-works that were instituted at the cave during the War of 1812, whence immense quantities of the salt were carried to Philadelphia on mules and in ox-carts, the *débris* of which still exist in great heaps of lixiviated earth, but of which no adequate record has been made.

The Floating Gardens of Cashmere.—The floating gardens of the Lake of Serinagur, Cashmere, are among the most curious specimens of horticultural art. A group of them when viewed in the evening gives an effect much like that of a harbor with its fleet of ships rising and falling with the swell of the waves. The foundation of the garden is formed by planting long stakes in the lake in two or three rows, at distances

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apart varying according to the size which it is intended to give the bed. Rooted plants are gathered from the lake and interwoven with the stakes. They continue to grow and form the floor of the bed, upon which more plants brought up from the lake are piled, until a kind of hill is formed half a yard in diameter and about two feet high. These hills are placed at distances apart which vary according to the nature of the vegetables that are to be raised upon them; the weeds of which they are formed soon dry up and decay, and the plants which are to be cultivated, consisting mostly of melons and allied species, are taken from the seed-beds in which they have been started, and planted upon them. At first, the plants are watered regularly, but their roots soon reach the water beneath the floor, and they then take care of themselves. The products of the gardens are gathered during the summer as they mature, by means of little boats which circulate among the floats, and are taken to the city and sold to a population which willingly pays a good price for them. The floating gardens will last for a great many years, or until the stakes which support them are rotted away, and may be perpetuated for an indefinite period by simply renewing the stakes at the proper time. They can be moved, but are generally fixed at the spot which the cultivator selects as most convenient for himself. Floating on the surface of the water, they rise and fall with the rise and fall of the lake, without any interruption to the development of the crops growing upon them. A very large amount of produce is raised upon the lake. Besides those plants which are cultivated directly, it furnishes several other useful productions spontaneously, such as the lotus, whose roots look like giant asparagus, without having its taste or flavor, but the seeds of which remind one of fresh nuts; water-chestnuts (*Trappa natans*), which are abundant; and quantities of water-lilies, the seeds and roots of which are often eaten. The fish also are excellent, varied, and abundant. The government derives a considerable revenue from the rent of fishing and gardening privileges.

Characteristics and Diversities of Deep-Sea Fauna.—M. A. Milne-Edwards has derived some novel and interesting if not startling conclusions from the study of the deep-sea fauna which were discovered by the dredging expeditions in the Caribbean Sea. He has been especially struck by the differences that exist between the animals of the bottom of the ocean and those of the surface and littoral. When, he says, we compare the specimens, we seem to have under our eyes two distinct fauna, which belong neither to the same period nor the same climate. The importance of this fact ought not to escape any one, and geologists should take it into account in determining the age of any formation. In reality, there are being formed to-day in the same seas deposits of which the contemporaneousness can not be put in doubt, but which contain the remains of beings entirely dissimilar. The animals in the deposits near the shores are related to the highest types of organization; those of the deep-sea-beds are of a more ancient character. Some among them exhibit incontestable affinities with fossils of the secondary epoch; others resemble the larval state of certain existing species. The infinite variety of zoölogical forms excites astonishment, and makes the application of existing classifications almost impossible. Transition types abound, with numerous intermediaries between groups, which we have hitherto been in the habit of considering as distinct. "Researches," continues M. Milne-Edwards, "on the animals of great depths have only been begun; and when we compare the limited extent over which dredgings have been made with the immense spaces that have never been penetrated, when we reflect on the many causes which still make the retreats of certain animals inaccessible to any means of investigation that we have, we become convinced that the results which have been obtained are only a small part of what the future has in reserve for us. We can not, then, insist too much on directing the attention of men of science of all countries to the usefulness of making their efforts coordinate, and of undertaking methodical explorations in the seas to which they have the most easy access. Our zoölogical tables still present so many gaps that it is impossible to comprehend the wholeness of the plan which has presided over the grouping

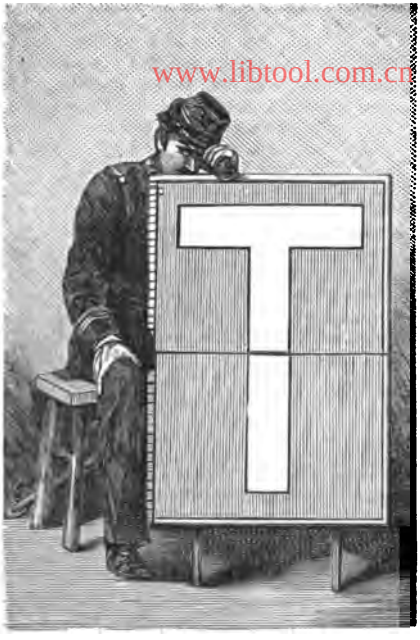
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of beings. Paleontological discoveries on the one side, and those which submarine explorations promise us on the other, will gradually fill these voids, and will, perhaps, some day permit naturalists to grasp the relations which exist between animals."

Images of the American Stone Age.—Among all the relics of the stone age, said Mr. William McAdams, in his paper on the subject, read at the Cincinnati meeting of the American Association, none are of more interest to the student of ethnology than the sculptured forms of men and animals found on some of the stone objects taken from the mounds. These objects might be divided into four classes: 1. The mound-pipes, with a curved or crescent-shaped base forming the stem, the bowl of the pipe representing some animal. These pipes are not made of very hard stone, as has generally been supposed. They are quite small and delicate, many of them showing both taste and skill in manufacture. 2. A class consisting of much larger and somewhat exaggerated representations of men and animals, many of them having a crouching, sphinx-like form, strongly resembling the ancient forms from the Nile. Some of them have no perforation, but the majority of them have two funnel-shaped perforations, and were probably used as pipes on occasions of great ceremony. Some of these images, from mounds in Illinois, weighing ten or twenty pounds or more, are sculptured from hard stone, and are among the finest works of the stone age. 3. A class of singular mask-like figures, in which the human face alone is represented presumably of the natural size. The fourth class consists of representations of the human form which may have been real idols. One from Union County, Illinois, cut from quartzite, the most refractory material known, represents the body in a sitting posture, with the hands on the knees, has a face with features not those of a modern Indian, is smooth and highly polished, and is, perhaps, the finest piece of aboriginal sculpture that has been found in the United States. Mr. McAdams thought these objects were used in religious observances, and believed that the evidence showed that the mound-builders were fire-worshippers. Professor Putnam, who is one of the unbelievers in a distinct race of mound-builders, remarked that many of the supposed idols, pipes, etc., may have been toys for children.

The Telelogue.—The visibility of signals designed to be seen at a distance depends upon the contrast between the light given by the signals and that of the ground against which they are seen. The contrast has commonly been obtained in aërial telegraphy by exhibiting dark bodies against the light of the sky. To make this effective, it is necessary to raise the dark bodies to some height, and this involves the use of apparatus which must be more or less cumbrous. In the telelogue of Captain Gaumet, the difference in brilliancy required to give distinctness to the signal is gained by employing a silver surface designed upon a dark ground. A slight inclination of the apparatus is enough to cause the silver to shine very brightly, and in strong contrast with the dark ground, by the reflection of the diffused light which it receives from the sky. For signals, Captain Gaumet employs the letters of the alphabet and the numerals, remembering that we most readily recognize those forms with which we are familiar. The telelogue consists of two essential parts: the telegraph-album, or book of signals, and a telescope. The telegraph-album is a collection of forty leaves of coarse black cloth on which the silver signals, including the letters of the alphabet, the numerals, and a few conventional signals, are fixed. To secure economy of bulk while the letters shall be as large as possible, each signal occupies the reverse of one leaf and the front of the leaf behind it, as is shown in the figure, where the leaf that is turned down bears the lower part of the T on its back, and the upper part of the letter is exposed on the leaf behind it. Each leaf is marked with an index to enable the operator to find it quickly. The cover of the album is made of stiff leaves, which put together form a table or a rigid back, and one of which is furnished with feet, to which a third foot is added, constituting a tripod when the apparatus is used. The telescope should be strong and very clear. The dimensions, both of the album and telescope, will depend on the

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distance at which the signals are to be seen. At present three sizes are used, corresponding with distances of two and a half, eight, and ten and a half miles. The medium size measures about twenty by thirty inches, and weighs, with the telescope, less than twenty pounds. If the apparatus is to be used at night, artificial illumination will be needed; a petroleum-lamp with a reflector, or, for greater distances, two lamps, will be enough. To use the apparatus, the album must be fixed on its tripod at such an angle that the reflection from the silver shall be brightest, and shall reach the spot with which communication is to be had. A plate which is all silvered, and which appears in the distance as a bright point, is exposed as a signal of warning: the operator at the other post answers with an identical signal that he is ready. The letters composing the telegram are then exhibited one after the other, and the words are separated by showing the wholly silvered plate or plain spot. If any signal is to be repeated, as in the case of double letters or the repetition of a figure, it is hid for a moment by a black leaf and shown again. The operator at the other station receives the dispatch with the aid of his telescope, distinguishing the letters and spelling the words as they come, and writing them, or having them written, down. The image produced by these large characters, seen at a distance through the glass, corresponds with sufficient exactness with that produced by the same characters when read in a book or a newspaper. In the experiments that have been made, dispatches of twenty words have been transmitted in five minutes. Speed may be gained by using single conventional characters for the more common words. Secrecy may be secured by so fencing in the album as to prevent the diffusion of its reflection, and limit the field of its visibility to the other station, or by employing a cipher.

Ancient Aboriginal Houses.—Judge Henderson, of Illinois, discussing the character of the houses of the ancient inhabitants of the Mississippi Valley, said that it was a mistake to regard the "cone-like cabin"—which is really only a temporary hunting-hut or abode of a tribe in a nomadic condition—as the typical wigwams of the aborigines at the beginning of the historic period. Such houses were not found in the villages of the sedentary tribes, but these lived in large houses, each accommodating a number of families belonging to the same *gens*. These long houses were made with framework, and covered with such material as the country afforded—bark in the East, mats made from the leaves of the cat-tail in the prairies of the West—and were divided into sections by skins, sheets of bark, or mats hung up at intervals, and had a hallway in the middle, extending the full length of the house. One family occupied each of these sections, and a fire built in the doorway of every second partition served for two families. In the South, the houses were of sticks plastered with mud, and sometimes covered with mats, while the roof was covered with mats or thatched with straw or canes. The absence of any traces of ruins or of foundations shows that the houses of the ancient inhabitants of the land could not have been of stone, or massive structures of wood; and they could not have been of adobe, for that would not have withstood our winters. Professor Morgan's theory that the houses were pueblos, built

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on raised terraces, like those found in the Ohio Valley, is not sustained, for no such terraces are found near the animal-shaped mounds of Wisconsin or the burial-mounds of the Illinois River. Judge Henderson believes, therefore, that the ancient houses were of a similar character to those that he has described as existing at the beginning of the historical period.

NOTES.

DENISON'S Improved Reference Index is an ingenious arrangement to give aid in making references in dictionaries and cyclopædias. It can be added to any such book at small cost and without disfiguring it, saves time and avoids perplexity at exactly the right moment when a reference is to be made. Instead of fumbling till patience is exhausted, and the mind distracted by the host of suggestions in looking over the pages—with the imminent danger of forgetting what one is after—Mr. Denison's device takes you to the letter you want instantly, by a single glance and a single motion. The invention is a godsend to students.

JOHANN MARIA HILDEBRANDT, a German African traveler of growing reputation, died in Antananarivo, Madagascar, while engaged in exploring the island, May 29th. Previous to going to Madagascar, he had spent several years on the eastern coast of Africa, and had had the honor of having a characteristic African moss (Hildebrandtiella) named after him. One of his later contributions to the Berlin Geographical Society's "Zeitschrift" contained an interesting description of the vernal phenomena in Madagascar, in which he said that spring arrives about the middle of November, when the cold southeastern wind which has blown throughout the winter, leaving its moisture on the eastern slopes of the forest-covered highlands and driving before it the savanna-fires, gives place to the northwestern wind, bringing warmth and moisture.

M. DE LESSEPS has been elected President of the French Geographical Society, "in recognition of the services he has rendered to science, and of his rank among the most illustrious men of his country and of the whole world." The enthusiasm which Frenchmen feel for their great engineer was tersely expressed by General Turr, who, asking the patronage of M. de Lesseps for his canal across the Isthmus of Corinth, styled him "General-in-Chief of Isthmuses and Canals."

JOHN DUNCAN, the weaver-botanist of Alford, England, died in that place, on the 9th of August, in the eighty-seventh year of his age. Though he had been known in private to a few men of science as a man dependent on daily labor for the means of subsistence, who had become perfectly accomplished in the botany of his district, and had made valuable researches in it, he was not known to the public till about a year ago. Then, when, enfeebled by age, he was about to fall upon the parish, Mr. Jolly, inspector of schools, published an account of his work and his condition in the newspapers. A general interest was awakened in his case, and subscriptions were spontaneously offered, which enabled him to pass his few remaining days in comfortable ease. What he had—his books and the proceeds of the subscriptions—he has left in trust for the promotion of the study of science in Alford and its neighborhood.

MR. HEWETT COTTRELL WATSON, one of the most indefatigable workers in British botany, died July 27th, in his seventy-eighth year. He was a prolific writer on the geographical distribution of British plants, and on the distinguishing characters of the more critical species, a contributor to periodicals, and editor of the "New Botanist's Guide," "Cybele Britannica," and the "London Catalogue of British Plants." In his garden were collected growing specimens of rare or little known British plants. He visited the Azores in 1847, with the result of adding much to the world's knowledge of the botany of the islands.

IT was already known that music exercises a very perceptible influence upon the circulation and respiration of the human subject. Recent researches by M. Dogiel have shown that the same is the case with animals.

DR. FERDINAND KELLER, the discoverer for science of the lake viliages of Switzerland, died at Zurich, May 19th, at the age of eighty-one years. His attention was first called to the lake villages in the winter of 1853–'54, when the remains of the structures at Obermeilen were made visible by an unprecedentedly low stage of the water in the Lake of Zurich. He communicated an account of what he had found to the Antiquarian Society of Zurich, and thereby awakened a lively interest in what has become one of the most engaging and instructive departments of prehistoric research.

M. DUBRUNFAUT, a French chemist of considerable merit, who has recently died at the age of eighty-four years, was best known by his discoveries of new processes in the manufacture of beet-sugar, which are still in use. At the time of his death he was engaged upon a treatise on human longevity.

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JOHN WESLEY POWELL.

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THE

POPULAR SCIENCE MONTHLY.

JANUARY, 1882.

EARTH-WORMS AND THEIR WONDERFUL WORKS.*

By W. H. LARRABEE.

THE subject of Mr. Darwin's latest volume is the share which worms have taken in the formation of the layer of vegetable mold that covers the surface of the land in every moderately humid country. It is a real surprise to learn, from the observations which Mr. Darwin has so patiently made for nearly half a century, and which he records in this work, how important a part these unconsidered creatures have played in giving to the surface of the land its generally fine consistency and fertile properties, and how essentially and vastly they have contributed to the comfort and prosperity of mankind. Ever since his first paper on vegetable mold was read before the Geological Society of London, in 1837, Mr. Darwin has kept on with his investigations, in flower-pots in his room, in his garden, and in the field, and has detected the work of the worms wherever anything will grow—in meadows and table-lands, in cultivated places and in woods, on mountains fifteen hundred feet high in Scotland, nearly twice as high at Turin, seven thousand feet above the sea on the Nilgiri Hills of Southern India, and on the slopes of the Himalayas—effecting the transformation of the hard, cold earth, and the raw leaves into fine, fruitful soil. It is easy to say, as some have done, that the creatures are too insignificant to accomplish so extensive a work; but the facts adduced by Mr. Darwin convey a striking lesson in the principle that nothing is so minute that it can be despised.

We may first consider the agent apparently so insignificant that has done so much to transform and clothe the surface of the earth.

* The Formation of Vegetable Mold through the Action of Worms, with Observations on their Habits. By Charles Darwin, LL. D., F. R. S. With Illustrations. Published by D. Appleton & Co., New York.

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Lumbricus is the name of the best-known genus, of which the species have not been accurately distinguished and numbered; but only a part of them bring up earth in the form of castings, and are engaged in making tillable soil. They appear to be found wherever there is moist earth containing vegetable matter, but seem to abound most where the ground is loose and well charged with humus. Dryness is unfavorable and even fatal to them; but, although they are terrestrial animals, they have been found by M. Perrier to be capable of living for a considerable time under water. During the summer, when the ground is dry, and during the winter, when it is frozen, they penetrate to a considerable depth in the earth and cease to work. They are nocturnal in their habits, and may be often seen at night crawling over the ground, more often moving their heads and bodies around while their tails are still inserted in their burrows. Only sickly worms, such as are afflicted by the parasitic larva of a fly, as a rule travel in the day-time; and those which are seen dead on the ground after heavy rains are supposed to have been creatures afflicted in some way that have died of weakness rather than by drowning. They often lie quite still close beneath the mouths of their burrows, where their heads may be seen on looking for them, and, in this position, offer a tempting bait to birds.



FIG. 1.—DIAGRAM OF THE ALIMENTARY CANAL OF AN EARTH-WORM (*Lumbricus*), (copied from Ray Lankester in "Quarterly Journal of Microscopical Society," vol. xv, new series, pl. vii).

The body of a large worm consists of one or two hundred almost cylindrical rings or segments, each furnished with minute bristles, and is endowed with a well-developed muscular system. The mouth is provided with a little projection or lip, capable of taking hold of things, and of sucking. Internally, a strong pharynx, corresponding, according to Perrier, with the protrusile trunk or proboscis of other annelids, and which is pushed forward when the animal eats, is situated behind the mouth. The pharynx leads into the œsophagus, on each side of the lower part of which are three pairs of large glands, which secrete a surprising amount of carbonate of lime. They are unlike anything that is known in any other animal, and their use is largely a matter of speculation. Mr. Darwin thinks they are partly excretions of the excess of lime contained in the leaves which the animal eats, and that they otherwise aid digestion by affording a neutralizing agent against the acids of its food. In most of the species the œsophagus is enlarged into a cup in front of

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the gizzard. The latter organ is lined with a smooth, thick, chitinous membrane, and is surrounded by weak longitudinal but powerful transverse muscles. Grains of sand and small stones, from one twentieth to a little more than one tenth of an inch in diameter, may be found in the gizzard and intestines, and are supposed to serve, like millstones, to triturate the food. The gizzard opens into the intestine, which presents a peculiar remarkable longitudinal involution of the walls, by which an extensive absorbent surface is gained. The circulatory system is well developed. Breathing is done by the skin, without special respiratory organs. The nervous system is fairly developed, with two almost confluent cerebral ganglia situated near the anterior end.

Worms have no eyes, and are measurably indifferent to light; yet they can distinguish night from day, and are quickly affected by a strong light, and after some time by a moderate light shining continuously upon them. They do not much mind a moderate radiant heat, but are sensitive to cold. They have no sense of hearing, but are extremely sensitive to vibrations in any solid object. Worms in pots, which had paid no attention to the sound of a piano, when placed on the piano instantly drew into their holes when the notes were struck. Their whole body is sensitive to contact, as of a puff of air. Their sense of smell is feeble, but responds fairly well to the odor of the cabbage and onion or whatever they like, as was shown to Mr. Darwin by some very interesting experiments. They are omnivorous, and swallow enormous quantities of earth, out of which they extract any digestible matter which it may contain, consume decayed and fresh leaves and vegetable matter, and raw, roasted, and decayed meat, but like raw fat best.

Mr. Darwin discovered in worms evidences of a degree of intelligence. They line their burrows with leaves as a protection, it is supposed, against the cold of the clammy ground, and plug the entrances to them with leaves and leaf-stalks. It requires some manipulation to get these leaves in right, but the worms know how to perform it, and can discriminate between the easiest way to draw the leaf in and other ways. Commonly, seventy or eighty per cent of the leaves are drawn in by the tips, that being the direction in which they go in most easily and fold most nicely. Some leaves, however, may be drawn in nearly as easily by the sides or the bases as by the tips, and a larger proportion of these are drawn in in those ways. The worm likes to gnaw the base of the petiole of the ash-leaf, and this leaf is drawn in by the base. Pine-leaves, which grow in pairs attached to a single base, must be drawn in by the base or not at all, and the worm rarely makes a mistake in the matter. Mr. Darwin suggests here, however, that we must not suppose the worm to know too much, and that some other quality than mechanical convenience may guide it to the selection of the base of the pine-leaf. Sometimes, when the worm begins to plug

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its hole, it drags leaf-stalks in by the base so as to fill it faster; but as soon as it comes to close quarters, it turns and drags the rest of the stalks in by the tips. Triangles of paper were given worms instead of leaves, and they likewise drew them in in the easiest way, apparently at the first trial. When worms can not obtain leaves, petioles, sticks, etc., with which to plug up the mouths of their burrows, they often protect them by little heaps of stones; and such heaps of smooth, rounded pebbles may frequently be seen in gravel-walks. A lady interested in this study removed the little heaps of stones from the mouths of several burrows, and cleared the surface of the ground for some inches all around. She went out on the following night with a lantern, and saw the worms, with their tails fixed in their burrows, dragging the stones inward by the aid of their mouths. After two nights some of the holes had eight or nine small stones over them; after four nights one burrow had about thirty and another thirty-four stones, and one of the stones weighed two ounces. The strength of worms is also shown by their often displacing stones in a well-trodden gravel-walk, a task that sometimes demands considerable effort.

Worms excavate their burrows in two ways: by pushing away the earth on all sides where the ground is loose or only moderately compact, and where they are able to disappear from sight with surprising agility; and by swallowing the dirt, where the ground is hard, and ejecting the swallowed earth afterward in the form of the "castings" which are found at the mouths of their burrows. Worms also swallow earth to extract the nutritous matter which may be contained in it, and in larger quantity than for making their burrows; and the residue of this, after the nutriment is extracted, is also cast out. The deposition of castings, then, is no insignificant part of the labor that they perform, and leaves very perceptible traces upon the surface. The castings may be seen by any one who will take the pains to look for them, and often in garden-walks without looking for them, piled up in the shape of towers of greater or less height around the burrows. The towers formed by a naturalized East Indian worm, at Nice, France, which are sometimes distributed as thickly as five or six to a square foot, are built to a height of from two and a half to three inches. The tower of a *perichæta* in the Botanic Garden at Calcutta, of which Fig. 2 is an exact representation, measured three and a half inches high and 1·35 inch in diameter. One tower from Calcutta was five inches high and two and a half inches in diameter; and the average weight of twenty-two castings sent Mr. Darwin from Calcutta was an ounce and a quarter. The largest castings mentioned came from the Nilgiri Hills in South India, seven thousand feet above the sea, and afforded one specimen that weighed a quarter of a pound, the largest convolutions of which were about an inch in diameter. The manner of forming the casting is described by Mr. Darwin: "A worm after swallowing earth, whether for making its

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burrow or for food, soon comes to the surface to empty its body. The ejected earth is thoroughly mingled with the intestinal secretions, and is thus rendered viscid. After being dried it sets hard. I have watched worms during the act of ejection, and when the earth was in a very liquid state it was ejected in little spurts, and when not so liquid by a slow, peristaltic movement. It is not cast indifferently on any side, but with some care, first on one and then on another side, the tail being used almost like a trowel. As soon as a little heap is formed the worm apparently avoids, for the sake of safety, protruding its tail, and the earthy matter is forced up through the previously deposited soft mass." Some of the towers, as the figure shows, exhibit a considerable degree of skill in their construction. The castings are not always ejected on the surface of the ground, but are often lodged in any cavity that may be met in burrowing. The burrows run down, sometimes perpendicularly, generally a little obliquely, to a depth of three, six, and even eight feet, and are usually lined with a thin layer or plaster of fine, dark-colored earth which the animals have voided, in addition to which a lining is made, near the mouths, of leaves, also plastered. Bits of stones and seeds are also sometimes found in the bottom of the burrows, having been taken down apparently with a purpose.



FIG. 2.—A TOWER-LIKE CASTING, PROBABLY EJECTED BY A SPECIES OF PERICHÆTA (from the Botanic Garden, Calcutta: of natural size, engraved from a photograph).

The amount of earth brought up by worms from beneath the surface has been carefully estimated by observing the rate at which stones and other scattered objects on top of the ground are buried. A piece of waste, swampy land, which was inclosed, drained, plowed, harrowed, and thickly covered with burned marl and cinders, and sowed with grass, in 1822, fifteen years afterward, presented the appearance, where holes were dug into it, shown by Fig. 3, the scale of which is half that of nature. Beneath a sod an inch and a half thick was a layer of vegetable mold, free from fragments of every kind, two and a half inches thick. Under this was another layer of mold, an inch and a half thick,

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full of fragments of burned marl, conspicuous from their red color, fragments of coal-cinders, and a few white-quartz pebbles. Beneath this layer, and at a depth of four and a half inches from the surface, the original black, peaty, sandy soil with a few quartz pebbles was

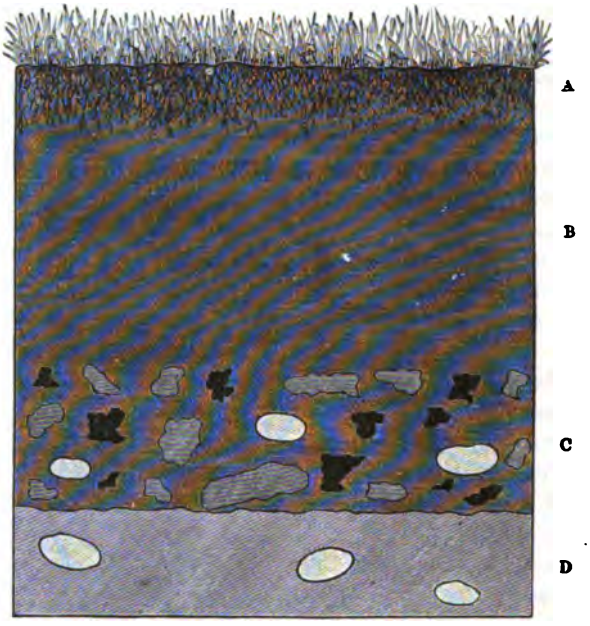


FIG. 3.—SECTION, REDUCED TO HALF THE NATURAL SCALE, OF THE VEGETABLE MOLD IN A FIELD, DRAINED AND RECLAIMED FIFTEEN YEARS PREVIOUSLY. A, turf; B, vegetable mold without any stones; C, mold with fragments of burned marl, coal-cinders, and quartz-pebbles; D, sub-soil of black, peaty sand, with quartz-pebbles.

encountered. "Here, therefore," says Mr. Darwin, "the fragments of burned marl and cinders had been covered in the course of fifteen years by a layer of vegetable mold, only two and a half inches in thickness, excluding the turf." Six and a half years afterward this field was re-examined, and the fragments were found at from four to five inches beneath the surface, having been covered in that time with an inch and a half more of mold. The average annual increase of thickness for the whole period was ·19 of an inch. This was less than the average increase of thickness in some other fields similarly observed, in which the accumulation amounted to ·21 and ·22 of an inch annually.

Another field, lying upon the chalk, and sloping rather steeply in one part, which was turned into pasture-land in 1841, was for several years so thickly covered with small and large flints that Mr. Darwin's sons always called it "the stony field." When they ran down the slope the stones clattered together; and Mr. Darwin remembers doubting whether he should live to see the larger flints covered with vegetable

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mold and turf. But the smaller stones disappeared before many years had elapsed, as did every one of the larger ones after a time; so that after thirty years, or in 1871, a horse could gallop over the compact turf from one end of the field to the other, and not strike a single stone with his shoes. This, says Mr. Darwin, "was certainly the work of the worms, for, though castings were not frequent for several years, yet some were thrown up month after month, and these gradually increased in numbers as the pasture improved." The accumulation of mold was, however, of the slowest, measuring only .083 of an inch a year. A flagged path in Mr. Darwin's garden disappeared in the course of years, it might be said under his very eyes, the worms covering it with an inch of mold.

A stone, sixty-four inches long, seventeen inches broad, and from nine to ten inches thick, part of the ruins of a lime-kiln that had been torn down thirty-five years before, lay in a field, its base sunk from one to two inches below the general level, while the surface of the field for about nine inches around it sloped up toward it to the height of four inches above the surrounding ground close to the stone. The stone could not have sunk by its weight, and there was evidence that one of its pointed ends, the upper surface of which was now on a level with the surrounding turf, must have stood clear of the ground for several inches. The situation of the stone is represented in Fig. 4.

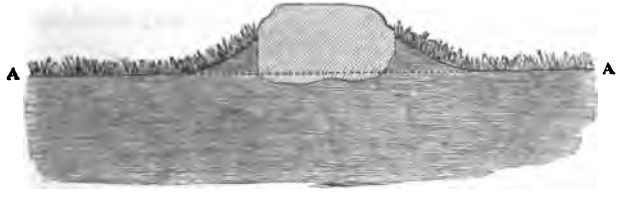


FIG. 4.—TRANSVERSE SECTION ACROSS A LARGE STONE WHICH HAD LAIN ON A GRASS-FIELD FOR THIRTY-FIVE YEARS. A A, general level of the field. The underlying brick rubbish has not been represented. Scale one half inch to one foot.

When the stone was removed, an exact cast of its lower side, forming a shallow crateriform hollow, was left, the inner surface of which, except where the base had been in contact with brick rubbish, consisted of fine black mold. The turf-covered border, which sloped up to the stone, consisted of fine vegetable mold, in one part seven inches thick, and was evidently derived from worm-castings, several of which had been recently ejected. This stone would have sunk to the level of the field in two hundred and forty-seven years if none of the castings were washed away by rains.

Some of the fallen stones at Stonehenge have become buried to a moderate depth in the ground, and are surrounded by sloping borders of turf, on which recent castings were seen. In the case of the stone represented in the cut (Fig. 5), which is by no means the most marked specimen, the turf-covered border sloped on one side to the height of

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four inches, and on the other side of two and a half inches, above the general level.

Thus, evidence is gathered that small objects left on the surface of the land where worms abound soon get buried, and that large stones

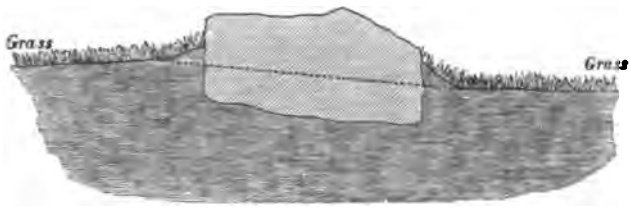


FIG. 5.—SECTION THROUGH ONE OF THE FALLEN DRUIDICAL STONES AT STONEHENGE, SHOWING HOW MUCH IT HAD SUNK INTO THE GROUND. Scale one half inch to one foot.

sink slowly downward by the same means. Every step of the process could be followed. Among the most striking features of the case are the straightness and regularity of the lines formed by the imbedded objects in cases where they have covered a considerable surface, and their parallelism with the surface of the land, for this parallelism shows how equally the worms must have worked. The specific gravity of the objects does not affect their rate of sinking, as could be seen by porous cinders, burned marl, chalk, and quartz pebbles having all sunk to the same depth within the same time; and many considerations seem to show that the sinking could not have been sensibly aided by the weight of the objects.

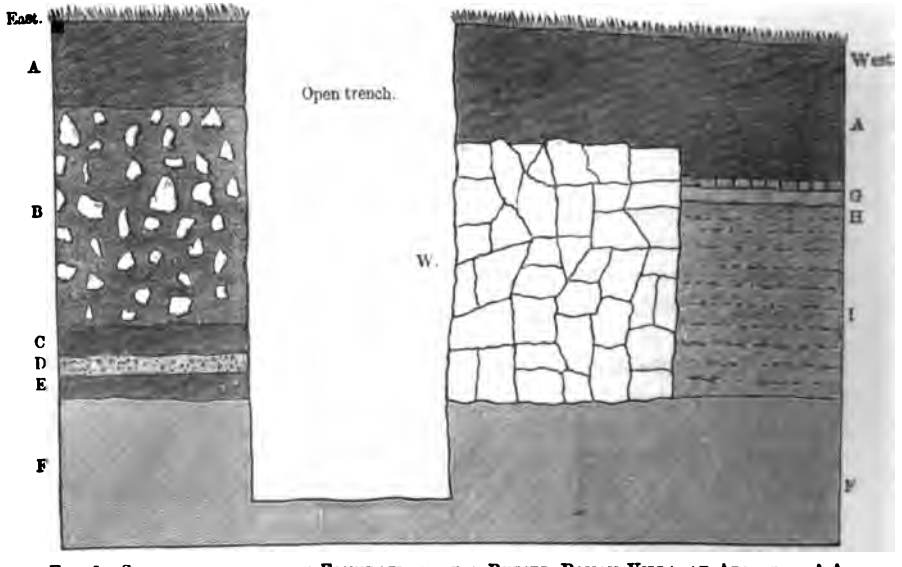


FIG. 6.—SECTION THROUGH THE FOUNDATIONS OF A BURIED ROMAN VILLA AT ABINGER. A A, vegetable mold; B, dark earth full of stones, thirteen inches in thickness; C, black mold; D, broken mortar; E, black mold; F F, undisturbed sub-soil; G, tesseræ; H, concrete; I, nature unknown; W, buried wall.

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The estimates of the amount of mold brought up by the worms, based on actual weighings and measurements of the castings at particular spots, give results ranging from 7·56 to 18·12 tons per acre in one year, and a volume sufficient to make when spread out a layer of soil of from one to more than two inches thick in ten years.

"Archæologists," says Mr. Darwin, "are probably not aware how much they owe to worms for the preservation of many ancient objects. Coins, gold ornaments, stone implements, etc., if dropped on the surface of the ground, will infallibly be buried by the castings of worms in a few years, and will thus be safely preserved until the land at some future time is turned up." The remains of ancient buildings seem also to have been buried effectively, in large part, through the action of worms. An example of this kind is furnished at Abinger, Surrey, where the remains of an ancient Roman villa were discovered in 1877. The cut (Fig. 6) represents the appearance presented by the buried wall and the ground around it at a point where one of the trenches was dug. The mold here was from eleven to sixteen inches thick over the tesselated floor, G, and from thirteen to fifteen inches thick over the broken summit of the wall, W. No signs of worms appeared on the trodden-down earth over the *tesseræ* when they were first cleared, but many signs of fresh worm-action were seen on the next day, and for the next seven weeks these signs were very abundant. Numerous burrows were also found in the course of the digging, and worms were brought up from a considerable depth. Three years afterward the worms were still at work, burrowing in the concrete floor and the mortar of the walls, as they had probably been doing ever since

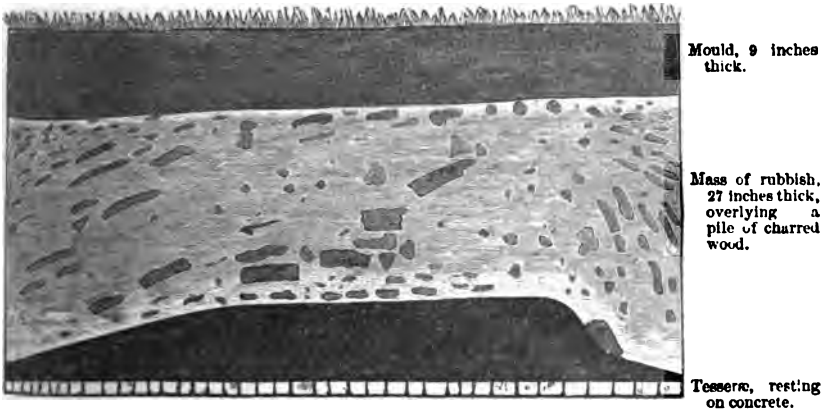


FIG. 7.—SECTION WITHIN A ROOM IN THE BASILICA AT SILCHESTER. Scale $\frac{1}{48}$.

the concrete had become decayed enough to allow them to penetrate it; and even before that period they probably lived under the floor, making burrows which, collapsing from time to time, helped make the walls and floor sink.

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Other striking examples of the action of worms are found in the ruins of the old Roman town of Silchester, of which Figs. 7 and 8 show the extent to which the basilica has been covered. In Fig. 7, the concrete floor, still covered here and there with *tesseræ*, is found at three feet below the surface, and on it are piles of charred wood, represented by the black. Fig. 8 does not reach to the natural subsoil. Worm-castings were observed on the floors of several of the rooms, in one of which the tesselation was unusually perfect. One or

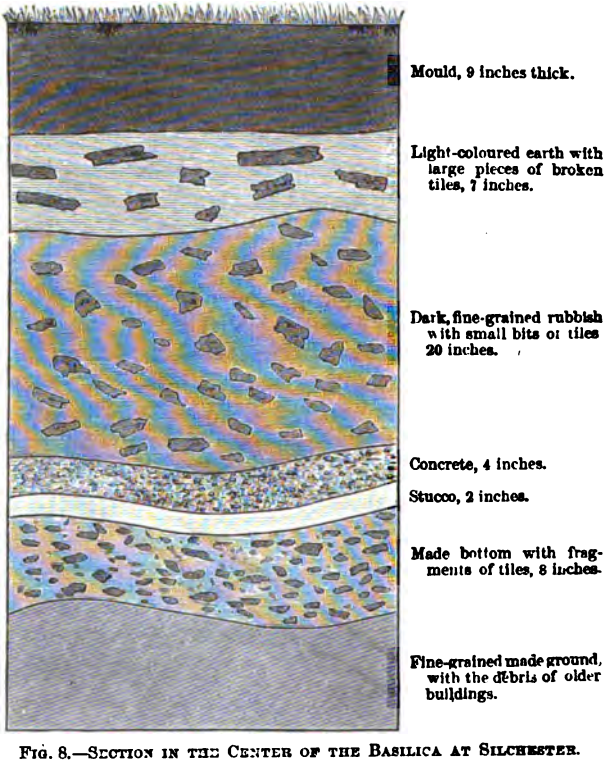


FIG. 8.—SECTION IN THE CENTER OF THE BASILICA AT SILCHESTER.

occasionally two open worm-burrows were found beneath all the loose *tesseræ*. Worms have also penetrated the old walls of the ruins, and were found in them, with traces of the mold which they had carried to them. In almost all the rooms the pavement has sunk considerably, as Mr. Darwin shows in three sections, one of which he gives (Fig. 9). Dust blown by the wind and earth washed from the hills may have partly aided in covering up these buildings, but the chief share of the work is attributable to worms.

Worms also contribute to the disintegration of the rocks and the denudation of the land, by generating humus acids which act on the carbonates, by grinding up in their crops the stones they swallow, and

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by bringing earth to the surface in their castings, to be blown away by the winds and washed away by the rains into the valleys. They are extraordinarily numerous. Hensen says there are 53,767 of them in an acre of garden-soil, and Mr. Darwin is willing to allow half that number, or 26,886, to the acre in corn-fields and pasture-lands; and as in many parts of England a weight of more than ten tons of dry earth annually passes through their bodies and is brought to the surface on each acre, the whole superficial bed of vegetable mold must pass through them every few years. By triturating this earth, by subjecting its minerals to the action of the humus acids, and by periodically exposing the mold to the air, they prepare the ground in an excellent manner for the growth of fibrous-rooted plants and for seedlings. The bones of dead animals, the harder parts of insects, the shells of land-mollusks, leaves, twigs, etc., are before long all buried beneath the accumulated castings of worms, and are thus brought in a more or less decayed state within reach of the roots of plants. Leaves are digested by them and converted into humus. Their burrows, penetrating to a depth of five or six feet, are believed to aid materially in the drainage and ventilation of the ground. They also facilitate the downward passage of roots of moderate size, which are nourished by the humus with which the burrows are lined. Many seeds owe their germination to having been covered by castings; others, buried more deeply, lie dormant till they are brought under conditions favorable to germination. "The plow," says Mr. Darwin, in conclusion, "is one of the most ancient and most valuable of man's inventions; but long before he existed the land was in fact regularly plowed, and still continues to be thus plowed, by earth-worms. It may be doubted whether there are many other animals

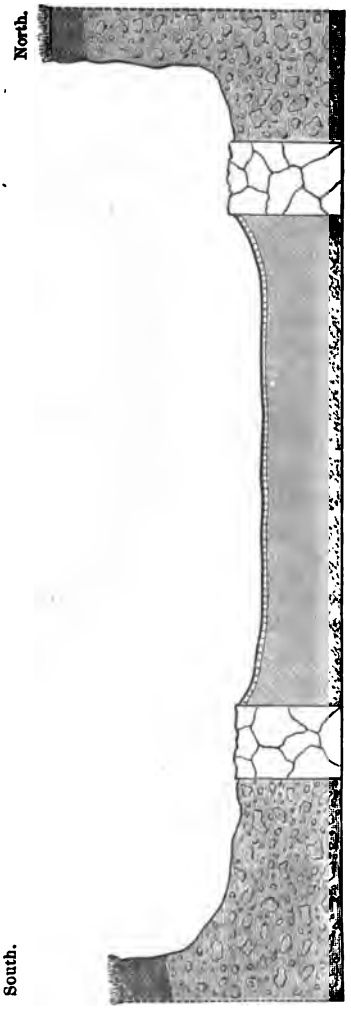


FIG. 9.—A NORTH AND SOUTH SECTION THROUGH THE SUBSIDED FLOOR OF A CORRIDOR PAVED WITH TESSERÆ. Outside the broken-down bounding walls, the excavated ground on each side is shown for a short space. Nature of the ground beneath the tesseræ unknown. Silchester. Scale, ½.

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which have played so important a part in the history of the world as have these lowly-organized creatures." The coral animal is their most conspicuous rival in this claim.

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ASTRONOMY IN HIGH-SCHOOLS.

By MISS ELIZA A. BOWEN.

I HAVE for some years been much interested in trying to introduce improved scientific teaching into girls' schools; and I propose to tell the result of some experiences in teaching astronomy.

Of course, the astronomy taught has been of the most elementary character. But it is therefore exactly the foundation which it is important to lay well. My object has been to gain for my pupils from this study, not merely knowledge, but all the mental discipline it could afford. In order to accomplish this, I have made it an invariable principle to make them do all the *observing*, all the *thinking*, possible. They have watched the heavenly bodies to discover their appearance and motions, and then I led them on to discuss the causes. It has been genuine inductive study, so far as it has gone. My own work seemed very simple; but it occasioned me a great deal of observation, thought, and study. I have simply *kept them on the track.*

It may at first seem a little absurd to talk of a set of school-girls treading, with any degree of mental independence, the path which Kepler and Tycho Brahe found it so difficult to walk in. Of course, it would be utter nonsense to say that they could exercise anything like the mental activity of those great men. But there are various degrees of the mind's activity, and it is possible to arouse, even in school-girls, a very wholesome and improving amount of it.

When I first began, I merely intended to make some girls of seventeen years old, who were soon to study Lockyer's "Astronomy," do some preparatory observing. I soon saw that it would have been desirable to begin earlier; and, in the room in which I talked to these young ladies, there were seated at desks some young girls of thirteen and fourteen years old, who listened to my talk and directions with great interest, and, as I soon found, were observing and thinking with as much energy as their older companions. It became out of the question to refuse instruction to those who showed themselves so capable of learning. All the work of which I am about to tell was well performed by girls of fourteen years old.

The method I tried can best be understood by one or two illustrations. I will first say, briefly, that they found for themselves the chief stars in nearly every important constellation by drawings I made on the blackboard or on bits of paper (aided by my hectograph). As

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soon as they learned the Dippers in Ursa Major and Ursa Minor, and Cassiopeia, I put them to making observations at an interval of several hours on the same night, so as to find out the daily apparent motion. Thus far they knew Polaris only as "the star in the handle of the Little Dipper." It was some days before all reported observation, and I did not indorse any report until we had full concurrent testimony that from 6 P. M. to 12 the Great Dipper moved down toward the horizon and then east (it was autumn), that Cassiopeia moved up and then west, and that the bowl of the Little Dipper had turned on the handle until it was nearly upside down. They drew the Little Dipper on the blackboard, and made arrows to indicate the direction in which the other constellations moved. They remarked, without prompting, that the arrows made a kind of circle. After another night's observation, the report was brought that at 6 P. M. the constellations had returned to the positions occupied by them at 6 P. M. of the previous day. They said the stars must have gone entirely round that star in the handle of the Dipper, or else have moved backward. By this time the interest had become so great that a number of girls rose before day to take a look; so we had a further report. When they had settled as fully as they could the fact of the apparent motion, I asked them, "When an object seems to move, does it always prove to be in motion?" Many cited in answer the apparent motion of the trees when one journeys by rail. After drawing from them the fact that the real and the apparent motions are always in opposite directions, I asked, "Do you think the earth is turning round, or are the stars moving round it?" Up to this time several intelligent girls had been without suspicion that they were coming round to the familiar fact of the earth's rotation on its axis, learned from the beginning of their geographies. Their surprise, when my question flashed this result on them, was very amusing. It was to me a striking illustration of the inadequacy of learning things about nature from books alone.

I will not weary the reader with an account of the observations which detected the apparent annual motion of the stars, and the facts and questions which led them to conclude that it resulted from a real motion of the earth, in a circle, with the sun in the center. They also detected the apparent motion of the sun north and south, and had a very interesting discussion whether this was real or apparent. In the course of this study, they experimented in a darkened room with a light, and a ball revolving on its axis. The ball was held at the solstitial and equinoctial positions, and revolved, and they drew the conclusions regarding length of days. The work was just as much as possible their own.

One of the most interesting studies made by my pupils was that of the moon. They began with the new moon, and of course very soon accounted for its daily apparent motion west. Then they watched the real motion from night to night. I must not forget to say that regu-

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lar books were kept by them for recording observations. They kept account of the phases and the corresponding relative positions of the sun, moon, and earth. This led to a very interesting discussion as to what makes the moon shine. In the course of this, they drew diagrams and experimented with the ball and light. They detected the earth-shine, and settled its cause for themselves; found out that the moon moves round the earth, and noted the time; noted the hours of rising; noted the various constellations through which the moon takes its path; and noted the effect of their situation on the moon's time of rising. After these points had been settled, I asked them, had they ever seen the moon show more than one face. As this called attention to the fact that the moon always shows (substantially) the same face, the cause was discussed. To settle it, a girl stood in the middle of the room and another walked round, facing her all the time. They finally settled for themselves that the moon revolves once on its axis while it moves once round the earth. I gave them no further help than the question I have just stated. I have not yet had pupils trace the moon's path and that of the sun so accurately as to discover the nodes, but I certainly shall try to do so, and to have the retrograde motion of the nodes detected; the time (approximate) of their revolution. I shall pass over nothing that ordinary eyes can see, ordinary minds reason out.

The study of planets affords delightful work. Some of my pupils have studied Mercury with great interest, finding that his orbit is within that of the earth and of Venus; finding the direction of his motion round the sun, and the period. The study of Mars is in the highest degree profitable, and so is that of Venus. The young folks can readily discover the retrograde motions, and, with the simple suggestion that the apparent retrograde may result from the changed position from which we view the planet, may find the relative positions and detect the cause.

I occasionally report to my young astronomers a little of the testimony of other persons. Thus, in discussing the cause of the moon's light, I told them of stars occulted by the dark part of the moon. In doing so, I always wait until they have exhausted the evidence of their own senses; and I am specially careful to distinguish between the two kinds of testimony. It leads, with older girls, into some very interesting discussions as to the value of other people's evidence.

Sometimes some of the girls begin to *guess*. I always take special care (in a good-natured way) that guessers shall come to shame. I endeavor to make them as accurate as possible, allowing the evidence to prove just what it ought, and no more.

My pupils have been so much interested in astronomy, that their talk about it has brought to me a good many persons who wish to sell me some sort of apparatus for illustrating the motions of the solar system or some part of it. I do not much believe in these contriv-

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ances. They are very apt to take the place of the observation of nature, a very pernicious result. Besides, to understand the motions, one must study each separately. The observation of nature must precede the illustration of nature. A light and a ball revolving on its axis sometimes help. The very simplest apparatus is the best. Young folks have a superstition about complicated apparatus. It begets a vague wonderment which is very far removed from a scientific temper. God's own great machinery is undoubtedly the thing to study. But a small telescope would enlarge greatly the field of observation. The pupils could, with its aid, study Jupiter's miniature system, the rings of Saturn, the phases of Venus and Mercury; and, by the sun-spots, they could detect the revolution of the sun on his axis. Mr. Whitall, of Phillipsburg, New Jersey, gets up a small telescope for fifty dollars which would be of great use. I find the astronomers who wish to do original work have great contempt for a telescope costing less than eight hundred dollars. Mr. Whitall's telescope is probably better than that which discovered Jupiter's moons and Saturn's rings, and, for the sort of teaching I have described, would do a great deal of good.

I have a good deal of trouble with people who are attracted by the interest of my girls, and who always want to tell them the things they ought to find out for themselves. Bright young fellows from college, who want to show off before the girls, are particularly given to this. But my pupils themselves aid me, for they do not wish to be told.

It is important to have a good deal of drawing. Fortunately, in the best schools, the importance of this art is now appreciated. The constellations should be drawn from nature and from memory, with a statement on each map of the boundaries. When any planet is under study, I always have diagrams drawn showing its various positions in relation to the sun and the earth.

I do not pretend that this is other than the most elementary work, and I do not myself pretend to be much of an astronomer.

There is nothing wonderful in teaching as I have described, but it is certainly a great mistake to teach otherwise. It is probable that, in the active centers of thought, others have adopted this plan. It is certainly far from general. I am sure nearly all teachers of girls would find their own knowledge made more accurate by the observation and study it requires. Teachers in boarding-schools, who are with their pupils at night, could accomplish admirable results; and I should think intelligent parents would be delighted to train their own children.

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TIME-KEEPING IN PARIS.

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By EDMUND A. ENGLER,
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MANY of the discoveries of science which at the time are regarded merely as refinements—very interesting, but without practical value—sooner or later find their special uses in supplying wants before unfelt. It is but one of the evidences of the advance of civilization that exact methods of dividing and measuring time are now in demand, not only by scientists and professional men as formerly, but by persons in the most ordinary pursuits of life. To railroad-men and watch-makers as a matter of necessity, to manufacturers and business-men as a matter of economy, and to individuals as a matter of convenience, it has come to be highly important to know what is the exact time of day to the second, in circumstances where half a century ago it would have quite sufficed to know the minute or even the hour. This may be due to the increased value of time when measured by the number of events or the magnitude of operations which modern ingenuity is capable of crowding into a given interval; there can be no doubt that a second to-day records a greater stride in the world's progress than did many hours in the days of our ancestors. Of so great importance, for many evident reasons, has the knowledge of the exact time become, that much thought of some of the best heads has been devoted to methods of ascertaining it and making it available by distribution for public use.

The methods of obtaining the exact time by astronomical observations have long been well established, and are, except in minor details, the same in all parts of the world. It will here be sufficient to say, in explanation of the usual method, that time is determined by observing the transit, over the meridian, of stars—or other heavenly bodies—whose position is known by previous calculation verified by repeated observation. The difference between the time of the calculated meridian passage and the time indicated by the clock when the star was observed to pass the meridian is the error of the clock. The face-reading of the clock at the instant of transit corrected for this error is the exact time at that instant.*

* It is, perhaps, needless to say that the operation of taking time by the transit instrument is really far more complicated than would appear from the description above; but the difficulties arise only from mechanical or physical imperfections, or from uncertain or changing conditions. Thus, corrections must always be made in nice work for errors in the instrument or its setting—such as the level, azimuth, and collimation corrections—for personal equation of the observer, and for aberration; these corrections, however, only aid the observer in ascertaining the exact instant when the star actually crossed his meridian and do not in any way affect the principle already given. For a full account of the methods of making these corrections, the reader is referred to Chauvenet's "Astronomy."

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But experience has shown that no clock, however fine its mechanism, will run without change of error; so that, although for a particular instant the error of a clock is known by astronomical observation, it is by no means certain what will be its error for any subsequent instant. Its error for this instant can be determined with precision only by another observation. An approximation to its error at any instant can, however, be obtained by simple calculation, based upon two assumptions: first, that the change in error between the last two (or any previous two) observations was uniformly distributed over the interval of time between those observations, thus making it possible to determine a rate of change; second, that the rate of change in error since the last observation has been uniformly the same as during the previous interval. The reliability of this approximation is evidently entirely dependent upon an empirical knowledge of the clock. Cloudy weather sometimes makes this method the only resource.

In order that a clock should be used as an indicator of time, it is not enough that its error at every instant should be known; its error must be continually corrected so that its face-reading shall always indicate true time. And, in order that a clock should be used as a distributor of time, it must be provided with apparatus, distinct from the mechanism which keeps the time and in no way interfering with it, which is capable of sending time to other clocks. The methods and instruments in use in Paris for the accomplishment of these two objects will be described in this paper.

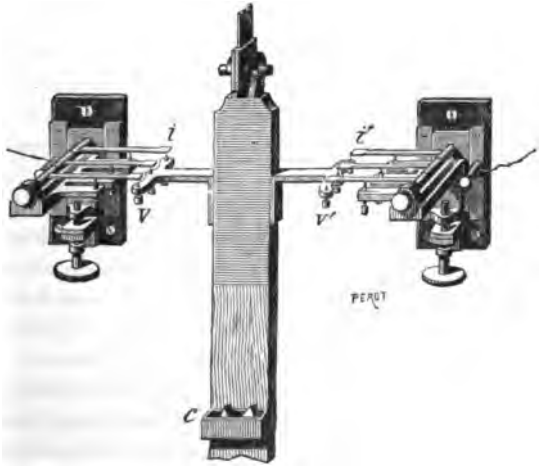


FIG. 1.—REGULATOR OF PARIS OBSERVATORY—PENDULUM CONTACT-PLATES.

At the Paris Observatory a very fine standard clock or astronomical regulator is kept running on correct mean time by transit observations, being provided with the most approved self-compensating

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apparatus, and being further corrected daily by the adjustment of weights to the pendulum. For the latter purpose the pendulum-rod is provided with a box, *c* (Fig. 1), for holding small weights; these are made of such shape that they can be easily put into the box or taken out by means of a small pair of pincers without in any way affecting the running of the clock. The box being placed above the center of oscillation of the pendulum, the addition of a weight makes the clock go faster and the removal of a weight retards it. By repeated experiment it has been ascertained what change each weight, under given conditions of atmospheric influences, will produce in a given time; so that the operator knows how to adjust the weights in every case, and the clock can be kept running on mean time with the greatest attainable accuracy.

This clock, beating seconds, closes for, say, one half second during each vibration an electric circuit along the line of which the secondary clocks are situated. This is done by means of the apparatus shown at the top of Fig. 1. To the upper end of the pendulum-rod are attached arms, *V* and *V'*, which alternately raise the levers, *i* and *i'*, as the pendulum vibrates, thus closing the contact of the electric circuit, one wire of which reaches the arms *V* and *V'*, while the other is attached to the levers *i* and *i'*. There are three levers at *i* and *i'*, and three contact points on the arms *V* and *V'*, in order that the transmission of the current need not depend upon a single contact which some trivial circumstance—as, for example, the lodging of a grain of dust—might prevent.

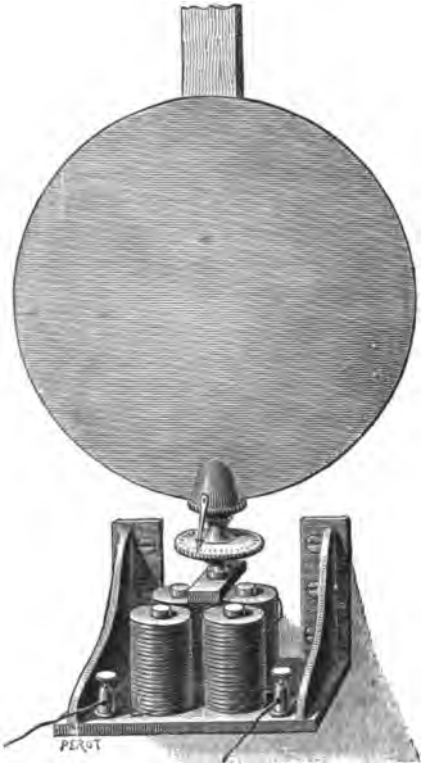


FIG. 2.—PENDULUM OF SECONDARY CLOCK.

The current thus transmitted is carried laong wires placed in the city drains to the secondary clocks, which are controlled by the regulator at the observatory, as shown in Fig. 2; but the motive-power of each is a weight operating as in ordinary clocks. To the foot of the pendulum of each secondary clock is attached a piece of soft iron, which swings just above the poles of two electro-magnets in the

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circuit of the observatory clock. The operation is as follows: The secondary clocks are kept running with a very small gaining rate. At each vibration of the pendulum of the observatory clock the circuit is closed, and a current passes from a battery of six Daniell cells and magnetizes one of the electro-magnets at the foot of the pendulum of each secondary clock, which, attracting the piece of soft iron, retards its motion. The adjustment is delicately made, so that the retardation is just sufficient to keep the secondary clocks beating synchronously with the observatory clock.

This system, in Paris the device of M. Breguet, is a modification of the Jones system, which is considered by scientists the best ever invented for regulating clocks at a distance from the standard clock. Its main advantage lies in the fact that by no disaster to the wire of the circuit or to the regulator of the system can the secondary clocks be stopped. Should, by any accident, the wire be broken or the observatory clock stopped, the secondary clocks move right on, only slightly too fast; whereas, in any system of dials which are driven by a standard clock, any such mishap must of necessity stop the dials, whereby those depending upon them for time are misled, if not entirely deprived of time. In point of accuracy the results in this system are indeed all that could be desired, the error of the secondary clocks being kept less than one tenth of a second; but, because the secondary clocks must be fine time-keepers, the system is quite expensive. The estimated cost of each of these clocks is from 2,400 to 2,500 francs, or from $480 to $500. On the two circuits, each terminating at both ends at the Observatory of Paris, there are distributed thirteen clocks, the farthest being at a distance of seven and a half kilometres, or nearly four and a half miles from the observatory. The clocks are furnished with second-hands, and are placed so that they can be easily seen from the street, and usually in prominent positions. The system is entirely under municipal management and has been in successful operation for about four years.

But the system thus far described is the basis of a much wider distribution of accurate time; for each of the secondary clocks is itself provided with apparatus, by means of which it sends a signal every hour to clocks placed on special circuits and to the public clocks of the city. For this reason the secondary clocks have come to be known as "horary centers." The methods employed for the distribution of the hourly signals from the "horary centers" are not uniform, nor are they of equal importance or extension; some of the principal watchmakers have invented methods of their own for special services, which are not of general interest, but the system which radiates from the "horary center" at the Hôtel de Ville (at present the Tuileries) to the twenty *mairies* of Paris is worthy of mention here both on account of its importance and ingenuity. There is a system of telegraph-wires connecting all the *mairies* of the city with the Prefecture of

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FIG. 3.—MAP OF PARIS. The two circuits from the Observatory are represented by heavy black lines: the lines from the "horary centers" are represented by dotted lines.

the Seine; the regulator at the Hôtel de Ville automatically sends a current into twenty relays at precisely one hundred seconds before the end of each hour, and thus cuts these wires off from their ordinary telegraphic duty and places them in the circuits of the different *mairies*. Then, at twelve seconds before the end of the hour, the regulator sends another current into the circuit of the *mairies;* this current is stopped precisely at the end of the hour. At each *mairie* the clock automatically shuts off the wire from the telegraph and connects it

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with the electro-magnet of the clock at sixty-five seconds before the end of each hour, and reverses the operation at five seconds after the end of the hour. Ten seconds after the end of the hour the first current from the regulator at the Hôtel de Ville automatically stops, and the wires are restored to the telegraph. The clocks at the *mairies*, being thus corrected every hour, run with very small error; but, should for any reason the error become large, or the clock stop, this is indicated automatically by the fact that the current from the "horary center," instead of stopping precisely at twelve o'clock, continues for thirty seconds. By this, the operator at once knows that his clock is wrong, and can have it set right. From the other "horary centers" the number of lines is in no case larger than six, the lines are shorter, and the apparatus accordingly simpler.

But there is another novel and ingenious method for the distribution of time in use in Paris, which, though lacking in accuracy sufficient for scientific purposes, has both convenience and economy to recommend it for general uses, and for that reason has become quite extensively employed in a short time. Abandoning electricity as an uncertain means for moving clock-work at a distance, the inventors of this system, Messrs. Popp and Resch, have accomplished the same object by the use of compressed air and for this reason have called their clocks "pneumatic clocks." They were exhibited at the Exposition at Vienna in 1878, and are now widely distributed in that city.

The essential parts of the system are three: 1. Machinery whose function it is to compress the air, and to propel impulses of the same every minute; 2. Pipes led through the streets and into the houses; 3. Dials provided with mechanism for receiving the pneumatic impulses.

1. At a central point a steam-engine drives pumps which compress air to five atmospheres in a reservoir holding eight cubic metres. This compressed air is sent, by means of a special regulator, into a second receiver called the "distributing reservoir," where the pressure is kept constant at seventh tenths of an atmosphere, or a little less—a pressure determined empirically to be sufficient to move the dials. The "distributing reservoir" is opened to transmit an impulse into the pipes each minute, for about twenty seconds, by a distributing clock (Fig. 4). This consists of two distinct movements. The one to the left, provided with balance-wheel, counter-weights, etc., is simply an ordinary clock, and indicates the hour, minute, and second, as shown in the figure. The movement to the right is contrived especially for moving the distributing valve, R. This valve, ingeniously arranged in such a way that the pressure acts only on a minimum of its surface, is inclosed in a valve-box and has three orifices. The first of these puts the valve in communication with the "distributing reservoir"; the second puts it in communication with the street-pipes; and the third puts the pipes in communication with the atmosphere. The first orifice is always

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open ; the other two are normally closed. The automatic escape of the lever G, at the end of each minute, moves the slide-valve, opens the second orifice, and sends an impulse into the pipes ; at the end of a number of seconds, determined by experience and dependent on the length of the pipes (a number which varies from ten to fifteen sec-

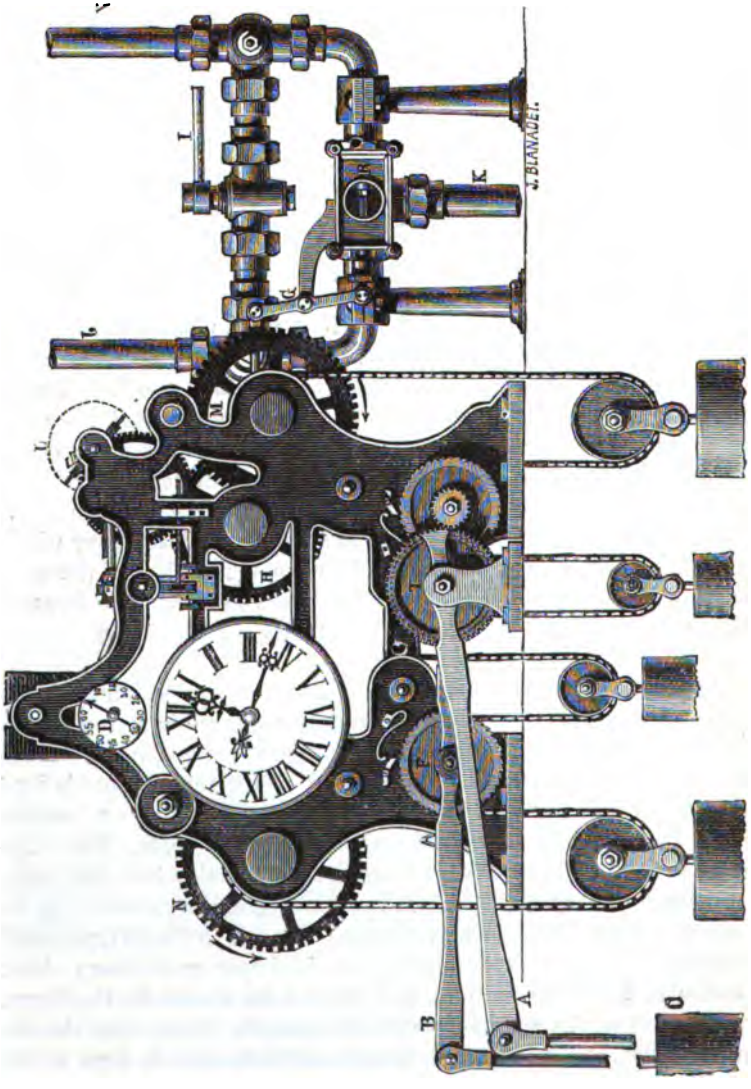


FIG. 4.—DISTRIBUTING CLOCK OF THE PNEUMATIC SYSTEM.

onds), the slide-valve is brought back to its original position by the clock-work, closes the two orifices, and allows the extra pressure which has been introduced to escape into the air. This operation is repeated every minute. The motive-power for the clock-work of both move-

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ments is furnished by the compressed air, which automatically lifts the pistons in the cylinders, C, at the end of each minute. The pistons move the levers B and A; the first of these, B, winds up the counter-weights as much as they have fallen during the preceding minute; the second, A, imparts motion to the slide-valve.

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2. The impulse given by the clock-work is distributed through the city by means of pipes laid like ordinary gas-pipes. In the streets the pipes are of iron, and have a diameter of twenty-seven millimetres (about one inch); but in the houses the pipes are of lead, and of different sizes—the diameters being fifteen, six, or three millimetres (practically one half, one quarter, or one eighth of an inch), depending on the number and size of the dials to be operated. These pipes are entirely hidden from view, and in no way interfere with the appearance of the dials.

3. The mechanism of each dial, whatever the size, is shown in essential part in Fig. 5. A leather or rubber flap, seen in the cylinder, receives the impulse as it comes from the pipe and moves a piston, which acts upon a lever-arm arranged by simple connections to move the minute-hand one space forward. The ordinary clock-gearing (not shown in the figure) secures the proper motion for the hour-hand. This part of the apparatus can be inclosed in any case—as plain or as ornamental as desired. The cases are made in all the designs and sizes of ordinary clocks, and appear precisely like them, except that the minute-hands jump suddenly over one space at the end of each minute, and remain stationary during the minute, instead of moving gradually over the space.

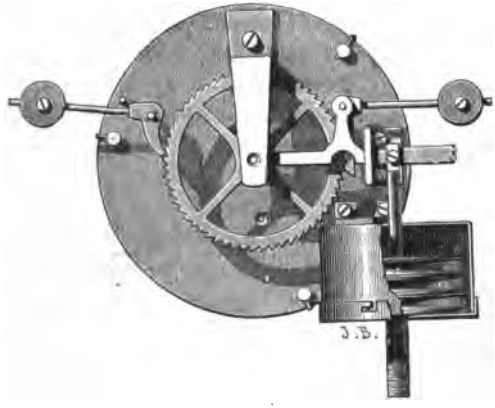


FIG. 5.—MECHANISM OF A PNEUMATIC DIAL.

All the machinery of the system is in duplicate, for use when repairs are needed. Delicate manometers indicate the pressure at all times, and the most approved electric apparatus is used to indicate the particular point at which a defect has occurred. A skilled engineer is on the watch at all times. Provision is also made so that, in case of any interruption in the regulator, the dials may be run by hand. Accuracy of time is secured by daily comparison with the observatory clock.

Excellent as the system is for general uses, the pneumatic dials can not be used for accurate time-work, because it requires in the extreme case, namely, for a distance of twenty thousand metres, at least ten

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seconds for the impulse to reach its destination. Thus it will be seen that each dial is slow a certain number of seconds, depending upon its distance from the central station; nor has it been found that the error of any particular dial is constant. But the error will never be allowed to exceed ten seconds. Should the extension of the system require it, Paris will be divided into six districts (surveyed so that no point in the city shall be over twenty thousand metres from a central station), each provided with its central station equipped in other respects as the one described, but all receiving their compressed air from a common reservoir centrally located.

However, there are plenty of people in Paris, as there are, doubtless, in every city, for whom a time even ten seconds in error is accurate enough. The system was put into operation there about March 15, 1880, and in the first four months there were fifteen hundred subscribers, distributed in six hundred houses. The popularity of the pneumatic clocks is due to their convenience and cheapness. The rental is only five centimes (one cent) per day for the first clock; four centimes (eight mills) per day for the second clock; three centimes (six mills) per day for the third and every subsequent clock rented by the same person; and the expense of pipes and apparatus is borne by the company.

JURASSIC BIRDS AND THEIR ALLIES.*

By Professor O. C. MARSH.

ABOUT twenty years ago, two fossil animals of great interest were found in the lithographic slates of Bavaria. One was the skeleton of *Archæopteryx*, now in the British Museum, and the other was the *Compsognathus* preserved in the Royal Museum at Munich. A single feather, to which the name *Archæopteryx* was first applied by Von Meyer, had previously been discovered at the same locality. More recently, another skeleton has been brought to light in the same beds, and is now in the Museum of Berlin. These three specimens of *Archæopteryx* are the only remains of this genus known, while of *Compsognathus* the original skeleton is, up to the present time, the only representative.

When these two animals were first discovered, they were both considered to be reptiles by Wagner, who described *Compsognathus*, and this view has been held by various authors down to the present time. The best authorities, however, now agree with Owen that *Archæopteryx* is a bird, and that *Compsognathus*, as Gegenbaur and Huxley have shown, is a Dinosaurian reptile.

* Read before Section D, British Association for the Advancement of Science, at York, September 2, 1881.

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Having been engaged for several years in the investigation of American Mesozoic birds, it became important for me to study the European forms, and I have recently examined with some care the three known specimens of *Archæopteryx*. I have also studied in the Continental museums various fossil reptiles, including *Compsognathus*, which promised to throw light on the early forms of birds.

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During my investigation of *Archæopteryx*, I observed several characters of importance not previously determined, and I have thought it might be appropriate to present them here. The more important of these characters are as follows:

1. The presence of true teeth, in position, in the skull.
2. Vertebræ biconcave.
3. A well-ossified, broad sternum.
4. Three digits only in the manus, all with claws.
5. Pelvic bones separate.
6. The distal end of fibula in front of tibia.
7. Metatarsals separate, or imperfectly united.

These characters, taken in connection with the free metacarpals, and long tail, previously described, show clearly that we have in *Archæopteryx* a most remarkable form, which, if a bird, as I believe, is certainly the most reptilian of birds.

If now we examine these various characters in detail, their importance will be apparent.

The teeth actually in position in the skull appear to be in the premaxillary, as they are below or in front of the nasal aperture. The form of the teeth, both crown and root, is very similar to the teeth of *Hesperornis*. The fact that some teeth are scattered about near the jaw would suggest that they were implanted in a groove. No teeth are known from the lower jaw, but they were probably present.

The presacral vertebræ are all, or nearly all, biconcave, resembling those of *Ichthyornis* in general form, but without the large lateral foramina. There appear to be twenty-one presacral vertebræ, and the same, or nearly the same, number of caudals. The sacral vertebræ are fewer in number than in any known bird, those united together not exceeding five, and probably less.

The scapular arch strongly resembles that of modern birds. The articulation of the scapula and coracoid, and the latter with the sternum is characteristic; and the furculum is distinctly avian. The sternum is a single broad plate, well ossified. It probably supported a keel, but this is not exposed in the known specimens.

In the wing itself the main interest centers in the manus and its free metacarpals. In form and position these three bones are just what may be seen in some young birds of to-day. This is an important point, as it has been claimed that the hand of *Archæopteryx* is not at all avian, but reptilian. The bones of the reptile are indeed there, but they have already received the stamp of the bird.

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One of the most interesting points determined during my investigation of *Archæopteryx* was the separate condition of the pelvic bones. In all other known adult birds, recent and extinct, the three pelvic elements, ilium, ischium, and pubis, are firmly anchylosed. In young birds these bones are separate, and in all known Dinosaurian reptiles they are also distinct. This point may, perhaps, be made clearer by referring to the two diagrams before you, which I owe to the kindness of my friend Dr. Woodward, of the British Museum, who also gave me excellent facilities for examining the *Archæopteryx* under his care. In the first diagram, we have represented the pelvis of an American Jurassic Dinosaur allied to *Iguanodon*, and here the pelvic bones are distinct. The second diagram is an enlarged view of the pelvis of the *Archæopteryx* in the British Museum, and here too the ilium is seen separate from the ischium and pubis.

In birds the fibula is usually incomplete below, but it may be co-ossified with the side of the tibia. In the typical Dinosaurs, *Iguanodon*, for example, the fibula at its distal end stands in front of the tibia, and this is exactly its position in *Archæopteryx*, an interesting point not before seen in birds.

The metatarsal bones of *Archæopteryx* show, on the outer face at least, deep grooves between the three elements, which imply that the latter are distinct, or unite late together. The free metacarpal and separate pelvic bones would also suggest distinct metatarsals, although they naturally would be placed closely together, so as to appear connate.

Among other points of interest in *Archæopteryx* may be mentioned the brain-cast, which shows that the brain, although comparatively small, was like that of a bird, and not that of a Dinosaurian reptile. It resembles in form the brain-cast of *Laopteryx*, an American Jurassic bird, which I have recently described. The brain of both these birds appears to have been of a somewhat higher grade than that of *Hesperornis*, but this may have been due to the fact that the latter was an aquatic form, while the Jurassic species were land birds.

As the *Dinosauria* are now generally considered the nearest allies to birds, it was interesting to find, in those investigated, many points of resemblance to the latter class. *Compsognathus*, for example, shows in its extremities a striking similarity to *Archæopteryx*. The three clawed digits of the manus correspond closely with those of that genus; although the bones are of different proportions. The hind-feet also have essentially the same structure in both. The vertebræ, however, and the pelvic bones of *Compsognathus* differ materially from those of *Archæopteryx*, and the two forms are in reality widely separated. While examining the *Compsognathus* skeleton, I detected in the abdominal cavity the remains of a small reptile which had not been previously observed. The size and position of this in-

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closed skeleton would imply that it was a fœtus; but it may possibly have been the young of the same species, or an allied form, that had been swallowed. No similar instance is known among the Dinosaurs.

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A point of resemblance of some importance between birds and Dinosaurs is the clavicle. All birds have those bones, but they have been considered wanting in Dinosaurs. Two specimens of *Iguanodon*, in the British Museum, however, show that these elements of the pectoral arch were present in that genus, and in a diagram before you one of these bones is represented. Some other *Dinosauria* possess clavicles, but in several families of this sub-class, as I regard it, they appear to be wanting.

The nearest approach to birds now known would seem to be in the very small Dinosaurs from the American Jurassic. In some of these, the separate bones of the skeleton can not be distinguished with certainty from those of Jurassic birds, if the skull is wanting, and even in this part the resemblance is striking. Some of these diminutive Dinosaurs were perhaps arboreal in habit, and the difference between them and the birds that lived with them may have been at first mainly one of feathers, as I have shown in my memoir on the *Odontornithes*, published during the past year.

It is an interesting fact that all the Jurassic birds known, both from Europe and America, are land-birds, while all from the Cretaceous are aquatic forms. The four oldest known birds, moreover, differ more widely from each other than do any two recent birds. These facts show that we may hope for most important discoveries in the future, especially from the Triassic, which has as yet furnished no authentic trace of birds. For the primitive forms of this class we must evidently look to the Palæozoic.

WHAT IS TRANSCENDENTAL PHYSICS?

By PAUL R. SHIPMAN.

THE theory of a fourth dimension of space has lately been brought forward somewhat prominently, under the imposing title of "Transcendental Physics," by Mr. John Charles Frederick Zöllner, Professor of Physical Astronomy in the University of Leipsic, although the learned professor, it should be said, imputes the suggestion of the theory primarily to Kant, and secondarily to Gauss, the celebrated mathematician of Göttingen, both of whom, he says, struck out the thought. In this, it is possible, the professor does himself less than justice.

Gauss had large expectations from the geometry of position, but its development, as contemplated by him, does not appear to have

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included the development of a fourth dimension, and we know he expressed a lofty scorn for table-tippings and other things of the sort, to which the new dimension, it would seem, has thus far lent itself exclusively. Kant, it is true, admitted the possibility of other dimensions, but derived it from the impossibility of knowing what exists outside of the limits of our faculties, and consequently of legitimately affirming or denying anything about it. He suggested the possibility of other dimensions of space, and, for that matter, the possibility of no space, but not the possibility of the discovery and comprehension of either by the human mind. So far from this, he distinctly suggested the reverse, actually citing, as an example of truths "always united with the consciousness of necessity," the proposition, "Space has only three dimensions"; and, since a necessary truth is one of which the contrary is inconceivable, he could not have suggested, without self-contradiction, that space may have more than three dimensions. If other dimensions exist, they exist, according to Kant, not for man, but for other orders of beings, endowed with corresponding forms of perception—exist as parts of the original furniture of the intelligences of other spheres—hypothetical properties of hypothetical creatures in hypothetical worlds, one and all of which transcend our faculties. This, however, is by no means the theory of Professor Zöllner.

"In my first treatise, 'On Action at a Distance,'" says that distinguished physicist, "I have discussed in detail the truth, first discovered by Kant, later by Gauss and the representatives of the anti-Euclidian geometry, viz., that our present conception of space, familiar to us by habit, has been derived from experience, i. e., from empirical facts, by means of the causal principle existing *a priori* in our intellect. This in particular is to be said of the three dimensions of our present conception of space. If from our childhood phenomena had been of daily occurrence, requiring a space of four dimensions for an explanation which should be free from contradiction, i. e., conformable to reason, we should be able to form a conception of space of four or more dimensions. It follows that the *real* existence of a four-dimensional space can only be decided by *experience*, i. e., by observation of *facts*. A great step has been made by acknowledging that the possibility of a four-dimensional development of space can be understood by our intellect, although, on account of reasons previously given, no corresponding image of it can be conceived by the mind." Probably the first thought which will occur to the intelligent reader of this passage is that Professor Zöllner mistakes Kant; and perhaps the second thought will be that the professor mistakes himself. If these impressions prove just, he may find one day that his theory of a fourth dimension has suddenly passed away more completely, if less mysteriously, than the book from the slate at Vienna, or the round-table from the sitting-room at Leipsic. Let us inquire whether or not they are just.

Professor Zöllner thinks "our present conception of space" has been

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derived from experience, "by means of the causal principle existing *a priori* in our intellect." Kant held, on the contrary, that our idea of space is not a mere conception, but a pure intuition; that it belongs to the faculty of sense; that it is in fact one of the necessary conditions of sensation, without which experience itself is impossible; and, finally, that the "causal principle" originates in the higher faculty of the understanding, to which sense delivers up its presentations ready cast in the mold of space. In the philosophy of Kant, therefore, the "causal principle" has nothing to do with the origin of the idea of space, which emerges before sensation rises to the sphere of that principle. Kant, among his endless subtilties, distinguished indeed between the form of the intuition and the formal intuition, in which space is represented as an object, and with which unity of representation is given through the understanding; but the determination of this unity, he taught, is contained *a priori* in the intuition, not developed *a posteriori*, gradually or otherwise. As a formal intuition, space, like every other sensuous intuition, Kant maintained, is subject to the categories of the understanding, causality included, but the subjection, besides extending to all sensuous intuitions alike, is *a priori*, and as such incapable of expansion or contraction by experience, the possibility of which presupposes it. In the Kantian theory causality has nothing special to do in any mode with the idea of space in any aspect. In common with the other categories, it is simply presupposed in every intuition of sense, that of space with the rest. It lies at the bottom of the possibility of experience in general. Moreover, an *a priori* principle, as already intimated, is not a germ susceptible of growth, but rather a die, which for ever impresses the same form. A new kind of impression necessitates a new kind of die, and, if you would have a new kind of determination, you must get a new *a priori* principle; a given principle can not be altered to suit emergencies. Experience may sharpen but not remodel it: as well expect the metal to remodel the die that cuts it. An *a priori* principle reconstructed *a posteriori* is an article which the author of the "Critique of Pure Reason" happened never to turn out from his workshop, although, if it had found entrance, he infallibly would have turned it out in double-quick time.

Yet Professor Zöllner thinks not only that the "causal principle" is a special agent in producing our conception of space, but that "this, in particular, is to be said of the three dimensions of our present conception of space," implying thereby, in the teeth of the Kantian dogma, that we have arrived by degrees at a conception of three dimensions, halting for a time at two, if not halting before at one. Indeed, Professor Crookes, expounding in "The Quarterly Journal of Science" Professor Zöllner's theory, affirms as much explicitly. "The totality of all empirical experience," he states, doubtless repeating the language of his theorist, "is communicated to the intellect by the senses, i. e.,

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by organs which communicate to the mind all the sensuous impressions which are received at the *surface* of our bodies. These impressions are a reality to us, and their sphere is two-dimensional, acting not in our body, but only on its *surface*. We have only attained the conception of a world of objects with three dimensions by an intellectual process. What circumstances, we may ask, have compelled our intellect to come to this result? If a child contemplate its hand, it is conscious of its existence in a double manner—in the first place, by its tangibility; in the second, by its image on the retina of the eye. By repeated groping about and touching, the child knows by experience that his hand retains the same form and extension through all the variations of distance and positions under which it is observed, notwithstanding that the form and extension of the image on the retina constantly change with the different position and distance of the hand in respect to the eye. The problem is thus set to the child's understanding: How to reconcile to its comprehension the apparently contradictory facts of the *invariableness* of the object, together with the *variableness* of its appearance. This is only possible within space of three dimensions, in which, owing to perspective distortions and changes, these variations of projection can be reconciled with the constancy of the form of a body." The italics in this extract, as in the preceding one, are the author's.

Professor Zöllner describes the problem which he conceives to be set before a child. The problem which the professor seems to have set before himself may be described thus: Given a tatter of Kantism, a scrap from the received doctrine of our acquired perceptions, and the rickety figment of a fourth dimension, to evolve a theory which shall save the fourth dimension at all hazards. And we have here the outcome. His theory is, that our idea of space is not, what Kant declared it to be, a pure intuition, constituting one of the necessary conditions of experience, but a conception gradually arising from experience, modified by the "causal principle," or, more precisely, modifying the "causal principle," which last the professor apparently regards as a kind of store-house of potential dimensions, projecting into space a new dimension whenever hard pressed by the contradictions of things, very much, one may suppose, as M. Faure's secondary battery gives out its store of energy at the touch of the operator. In short, Professor Zöllner holds that our idea of space is not intuitive, but ratiocinative, limited only by the diversity of contradictions that present themselves to thought, each of which, if otherwise irreconcilable, is pregnant with a new dimension. A child, for instance, because sensuous impressions are received at the surface of its body (and partly, we may presume, because it takes logical contradictions easy, and is not particularly strong in ratiocination anyway), perceives only two dimensions, we are told, until such time, indeed, as, grown impatient of contradictions, and withal a mighty cause-hunter, it seeks to recon-

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cile the invariableness of an object with the variableness of its appearance at different distances, when, *presto*, forth from the battery of the "causal principle" streams a third dimension, to smooth away the contradiction, and solve the problem; although how, meanwhile, the two-dimensional little one contrives to crawl over the house-dog, or to keep its own body in its own sight when lifted out of the cradle, or to "contemplate its hand," and go through with "repeated groping about and touching," without stumbling on the third dimension, is a puzzle that must tax the resources even of transcendental physics. To them I leave it.

Professor Zöllner's theory, it goes without saying, is important, if true; for, if one contradiction may determine a new dimension of space, another contradiction, by the same token, may determine another new property, and so on, till everything shall be made plain, and we "be as gods." The theory, as will be observed, is propounded in its seminal form; but its capabilities of explanation are restricted only by the number of possible contradictions inexplicable without it, so that, if capable of solving a single problem insoluble in any other way, it is capable of solving every insoluble problem—is a philosophical menstruum, a logical catholicon, a key to all the mysteries that mind is heir to. It is this, or nothing; but this, alas! is quackery. Yet Professor Zöllner is no quack. He is a trained scientist, enthusiastic without doubt, but equally without doubt sincere. What, then, is at fault? To be sure, he is a man with a theory, and that means a good deal; but it does not cover the whole ground. He, above all, is a man with an impossible fact. By this he has fallen. Theorizing to *explain* a fact is hazardous enough, and theorizing to *prove* a fact more hazardous still, but the man who theorizes to *prove a fact beyond the bounds of human knowledge* is lost; and this is the predicament of our worthy professor. Through his zealous efforts to prove a fourth dimension he has got psychology at sixes and sevens. In framing his theory of space, he unconsciously has made hash of Kant's theory, as in expounding it he has unconsciously perverted Berkeley's theory of vision; his theory, accordingly, is itself a hash. In other words, Professor Zöllner, having mutilated Kant, and backed the fragments, has mixed up with the remains a sprinkling of Berkeley (after vitiating it), and taken the resulting hodge-podge as his theory of space, which, like the honey in Samson's riddle, comes out of the carcass of the lion he has rent, though in his case, unhappily, the bees have swarmed from his own bonnet. It would be superfluous to characterize seriously his account of the origin of our idea of space. It is enough to say that the account has no warrant in the teachings of Kant, or of any other metaphysician, from Zeno to Spencer. It is not Kantian in the least, but purely Zöllnerian; and, as John Wilkes acknowledged that he was never much of a Wilkesite, so Professor Zöllner, if he some day becomes as well versed in psychology as he is in physics, will be tempted

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to deny that he was ever a Zöllnerite at all; and, should he yield to the temptation, the recording angel might fitly blot with a tear the record of the lapse. At all events, Professor Zöllner does not understand Kant.

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Does he understand himself? "If from our childhood," he says, "phenomena had been of daily occurrence, requiring a space of four dimensions for an explanation which should be free from contradictions, i. e., conformable to reason, we should be able to form a conception of space of four or more dimensions. It follows that the *real* existence of a four-dimensional space can only be decided by *experience*, i. e., by observation of facts." Yes, it all depends on experience, which, as every good Kantist will tell you, furnishes the matter of our cognitions, while the mind furnishes the form, the two elements uniting in the act of cognition; insomuch that the form without the matter is void, as the matter without the form is undetermined. Wherefore, we can have no conception the matter of which has not been furnished by experience, or, as a strict Kantist would say, by sensibility. But what experience, known or conceivable, can furnish the matter of the conception of a fourth dimension? Contradictions, which nothing but a fourth dimension will reconcile, answers Professor Zöllner—such as the tying of knots in endless cords, disappearance and reappearance of solid objects, passage of a shell through a table, impressions of feet on the inner sides of a closed book-slate, and other "contradictions" emerging or appearing to emerge in the presence of Dr. Slade. But contradictions are objects not of the sensitive faculty but of the understanding, and, however amazing, do not furnish new matter of conception; they merely call for new applications or new combinations of the conceptions we have. A knot tied in an endless cord is, so far as presented to us, a phenomenon within three dimensions, and, though we may not know how the knot was tied, our ignorance of the way of tying it can give us no new matter of thought. It is an appeal to our sense, not to our senses; and the office of our sense is to receive and organize the matter of thought, not give it. The mind has no portal through which a fourth dimension can enter, no chamber in which it may lodge. To assume that, because the contradictions in question are irreconcilable, they *ipso facto* present to our mind a new dimension of space, in the perception of which only they become reconcilable, is to make the simple inexplicability of a problem not only the verification of a given solution of it, but the occasion of a new experience in sense, and a new form in thought—a change, that is, in the constitution of our faculties. If a theory explains a phenomenon, the theory is so far confirmed; but, if the phenomenon is comprehensible only by a theory which is incomprehensible, the phenomenon itself is incomprehensible, and, a sensible person would say, there is an end of it. With Professor Zöllner, however, there is only the beginning of it, the incomprehensibility of the phenomenon,

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he contends, verifying the incomprehensible theory, which in return explains the phenomenon "conformably to reason." This is arguing in a circle as vicious as ever a bedlamite whirled in. From the point of view of any system of philosophy under heaven, it is vile metaphysics, and viler physics!

Could Kant have been a Zöllnerist, instead of a Kantist, we should never have heard of his wrestle with the famous antinomies, which in that event would have disappeared before a new world and a new mind, evoked by the contradictions themselves, from which he would have freed his reason by the cheap and easy method of a new dimension of space, and, if necessary, a new dimension of time, with as many more transcendent discharges from the "causal principle" as the pinch required; but the philosopher of Königsberg knew not this master-key of mysteries, and, had it been put before him, we can faintly imagine with what pulverizing force he would have brought down on it his Thor-hammer, unless, forsooth, it vanished before the "whiff and wind" of the ponderous weapon. Germany is responsible for some wild philosophers, but Professor Zöllner, it must be confessed, has "bettered the instruction" of the wildest of them. What Kant styled "the error of inactive reason," Zöllner runs into "the very error of the moon." Assuredly he leads the canons of scientific inquiry a pretty dance. It is not reckoned sound philosophy to multiply causes unnecessarily, or to assume unknown causes before exhausting known ones; but what should be thought of a method which, not content with brushing aside the law of parcimony, goes on to account for an effect by assuming a cause beyond the grasp of the intellect—to explain what is not understood by what can not be conceived—to make known the unknown by the unknowable; and which, not stopping at this, turns round, and from the mystery of the effect infers not merely the reality of the inconceivable cause, but the evolution of a new faculty to match it? If ever there was pressing need for the application of Occam's razor, it surely is afforded by the theory of this German scientist, whose general method in his professional domain, we may be sure, it does not fairly exemplify. If it did, his occupancy of a chair in the University of Leipsic would be almost as great a marvel as the fourth dimension itself.

"A great step has been made," Professor Zöllner congratulates himself, "by acknowledging that the *possibility* of a four-dimensional development of space can be understood by our intellect." This possibility our professor, of course, fancies that he himself understands; and no doubt he is as capable of understanding it as anybody else is. But does he understand it? Nay, can he think of it? To think of the possibility of a thing is to put together in thought the terms of the proposition asserting the possibility. In the case under notice, can Professor Zöllner do this? He owns that he can not. "No corresponding image of it can be conceived by the mind," he avows. If

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he can not imagine the thing, he can not imagine the possibility of the thing, the imagination of which involves the imagination of the thing itself; possibility, as every Kantist should know, being simply a mode of conceiving the thing. And what he can not imagine he will scarcely insist that he understands. As a rule, we do not understand what we can not conceive. They may order things differently in Germany; but, as yet, Professor Zöllner is the only evidence of it that we have, and it is now tolerably clear that he does not think what he thinks he thinks. He deceives himself. He will not venture to say, for example, that he understands the possibility of a round triangle, or of a whole equal to its part, or of three and two making seven. Yet it is certain that he understands any one of these propositions as truly as he understands the possibility of a fourth dimension: which is as good as saying that the latter proposition is without meaning to him, as to every other human being, and can have no meaning to any mortal so long as the constitution of our minds remains what it is. Professor Zöllner, able and accomplished though he be, is the dupe of words. It is not possible to understand the possibility of a fourth dimension. *Fourth* we know, and *dimension* we know; but what is *fourth dimension?* The realities denoted by the words can not be united in thought. The phrase is perfectly empty—a sign that signifies nothing. To use a Wall-Street figure, it is a metaphysical kite, not worth the breath that flies it.

Professor Zöllner's diagrams—intended to show how a twist in a cord, which we three-dimensional beings can do or undo by turning over a part of the cord, could not be done or undone by two-dimensional beings without making one end describe a circle, and, by means of this showing, to illustrate the possibility of a four-dimensional creature tying and untying knots in an endless cord as easily as we do and undo twists in it—are sheer delusions. A cord, whether laid on itself or extended in only one direction, and though conceived of the utmost conceivable thinness, can not be conceived with less than three dimensions. Nor can a line or a point. When we think of a mathematical plane or line or point, we do nothing more than fix our attention on length and breadth, regardless of thickness; or on length, regardless of both breadth and thickness; or on position, regardless of all three: we think away from what remains, but we do not think it away. It is thrust off, but not out—minimized, not annihilated. No effort of thought can annihilate it. Professor Zöllner either mistakes the hyperboles of geometry for literal expressions, or supposes that they are as valid for what he calls transcendental physics as for physics, forgetting that in the former, if we vex them at all, we must pass behind symbols to the things symbolized, which, if inconceivable, are of no use in aiding us to conceive anything else. And that is the trouble with his diagrams. They symbolize inconceivable things, whereas, to answer his purpose, they should symbolize conceivable ones; seeing that the ordinary

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acceptation of lineal diagrams, although sufficiently true for the conclusions of mathematics, does not cut deep enough for a fourth dimension, which, if diagrams are to facilitate our comprehension of it, needs the exact truth of what they postulate. Less than this will leave us where it finds us—"cabined, cribbed, confined" in three dimensions. Professor Zöllner will pardon a little rigor in the interpretation of figures employed to throw light on a theory so occult. For the purpose he has in hand, which lies considerably deeper than the lowest foundation of mathematical reasoning, we are bound to demand that his diagrams shall represent in reality exactly what they purport to represent; that, in plain words, they shall stand for real surfaces without thickness, and real lines without breadth or thickness. But these things do not exist for the human mind. They are incapable of representation in thought. If they were conceivable, they might then assist us to comprehend a fourth dimension, because, if we once cross the absolute limits of conceivability, there is no telling what we might or might not comprehend: presumably new heavens and a new earth would open on us, and certainly a new mind would open in us. But they are not conceivable, and the speculation is idle. For this reason, if no other, Professor Zöllner's digrammatic illustrations do not illustrate. They but offer one inconceivable thing to help us conceive another. They begin and end in nothing.

It turns out as was foreseen. Professor Zöllner understands himself even less than he understands Kant. It is very sad; yet the sadness has a silver lining. His merit is greater than he has dreamed. Although evidently a modest man, his modesty can not be spared. He is himself the author of his theory. He owes nothing to Kant. Let justice be done, though the blushes rise. But justice requires another word. Professor Zöllner can not imagine the possibility of the truth of his theory. He can not represent to his own mind the theory itself. It is unthinkable. Not to put too fine a point on it, his theory, in philosophical strictness, is pure nonsense. Let justice be done, though the blushes spread. We are now in a position to answer the question at the head of this paper, and the answer can hardly be put more aptly than in the terms of a definition of metaphysics familiar to every civilized country, and claimed as its own, I believe, by each in turn, if not simultaneously: When Zöllner tells the world what the world can't understand, and what Zöllner doesn't understand himself, that is transcendental physics.

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NEW GUINEA AND ITS PEOPLE.*

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By Rev. W. G. LAWES.

THAT part of the coast-region of New Guinea extending from Yule Island to its eastern extremity presents a striking contrast to the central part of the island, or that lying to the west of the Gulf of Papua. There all is lowland, not visible at sea a few miles distant. Here, farther east, we have a lofty mountain-range running all along the southeastern peninsula, and reaching in Mount Owen-Stanley the height of thirteen thousand feet. Variety and beauty are given to the landscape by hills of every imaginable shape, which appear gray and barren, or green and fertile, according to the season. Only a few of the rivers in this part of New Guinea are of considerable size, but some fine harbors have been found, and the voyages of the mission-steamer Ellengowan have resulted in the marking of many reefs, bays, creeks, headlands, and islands on the chart, to the increased safety of navigation. The flora and fauna are to a great extent Australian. Coarse kangaroo-grass covers much of the land, and the open forest country is studded with white-gum, wattle, and other Australian trees. It is only near the water-courses and rivers, or in the gorges and ravines of the hills, that the vegetation is luxuriantly tropical. Here are the areca-palm, the bread-fruit, wild mango, and chestnut, the pandanus in several varieties, crotons of variegated leaf, crimson *Dracænæ*, orchids and creepers in great variety, and ferns in abundance. Near the coast, and especially about Hood Bay, groves of cocoa-nut trees, miles in extent, cast their grateful shade. Some districts are hungry and barren, while in others food is plentiful, yet in all the bill of fare lacks variety. Every traveler makes the acquaintance of the palm called the "lawyer." It has received its name, I suppose, from the fact that at the back of its fronds are double rows of hooked thorns. These lay hold of any unwary passer-by, and the more he struggles to escape the tighter he is held. It is only by going back and patiently unhooking, that escape from its grasp is possible.

The fauna is also to a great extent Australian. Flocks of small kangaroos, or wallabies, rush away from one's path in journeying inland. The opossum, *cuscus*, flying phalanger, and bandicoot, are other representatives of the marsupials. I have had the honor of discovering an *echidna*, or prickly ant-eater; also an animal of the marsupial order, closely allied to the North Australian species.

* Abstract of an address before the Royal Geographical Society of London. The statements here given are the result of observations made by the author during three years' residence, from 1874 to 1877, as a missionary of the London Missionary Society, on the southeast coast of New Guinea. During the period named, he made several journeys into the interior, and more than one voyage along the coast to the east.

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There are no large quadrupeds in this part of New Guinea. The largest known at present is the pig. This is found wild in the bush, and is also domesticated. Fat pork is to the natives of New Guinea a dish deemed worthy of the gods, but not often conceded to mortals. We introduced a new species of hog, which is greatly prized.

Many of the birds are of Australian species—such as the "magpie," "laughing jackass," and "leatherhead," of the Australian colonists, which are very common everywhere along the coast, and parrots, paroquets, and cockatoos are very numerous. There are other birds, however, peculiar to the island. New Guinea is particularly rich in birds-of-paradise, of which beautiful and characteristic group no fewer than twenty different species have been found. Only two are, however, known in the Port Moresby district. One of these, the *Paradisea Raggiana*, is comparatively new, and peculiar to the south coast; while the other, the king bird-of-paradise, has been long known to naturalists. They are very shy, difficult to see, and more so to shoot. I have had the honor of making and eating bird-of-paradise soup. It is very unparadisaical in its flavor. The cry of the bird-of-paradise is something between the quacking of a duck and the cawing of a crow. The mound-building fowl and the bush-turkey are common, and so on the river-banks is the magnificent crowned pigeon, the *Goura coronata*. This is not to be despised by the sportsman. The bird is as large as a small turkey, and the flesh white and delicate in flavor. The bower-bird is peculiar, making a bower to play in and adorning it every morning. Other birds are the hornbills, which make a great noise while flying, and the cassowaries, which are the fleetest and strongest animals the natives are acquainted with.

The climate has hitherto been very trying, both to Europeans and Polynesians. The average maximum temperature for the year at Port Moresby was 86.71°. Foreigners suffer from malarial fevers, but the natives are healthy, though suffering slightly from fever, and wonderfully free from European diseases, except the small-pox.

Although Mr. Wallace has spoken of the natives as one race, those who have seen the inhabitants in the southeast find greater difficulty in classifying them. All agree in testifying to the great variety of physiognomy and the apparent difference in shape of skull in almost every district. Whatever the true typical Papuan may be, I have seen natives who possess many of the characteristics said to be distinctive, with others quite at variance with them. In a letter I recently received from Professor Giglioli of Florence, he speaks of having seen the large collection of skulls made by Signor D'Albertis in his voyage up the Fly River, and says: "The great variety in the shape of the crania of some of the inland natives has sorely puzzled me. Indeed, the only feasible explanation is, that there has been a great mingling of races in that great island."

The difference in color is very marked. To the west, black natives

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are found, while from Redscar Bay eastward a light-brown race inhabits the coast. On the mountains, in the interior, are people intermediate between these two in color, and essentially different in all their habits. I should say these are the true aborigines of this part of New Guinea, while the coast tribes, black and brown, are probably settlers. The light-haired natives belong undoubtedly to the same



FIG. 1.—DURABI, A NATIVE OF KIWAI ISLAND, AT THE MOUTH OF THE FLY RIVER. (From "New Guinea, what I Did and what I Saw." By L. M. D'Albertis.)

race as the New-Zealanders, Tahitians, Samoans, etc., but are so split up and divided that every few miles of coast brings you to a people speaking a different language from those you have just left. These are often dialects, but are quite as dissimilar as those spoken in the various islands of Eastern Polynesia. Altogether, I know of twenty-five different languages spoken in the three hundred miles of coast I am personally acquainted with. My previous acquaintance with several languages of Eastern Polynesia was a great help in acquiring that of the people among whom I was living in New Guinea. I had the pleasure of reducing two of these to a written form, and getting books printed in them, and before I left New Guinea I had the greater pleasure of hearing some of the native children read fluently in their own language.

The men are of a warm brown color, muscular and well developed, straight and agile, with fairly well-formed noses, and lips neither protruding nor thick. Many have intelligent faces, and all glory in their huge mop of hair. They carefully pull out every hair from their

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beards, and at times shave off their eyebrows and the hair from their temples; and most wear ornaments in their noses and tightly plaited armlets, which they make to serve them as pockets. The women wear a decent girdle or petticoat, reaching from the hips to the knees, are tattooed very closely, pierce their ears with many holes, load them down with ornaments, and shave their heads when they are married. All their muscles and limbs have free action, they are stately and graceful in all their movements, and their use of colored leaves and flowers no rules of art could improve. The position of the women is not so low and degraded as it often is among barbarous races.

The houses are built on piles, and we are everywhere reminded of the prehistoric lake villages of Europe. Port Moresby consists of two villages standing on the beach just below high-water mark. The houses are not built on a platform, as they are often represented, but the piles also form the posts of the houses. The natives live, as we should say, in the roof. The huts are made of thatch and wood, and floored with the sides of old canoes, which are adzed down to some approach to flatness. In the interior the floor is made of the mid-rib of the sago-palm fronds. It is light and springy, but not good to sleep on, as I can testify from experience. There is always a square fire-place, made with earth, in the center of the house. You are a fortunate visitor if you go when the fire is out, and thus escape being blinded by the smoke. All along the coast the houses are built in the same way, with slight variations in the shape of the roofs. Some look like a whale-boat, depressed in the center, while others resemble the keel of a boat turned upside down. In many cases the village stands a good way out to sea, and is surrounded by water even at low tide. We could steam down the street of many of them in our little mission-steamer, and in several cases we used to anchor alongside the houses. The boys and girls can sit in the door-way and fish. The houses are detached, but are generally connected by a pole laid from one veranda to another. The shoeless feet of the people enable them to run along these, and they laugh at our objection to so round and slippery a bridge.

The canoes of the Papuans furnish an interesting illustration of the earliest styles of naval architecture. As the people are largely dependent on the sea for means of subsistence and transport, every village has its fleet of canoes, of all sizes. Those at Port Moresby consist simply of a hollowed log, pointed at each end, and attached to an outrigger. All are propelled by paddles, or by mat-sails whenever there is any wind. When longer voyages are undertaken, four or five, and even ten, canoes are lashed together. These are decked over with poles, houses are built at each end, covered with thatch, and a sort of bulwarks made of the same material all round the sides. A mast is raised, consisting of the stem of a small tree with its principal roots, which latter are lashed to the deck, and then a huge mat-sail, crab-claw

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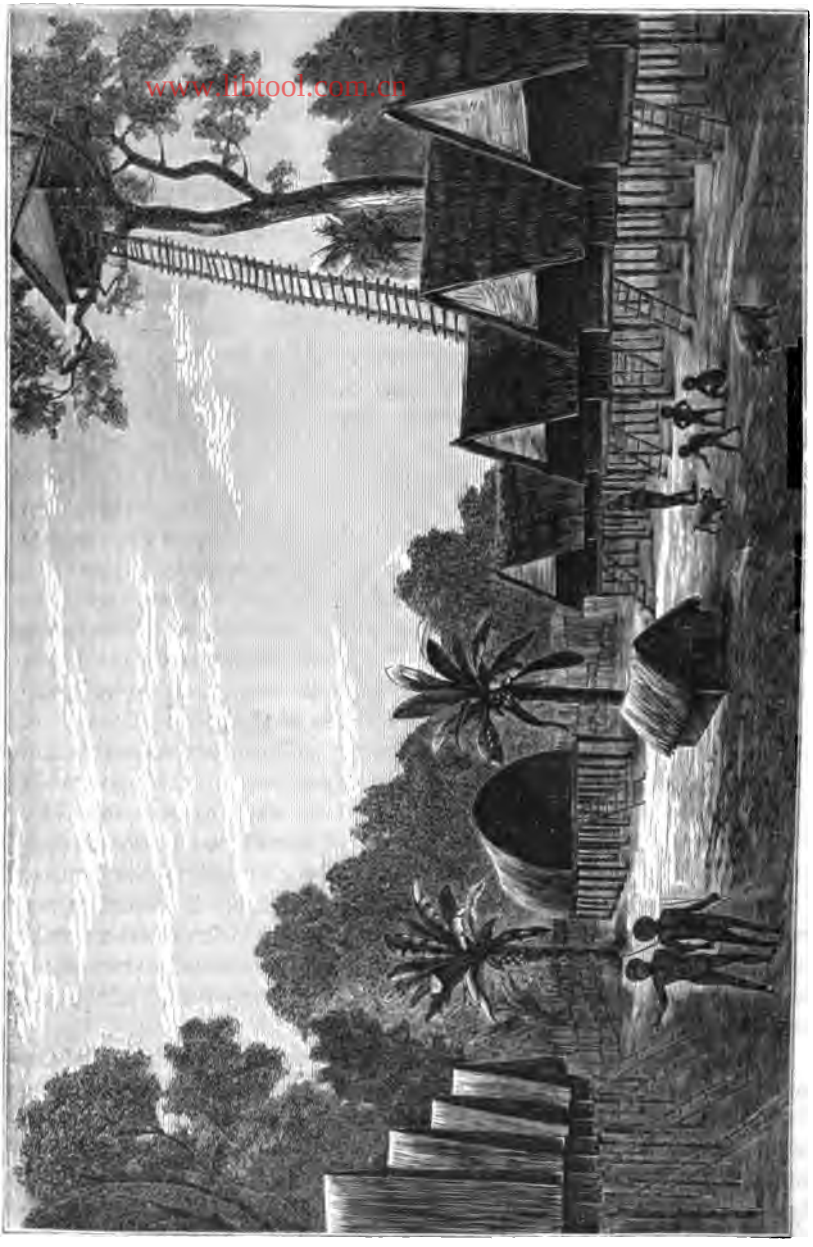


FIG. 2.—A VILLAGE OF THE MAIORI-PAPUANS. (L. M. D'Albertis.)

shape, is hoisted by a rope passed over a fork at the top of the mast. A more unwieldy, unseaworthy-looking craft it is impossible to conceive, and yet they make long voyages in such a vessel—to places two hundred miles distant. They have been aptly described as huge floating hay-stacks. As they can only run before the wind, the crew choose

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the end of one monsoon to go to their destination, waiting the setting in of the other to return. Farther to the east the style of the canoes improves. At Orangerie Bay they are adorned with elegant and elaborate carvings, and are often very well shaped, with seats for as many as eighteen paddlers. Sometimes two or three are lashed together, while the captain sits on a raised deck between them. The war-canoes of this kind are elaborately ornamented with carved figure-heads, painted black and white, and decorated with many streamers. The women can paddle their canoes quite as well as the men; and I have seen a double canoe, propelled by twenty-four women, flying over the water, the women keeping perfect time with their paddles.

The people are still in the stone age, for iron and its uses are unknown among them. They are all gardeners, and cultivate the soil carefully, with a set of agricultural implements consisting of two pointed sticks, which serve them for plow and harrow, spade and rake. One stick is inserted five or six inches into the soil, and then the other at an angle with it; with the leverage thus obtained a sod is turned, and, this being done in regular order, a field looks, when finished, almost as if it had been plowed. Bananas are planted in these furrowed gardens. In other cases the large sods are broken up, the weeds picked out, and the whole smoothed over by the stick, until it has the appearance of a well-raked, carefully cultivated English garden. The men do the heavier work of digging, while the women plant and weed. All their gardens are inclosed by well-made fences.

Hunting the wild-pig and kangaroo are favorite sports. With no other weapon than a smooth-pointed spear and a coarse net, they obtain enormous quantities of kangaroo-meat. All the men and boys join in the grand hunts. A tract of land is selected on a day when the trade-wind is blowing steady and strong. The hunters pull up the dry grass in a narrow belt to leeward, and place their nets along the strip, each man's net being joined to his neighbor's, so that a continuous fence of nets is formed across one side of the hunting-ground. The men stand behind this barrier, with their spears and dogs, and the grass is set fire to all along the line to windward. The animals are driven, by the fire and smoke and boys, up to the nets, where their chances for escape are very small. The fishing is all done with nets.

The people have no metallic vessels, or ovens of any kind. Most of the food is boiled, and, before it can be cooked, the women have to make the pot to boil it in. They make very good pottery, which is slightly burned after being dried in the sun. They use no wheel, and yet they make well-shaped globular vessels. Roasting over a slow fire is also often practiced, and the South-Sea Island mode of cooking with hot stones is employed by the inland tribes. All the food is well cooked; and they look upon us as barbarous for eating our meat, as they say, half raw. This does away altogether with the idea of gnawing and tearing which we generally associate with eating without

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knives and forks. The water in which food has been boiled is generally drunk, even when it is fish-broth. This is their only warm drink. Tea and coffee are unknown. They have no intoxicant, and are content and healthy with no stronger beverage than the fresh cocoa-nut and running stream afford.

The women excel in making netted bags of all sizes. The large bags, which are used by the women to carry their burdens in, and also as cradles, were interesting as the only article I had met which was also made by the aborigines of Australia. The women are charged with the bartering, and are skillful at driving a bargain; and they have the Eastern custom of going for water at daybreak, carrying the water on the head or shoulder, and meeting for gossip at the well.

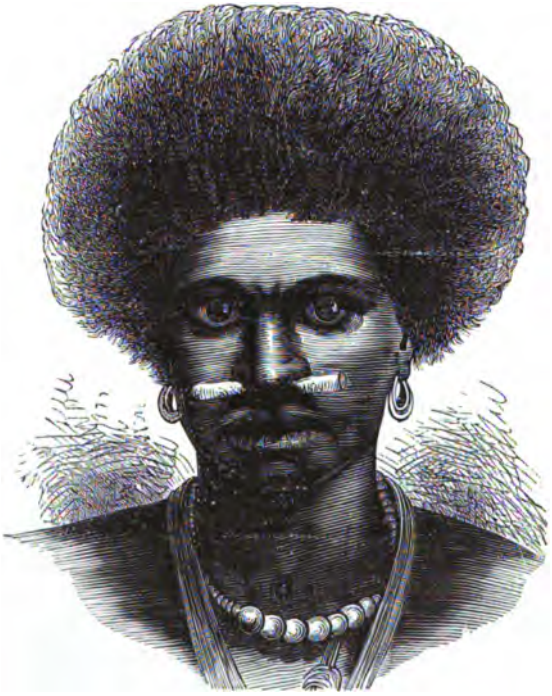


FIG. 3.—FAUDORE, A DOREY PAPUAN. (L. M. D'Albertis.)

When food is plentiful, the day is generally closed with a ball in the open air under the cocoa-nut trees. The young people dance, while their seniors look on and criticise or commend. They will often keep up the dancing, to the monotonous music of their drums, until the small hours of the morning.

Strangers are saluted by putting the hand to the nose and then to the stomach. Shaking hands and kissing are alike unknown; but many among the inland tribes welcome their friends by chucking them under the chin. It is considered bad manners to omit, on meeting a

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friend, to ask him where he is going, or to deliver a message to a superior standing. Among some of the inland tribes the custom prevails of smoking, instead of drinking, to one's health. When the bamboo pipe is filled with smoke and ready for inhaling, the man shouts out the name of the friend he wishes to honor, before taking a whiff; he then passes it on to the next, and he shouts out in the same way, and so on all round the circle. The habit of smoking seems to be original, not borrowed. The practice of chewing the betel-nut is still more prevalent.

The government is patriarchal, the chiefs ruling over villages which are independent of each other, holding their office by inheritance, but having to maintain themselves in it by their energy and force of character. The son of a chief who is weak-minded and a fool soon sinks to the common level; while a commoner, who is strong and brave, with greater mental power than his fellows, comes to the front and is soon recognized as a chief. The moral condition of the people is deplorably low. All are thieves, seeming to feel no sense of shame in stealing; and we were looked upon as great wonders by the natives because we did not steal, and our honesty was always mentioned, in any description of us, as one of our peculiarities. Human life is invested with no sanctity, but the distinction the men are most proud of is that of having shed human blood. No one has a right to be tattooed until he has killed some one, and the right is sought as a privilege.

The natives are not often on peaceful terms with their neighbors, though their warfare is not deadly. They are exceedingly suspicious and distrustful. They never sleep without their weapons within reach, and never go out without spear or club. They came to our house readily enough at first, but the slamming of a door or any unexpected noise was enough to bring them to their feet.

The family tie is strong and lasting. Men live virtuously with their wives and children. Polygamy is not common, although it is thought to be proper for chiefs. The burden of labor is fairly divided between the men and the women; and the women insist upon carrying wood, water, and burdens, as of their rights.

The people seem to have no religious ideas, no idols, no idea of a God as a supreme being or a good being. Their only religious ideas consist in a belief in evil spirits, toward whom they live in slavish fear, but without any idea of propitiating them by sacrifice or prayer. They believe also in the deathlessness of the soul, without having any definite ideas as to its abode or condition. Much difference, however, prevails among the different tribes as to the development of ideas of this character. Among some there seems to be a vague recognition of a Great Spirit who gives them plenty and other blessings; and to the west of Port Moresby, in the district of Elema, are idols and idol-temples, but the natives there belong to the darker-colored race.

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I was glad to read, in the report of the Geographical Section of the British Association meeting at Sheffield, that several travelers from Africa had said a good word for the cannibals. I should like to do the same for the cannibals and non-cannibals of New Guinea. I have visited a great many villages, in most of which no white man had been before; my wife and I were for a time the only Europeans living on the island, but I have never been molested anywhere. We are known along the coast as the bearers of peace. As I went through one of the villages for the first time, a native from another ran before us and shouted, "These are the *maino taunas* (the peace-men), who bring and make peace everywhere!" Confidence begets confidence, and there is a wondrous power in human kindness.

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SANITARY RELATIONS OF THE SOIL.*

By Dr. MAX VON PETTENKOFER.

I.

I AM well aware that I have chosen no new theme when I assume to speak of our soil and its relations to our health. It is, on the contrary, very old—for Hippocrates wrote two thousand years ago on air, water, and earth in their hygienic relations—but there are old subjects that are always awakening a new interest, and always appear fresh when considered in a new light or from a new side. To these eternally fresh subjects belongs that of the ground on which we stand and live, on which we are born, and in which we are to be buried. Since mankind has comprehended the idea of health, sickness-giving and health-promoting properties have been ascribed to the locality, which has been regarded as consisting of air, water, and earth; but the seat of that which makes sick and makes well has been supposed to be more in the air and water and less in the soil; that is, it has been conceived that a place might have its own air and its own water which we have to use directly in breathing and drinking, while we could be independent of the soil, on which we only tread. The local air could, however, hold the first place in hygienic regimen only as long as it was not known that the average velocity of the atmosphere over the surface of the earth is three metres (or ten feet) in a second, and that, even when we feel that it is perfectly calm, the air is moving at the rate of a half-metre (or twenty inches) in a second. A real stagnation of the air, even in deep cloves and valleys, or in the narrowest streets, is not to be spoken of; the air is rather to be conceived as undergoing a constant

* An address delivered before the Association of German Naturalists and Physicians, at Salzburg, September 18, 1881.

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change of place. And if it has properties or contains matters in one place which are not remarked in a neighboring place, they can not originate in the air itself, but must be derived from the locality from which they are communicated to it, and are then carried away in the free atmosphere, to disappear by dilution and other processes.

The same is the case with the local water. All the water that we drink on the earth falls from the sky, and is everywhere of precisely the same composition. Only when it penetrates the soil is it changed by taking up matter which is derived from the ground through which it flows, a fact that was mentioned by Hippocrates. And the local admixtures disappear from water, partly by dilution, partly by chemical changes, just as they do from the air; only in a lesser degree and more slowly, because water is present in the soil in smaller quantity and moves more sluggishly than air. This purification of the water takes place not only during its continuous retention and movement in porous soils, but also in open river-beds and streams. Brunner and Emmerich have drawn water from the Isar at numerous places between the mountains and the mouth of the river at the Danube, on the same day, and have found it essentially alike everywhere, although the stream receives considerable admixtures from the towns on its banks.

What is there that does not fall into the Elbe in its course from Bohemia down to the sea? Yet filtered Elbe water is considered a pure drinking-water at Hamburg and Altoona.

The river Trent receives, before it reaches Nottingham, the sewer-water of two million people dwelling on its banks, amounting to at least five hundred thousand gallons a day, yet its waters at that city are clear, sweet-smelling, and chemically free from injurious constituents.

At Paris, the collecting sewer of Clichy pours a great stream of blackish water into the gently flowing Seine below the bridge of Asnières, by which the river is so fouled that neither fish nor plants can live in it; but at Meulan, a few miles below Paris, every trace of impurity has disappeared from the stream.

When the air and water at any place are contaminated, the contamination does not proceed from any combination or decomposition of those two elements, but from qualities of the place, and they soon purify themselves again. An impurity cleaves longest and most tenaciously to the soil, which suffers no change of place, like air and water. While formerly we esteemed the hygienic value of the air first, of the water second, and of the soil third, we should now reverse the order.

The influence of the soil upon the health of those living upon it is brought out very plainly during the prevalence of epidemic diseases. That malarial diseases, like intermittent fevers, originate from the soil, is already accepted; and the more exact studies in recent times of the manner in which cholera, abdominal typhus, yellow fever, and the plague are spread, has convinced many that these diseases, also, which

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were formerly considered independent of the soil, because their specific germs are communicable and are actually communicated by human intercourse and trade, are still in some way connected with it, although the nature of the connection is yet to be found out. The explanation of the frequent, sharply defined local limitations of cholera and typhoid has been sought first, in influences not of soil but of water and air, to which the germs of disease have been imparted from men; but a clear and impartial examination of the local prevalence of these diseases in circles of greater or lesser extent has now furnished evidence that in many cases air and water can no longer be maintained to be the causes of the localization, but that the sources of the epidemic must be sought in the soil.

In the occurrence of cholera on ships at sea, where any influence of soil would seem to be absolutely out of the question, that influence often makes itself apparent in a striking manner by the fact that only persons who have come from certain places are attacked, while other persons on the ships do not even have a diarrhœa, although they are all the time with the sick, and use the same food and water and air. Ships at sea may be considered as in themselves safe from cholera; usually sickness brought upon them in individual cases dies out; and it is regarded in seafaring practice as an excellent prophylactic measure to go to sea, taking the sick along and breaking up all communication of the men with the infected port or shore. Exceptional cases of epidemics breaking out on ships can not be regarded as arising from contagion from person to person, but always from previous communication of the ship or its crew or passengers with some place infected with the disease.

Not less plainly and frequently is the real influence of the soil shown in inland regions and towns that enjoy immunity from cholera. Permit me to bring forward as a well-known but pregnant example the great manufacturing and commercial city of Lyons, in Southern France, which has constantly maintained with impunity the most active intercourse by sea and land with cities infected with cholera ever since the disease first appeared in Europe. Often as cholera-epidemics have prevailed in Paris and Marseilles, the disease has never yet gained an epidemic footing in Lyons, which lies right between those two cities, notwithstanding many cases have been brought into it from without. Even in 1849, when the city was in revolt and was besieged and occupied by cholera-infected regiments from Paris and Marseilles, and the civil population were suffering from disorder, want, and misery of every kind, the disease did not spread.

The immunity of Lyons is now a generally recognized fact in France, and the city derives a considerable profit from it; for the rich people of Paris and Marseilles, whose circumstances permit it, are accustomed to flock to Lyons like sheep as soon as cholera breaks out in their homes, and readily pay a good price for the patient hospi-

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tality of the people. Formerly, if one asked in Lyons why the city was so happily and so strikingly spared, he would not be referred to the unusual cleanliness and comfortable life of the common people, nor to the splendid drinking-water, for, before filtered Rhône water was introduced in 1859, this was very bad, but to the air, whose circulation through the confluent valleys of the Rhône and the Saône was so lively that it was always master over the imported cholera-poison, and would not let it develop. But if we compare the velocity of the wind as observed at the Lyons meteorological station with that of other places much afflicted with cholera, we shall not find the slightest difference in favor of Lyons. The plain of Languedoc, over which the *mistral* blows so often, unroofing houses, uprooting trees, and destroying ships in the very harbor of Marseilles, is not seldom visited by epidemic cholera. Later investigations show that nothing is left with which to explain the immunity of Lyons but the condition of its soil. Apart from the size of the city, this immunity is not more striking—it is, in fact, not so striking—than that, for example, of Versailles, where, notwithstanding a constant daily and hourly communication with Paris, cholera has never broken out in an epidemic form. Decaisne has shown that the condition of the soil only can be regarded as bearing upon the immunity of this place.

Analogous facts may be found wherever the spread of cholera or typhoid is earnestly investigated. The beautiful city of Salzburg, which is now so hospitably entertaining the Association of Naturalists and Physicians, belongs to the number of fortunate cities that have so far been spared cholera-epidemics, notwithstanding numerous refugees from cholera have collected here when the disease prevailed in Austria and Southern Bavaria; among whom cases have occurred without the infection passing over to the city. Only in the winter of 1873–'74, when a severe outbreak of cholera occurred in the prison establishment at Laufen, did weak signs appear in Salzburg, showing that at least certain quarters of the city were not absolutely and invariably protected against cholera. So Lyons was made aware once, in 1854, that the whole city was not insusceptible to it. The Lyonnese were not willing to acknowledge this, for they had boasted too much of their immunity; but they asked, What do a few hundred cases of cholera in fifty years amount to in comparison with the total population (400,000 souls) of the city? We should not treat the subject in this way, but should rather ask, How many inhabitants has the part of the city which, even if it was only once, had a considerable number of cases of cholera? and then the reply can not be evaded that the suburb of Guillotière suffered from a decided cholera-epidemic in 1854. This once-occurring epidemic was associated with an equally rare abnormal drought and a long-continued low stage of water in the Rhône, such as had not been observed since 1826. So Salzburg might at some time be visited with cholera, at least here and there, if the sky should obstinately keep

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its gates closed for an unusually long time, and the disease were in its neighborhood.

The reports of the cholera commission for the German Empire contain a large number of proofs of the influence of the locality, particularly of the soil, among which I might especially mention the reports of Gunther on the spread of cholera in the kingdom of Saxony, and of Pistor on the government district of Oppeln. Both these investigators, not satisfied with considering only the last visitation of cholera in 1872–'74, have also included within the circle of their inquiry all the outbreaks that have come to knowledge since the appearance of the disease in Europe in 1832. The confirmation of the localistic theory of cholera and other epidemics can no longer be put in question; and, if it were the only result reached by the German cholera commission, the money appropriated to the investigation would have been well spent.

We may now ask, What can there be in the soil that can exert so powerful an operation for good or evil upon our health? To this question, so far as concerns injury to health, the answer may be returned that, in all probability, the property is derived from the minute organisms or their products, of which many million individuals can be put within the area of the head of a pin, and which inhabit the porous soil from the surface down to a great depth—organisms which are capable of being injurious or harmless, or even useful to us, as we are already acquainted with injurious and harmless and useful plants and animals. They have heretofore been invisible to us, having only just been brought to knowledge, in the course of recent investigations in vegetable and animal physiology and pathology, by means of the microscope and experimental cultivation. A prominent vegetable physiologist, Naegelli, has accurately and clearly described them with direct reference to their hygienic significance in his well-known work, "Die niederen Pilze in ihren Beziehungen zu den Infectionskrankheiten und der Gesundheitspflege." Their mysterious presence recalls the ancient belief in invisible spirits that were accustomed to rise out of the earth, float in the water, and cast gloom over the spots haunted by them. Naegelli called a soil that produces or favors epidemics a disease-bearing (*Siechhaft*), and its opposite a healthful (*Sicchfrei*) soil. We must not conclude that only a locality of the former kind harbors molds and similar lower organisms, and one of the latter kind does not, or that these organisms reach us only from the former and not from the latter; on the contrary, they are always present everywhere. If they sometimes appear deleterious, at other times harmless, the conviction is forced upon us, either that the same species do not occur universally, or that the same species assume different properties at different places, under different circumstances, and at different times; that is, that they are only here and there and occasionally poisonous. If either is the case, the medium in which they

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live must exercise a very great influence upon them; and, so far as this medium is the soil, we have to investigate the conditions which it offers for the growth of these organisms and the communication of them to men. It must be admitted that mycology has so far given us very little light on this point, and many problems respecting it are still waiting to be solved; but it is already well established that hygiene as well as agriculture has much to do with the ground.

Some advance had already been made in the investigation of the hygienic relations of the soil before molds were mentioned as causes of infectious diseases. The simple observation that such diseases occurred or did not occur under certain conditions of the soil was enough to provoke this. It had already become possible, without knowing the more immediate causes, to make an unhealthy soil healthy. The best-known examples of this kind are given in the cases of intermittent fevers and malarial soils, in which the deleterious properties have been wholly or partly remedied by drainage and the drying up of the subsoil, and the fertilization and cultivation of the surface. Tommasi-Crudelli has a remark of the highest interest in his recent work on the malaria of Rome and the former drainage of the Roman hills, to the effect that the ancient Romans suffered much less from fevers than the Romans of after-times and of to-day. The archæologist De Tucci having called attention to some underground canals of a peculiar kind, called *cuniculi*, in the Roman hills, Tommasi examined them, and found that they were designed exclusively to drain the hills, and that they were now choked up and inoperative. Formerly, he thinks, they were so familiar that the ancient Roman writers did not think it worth while to speak of them; they passed into forgetfulness during the irruptions of the barbarians and the middle ages, and have now had to be discovered anew.

Measures directed against other infectious diseases that depend on the soil have not been without results, although the specific causes of the diseases are not known.

What are the conditions of soil favorable to epidemics?

It is an old experience that certain infectious diseases have their favorite seats in the so-called alluvial soils, in lands subject to overflow. Alluvial soil consists chemically and geognostically of substantially the same mineral matters as the compact mountain-masses, from the disintegration of which it has originated—except that its physical aggregation is essentially different; and it is distinguished from rock-soils by the great permeability for air and moisture arising from its great porosity, that is, from the spaces in which air and water, as well as organic matters, can find place. There are also kinds of rock which are very porous, and their behavior is not materially different from that of alluvial soils, as is shown by the cholera-epidemics in the Island of Malta.

In common life we can hardly conceive the extent of the porosity

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of the soil on which we dwell. Heavy, towering buildings often stand on a soil which is filled to the extent of a third of its volume with air. The investigation of ground-air has just begun, but it has already surprised us with some unexpected revelations. Ground-air is distinguished from the air that passes over the surface by the higher proportion of carbonic acid it contains, which increases, as a rule, with the distance from the surface, and to which our springs owe their charges of that gas. This carbonic acid is chiefly derived from organic matters and organic life in the ground, with which it increases and diminishes. Air brought by Zittel from the dead dry soil of the Libyan Desert, sealed in glass tubes, showed no larger proportion of carbonic acid than the free superficial air, but the ground-air from a palm-garden in the oasis of Farafreh yielded much carbonic acid. That this gas is mostly derived from organic changes is shown from the investigations of Fleck, Fodor, Wolffhügel, Möller, Wallny, and others, who found that the proportion of oxygen in ground-air was lower, while that of carbonic acid was higher, than in free air.

That the air in the soil does not become stagnant, but is always in motion, though sluggish, not only follows from physical laws, but may be easily proved by experiments and observations. Our houses are aired or ventilated in no small degree by the ground-air. Renk has been inquiring, with the aid of Recknagel's differential manometer, whether the air flows from the ground into the house or from the house into the ground, and has found that through most of the year the draft is from the ground into the house. He has also found that the ground-air, which is sucked into the house, brings, dust with it, and other observers have shown that the same air also carries germs susceptible of development in suitable solutions.

It is thus easy to see how the soil affects our health without our having to eat it; the ground-air plays the part of an always ready intermediate agent, so far as concerns the molds. In this light it is easily seen why some houses sometimes have to suffer so badly from certain conditions of the soil, especially when they are badly ventilated. The movement of the air in a close house is many thousand times less active than where the circulation is free; and the air entering into the house suffers correspondingly less dilution than that passing into the free atmosphere, and leaves in it much more of what it brings up from the ground. While the house is heated during the cold season, and at night in the summer, while the air within-doors is warmer than the surrounding out-door air, the houses act as draught-flues, and suck air out from the ground as if they were cupping-glasses set over it. Experience has long taught us that it is most dangerous to sleep—that is, to pass the night—in such noted fever regions as the Pontine Marshes.

Many persons believe that the ground-air is an object whose existence is still pre-eminently theoretical, and that its practical influence

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is exceedingly remote. It does not present itself in this light to the physician who has had to deal with it. I am reminded of what the chief staff physician, Dr. Port, has remarked, as if by intuition, on the etiology of abdominal typhus, with immediate reference to military hygiene, and its bearings on the construction of barracks and camps. He says: "If we consider the danger to which the inhabitants of a disease-bearing soil are exposed by leaving their houses without protection from the soil, I might say by putting them on the ground barefooted, and, if we reflect that our most imposing palaces labor under this partial nakedness, we must of necessity receive the impression that there is some lack in our civilization. We have in this respect not only not excelled the most primitive constructions of the childhood of the building art, but have fallen behind them in a very important matter. We have no reason, from the hygienic point of view, to look down disparagingly on the pile-dwellings of some foreign races and the mud huts which our peasants still live in here and there: both of these classes of people, although in very different ways, have respected, in building, a hygienic principle that has escaped our architects. They have made their dwelling-places independent of the ground, in the former case by putting under them a grating of piles admitting a circulation of air; in the latter case by isolating the hut by means of a plaster floor. The superiority of these primitive dwelling-houses over our modern buildings can not be made to appear more clearly by any other example than by the sketch which Dr. Hirsch has given of an outbreak of cholera on the estate of Herr von Winter, chief health-officer of Dantzic:

"Nine houses stood in a group in front of the manor-house of the estate, and were inhabited by the farm-servants; seven of them had been rebuilt in timber with brick fillings, and furnished with cellars, which were perfectly dry; their ground-floors were lined with deal, were dry, airy, and kept clean; the manure-heaps were arranged in the manner that is common in rural districts. Two of the houses in the group had not been rebuilt; they were old mud huts, with low stories, without cellars; the rooms were not boarded up, but only plastered; and their condition seemed on the whole much more unfavorable than that of the others, while the manner of living of their inhabitants in other respects was in no way different from that of their neighbors in the modern cottages. About one hundred and fifty persons lived in all the nine houses. A woman, suffering from an attack of cholera, was taken into one of the new houses; three days afterward the first cases of sickness appeared in the neighborhood of this house, and the disease quickly spread to all the houses except the two old huts. The inmates of these houses had the same intercourse with their fellow-dwellers on the premises as the latter with each other; yet, while seventeen persons (or fifteen per cent of the whole number) in the seven new houses were prostrated, not a case of sickness occurred in the old huts. The

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exemption of the latter was attributed to their being isolated from the ground by means of their plaster floors. The change of the other cottages into modern dwellings, with exposed foundations, was hygienically a reformation for the worse. We frequently commit the mistake, in carrying out our ideas concerning the salubrity of a house, of confounding hygienic considerations with those of comfort."

Dr. Port brings forward other facts speaking for the influence of ground-air, and summarizes his view in the remark that he regards "a proper treatment of the soil as the first hygienic consideration, the chief prophylactic measure against certain infectious diseases, as the means by which we may make houses, barracks, tents, etc., dwelling-places free from disease. . . . From such dwellings we need not flee on the appearance of epidemics, but in them can bid defiance, as from a fortification, against disease; of such a dwelling we may say with truth, 'My house is my castle.'" It is very much to be desired that the building art could be turned, at least experimentally, in the direction indicated by Dr. Port. Practical hygiene is as little capable of being advanced without experiments as any other art; and where individuals can not experiment, the state should step in, in the interest of the public weal, and provide the means for answering important questions.

PROGRESS OF COPYRIGHT LAW.

By BENJAMIN VAUGHAN ABBOTT.

WHATEVER progress has been made in the law of copyright, during the past year or two, is seen in decisions of courts. In the realm of legislation no positive progress has occurred. A project of a general revision of the English enactments, which has been several years in preparation under parliamentary authority, has been fully completed and submitted for debate and enactment; and a very interesting and important negotiation for an international treaty has been carried far toward successful completion. But no actual results are yet achieved by either of these efforts to improve the law.

What literary compositions may be secured by copyright? The claim of a "law-reporter" has been sustained. For more than a century it has been customary to publish reports of the decisions of courts, in form somewhat peculiar and characteristic. The main thing to be given is, of course, the opinion of the court; and this, by general opinion, can not be copyrighted in the reporter's behalf; it is the official work of the judge, and is public property; or, at the least, it is not the reporter's property; whether the government employing and paying a judge can, by copyrighting reports, maintain a literary property in his official opinions, is a question not yet decided. But a

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report contains matters auxiliary to the "opinion," the preparation of which involves much literary labor and skill; such as a "syllabus" of the case, or brief statement of the points of law decided; a narrative of the facts involved in the trial; a condensed statement of the arguments; and, perhaps, a foot-note collating other decisions germane to the subject. A majority of existing law reports have been compiled by the reporters in the expectation of taking out a copyright and realizing a profit upon sales. The practice of paying a reporter a salary, now very common, is of recent introduction. Lately complaint was made on behalf of an official law-reporter who had no distinct salary, but compiled the reports relying on the copyright as his compensation, that a rival publishing firm were issuing a condensed edition. The publishers argued that the reporter's work was official, and not a subject of copyright. The judge said he thought an officer enjoying a salary for his work probably ought not to claim a copyright, but one who worked for the copyright as his compensation ought to be sustained in it. The publishers also showed that they had instructed their editors to draft new head-notes and narratives of facts. The judge said he could scarcely see how new editors could in fact compile these parts anew unless they consulted the original records. It was not shown that they had done this; moreover, the judge's comparison of the two books led him to think that the editors had in fact used the reporter's work to a considerable extent. The decision was in favor of the reporter's claim. It is noteworthy that a decision rendered half a dozen years ago, though published recently, declared that a reporter could not claim copyright in head-notes furnished to him by the judges as part of their official duty.

Upon the death of Lord Beaconsfield, the London "Times" published an elaborate memoir. Some one reprinted it in a penny pamphlet. Of this the proprietor of the "Times" complained; but the publisher of the pamphlet said that he had the right to issue it because the "Times" was not copyrighted. Now, the copyright laws do not mention newspapers by that name; they allow copyrighting "books"; when newspapers are copyrighted, it is done upon the idea that the term "book," liberally understood, includes a newspaper. For the proprietor of the "Times" it was argued that a newspaper like the "Times" is not a proper subject of copyright; and that, there being no copyright law available for articles in newspapers, the publisher has "a common-law right"—a natural property, independent of statute—by virtue of which he can forbid any one else from reprinting them. There is said to be a former English decision to this effect. But the judge decided, in respect to the Beaconsfield memoir, that the "Times" newspaper can be copyrighted, and that it should have been, in order to sustain the claim made. He sanctioned the little pamphlet.

Many of our readers know the two books "Monitor Post-Office,

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etc., Guide," and Mackey's "Shippers' Guide." The proprietor of the "Monitor Guide" sued Mr. Mackey for violation of copyright. The judge said that such guide-books are a proper subject of copyright; but that the right was not so broad and full as the plaintiff claimed; it did not forbid Mackey from collecting similar information to that given in the "Monitor Guide," about post-office, railroad, express, and telegraph business, or from arranging and exhibiting it in much the same general ways, but only from copying material portions of the "Monitor Guide."

Recent decisions on the question whether books designed to be used in a *quasi*-mechanical way—ruled account-books, bond-registers, and the like—should be copyrighted or patented, were narrated in an article in the July number. Nothing new on that topic has transpired, except that a patent has just been sustained for an improved "check-book."

Does the copyright law sustain property in the mere title of a book? The tendency of thought is that the law of trade-marks affords such protection as there is for a title, as distinguished from the body or contents; that the purpose of the copyright law is to secure the exclusive right of publishing the substantial work, and that it protects the title only as being a part of the work. But it can not be said that this has been sharply decided. When the directory for London was established, which was about seventy years ago, the necessary information was gathered or furnished by post-office clerks; hence the book was called, naturally enough, the "Post-Office Directory." In later years the post-office aid was discontinued; the proprietor of the enterprise continued, however, to issue the book annually, on information gathered by his own canvassers. He adhered to the familiar title, registering the successive volumes, under the copyright laws, as "Post-Office Directories." At length a rival commenced a directory for Bradford, which lay within one of the districts covered by one of the issues of the old directory; and this rival called his work also "Post-Office Directory." He has been sued; but both courts held that he was not violating copyright; nor, indeed, the trade-mark law.

Miss Braddon wrote a novel to which she gave the name "Splendid Misery," and sold it to the London journal called "The World," conducted by Mr. Edmund Yates; and "The World" began publishing it as a serial story. This occurred in 1879. Before long the proprietor of "Once a Week" entered a complaint, saying that in 1874 he had purchased and published in his paper a novel by C. H. Hazlewood (which had been duly copyrighted), also under the title "Splendid Misery." He did not suggest that Miss Braddon's story imitated Mr. Hazlewood's; the only question was whether he had an exclusive right to the title, by virtue of the copyright law. The vice-chancellor thought his claim good; and, indeed, there is an earlier decision to much the same effect. But Miss Braddon's publisher learned that, as

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long ago as 1801, a novel written by still another author had been published under the same title—"Splendid Misery." Partly on the ground that this publication had rendered the title common property, so that now any one may use it, the Court of Appeal decided in favor of Miss Braddon's publisher. Apparently, however, the judges consider the general English law to be: 1. A title has no special protection by the copyright law; that protects it only as any other part of the book; 2. Another person who uses the same title only, without either imitating the book or deceiving the public, can not be stopped by a copyright suit; 3. Appropriating a title under circumstances which show an intention to attract people to buy the book under the supposition that they are getting another well-known one—as, if one should publish an anonymous, inferior story under the title "Vanity Fair," for the purpose of leading buyers to think it was the celebrated story by Thackeray—is a fraud on the public, which may be published or stopped, independent of copyright law. But the question of holding a title by force of the copyright law should, perhaps, be deemed an open one in England; two vice-chancellors have decided that it may be; but the judges of the Court of Appeal have said that they do not think so; this was said, however, in a case in which the facts did not enable them to make an authoritative decision.

In America, when the copyright of "Irving's Works" expired, recently, a rival publisher issued a volume of selections, using the same title—"Irving's Works." The former publisher, though he could not complain of the publication of the substance of the volume, did bring his suit to forbid using the title; it was, as he claimed, his trade-mark. But the judge said that the public were not misled; the selections comprised in the book were genuine writings of Washington Irving; and, now that any one may publish Irving's writings, he has the right to style them "Irving's Works."

There has been a decision on a matter very germane to copyright, the affixing of an author's name to a book. The story of the plaintiff, who was an American publisher, was, that he devised a new plan for compiling illustrated guide-books to towns, according to which a Mr. Kenny prepared several such books relating to towns in America. They were known as "Kenny's Guide-Books." Subsequently the publisher agreed with Kenny for the use of the latter's name upon a guide-book for London; and he employed Mr. Marsh (against whom the suit was brought) to write the London book. The engagement was on the distinct understanding, so the publisher said, that Marsh's name would not appear as author. The publisher, however, announced the book as being "by D. J. Kenny (assisted by John B. Marsh)"; but Marsh, then, although he had drawn his pay for preparing the work, withheld the manuscript. The publisher asked the court to compel him to deliver it. The author, Marsh, denied positively that he ever

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agreed that the book should be published without his name, and said that his reason for withholding the manuscript was, that styling the book on the title-page as being "by D. J. Kenny" would be a fraud on the public, since Kenny had taken no part in preparing it. The court decided in favor of the author. This is as much as to say that a writer shall not be compelled to furnish manuscript which he withholds because he knows it will be published under another man's name in a way to deceive the public; but whether an author has a legal right to have his own name appear on a book he has sold outright is another question.

Dramatic copyright is a fruitful field of litigation. To protect a play by any legal methods is difficult, and the laws having that aim have not been so distinctly and judiciously framed as they might be. Several suits have been brought, in this country, within the past year or two, to protect noted plays. An English suit, which reached an authoritative decision in the House of Lords, arose upon two rival dramatizations of Eugene Sue's novel, "The Wandering Jew." This novel was dramatized in France quite early after its publication, and Englishman number one prepared a play described as an "adaptation" of this French play. He, however, introduced two striking scenes: one displaying the wandering Jew strolling in the Arctic regions (real icebergs and a lime-light) and beholding, in a mysteriously managed vision, the future perils and sufferings of his descendants; the other exhibiting the final triumph over the enemies' machinations, and introducing the figure of the Jew in the background, under brilliant red lime-light. In the French play, these matters were not scenically represented, but were described in a prologue and epilogue; perhaps because the devices of stage carpenters and property men were not sufficient, fifty years ago, for such spectacles. Englishman number two also dramatized the story, independently of and differently from the play by Englishman number one, except that he took from the latter's play the points of bringing these two matters into actual representation, instead of leaving them to prologue and epilogue. For this he was sued. But the courts, including the House of Lords, held that taking the two scenes was not enough, under the circumstances, to constitute an infringement. Copyright of a play is not infringed unless some substantial, material part—more than a new mode of representing a couple of matters not really essential to the unity of the plot—has been taken.

Another English decision has said that, when two or more persons own together the copyright of an opera or drama, one can not represent it or license a manager to do so, without consent of the others.

In respect to musical compositions, decisions have been made in England upon the right to publish the songs "Kathleen Mavourneen" and "Dermot Asthore," and the opera "Vert-Vert"; but they turned on the bargains the parties had made, and do not explain copyright

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law except that they clearly show musical compositions to be fully entitled to the protection. An odd case occurred in Pennsylvania, which was thus narrated in the "New York Times": "A publisher copyrighted and brought out an 'arrangement,' made by an American musician, of a popular French waltz, christening it 'Manola Waltz.' A competitor republished it with scarcely any changes, and when the first publisher complained, 'Your waltz is only a copy of mine,' he answered, 'Yours is only a copy of the Frenchman's.' The judge said that a man need not be an original author—the sole creator of the work; the first publisher could fairly get a copyright for his arrangement'; and the second one had no right to reprint that arrangement, though he might have made a new and different one."

Pictures have given rise to several decisions. Some manufacturers of earthenware for the Cuban market ornamented their ware with a portrait of the Captain-General of Cuba, surrounded by a wreath; this portrait was copied from a photograph of the general. Also the father of an attractive young lady had her portrait painted in "character," representing her as a young girl walking on the sea-shore, shoeless and stockingless, and carrying a spade and basket; this picture he copyrighted and had it engraved for publication as "Going to Work." Lawsuits were brought to protect these two copyrights. The decisions apparently take the view that a picture of a living person is not a proper subject-matter of copyright; that the law will not protect a "design," the chief element of which is a portrait, while the additions or accessories are but trivial. In a lawsuit over a book "with illustrations by John Leech," it appeared that the designs were drawn by Leech himself, upon the blocks; and he retained the copyright; the publishers, apparently, however, furnished the wood; and, when a controversy arose, they made the law point that, though the designs possibly belonged to Leech, the blocks belonged to them (the publishers), and they meant to keep them. The court said that, considering the way in which the parties had dealt, also that the wood was worth next to nothing in comparison with the designs, it was fitting that the publishers should surrender the cuts. In America, a publisher who was sued for violating the copyright of a picture, proved that, in preparing the chromo which he sold, he had not copied from the picture copyrighted in this country, but had followed an English original; and the court pronounced this a good defense. Copyrighting a picture forbids another person from copying it, but does not forbid copying a picture like it from foreign publications, or designing one anew.

More interesting than either of these is a decision involving the famous picture originally painted by Millais, about thirty years ago, known as "The Huguenot." From this painting an engraving was taken, which was duly copyrighted, and has had a wide sale. More lately the publishers of the London magazine "Bow-Bells," in a Christ-

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mas supplement, issued a chromo-lithograph pattern for Berlin-wool work, embodying this picture. When sued, they said that they bought the pattern in Germany; they did not, however, dispute that it had been copied from the engraving, but claimed that copyright in an engraving only protects the proprietor from competition of engravings and other prints adapted to be sold and used as engravings are; that is, as works of art to please the eye. And the Court of Appeal so decided. The purpose of any kind of picture intended to be hung as an ornamental work of art, and that of a mere pattern to be used as a guide for an embroiderer or artisan, are so different that the pattern can not be called a copy of the picture, in the sense that it violates the copyright law.

Recent decisions have not been particularly favorable to maps and charts. In America the compiler of "insurance maps" devised a novel system of colors and signs, explained by a key, enabling a person to see at a glance the character of the buildings and other facts about the property important with reference to insuring it. He copyrighted these maps. An imitator prepared maps of Philadelphia on the same plan, and using like colors, signs, and key. The Supreme Court said that this was no infringement. A copyright gives the exclusive right of multiplying copies: to infringe it, a substantial copy of the whole or of a material part must be produced. Now, maps of Philadelphia can not possibly be deemed copies of maps of New York. Scarcely any map is published on which some arbitrary signs explained by a key are not used; but copyrighting the map does not secure an exclusive right to the signs and key for all other maps. A dealer in zinc paints contrived an advertising card bearing bits of paper painted in colors and serving to exhibit the hues of the paints sold by him; and this card he copyrighted as a chart. The judge said that it was not a chart, nor the subject of copyright; and that, if it were, a rival dealer's similar card using colored papers to show what paints were sold by him would not be an infringement, because it was not a copy of the information conveyed by the first card. A print-dealer contrived pattern-prints of balloons, hanging-baskets, etc., bearing printing as a guide for embroidery, and cutting-lines, showing how the paper might be cut and joined to make the different parts fit together. The judge said that things of this nature are not the subject of copyright.

A recent decision in favor of a lecturer's right to control publication of addresses which he does not print but retains for repeated oral delivery, is narrated, in an article entitled "Medical Lectures and the Law of Copyright," in the "New York Medical Journal" for June last. Rumor says that the question is to be raised again in a suit by Colonel Ingersoll.

London and New York have each a "Coach-makers' Journal"; and the New York editor copied an article from the London paper. Thereupon the London publishers, finding that a news-agent there was im-

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porting and selling copies of the American paper, prosecuted him. He argued that it was impossible for him to know, when ordering books from America, that they contained English extracts, and that he ought not to be punished for simply importing and selling books in the ordinary way of business. But the decision was, that an importer is bound to ascertain; or, if he imports without inquiry, he takes the risk that there may be something in the books which he will not be allowed to sell. A more lenient view of a somewhat similar question was taken in an American decision; it held that a partner or employer is not chargeable with a statute penalty for acts in violation of copyright done without his authority or knowledge by his partner or agent. Some intention to violate the law must be shown, according to this case, to sustain a prosecution.

VOLCANIC PRODUCTS.*

THE most abundant of the substances ejected from volcanoes is steam, or the vapor of water, which issues in prodigious quantities during every eruption. With it frequently appear numerous other volatile matters—the acid gases, hydrochloric, sulphurous, carbonic, and boracic acids; sulphuretted hydrogen, hydrogen, nitrogen, ammonia; the volatile metals, arsenic, antimony; and some other substances not usually volatile, but which are nevertheless easily carried away in fine particles when a current of steam is passed over them. These various substances react upon each other, and give rise to the formation of many new compounds. Deposits of sulphur result from the action of sulphuretted hydrogen and sulphuric acid on each other; hydrochloric acid forms, with the iron in the rocks, the yellow ferric-chloride which coats the vents, and is often mistaken for sulphur. The iron, lime, and alkaline materials of the rocks are converted by the acids into soluble salts, which, being washed away by the rains, leave a white powdery deposit of silica that so much resembles chalk that travelers have been led to describe islands in which it appears very abundantly as being composed entirely of that substance. Some of the gases, as hydrogen and sulphuretted hydrogen, are inflammable, and may sometimes be seen at night playing over the fissures in faint, lambent flames, occasionally brightly colored with metallic salts. These transient flames are not, however, to be confounded with the red, glowing light which is commonly called "volcanic flames," but which is not really a flame, only the reflection in the vapors of the glowing mass in

* Volcanoes, what they Are, and what they Teach. By John W. Judd, F. R. S. With Ninety-six Illustrations. "International Scientific Series." New York: D. Appleton & Co., 1881.

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the crater beneath. Some of the volatile products of volcanoes are of economical value, like the sal-ammoniac, sulphur, and boracic acid of Vulcano, which have given rise to extensive chemical works.

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Solid substances are ejected and accumulate around the orifices, where they frequently form large mountains. They are fragments of rock torn from the formations through which the eruptive stream passes—crystallized minerals, or matters which, derived from sources far below the earth's surface, issue in an incandescent or molten condition, and to which the name of lavas is properly applied. The lavas are composed of the silicates of aluminium, magnesium, calcium, iron, sodium, and potassium in different degrees of combination or mixture. Oxygen, in silicic acid or in a metallic oxide, makes up nearly half the weight of all of them, the metalloid silicon one fourth, and aluminium one tenth of the most of them. Silica or silicic acid—rock-crystal or flint—is present in proportions varying from one half to four fifths of the whole mass. Those lavas in which silica is present in larger proportion are called "acid lavas"; those in which the base is in greater proportion, "basic lavas." Between these are the "intermediate lavas," in which the proportion of silica is lower than in the acid lavas, and the proportion of bases is lower than in the basic lavas. Of the five great groups into which geologists have divided the lavas, the rhyolites are acid, the basalts are basic, and the trachytes, andesites, and phonolites are intermediate.

The structure of lavas can be more clearly ascertained by studying them in the condition of transparent or semi-transparent slices under the microscope. Most of them are made up of crystals of different minerals, varying in size from those which are hardly visible to the naked eye to those of an inch or more in length. Others appear glassy in structure. Under the microscope, they are shown to be made up of two kinds of materials, a base or ground-mass of a glassy character, and distinct crystals irregularly distributed through this glassy base, like the raisins in a cake. In some cases the vitreous part makes up the whole mass of the rock; in others smaller or larger numbers of crystals are seen to be scattered through a glassy base; while in others again the crystals are so numerous that the presence of an intervening vitreous ground-mass can be detected only by the aid of the microscope. When slices of the glassy materials are examined with high powers, cloudy patches are seen diffused through the substance, which under still higher powers resolve themselves into innumerable particles having very definite outlines, some transparent and some opaque. At the same time fresh cloudy patches are brought into view, requiring still higher powers for their resolution; and so the process may go on, as it does in examining the nebulæ with the telescope. The minute particles thus brought into view are called microliths or crystallites. Sometimes, instead of being indiscriminately diffused, they are collected in groups of very definite form, resembling the frost-work on

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window-panes. In other cases they unite in radial groups about certain centers, and thus build up globular masses to which the name of "spherulites" has been given.

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In Figure 1 No. 1 represents a glass through which microliths or crystallites of different dimensions and character are diffused. In

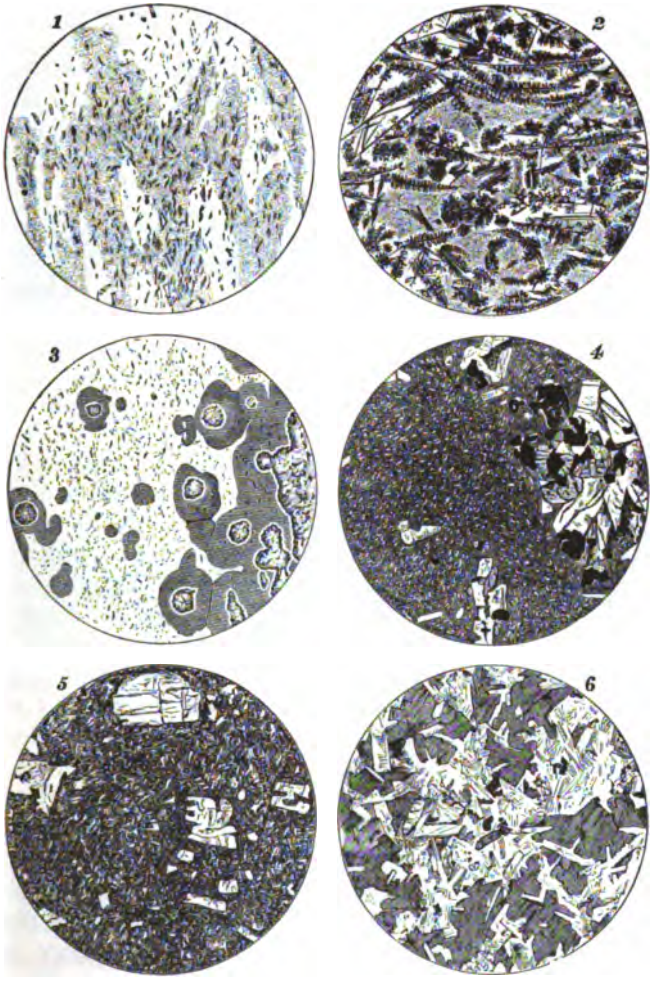


FIG. 1.—SECTIONS OF IGNEOUS ROCKS, ILLUSTRATING THE PASSAGE FROM THE GLASSY TO THE CRYSTALLINE STRUCTURE. 1. Vitreous rock. 2. Semi-vitreous rock. 3. Vitreous rock with spherulites. 4. Rock with cryptocrystalline base. 5. Rock with microcrystalline base. 6. Rock of granitic structure built up entirely of crystals.

Nos. 2 and 3 the crystallites have united to form regular groups. No. 4 represents a glassy ground-mass containing microliths (a cryptocrystalline base), through which distinct crystals are distributed, and is typical of the features presented by most lavas. Nos. 5 and 6 illus-

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trate the characters presented by lavas which have consolidated at considerable depths below the surface.

The microliths have been proved to be the minute elements from which common crystals are built up; and cases occur in which a group of them may be seen gradually assuming the outward form and internal structure of a crystal, and in other cases crystals may be found which are undergoing a disintegrating action, and are then seen to be made up of minute elements similar to the microliths.

The same materials which go to form a lava may assume a glassy condition, or that of a rock built up entirely of crystals. Geologists have given distinct names to the glassy and crystalline forms of lavas, which correspond with the five great classes into which lavas have been divided as follows:

Crystalline forms.	Lavas.	Glassy forms.
Granite	Rhyolite	Obsidian.
Syenite	Trachyte	
Dyorite	Andesite	
Miascite	Phonolite	
Gabbro	Basalt	Tachylyte.

The obsidians do not exhibit enough differences to demand a distinction.

When the large crystals imbedded in granitic rocks and in some lavas are examined with the microscope, they are often found to contain numerous minute cavities, each of which resembles a small spirit-level, having a quantity of liquid and a bubble of gas within it.

In No. 1 of Figure 2 a group of such cavities is represented, one of which is full of liquid, while two others are quite empty; the remaining cavities all contain a liquid with a moving bubble of gas. In No. 2 two larger cavities are shown, containing a liquid and a bubble of gas. In Nos. 3, 4, and 5 the liquid in the cavities contains, besides the bubbles, several minute crystals; and in No. 6 we have a cavity containing two liquids and a bubble.

In the largest of such cavities the bubble may be observed to change its place when the position of the cavity is altered, so as always to lie at the upper side, just as in a spirit-level; while in the smallest cavities the bubbles appear to be endowed with a power of spontaneous movement, and are seen continually oscillating from side to side and from end to end of the hollow, as in Figure 3, where the dark line shows the path pursued by the bubble. These cavities are exceedingly minute, and so numerous that there must be millions of them in some crystals; indeed, in certain cases, as we increase the magnifying power of the microscope, new and smaller ones continually become visible; and it has been estimated that in some instances the number of them amounts to from one thousand million to ten thousand million in a cubic inch of space. In many cases the included liquid is water containing saline matters in solution,

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and often so saturated that free crystals of the salt appear floating in it; in other cases it is some hydrocarbon; and sometimes it is lique-

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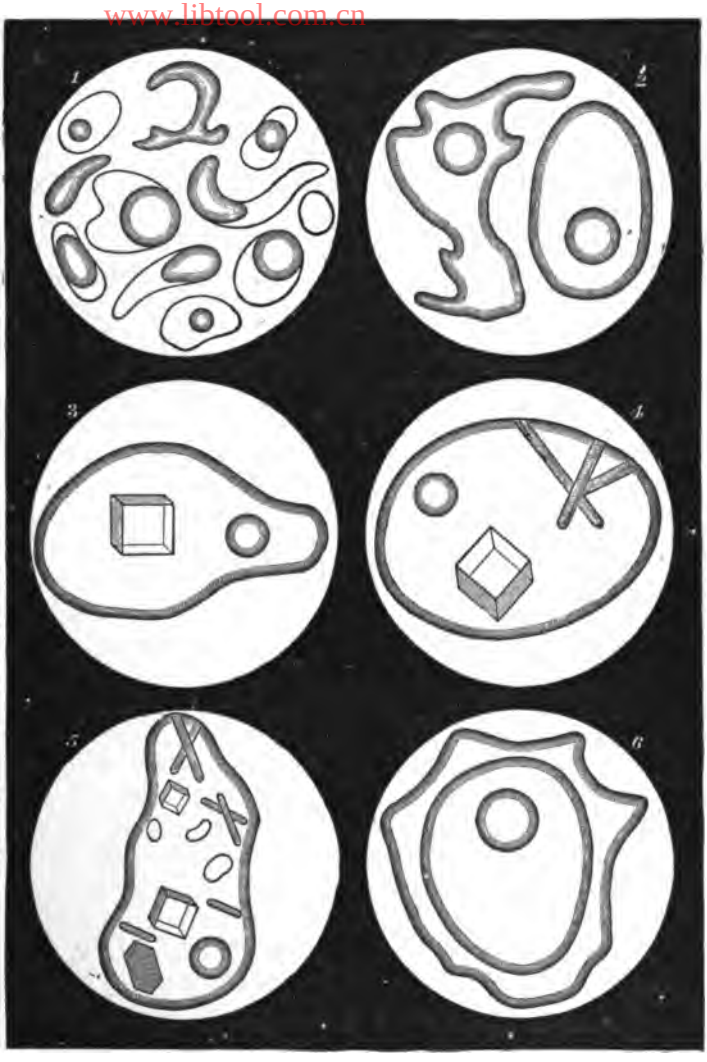


FIG. 2.—MINUTE CAVITIES, CONTAINING LIQUIDS IN THE CRYSTALS OF ROCKS.

fied carbonic acid. The presence of these liquids under such circumstances shows that the crystals have been formed under an enormous pressure.

The surface of fluid and semi-fluid lavas is covered with vast quantities of froth or foam which has been generated by the action of the escaping steam. If the lava consists of a mass of crystals floating in a liquid magma, this froth cools into the rough, cindery-looking mate-

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rial which is called scoria. If the lava is glassy it becomes pumice, a mass of minute glass bubbles drawn out in one direction by the movement of the mass while it was still in a plastic state. Fragments of scoria and pumice are often thrown by a violent escape of steam to a height of hundreds or thousands of feet into the atmosphere. While going up and coming down, they encounter each other and wear each other away by their frequent rubbing, with a noise which is one of

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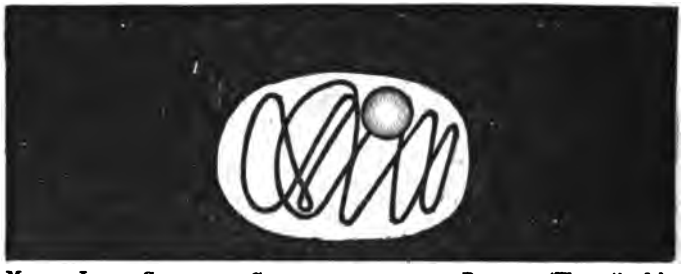


FIG. 3.—MINUTE LIQUID-CAVITY IN A CRYSTAL, WITH A MOVING BUBBLE. (The path of the bubble is indicated by the dark line.)

the most noteworthy accompaniments of volcanic eruptions. Mr. Poulett Scrope, who watched the Vesuvian eruption of 1822 for nearly a month, remarks that at first fragments of enormous size were thrown out, but that they were gradually reduced by constant re-ejections, till at last only the most impalpable dust issued from the vent—a dust which was so excessively finely divided that it went everywhere, even into the most closely fastened boxes. Mr. Whymper estimates that no less than two million tons of dust must have been ejected during a single slight outburst of Cotopaxi which he witnessed; and Professor Bonney calculates from actual examination that it would take from four to twenty-five thousand particles of this same dust to make up a grain in weight!

The temperature and consistency of lava-streams vary greatly, and the variations give rise to differences in the appearance of the cooled mass. The surface of the stream cools rapidly in the air, so that it appears dull-red at night and black by day—like a great mass of rough cinders—while all is of a white heat beneath, and may be so seen at night shining through the rough, cindery masses. Some streams are very liquid, resembling rivers and filling every channel in their course; while others, cooler and stiffer, might be more fitly compared to glaciers, creeping along so slowly that the fact of their movement can be established only by the most careful observation. The stiff lavas leave a crust wrinkled and folded like coils of rope, and are then frequently called "ropy lavas." The very liquid, fast-flowing lavas leave a surface covered with rough, cindery masses presenting jagged projections. Admirable examples of the ropy lava are afforded by the Vesuvian lava-stream of 1868 (Fig. 4), and by the lava-cascade of the Island of

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Bourbon, where the stream, flowing over a precipice, has left heavy pendent masses resembling the drippings of a guttering candle. Another illustration of the forms produced by very viscid lavas is afforded by the so-called "mamelons" of the island of Bourbon. The flow of rapid

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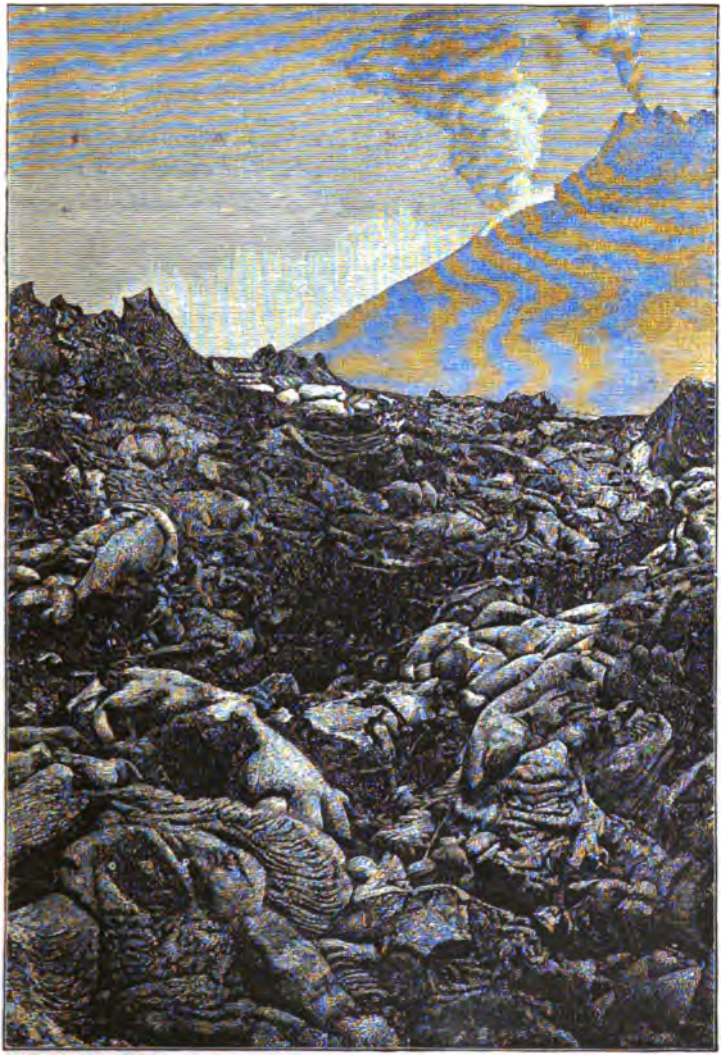


FIG. 4.—VESUVIAN LAVA-STREAM OF 1858, EXHIBITING THE PECULIAR "ROPY" SURFACES OF SLOWLY-MOVING CURRENTS. (From a Photograph.)

currents is generally accompanied with the disengagement of vast quantities of steam, and this, doubtless, has much to do with the formation of the cindery projections which characterize the cooled surfaces of such streams. Little parasitic volcanoes are often formed on the top of the

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lava by the action of the escaping steam. Some such miniature volcanoes, formed on Vesuvius in 1872, were so small that they were carried away on boards to be employed as illustrations in the lecture-rooms

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FIG. 5.—CONCENTRIC FOLDS ON MASS OF COOLED LAVA.

of the University of Naples. When very viscous lavas are forced through fissures, they arrange themselves in concentric masses, like that represented in the illustration (Fig. 5), which is from New Zea-



FIG. 6.—MASS OF COOLED LAVA FORMED OVER A SPIRACLE ON THE SLOPES OF HAWAII.

land. More liquid masses give rise to variously shaped structures, the bottle-shaped heaps of the "petrified fountains" (Fig. 6), or forms illustrated by the groups (Fig. 7) of small cones from Vesuvius. The con-



FIG. 7.—GROUP OF SMALL CONES THROWN UP ON THE VESUVIAN LAVA-CURRENT OF 1855.

traction of lava in cooling tends to produce fissures through the mass, breaking it up into prisms. Hence we have the columnar structure

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of basalt. A similar structure is exhibited in all kinds of lavas, and in other rock-masses which have been heated by contact with igneous rocks and gradually cooled. Columns of a dissimilar character are produced by the unequal cooling of different parts of the stream, so that, if the stream be thick, the lower parts will form stout, vertical columns of great regularity; while the upper part, cooling less regularly, will produce smaller and less regular columns (Fig. 8). Fingal's

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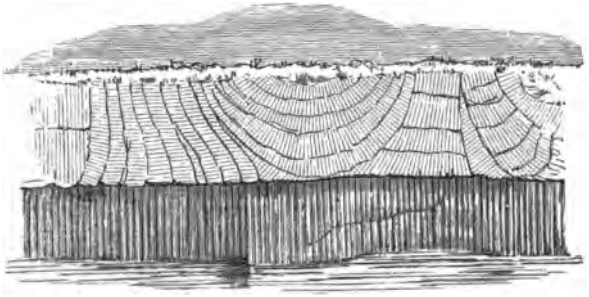


FIG. 8.—SECTION OF A LAVA-STREAM EXPOSED ON THE SIDE OF THE RIVER ARDÈCHE, IN THE SOUTHWEST OF FRANCE.

Cave, in the Island of Staffa, has been formed in the midst of a lava-stream which has been cooled in this manner. The thick, vertical columns, which rise from beneath the level of the sea, are divided by joints and have been broken away by the action of the sea, and a great cavern has been produced, the sides of which are formed by vertical columns, while the roof is made up of smaller and interlacing ones; and the whole structure bears some resemblance to a Gothic cathedral. The columns formed in cooling vary in size from those of the Shiant Islands, near Skye, which are eight or ten feet in diameter and five hundred feet long, to the minute columns, an inch or two in length and hardly thicker than a needle, of the volcanic glasses. The larger columns are formed in slowly cooling masses. The quantity of matter that is ejected from volcanoes in the form of lava is truly enormous. Lava-streams have been described which have flowed for a distance of from fifty to a hundred miles from their source, and which have had a breadth varying from ten to twenty miles; some are five hundred feet thick, or even thicker. A mass estimated to be equal in bulk to Mont Blanc flowed out in a single eruption of Reykjanes in Iceland, in 1783. In many parts of the earth's surface, among which are tracts in our Rocky Mountain regions, successive lava-sheets have been piled upon one another to the height of several thousand feet, and cover areas of many hundred or even thousand square miles. The marks of the effects of the passage of the hot volcanic matters, with the powerful chemical agents with which they are charged, are left upon the adjoining rocks, where, for a considerable distance from the vent, limestones are converted into statuary marble, sandstones into

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quartzite, clays become hardened and lustrous, and coals assume a form like coke and graphite. Crystalline minerals and gems are formed, the rarest ones under a combination of powerful forces of heat and pressure which has been imitated by man only in the feeblest degree, most notably in the production of minute artificial diamonds by Mr. Hannay. The steam-jets which issue from volcanic fissures carry up fragments of rock torn from the sides of the vent, in the cavities of which beautiful crystallized products are often found. The various metallic minerals have nearly all been brought from away down in the earth's crust and deposited upon the sides of rock-fissures, the same volcanic forces opening the cracks through the solid rock, and then bringing up the metallic compounds and causing them to crystallize on the sides of the fissures. The cavities of the igneous rocks, when filled with water, constitute laboratories in which real chemical reactions take place—where the materials of the lava are gradually dissolved and recrystallized in new combinations, and the agates, the onyxes, the rock-crystals, the Iceland spars, and the class of zeolites have been formed. "No one can visit a large collection of crystalline minerals without being struck with the great number of beautiful substances which have thus been formed as secondary products from volcanic materials."

Hot springs, geysers, and carbonic-acid springs, which are also volcanic in their origin, afford another variety of curious products. Hot springs often contain in solution large quantities of silica, which has been taken up at the moment of its separation from the alkalies or alkaline earths with which it has been combined, and which is deposited when the water, having reached the surface, is relieved from pressure and cools down. Thus are formed the basins of the geysers of Iceland,



FIG. 9.—SINTER-CONES, SURROUNDING THE ORIFICES OF GEYSERS. 1. Basin of the Great Geyser, Iceland. 2. Hot-spring cone. 3. Old Faithful. 4. The Giant Geyser. 5. Liberty-Cap. (2, 3, 4, and 5 are in the Yellowstone Park district of the Rocky Mountains.)

and the curious structures with fanciful names which distinguish the geysers of the Yellowstone. The outlines of some of these structures are given in the figure (Fig. 9). The deposited silica is known to geologists as "sinter." Carbonic-acid water, in a similar manner,

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losing its acid on exposure to the air, leaves a deposit known as "travertine," sometimes in great masses. In the Auvergne, the travertine exists in large rocks which take the form of natural aqueducts and bridges; in Carlsbad it has filled the whole bottom of the valley, and lies under the foundations of the town; and in Rome it has furnished the stone for St. Peter's and all the principal buildings. When springs charged with silica or carbonate of lime appear upon the slope of a hill composed of loose volcanic materials, they give rise to the remarkable structures known as sinter- and travertine-terraces. The water flowing downward from the vent forms a hard deposit upon the lower slope of the hill, while the continual deposition of solid materials within the vent tends to choke it up. As a new vent can not be forced by the waters through the hard rock formed below, it is opened a little higher up (Fig. 10). Thus the site of the spring is gradually

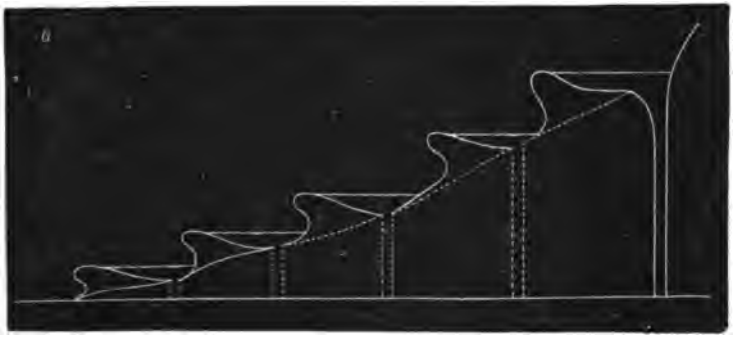


FIG. 10.—DIAGRAM ILLUSTRATING THE MODE OF FORMATION OF TRAVERTINE- AND SINTER-TERRACES ON THE SIDES OF A HILL OF TUFF.

shifted farther and farther back into the hills. As deposition takes place along the surfaces over which this water flows, terraces are built up inclosing basins. Of structures of this kind we have remarkable examples in the sinter-terraces of Rotomahana in New Zealand, and the travertine-terraces of Gardiner's River in the Yellowstone Park.

We sometimes find examples of volcanoes which by the action of denuding forces have had their very foundations exposed to view. Such examples occur in the Western Islands of Scotland, where we are able to trace the ground-plan of the volcanic pile, and study the materials which have consolidated deep beneath the surface in the very heart of the mountain. An admirable specimen of them is given by the "dissected volcano" forming the Island of Mull, which was probably originally nearly thirty miles in diameter at its base, and ten or twelve thousand feet high, but is now reduced to a group of hills few of which are more than three thousand feet high. Here, as shown in the figure representing the ground-plan (Figs. 11 and 12), great masses of granite, syenite, and diorite—the crystalline representa-

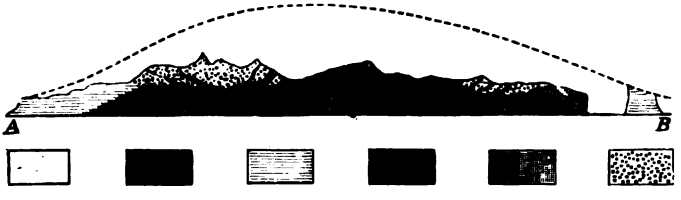
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tives of the first extruded lavas—are penetrated by intrusions of gabbro, the granitic form of the later ejected lavas. From these great intrusive masses of highly crystalline rocks proceed in every direc-

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FIG. 11.—PLAN OF THE DISSECTED VOLCANO OF MULL, IN THE INNER HEBRIDES.





a Rocks, on which the volcano has been built up. *b* Great intrusive masses of acid and intermediate rocks. *c* Lava-currents of basalt which have flowed from *d*. *d* Intrusive masses of gabbros and dolerite. *e* Lava-currents which have flowed from *b*. *f* Volcanic tuffs and agglomerates.

FIG. 12.—SECTION OF THE VOLCANO ALONG THE LINE *A B*.

tion spurs or dikes, which are evidently the radiating fissures formed during the outwelling of igneous materials from below, injected by fluid substances. Besides the vertical or oblique dikes we also find horizontal sheets, which, passing from the central masses, have pene-

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trated between the surrounding strata, often to enormous distances. The hard crystalline materials and dikes remain now as mountains; the remnants of lava-streams stand as isolated plateaus; while the softer materials have been carried away. The matters ejected from volcanoes are often carried by winds or currents to very great distances. Pumice floats out upon the ocean, and has been found so thick near the Lipari Islands that a boat could hardly make progress through it, and so abundant near the Solomon Islands that it took ships three days to force their way through the floating masses. Volcanic dust has been blown all over the ocean and across it, and has been found by deep-sea soundings to cover the bottom of the deepest parts and those farthest from the land.

The results of volcanic action, whether viewed singly or collectively, appear immense, and seem to indicate that the earth is or has been the prey to tremendous and terrible forces. Yet the action passes, and probably always has passed, without inflicting any permanent disturbance upon the condition of the earth's surface over more than the most limited areas. Clear proofs exist that the volcanoes of the Hebrides, of the Auvergne, and of Hungary, were clothed in Miocene times with luxuriant forests. The Island of Java, near the heart of the present most active volcanic center on the globe, is at the same time one of the richest and most fertile spots in respect to vegetable and animal life. The slopes of Vesuvius afford the best field for vineyards, and are in constant demand for that purpose, notwithstanding the danger of spasmodic outbreaks, for the eruptions of the volcano are short and its periods of repose are long. Volcanic action is only one of the ordinary forces of nature, probably quite as beneficial as destructive in the long run.

THE CHEMISTRY OF COFFEE AND TEA.

By ALBERT B. PRESCOTT,
PROFESSOR OF ORGANIC AND APPLIED CHEMISTRY IN THE UNIVERSITY OF MICHIGAN.

THE vegetation on the southern slopes of the eastern Himalayas, three or four thousand feet above the sea, though by no means luxuriant, is said to be very agreeable and of much interest to the botanist. Among the plants native to these slopes, planted in the course of nature during the preparation of the earth for man, and left wild with the elephant and the leopard, is a shrub growing from twenty to thirty feet high, and well worthy to be selected for pleasant foliage and fine flowers. The lanceolate leaves are from two to six inches long, and the flowers are large and white, very fragrant, in clusters of two or three in the axils of the leaves. This is the tea-plant, of the genus *Thea*, very nearly allied to the genus *Camellia*, of which the

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Japonica and other species from China and Japan are favorite cultivations of the greenhouse in Europe and this country. Nowhere in the world but on the borders of the Himalayas and in the wild regions of Assam is the tea-plant found growing uncultivated, but it was not discovered in this its natural habitation until the present century. As a cultivated plant, the Chinese have certainly had it since the fourth century, and they claim it to be indigenous to their own soil—just as confidently as they claim the parentage of numerous valuable articles. China has given tea to the world, and has furnished a favorable home to the plant, which is nevertheless quite as well suited in its native land, farther east. When it became known in England that the tea-plant grew native in the highlands of the Himalayas, English companies engaged extensively in the cultivation of tea in that region, and finally, after the correction of notable failures in methods of culture and of cure, it appears that the finest teas of Asia are those of these mountain-plains and the choicest plants are of variety *Assamica*, lately propagated from the wild shrub of the mountains.

A child would ask the question, What is there so very good in the tea-plant or in its dry leaf? And a philosopher may well ask, What is there about it, that this article has had a commercial history since the early middle ages, and men toil to till it, and with infinite detail to pick it and dry it and roll it, and spread and stir and roast and toss it, and then carry it over the globe in quantities to distribute for every household and amounting in sum-total to a quarter of a billion of pounds every year? In the first place, what does the tea-leaf contain —the fresh leaf from the wild bush of the mountains, never gathered for use, or the leaf picked on the tea-farms and carried dry to your tea-caddy—what kinds of compounds are in it, and can no other plant than this produce them?

To leave out a long story of progressive investigations, and to say nothing of the ways and means of analysis, the chief constituent to be named is the alkaloid *theine*. When separated from the other constituents of the tea-leaf, so as to be seen in its perfect purity, theine appears in snow-white, silky, filiform crystals, flexible and fragile, without odor, but having a mildly bitter taste. It dissolves readily in ten times its quantity of boiling water, and more slowly in a larger proportion of boiling water. It does not vaporize or decompose in the least at water-boiling heat; it melts at higher temperature and vaporizes slowly at about 360° Fahr., without decomposition. Chemically, it is a compound of the four organic elements, and is classified within the borders of the great group of alkaloids, but it differs distinctly from all other alkaloids (except its near relative, theobromine) in various chemical characteristics. It has, also, a much larger proportion of nitrogen than the other natural alkaloids. But it remains an important consideration that this crystalloid constituent of the tea-leaf is built on the chemical type of the alkaloids, a class of bodies which

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nature forms in plants but not in food-plants—bodies that include narcotics, stimulants, hypnotics, delyriants, poisons, antidotes, tonics; some of them affecting the whole nervous system, one to excite and another to depress, and others influencing only parts of the nervous system, for special functions of the body. There is an alkaloid that gives steady impulse to spinal nerves, causing continuous contraction of one set of the muscles of the body; another that diminishes nervous effort upon all the muscles, and so impresses the brain as to produce sleep along with dreamy activity of the mind; another that, among other effects, so controls certain muscles as to open wider the pupil of the eye, and another that promotes digestion by arousing force in the nervous supply of secretory functions. Again, in the observation of the effect of an alkaloid it is found that, while a small portion stimulates the nervous system, a large portion acts as a sedative, so that a difference in quantity of the potion causes a difference in kind of its effects. By far the greater number of alkaloids do exert some sort of specific effect on the nervous system, but even to this generalization there are exceptions, and we could really infer nothing from analogy as to the effect which theine should have on the system.

The administration of theine in small portions, to animals or to man, quickens the circulation and effects some degree of mental exhilaration and wakefulness. In final result, the excretion of carbonic-acid gas is diminished, and the flow of blood through the capillaries is retarded. Larger portions prove poisonous, causing painful restlessness, rigidity of the muscles, and general exhaustion. Not more than three or four grains at once can be properly taken for medicinal or experimental purposes. As to the effects of the habitual use of small portions of theine, the tea-drinking peoples of the world ought to be competent witnesses, and their testimony, *pro* or *con*, may be brought by any advocate before the judgment of the world.

But we have to ask whether the alkaloid theine is found elsewhere in the vegetable kingdom. The coffee-tree (*Coffea Arabica*, *Rubiaceæ*) appears to have been planted by Nature in the heart of tropical Africa. At present it grows wild in Liberia, and is cultivated in most regions of the tropical world. It is twenty to thirty feet high, though, like the tea-plant, in the course of culture it is cut down to the height of five or six feet. It has the general appearance of a cherry-tree. It is an evergreen, with leaves four or five inches long and one and a half or two inches wide, and bearing clusters of white and richly fragrant flowers, the fruit being dark-red when ripe, and each holding two seeds, the coffee-berries of commerce.

In chemical analysis coffee yields an alkaloid, at first named *caffeine*, but long since determined to be identical with the alkaloid of the tea-plant, so that while the terms *theine* and *caffeine* are both in use, chemists recognize them as synonyms. Theine is found not only in the seed—the "berry" of the coffee-plant—but even more

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abundantly in the leaf, though the latter, of less agreeable flavor, has been little used, and is not in commerce. The use of the coffee-leaf is further discouraged by the fact that the plucking of the leaf is injurious to the crop of the berry.

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The chemist also finds theine or caffeine in two South American plants, the maté and the guarana. The former, *yerba maté*, or "Paraguay tea" (*Ilex Paraguayensis*), is a small forest-tree, bearing fine white flowers, indigenous to Brazil and the Argentine Republic, where it has long been prepared for a beverage which is drunk throughout South America. The leaves and twigs are employed, sometimes with inclusion of the fruit. Brazil also furnishes guarana, an article known in medicinal commerce, and obtained from the seeds of *Paulinia sorbilis*, a climbing shrub. Its fruit is of the size of the grape, and has a single seed. The seeds are bruised into a pulp, molded into cylindrical cakes, and dried. So prepared, guarana is in habitual use in South America, infused as a beverage, and also taken solid as an adjunct to food.

One more plant has to be named as a source of theine—the tree of the cola-nut, of Western Africa (*Cola acuminata*). The tree, of which two varieties are found, one with broad and one with narrow leaves, has been cultivated somewhat in tropical countries. The nuts are of the size of a pigeon's-egg, of a brownish color, a fragrant odor, and aromatic, bitter taste. The natives prize them very highly, using them in the solid state as a condiment with food, and to sustain strength during continued exertion when the supply of food is deficient. The cola-nut is rich in theine, as first shown by the analysis of Professor Attfield, at London, 1864.

So far, then, only five plants on the globe have been found to contain the alkaloid theine or caffeine, but the chemist finds an alkaloid very closely allied to this one, though of distinct individuality, namely, theobromine. This interesting chemical compound is homologous with the alkaloid of tea and coffee, differing in the molecule by one atom of carbon and two of hydrogen, theine having the structure $C_8H_{10}N_4O_2$, and theobromine $C_7H_8N_4O_2$. The relation is the same as that between any two contiguous members of the methylic alcohol series. Theine is constituted as methyl-theobromine, $C_7H_7(CH_3)N_4O_2$, and the chemist finds it an easy task to change theobromine into theine. Now, theobromine can be artificially produced from xanthine ($C_5H_4N_4O_2$); indeed, theobromine is dimethyl-xanthine, and theine is trimethyl-xanthine. In other words, xanthine may be presented as a chemical ancestor of the active principle of tea and coffee, and so it becomes of interest to inquire into the origin of xanthine, so called. In reply, it must be said that xanthine is not found in plants, but it is found in chemical laboratories; it is not a myth, and it can be made from a good many things that are abundant on the face of the earth. It can be made from uric acid, and

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it can be made (simply by action of nitrous acid) from guanine, which is abundant enough in guano. Guanine is found here and there in animal excrementitious material, is produced by spiders, and occurs in the pancreatic gland of the horse, and in organs of the salmon. The extensive group of bodies related to xanthine and theine have been found a very rich field of chemical research. Theine itself is a body of a very simply distinctive chemical structure, from which numerous derivatives are readily constructed. Hitherto, however, the chemical synthesis of theine from inorganic elements fails by lack of some short link whereby to form uric acid from any one of its own derivatives, nearly all which can be artificially formed. But the change of guanine into theine is easily accomplished. It is perfectly practicable to bring guano material to the laboratory, and send away the same atomic elements transformed into the snow-white, silky crystals of theine. Given only a sufficient demand for the pure stimulant principle of tea and coffee, and a market value high enough above the cost of its vegetable sources, and it might then safely be predicted that not many months would elapse before companies with thousands of capital stock would engage successfully in the chemical manufacture of theine from guano. Then, very likely, rival companies would establish the claim to manufacture a still purer article from certain of the waste substances of the world—articles more accessible than guano.

But it must not be forgotten that theobromine, just mentioned as an intermediate body in the chemical transmutation of guanine into theine, is itself an alkaloid of well-known vegetable origin. It has been found in only one plant (the *Theobroma cacao*), a beautiful evergreen tree of Mexican nativity, extensively cultivated in South America, growing twenty to thirty feet high, bearing small flowers in clusters on the large branches, and yielding fruit in a purple-yellow pod, seven or eight inches long, each holding twenty to forty seeds—the "cocoa-beans" of commerce. From these are prepared all the forms of chocolate, "cocoa," and "soluble cocoa," now in use over the world as a beverage, a competitor for the favor accorded to the more nearly equal claims of coffee and tea. At the discovery of Mexico and Peru, the Spaniards found chocolate from time beyond record an habitual beverage, and the chocolate-tree in extensive cultivation, in both countries.

The chemist has yet to find, if he can, a plant on the globe containing the alkaloid theine, or its chemical associate, theobromine, that has not been, by some of the races of men in some of the ages of the world, brought into use as a refreshing beverage, or adjunct to food, prized for adding cheerfulness to nourishment, and giving solace to fatigue. However the peoples of the world—while wholly unconscious of the identities of chemical science—have been guided in their search over forest and field for a herb to infuse, in a beverage that should cheer but not inebriate, it is certain that no hint

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of common qualities is to be gained from the external aspect of the plants so brought into use. Between the leaf of the tea-plant and the long pod of the cacao-tree there is no visual resemblance to indicate a common constituent, or to suggest a parallel use. As unlike as their general appearance, even more diverse are the botanical characteristics of the caffeine-containing plants, representing, as they do, diverse families in the vegetable kingdom.

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In the modes of *preparation for use*, the sources of caffeine present some coincidences, with many diversities. The *coffee-berry*, except in some Eastern countries, is roasted, an operation to which its valued fragrance is almost wholly due. The roasting develops from inodorous constituents a very diffusible empyreumatic oil of very appetizing odor. In the more elaborate preparation of the *tea-leaf* a degree of roasting appears to be always necessary for development of agreeable flavor, while a certain extent of fermentation precedes the roasting in the manufacture of black teas. For black tea the leaves are withered a little, rolled to liberate the juice, then left in balls for just enough fermentation, then sun-dried, and subjected to a careful firing in a furnace. For green teas the fresh leaves are first withered in hot pans, then rolled to liberate the juices, and slightly roasted in the pans, now sweated in bags, and returned to the pans for a final slow roasting, with stirring for eight or nine hours, beginning at the temperature of 160° Fahr. and falling to 120° at the close. These operations are here given as now conducted by the planters in India, and as proposed for tea-culture in the Southern United States, and are considerably abridged from the time-established routine of minute detail in China. The teas of commerce contain a distinct essential oil, a constituent which does more than all others to obtain the esteem and fix the value of each grade of tea in the market. The question of the effect of the curing process upon the essential oil—to liberate or generate or modify or dissipate it—is an inquiry of no little interest and consequence, and deserves more chemical investigation than it has received. In the manufacture of all the forms of *chocolate*, the cacao-seeds, cleared of the shell-coat, are roasted to begin with. Without further treatment they constitute the "cacao-nibs." When ground, pressed to remove a part of the oil, made with sugar into a paste, flavored with vanilla, spices, etc., and cast in molds, we have "chocolate" proper. When left in the pulverulent form, or molded in porous and friable cakes, the article is presented as cacao or "cocoa," or "soluble cocoa"—the proportion of oil being diminished either by its removal under pressure, or by adding some form of starch or farina. "Flake cocoa" is made by crushing the roasted seed, shell and all. In the preparation of the South American *maté*, the leaves and twigs are subjected to a "curing" process, and roasted under a covering of earth to develop an aromatic principle which gives flavor to the beverage. The *guarana*, also, is dried or lightly roasted, though acquir-

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ing only slight fragrance. The African *cola-nut* is strongly aromatic as taken from the tree, and this seems to be the only one of the six chosen foods furnishing theine or theobromine that is not subjected to dry heat in its preparation.

Tracing, so far in our study, the common constituent of coffee and tea, in its occurrence in various vegetable products which have been appropriated, after similar methods of treatment, to the uses of adjunct food, it is full time to inquire what else is to be found in the tea-leaf, the coffee-berry, and the chocolate-nib, besides a certain stimulant alkaloid. With entire justice to the remaining components they may be here classified in three groups—nutritious substances, astringents, and aromatics.

Tea yields from thirty to fifty per cent of its substance to solution by prolonged boiling in water; but, as the beverage is properly prepared, probably not over twenty to twenty-five per cent of the solids are dissolved. This soluble portion includes dextrine, glucose, gum, and potassium salts, besides tannin and the alkaloid. The nutrient portion of tea is comparatively small. In coffee we have ten to thirteen per cent of fixed oil, and about the same proportion of legumine, with gums and extractive matters, and two per cent of soluble potassium salts. The roasting reduces the glucose from six or seven to one or two per cent, liberates the oily matter, and so modifies the legumine as to render it measurably soluble. The beverage seldom contains over ten or twelve per cent of the roasted berry in absolute solution, so as to be retained in the liquid when perfectly clear, but some of the finer powder is likely to remain in suspension, and the oil is held with the liquid, while hot, to a still greater extent. In quantity, the food-constituents of roasted coffee are generous enough, but in digestibility it is more than probable that they are deficient. As to the cacao-seed, its oil, constituting half its weight, is a substance well known in its separated state as cacao-butter, and is an agreeable and very wholesome form of oleaginous food. In quantity it ought not to be unduly diminished, either by removal with the press or by addition of farina, and it should constitute as much as twenty-five per cent of all of the cacao preparations. Besides the oil, a good portion of starch and about eighteen per cent of albuminoids are found in cacao-seeds, and all these are to a large extent obtained in chocolate beverages. The butter of these creamy liquids is less likely to cause disturbance of digestion than the roasted albuminoids they contain.

The astringents of tea and coffee are tannins, properly classified along with the numerous varieties of tannic acid, the astringent principles of plants. In tea the proportion is large, ranging, according to the lowest statements, from nine to twelve per cent, and placed by some authorities as high as thirty and forty per cent. Dragendorff reports green teas to bear a higher percentage of tannic acid than black, and this difference may be due to a decomposition of tannin

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during the fermentation in the manufacture of black teas. But it is important to know that only a small part of this tannin is extracted from the leaf in the suitable preparation of the beverage. Some experiments with tea as it is prepared for the table gave, for a five fluid-ounce cup of the liquid, in ten instances an average content of a trifle over one grain of tannin. Other experiments with tea after five minutes' steeping gave in twelve instances an average of tannin equal to only $\frac{8}{100}$ per cent of the dry leaf; while the same teas, on thirty minutes' gentle steeping, yielded tannin amounting to an average of 2½ per cent of the dry leaf. In another case, by thirty minutes' active boiling, so much tannin as 11½ per cent of the tea-leaf was obtained in solution. Black teas are necessarily steeped longer than green, as they yield all their soluble matters more slowly. In coffee the proportion of tannin is not over one third, perhaps on an average not over one fourth or one fifth, of that in tea. The cacao-nib and its preparations are free from tannin. Guarana is heavily charged with a specific variety of tannic acid, and the maté is even more astringent than the tea-leaf.

The fragrant principle of tea, the essential oil, already referred to, has not been separated in notable quantities, but it is recognized as a diffusible stimulant, transient and harmless in its effect on the system, and certainly attracting no little favor to the tea-cup. The diffusible flavorous substance of coffee is a product of its roasting, and the same is true of the proper fragrance of cacao, to which other odors are often added. These vaporous bodies are so easily dissipated by a prolonged steeping, and especially by an active boiling, that brief infusions of tea and of coffee are likely always to be preferred.

In the quantity of the alkaloid, theine or caffeine, the tea-leaf is over twice as rich as the coffee-berry. The medium proportion is that of 2 to 2½ per cent in tea, a little under 1 per cent in coffee, and about 1½ per cent (theobromine) in the cacao-nib—while the guarana preparation has 5 per cent, and the maté 1½ per cent. Attfield found 2 per cent of alkaloid in the cola-nut. From a pound of tea, then, there can be obtained at least 140 grains, or over a quarter of an ounce, of the crystallized alkaloid, about enough to balance a silver quarter-dollar and a dime. The theine in a pound of tea is twenty-five or thirty times as much as could be taken at once without notable disturbance of the nervous system. A pound of coffee contains twelve or fifteen times as much theine as one ought to take at once.

The greater portion of the alkaloid enters into solution in making the common hot infusions of coffee and tea. Tea yields its alkaloid to hot water upon even brief application; coffee, especially when but lightly roasted, requires longer steeping for the extraction of the theine. It may be said, then, of long steeping of coffee and tea, that it is not required in obtaining the chief portion of the stimulant principle; that it only serves in the case of coffee to increase somewhat

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the nutrient matters; that, unless in tightly closed vessels, it wastes the fragrance, the qualities held in choicest esteem and highest value; and that, when used with teas, it renders the beverage so strongly astringent as to be both disagreeable and unwholesome.

The opinion is general, though not universal, that coffee is a stronger stimulant than tea, comparing them as American beverages. On this question, the analyst can only aver that a given weight of tea-leaf yields about three times as much of the common stimulant principle as the same weight of roasted coffee. How many cups of tea may be made from a pound of the dry leaf, or how few cups of coffee are made from a pound of the browned berry; and how long either quantity, dispensed under regulations both prudent and generous, will continue to supply a flowing cup in daily service of an individual—these questions may be respectfully referred to authorities more competent than chemists. The proper judges can comprise none other than the gracious autocrats of the tea-table themselves; and when they shall have vouchsafed perfectly definite replies, regarding these desired numbers and quantities, then in a very short time some assurance can be given of the stimulating effects of coffee in comparison with tea.

But, pending all conclusion from chemical identity and parallel quantity of constituents, any sufferer from coffee may resort to tea, and any injury from either may be cited against the closest chain of reasoning which chemistry can present. Most people have a small stock of experimental science of their own, sufficient for personal theory, if not wholly in accord with personal practice. And now regarding the effects of coffee in comparison with tea, let it be remembered that sleeplessness during the hours of repose may come from irritation in the stomach as well as from stimulation in the brain. The rich, oily, and albuminoid matters of roasted coffee, and especially the empyreumatic oil to which its flavor is due, are liable to derange the digestion of many persons, while tea is seldom subject to this disadvantage, and its diffusive fragrant oil may be helpful to the action of the digestive powers. In countries where the people rarely have indigestion, it is not found that coffee prevents sleep more than tea, but this report is often made in America, where the digestion is not the best in the world. The astringent influence of tea, unless prepared with brief steeping, may produce ultimate injury, but seldom causes immediate disturbance. To the action of the stimulant alkaloid itself, of course some persons and some nations are more susceptible than others, but we may be sure that it is only from this action that increased mental activity and the wakefulness of nervous exhilaration are obtained, alike in the use of coffee and of tea. And it is doubtless far more from this action of the one alkaloid found in both beverages, than from any other constituents, that their habitual use becomes injurious to many persons.

The consumption of coffee and tea in the United States in one year

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(1877) provides about 8½ pounds of coffee and 1⅓ pound of tea to each inhabitant. The importation of coffee, in Europe, is stated to furnish for each inhabitant, in France, 2 7/10 pounds; in Belgium, 13½ pounds; in Holland, 21 pounds; in Sweden, 6 pounds; in Norway, 9 pounds; in Austria, 2 pounds; in Russia, ⅛ pound; in Italy, 1 pound. In Great Britain, the consumption of coffee has been on a decrease for the last thirty years. The tea consumption in that country amounts to 2 pounds to each individual. The total amount of tea consumed on the globe would give about ¼ pound to each of its inhabitants.

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The grades of coffee in the market come from different varieties of the tree, and from different countries where it is cultivated. The various kinds of tea result primarily from differences in the age of the leaf when gathered. The choicest teas are from the younger and more succulent leaves, the earliest leaf producing flowery pekoe, the next orange pekoe, then pekoe and souchong, and from the oldest leaves bohea proper. Differences of manufacture have already been noted for black and green teas. The processes of manufacture in China and India are necessarily modified to enable the tea to bear sea transportation without injury, and it must be accepted that the finest tea can only be obtained in tea-growing lands. When American enterprise shall have devised such means of preparation as may dispense with the present lavish use of hand-labor in Asia, then we may have tea ranking above tobacco in the products of the Southern United States.

The adulterations of tea comprise mineral matters, foreign leaves, and spent tea. The food-analysts of Great Britain have fixed the maximum limit of eight per cent of mineral matter, including three per cent to be soluble in water, and a minimum limit of thirty per cent aqueous extract. The color-facing of turmeric, prussian-blue, and gypsum, though not excluded as fraudulent, is characteristic of poorer qualities of green teas. The adulterations of coffee, sold in the ground condition, are multifarious, all sorts of roasted grains, nuts, and shells having been taken for this use, but the chiccory-root has been the most extensive admixture, and in Great Britain has been in actual demand by the consumer. Even the entire coffee-berry is sometimes counterfeited—a suggestion from the legendary wooden nutmegs of New England invention. But we may trust that the great body of tea and of unground coffee in commerce is nearly or quite innocent of adulteration. No positively hurtful impurities are apt to be found, but not the less all falsifications of these or other articles of food should be severely punished. It is clearly a misdemeanor to tamper with the food which any man may select by its distinctive name, in his own discretion, for his personal use.

Notwithstanding the adoption of theine-containing beverages by mankind at large, we can not hesitate to commend that robust habit which discards all dependence on adventitious food, even on so mild a stimulus as that of the tea-cup, and preserves through life the fresh

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integrity of full nervous susceptibility. And probably there was never a time when there were so many persons as now who are disposed, by conviction and by a desire for a stalwart physical independence, to refuse to fix any habit that holds the nervous system.

But, taking the world and its discomforts as we find them, it must be granted that the thralldom of tea is comparative physical freedom, and we can gladly give voice to those who praise these comfortable beverages. "Near the fire," says De Quincey, "paint me a tea-table —place only two cups and saucers upon it—and beside them paint me an eternal tea-pot. . . . For tea," he says, "will always be the favorite beverage of the intellectual, and for my part I would have joined Dr. Johnson against any impious person who should presume to disparage it."

THE ANATOMY OF AN OLD ANECDOTE.

By WILLIAM W. BILLSON.

IT is a matter of common knowledge that Shakespeare's story of the bond for a pound of flesh is not of his own invention, but is merely a modern and dramatic version of a very old tale which, with slight but frequently significant variations in form, had already become the common property of many nations, East and West.

Even though these legendary antecedents of the drama had never been actually discovered, their existence could nevertheless with great confidence be affirmed; for in no other manner can we account for the singular and unconscious fidelity with which the anecdote illustrates legal conceptions highly characteristic of primitive ages, but alien to that in which Shakespeare lived.

The scientific value of a good story as a clew to the institutions, the intellectual and social life of the people among whom it originated, or in whose hands it has undergone modification, is now so well understood that to collect, anatomize, and interpret recently despised folk-lore, romances, anecdotes, and ballads, is a recognized function of modern scholarship.

The story of the bond is not only one of great inherent interest and scientific value—it is rendered doubly attractive as an object of study by the fact that a correct apprehension of its original meaning constitutes an excellent preparation if not an indispensable condition to a sound analysis of Shakespeare's play; to a discovery of the motives through which, as poet and playwright, he was led to select the story for the purposes of his art, and to a correct understanding of the many passages by which with admirable skill he sought to conceal or evade the annoying discrepancy between the ideas out of which, in the barren soil of a very remote antiquity, the story originally grew,

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and those of the civilizations into which it was afterward transplanted. The inadequacy of the treatment which the anecdote has hitherto received is forcibly illustrated by an article in a late number of the "Nineteenth Century," in which Moncure D. Conway essays to unfold the principles lying at its root. Mr. Conway precipitately assumes that it is the product of theological conceptions, and, by confusing it with purely religious Hindoo legends, designed to inculcate the virtue of self-sacrifice, forecloses at the threshold of his inquiry all hope of conducting it to a successful issue.

He regards it as one of the earliest fables concerning the ever-conflicting principles of retaliation and forgiveness. To him Shylock is Indra tearing Vishnu's breast; Elohim demanding Isaac's death; the First Person exacting the Second Person's atoning blood. Antonio stands for the Christ, the forgiver, the sufferer. Antonio suffering for Bassanio is the just suffering for the unjust. The representative figures of the Venetian court-room are only transformations from the flying doves and pursuing hawks, bound victims and exacting deities of ancient mythology. Portia is that human heart which in every age, amid hard dogmatic systems and priestly intolerance, has steadily appealed against the whole vindictive system, whether Jewish or Christian. She is made to assume the ermine because, with his wonted felicity, Shakespeare perceived that the genius of this human sentiment, slipping through the technicalities of priest-made law, could be most fitly impersonated by a woman.

Now, while we can not concede the soundness of this interpretation, it is justly entitled to the praise which next to a positive indorsement will be most gratifying to one of Mr. Conway's philosophic turn of mind, that it is so palpably and almost comically unsound as to be perfectly harmless. It so obviously rests upon a systematic belittlement of the essential and exaggeration of the non-essential in the story, that, though interesting reading for all, there is little danger of its misleading any.

The widely diffused story of the bond originated in strictly legal conceptions. It embalms in an excellent state of preservation several interesting phases of early law.

Whether it is the record of an actual occurrence, it is alike immaterial and impossible to determine. Certain it is that both the facts and the law of the case are substantially historical. They precisely represent views concerning contract, criminal liability, and law reform, which, however absurd they may appear to us, have widely prevailed, and must be regarded as characteristic of certain early stages of intellectual development. In the bond itself, as it was regarded by the interested parties, we recognize the substance of the debtor's life-pledging contract which filled so large a place in the commercial economy of ancient societies. As a means of securing the payment of debt, the pledging one's life and the lives of the members of one's family, in the

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history of many races, preceded in order of development the pledging of property—the right to legal process against the person likewise becoming established as a means of collection before process against property was known to the law. It was so with the Romans. The persons, the lives, of the debtor and his family were long considered by them as the creditor's normal security. It was fully four centuries from the foundation of the city before the Roman creditor was entitled to resort, without the debtor's consent, to any portion of the latter's property except such as had been delivered to the creditor in pledge. It would be interesting to inquire why remedies against the person thus preceded those against property; and, though too remote and obscure a problem for treatment here, we may hazard, in passing, the conjecture that the explanation is to be found in the generally communistic form of primitive property. When all property was vested in the village tribe or *gens*, the individual really had nothing he could call his own except himself and his family. The idea that the creditor's remedy was exclusively against the person, being thus engendered, would, through the sluggishness of the primitive intellect, continue to subsist long after its original cause had been removed by the institution of individual property. Again, the whole structure and theory of early society was such as to give credit and currency to measures which, while perhaps not legally charging the minor social and proprietary organisms with debts contracted by their constituent individuals, might yet be employed by the creditor of an individual to force the organization to aid its defaulting members. Such was doubtless one theory upon which the unconscionable power of the creditor over his debtor was upheld. It operated as a harsh and awkward leverage by which the creditor could reach the property, not only of the debtor, but of his sympathizing relatives and friends. However this may be, the power of the creditor was habitually pushed to such merciless extremity that indescribable hardships befell the debtor class in all the early civilizations. It is true that within historic times the creditor, in many instances, derived the authority for his atrocities, not from the stipulations of his contract, but from general provisions of law. The Roman law, under which a creditor could, at his option, put his defaulting debtor to death or sell him as a slave into a foreign land, and the several creditors of an insolvent could hew his body in pieces and divide it between them, is a fair example of the almost incredible inhumanity of the early law toward this unfortunate class.

The traits of character and the social conditions which led to the toleration of such laws, it would not be difficult to specify, for, though numerous, they are by no means obscure. But in this instance, as with all irrational customs, laws, or beliefs, the secret of their maintenance is a very simple matter compared with the mystery of their first cause. Assuredly it is hard to distinguish in the mere fact of indebtedness, in the simple relation of debtor and creditor, anything which could have

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suggested the investment of the creditor by law with the unnatural power which we find him enjoying. That power, it is far more reasonable to suppose—indeed, the supposition affords the only plausible explanation of it—was originally claimed by the creditor as Shylock claimed his pound of flesh, only by virtue of the condition of his bond; only through the debtor's express concession of it at the time of incurring the debt. In the history of debtor and creditor, back of all life-forfeiting laws there must have been life-forfeiting contracts; the former being the outgrowth of the latter. That such stipulations, after becoming a customary clause in contracts, would have a tendency to crystallize into law, is aptly illustrated in the law of Scotland. It is shown by Lord Kaims that such has been precisely the history of imprisonment for debt in that country. Originally unknown, it was at first introduced by the debtor's agreement that, in case of default, process might issue against his person. The courts recognized the validity of such agreements, enforced them, and ultimately fell into the habit of allowing the remedy, without inquiring whether it was authorized by the contract or not.

Having thus noted the essentially historical character of the life-pledging contract, it is to be remarked that its legal recognition carries us back to the time when the right of contract was comparatively free from limitations as to its subject-matter. Under matured systems of jurisprudence a great variety of agreements are denied legal recognition, on the ground that their performance would involve a violation of law, or would be incompatible with good morals or public policy. But the catalogue of agreements thus condemned was originally very meager. Though it is probable that from the earliest times the law may have refused to enforce a few contracts of a grossly criminal character, it was only gradually that the broad principle was evolved that one can not legally obligate himself to the performance of an unlawful or immoral act, or an act inconsistent with public policy.

The story of the bond for a pound of flesh not only speaks to us, through the atrociousness of the contract, which was held valid, of the former feebleness and obscurity of that principle; it also affords an example of the curious indirection through which at first the principle usually ventured to assert itself. For, in all its forms, the story points to a society or a stage of development in which the law, while conceding the validity of the life-pledging contract, regarded it with great disfavor, and, in the interest of advanced views of morality and public policy, was seeking its overthrow.

Many versions, including Shakespeare's, represent the judge as affirming the validity of the bond, and the right of the creditor to take the stipulated flesh, and at the same time as declaring a forfeiture of all his estate for simply proposing so to do; a laughable incongruity, so utterly repugnant to existing legal views, and so strikingly representative of the methods of early law, as to constitute one of the

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most curious features of our anecdote. For, even when ancient societies sought to discourage contracts made in contravention of law, morals, or public policy, it was their practice not to deny their validity but to rely for their suppression upon penalties denounced against parties who should enter into them. This indirect method of reform was eminently characteristic of such societies, and the evidences are abundant of its application to all branches of the law.

The conservatism of such communities was so controlling that, when, through changed social conditions, a modification of existing law became unavoidable, the tendency was, while adhering nominally to the old law, to inflict penalties upon or in some way obstruct those who attempted to assert rights under it; an expedient whereby the effects of amendment might be obtained without a confessed abandonment of ancient principles. The proverbial unchangeability of the laws of the Medes and Persians represents only in aggravated form the extreme aversion to change almost universal in early societies; and the effectual manner in which the unchangeable proclamation of King Ahasuerus for the extermination of the Jews was annulled by his subsequent decree, declaring it lawful for them to defend themselves, is not a bad example of the tortuous method of reform which we are now considering. Another example equally in point is afforded by the history of the doctrine of jurisdiction. In Europe certainly, and probably elsewhere, the jurisdiction of courts was originally voluntary. They tried causes only in the presence and with the consent of both of the litigating parties. It would have been regarded as an unwarrantable encroachment upon the liberty of the citizen for a court to entertain a controversy at the solicitation of the complainant only, and without the express consent of the defendant. This theory of jurisdiction disappeared in the different nations of Northern Europe at an early or late day in proportion to the strong or weak influence of the Roman law, and remained unshaken in England until within a century. At a very early day the principle was perceived to be inconsistent with the maintenance of social order. But, instead of renouncing it in favor of the rule since adopted, that the service of citation upon the defendant shall confer jurisdiction whether he consent or not, the old doctrine was rigidly maintained, and outlawry, forfeitures, and attachments were resorted to, to compel the defendant to signify his indispensable consent. If, in spite of these severe measures, the jurisdiction was still resisted, the court remained powerless to proceed.

The historical as well as the dramatic interest of our story culminates in the celebrated quibble through which the judge, after dispelling the forlorn hopes and realizing the worst fears of the debtor by sustaining the validity of the bond, suddenly puts an entirely new and happy face on the transaction. He says:

> " . . . Tarry a little; there is something else.
> This bond doth give thee here no jot of blood;

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The words expressly are, *a pound of flesh;*
Then take thy bond; take thou thy pound of flesh;
But, in the cutting it, if thou dost shed
One drop of Christian *blood*, thy lands and goods
Are, by the laws of Venice, confiscate
Unto the state of Venice.
. . . . . .
Shed thou no drop of blood, nor cut thou less nor more,
But just a pound of flesh; if thou tak'st more
Or less than just a pound—be it but so much
As makes it light or heavy in the substance
Or the division of the twentieth part
Of one poor scruple—nay, if the scale do turn
But in the estimation of a hair—
Thou diest, and all thy goods are confiscate."

This play upon words is so transparently illogical, that while the righteousness of the end might in a romance he held to justify the absurdity of the means, the modern mind, and particularly the legally trained mind, intuitively shrinks from accepting it as the *bona fide* judgment of any court; a fact which, as we shall hereafter observe, is the key to the later modifications of the story. And yet nothing could be more suggestively true to nature and history than that a judge of the remote age from which this story is inherited, in struggling to assert against an old and harsh rule of law more recently developed sentiments of humanity, should seek the accomplishment of his purpose through a play upon words.

There is a popular superstition that such exercises are still the delight of lawyers; but the truth is that, in this age of highly developed rational faculty, a quibble has neither friends nor function, and is an object of universal contempt. There was a time when it was not so. A volume might be and indeed ought to be written upon the astounding and universal susceptibility to quibbles which characterized the ancient mind until Aristotle in Greece and Seneca in Rome. All literature, legal, philosophic, and religious, was sadly disfigured by them. The proneness of the really primitive mind to indulge in them is well known: it is not so generally appreciated how late it was in the history of intellectual development before the infirmity was outgrown. Even the imperial intellect of Plato, the life-long enemy of the professional sophist, staggered visibly and habitually under the influence of this sort of sophistical taint. Among the laws governing the concurrent evolutions of thought and language, there is one not yet fully definable, but unmistakably discernible in its effects, by which for ages the human mind was irresistibly addicted to the drawing of irrational verbal distinctions or analogies. Nor does the modern mind display in any respect a more marked contrast with the ancient than in its keenness to detect and swiftness to repudiate everything in the nature of a quibble. No one, for instance, would now admit that, conceding

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Shylock's right to the pound of flesh, he should be held to incur death if, waiving a part, he took *less* than was called for by his bond. Yet that such a quibble was not always impossible, but is probably historical, must be inferred from the fact that the laws of the Twelve Tables, after authorizing the creditors of an insolvent to divide his body between them in the proportion of their respective claims, expressly provides that no creditor shall incur liability by taking, without bad faith, either more or *less* than his share. Whether this protection to the creditor taking less than his share was, as seems probable, enacted in settlement of an old and mooted question or only in anticipation of a new one, it is in either event highly significant as having been thought necessary in order to preclude just such a construction of the law as the judge in our story placed upon the bond.

Nor was the quibbling infirmity without its compensations. In the domain of law, at least, it had substantial functions, and paved the way to reforms otherwise unattainable. We have already had occasion to notice why ancient societies required methods of reformation not involving an avowed abandonment of established rules. To leave such rules nominally intact, and at the same time to indefinitely curtail or enlarge their operation by the withdrawal or addition of particular classes of cases through judicial construction, was a mode of legal amendment eminently adapted to the genius of such communities, and fruitful of many beneficent modifications of the law. It was a matter of minor consequence whether such modifications were effected by sound arguments or quibbles. In an age habituated to the amendment of law by legislation, nothing can be said in defense of the vicious practice of judicial quibbling. However faulty existing law may be, legislation is the appointed, effective, and only appropriate agent for its reformation. But, during the ages when men were as ignorant of the processes of legislation as they were implacably hostile to the theory of innovation upon which nearly all legislation proceeds, the only alternative was between an absolutely unprogressive condition of the law and an effort to bring it into harmony with the requirements of an ever-advancing society by a resort to such methods of amendment, however vicious or clumsy, as had then been efficiently evolved. The reform of law by judicial construction, however forced and illogical, being a much more familiar and agreeable process than amendment by legislation, the art of quibbling, of drawing distinctions where there was really no difference, and of detecting resemblance though there was no essential similitude, was employed with no inconsiderable effect in contracting or enlarging the operation of legal principles; and, exercised, as it usually was, in aid of the finer sentiments and more advanced conditions of a later age, against the crude customs of an earlier, was an important factor in legal development. The agencies by which early societies modified their law and which discharged imperfectly, indeed, yet almost exclusively, the func-

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tions afterward discharged by equitable construction and still later by legislation, have been fitly grouped together under the common name of legal fictions. Sir Henry Maine, in adopting such a classification, explains that by a legal fiction he means any assumption which conceals or affects to conceal the fact that a rule of law has undergone alteration, its letter remaining unchanged, its operation being modified. Now, a judicial quibble was a kind of legal fiction—a product of the same conditions and charged with the same functions as legal fictions generally. That is to say, it was a thin disguise, under which, owing to the prevailing laxity and vagueness of current intellectual processes, reforms could be introduced without actively antagonizing the conservative propensity.

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While amplifying the historical suggestions of our story, we must not ignore the interest attaching to the circumstance that the quibble employed by the judge was one which, though inspired by a desire to defeat the forfeiture, took effect not through an impeachment of the bond's validity, but in such a definition of the remedy upon it as was calculated to discourage its enforcement. It thus represents the very marked propensity of early societies to assail an obnoxious legal right indirectly through its remedy; impairing the latter either by regulations making a resort to it difficult or impossible, or by encumbering its exercise with stringent and technical limitations, the non-observance of which would subject the party to heavy penalties.

It is in this tendency that we find the key to much that is otherwise unaccountably harsh, technical, or absurd in early judicial remedies and procedure. Whenever any recognized legal right came to be regarded as unconscionable or otherwise objectionable, rules adapted to hamper or imperil the complainant in the pursuit of his remedy were sure to spring up. Procedure, instead of being shaped as now with an eye single to the ascertainment and enforcement of the rights of litigants, was therefore frequently designed to render those rights nugatory; and, as the latter function was often more influential than the former in molding the procedure, so they were both at times overshadowed by such a regulation of remedies as would be most likely to frighten both parties out of court and into an amicable adjustment of their differences. We find ample illustration in the history of the law of distress. The right of a creditor to seize without legal process the goods of his debtor in satisfaction of his claim, which once so widely prevailed, may be said generally to have fallen a victim to the constantly increasing technicality of the procedure regulating its exercise. The value of the right was destroyed by the technicality which its harshness had induced; so that creditors were usually glad to abandon the right before it was taken from them. It was, as has been well said, a kind of two-edged sword. "You might bring your adversary to the ground by it, but you were extremely likely to injure yourself. For, unless the complainant who sought to distrain went through

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all the acts and words required by law with the most rigorous accuracy, he, in his turn, besides failing in his object, incurred a variety of penalties which could be just as harshly exacted as his own original demand."

In like manner, and in deference to the same conservative propensities heretofore noted, an irrational rule of procedure was often adopted in order to preclude the exercise of unconscionable privileges by a defendant. Such, for example, was the origin of that disgraceful rule of English law which so long denied to persons accused of felony or treason the benefit of legal aid in making their defense. The English law of crimes and criminal procedure became at a very early stage in its history so excessively technical as to render it intolerably difficult to secure conviction in the face of a skillful defense. In obviation of this difficulty, the rule now is, that the proceeding shall be vitiated only by such inaccuracies as are substantially prejudicial to the accused. But the conservative tendency was formerly too strong to admit of this curtailment of the defendant's rights.

He must not be denied the right to immemorial objections, however irrational. But he could be hampered in the exercise of the right, and, as the most effective expedient for that purpose, he was denied the legal aid through which alone he could ascertain what his rights might be; and such was unquestionably the origin of the rule forbidding defense by attorney.

It is now reasonable to assume that the story of the bond was the product of the crude legal notions with which we have found it to be so replete. It is not within the scope of our inquiry to exhibit the bearings which this view of the story's origin may have upon its Shakespearean interpretation; but, that it casts strong light upon the latter subject, we have now occasion incidentally to point out.

The most noteworthy circumstance in the modern history of the story is its transformation into a comedy; no flavor of humor being discoverable in what were probably its earliest forms. It had already undergone this metamorphosis when it came to Shakespeare's hands. Italian predecessors of our poet, in adapting the story to their own civilization, recognized the absurdity of ascribing its obsolete legal notions to their own courts. To avoid so glaring an anachronism, they substituted, for the legitimate tribunal of the old story, an irresponsible mock court or make-believe judge by whom, without impropriety, the law of the story could be enunciated as a solemnly disguised jest. Henceforth the subject belonged of right to the comedians. Of all the legal conceptions embodied in the story, scarcely one could have emanated from a Venetian court; nor, indeed, when properly understood, do they purport so to do: they all without exception being transparently exhibited not as good law, but as the curious conceits of a playful and ingenious woman.

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The graceful pleasantry which Shakespeare, following the Italians, has freely and deftly interwoven with the incidents of the original tale, avouches his realization of the radical change which had been wrought upon it by the unavoidable introduction of the mock court. He not only garnished it profusely with humorous passages, but, as Mr. Conway reminds us, produced it as a pronounced comedy in his own theatre. The fact that, notwithstanding this, the world has finally settled down upon a serious or pathetic interprefation of Shylock's character, and of the trial-scene, and exhibits a disposition, by repudiating the last scene of the play and by a variety of other expedients, to exorcise the comedy element, is certainly a high tribute as well to the irrepressible charm and dramatic quality of the old form of the story as to the overmastering power with which Shakespeare has told it. Whatever may be the merits of the reactionary or tragic interpretation, it has been largely facilitated by a vague assumption that Portia, though a usurper of the judicial office, might be, and, within the spirit of the play, ought to be regarded as a reasonably sound expositor of the Venetian law, and it is doubtful whether it would have been possible, had the public generally known as well as did Shakespeare and the Italians, that the mock court was improvised only because the time had long since passed when the law of the case could be plausibly credited with recognition in a legitimate tribunal. For, this being so, old Shylock, in the drama, through all the absorbing vicissitudes of the trial-scene, is as certainly the victim of a clever and frolicsome deception as was poor Christopher Sly, when, with manifold misgivings, he suffered himself to be persuaded that he was a lord, indeed, and not a tinker. It must, therefore, be admitted that the comic cast given to Shakespeare's Shylock by his early impersonators was not entirely inappropriate to so gullible an old Israelite as he proved himself to be.

THE BUNSEN LAMP.

By H. P. ARMSBY.

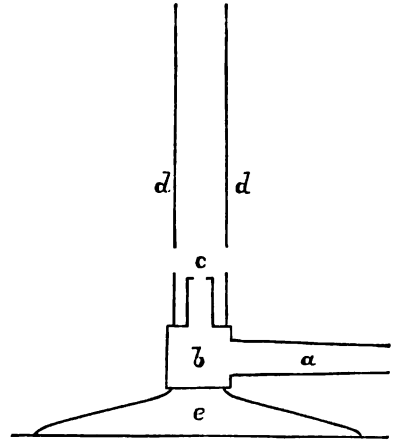
THE great convenience of gas as an illuminating agent, due to its cleanliness and immediate availability in any desired quantity, soon led to its use as fuel; and to-day we have apparatus of all degrees of size and complexity, from the simple burner of the chemical laboratory to the gas-stove with which the meals of a large family may be cooked, or the gas-furnace capable of melting iron or satisfying the demands of the gold and silver assayer, all using gas as fuel—not to speak of the numerous applications of the waste gases from blast-furnaces and the like, or of the Siemens gas-furnace, using gas made especially for it, and in which the degree of heat that can be

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attained is practically limited only by the capacity of the furnace itself to withstand it.

In all or nearly all the applications of illuminating gas to heating purposes, however, a practical difficulty has to be overcome. The gas is made for illuminating purposes, and therefore burns with a bright flame, which deposits a layer of lamp-black, or soot, on everything brought into contact with it. Evidently this difficulty must be overcome before any extensive use could be made of gas as fuel, particularly for those domestic purposes to which it finds one of its chief applications. For practical purposes one of two methods is adopted. One of these is to cause the gas to burn from a number of small openings in a metal pipe. Two effects are thus produced. The large mass of metal in the tubes abstracts heat from the flame, and, as a result, the latter burns mostly blue and produces little smoke or soot; and, secondly, the distribution of the gas into several small flames allows us to place the article to be heated high enough over the flame to avoid the soot, and yet near enough to get a good heating effect. A second and more common method of preventing the deposition of soot is by the use of some form of the Bunsen lamp.

Nearly all the common gas-stoves and other arrangements for heating by gas are essentially Bunsen lamps, more or less modified to suit particular purposes. One of the simplest and most common forms of this lamp is represented in section in the annexed figure. The gas enters through the metallic tube *a*, passes through the block *b*, and finds an outlet through one or more small apertures at *c*. Surrounding *c* is a larger metallic tube, *d d*, having at its base two apertures for the admission of air. The mixed gas and air rise through the tube *d d*, and burn at the top with a pale-blue, smokeless flame. The lamp is supported by a heavy cast-iron foot, *e*.



Though this lamp is of simple construction, the explanation of its operation involves some very curious and interesting facts regarding the theory of flame, as well as some very familiar ones, and in order to comprehend it we shall need to begin with a study of flame in general, and of luminous flames, like that of ordinary gas, in particular.

When a solid combustible, like charcoal, burns in the air, it produces no flame, but simply glows. The blue flame that is often observed playing over the surface of a coal-fire is that of the carbonic-oxide gas

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produced in the fire, and not that of the coal itself. *Only gases burn with a flame.* In those cases where a solid or liquid seems to do so, it will be found that it is either volatilized or decomposed by the heat of the combustion, and thus converted into gas before it burns.

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Let us now begin our study of the phenomena of flame by considering the flame of hydrogen. Suppose we have hydrogen-gas flowing from a round jet. Just over the opening we have a round column of pure hydrogen. This gas, being lighter than air, and being forced out under some pressure, rises. As it rises it mixes with the air, and we immediately have, surrounding the jet of hydrogen, a layer of mixed hydrogen and air which is inflammable. If we now apply a light this mixture takes fire. The hydrogen unites with the oxygen of the air, forming steam, which is carried away by the current of hot gases; more hydrogen is continually supplied from the jet, and more oxygen from the atmosphere: and thus we have a continuous formation, as fast as it is burned, of this inflammable mixture of hydrogen and oxygen around the central column of hydrogen.

Evidently, then, the flame must be hollow. That it is so may be shown by the familiar experiment of quickly inserting the phosphorus end of a match into the center of the flame, where it may sometimes be held until the wood of the match is burned through without taking fire. The flame can not spread inward, because there is nothing there to support combustion; nor outward, because there is nothing there to burn. The flame is simply that part of the current of gases where the chemical action takes place, and where, consequently, the heat is produced. It is more nearly a *place* than a *thing*. If we leave out of account for a moment the chemical changes, we may compare the current of gas which flows from the tube to a metallic rod which is being slowly pushed through a fire. The portion in the fire glows, and, as the rod moves on, different portions of it glow, while the glowing spot, which may be compared to the flame, remains stationary. In the hydrogen-flame the rod is of gas and invisible. We see only the spot which glows, and, as this is stationary, we are apt to regard it as an object by itself, instead of considering it as a spot in a constantly flowing stream.

The hydrogen-flame gives out very little light. If burned from a metallic jet, the flame becomes almost invisible. What little light such a flame does emit, it emits because the gases of which it is composed are hot; but ordinary gases, when heated to the temperature of a flame, emit very little light.

To render a flame luminous in the sense in which an ordinary gas-flame is luminous, we must introduce into it some solid which is not converted into gas at the temperature of the flame. The light of a common gas-flame is due to innumerable small particles of carbon, which are separated from the gas in the interior of the flame and are heated white hot while passing through the flame. Illuminating gas

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consists practically of compounds of carbon and hydrogen. The gas must get very hot before it actually begins to burn, and it is a well-known fact that at a high temperature some of the compounds contained in it are decomposed, with separation of carbon.

In the interior of the flame, likewise, the *compound* of carbon and hydrogen is decomposed, and yields a *mixture* of carbon and hydrogen. The hydrogen burns with a colorless flame, but the solid particles of carbon, as they float through the flame, are heated white hot, and furnish the light of the flame. Finally, as these glowing particles reach the outside of the flame, where there is more air, they also burn, evolving still more light.

We are now prepared to study the ways in which such a flame may be converted into what is frequently called a "non-luminous" flame, by which is meant, not a flame that gives out *no* light, for no such flame exists, but one which emits only the faint light of incandescent gases. For brevity I shall use the term "non-luminous" in this article.

A luminous flame may become "non-luminous" from three causes:

1. Cooling.
2. Dilution of the gas or the air.
3. Too rapid oxidation of the separated carbon.

1. Cooling.—The gas in a flame must be heated to a certain temperature in order that carbon may be separated from it in the manner described.

If the heat of the flame is reduced below this point, no separation of carbon takes place, the flame contains no solid matter, and becomes "non-luminous." For example, if a small gas-flame be caused to play against a cold platinum dish, the flame is spread out over the surface and becomes "non-luminous." The dish, being cold, abstracts so much heat from the flame as to render the separation of carbon impossible. If the dish be heated by a gas-lamp held on the other side, this loss of heat by the flame is checked, and it at once becomes luminous again. A familiar example of the effect of cooling a flame is seen when an ordinary gas-flame is turned very low. Heat is abstracted from the flame by the cooler burner and conducted away, and the result is a small blue flame, emitting scarcely any light. The blue space in the lower part of an ordinary flat gas-flame is likewise due in part to the cooling effect of the burner and in part also to the rush of cold gas into the flame. That this is so is shown by heating the burner, by which means the area of the blue space is notably diminished.

Exact experiments with the photometer have shown that considerably more light is emitted when the gas burns from a red-hot burner, while the consumption of gas is rather diminished than increased. It might seem from these facts that burners of lava, or some similar substance, would have a decided advantage over burners of metal, in regard to the amount of light obtained, since lava is a poor conductor

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of heat, and would therefore not convey away the heat of the flame so rapidly as metal. Experiment shows, however, that the difference is very slight. It is measurable, but not of practical importance. The practical value of a lava-tip lies simply in the fact that it does not rust. Neither are any arrangements for heating the burner likely to effect any gain in illuminating power. Obviously the heat for this purpose must not be taken from the flame itself, but must either be obtained from its waste heat or from a separate source of heat. The waste heat of the flame would probably not heat the burner hot enough to produce any appreciable effect, while a separate source of heat involves additional expense enough to overbalance any gain likely to accrue.

A flame may be cooled in another way than by means of some cold body held in it, namely, by mixing some indifferent gas with the combustible gas. If, instead of air, a stream of carbonic-acid gas be admitted at the bottom of a Bunsen lamp, the flame becomes "non-luminous." We get the same amount of heat in the flame as before, since we burn the same amount of gas; but this heat has not only to be applied to heating the illuminating gas and the products of its combustion, but has also to heat the carbonic-acid gas. As a consequence, no part of the flame can be so hot as it was before, and the separation of carbon does not take place.

If the tube through which the gases pass be heated, the heat thus added counteracts the cooling effect of the carbonic-acid gas, and the flame becomes luminous again.

2. Dilution.—The second way in which we may render a gas-flame "non-luminous" is by dilution, either of the gas or the air. This can be shown by substituting for the carbonic-acid gas some combustible gas which does not give a luminous flame; for instance, carbonic-oxide gas. This gas can not essentially lower the temperature of the flame, for it burns with as hot a flame as gas, yet the mixture of it with illuminating gas gives a "non-luminous" flame. Plainly, then, we must conclude that simple dilution is able to produce this effect. Apparently such a mixture as this—that is, a mixture of two gases, one of which burns with a luminous and the other with a "non-luminous" flame—requires to be made hotter in order to produce a separation of carbon, and consequently a luminous flame, than does the illuminating gas when burned alone. If we raise the temperature of the flame by heating the burner, it becomes luminous again. Dilution, then, renders a flame "non-luminous," because the temperature of the flame is not high enough to cause a separation of carbon from the *diluted* gas.

3. Too Rapid Oxidation of the Carbon.—The third method of rendering a flame non-luminous is to supply it with so much oxygen that the carbon is burned at once before it can separate in the solid form.

If we put a small gas-flame into a jar of pure oxygen it is rendered

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"non-luminous." This effect can not be caused by cooling, for the greater supply of oxygen makes the flame hotter, nor by dilution, for nothing is diluted. Evidently it must be caused by the greater supply of oxygen. The air contains four volumes of nitrogen-gas for every one volume of oxygen. When a substance burns in air, the particles of oxygen are hindered in getting at the combustible by the particles of nitrogen, which are four times as numerous. When the substance burns in pure oxygen there is no trouble of this sort, and the combustion takes place much more rapidly and energetically. Such is the case in our experiment. The oxygen-particles are no longer hindered in getting at the carbon by the inert nitrogen, and therefore seize on it so promptly as to leave none to make the flame luminous. If we allow the carbonic-acid gas, resulting from the burning, to accumulate in the jar, this gas will perform the function of the nitrogen of the air. At first a very bright spot appears in the center of the flame where the least oxygen penetrates. It is brighter than a gas-flame in air, because the more rapid combustion makes the flame hotter, and consequently the little particles of carbon glow more intensely. As the carbonic-acid gas accumulates, it becomes more and more difficult for the oxygen to get at the flame. When four fifths of the gas in the jar are carbonic acid, the flame burns as it does in the air. As the carbonic acid still goes on accumulating we get another effect, viz., that of dilution, and the flame becomes "non-luminous" again. In this experiment are illustrated all three of the causes which render luminous gas-flames "non-luminous." At first we observe that the combustion is so rapid that no carbon is separated. At the close of the experiment we see the flame become "non-luminous" again on account of the dilution of the air with inert gas and the attendant cooling of the flame.

If we try this same experiment with a flame which owes its luminosity to incombustible solid particles, or to vapors, we shall get only the effect of the greater heat of the flame. For example, hydrogen-gas containing a small proportion of the vapor of chromyl chloride burns with a luminous flame, the light being due to the separation in the flame of particles of solid oxide of chromium. If this flame be placed in pure oxygen it becomes of an almost dazzling brilliancy. The particles of oxide of chromium are incombustible, and therefore the greater heat of the flame only makes them glow the more brightly. This experiment shows that a flame becomes hotter in pure oxygen than in the diluted oxygen of the air, and furnishes an indirect proof that the reason why a gas-flame is made "non-luminous" in oxygen is because its carbon is burned up so quickly.

We distinguish, then, two effects produced on a luminous gas-flame by pure oxygen. First, it makes the flame hotter, and consequently tends to make it brighter; and, second, if the supply of oxygen is relatively large, it burns up the carbon of an ordinary flame at once, and thus renders the flame "non-luminous."

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Having now considered the three causes which may convert the luminous flame of our common street-gas into a faint and so-called "non-luminous" flame, we are prepared to trace the operation of these causes in the Bunsen lamp. All the various forms of the Bunsen lamp burn a mixture of gas and air. Now, the air is itself a mixture of four parts of nitrogen with one part of oxygen. The nitrogen of the air takes no part in the process of combustion, but simply passes unchanged through the flame. It is plain that this nitrogen must act on the flame in two ways. First, it must cool it, just as any cold substance passing through the flame would cool it; and, second, the nitrogen dilutes the illuminating gas. The effect of both cooling and dilution, as we have seen, is to make a flame "non-luminous."

But one fifth of the air is oxygen; and this also has two effects upon the flame. It makes it hotter, and it also tends to burn up the carbon of the illuminating gas at once, before it can make the flame luminous. All these causes cooling, dilution and oxidation of the carbon are operative at once in the Bunsen lamp, and the effect that we see is the resultant of all these forces. Probably the most important of them are the cooling and dilution by the nitrogen; for, if the burner through which the gases issue is heated, the flame becomes luminous again.

The Bunsen lamp takes various forms, according to the purpose for which it is to be used. In some of these the gas burns on the top of a piece of fine wire-gauze, after becoming mixed with the air below it. This form of burner is a very common one. It differs in appearance from the usual form of Bunsen lamp, but is essentially the same in principle; that is, it burns a mixture of gas and air, and gives a "non-luminous" flame for the same reasons that the ordinary Bunsen lamp does.

THE COLORADO DESERT.

By JOSEPH F. JAMES.

THERE is an old adage which says that Arizona was the last spot on earth to be created; that Yuma is the outpost of the nether regions, and the hottest place in the world. Every one knows the old story of the two soldiers who, while stationed at Fort Yuma, died, and, going straight to Hades, returned in a short time for their blankets! Be that as it may, there can be no doubt that parts of Southern California and Arizona are among the hottest regions of the world. Neither the Desert of Gobi in Asia nor the Great Sahara in Africa can be worse, in this respect, than their small relative, the Colorado Desert, in California. A protracted journey of some four weeks over this desert gave me an excellent chance to see it and its

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worst aspect, and I purpose trying to give others an account of its most interesting features.

The desert occupies almost the whole of the large county of San Diego. It is some one hundred and fifty miles long and fifty miles wide, and the Southern Pacific Railroad runs through the center of it. About sixty miles from Los Angeles, the railroad encounters a very heavy grade, one hundred to one hundred and ten feet to the mile, and it continues for twenty-two miles. At the summit, known as San Gorgonio Pass, begins the descent into the desert, and every mile brings you to a more desolate country. At Whitewater Station, twenty miles from the summit, the desert commences in earnest. First a few flowers enliven the scene. Large *Œnotheras*, three or four inches in diameter, grow on small stalks five or six inches high. Large plants of *Abronia maritima*, with clusters of brilliant purple flowers, spread over the ground. A little *Gilia* (*G. Lemmoni*), with white corolla and yellow center, adds its beauty to the scene; and the only shrub, *Larrea Mexicana*, or creosote-plant, with yellow flowers and sticky leaves and branches, reminds you of the forests you have left behind.

During the seven miles to the next station, known as Seven Palms, the vegetation gradually thins out. As we progress beyond, the flowers disappear, and cacti predominate, and farther on these are replaced by the stunted grease-wood. Finally, even this vanishes, and when Dos Palmas is reached we have come to a country where there is absolutely nothing in the shape of vegetation. Every one knows how a well-kept field looks when it has been plowed, and harrowed, and cultivated until not a stick, nor a stone, nor a weed shows itself above-ground. Well, in order to form a picture of this part of the Colorado Desert, imagine a field such as this extending for miles and miles, level as a floor, with no signs of life visible, and no indication of man's presence save the railroad-track and the telegraph-poles. Imagine the ground covered with an incrustation of alkali, which, when stepped on, breaks, and lets one sink ankle-deep into soil as soft and fine as powder. Picture to yourself a gale of wind blowing over the waste, the air filled with fine particles of sand, the sun obscured, and no objects visible one hundred feet away, and you will have formed a faint idea of the worst aspect of the desert.

But it is hard to imagine anything so fearful as the reality, and unless one can see the ground, and feel the sand, and experience a heat of 120° in the sun, one can have only a poor conception of the desert. Every one knows the efficacy of the sand-blast. In no place in the world can its effects be better seen than on this desert. The telegraph-poles are polished on one side as smooth as glass. The white paint on the sign-posts is worn off as clean as if scraped and rubbed with sand-paper. Many of the ties, and the timbers of small bridges and culverts along the railroad, look as if some industrious

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Dutch housewife had washed and scrubbed them with soap-and-water, until they resemble in their whiteness the boards of her own kitchen-floor. Glass bottles, left for a short time on the ground, lose their original appearance, and are ground inside and out. All this is the effect of the blowing sand.

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Here, at the station of Dos Palmas, we are some two hundred and seventy-five feet below the level of the sea. The heat in summer is simply fearful, and this, added to the sand-storms, makes it anything but a desirable place of residence. Men can only be induced to work on the railroad by offering them increased wages. All the section-houses along the road (and for nearly two hundred miles there are no other habitations) are built in a peculiar manner. None are more than one story high. Each has a large porch at one side and a double roof. The lower one constitutes the ordinary roof, but the upper one is raised up about two feet, and the eaves project some four feet beyond the walls. This arrangement, leaving an open space between the two roofs, admits the circulation of air, and keeps the interior of the house cooler than it would otherwise be. Such precautions will be thought to be by no means extraordinary, when it is known that 95° to 100° is the ordinary temperature in a shady spot, and 115° or 120° is by no means uncommon.

Rain never falls on this desert in the natural manner. Cloud-bursts and water-spouts, accompanied by fearful thunder and lightning, are of frequent occurrence. The ground between Frink's Spring and Flowing-Well Stations, a distance of seventeen miles, is cut and gullied in a most remarkable manner. In this distance there are no less than seventy-five bridges and culverts on the railroad-track. The gullies vary from five to twenty-five feet in depth and about the same in width. The banks are so steep and precipitous that, in walking along, one does not see the cañon until it yawns at one's feet. These gullies are all caused by the rush of water from cloud-bursts and water-spouts.

Some six miles from Frink's Spring Station is a section-house known as Volcano. Close to it, and a few yards from the track, is a mud-spring, and from this the house takes its name. The spring is situated in a depression about twenty-five feet deep, and the same in diameter. In the bottom is a small lake, or mass of liquid mud. This rises in great bubbles as large as a hat, breaking and sputtering like boiling lard. All over the surface of the water are little bubbles, caused by carbonic-acid gas. Both mud and water have a strong smell of sulphuretted hydrogen, and the spring is evidently the result of volcanic force, which has, at some former period, been very active.

At Flowing-Well Station there was, when the railroad was first put through, a well bored to get water to supply the locomotives. The surface-water, all through the desert, is so alkaline that it is impossible to use it. It is, therefore, necessary for the railroad to haul water

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on every train for about a hundred miles. Trains going both ways take one or more tank-cars, for the supply of section-hands and engines. In the well referred to, water was finally reached, and in such quantities that the flow could not be stopped. It ran for three days, flooding the whole country for miles around, and then stopped, and has not run since. The water of this well had the same sulphur taste and smell as that now found at Volcano.

Just beyond Flowing-Well Station, the road runs along a chain of most desolate sand-hills. These continue for twenty miles. During severe winds, which are of frequent occurrence, the sand drifts over the track very rapidly, and in a few hours covers it to the depth of a foot or more. It has been found necessary to have a relay of men constantly on the ground, and every day they are engaged in clearing the track. The engineers are warned of their approach to these bad places by large posts, with the word "sand" painted on them, and must then take extra care.

There are many things to indicate that at one period the lowest portion of the desert was covered with water, forming an extensive lake. In places the character of the soil is such that there can be no doubt that it was deposited in still water. It is as soft and fine as powdered chalk, and not a stone can be found for long distances. We pass in one place, quite suddenly, from a gravelly, stony soil to one which is neither. It seems to mark the shore or boundary of the lake, and here the ground is covered with shells of various species. *Anodonta Californiensis*, *Amnicola longinquas*, *Tryonea protea*, and *Physa humerosa*, are very common, and all of them are living in Western waters at the present day. Then, again, we come to piles of stones, all water-worn, and showing the former presence of water where now there is not a drop.

Where has the water gone to? There can be no doubt that volcanic action has had much to do with its disappearance. Black, lava-like stones are found in huge streams, as they might be called, extending for miles. Pumice-stone is found in large quantities in many places, and great blocks of lava are said to lie at the foot of the mountains bordering the desert, some twenty-five miles away. The presence of the volcanic spring, already referred to, is corroborative evidence of volcanic action. There is still a large body of salt-water lying at a considerable depth under the surface. At Mammoth-Tank Station the railroad company has been engaged for some time past in boring a well. They had reached a depth of thirteen hundred and fifty feet at the time I passed, and had then found nothing but salt-water.

It is curious that the various stations on the road have been called after things nowhere to be seen in their immediate neighborhood. Seven Palms takes its name from a group of trees fifteen miles away toward the mountains. Flowing Well is very dry. Mesquite has not

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a bush of any consequence anywhere near, though they are common enough near Indio. Frink's Spring has no water within six miles; and at Cactus, strange to say, there is hardly a plant in sight.

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The animal life in the desert is meager in the extreme, and in many places there is none at all. Along one stretch of twenty miles, where there are no trees of any size, the woodpeckers and little wrens have made their nests in holes dug in the telegraph-poles. It is strange that the habits of these birds have not been modified to suit the surroundings, but they have probably come into the country since the poles were erected. Snakes are in places comparatively common, but still, one might travel for two or three days and not see any. Rattlesnakes live under the stones, and resemble the ground so closely that they are hard to distinguish. Lizards delight in the hot, sandy wastes, and at all times are darting hither and thither with the rapidity of light. In places are regular beaten tracks made by them along one side of the rails. Horned toads, really lizards (*Phrynosoma cornutum*), are common, and so near the color of the sand that it is almost impossible to recognize them except when running, and utterly impossible to catch them. Three or four kinds of beetles are common in places. *Cryptoglossa verrucosa*, *Cysteodema armata*, and *Endrotes ventricosus*, are the most common. The first has such hard *elytra* that they can almost be stepped on without fear of crushing them. They generally take refuge from the sun on the shady side of the rails, and the tracks left by them are plainly visible. Great numbers are found dead on the sand, and it would seem that the heat of the sun and of the sand combined was too much for them. The much-dreaded scorpion and the centiped are also found, but are not common.

The vegetation of the desert is, of course, of a peculiar character. For about twenty miles near Indio, the mesquite (*Prosopis juliflora*) is very common. It forms a tree twenty or thirty feet high, with a very rough bark, scraggy branches, and sharp thorns. The leaves are like those of the acacia, and the flowers yellow, in long racemes. The pods succeeding the flowers are long and crooked, and are used by the Indians for food. The branches are often burdened by huge masses of mistletoe, sometimes as large as a barrel, and serve as nesting-places for birds. The mesquite-wood is excellent for fires, and the Indians cut and stack it along the road to sell to the company for fuel.

Cacti are common over a large part of the desert, and the brilliant crimson and yellow flowers serve to enliven the otherwise desolate wastes. *Larrea Mexicana*, the creosote-plant, is also common. It is so called on account of its peculiar odor. The leaves are small and sticky, the flowers yellow, and the seeds are covered with a whitish fuzz. Nothing will eat it, it is unfit for burning, and it is hard to tell what place it fills in the economy of nature. The *Parkinsonia Torreyana* is another peculiar desert-plant. The Spaniards call it "palo

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verde," on account of the pale-green color of the branches. The blossoms are of a bright yellow, hang in long clusters all over the tree, and are visited by great numbers of wild-bees for the honey they contain. When in blossom there are no leaves on the trees, these coming out afterward, small, awl-shaped bodies, almost invisible to the eye. It would seem that the branches serve the purpose of leaves, and probably contain the stomata, in the same way as do the trunks and branches of the cacti. The *Fouqueria spinosa*, the "ochotilla" of the Mexicans, is one of the most remarkable of all the desert-plants. The stem or trunk is very short, and branches into a number of long, lithe, whip-like shoots, covered with curved spines an inch or so long. The flowers are bright red, forming clusters at the ends of the shoots, and are succeeded by oblong capsules filled with minute seeds.

When the borders of the desert are reached, and we catch the first glimpse of the Colorado River near Yuma, the eye rests with delight upon the broad, rolling stream, and the banks lined with mesquite-trees. No one can fully appreciate the beauty of forest vegetation unless he has spent some time on a desert waste, where even water to drink is scarce, and where vegetation of any consequence is unknown. The mesquite-trees along the Colorado are quite large, and the Yuma Indians find a considerable store of food in the beans.

It is surprising to a stranger to see these Indians walking round in the sun without any head-covering except their hair, and nothing whatever on their feet, with the sand hot enough to scorch the skin of any one unaccustomed to it. They are not bothered with clothes, the braves at all events, for their dress is often solely a breech-clout about the waist, or occasionally a thin under-shirt in addition. Some have finely-formed figures, straight as an arrow, and, with their bronzed skin, look almost like statues when they pose. They are a worthless set, however, and live upon what they steal or find on the trees or take from the river. The squaws do the household work and carry wood and water, while their lazy lords spend the time roaming about or sleeping in their tents.

The Colorado River at Yuma is a good-sized stream. The water is very muddy, and, even when settled, has a milky tinge. It is, nevertheless, very good to drink, being, in fact, the best in the country. The stream is navigable for small steamers for about three hundred and seventy-five miles above Yuma, but in low water the boats often run aground on the sand-bars, and have to be stilted over them with timbers. An old navigator said that sometimes it was necessary to turn the bow down-stream, start the engine backward, and use the paddle to dig a way over the shallow places!

Yuma itself is situated in a hollow, surrounded on three sides by sand-hills. No breeze can cool the air, and the sun, beating down with almost tropical fervor, often causes the thermometer to register 120° in the shade. Even at night it is hot, for the earth radiates the heat

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received during the day, and the inhabitants find it almost unbearable. Many sleep on the house-tops, and many more on the sidewalks in front of the houses, making their morning toilets in the open air. The houses are built of adobe or mud-bricks, with heavy walls and flat roofs, all of them but one story high. Taking everything into consideration, Yuma is not a place to have a summer residence in, however pleasant it may seem to one after a four weeks' journey over the Colorado Desert.

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PROFESSOR JOHN W. POWELL.

PROFESSOR JOHN W. POWELL, better known as Major Powell, Ph. D., founder and director of the Bureau of Ethnology of the Smithsonian Institution, and present director of the United States Geological Survey, is a pattern of the American self-made man, and well illustrates in his life and achievements what may be accomplished with honest, steady adherence to a definite purpose. He was born at Mount Morris, New York, on the 24th of March, 1834, a short time after the arrival of his parents from England. His father was a Methodist clergyman, and was required to lead a very unsettled life. In his early childhood the family removed to Ohio ; eight years afterward, to Wisconsin ; and again, when he was fifteen years of age, to Illinois, where young Powell remained most of the time until the breaking out of the war.

It was during this latter period that his mental characteristics were developed. He was eager for knowledge, and used every opportunity to pursue such courses of study as were accessible to him, or appeared to be adapted to his case. He studied for a time at Illinois College, Jacksonville, and subsequently entered Wheaton College. Unable to attend school continuously, he alternated between teaching in the public schools and studying, and in 1854 he went to Oberlin to pursue a special course of two years.

From the first he was strongly attracted to the natural sciences, and particularly toward natural history and geology. He was fond of making collections, which he studied for their own sake. He commenced with botany, to which he has made some valuable contributions. Being much interested in nature, he acquired a roving disposition, and lost no opportunity of making scientific excursions, sometimes extending to long journeys. Having already made journeys on the Mississippi to St. Paul and across the State of Wisconsin to Mackinaw, in 1856 he descended the Mississippi River in a skiff and alone from the Falls of St. Anthony to its mouth, making collections, which he gave to the various museums of the State institutions. The next year he rowed from Pittsburg to the mouth of the Ohio,

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and spent the fall in Missouri, studying the geology and mineralogy of the Iron Mountain region. In 1858 he made a trip from Ottawa, Illinois, down the Illinois River to its mouth, and later ascended the Desmoines River, returning laden with specimens.

The various institutions of the State of Illinois, and some of other States, soon came to depend upon his collections for illustrating their courses of scientific lectures, and the Illinois State Natural History Society elected him its secretary, and extended to him facilities for prosecuting his researches, now recognized as of high value. The funds necessary for conducting these operations he was obliged to obtain by teaching a portion of each year.

The breaking out of the rebellion put a temporary check upon Professor Powell's scientific adventures. He enlisted as a private in the Twentieth Illinois Infantry. Having been made a lieutenant, he was transferred to Battery F, Second Illinois Artillery, and was afterward promoted to be captain of the battery, then major of the regiment, and finally lieutenant-colonel. In the last days of the war he received a commission as colonel, but, having no desire to follow war as a profession, declined it.

At the battle of Shiloh he lost his right arm. As soon as he had sufficiently recovered from his wound he returned to his post, and continued to serve to the end of the war.

His passion for collecting did not forsake him even while in the army, and wherever he was stationed for a sufficient length of time he found means of studying the geological formations, and of shipping from time to time to the State Museum large invoices of valuable material.

On his return from the army he was offered a lucrative civil position in his own town of Wheaton, but he preferred to accept the comparatively unremunerative one of Professor of Geology and Curator of the Museum of the Illinois Wesleyan University at Bloomington. This he afterward exchanged for a similar post in the Illinois Normal University.

In the summer of 1867 Professor Powell, taking with him his class in geology, visited the mountains of Colorado for the purpose of study. This excursion was the first attempt of its kind in this country, and to Professor Powell is therefore due the credit of having inaugurated a practice of the highest value to science and to education, which has been continued by many eminent teachers at leading institutions, until a certain amount of field-study has become recognized as a necessary part of a course of instruction in all branches of natural science.

Professor Powell saw more in the parks and cañons of Colorado than a mere training-school for students. He saw, stretching far westward and southward, a vast unexplored region, hitherto represented on all maps by an utter blank, and through which at some point must flow an immense river, the Colorado of the West, whose

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upper tributaries and lower portion were alone known to civilized man. That such an unexplored region should exist within the limits of the United States seemed to him almost a reproach to the boasted enterprise of our people, and he began to lay plans for its exploration.

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In the summer of 1868 he organized a party of men, some of whom were mountaineers, and, starting from Middle Park, followed down the Grand River to the head of Cedar Cañon, thence over the Park Range through Gore's Pass to the White River, one hundred and twenty miles above its mouth. Here the party went into winter-quarters, and during the winter made reconnaissances, and completed their preparations for an early expedition in the spring.

Proceeding, in the spring of 1869, to Green River station, on the 25th of May the expedition launched its four small craft in Green River, the largest of the tributaries of the Colorado.

We have not space to follow them through their perilous voyage of over three months' duration, or to describe the succession of hardships, disasters, and hair-breadth escapes, by which almost every day of this period was characterized. All this has been written by the hero of the expedition. We can only say here that it was not until the 20th of July that the brave party reached the junction of the Grand and Green, or the head of the Colorado River proper; that on the 13th of August they entered the Grand Cañon, from which they did not emerge until the 29th; and that on the 30th of that month they at last arrived at the mouth of the Rio Virgen, where, for the first time, they saw the faces of white men.

After having been two weeks in the Grand Cañon, already for some time reduced to half-rations, three of the men refused to go farther, and endeavored to induce Major Powell to turn back. He explained to them that they were very near the end of their journey, but was himself almost tempted, in view of the scarcity of provisions, and the probable nearness of Mormon settlements, to yield to their arguments. He passed a sleepless night, and expresses the result of his reflections in the following words: "But for years I have been contemplating this trip. To leave the exploration unfinished, to say that there is a part of the cañon which I can not explore, having already almost accomplished it, is more than I am willing to acknowledge, and I determine to go on." The three men undertook to reach the settlements by a journey across the country, and were murdered by Indians; the boatmen emerged the next day in safety from their granite prison.

This daring voyage was not a barren adventure. In many respects it was a scientific expedition, and as many instruments as could be taken were carried, and determinations were made wherever practicable, the accurate records of which were kept in duplicate, so that one set was safely brought through. The importance of Professor Powell's labors, and their thorough and scientific character, made it apparent that they should be followed up, while their national bearing sug-

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gested to Professor Henry, of the Smithsonian Institution, the propriety of asking the Government to lend its assistance.

Accordingly, a topographical and geological survey of the Colorado River of the West and its tributaries was inaugurated by Congress and placed under Professor Powell's direction.

With these added facilities the exploration was pushed from year to year with great energy and success, and a systematic survey was conducted, until all the streams, mountains, plateaus, and other physical features of the Colorado Valley, embracing an area of nearly one hundred thousand square miles, have become thoroughly known topographically and geologically, and there is no longer an unexplored region within the confines of the United States. In 1875 Professor Powell published some important chapters "On the Physical Features of the Valley of the Colorado," which, while dealing largely in the physical geography of the country, were in the main geological, and set forth for the first time the fundamental principles that underlie the structural formation of a large part of the Rocky Mountain region. The next year appeared his "Geology of the Uintah Mountains," which is likewise a model of clearness, and consists in a careful analysis of the laws which have operated in the formation of these masses; while much of the consistent reasoning from the closely observed phenomena of this region is equally applicable to all parts of the West.

So great was the general interest at this time in acquiring an accurate acquaintance with the Western portion of the country, that no less than four authorized surveys were operating simultaneously in the different Territories. These were: 1. The special survey of the fortieth parallel, under the War Department, in charge of Mr. Clarence King, organized in 1867; 2. Dr. F. V. Hayden's geological and geographical survey of the Territories, organized and operating under the direction of the Secretary of the Interior since 1867; 3. A military and topographical survey, conducted by Lieutenant G. M. Wheeler, under instructions from the Chief of Engineers of the War Department, organized in 1869; and 4, and last in chronological order, that of Major Powell, which received its first national aid in the year 1870, although, as we have seen, it had been in the field as a private enterprise since 1868.

These various expeditions became to a great extent rivals, and, being not only independent of each other, but conducted by different departments of the Government, it was impossible to avoid the duplication of much of the work, or to prevent the growth of discordant methods. Occasional collisions occurred between parties of different surveys in the field, bitter feelings were engendered, and the two departments under which the parties were serving found themselves called upon to defend their jurisdiction and claims to the right of conducting public surveys.

The attention of Congress was called to the matter, and on the 15th

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of April, 1874, the House of Representatives adopted a resolution asking information from the President respecting the surveys that were operating in the same and contiguous areas of territory west of the Mississippi, and whether it would not be practicable to consolidate them under one department, or to define the geographical limits to be embraced by each.

The President's message in reply to this resolution was accompanied by a report from the Secretary of War, who transmitted the views of the Chief of Engineers, and one from the Secretary of the Interior, transmitting in like manner sub-reports from the heads of the respective surveys under his superintendence, viz., Hayden and Powell. Upon the question of consolidating all the surveys then in operation under one department, but one opinion was expressed, all being in favor of such a measure; but, as to which department should control them, the views were discordant—the President, the Secretary of War, and the Chief of Engineers, urging the claims of the War Department, and the Secretary of the Interior and both the heads of surveys under his direction as firmly advocating the fitness of that department to administer them. The War Department claimed this right by a sort of *prescription*, as it was under its protection and control that all the early explorations, including the celebrated expedition of Lewis and Clarke, had been conducted, and by it the leading object was declared to be the accurate mapping of the country for military operations. It also claimed a higher scientific training and discipline for performing the work.

The Department of the Interior, on the other hand, connected the surveys primarily with the public domain, and showed that they were chiefly ancillary to the operations of the Land-Office, which had always been under that department. It also maintained that even in the expeditions under the Engineer Corps civilians had always performed the bulk of the scientific work.

The committee to which the reports were referred recommended that the surveys under the War Department should be continued, so far as they were necessary for military purposes, and that all other surveys for geographical, geological, topographical, and scientific purposes should be continued under the direction of the Department of the Interior.

This report left matters nearly where they were, and was not satisfactory to either party. A second inquiry was ordered by the House in March, 1878, and the officers immediately charged with the surveys were again called upon to express their views on the subject. Major Powell, in his statement, pointed out the essential vices of the multiple surveys; proposed that each branch of natural history should be prosecuted wholly by some one of the divisions, which should be in possession of all the materials; offered to turn over to Dr. Hayden all the materials in his possession relating to any or all of these branches,

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or to receive and elaborate the materials collected by other surveys; and pointed out the different methods by which the work of surveying was performed by the parties of the War and those of the Interior Department, and the impossibility of ever completely harmonizing them. He also presented a map, showing the amount and location of the duplicated work. His paper concludes with these remarks: "If the surveys of both departments are carried on over the entire region, there will be two general atlases of the whole area, and the work will be twice done. If the surveys are confined to different areas, there will be an Interior Department atlas of one region and a War Department atlas of the other, and neither atlas can be completed for the entire region without reconstructing the maps of the other. In view of these facts, it is manifest that the work should be unified and a common system adopted. This may be accomplished either by an act of Congress, by executive direction, or by placing the work under one management."

The improbability that, in case of consolidation, Professor Powell would be called to the head of the surveys, as well as the known sincerity of his personal character, precluded suspicion of any other motive for such an expression of views than that of concern for the interests of the service.

A provision was inserted in one of the appropriation bills, requiring the National Academy of Sciences to take into consideration "a plan for surveying and mapping the Territories of the United States on such general system as will secure the best results at the least possible cost." Professor O. C. Marsh, president of the academy, and chairman of the committee appointed by it to consider the subject, requested the Secretaries of War and of the Interior to furnish the committee with any data at their disposal to aid it in performing the duty thus imposed upon it. Both secretaries responded through their chosen representatives, Professor Powell, with Dr. Hayden and Commissioner Williamson of the Land-Office, appearing for the Interior Department. Professor Powell's paper was even a more clear and complete statement than the one he had made before the congressional committee, of the necessity of consolidating the surveys and making a division of the labor on a scientific basis. On the 26th of November the National Academy submitted its report, on the basis of the one that had been made to it by its committee, recommending the establishment, under the Department of the Interior, of an independent organization, to be known as the United States Geological Survey, to be charged with the study of the geological structure and economical resources of the public domain, the director of which should be appointed by the President. A provision organizing the survey, in accordance with these recommendations, was passed by Congress in an appropriation bill.

Professor Powell supported Mr. Clarence King, who was appointed

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for the position of director of the survey, and was himself placed upon the commission on the codification of existing laws relating to the survey and disposition of the public domain.

The labors of this commission concluded, Professor Powell was glad to be able to turn his attention once more to science. The one field which now most deeply interested him was that of American ethnology. From the very beginning of his Western explorations, the aborigines had strongly engrossed his thoughts, and among all his scientific collections and investigations which he had been enabled to make none had received more careful attention than those relating to the Indian tribes. While the other surveys had devoted much attention to the collection, study, and illustration of the various departments of natural history, he had made ethnography, next to geology and topography, the chief object of his expeditions. Prior to the date of the consolidation, three volumes relating to ethnology had been published by the Powell Survey, and eight more were in different states of preparation, while in addition to this the material collected and deposited in the Anthropological Hall of the Smithsonian Institution was sufficient for several other volumes, and demanded elaboration. The study of Indian languages had especially interested him, for he saw that, whatever success might be attained in preserving the Indians themselves from extermination, the fate of their languages was already settled, and in a short time the primitive stocks would have inevitably become so badly corrupted that the philologist would find it impossible to deal with them in a scientific manner.

Efforts were made by the Secretary of the Smithsonian Institution and the Secretary of the Interior to prevent the discontinuance of this work, and an appropriation of twenty thousand dollars was secured in March, 1879, for completing and preparing for publication the "Contributions to North American Ethnology," under the Smithsonian Institution, with a provision that all the material collected in the surveys that bore on that subject should be turned over to that institution.

Professor Powell was put in charge of this department, and has prosecuted it with great vigor and success to the present time. A Bureau of Ethnology grew up under the Smithsonian Institution, which has become the recognized center of ethnographic operations in this country.

When, in the spring of 1881, Mr. Clarence King retired from the work of the surveys, there seemed to be no rival candidate to Professor Powell for the vacant position, and it fell to him as the most obviously suitable person to fill it.

Without mentioning particularly the numerous official reports into which important scientific matters have often found their way, the principal literary contributions of Professor Powell are the following:

1. "History of the Exploration of the Cañons of the Colorado."

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This work, which was published in quarto form and illustrated, as Part I (Chapters I to IX) of the original volume of "Exploration of the Colorado River of the West and its Tributaries, explored in 1869, 1870, 1871, and 1872, under the Direction of the Smithsonian Institution" (1875), consists of the personal narrative, from Professor Powell's diary, of the celebrated voyage down the unexplored river.

2. "On the Physical Features of the Colorado Valley." This forms Part II of the same work.

3. "Geology of the Uintah Mountains, with Atlas" (1876).

4. "Introduction to the Study of Indian Languages, with Words, Phrases, and Sentences to be collected" (1877).

5. "Report on the Lands of the Arid Region of the United States, etc., with Maps" (1879). This is a highly important public document, and one with the contents of which the country generally should be familiar. Though containing able chapters by Mr. G. K. Gilbert, Captain C. E. Dutton, Professor A. H. Thompson, and Mr. Willis Drummond, Jr., it is, in its general plan and in the chief part of its matter, the work of Professor Powell.

6. "Introduction to the Study of Indian Languages, etc. Second edition—with Charts" (1880). We enter this work as distinct from the first edition, published in 1877 under the same title, because, with the exception of the schedules, notes to collectors, and remarks on the alphabet, its matter is wholly new. Though small, it is one of the most important of Professor Powell's contributions to science.

Professor Powell is a member of the National Academy of Sciences and a Fellow of the American Association for the Advancement of Science, and presided over the Biological Section of the latter in 1879. He has been the President of the Anthropological Society of Washington since its organization, and his annual addresses before it are published in its "Transactions."

Personally, he is of most agreeable manners, frank, genial, and cordial under all circumstances, and possessed of great individual magnetism. Though social by nature, he has a strong preference for persons of culture, and especially of independence of thought, as his friends, and seems to possess the tact of securing such without giving offense to others. It is a favorite theory of his that, to observe well, one must also think deeply, and that observation without theory is necessarily sterile; and these ideas he carries into practical affairs in the selection of his assistants in all branches of his service. His mind is in the highest degree realistic, and he looks upon all classes of phenomena from the objective point of view. In anthropology he belongs to the strictly scientific school, represented by Mr. Lewis H. Morgan, which rejects the imaginative and poetical accounts of the lower races. He accepts the doctrine of evolution, but has not failed to perceive inadequacies in the systematic developments which some of its disciples have sought to make of certain of its minor details.

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ENTERTAINING VARIETIES.

—— The moral responsibility of some animals seems less doubtful than that of "intermittent lunatics." If it should become the duty of a public attorney of the future to prosecute a homicidal monkey, the following case (quoted in Brehm's "Thierleben") would furnish an ugly precedent against the counsel for the defense: A few years ago Dr. Schomburg, the Superintendent of the Botanic Garden of Adelaide, Australia, took charge of a select corps of monkeys and kangaroos, a "happy family," he might have called them, if it had not been for the depravity of an old babuina, or female Bhunder baboon. If she had not been the only representative of her species, he would have tried to get rid of her, for her only object in life seemed to be to make herself as disagreeable as possible. Solitary confinement made her wildly obstreperous, but in the family cage she kept the marsupials in a delirium of terror, and in the evening when her younger relatives ventured to enter the sleeping-box she seemed to consider herself divinely ordained to remove them by force. But one day she attacked her own keeper, and without any apparent provocation lacerated his wrist in a shocking way. Schomburg at once ordered her to be shot. The next morning the assistant keeper approached her cage with a shot-gun, which had often been used to shoot the rats that infested the menagerie-building. The other monkeys seemed to expect another *razzia*, but the Bhunder knew better. The moment she saw the gun she made a dash into the sleeping-cage, and when the keeper tried to open the door she yelled as if she hoped to get off on a plea of insanity. Meaning to try her, the keeper waited till breakfast-time, but the babuina did not show herself. She kept out of sight a full hour, till the mess-boy brought an extra lunch of sliced pumpkins, when she made a rush for the bucket in hopes of securing a portable piece. In that moment the keeper bolted the door of her sleeping-cage, and went back for his shot-gun. As soon as the babuina caught sight of him she flew toward her place of refuge, and, finding the door locked, made a mad attempt to squeeze herself through the interspaces of the front railing. But the bars proved inflexible, and, after another desperate pull at the sleeping-cage door, the babuina flung herself into a corner, closed her eyes, and was apparently dead with fear before the buckshot struck her.

—— Everybody has heard of the *Talmud* (which means *a study*), a venerable work of Hebrew lore, traditions, and commentaries, in twelve folio volumes. There have been many editions of it, and many books about it by renowned scholars. According to the "Encyclopædia Britannica," this is the way the Talmud puts the legendary trimmings on to the history of Adam: "He was made as a man-woman out of dust collected from every part of the earth, his head reached to heaven, and the splendor of his face surpassed the sun. The very angels feared him, and all creatures hastened to pay him devotion. The Lord, in order to display his power before the angels, caused a deep sleep to fall upon him, took away something from all his members, and, when he awoke, commanded the parts that had been removed to be dispersed over the globe, that the whole earth might be inhabited by his seed. Thus Adam lost his size but not his completeness. His first wife was Lilith, mother of the demons. But

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she flew away through the air; and then the Lord created Eve from his rib, brought her to Adam in the most beautiful dress, and angels descending from heaven played on heavenly instruments; sun, moon, and stars dancing. He blessed the pair and gave them a feast upon a table of precious stones. Angels prepared the most costly viands. But Adam's glory was envied by the angels, and the seraph Sammael succeeded in seducing him. The pair were driven out of paradise into the place of darkness, and wandered through the earth."

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—— Jérôme de Guise, the "champion *lady-killer*" of the eighteenth century, left among his trophies eight *billets-doux*, framed like pictures, and displaying eight different signatures under as many different petitions for immediate—elopement. Yet the triumphs of that charmer are far eclipsed by the record of Abdallah-ben-Abdol, the father of the Prophet Mohammed. On the eve of his nuptials, says the chronicle of Abulfeda, not less than two hundred virgins attested the poignancy of their chagrin by committing suicide.

—— Anaxagoras, the Rhodian, held that *Earthquakes* are nothing but a sort of cosmic flatulence—winds which have strayed into caverns, where they can not find an outlet. Aristotle ascribes them to vapors generated by the infiltration of water through the fissures of a rocky sea-bottom; and Pliny, to the pressure of air confined in deep caves, and reacting against the collapse of superincumbent rock-strata. But the most ingenious explanation is offered by St. Thomas of Aquinas. Earthquakes, he suggests, may be caused by the struggles of defunct misbelievers trying (by a simultaneous stampede, perhaps) to escape from the pit of torment.

—— *An Accomplished Vandal.*—Some of the "truculent and turbaned Turks" of the fifteenth century were very far from being barbarians. Mohammed II, the destroyer of Constantinople, spoke fluently five Asiatic and two classic languages, had mastered the Arabian system of astronomy, the philosophy of Aristotle, and the theogony of the Sufist mystics, and achieved distinction as a poet and a national historian.

—— *A Vegetable Monument.*—The oldest tree on earth is probably the cypress of Santa Maria del Tule, in the Mexican State of Oaxaca. It is still growing, and, when Humboldt saw it, in 1851, it measured 42 feet in diameter, 146 in circumference, and 282 feet between the extremities of two opposite branches.

—— And so Mr. Darwin has given us a new philosophy of *angle-worms*. We had supposed that this "humble creature" was created chiefly for the use of country-boys as bait when they go a-fishing, and so were always to be conveniently found in the garden; but our indefatigable naturalist says that this despised earth-worm is nothing less than an ameliorator on the surface of the globe—a forerunner and coadjutor of the agriculturist in promoting the conditions of life. This is another revolution of ideas that is making our age so uncomfortable. "Worms of the dust" seems to be, after all, not so bad a thing. The sluggard is bidden to go to the ant and learn wisdom; but, while he is about it, he can profitably call also upon the worm. We give some poetry from "Punch" on this subject, and also "Punch's" portrait of the great Darwinian in his last *rôle*. He has not the elated expression of a triumphant discoverer. It was said of Agassiz that when he had found some new and long-sought marking or feature in a fish he waxed hilarious, and would dance about the room, but Mr. Darwin

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appears thoughtfully sad. Having accomplished the descent of man and the ascent of the worm, perhaps he is puzzling himself as to what next.

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THE WORM TURNS.

I've despised you, old Worm, for I think you'll admit
  That you never were beautiful even in youth;
I've impaled you on hooks, and not felt it a bit;
  But all's changed now that Darwin has told us the truth
Of your diligent life, and endowed you with fame—
  You begin to inspire me with kindly regard:
I have friends of my own, clever Worm, I could name,
  Who have ne'er in their lives been at work half so hard.

It appears that we owe you our acres of soil,
  That the garden could never exist without you,
That from ages gone by you were patient in toil,
  Till a Darwin revealed all the good that you do.
Now you've turned with a vengeance, and all must confess
  Your behavior should make poor humanity squirm,
For there's many a man on this planet, I guess,
  Who is not half so useful as you, Mister Worm!

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—— "What is the correct pronunciation of the name of the German poet Goethe?" It is impossible to reproduce the sound of this name accurately through English letters. A partial approximation may be made, however. Try *Gay-teh*, and you will not be so very wrong.—*Sun.*

So Bagehot is *Bah'-jote;* and Quatrefages, *Kah'-tre-fahj.*

—— There seems to be more sentiment than science in objecting to the study of insects on account of the pain occasioned by their capture and preservation. Shakespeare says, "The poor beetle that we tread upon, in corporeal sufferance feels a pang as great as when a giant dies"—which shows that he did not understand the anatomy of insects. "Minute dissections and the closest anatomical examinations have proved that, though insects are possessed of nerves, they have no well-defined organs representing the brain, the seat of concentrated feeling, where all the nervous connections meet. They have, instead, a chain of ganglia or bundles of nerve-substance, from each of which nerves branch out to contiguous parts, so that the sensations are not all carried to one grand central focus of acute sensibility as with us; but form as it were separate systems, any one of which might be destroyed without disturbing the sensation of the others." It is well known that large moths, found asleep in the day-time, may be pinned to the trunks of trees without suffering pain enough to awaken them, and, only at the approach of twilight, do they seek to free themselves from what they doubtless consider an inconvenient situation. It is related that Mr. Haworth, the well-known English entomologist, being in a garden with a friend who firmly believed in the acute susceptibility of insects, struck down a large dragon-fly, and, in so doing, accidentally severed its long abdomen from the rest of its body. The mutilated insect, after this misfortune, felt so little inconvenience or loss of appetite that it greedily devoured two small flies. Mr. Haworth then contrived to form a false abdomen, to create such a balance to the rest of the body as would enable it to fly; after which, it devoured another fly, and on being set at liberty, flew away with the greatest glee, as if it had received no injury. But all dispute upon this point should be ended by the entomologist's simple expedient of dipping his pin in prussic acid before piercing the insect, so that the effect is instantaneous.

—— Sir Charles Bell, upon looking over a biographical sketch of himself, made the following marginal comment on that part of it which spoke of his education: "Nonsense! I received no education but from my mother; neither reading, writing, ciphering, nor anything else. My education was the example set by my brothers. There was, in all the members of my family, a reliance on self—a true independence; and, by imitation, I obtained it. People prate about education, and put out of sight example, which is all in all."

—— A teacher in London, on being asked what moral education or training he gave to his scholars—what he did, for instance, when he detected a child in a lie—his answer was this: "I consider all moral education to be a humbug. Nature teaches children to lie. If one of my boys lies, I set him to write some such copy as this: 'Lying is a base and infamous offense'; I make him write a quire of paper over with this copy, and he knows very well that, if he does not bring it to me in a good condition, he will get a flogging."

—— Xanthus, the historian, says that a man killed by a dragon will be restored to life by an herb which he calls *balin.* Democritus asserted and Theophrastus believed that there was an herb at the touch of which the wedge the woodman had driven into a tree would leap out again.

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—— The cautious and conservative old French *savant* Quatrefages says the more he reflects, the more he is convinced that man and animals think and reason in virtue of a faculty that is common to both, and which is only far more developed in the former than in the latter. He is very certain that when a cat is trying to catch sparrows on level ground, and creeps along the hollows, availing herself of every tuft of grass, however small, she knows what she is about just as well as the hunter who glides in a crouching attitude from one bush to another. He illustrates dog capacity as follows: "I once had a mastiff of pure breed, and which had attained its full size, remaining, however, very *young in character*. We were very good friends, and often played together. As soon as ever I assumed an attitude of defense before him, he would leap upon me with every appearance of fury, seizing in his mouth the arm which I had used as a shield. He might have marked my arm deeply at the first onset, but he never pressed it in a manner that could inflict the slightest pain. I often seized him by his lower jaw with my hand, but he never used his teeth so as to bite me; and yet, the next moment, the same teeth would indent a piece of wood I tried to tear away from them. This animal evidently knew what it was doing when it feigned the passion precisely *opposite* to that which it really felt; when, even in the excitement of play, it retained sufficient mastery over its movements to avoid hurting me. In reality it *played a part in a comedy*, and we can not act without being conscious of it."

—— Sydney Smith exhorts against *over-caution*. He says: "A great deal of talent is lost to the world for want of a little courage. Every day sends to their graves men who have remained obscure because of timidity. The fact is that, in order to do anything in this world worth doing, we must not stand shivering on the brink and thinking of the cold and danger; but jump in and scramble through as well as we can. It will not do to be perpetually calculating risks, and adjusting nice chances. It did all very well before the flood, when a man could consult his friends upon an intended publication for a hundred and fifty years, and then live to see its success for six or seven centuries afterward. But at present, a man waits, and doubts, and hesitates, and consults his father, brother, cousin, friends, till one fine day he finds that he is sixty-five years of age. There is so little time for our squeamishness that it is no bad rule to preach up the necessity of a little violence done to the feelings and of efforts made in defiance of strict and sober calculation."

—— The stories of Jonah and Methuselah are—but we should not complain; the faith of an orthodox Brahman is subjected to still severer tests. The sacred authority of the Sama-Veda vouches for the fact that Prince Yudirishi lived 2,300 and his rival Alerka 4,650 years. That is, however, a mere trifle, for a successor of the last-named potentate lived just 66,000 years; and the reader has hardly recovered his breath, when the next chapter informs him that King Yakoyesha lived 2,260,000 years and five months.—("Asiatic Researches," vol. ix, p. 305; compare Buckle's "History of Civilization," vol. i, p. 52.)

—— Truly *Heroic Cures* have somehow gone out of fashion. Dr. Hunt, writing in "Lippincott's Magazine," says that Paracelsus cured a leper by keeping him sixty hours in a bath of hot mud (Schrodt's "Analekten," vol. i, p. 106); and when medicine failed to relieve the chronic headaches of Count Philip, of Nassau, his surgeon trepanned his cranium *twenty-seven times*, and made him sign a certificate to that effect.

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CORRESPONDENCE.

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THE SCIENTIFIC EXPLORATION OF MAMMOTH CAVE.

Messrs. Editors.

IT is due to the trustees of Mammoth Cave to state that, while guarding their property rights, they have uniformly encouraged scientific investigation. Certain maps may have been modified and others suppressed; but, on the other hand, it should be noted that Manager Klett, with authority from the trustees, let me exhibit before the American Association the results of his own accurate survey of the cave, which it is his intention to publish when it is completed, in a form that can be depended on for all scientific ends. He laid no restraint on the members of the Association who visited the cave, at the close of the Cincinnati meeting, but allowed them to use barometers, pedometers, and other instruments. I regarded his request as reasonable that I should not give the *scale* on which his map is drawn, nor my own *table of distances*. The dimensions of domes, pits, and several large chambers were given, and other particulars of interest, that could not have been obtained but for the liberal aid of the manager.

Let me add, as to the temperature of the cave, that the maximum is 56° Fahr., the minimum 52½°, and the annual average 53°. The latter may also be taken as the mean temperature of the earth's crust in the locality of the cave, namely, latitude 37° 14′ 5″; longitude west from Washington, 9° 4′; and at an elevation of about five hundred feet above the level of the sea.

Please make the above corrections in your very gratifying report of my remarks before the American Association, and oblige,

Yours, respectfully,

H. C. HOVEY.

NEW HAVEN, CONNECTICUT, *December* 1, 1881.

[It is proper to add that, in making up our notices of the papers read at the last meeting of the American Association, we had to depend largely upon the reports of the proceedings in the daily papers, which are often imperfect in many points, and can not always be relied upon as correctly representing the author's meaning.—EDITOR.]

A CORRECTION.

Messrs. Editors.

IN the December number of the "Monthly" I have coupled the names of Torel and Dana as believing that Greenland was the source of the American ice-sheets. If I had read Professor Dana's remarks more carefully, I should have discovered that he pronounced this view "absurd." Furthermore, in referring to the Canadian highlands as the starting-point of this ice, the early view of the same author was mentioned, but not the later one. Since 1873, Professor Dana has taught that the ice probably flowed from the Canadian (Laurentian) highlands across the St. Lawrence Valley into New England over the higher mountains, upon a lower over a higher level to the sea; and the motion was occasioned in great measure by the enormous ice accumulations of the north overflowing southerly. I regret exceedingly the misstatements.

C. H. HITCHCOCK.

HANOVER, NEW HAMPSHIRE, *December* 7, 1881.

A TYPOGRAPHICAL ERROR.

Messrs. Editors.

ON page 267 of the December number, at the bottom of the first column,

Boston	164	0
Cincinnati	0	155

should read—

Boston	164	—
Cincinnati	—	155

The Cincinnati members present at Boston were counted from Ohio, the Boston members at Cincinnati from Massachusetts.

E.

November 24, 1881.

AN ARCHÆOLOGICAL QUESTION.

Messrs. Editors.

The following inscribed objects have been found within the limits of the United States:

1. The Grace Creek stone, West Virginia.
2. The Pemberton axe, Pemberton, New Jersey.
3. The Davenport slates, Davenport, Iowa.
4. The Piqua tablets, Piqua, Ohio.

It is evident that, if they are authentic, they are of immensely more importance than implements or pottery.

If they are "archæological frauds," gentlemen who follow that branch of science should lend their aid to convict them.

Under these circumstances, and having devoted as much time to the study of this particular branch as any person with whom I am acquainted, I take the liberty, in the interest of knowledge, to ask an expression

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of opinion in regard to any or all of these objects from the following gentlemen: Professor Putnam, of the Peabody Museum; Professor Rau, of the Smithsonian Institution; Colonel Mallery, of the American Association for the Advancement of Science, and chairman of its Anthropological Section; and Judge Henderson, of the same section.

I have no hesitation in saying for myself that I think there is absolute certainty of the genuineness of these objects; and I can hardly doubt that these gentlemen will avail themselves of an opportunity to confirm my impression, or disabuse me of my error.

I am, sir, your obedient servant,
WILLIAM S. BEEBE,
Brevet-Major U. S. Army.

BROOKLYN, *December* 6, 1881.

EDITOR'S TABLE.

THE CHARGES AGAINST "THE POPULAR SCIENCE MONTHLY."

THE publishers of this magazine, having declined any longer to issue the "North American Review," because of its recent articles from the pen of Colonel Ingersoll, have been charged with inconsistency on the ground that, in respect to the matter objected to, the periodical they retain is as bad as the one they have dismissed. A writer in the "Evening Post" says: "I would like to know how and where Messrs. Appleton & Co. draw the line which makes the same opinions detestable in the 'North American Review,' which are endured in 'The Popular Science Monthly.' The editorial views of the latter publication are certainly as pronounced in their atheistical tendencies as anything Colonel Ingersoll ever uttered, and for a long period of years this journal has published everything of interest written by pronounced atheists, and excluded everything which has appeared of merit on the other side. The papers of Herbert Spencer, and others of his class, have been presented, but such writers as the Duke of Argyll have never been permitted to offer their views."

This accusation against "The Popular Science Monthly," that it is a teacher of atheism, has been made before, and met before; but, as the present circumstances give it point and revive its interest, we propose now to reconsider it, and again see what it amounts to. We shall thereby be enabled to judge whether the two magazines really teach the "same opinions" upon this subject, as the writer in the "Post" affirms.

The paragraph just quoted would have been more satisfactory if it had been more explicit; for here, if anywhere, clear distinctions are demanded. What does the writer mean by "pronounced atheistical tendencies" and "pronounced atheists"? Does he mean that their atheism is avowed or imputed; that they pronounce themselves atheists or are so pronounced by others? These are not only different things, but the distinction is here very material; so that it becomes necessary, before we can find out who are truly atheists, to have the test by which they are known. Because a man is called an atheist, are we to hold that he is therefore, in fact, an atheist? We were once accosted by an inquisitive Irishman thus: "D'ye b'lieve in the mother o' God?" "No." "Be gorry, y'er an atheist; I wouldn't be in y'er boots for twenty pound." Was that a satisfactory basis of classification? Professor Huxley had a cook who got on a drunken spree, and made such a row in the house that the police were called. As she was hustled through the yard, she sent back a blast, of which all that could be understood was an emphatic "damn athish!" Is Professor Huxley, therefore, to be ranked as a "pronounced atheist"? But, if a drunken cook is not an authority on this point, is a

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sober bigot any better? It is the common and very foolish trick of religious partisans to stigmatize those who differ from them in their views of Deity as atheists. Each one identifies God with his own scheme of belief, and, if that scheme is objected to, the objector is denounced as a denier of God. Particularly where the conception of God is low, gross, and materialistic, is every higher view charged with atheism. There is, however, no honest difficulty here. We have exactly the same means of knowing atheists that we have of knowing Baptists or Buddhists, that is, by what they profess and teach. We should call Bradlaugh a "pronounced atheist," because we have heard him say that he is the only man who ever ran for Parliament distinctly as an atheist. He has, besides, a large following in open agreement with him, and who may, therefore, be properly called atheists. A "pronounced atheist," in short, must simply be one who pronounces himself an atheist.

And now, having found that atheists are those who avow a certain belief, it is desirable to note distinctly what that belief is. Atheism, says Webster, "is the denial of the existence of a God." But the term God has many significations, and is variously defined. We take the highest definition given by Webster, "the Supreme Being; the Eternal and Infinite Spirit." A pronounced atheist, therefore, is one who professes to deny the existence of "the Supreme Being; the Eternal and Infinite Spirit."

The writer in the "Post" declares that "The Popular Science Monthly" "has published everything of interest written by 'pronounced atheists,' and excluded everything that appeared of merit on the other side." The other side of what? Why, the advocacy of atheism, of course! That is, "for a long period of years" this magazine has been given over to the work of teaching the doctrine of the non-existence of "the Eternal and Infinite Spirit." This statement is not true; it has not a vestige of truth in it; it is wholly and absolutely false. This is one of the charges that calls for proof, and happily the writer has given his proof. It is this and nothing else, that "the papers of Herbert Spencer and others of his class" have appeared in "The Popular Science Monthly." That any such papers really have the character charged, there is not the slightest attempt at proof.

But Herbert Spencer is not an atheist, and never has been. He has never declared his belief in atheism, and he is a man who expresses his opinions very freely and with but little regard for their popularity. He has been called an atheist, but that, as we have seen, will not do. If we had space we could fill pages with admissions on the part of all his ablest theological critics that he is not an atheist. We challenge the "Post" writer to produce a single passage in all his writings, in the "Monthly" or out, either avowing or defending atheism. On the contrary, he has labored with all the power of his genius to prove that atheism as a theory of the universe (which it professes to be) is baseless and indefensible. And more than this, no man of the present age has reasoned out the foundations of man's belief in the existence of the "Infinite and Eternal Spirit" with such a depth of analysis and logical force as Herbert Spencer. He has sought to show that the "Infinite and Eternal Spirit," of which all the phenomena of the universe are but the manifestations, is the most absolute of all realities.

And still more than this is true. Mr. Spencer has gone beyond the theologians in their own line, and has rescued them from the consequences of their own logic. Every intelligent person knows that there has been a great progress in the religious ideas of man-

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kind; and in nothing has that progress been so clearly evinced as in the gradual elevation of man's conceptions of the character of the deity he worships. During all the primitive ages, religion was idolatry, and still is so, almost all over the world. But with growing intelligence there slowly arises a higher idea of the Divine Nature. Polytheism passes into monotheism, and the gross, limited, anthropomorphic idea of God gives place to the loftier ideal of an "Infinite and Eternal Spirit." In this clearing away of limitations how far was the work to go, and what to be finally left? The theologians had been driving destructive criticism to its last extreme, with but little apparent care for the consequences. There grew up a vigorous ecclesiastical agnosticism, asserted even by the fathers of the Church. Clemens Alexandrinus (A. D. 200) says of God, "We know not what he is, but only what he is not." Cyril of Jerusalem (A. D. 350) affirms, "To know God is beyond man's power." St. Augustine (A. D. 400) observes, "Rare is the mind that in speaking of God knows what it means." John of Damascus (A. D. 800) declares, "What is the substance of God or how he exists in all things, we are agnostics, and can not say a word." Duns Scotus (A. D. 1300) remarks: "Is God accessible to our reason? I hold that he is not." This tendency to remove the Divine Nature beyond the grasp of reason, and to hold that "a God understood is no God at all," has grown in strength in modern times, and reached its full expression in the theological philosophy of Hamilton and Mansell, which landed inquiry upon this subject in blank negation. Finding that the "Infinite and Eternal Spirit" transcended and baffled all reason, they assumed that reason brings us to an infinite nothing, so that we have no alternative but to give up the idea of an Infinite Power, or fall back upon faith. Mr. Spencer strenuously resisted this conclusion. He maintained that the most inexorable logic brings us not to an Infinite Nothing, but to an Infinite Something; and, although this "Eternal Spirit" transcends the reach of reason, and is "past finding out," yet that its existence is the profoundest of all verities. Where the case broke down in the hands of the theological analysts, he insists that it is demonstrably the strongest. Whether he proves his case is not here the question; we only declare that such is his position, which is in dead antagonism to atheism. But it is proper to say that many of his able opponents acknowledge that Mr. Spencer has contributed new and powerful arguments for the existence of an "Infinite and Eternal Spirit." In the presence of these facts, well known to all who care to know, what shall we say of the veracity, the honor, or even the decency, of those who flippantly reiterate this groundless charge?

And it is important here still further to observe that Mr. Spencer is not a denier or antagonist of religion. He holds it to be a reality, a great truth; in short, nothing less than an essential and indestructible element of human nature. The religious institutions of the world, he maintains, represent a genuine and universal feeling in the race just as really as any other institutions. With the accessory superstitions which in all ages of ignorance have overgrown and perverted the religious sentiment, he is, of course, not in agreement; and he maintains that the confounding of these with the religious sentiment itself, is a mischievous mistake of religionists and anti-religionists alike. And he furthermore holds that science, in clearing away these superstitions, is bringing us ever nearer to the underlying truth, and is, therefore, doing the highest religious work. And, besides, in all his discussions of religious subjects, though bold, he is reverent, respectful to sincerity, tolerant of honest prejudice, and never wantonly irritat-

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ing in the treatment of what he regards as religious errors.

A line is to be here drawn, clear and sharp, separating this mode of regarding religion from that which proclaims it to be a sham, an imposture, and a mere invention of priestcraft to cheat credulous people. Between him who believes that religion is a great and sacred reality, and him who denounces it root and branch, as a delusion originating in fraud and knavery, there can be no common ground. These are not the "same opinions," but diametrically opposite opinions. A criticism of religious errors, however trenchant it may be, if it gives the subject sincere and respectful consideration, is as different as any two things can be, from a spiteful, ruthless, and exasperating assault upon the religious sentiment of the community. And when these opinions are published for no other reason than to startle and shock the public by their audacity, and for no other than a sordid purpose, the case is still further aggravated. "The Popular Science Monthly" has left others to make what they might out of this policy.

The writer in the "Post" complains that we have not published the views of such men as the Duke of Argyll, to which we reply: 1. That we should have been glad to publish the Duke of Argyll's articles, but had no room for them. 2. That we started a supplement to make more room, and *did* publish the views of the Duke of Argyll. 3. That the papers of his Grace have been very widely reprinted in other channels, so that the public has experienced no inconvenience from the want of them. The "Monthly," we must remember, was established, not for the display of polemical pugilism, but for the serious purpose of placing before American readers the most important results of scientific thought as presented by its ablest expositors. So far, indeed, has it been from seeking sensational papers, that its main purpose was to publish a class of valuable scientific articles, which, because they are too heavy or will not pay, or conflict with public prejudices, were systematically excluded from our current magazines. While striving to make our pages as varied and attractive as possible, we have not sacrificed the character of the magazine to promote its pecuniary success. We have maintained a steady course, our last issue is strictly in the line of the first, and all the wide approbation that has been accorded us from the beginning is as applicable now as it ever was.

The "New York Observer," in commenting upon this subject, agrees with the writer in the "Post" that the "Monthly" is as bad as the "Review," if not worse, and it very plainly says: "We with thousands hope sincerely that the commendable course taken by the eminent publishers, in kicking the 'Review' out of their premises, will be followed in regard to the 'Monthly.' Or, what would be better still, let us hope the 'Monthly' will omit its atheistic teachings, and become such an organ of science as the great body of intelligent people will admit with confidence into their homes."

We have exploded the charge of the "Post" writer, here repeated, because he gave us his evidence, and we had something tangible to deal with. But the "Observer" scents atheism in everything scientific, and, if we began to expurgate in accordance with its notions, we should have to expunge the whole "Monthly." For does not the "Observer" hold evolution to be atheistic? And what would "The Popular Science Monthly" be, *minus* evolution? It is the new dispensation of scientific thought, cropping out everywhere, antiquating old views, affording new explanations, reorganizing knowledge, and guiding the researches of scientific men in every field of investigation. Those who do business on old opinions are in a great state of perturbation and

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distress about it. Some are for "giving in," some are for patching up compromises, and some for "fighting it out." Meanwhile the tide is carrying everything before it, and the confusion of the unready waxes grotesque. The foreign periodicals arrive monthly loaded with evolutionary discussions; and in the last "Contemporary Review" Calderwood, of Edinburgh, announces that even Hegelianism is but "dialectical evolution."

The "Observer" suggests that we make such a periodical "as the great body of intelligent people will admit with confidence to their homes." This sounds well, but what is it in a little plainer English? "Divest your 'Monthly' of every feature that can be objectionable to those who care a good deal more for theological than for scientific teachings, and who have a horror of all science as tending to infidelity." We should not be permitted to say a word of the progress of scientific thought, because hardly a step is taken anywhere that somebody with a dogma in that direction does not cry, "Halt, you destroyer of religion!" We indulge in no exaggeration. The "Observer" is authority here, and right above the article in which it recommends that the "Monthly" be kicked off the premises, we read, "SCIENCE FORGES WEAPONS CONSTANTLY TO DESTROY THE FAITH." What kind of a scientific magazine would that be which should be suited to the state of mind of the dismal creatures who take such a view of science as this? We should rather take the "Observer's" alternative, and be kicked into the street, than to edit such a periodical.

The "Observer" accuses science of "forging weapons to destroy the faith"; but need we remind it that science destroys nothing but ignorance and error? Only where faith is the enemy of truth can science be the enemy of faith. Science is the best friend of faith, for only when it has destroyed all it may, can faith have any "abiding foundation." We are afraid that, when the "Observer" invokes the publishers' boot as a censor of science, it betrays some want of confidence in its own foundation. What shall we say of the security of a religious edifice built upon the basis of literal Old Testament history? But in the very next column to the article we are noticing, it is laid down: "A DENIAL OF THE LITERAL VERITY OF THE OLD TESTAMENT HISTORY IS THE FIRST STEP IN MODERN INFIDELITY."

No more complete or more mischievous mistake can be committed than to impute to the scientists of this age any hostility to religion as the motive of their labors. That the course of inquiry often conflicts with cherished tenets is undoubtedly true, and it is a painful fact; but to charge scientific men with any intention of inflicting this pain, or to make them responsible for it, is wholly unjust. The world has never seen in all its history a class of men more noble in purpose, more fair-minded, more candid, tolerant, or considerate, than the class of men who, in all countries, though with a common spirit, have devoted themselves to the truth—as it is in science. They have done their work with a single-mindedness, a freedom from partisan and sectarian passion, and an openness and uprightness of purpose, that find no parallel in any other great group of men engaged in the advancement of a common interest. These men are entitled to stand first in the respect and confidence of the community; and to accuse them of being animated in their study of nature by a desire to destroy religion, or to wound the feelings of religious people, is thoroughly unjustifiable.

"The Popular Science Monthly" is a record of the scientific activity of the age for the last ten years, and it reflects the breadth, the independence, and the catholicity of thought that distinguish

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the scientific men of our time. There may have been many things said in it which people with a formulated faith find objectionable; but they are the results of honest and earnest thought, and the incidents of legitimate discussion, and must, therefore, be tolerated. Science can not work under the dictation of those interested to restrain it. Are men who make the supreme purpose of their lives the understanding of nature, to stop research into the laws of life, the genesis of species, the antiquity of man, the functions of the brain, the laws of social growth, or the natural history of superstitions, because there are many who, without ever studying these subjects, have views in relation to them which they do not wish disturbed? It is impossible. The great modern movement of the human mind which we call science is a part of evolving nature, and we have no liberty to do anything but represent it as faithfully as we are able.

ANNOUNCEMENT.

THE next volume of the "International Scientific Series," to be issued early in January, will be a work of such exceptional importance to various classes of thinkers, that we deem it proper to call especial attention to it in this place. It will be entitled "The Concepts and Theories of Modern Physics," and is written by Judge J. B. Stallo, of Cincinnati, author of a work, published many years ago, on "The Philosophy of Nature."

The book is a critical inquiry into the validity and sufficiency of what may be called our present scientific foundations. The author holds that the generally accepted hypothesis of the atomo-mechanical constitution of nature, and the various modern theories that grow out of it, are deeply tainted with metaphysical error; and his purpose has been to draw the line between legitimate science and illegitimate speculation. There is now no subject that more urgently needs to be cleared up than this.

The author says of his work: "Its tendency is throughout to eliminate from science its latent metaphysical elements, to foster and not to repress the spirit of experimental investigation, and to accredit instead of discrediting the great endeavor of scientific research to gain a sure foothold on solid empirical ground, where the real data of experience may be reduced without ontological prepossessions. An attentive perusal of these pages will make it clear, I think, that this endeavor is continually thwarted by the insidious intrusion into the meditations of the man of science of the old metaphysical spirit. This fact having been established, it was incumbent on me to ascertain, if possible, its causes and, within the narrow limits at my command, to develop its consequences. . . . What is here presented is not, of course, a new theory of the universe, or a novel system of philosophy. I have undertaken, not to solve all or any of the problems of cognition, but simply to show that some of them are in need of being stated anew so as to be rationalized, if not deepened."

Judge Stallo is a master of the field of modern physics, and the original views of his book are presented with great clearness and force. This volume will be one of the very ablest of the "International Scientific Series."

LITERARY NOTICES.

ARTIFICIAL ANÆSTHESIA AND ANÆSTHETICS. By HENRY M. LYMAN, A. M., M. D., Professor of Physiology and of Diseases of the Nervous System in Rush Medical College, Chicago, etc. New York: William Wood & Co. 1881. 8vo. Pp. vii–338.

"The most ancient record of the race," says Professor Lyman, "introduces the hero of the flood plunged in a deep and scandalous sleep, under the influence of wine which

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he had prepared." From the time of Noah to that of Long, Morton, Wells, and Warren, the history of anæsthesia is concisely summarized in the first chapter of the present work; a history terminating in the final success of the search, which man has been making from the remotest antiquity, for the means of arresting or annihilating physical pain. "The venerable Nestor came to the relief of the wounded Machaon with a medicated poultice composed of cheese, onions, and meal, mixed with the wine of Pramnos. . . . Some preparation of opium or of Indian-hemp it may have been with which, after the ten years' siege was ended, beautiful Helen drove away sad memories from the minds of her husband and his friends, making them drink of wine into which she cast a drug presented to her by the Egyptian princess Polydamna. Most potent this same nepenthe must have been, for we are told (Odyssey, iv, 220) that it delivered men from grief and wrath, and caused oblivion of every ill." Some of the ancient soporifics are well-known to us, as opium, Indian-hemp, mandragora; and probably they employed carbonic-acid gas also. Mandragora was the favorite among the Greeks; infused in wine, it was known as *morion*. "Apuleius states that half an ounce of this would render a person insensible even to the pain of an amputation. Dioscorides taught that the sleep thus produced might continue four hours or more; hence, no doubt, various legends which were by Shakespeare interwoven into the story of Juliet. The wine mingled with myrrh which was offered, according to the custom of the kind-hearted Jewish women of the day, to Jesus on the cross, was unquestionably this same mandragora-wine." During the time of Dante the following soporific, Hugo di Lucca's prescription, was used for patients about to undergo operations: they were caused "to breathe the vapors given off from a sponge moistened with warm water, after it had been thoroughly steeped in a decoction of opium, deadly nightshade, hyoscyamus, mandragora, hemlock, ivy, and lettuce. Sponges thus medicated were to be dried in the sunshine, and stored for use as occasion might require.

During the eighteenth century trials were made for anæsthetic purposes of hypnotism, freezing mixtures, intoxication, and pressure upon the trunks of the principal nerves. All these methods were, of course, unsatisfactory; chemical science, indeed, was not yet sufficiently advanced for the more recent discoveries. In 1799 Sir Humphry Davy discovered the intoxicating effects of nitrous oxide gas. Sulphuric ether was employed by Dr. Pearson, of Birmingham, in 1785, as a means of relief for spasmodic asthma; and in 1805 by Dr. Warren, of Boston, in the later stages of consumption. It was first used to produce insensibility to pain during a surgical operation by Dr. W. C. Long, of Jefferson, Georgia, in 1842. This great event, says Professor Lyman, "was thus simply recorded by Dr. Long in his ledger: 'James Venable, 1842. Ether and excising tumor, $2.00.' In the same year, William T. G. Morton employed sulphuric ether in tooth-pulling. Then came nitrous oxide or laughing-gas, used in tooth-pulling in 1844, by Horace Wells. In October, 1846, Morton made the surgical use of ether known to the world. "From that date the success of anæsthesia in surgery was placed beyond all doubt." In 1847 the eminent physiologist, Flourens, discovered the anæsthetic properties of chloroform, and it came rapidly into use. These are the facts over which the endless controversies of the rival claimants have been raised—controversies which this is not the place to follow.

From the history of anæsthesia Professor Lyman passes to its physiology and its phenomena; discussing the various procedures by which it is produced, whether generally or locally, the statistics and the treatment of the accidents resulting from it, the medico-legal relations of the subject, and the various classes of cases in which the anæsthetic substances may be employed. The larger part of his book is taken up by a detailed examination of the numerous substances classifiable under his title, no less than forty-seven being enumerated and described, besides which other methods than the posological, as anæsthesia by electricity, by rapid respiration, and by cold, are studied. A feature of the work is the citation of remarkable illustrative cases. The experience of Dr. J. Marion Sims (p. 58), in a case of apparent death from chloroform, is one of those dramatic recitals which give

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irresistible interest to a purely scientific discussion.

Professor Lyman has made an excellent compend of what is known upon the subject of anæsthetics and their use. The book covers the history, theory, and practice of the topics discussed; and not the least merit of the treatment is its attractive style. Dr. Lyman has not availed himself of the ancient prerogative of medical science, to be dull. The work of a learned physiologist and practitioner, it is properly classed by its publishers among their standard medical authors.

A REPORT ON THE TEACHING OF CHEMISTRY AND PHYSICS IN THE UNITED STATES. By FRANK WIGGLESWORTH CLARKE, S. B., Professor of Chemistry and Physics in the University of Cincinnati. Washington: Government Printing-Office. Pp. 219.

THIS is No. 6 of the "Circulars of Information" of the Bureau of Education for 1880. It embraces the substance of the replies to a schedule of questions which the Commissioner of Education sent out in 1878 to the schools of the country relative to the teaching of physics and chemistry, and covering the items of the courses of study, the text-books used, the value of apparatus, the library facilities and policy, the character of examinations, and the cultivation of original research. These replies were referred to Professor Clarke to digest and collate. His report, the purpose of which, in accordance with the design of the Commissioner of Education is, first, to state the facts, and second, to point out defects and remedies, includes a specific account of the instruction given in all those schools, public or private, of whatever grade, from which sufficient information to form the basis of such an account was received. In the prefatory parts of the descriptive chapters assigned to the several classes of schools, the author offers free general criticisms of the methods, and his own views of their defects, and the improvements of which they are susceptible, in observations which are of much value and interest. Passing the question of the desirability of teaching the sciences in primary and intermediate schools as an open one, the expediency of teaching chemistry and physics in secondary schools is regarded as generally admitted. Not less than half a year should be given to each, and "a year can usually be given without difficulty." Instruction should be general rather than special, and the text-book should be supplemented by the knowledge of the teacher, which ought to be enough "to render him in a measure independent of text-books." Normal schools by the theory of their existence ought to recognize the fact that their students may be called upon to teach chemistry and physics, and endeavor to train them intelligently in methods of instruction, and a few of them do so. As to the colleges, in most cases they teach chemistry and physics to the same extent as the preparatory schools, and in essentially the same way. "The conclusion is obvious that the colleges ought to do higher work. . . . The present repetition or duplication of studies is clearly wasteful, and ought to be abolished." With a few honorable exceptions, the colleges which are doing the best work in chemistry and physics are those which have adopted the elective system. The system of instruction in medical and related schools needs, as a rule, much improvement, but, "fortunately, a healthier state of affairs is rapidly developing." Insufficient attention to laboratory work or the neglect of it is a chief defect in a large proportion of the schools. Laboratory practice in physics is necessarily limited in preparatory schools, but a greater variety is attainable in chemistry, in numerous simple and ordinary experiments, which are cheap, and ought to be sought out and used. In the normal schools the future teacher may be taught the art of getting along with make-shifts, and to construct simple apparatus out of the commonest materials.

ILLUSTRATIONS OF THE EARTH'S SURFACE. GLACIERS. By NATHANIEL SOUTHGATE SHALER, Professor of Paleontology, and WILLIAM MORRIS DAVIS, Instructor in Geology, in Harvard University. Boston: James R. Osgood & Co. Pp. 196, with 25 Plates and Descriptive Texts. Price, $10.

THIS work is designed to be one of a series of volumes of "Illustrations of the Earth's Surface," to be entitled severally "Glaciers," "Mountains," "Volcanoes and

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Earthquakes," "Lakes and Plains," "Rivers and Valleys," "The Sea and its Shores," "Structure of Rocks," and the "Effects of Life." The purpose of the series is to remedy, as far as can practically be done by using the best attainable pictorial illustrations, the difficulties besetting the teaching of geology, which arise from the remoteness of the facts on which the teaching must rest, and the present impossibility of the pupil's going and observing them for himself. Hence, photographs are chosen, when they can be got, on a scale represented by a page as large as that of the current sixteen-page newspaper. The present work was originally designed merely to furnish a collection of photographs of glaciers, along with descriptions that might serve to call the attention of the student to the most noteworthy features in the objects represented. The photographs given are bright and spirited, far superior to anything found in books accessible to students, and the descriptions, lucid and satisfactory; but it was found by the projectors of the work that this would not be enough. The descriptions needed to be supplemented by a connected sketch of the more important part of the subject-matter. The author of the sketch, Professor Shaler, was compelled by the contract with the publishers to prepare it "with far greater haste than was proper in such a work," a fact which he and the publishers should not have tolerated, for the public have a right in such a work to the best preparation possible; but he has given a comprehensive and excellent review of the whole subject of glaciers and glacial action. The sketch embraces chapters on existing glaciers and their distribution, the distribution of ancient glaciers, "The Work of the Glacial Time," "The Origin and Nature of Glacial Periods," "Ancient Glacial Periods," "The Climatal Conditions of Glacial Periods," "The Effect of Glaciers on the Altitude of the Lands," "The Effect of Glaciation on the Life of the Earth," "Relation of Glaciation to the History of Man," "The Movement of Glaciers," "Certain Effects of Glaciers," a glossary, and a bibliography of the subject. The plates are mostly illustrative of Swiss glaciers, and are arranged so as to show—1. A general view of glacial form; 2. Details of structures from greater to less altitudes; and, 3. Effects of glacial action. A few are added from Norway, the Himalayas, and Colorado, with illustrations of glacial and weather-marks on rocks, and maps of the distribution of glaciers, ancient and modern.

ADAMS'S SYNCHRONOLOGICAL CHART OF UNIVERSAL HISTORY. Price, $15. New York: Colby & Co., No. 5 Union Square.

THE superiority of the eye as an inlet of knowledge, over all the other senses, is generally admitted, though it is not generally half appreciated. If people will examine the contents of their minds, they will find that far the greatest portion of them are visual acquisitions. It would be a very moderate estimate to say that nine tenths of our ideas are got through the help of the eye. Visual impressions are, besides, of a higher grade than those of the other senses. They are sharper, clearer, and all their relations are more definite. Then, again, they are more adherent than any other impressions—that is, they stick in the mind and are easiest remembered. Visual ideas are also the most perfect—that is, all the complexities and fine diversities of nature are reproduced in thought through the eye. At a glance a whole landscape becomes the property of the mind. We think in pictures; and the highest faculty of the intellect is that which pieces together old pictures and creates new ones. The eye is the only sense that gives us images; and how far imagining goes in mental processes is shown by the exalted office of the *imagination*—the image-working faculty of the mind.

From these facts we are led to perceive the transcendent importance of the eye in education. Acquisitions made by light are of course the most lucid. They are not only the most vivid, but the easiest understood and the longest retained. Hence, wherever a subject can be illustrated by maps, charts, and pictorial diagrams, there is an enormous gain in the mental economics of learning.

History is a subject which in its leading facts is capable of treatment by the visual method, as Adams's chart strikingly illustrates. The events of the world have all occurred in a double relation of coexistence and of sequence. Many trains of occur-

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rences go on together or synchronously; and in each line there is a chain of succession in the parts, which proceed in the order of cause and effect. Nations and empires run their careers as it were side by side, rising, flourishing, decaying, and giving place to others; while each nation has its epochal changes of dynasty, revolution, or conquest. These relations of events are capable of being mapped, and they are so skillfully represented in Adams's chart that we get, as it were, a bird's-eye view of the procession of great terrestrial affairs. The chart is twenty-five feet long by three deep, and mounted on rollers, so that, if there is not room to fully display it, its parts may be brought successively into view. Vertical lines show contemporaneous events, and horizontal bars of color represent succession, the stream of time, and the progress of civilization. The march of fifty-nine centuries is delineated, and the great transactions of the world—national, civil, military, religious, maritime, architectural, inventive, and literary—with the advent of great men, are all pictorially represented in their time-relations, so that an accurate outline of history may be rapidly and easily acquired.

It would take a book to describe the chart, and so we shall not attempt it, but will only say that for introducing the young to the study of history, and for common reference in reading general history, it will have great usefulness. Much pains has been bestowed upon its preparation, and a good deal of information crowded into limited space. The Hebrew cosmology and Usher's chronology are adopted, and more supernatural events are located than science might perhaps approve; but this does not impair the general utility of the work, which is conformed, if not to the latest, at any rate to the prevailing, state of knowledge.

MEXICAN PAPER: AN ARTICLE OF TRIBUTE. Its Manufacture, Varieties, Employment, and Uses, compiled from Pictorial and Written Records. By PHILIPP J. VALENTINI, Ph. D. Worcester, Massachusetts: Charles Hamilton. Pp. 26.

AN interesting study of a single feature of ancient Mexican civilization. The painted records of the "Codex Mendoza" show that certain towns had to furnish enormous quantities of paper to the city of Mexico. The fact suggests an examination into the Nahuatl name for paper, and its occurrence in combination in the names of some towns, the symbols by which it is represented in the pictographs, the method of manufacturing it, and the uses that were made of it, which were very diversified. Especially were large quantities of paper employed on occasions of ceremonial and dress.

TENTH REPORT OF THE STATE ENTOMOLOGIST ON THE NOXIOUS AND BENEFICIAL INSECTS OF THE STATE OF ILLINOIS. Fifth Annual Report, by CYRUS THOMAS, Ph. D., State Entomologist. Springfield, Illinois: State Board of Agriculture. Pp. 244.

THE demand for the entomological reports is steadily increasing within and without the State, and even in Europe. In order to make the work as useful as possible to farmers, who most frequently meet the insects and can most readily recognize them as larvæ, predominance is given to descriptions of the larval state. The plan has been adopted of making a specialty each year of some particular class of insects. Thus Dr. Thomas's second report gave considerable space to the chinch-bug; his third report was devoted to plant-lice; the fourth report largely to the European cabbage-worm; and the present volume considers at some length the history and habits of the army-worm, with a view of arriving at the best practical remedy. It also gives a paper, by Dr. A. S. Packard, on the Hessian fly, and accounts of many other insects.

THE LANDA ALPHABET A SPANISH FABRICATION. By PHILIPP J. VALENTINI, Ph. D. Worcester, Massachusetts: Charles Hamilton. Pp. 35.

GENERALLY, the ancient Mexicans were supposed to have no alphabet, and their writing to be pictorial, but an alphabet ascribed by Bishop Diego Landa, of Yucatan, to the Maya people was regarded as an exception. The author advances the opinion that this was not a genuine alphabet, but was compiled by the bishop from selections of ideographs whose sounds most nearly approached the sounds of the letters, for the purpose of assisting the Yucatecans in learning their *pater nosters*. In support of this position, an analysis of each character is presented.

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BOTANY. Outlines of Morphology, Physiology, and Classification of Plants. By WILLIAM RAMSEY MCNAB, M. D., F. L. S., Professor of Botany, Royal College of Science for Ireland, Dublin. Specially revised for American Students, by CHARLES E. BESSEY, M. Sc., Ph. D., Professor of Botany in Iowa Agricultural College. New York: Henry Holt & Co. 1881. Pp. 400. Price, $1.10.

IT is claimed for the American revision of McNab's work that it is less technical than the foreign book, and has been completely adapted to American use by changes in the classification, and by the introduction of American examples. There has also been a considerable simplification of the text, an omission of some paragraphs and a use of smaller type in others, so as to bring the work into the compass of one volume. Besides, the book has been divided into chapters, sections, and numbered paragraphs. It is designed for "second or middle class schools," and aims to present the "study of plants as living things, rather than their bare analysis and classification."

In clearness, conciseness, and perfect adequacy of statement, the text of this school-book leaves nothing to be desired. It is well illustrated, and may be recommended as a valuable book for general readers. But we are a little puzzled about its place as a school-book. We do not understand what the editor means by "second or middle class schools." Is it the next grade above our primary schools? Is it meant as a first book to introduce children of say a dozen years to the study of plants. If it is designed for beginners in botany, we do not hesitate to pronounce the work a mistake. To begin this study with the minute structural elements of plants which are only discernible through the microscope, and with the lower microscopical forms of vegetation, is to put the difficult and complex before the plain and apparent. It can not be claimed that vegetable anatomy is a more important division of the science than organography; but it is certainly more requisite to the comprehension of vegetable physiology, or the plant considered as a "living being." It would seem that there existed in the mind of the American editor a kind of partisan feeling as regards the various departments of this science. He prefers the "study of plants as living beings," to what he terms their "bare analysis and classification," and so he offers us a school-book which is neither in accord with the true order of the science of botany nor with the unfolding faculties of the pupil.

Botany has to deal with plants in respect to their kinds as well as their functions. Professor Gray, who has had some experience of the contrary method, says that the study of botany naturally begins with the structural botany of flowering plants. In his recently published "Structural Botany" he omits, as far as possible, all reference to intimate structure, development, and function, leaving these subjects to be treated in the second part of his work, which has not yet appeared, and which is devoted to physiology.

That children should begin the study of botany with organography follows, not only from a consideration of the science as a whole, but is still more obvious when we regard the particular subjects dealt with in its various divisions. In organography, distinctive names are applied to the different organs of plants and their endless variations of form. A knowledge of these terms is indispensable to the botanist, and in childhood it is acquired with ease and pleasure. This botanical vocabulary enables the student to describe the objects of his study with precision and brevity, and in its acquisition and use he is forming the all-important habit of careful observation, and is getting knowledge at first-hand or by self-teaching. In fact there is not another subject in the whole range of the sciences so well suited to the training of the dominant faculties of children in the earlier grades of our public schools as is this department of botany, which is declared on high authority to be the natural beginning of the study.

SEEDLESS FRUITS. By E. LEWIS STURTEVANT, M. D., South Framingham, Massachusetts. Pp. 29.

NUMEROUS instances of plants in which such combinations occur are cited in support of the view that the abnormal development or richness of any part of a plant, as the pulp of a fine fruit, the root, or the tuber in case of the potato, is apt to be attended with deficiency, defectiveness, or entire absence of seeds.

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A MEMOIR ON LOXOLOPHODON AND UINTATHERIUM, by HENRY F. OSBORN, Sc. D.; accompanied by a STRATIGRAPHICAL REPORT OF THE BRIDGER BEDS IN THE WASHAKIE BASIN, by JOHN BACH MCMASTER, C. E., Princeton, New Jersey. Pp. 54, with Four Plates, a Map, and a Profile.

BESIDES its ample collection of specimens for college instruction, the E. M. Museum of Geology and Archæology of Princeton College contains a large amount of material for more advanced study in the shape of fossils new to science, mainly collected by the college scientific expeditions of 1877 and 1878. The paleontologists and biologists connected with the museum have decided to place the results of their studies in a permanent and suitable form before the scientific public; and, in pursuance of this resolve, begin, with this pair of monographs, a series of memoirs, in quarto, of more mature researches, in addition to the bulletins of their current work which they have published since 1878. There are many persons not acquainted with the early history of the institution who might be glad to know the meaning of the initials E. M., in the name of the museum.

A SKETCH OF ANCIENT PHILOSOPHY, FROM THALES TO CICERO. By JOSEPH B. MAYOR, M. A., Professor of Moral Philosophy at King's College. New York: Macmillan & Co. Pp. 254. Price, 75 cents.

THE large divisions of this work are three, as follows: (A.) The Socratic Philosophy of Nature. (B.) Socrates to Aristotle —Philosophy of Nature and Man. (C.) Post-Aristotelian Philosophy of Man.

Under these divisions there is given an account of—1. The Ionic School; 2. The Italic School; 3. The Ionico-Italic School; 4. The Sophists; 5. Socrates; 6. The Cynics; 7. The Cyrenaics; 8. Plato; 9. Aristotle; 10. The Peripatetics; 11. The Skeptics; 12. The Old Academy; 13. The Skeptical Academy; 14. Stoicism; 15. Epicureanism; 16. Eclecticism; 17. Cicero.

As to the treatment, it is brief; but quite sufficient and most scholarly—so much so, indeed, as quite to unfit the book for general use. It abounds with Latin and Greek quotations that are not translated, and this was in accordance with the author's plan, which was to prepare a book expressly for students acquiring these languages. It is, therefore, properly "A Classical Student's Ancient Philosophy," and the author intends it for "undergraduates at the university," or others who are commencing the study of the philosophical works of Cicero, Plato, or Aristotle, in the original language." Nothing could certainly be more sensible than to furnish them at the outset in English what they propose to get in the original, but by all experience very rarely do get. The author complains of his own bewilderment in early student days when he was put upon the works of the classical masters, and proposes to help those similarly situated. But the question remains, Is it worth while, after all, to go beyond what is communicable in English?

Professor Mayor, of course, thinks it is, as he is an inveterate classicist; but he furnishes a fine example of the blinding and distorting bias of classical studies. Having given his life to the study of the ancients, all his feelings go in the direction of his work, so that he has become a devout worshiper of the ancients. We will not say that Professor Mayor is *ignorant* of modern science, but it is obvious that from his classical prejudices he has but little interest in it, but little sympathy with it, and therefore no just appreciation of its proper influence or true value. The author is a Professor of Moral Philosophy in King's College, and ought, therefore, to be intelligent on this subject, yet he says: "Is there any modern work of systematic morality which could be compared with Aristotle's 'Ethics,' for its power of stimulating moral thought? Most moderns appear to write under the consciousness that they are uttering truisms; or, if they escape from this, it is by running off from the main highway of morality into by-paths of psychology, or physiology, or sociology." Does he think, then, that the laws of mind, the laws of life, and the laws of social relations, as determined by modern science, have no bearing upon the laws of human action and conduct? Have the nature, constitution, and conditions of man nothing to do with his obligations?

The author agrees with Clement of Alexandria that "philosophy was to the Greek what the law was to the Jew, the schoolmaster to bring him to Christ"; but to what

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moral end bring anybody to Christ, if, as he elsewhere says, "there is a freshness and a completeness about the ethics of the ancients which we seek in vain in the moderns"? Again, he remarks, "We might be spared much of crudeness and violence and one-sidedness, if people were aware that what they hold to be the last result of modern enlightenment was, perhaps, the commonplace of two thousand years ago." But would it not be better if we could be spared something more of that crude, one-sided education which disqualifies its victims from understanding what are "the last results of modern enlightenment"?

ANNUAL REPORT OF THE CHIEF SIGNAL-OFFICER TO THE SECRETARY OF WAR, FOR THE YEAR 1879. Washington: Government Printing-Office. Pp. 782, with Seventy-four Charts.

THE report claims that the duties of corps analogous in their service to the Signal Corps become more prominent with each ensuing year, and hardly a month passes without some improvement in apparatus deserving the attention of the office being suggested. Instruction on the subjects bearing on the duties of the service is given regularly at Fort Whipple, Virginia, whence it is intended a supply of well-drilled men shall be kept to draw from for the needs of the work. The men of the Signal Corps being engaged on duty as constant in time of peace as in the presence of actual war, return, it is admitted, more than the cost of the service, and are at the same time kept in readiness for any emergency of armed duty by regular drills. The value of the advantages gained by the existence of a corps so trained and having its experts distributed as they are over the country, can hardly be estimated; and the adoption of the exercises and practice of the corps is recommended to the militia of the several States. The office is in communication with numerous foreign correspondents, has official relations with the scientific men and chiefs of meteorological services of nearly every prominent power in the northern hemisphere, has become the acknowledged center of meteorological information on the continent, and has connected itself with the meteorological work of the world. It had, at the date of the report, two hundred and twenty-nine stations in the United States, and also received reports from twenty stations in Canada and British America. The summaries of the reports from these stations, which are published in the volume, illustrate the variety of ways in which the stations have made themselves useful and beneficial to the people and interests of the localities in which they are situated.

FIRST ANNUAL REPORT OF THE ASTRONOMER IN CHARGE OF THE HOROLOGICAL AND THERMOMETRIC BUREAUS OF THE WINCHESTER OBSERVATORY OF YALE COLLEGE, 1880–'81. By LEONARD WALDO. New Haven: Tuttle, Morehouse & Taylor. Pp. 32.

THE tests for watches are more stringent in some points than those made at Neufchâtel and Geneva, but a uniform standard is declared desirable. The time, as determined at the observatory, has been made by law the standard for the State of Connecticut, the first instance in the United States in which a State standard of time has been officially adopted. The testing of thermometers has been so satisfactorily done that the makers, particularly the makers of physicians' thermometers, have accepted the authority of the observatory as final, and have greatly improved under its encouragement. Thus, while in June, 1880, all the thermometers received were in error over one third of a degree, and two per cent. of them had errors exceeding a whole degree, in April and May, 1881, four fifths of all sent had errors of less than three tenths of a degree. The experiments indicate that the majority of physicians' thermometers in use are from one half a degree to two degrees too high.

REPORT OF FIELD EXPERIMENTS WITH FERTILIZERS. By Professor W. O. ATWATER, Wesleyan University, Middletown, Connecticut. 1881. Pp. 56, including five tables.

THE investigations have now been conducted for four years, both in the form of general experiments involving the use of seven or eight or more different kinds and mixtures of fertilizing materials, containing nitrogen, phosphoric acid, and potash, for the purpose of ascertaining what fertilizing

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ingredients would most benefit the several soils and crops; and in the form of special experiments of a more complicated character, for the study of the feeding capacities of some of the more common plants, with special reference to the nitrogen supply. The present report gives the results for 1880.

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REPORT OF PROFESSOR SPENCER F. BAIRD, SECRETARY OF THE SMITHSONIAN INSTITUTION, FOR THE YEAR 1880. Washington: Government Printing-Office. Pp. 83.

WITHIN the few pages of this publication are reviewed very briefly the transactions of the Institution in connection with numerous enterprises and interests bearing upon the advancement of science. Among them are the announcement of astronomical discoveries by telegraph; the exchange and distribution of publications and specimens; explorations in New Mexico, the West Indies, Arizona, Oregon, the Pacific coast, and Alaska; the Howgate Arctic Expedition; the publication of the twenty-second and the near readiness of the twenty-third volumes of "Contributions"; the publication of the sixteenth, seventeenth, eighteenth, and nineteenth volumes of "Miscellaneous Collections"; the transactions of the National Museum and the growth of its collections; and the work of the United States Fish Commission.

A SHORT HISTORY OF THE BIBLE. Being a Popular Account of the Formation and Development of the Canon. By BRONSON C. KEELER. Chicago: The Century Publishing Company. Pp. 126.

THIS is an inquiry into the origin and development of the doctrine of divine revelation, "beginning with a time when the books composing the Bible were not considered inspired, and following the belief, in the light of history and approved scholarship, from its inception to the present day." It aims to show who first affirmed the books to be inspired, who compiled them into the accepted volume, what changes have taken place in the canon, and "who first affirmed that we must believe the Bible or be damned." The author says that he has no theory to advocate, but he is evidently opposed to the doctrine of inspiration.

THE SPELLING REFORM. Circulars of Information of the Bureau of Education, No. 7, 1880. Washington: Government Printing-Office. Pp. 36.

THE statement embraced in this publication was prepared at the request of the United States Commissioner of Education by Professor F. A. March, of Lafayette College, President of the American Spelling Reform Association. It reviews the reasons for the spelling-reform movement and its history; explains the plan proposed by the American Philological Association, in accordance with which a large part of the essay is printed; gives a list of special words for which the Philological Society of England has proposed a reformed spelling, and catalogues the literature of the subject.

ENGLISH HISTORY FOR YOUNG FOLKS, B. C. 55 TO A. D. 1880. By S. C. GARDINER, Honorary Student of Christ Church, and Professor of Modern History at King's College, London. Edition revised for American Students. New York: Henry Holt & Co. Pp. 457.

THE subject is presented in an easy, flowing style, designed to engage the attention and hold the interest of young readers. With this purpose, important events have been given in fuller detail than usual, though no story has been told simply because it is interesting, and much has been omitted that would be merely burdensome to the memory. The character of the revision that has been made for American readers is not defined, nor is the necessity for it explained.

ON MAXIMUM SYNCHRONOUS GLACIATION. By W. J. MCGEE, of Farley, Iowa. Pp. 65.

THIS is the substance of a paper which was read by the author at the Boston meeting of the American Association reviewing what is known as the "ice-cap theory." It endeavors to show, from the mode of operation of the agencies which effect glaciation, that precipitation over the central parts of any extensive ice-field must be very slight or even *nil*, and that there is no sufficient reason for believing that the polar regions were ever much more extensively glaciated than at present; and that the assumption

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of a vast polar ice-cap to force outward the peripheral portion of the ice that may have accumulated in any latitude is unnecessary and incompetent. The viscous theory of ice-motion is adopted, with some modifications, and some of the most serious objections to it are considered.

CIRCULARS OF INFORMATION OF THE BUREAU OF EDUCATION. 1881. No. 1. THE CONSTRUCTION OF LIBRARY-BUILDINGS. Pp. 26. No. 2. THE RELATION OF EDUCATION TO INDUSTRY AND TECHNICAL TRAINING IN AMERICAN SCHOOLS. Pp. 22. Washington: Government Printing-Office.

THE first of these circulars is the paper on the construction of library-buildings, which was read by Mr. William F. Poole, of Chicago, at the last meeting of librarians in Washington. Its object is not to formulate rules that must be rigidly followed, but to set forth the conditions for library-buildings which experience has shown to be indispensable.

The second circular embraces papers which have been prepared by President White, of Purdue University, Lafayette, Indiana, on the two subjects of "Technical Training in American Schools" and "The Relation of Education to Industry."

THE DISPOSAL OF THE DEAD: A PLEA FOR CREMATION. By EDWARD J. BERMINGHAM, M. D. New York: Bermingham & Co. Pp. 89. Price, $2.

THE purpose of this volume is to give an exposition of the present state of the subject of cremation in public discussions, to point out the supposed evils of inhumation, to assist in removing the prejudice against cremation, and secure new friends for it. After considering the different methods of disposing of the dead, and the inconveniences of burial, it reviews the history of cremation among ancient nations and in modern times; considers it from a sentimental point of view, showing its consistency with the best and holiest feelings with reference to the dead; furnishes descriptions of the process and of the different apparatus in use; shows how economical and salutary it would be to cremate dead animals and garbage; and closes with a summary of the arguments on both sides of the question.

PLIOCENE MAN IN AMERICA. By JAMES C. SOUTHALL, A. M., LL. D., of Richmond, Virginia. Being a Paper read before the Victoria Institute, or Philosophical Society of Great Britain. With Remarks by the Duke of Argyll, Professor W. Boyd Dawkins, Principal Dawson, Professor T. McKenny Hughes, and others. New York: A. D. F. Randolph & Co. Pp. 80.

THE author takes up the cases of human relics that have been found in California in such situations and under such circumstances as to cause a pre-glacial antiquity to be assigned them, and argues to show that that conclusion is not necessary, and that there is nothing in either the situation or condition of the relics to make a post-glacial origin impossible or even improbable.

REPORT ON THE COTTON PRODUCTION OF THE STATE OF LOUISIANA, WITH A DISCUSSION OF THE GENERAL AGRICULTURAL FEATURES OF THE STATE. By EUGENE W. HILGARD, Professor of Agriculture at the University of California (extra "Census Bulletin"). Washington: Government Printing-Office. Pp. 99.

THIS report is intended to form a part of the complete report on the cotton-culture of the United States shortly to be issued. It is designed for the information of the general public, as well as of the statistician and student, and is therefore thrown into a popular form. The author is surprised that so few State surveys have popular use of the results of their systematic investigations in view, but has always in his own work considered this the most important object to be compassed. Were it always sought, State surveys, he believes, would be more popular, better sustained, and therefore more complete.

THE YOUNG FOLKS' ASTRONOMY. By JOHN D. CHAMPLIN, Jr. New York: Henry Holt & Co. 1881. Pp. 236. Price, 60 cents.

THE author of this book says, "There can be little question of the propriety of early grounding a child in an elementary knowledge of the astronomical features of the earth on which he lives and of the universe of which it forms a part." He adds also that the "primers" hitherto made for the purpose are failures. In this he is right, and his own book will have to take its place

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among them, for the reason that he is wholly wrong in what he says of the propriety of grounding children in a knowledge of the astronomical relations of the earth to the universe. The reason of this is that the immature mind can not grasp that order of ideas, and ideas that can not be clearly seized are not suitable for educational purposes. A child sees the sun, moon, and stars, and may be curious to ask questions about them, but that is no evidence that it can *comprehend* those truths about them that it took thousands of years to discover, and which it still tasks the adult mind to understand. A child sees also that fire converts water into steam, but it is not, therefore, competent to take in, even in its rudiments, the science of thermo-dynamics. The child can learn words, and astronomical words just as well as any, because the power of verbal acquisition is quite independent of any meaning that may be attached to words. This learning of mere words and the passing off verbal statements for knowledge is the bane of education; and nowhere will this mischievous result be more certain than in the attempt to teach children astronomy. Nevertheless, parents will be flattered to see their wonderful little prodigies at the same time in breeches and astronomy, and so Mr. Champlin's neat little book will no doubt be a "success."

THE TOTAL SOLAR ECLIPSE OF JULY 29, 1878. Observations at Pike's Peak, Colorado. Report of Professor S. P. LANGLEY. Pp. 15, with Plate.

THE most interesting features of Professor Langley's observations were the narrow, structureless ring of vivid light around the sun, which faded suddenly into a nebulous luminosity, extending for two and a half solar diameters all around; and a stream of light with parallel borders extending to three and a half diameters on one side and six diameters on the opposite side, in a direction nearly corresponding with that of the ecliptic, which were seen with the naked eye; and a coarse, sharply defined filamentary structure in the corona seen through the telescope. Some of Professor Langley's assistants observed very peculiar and striking color-phenomena in the clouds during the moment of the coming on of totality.

PAPERS OF THE ARCHÆOLOGICAL INSTITUTE OF AMERICA. AMERICAN SERIES, I. 1. HISTORICAL INTRODUCTION TO STUDIES AMONG THE SEDENTARY INDIANS OF MEXICO. 2. REPORT ON THE RUINS OF THE PUEBLO OF PECOS. By A. F. BANDELIER. Boston: A. Williams & Co. Pp. 135, with Plates.

THIS handsomely printed and finished volume gives a favorable introduction to the society under whose auspices it is put forth and of which it is the first publication. The first part gives the history of the Pueblos from the time they are first mentioned by the Spaniards, and the theories that have been urged and inquiries made respecting them. The second part gives the results of the author's examinations, surveys, and measurements of the ruins of the Pueblo in the valley of the Rio Pecos, with views, plans, sections, and estimates, and observations such as the information at hand makes appropriate concerning the character, customs, and arts of the Indians who constructed the buildings.

MATERIALISM ANCIENT AND MODERN. By a late Fellow of Trinity College, Cambridge. New York: Macmillan & Co.

THIS essay of forty-three pages, in large type, is a very commonplace argument intended to be opposed to materialism, and its quality is as slight as its form. It can help nobody.

SEA-MOSSES: A COLLECTOR'S GUIDE AND AN INTRODUCTION TO THE STUDY OF MARINE ALGÆ. By A. B. HERVEY, A. M. Boston: S. E. Cassino. 1881. Pp. 281. Price, $2.

THOSE who live by the sea, and those who frequent the seaside for recreation and health during summer vacations, if they have any desire to improve their opportunities for improving their minds, are placed under obligations to Mr. Hervey for the preparation of this volume. The author thus indicates his object: "I have attempted to make a book which should be a real and helpful guide to those who, though not expert botanists, and not having or using any aids to a good pair of eyes other than a simple pocket magnifier, desire to begin the collection and study of marine plants." The author has been freely assisted by many

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adepts in this fascinating study, and he has evidently spared no pains in preparing his manual, as his publisher has certainly spared no expense in illustrating it.

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PUBLICATIONS RECEIVED.

Education in Charleston, South Carolina. The Disabilities of the Unaided South in Public School Facilities. Published by the City Council. 1881. Pp. 32.

The Gesture Speech of Man. Address of Colonel Garrick Mallery, U. S. Army, before the American Association for the Advancement of Science. Salem, Massachusetts. 1881. Pp. 33.

The Duties of Women. By Frances Power Cobbe. Boston: George H. Ellis. 1881. Pp. 198. 35 cents.

Annual Report of the Surgeon-General of the U. S. Army. Washington. 1881. Pp. 23.

Reform in Medical Education. Annual Address before the American Academy of Medicine at New York. By Edward T. Caswell, M. D., President. Philadelphia. 1881. Pp. 16.

Circulars of Information from the Bureau of Education, No. 3. 1881. Washington: Government Printing-Office. Pp. 79.

Study of the Sphecidæ; List of the North American Larradæ; Notes on the Philanthinæ. By W. H. Patton. Pp. 28.

Education and Crime, pp. 10; The Discipline of the School, pp. 15. Bureau of Education. Washington: Government Printing-Office. 1881.

On the Filling of Amygdaloidal Cavities and Veins in the Keweenaw District of Lake Superior. By M. E. Wadsworth, Ph. D. Pp. 12.

The Areas of the United States: The Several States and Territories and their Counties. By Henry Gannett, E. M. Washington: Government Printing-Office. 1881. Pp. 20. With Map.

The Kinematics of Machinery. By Professor Alexander B. W. Kennedy, C. E. With an Introduction by Professor R. H. Thurston, C. E. New York: D. Van Nostrand. 1881. Pp. 88. 50 cents.

Malaria: What it Means and how Avoided. By Joseph F. Edwards, M. D. Philadelphia: Presley Blakiston. 1881. Pp. 81.

The Nature and Function of Art, more especially of Architecture. By Leopold Eidlitz. New York: A. C. Armstrong & Son. 1881. Pp. 493. $4.

The New Infidelity. By Augustus R. Grote. New York: G. P. Putnam's Sons. 1881. Pp. 101. $1.25.

Dangers to Health: A Pictorial Guide to Domestic Sanitary Defects. By T. Pridgin Teale, M. A. Third edition. Philadelphia: Presley Blakiston. Pp. 170. $3.50.

The Honey Ants of the Garden of the Gods, and the Occident Ants of the American Plains. By Henry C. McCook, D. D. Illustrated. With Thirteen Plates. Philadelphia: J. B. Lippincott & Co. 1882. Pp. 198. $2.50.

Elements of Quaternions. By A. S. Hardy, Ph. D. Boston: Ginn & Heath. 1881. Pp. 230.

A Study of the Pentateuch for Popular Reading. By Rufus P. Stebbins, D. D. Boston: George H. Ellis. 1881. Pp. 233. $1.25.

Ecce Spiritus. A Statement of the Spiritual Principle of Jesus as the Law of Life. Boston: George H. Ellis. 1881. Pp. 238. $1.25.

Sparks from a Geologist's Hammer. By Alexander Winchell, LL. D. Chicago: S. C. Griggs & Co. 1881. Pp. 400. $2.

The League of the Iroquois and other Legends from the Indian Muse. By Benjamin Hathaway. Chicago: S. C. Griggs & Co. 1881. Pp. 319. $1.50.

Higher than the Church. An Art Legend of Ancient Times. By Wilhelmine von Hillern. From the German by Mary J. Safford. New York: William S. Gottsberger. 1881. Pp. 74.

Mechanics' Liens. How Acquired and Enforced. With an Appendix of Forms. By James T. Hoyt, of the New York Bar. New York: P. F. McBreen, printer. 1881. Pp. 310.

Zoölogical Atlas, including Comparative Anatomy, with Practical Directions and Explanatory Text. By D. M'Alpine, F. C. S. With 231 Colored Figures and Diagrams. Vertebrata. Edinburgh and London: W. & A. K. Johnston. 1881.

Report upon United States Geographical Surveys west of the One Hundredth Meridian. Vol. VII, Archæology. By Frederick W. Putnam. Washington: Government Printing-Office. 1879. Pp. 497. Illustrated.

POPULAR MISCELLANY.

Finding the Center of Population.—The computation of the center of population of a country, as explained by Mr. F. D. Y. Carpenter, who has performed the work for the United States, for the census of 1880, is not a simple or an easy process. As defined in the "Statistical Atlas" of 1874, this center is the point at which equilibrium would be reached were the country taken as a plane surface, itself without weight, but capable of sustaining weight, and loaded with its inhabitants, each individual being assumed to be of the same gravity as every other, and consequently to exert pressure on the pivotal point directly proportioned to his distance therefrom. In other words, it is the center of gravity of the population of the country. It may be illustrated otherwise, by saying that it is the point at which, if all the population should assemble, the aggregate distance traveled by all those coming from any two opposite points of the compass would be respectively equal. It is found approximately by assuming a point as nearly as possible to the true position of the center, and then finding its north, south, east, and west moments of population; that is, the four aggregate products formed by multiplying the local populations by the distances of their centers north and south of the assumed parallel, and east and west of the assumed meridian. The sums of the north and south moments, and those of the east and west moments should be severally equal to each other. The differences which will appear between the several sums in the

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trial-work, divided by the total population of the country, will give the measures of correction to be applied to the assumed point, in order to deduce the true center from it. In the case of a population so extensively and diversely scattered as that of the United States, there is room for any amount of refinement in the details of the calculation. The larger cities are treated as special centers. Leaving them out, the population of the country is grouped by square degrees—that is, by the spaces included between two consecutive degrees of latitude and of longitude, the centers of which, except where there are reasons for exception, are taken as the local centers of population. By this process, the center of population of the United States for 1880 is placed in latitude 39° 4′ 8″ and longitude 84° 39′ 40″, or at a point in Kenton County, Kentucky, one mile south of the Ohio River, and eight miles west by south from the heart of the city of Cincinnati. This location is, after all, only approximate, and extreme accuracy is hardly attainable under ordinary modes of calculation. In fixing it, the surface of the country has been assumed to be plane, whereas it is spherical or spheroidal, and a parallel of latitude has been made one of the axes, whereas the arc of a great circle should have been taken. Then there are differences in the kind of map-makers' projections that are used, all distorting the spheroidal surface in attempting to represent it as a plane, but some giving worse distortions than others. Mr. Carpenter believes that if it were practicable to make an absolutely correct calculation, the actual center would be found about thirty miles to the north and a trifle to the east of the present estimated location, or in Butler County, Ohio. The center is thrown so near the northern boundary, by the fact that our country in general shape is the segment of a zone; and the case is supposable, if the segment were extended far enough in longitude, in which the center of population would be situated entirely outside of the country.

Movements of Plants. — Mr. Thomas Meehan, of Philadelphia, has recently noticed some apparent irregularities in the motility of various plants which have not been adequately accounted for. The expansion and closing of the petals of *Draba verna*, which take place in connection with the diurnal erection and drooping of the pedicle, appear to require a clear light; yet while at one time the expansion seemed to be prevented by a cloudiness that hardly dimmed the sun's rays, it was at another time not at all interfered with during a densely cloudy, warm, and moist day that followed a thunder-shower. The earliest flowers of *Lamium amplexicaule* are the largest ones in the Isle of Wight; here the case is reversed: the flowers never expand; and plants alongside of each other under the same conditions and external influences vary a week in the time of their flowering. The drooping branches of the Kilmarnock willow have grown from the upward branching *Salix caprea* without any known external influence to determine a different direction of growth, and they bear erect catkins, while erect branches bear pendulous ones. Such facts should teach us that external causes have but little influence with motility, and that in many cases a combination of circumstances controls the influences attributed to one. The facts will vary with various observations—those of one observer seeming rather to conflict with than to confirm another—and it is too soon to form any conclusion as to the motive cause.

Inscriptions of the Mound-Builders.—Major William S. Beebe, of Brooklyn, gave an interesting account, at the recent meeting of the American Association, of his efforts to decipher the inscriptions that have been found in the mounds at Davenport, Iowa, and Piqua, Ohio. Two pieces of slate were found in a mound at Davenport, one of which was inscribed on one side, the other on both. The stone inscribed on but one side bore on its surface a series of concentric circles, between the outer two of which were twelve equidistant signs, presumably the zodiacal signs. About two years after these slates were found, two terra-cotta tablets were dug up at Piqua, Ohio, bearing series similar to each other of characters, "evidently letters," ranged in horizontal lines, on four of which the letters were in each case six in number. In the fifth and remaining instance there were five lines,

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but this arrangement was at some distance in the longitudinal direction of the tablet from the groups first mentioned, which were in both cases written in couples. Major Beebe claimed that these groups of six letters each, when separated into alternate threes and read right and left respectively, are the names of eight of the zodiacal signs on the Davenport slate—the other four signs, Capricorn, Aries, Cancer, and Libra, being represented by four initial letters on the back of one of the Piqua tablets. These letters represent the North, South, East, and West, respectively, and correspond to the "world-holders," as they were called, to which a particular importance was attached. The most significant detail of this identification is that the forms of the letters are almost precisely those that occur about the Mediterranean, whose phonetic values have been determined by Alois Hess in his work on the classification of old Spanish coins. Should this identification be correct, the point arises whether this alphabet originated in this country or in the old. Major Beebe claims to have traced each form of letter to aboriginal American picture-symbols, in which the same significance obtains in both European and American forms. Having fixed the significance of the letters, he has, he says, deciphered the inscription on the stone from Grave Creek, West Virginia, and that on the axe found at Pemberton, New Jersey.

Cremation in Italy.—As an evidence of the progress which cremation is making in Italy, the Journal of the Italian Hygienic Society states that one hundred and thirty-nine cremations have taken place in the crematories at Milan and Lodi, and that the number increases every month. Nine societies and nine committees for cremation exist in the kingdom, and new crematories are to be built at Rome, Varese, Leghorn, Pavia, Cremona, and Udine. Signor Loria, of Milan, has recently offered the municipality of the city twenty thousand francs for the establishment and maintenance of a laboratory for making autopsies of bodies destined to be incinerated when that is deemed expedient, or may be called for by the circumstances of the case. The French Government apparently does not favor the movement much. To a petition from the municipality of Paris, asking permission to incinerate bodies in certain cases, the Minister of the Interior replied that the law of the year XII, prescribing burial, would have first to be repealed, and the Government did not consider that the question had yet been enough studied by science or advanced in public opinion to justify the assumption of the responsibility of presenting it to the legislative bodies.

Sanitation of Cemeteries.—The Municipal Council of Paris in 1879 appointed a commission on the sanitation of cemeteries, with instructions to inquire especially whether that object could not be fully accomplished by the employment of chemical or physical agents combined with drainage; whether it could be assured for the future by the same means; and whether the disappearance of the organic parts of bodies could not be expedited by the addition, in the coffins or the soil, of chemical agents and other substances; and whether such additions were likely to do any harm. This committee, after a careful examination of the soil and air within the cemeteries and around them, has reported that, though accidents may have occurred from the escape of gases in close tombs and churches where bodies have been buried, they are not to be feared in the open air; that deleterious gases produced by the decomposition of corpses buried at the depth of a metre and a half (five feet) do not reach the surface; that nearly the entire organic constituents of dead bodies are consumed in the course of five years, and that consequently a tolerably permeable soil is not likely to be saturated; that this consumption may be accelerated by drainage; and that there is no danger to wells if they are at a reasonable distance away. These conclusions agree fully with those expressed by M. Robinet in his article "Are Cemeteries Unhealthy?" * They may possibly be modified in consequence of the researches that have brought the cadaveric alkaloids, the *ptomaïnes*, to light, and of M. Pasteur's discoveries concerning the preservation of carbuncular germs in the soil.

* Published in the "Popular Science Monthly" for September, 1881.

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Rodents, Fossil and Living.—M. E. L. Trouessart, in attempting to explain the geographical distribution of living and fossil rodents from the point of view of the doctrine of evolution, divides the living rodents into four principal groups, or tribes: the cosmopolitan rats and their allies, which appear to find everywhere and under all circumstances conditions favorable to their existence and multiplication; the sciuromorphs (squirrels and marmots) and the lagomorphs (hares), almost exclusively of the northern hemisphere; and the hystricomorphs (porcupines, Guinea-pigs, and capybaras), which are now confined to the southern hemisphere. The study of the fossil rodents shows that these four types were neither as narrowly confined to particular regions nor, except the hares, as clearly defined and separated from each other as now. The types of the southern hemisphere were represented during the Miocene epoch in the north of both continents, and appear to have been driven south by glacial cold. The existing types of rodents first appear in the Eocene epoch, and by the side of them mammals with similar dentition, of which the chiromys of Madagascar may be regarded as the last survivor. Some of the mammals of the secondary epoch present the characteristic incisors of the rodents, with molars indicating a carnivorous or at least a more omnivorous nature than that of the great majority of the modern rodents. Similar incisors are found in a number of insectivorous animals, as, for example, among the shrew-mice and several types of ungulates. We are thus led to conclude that this type of the rodents played at the beginning of the Tertiary period an important part in the history of a number of orders which have now become more specialized.

Whales and their Habits.—A correspondent of "Land and Water," who accompanied the Dundee whaling fleet to Davis Strait and Lancaster Sound last summer, mentions the change that has taken place in the geographical distribution of the Arctic whale. A century or two ago this animal was found everywhere north of the sixtieth degree of latitude, and extended many degrees farther south on the east coast of America. It abounded on the northern shores of Europe and the coasts of Iceland and Greenland, frequenting the islands of Jan Meyen and Spitzbergen in incredible numbers. Now it has deserted Spitzbergen and the north of Europe, it is becoming rare on the coasts of Greenland, and seems to be retiring farther into the unpenetrated recesses of the Polar Sea. Whalemen are not agreed as to whether the animals are actually diminishing in numbers. Some believe that they are still as numerous as they were at the beginning of the century; others predict that the time of their total extinction is approaching. They are still sometimes seen in enormous numbers. Whales exceeding forty-seven and forty-eight feet in length are caught every year. Captain Deuchars, of the Dundee fleet, two years ago took a whale sixty-five feet long, the "bone" of which measured twelve feet ten inches, and which gave twenty-four tons of pure oil. The largest whale ever caught in Davis Strait, in 1849, had a "bone" fourteen feet long, and yielded twenty-seven tons of oil. The destruction of "suckers," or baby whales, which is considerable, may have something to do with the present decadence of the fishery. Whalemen think that no animal should be killed whose "bone" is not more than six feet long. Whales may live to a very great, but no one knows to how great, an age. Although dead ones are often found floating on the water, none are ever discovered that have died from natural causes. Whales are monogamous, and are much attached to their consorts. The correspondent who furnishes these facts tells of an animal which came back every day for a fortnight through great peril from the fleet to the place where its mate had been taken, regularly going over the course followed by her in her flight, looking for her. The animals sleep on the surface of the water, enjoy fine weather and sunshine, and are often seen at play on bright days. When they are together in large numbers, the water becomes covered with an oily exudation from their bodies, which has a sickly smell, and attracts flocks of "molly" petrels. They can live only on the most minute marine animals, for, though a whale's mouth "would hold a whale-boat, with all its crew, its gullet would be choked by a herring. When feeding, it swims through

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the water with its mouth wide open, a constant stream passing in at the front, through the upright whalebone plates at the sides, and out again at the back. The small animals which form its food are entangled in the long hairs which fringe the internal edges of the plates, and from time to time, as they become collected in sufficient numbers, the whale closes its mouth, raises its tongue, and swallows the mass." Its favorite food is a black pteropodous mollusk, resembling a humble-bee, and, after this, jelly-fish, of which it takes millions to make a meal. Fortunately for the whale, these creatures go closely massed together in shoals many square miles in extent. After man, the whale's worst enemy is the grampus, which attacks it savagely, and is very destructive to the species. Its protection from both enemies is the ice; and it is, consequently, now found almost exclusively in the neighborhood of ice.

Typography and Eyesight. Dr. Javal considers the subject of typography in relation to the hygiene of the eyes in the "Revue Scientifique." His conclusions differ materially only in a few points from those which Professor Herman Cohn has published. He believes it important to make the several letters, particularly those which are allied in form, as distinct as possible, and therefore favors those fashions in the cutting of the types which tend to accentuate the distinctions. The superior importance of the upper part of the letters, which is generally recognized, is enforced by the fact that in the case of the irregularities in the lines occasioned by the "long letters," eighty-five instances occur in which the long strokes rise above the line to fifteen in which they fall below it. Of the groups of letters resembling each other the members of the one composed of *a*, *c*, *e*, *o*, and *s*, are most likely to be confounded with each other, and more clear distinctions in the formation of their upper curves are eminently desirable. The strokes of which the letters are composed should not be made so thick as to blur the figure of the whole letter, which is the feature the practiced reader regards; and only young readers require a particularly heavy stroke. The thin lines that cut off the strokes at either end are not without importance; and Dr. Javal prefers the English method of drawing them so as to leave a curve between the stroke and the line, to the French method of leaving a sharp angle. These lines may be used with good effect, with slight variations in their position to assist in marking distinctions between letters which are otherwise somewhat alike. Dr. Javal regards the width of the letters as of more importance than their height, and the spacing between them as of more moment than the separation of the lines by leads; he does not consider leaded matter as really more legible than "solid"; and he ascribes a superior legibility in English books to the predominance of short words, giving more horizontal spacing. He would prefer a large type "solid" to a finer type leaded, although he admits that a "solid" page has a blackish, heavy, and somewhat disagreeable aspect. If attention is paid to his views regarding the breadth of the letters and the inter-literal spacing, he believes that the height, in the case of ordinary reading matter, may be considerably reduced without marring the legibility. Different considerations must prevail in regard to school-books, in which the typography must vary according to the age of the pupil, within limits which can be determined only by experience.

Accommodative Cultivation of Infectious Organisms.—Dr. A. Wernich has considered, in "Kosmos," the extent to which the molds, the microbic parasites of the body, and the germs of infection, are able to adapt themselves to new conditions of existence, assume new forms, and produce different effects. When microbes are observed in great numbers, as they may be sometimes in the tissues and secretions even of healthy persons, much more of sickly ones, the temptation is very strong to associate them with the production of disease, and is apt to mislead. Naegele has expressed himself in favor of the doctrine of transformation, and says that the same fungoid, transferred successively from one medium to another, may produce, in milk, lactic acid; in meat, putrefaction; in wine, gum; in the ground, nothing; in the human body, disease; and that it may, in each

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place, gradually adapt itself to the new conditions, and even, in the course of successive transformations, acquire new facilities for adaptation. If four vessels, carefully cleansed, are filled with different fluids —such as carbolic acid, urine, Cohn's mineral plant-food, and Pasteur's fluid — all clear of bacteria, and a drop of the same putrefactive mixture is added to each of them, they will, in the course of forty-eight hours, show very different degrees of disturbance, according to their adaptation to promote the growth of the infective organisms. If the organisms themselves are examined, they will be found, although all originating from the same source, to be only similar, not identical. Even Pasteur, who stoutly advocates the specificity of the ferments, has been obliged to admit a few exceptions to his theory. Dr. Wernich had already called attention to observations by himself and others which tended to show that fungoids, which seemed harmless growths on the more exposed tissues, might, if the capacity of the body for resistance should be depreciated, become aggressive, and develop dangerous disorders. Grawitz cultivated a mold that grows on sour solids, but does not flourish in the bodies of animals, through successive generations, till he adapted it to a higher temperature than its natural one, to pastes, sweetened and alkaline fluids, and to blood. A living animal inoculated with spores of the last variety died in a few hours in consequence of a general development of the fungoid vegetation, particularly in the kidneys and liver. Dr. Wernich believes that he has evidence that the strength of the infective qualities of these organisms may be greatly increased by an accommodative culture. Cultivation in substances unfavorable to their growth is, on the other hand, found to cause a depreciation of their inoculative efficacy. If we select the most favorable substance for the growth of a mold, and plant upon it the most vigorous stocks we can obtain, we will soon perceive unmistakable indications of an increase of vigor. The period required for the development of the germs is shortened, and the organisms give way to their successors of the next generation in continually diminishing periods. The infective force becomes so much greater that the slightest contact is sufficient to effect a transplantation to a new medium, and the greatest pains are necessary to prevent a transfer without apparent contact of spores of the same kind as those which, subjected to unfavorable conditions of culture, require painful attention to induce them to take root in any new soil. A similar development of activity and infective power may be observed in the case of epidemics. The germs of disease do not exhibit their full vitality at once, as do poisons when absorbed, but require a period of incubation and the favor of diminished power of resistance in the body before they can exhibit their full effect. The first cases are indefinite, and hardly recognizable in their real character, and affect only the weakly; as the epidemic acquires strength, its manifestations are more determinate, and it affects all. The manner in which this growth of activity is produced may be illustrated by experiments that have been made in the inoculation of animals, in which an increase in infective power has been very distinctly perceived to accompany each successive transfer from one animal to another. Dr. Wernich suggests that there are some questions relating to the subject that need yet to be explained, and that it will not be safe to form definite conclusions upon it until after further investigation.

Explosive Force of Coal-Dust.—The Rev. H. C. Hovey has communicated to the "American Journal of Science" the results of the investigations of Mr. Gilpin, Inspector of Mines for Nova Scotia, into the part played by coal-dust in spreading and augmenting the explosions which took place in the Albion mine in November of last year. The mine was thoroughly ventilated, and was reported by the night-watchman, an hour before the explosions began, to be free from gas, except in small and harmless quantities. Yet the explosions, once begun, were continued at intervals till the mine was all aflame and had to be flooded. On examining the gallery shortly after the original explosion, dead bodies of men and horses were found six hundred yards from the shafts, and the wood-work was splintered, but nothing bore any marks of fire, "and the conclusion was plainly justifiable that

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the flame of the explosion had not extended thus far. The walls of the galleries had been swept clear of timber, and presented the appearance of having been brushed with a broom. Volumes of coal-dust had been driven along by the force of the blast, and lay in waves and drifts on the floor of the levels, into which the party sank to their knees. It was found that clouds of the finer particles had been carried to the shaft and beyond it into the main north level, where a secondary explosion had taken place. . . . Secondary explosions caused by extracted or generated gas are nearly always in the vicinity of the first one; but here is a case where the second was half a mile from the first, with an intervening space of at least a quarter of a mile known to have been free from flame and presumed to be free from gas, because men were in it with lamps which showed no indications of its presence." The conclusion is drawn that the fine dry particles were driven on by the force of the first explosion across the shaft, where the dampness preserved them, into the "lamp-cabin," where they were readily ignited by the lamp which was kept burning openly, and thus caused the second explosion; "and it is probable that the same agency was efficient in producing, or at least augmenting, the subsequent explosions that made it necessary to flood the whole mine." A competent explanation on chemical principles of the remarkable exhibition of force and heat accompanying dust-explosions is needed.

Significance of Ancient Masons' Marks.—Professor Franz Rziha, of Vienna, has published the results of investigations, to which he has devoted many years, into the origin and meaning of the masons' marks which are frequent in the constructions of antiquity and the middle ages, and which he specifies as occurring in Grecian, Roman, and Syrian buildings, as well as in later ones. They have been regarded as mystic signs, arbitrary marks, private signs, or simply as letters. Professor Rziha believes that they had a far wider significance, and that they formed, before the now recognized laws of statics on which the building art rests were made known by Galileo, the means by which the master transmitted to his students the secrets of his art, and to his workmen the principles of his plan. Particular figures were employed as a kind of a graphic key to the conditions of a consistent structure. The circle, square, cross, and triangle furnished the four elements of graphic delineation; the compass, rule, and square were the three tools absolutely necessary to guide the work, and were indispensable in securing the proportions best adapted to give strength to all parts of the building. The geometrical properties and relations of the figures used thus served to indicate the proportions that were to be obtained. Professor Rziha maintains that the figures were never arbitrary, but that they were always derived from and conformable to common geometrical types. A comparison of more than five thousand masons' marks which he has made shows that, however independently individual signs may have been chosen, the combination of the lines is subject to a law in the shape of a geometrical pattern, of which the lines, whether straight or curved, must be a part. He has traced out some of these original designs, and has been able to adapt the lines of the marks to them without any artificial straining—in strong confirmation, he believes, of his theory. After reviewing the modifications which these marks underwent in time and in different countries, Professor Rziha shows how it is possible to ascertain from them the ages at which buildings were erected.

Physiological Immunities of the Jews.—The "Revue Scientifique" has drawn the conclusion, from a comparison of the vital statistics of different countries, that the Jews nearly everywhere enjoy certain physiological immunities which distinguish them from the other inhabitants, among which are the following: their general fecundity (proportion of births to the whole number) is less; while the relative fruitfulness of their marriages to those of other races varies in different places; a greater proportion of their children survive everywhere; illegitimate births and still-born children are more rare among them; the proportion of males to females among the births is greater; their mortality is lighter, the mean duration of life is greater; they increase more rapidly by the excess of births over deaths; while they

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do not escape them entirely, they are less generally and less severely afflicted by contagious diseases; they are comparatively exempt from such diseases as consumption and scrofula; and they have the faculty of becoming acclimated and multiplying in all latitudes. These immunities are observed, notwithstanding the apparent condition of the Jews who enjoy them may be most miserable, notwithstanding the frequency of marriages of relatives among them, and notwithstanding the unwholesome conditions of the city life to which they mostly confine themselves. They may be explained as the consequence of the operation of a variety of causes, among which are suggested an inherent superior vitality in the race; the continued preservation of its purity from admixture with foreign blood; the faithful observance of the rules of hygiene laid down in Deuteronomy, which are particularly adapted to hot climates and hot seasons; the salutary influence of early marriages, of the spirit of order and economy, of moderation in tastes, of a comparative severity of manners, and of the domesticity of Jewish family life. It may be, too, that the misery in the Jewish quarters of European cities is more apparent than real, and that their inhabitants are really better off than the people around them. The facts are brought out in the statistics from which these conclusions are drawn, that Jews are quite liable to cerebral affections, and also to diseases that afflict mature and aged persons. The latter fact is explained by the existence of a greater proportion of mature and aged persons among them.

Constitution of Comet *b*, 1881.—The spectral phenomena and constitution of the comet were the subjects of several papers at the sessions of the French Academy of Sciences of June 27th and July 11th. Mr. Huggins stated that the lines as shown in his photographs indicated the presence of nitrogen with carbon and hydrogen, probably as cyanogen. M. Berthelot remarked that the exhibition of the lines of hydrocyanic acid would furnish an argument for the hypothesis of the electric origin of the light, as the spectra of acetylene and hydrocyanic acid are characteristic of the electrical illumination of a gas containing carbon, hydrogen, and nitrogen, whether free or in combination. M. Thollon described the nucleus as giving a brilliant continuous spectrum, and the nebulosity around the nucleus as showing three bands, one quite distinct, the others dim, separated upon a ground forming a continuous spectrum. The spectrum of the bands resembled that given by the blue flame of alcohol, and therefore indicated the presence of carbon or some of its compounds. M. Wolff recognized—1. A wide continuous spectrum, pale, but visible in all the regions of the comet; 2. A continuous spectrum, almost linear, lively bright, given by the nucleus; 3. The spectrum of the three bands—yellow, green, and blue—characteristic of the light of all the comets hitherto examined. The existence of a solid or liquid matter, luminous either by itself or by reflection, was indicated in the nucleus, and that of an incandescent gas, probably acetylene, in the surrounding nebulosity, while the light of the tail appears to come from a luminous or simply illuminated pulverulent matter. The polariscopic observations indicated the existence of reflected light, that is, of non-gaseous matter endowed with the power of reflection. M. Thollon noticed the modifications that took place in the spectrum as the comet receded from the sun. The violet rays were soon extinguished, while the yellow and red rays continued of full brilliancy. The bands appeared nearer the nucleus every day till the first day of July, when they were seen on the nucleus itself. M. Thollon supposes that the mass of the comet is formed partly of an incandescent gas, characterized by the banded spectrum, and partly of an incandescent solid or liquid matter in a state of extreme division, emitting a proper white light, and also capable of reflecting a part of the light it receives from the sun.

A South African River-Antelope.—Major Serpa Pinto, the African traveler, found on the Cuchibi a new antelope, of curious and remarkable habits. It bears, he says, among the Bihenos the name of *quichóbo* and among the Ambuellas that of *buzi*. It is of the size, when full grown, of a one-year-old steer, has dark-gray hair, extremely smooth, straight horns, about two feet long,

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and set at a slight angle to each other, "twisted around the axis without losing their rectilinear shape," and terminating in a broad spiral. The feet are furnished with long hoofs similar to those of the sheep, and are curved at their points; and this arrangement, together with the sedentary habits of the animal, renders this remarkable ruminant unfitted for running. "Its life is therefore, in a great measure, passed in the water, it never straying far from the river-banks, on to which it crawls for pasture, and then chiefly in the night-time. It sleeps and reposes in the water. Its diving powers are equal, if not superior, to those of the hippopotamus. During sleep it comes near to the surface of the water, so as to show half its horns above it. It is very timid by nature, and plunges to the bottom of the river at the slightest symptom of danger. It can easily be captured and killed, so that the natives hunt it successfully, turning to account its magnificent skin and feeding off its carcass, which is, however, but poor meat. Upon leaving the water for pasture, its little skill in running allows the natives to take it alive; and it is not dangerous even at bay, like most of the antelope tribe. The female, as well as the male, is furnished with horns. There are many points of contrast between the life of this strange ruminant and that of the hippopotamus, its near neighbor. The rivers Cubangui, Cuchibi, and the upper Cuando offer a refuge to thousands of quichôbos, while they do not appear either in the lower Cuando or the Zambesi. I explain this fact by the greater ferocity of the crocodiles in the Zambesi and lower Cuando, which would make short work of so defenseless an animal if it ventured to show itself in their waters."

Does Sea-Water contain Free Carbonic-Acid Gas?—M. P. Martin Duncan maintains that carbonic-acid gas is not present in sea-water in a free state, and cites in support of his view Tornö, of the Norwegian Deep-Sea Expedition, who has been quoted, erroneously it seems, on the opposite side. It appears from a careful examination of Tornö's essay that that author, in the course of his experiments, found that sea-water had an alkaline reaction, and then began to believe that the carbonic-acid gas which had been taken from the water in other experiments had been produced by the decomposition of neutral carbonates during the boiling. He then proved by experiment that the saline mixture in sea-water, on the temperature being raised to the boiling-point, decomposed neutral carbonates, and that all previous experiments for measuring the carbonic-acid gas in sea-water had been faulty. Of ninety-seven milligrammes of gas per litre of water found in one specimen, he estimated that about fifty-three milligrammes entered into the formation of neutral carbonates, and that the remaining forty-four milligrammes, instead of occurring free as gas, united with the carbonates to form bicarbonates. In one passage of his essay he speaks of sea-water as "an alkaline fluid which does not contain the smallest trace of free carbonic acid."

Photometry.—M. J. Janssen attaches importance to the application of photography to photometric measurements. It not only permits the registration of all the visible rays, but also reaches the ultra-violet rays, and is competent to give valuable ideas relative to the temperature of bodies. While ordinary photometric comparisons between two sources of light are essentially fugitive, and require the simultaneous presence of both bodies, photography furnishes permanent terms of comparison which we may bring to bear whenever we will, and may even bequeath to the future. The relative photogenic intensities of two different sources may be easily ascertained by causing them to act in succession on two similar plates. Comparisons of the photographic power of the sun and a star may be made directly, but it is necessary to obtain an image of the star of perceptible dimensions; this may be done by putting the plate on which the image is to be received out of focus, so that the rays from the star, instead of falling upon a point, shall form a small circle of light.

Disinfection of Alcohol.—M. Naudine recently described to the Chemical Society of Paris a method which he had discovered for relieving alcohol of the bad taste it often acquires from the substances from which it

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is distilled. This spirit, as prepared from various grains, fruits, beet-roots, etc., is produced in many qualities, each of which acquires some special and relatively disagreeable flavor from whatever article has been subjected to distillation; and the alcohols are therefore classified in the arts according to the sources from which they are derived, and subdivided into those of "good taste," "middling taste, and "bad taste." Other alcohols are found along with the vinous alcohol in fermentation, but, as a rule, they do not materially affect its taste. The case is different with the aldehydic or acetonic bodies that are produced, whose pronounced and disagreeable taste is obstinately persistent in rectification. The methods which have hitherto been employed to take away these tastes depend on oxidation; this acts, however, upon the alcohol itself, and generates odorous ethereal substances which only give another bad taste instead of the original one. No better results have been obtained with other substances that have been recommended, including potash, soda, oil, fat, soap, and sodium. M. Naudine has adopted a course which has been suggested by the fact that hydrogen, in a nascent state, converts the acetones into secondary alcohols. His method consists in the subjection of the alcohol to be purified to the action of the Gladstone and Tribe reducing pile, or a similar battery, whereby hydrogen is developed and acts immediately upon the impurities of the spirit.

Speed of Explosives.—M. Berthelot has been investigating the speed with which explosive phenomena are propagated in gases. For this purpose, he filled with the explosive mixture of oxygen and hydrogen, carbonic oxide, and oxygen under atmospheric pressure, an iron tube about sixteen inches long and a third of an inch in bore, so arranged that the passage of an explosive could be accurately registered at a point close to where the spark was applied, at the middle, and at the farther end of the tube. The experiment showed the speed of propagation to be about twenty-five hundred metres (8,125 feet) a second. The results should not be regarded as furnishing the absolute value of the speed of the explosive force, for the quantities measured are too small for that; but they at least give an indication that the speed is much greater than had been supposed. Bunsen, for example, in 1867, had estimated it at thirty-four metres a second for detonating gas, and one metre for carbonic oxide mixed with oxygen. The rapid propagation of explosive phenomena appears to be due to the transmission of the successive shocks of the gaseous molecules, which have been brought into a vibratory condition more intense than the heat disengaged in their combination. The phenomena of explosion are, then, more complex than a simple movement of transmission, or even than the propagation of a sonorous wave.

Fossilized Standing Trees.—M. Fayol has observed fossilized trees standing perpendicular to the planes of stratification of the beds that contain them, in the coal-measures of Commentry. In the bed of Roseaux the trunks are so numerous as to resemble a fossil forest. The standing trees are fragments of trunks, without branches or roots, and occur generally in the grits, occasionally in the conglomerates, rarely in the shales, but not in the coal-beds. Prostrate trees are numerous in the shales, less abundant in the grits, and rare in the conglomerates, while numerous traces of them may be distinguished in certain parts of the coal-beds. The prostrate trees are a hundred times more numerous than the standing ones, and are found almost everywhere in the beds. These facts may be explained as the results of a transporting movement. A recently pulled-up plant, when thrown in the water, stands vertically, then sinks to the bottom in the same position, and afterward falls prostrate, remaining in each position for some hours or even days. If the trees were carried by the current to a lake or estuary, they would, according to the condition they were in, either float around for a while or sink at once, and would become fossilized in the position they took.

Disinfecting Powers of Sulphurous Acid.—Dr. Victor Fatio, of Geneva, has made a series of interesting experiments on the disinfecting power of sulphurous acid, particularly with reference to the destruction

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of the phylloxera and its eggs. From them he has found that the application of the acid, in the proportion of fifty cubic centimetres of the liquid acid to one cubic metre of air, is sufficient to kill all the phylloxera and eggs in a closed box in two hours; that the same effects may be obtained immediately in the open air by sprinkling the box with fifty cubic centimetres of the acid to one square metre of surface; that confinement for a few minutes with the former proportion of acid is sufficient to kill the phylloxera and soft insects of an analogous nature and their eggs, and purely herbaceous plants, while dry seeds exposed to it retain their germinative powers; and that its application is equally efficacious against the parasites in museums, while it does not harm the specimens which they infest. Plants and insects of a moist texture are the more readily affected by the acid. A high temperature is favorable to the operation by promoting the diffusion of the acid gas; a moist atmosphere is against it, by its tendency to hold the gas in solution. The application of the anhydrous acid has advantages over that of burning sulphur in that it can be made where sulphur can not be burned, is safer, and more convenient.

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NOTES.

THE President of the Entomological Section of the American Association stated, in his address at the meeting of the section, that while there were not known to be more than ten or twelve working entomologists in the country forty years ago, four hundred and thirty-six names were reported in last year's "Naturalists' Directory" of persons designated as entomologists. No other distinct branch of natural history except geology and botany has so many representatives in that book. The various journals of the last year contained three hundred and thirty-six contributions to entomology exclusively by Americans, the work of eighty writers.

THE appointment of M. Wurtz, President of the Academy of Science, to be life-Senator, raises the number of members of the Academy belonging to the Upper House of the French Legislature to three, the two other members being M. Robin and M. Dupuy de Lorne. The election of M. Berthelot, which is considered certain, will give the Academy a fourth representative in this body.

MR. F. W. PUTNAM has exhibited to the Boston Society of Natural History specimens of a collection of several hundred rude stone implements which Mr. David Dodge has obtained from plowed gravelly fields at Wakefield, Massachusetts. The implements had not yet been found in place in the gravel, so that it was not possible to decide that they were true palæolithic implements; for rude forms of the same character are often associated in this country with finely polished implements of the Neolithic period. Some of the specimens were obtained from a very old pile of stone-chips nearly buried in the side of a hill, where similar implements to those found in the fields near by had evidently been made. It was worthy of remark that none of the arrow-heads and similar forms, common near places where palæolithic objects have been discovered, had been found in connection with these implements.

IN a pamphlet on "The Discipline of the School," published by the Bureau of Education, Dr. Hiram Orcutt gives as the elements of school discipline, each of which he discusses under its special head: thorough organization and classification; the establishment of the authority of the teacher; work; a sound public opinion in the school; mental and physical recreation (gymnastics and exercise); kindness; power to punish, with wise discrimination, and courage to inflict punishment when it is required; regular systematic study and recitation; and good manners, which are inseparable from good morals.

PROFESSOR CYRUS THOMAS has made a study of the Mexican manuscript called the "Manuscript Troano," which was discovered by the Abbé Brasseur de Bourbourg in 1865, and has concluded that it is a genuine Maya document; that it is a religious calendar of some kind, in which the day-characters are used for the purpose of designating the days and not for the signification of the words; and that it confirms the substantial correctness of Landa's characters for the day. He has begun the attempt to decipher the hieroglyphics of the text.

THE yucca seldom perfects its seed in the United States. The failure is believed by Professor Riley to be in consequence of the flower depending for its pollination upon the office of an insect which has not yet been introduced to an extent corresponding with the diffusion of the plant. In his paper on "The Pollination of Yucca," before the American Association, Professor Riley describes some insects which he has found in or about the plant, by the agency of one or more of which he thinks the pollination may be accomplished in the rare cases where it is observed to occur.

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THE experiments instituted by M. Pictet to determine the density of liquid oxygen, hydrogen, and nitrogen, have been followed up by Messrs. Cailletet and Hautefeuille, who have facilitated the processes by previously mixing the gases with carbonic acid and protoxide of nitrogen, whereby the liquefaction is made to take place more readily. The density of the liquids of the latter gases being known, it is easy to compute that of the substances under examination. The results of tests made at a very low temperature are favorable to the theory of the relations that have been suggested between hydrogen and magnesium, oxygen and sulphur, nitrogen and phosphorus; but, as the freezing-point of water is approached, discrepancies are manifested which grow more and more accentuated.

DR. LUTON, of Rheims, reports that he has discovered that the tincture of ergot of rye associated with phosphate of soda produces on those to whom it is administered an hilarious excitement, similar to that which is brought on by laughing-gas.

M. LENZ, in a communication made recently to the French Geographical Society, on his journey to Timbuctoo, says that in the Inguidi, a region of sand-dunes, he observed the equally rare and interesting phenomenon of resounding or musical sand. "All at once," he said, "there was heard in the desert, issuing from a dune of sand, a prolonged, muffled sound, quite like the sound of a trumpet. It continued for some seconds, then ceased, to be resumed in another direction. The phenomenon made the traveler anxious. I suppose it was occasioned by the friction upon each other of the burning grains of quartz, which are simply placed one by the other, and are continually in motion."

M. C. WIDEMAN has shown that the electrical qualities which are already plainly perceptible in most kinds of paper can be greatly increased by subjecting it to a previous treatment. Common unsized paper, Swedish filtering paper, or silk paper, when dipped in a mixture of equal volumes of nitric and sulphuric acids, washed and dried, becomes imperfectly transformed into pyroxile, and extremely electric. When put on a wooden table or an oil-cloth, and rubbed with the hand, it will immediately attract light bodies; if taken up from the oil-cloth in the dark, the whole surface shines like phosphorus; when the finger is brought toward it, it gives off a spark. A Leyden-jar may be charged with it. It gives off, when rubbed, the characteristic odor of ozone. It preserves its properties for a long time, and may have them restored by heating it. Thus, for a few cents, we may possess a machine competent to aid in the illustration of all electrical phenomena.

PROFESSOR LEBOUR, of Newcastle, in a paper on the geological distribution of endemic goitre in England, has shown that the conditions of the prevalence of this disease are substantially the same as they have been shown by the researches of Dr. de St. Lager, of Lyons, to be in France. In both countries the formations in which the most goitre is supported are both calcareous and metalliferous. Metalliferous impurities alone do not promote the disease, for the Devonian and granitic formations are free from it. The absence of limestone alone does not prevent it, for it exists on the lignitiferous beds of France, and the ferruginous sands of the weald. Dr. de St. Lager believes that endemic goitre coincides with metalliferous deposits, of which iron pyrites is most active.

PROFESSOR COPE, describing the *Canidæ* of the Loup Fork, or highest Miocene formation of the West, represents that the number of species is not so great as in the preceding periods of the Miocene, while those that are known more nearly approach the existing dogs in character, and are of a larger average size.

DR. J. YOUNG and Professor G. Forbes have made some new researches to measure the velocity of light, by the method that was employed by M. Fizeau and M. Cornu. The electric light was used, with two reflectors a quarter of a mile apart, and a revolving toothed wheel was employed to alter the intensity of the reflected light. Through this two stars of light were seen, one increasing, the other diminishing in intensity as the speed of the wheel was increased. The speed required to produce equality of the light was determined by means of a chronograph. The final result of the mean of the several observations for the velocity of the light from an electric lamp *in vacuo* was 187·273 miles a second. The observations on the color of the stars indicated that the blue rays travel faster than red rays, with a difference equivalent to about 1·8 per cent. of the whole velocity.

PROFESSOR RAOUL PICTET, of Geneva, announces the discovery of a method of construction for greatly increasing the speed of vessels by making such an arrangement of the keel as will diminish the resistance of the water to the lowest point. Where it is applied, the prow, instead of sinking deeper as the speed increases, will be raised, and only the sides of the hull and the neighborhood of the wheel will be exposed to the friction, so that the vessel will glide over the water instead of having to push its way through it. Professor Pictet expects to attain a speed of from thirty to thirty-six miles an hour. A vessel embodying his plans is building for Lake Leman.

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DR. HANICHI MURAOKA, a Japanese student at Strasburg, has recently determined experimentally the specific resistance and the change of resistance to the galvanic current at all temperatures shown by all the kinds of hard carbon, including some artificial carbons and graphites. The highest specific resistance, at the freezing-point, was given by the graphitic compound used in Faber's lead-pencils, 952·0, and the lowest by Siberian graphite, 12·2, while the resistance of the artificial carbons prepared for electric lighting ranged from 36·86 to 55·15. The resistance in all the carbons decreased with a rise in temperature, the coefficient of decrease being greatest for Siberian graphite, the least for a carbon pencil prepared from coke. The thermo-electric force of all the samples was found to be *plus* to that of graphite.

M. DE LESSEPS states that the latest examinations of the *chotts* of Algeria and Tunis have shown that no serious difficulty need be apprehended in digging the projected canal which is intended to transform the marshy and unhealthy lowlands of the southern parts of those states into an interior sea. The ridge (*seuil*) of Gerbes is almost wholly formed of sands and siliceous or argillaceous marls, instead of being a mass of hard rocks, as some geologists have asserted.

M. JANSSEN is of the opinion that while it is easy enough to obtain a photographic image of the brighter parts of nebulæ, it must be extremely difficult to secure such complete images as will permit of their being used as an accurate standard with which to compare future observations. A nebula has no regular outline like the stars, but presents the appearance of flecks of cloud or haze, with indefinite borders and most diverse degrees of luminosity. The character of its photographic image will be modified by several circumstances, atmospheric conditions, instrumental power, sensibility of the plate, length of exposure, which can never be exactly repeated. Hence, two images of it will almost of necessity be different, though it may not have changed.

MR. MACKENDRICK has made a study of the coloring-matter of the *Medusæ*, and has succeeded in extracting some of it. The matter was shown under a microscope having a power of twelve hundred, in the form of little irregular particles of a diameter of one thirty-thousandth of an inch included in the colorless protoplasm of the small cells. When extracted it proved to be soluble in acids, but insoluble in alkalies. The coloring particles appear as granulations in the neutral tissues of the living medusa, but are dissolved and scattered after death as the tissues become acid.

THE technical school which was opened last fall, under the direction of the Metropolitan Museum of Art, had a very successful career during the winter, and was attended by one hundred and forty-three pupils. This fall, the art classes having been removed to new quarters, the building at First Avenue and Sixty-eighth Street will be occupied wholly by the trade-schools, which were to be opened on the 21st of November. It is the purpose of these schools to make thorough, efficient, and practical mechanics, who can earn a living by their trade. They will have departments of plumbing and sanitary engineering; house, sign, and decorative painting, with special courses in mixing colors, fresco-painting, and polishing in hard wood; and the science and practice of brick-laying. Practical instruction will be given by mechanics skilled in the different branches of their trades. The charges will cover the actual cost of instruction and of the materials used.

IN a paper on "The White Pine and the Lumber Industry of Michigan," Mr. W. H. Ballou shows that the quantity of pine timber in that State has decreased from 135,000,000,000 feet on 20,000,000 acres of land to 35,000,000,000 feet on 10,571,000 acres. Some 5,000,000,000 feet are now annually taken away, so that in seven years the supply will be exhausted. It almost seems a despairing task to hope ever to raise forests for another such enormous production, and science will have to devise other materials as a substitute for wood. Lumber is already made in boards an inch thick from wheat-straw, and can be colored so as accurately to resemble any real lumber. The inventor manufactures two thousand square feet of a more durable and cheaper material than lumber from a ton of straw.

MANY birds, according to Mr. E. E. Fish, appear to possess powers of ventriloquism. A cuckoo, not a rod off, can make his voice appear to come from a furlong away; the thrush, singing from a low perch, seems to be in the tree-tops; the vesper-sparrow and field-sparrow on the road-side fence, as if singing from a distant field. The robin has a similar power of throwing its voice, and the cat-bird can sing in a loud, voluble sound or in a low, soft, sweet, and tender warble. The oven-bird, the smallest of the thrushes, singing from a distance, can throw its sharp, ringing notes in such a way as to cause the listener to believe that it is almost within reach.

MR. W. H. M. CHRISTIE, F. R. S., first assistant at Greenwich Observatory, has been appointed Astronomer Royal to succeed Sir George Airy.

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HENRI-ÉTIENNE SAINTE-CLAIRE DEVILLE.

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THE

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THE SEVEN WORLD-PROBLEMS.

By EMIL DU BOIS-REYMOND.*

WHEN, eight years ago, I undertook to address a public sitting of the Association of German Naturalists and Physicians, I hesitated for a long time before deciding to choose the "Limits of our Knowledge of Nature"† as my subject. The impossibility, on the one hand, of comprehending the existence of matter and force, and, on the other hand, of explaining consciousness, even in its lowest degree, on a mechanical theory, seemed to me a truism. That even the simplest sensation can not be made comprehensible as the result of any arrangement or movement of matter, has long been recognized by eminent thinkers. Although I knew that false ideas on the last point had been widely diffused, I was almost ashamed to offer so stale a draught, and hoped to awaken interest only through the novelty of my arguments. The reception given my exposition showed me that I had mistaken the condition of the case. Treated coolly at first, my essay soon became the object of numerous criticisms, which seemed to come from a diversity of points of view—from cordial approbation to utter rejection and censure—and the word *ignorabimus*, in which the investigation culminated, became a kind of philosophical shibboleth.

Flattering as it was to me to see my exposition regarded as a Kantian fact, I must decline the honor, for nothing was contained in it of which any one might not have informed himself by a study of the older philosophical writers. But, since philosophy was perverted by Kant, its culture has taken on so esoteric a character; it has, so far, unlearned the language of common sense and intelligent thought, and

* An address delivered in the Academy of Sciences at Berlin, in honor of the birthday of Leibnitz, July 8, 1880.

† See "Popular Science Monthly," vol. v, p. 17 (May, 1874).

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evaded the questions that move unprejudiced youth most deeply, or treated them from a superior altitude as officious speculations; and has, finally, held so hostile an attitude toward the new world-power, natural science, that it is not surprising that even the recollection of the earlier achievements of philosophy should have been lost. This is, indeed, partly due to the circumstance that the newer philosophy stands in a negative or in no clear relation to positive religion, and avoids expressing itself on certain questions; so that it has happened that the most pregnant problems in metaphysics have not been set forth and discussed by philosophy, at least not in a language acceptable to scientific men, since the middle of the last century. This may be one of the reasons why philosophy is often despised as objectless and useless, and why, when natural science and philosophy touch at so many points, such ignorance and lack of preliminary ideas are shown in connection with actual achievements.

I was reproached, on the other side, because I had assigned impassable boundaries to the human powers of knowledge, by men who could not understand why consciousness could not be made comprehensible in the same way as the development of heat by chemical action, or the excitement of electricity in the galvanic circuit. Cobblers left their lasts and sneered at the humble confession of "Ignorabimus," by which "not-knowledge" was declared in permanency; and I was denounced as belonging to the Black Band by fanatics who should have known better, and who showed anew how nearly together despotism and extreme radicalism dwell. More temperate heads betrayed the weakness of their dialectics in that they could not grasp the difference between the view which I opposed, that consciousness can be explained upon a mechanical basis, and the view which I did not question, but supported with new arguments, that consciousness is bound to material antecedents.

David Friedrich Strauss, who had recently turned from theological studies to natural science, saw more sharply. It did not escape him that I had put myself in regard to mental processes at the point of view of the inductive philosopher, who does not separate the process from the substratum on which he learned to know the process, and who does not without sufficient motive think of the process as disconnected from the substratum.

Even he criticised in a remarkable way my declaration of the incomprehensibility of consciousness on a mechanical basis, saying: "There are confessedly three points in the ascending development of nature to which the appearance of the incomprehensible is especially attached. They are the three questions, How has the living arisen out of the lifeless, how the sensible out of the senseless, how the understanding out of the not-understanding? The author of the 'Limits of our Knowledge of Nature' holds the first of the three problems, A, to be solvable. He facilitates the solution of the third problem, C, that of

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intelligence and free-will, apparently by including it in the closest connection with the second, that of reason, as the highest degree of the consciousness already given, with sensation. The second problem, B, that of sensation, on the other hand, he holds to be unsolvable. I grant that one might more readily enlighten me, if he should say to me: 'A, that is life, is and must remain inexplainable; but that once given, sensation and thought follow of themselves—that is, by natural development'; or, if it were stated in the inverse sense, 'A and B may indeed be comprehended, but the understanding is strained at C, or self-consciousness.' Either of these views appears to me more acceptable than the one that the middle station only is impassable."

Strauss has not touched the marrow of my observation. I called astronomical knowledge of a material system such knowledge as we might have of the planetary system, if all the observations were accurate and all the difficulties of the theory overcome. If we had astronomical knowledge of what is going on in ever so obscure an organ of the animal or vegetable body, our demand for a causal agency would be as well satisfied, so far as the nature of our intellect permits with reference to that organ, as with reference to the planetary system; but, if we had astronomical knowledge of what occurs within the brain, we would still not be advanced a hair's breadth with reference to the origin of consciousness. In regard to these problems, Laplace and Leibnitz, whose minds were so immeasurably superior, yet similar to ours, were no wiser than we; and if Leibnitz had realized his fiction that he could compose a *homunculus*, atom by atom, molecule by molecule, he might, perhaps, make his creature think, but not comprehend how it thought.

The primary origin of life in itself has nothing to do with consciousness, but is a question only of the arrangement of atoms and molecules and of the production of certain movements. Consequently, not only is astronomical knowledge thinkable of what we call original production, spontaneous or equivocal generation, or heterogeny, but it would satisfy our demand for a causal agency for the primary origin of life as well as in regard to the motions of the heavenly bodies. This is why, speaking with Strauss, "in the ascending development of nature" the gap in our apprehension does not open at the point A, but at B. I have not maintained that, sensation being given, every higher stage of mental development becomes comprehensible; that problem C is made solvable without further steps. I attached weight to the incomprehensibility of the simplest sensations on mechanical grounds, only because the incomprehensibility of all the higher mental processes follows from it by an *a fortiori* argument.

The origin of life seems to have become veiled in a deeper obscurity since men have hoped with the aid of the microscope to see the living come from the dead in their laboratories. According to M. Pasteur's researches, heterogeny is underlaid by panspermy, and, where life was

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believed to originate, it has only been developed from germs that were already present. Yet those who will not adhere to a wholly childish view may be logically compelled to concede a mechanical origin of life. Hardly any one can now be found to advocate the doctrine of periods of creation by which the Almighty was supposed to have repeatedly destroyed his work to do it over again for better or worse, in the face of geological facts and the theory of descent. The believer in a final cause must admit that such a proceeding is little worthy of a creative Almighty. It is most highly becoming to him once by supernatural interference with the world's mechanism to call the simplest germ of life into being, and let further organic creation proceed from that. If this is conceded, it is permissible to ask if it is not still more worthy of the creative Almighty to avoid even that single intervention by means of established laws, and to endow matter from the beginning with the power of originating life under suitable conditions. There is no reason for denying this view, but with its acceptance the possibility of a mechanical origin of life is conceded, and we have only to consider whether the matter which can thus mechanically compose itself into a living condition always existed, or whether, as Leibnitz thought, it was created by God.

I conclude that astronomical knowledge of the brain would not make consciousness more comprehensible on a mechanical basis because it must be indifferent to a number of atoms of carbon, hydrogen, oxygen, nitrogen, etc., how they are situated or how they move, unless they already had individual consciousness; and this would not help to explain consciousness in general, or the aggregated consciousness of the brain.

I hold this conclusion to be fully convincing. Herr Haeckel, however, has advanced as a metaphysical axiom that every atom possesses an inherent quantity of force, and is in this sense "be-souled," and that without the acceptance of an "atom-soul" the commonest and most general phenomena of chemistry are inexplainable. "Pleasure and displeasure," he says, "desire and aversion, attraction and repulsion, must be common to all the atoms, for the movements of atoms that take place in the formation and decomposition of all chemical compounds are susceptible of explanation only if we ascribe feeling and will to them. . . . If the 'will' of man and the higher animals seems to be free in contrast with the 'fixed' will of the atoms, that is a delusion provoked by the contrast between the extremely complicated voluntary movements of the former and the extremely simple voluntary movements of the latter." Quite in the spirit of the false philosophy from the same source that has been so pernicious to German science, Herr Haeckel goes on with the construction upon "unconscious recollection" of a certain "vivified" atom-complex that he calls "plastidule."

Thus does he disdain the path of inductive research shown us by

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La Mettrie, and sin against one of the first rules of philosophizing—"*Entia non creanda sunt sine necessitate*"; for what purpose does consciousness serve, what mechanism? And if the atoms feel, what need of organs of sense? He furthermore overlooks the difficulty that I have fully pointed out, of comprehending how the numerous "atom-souls" can give rise to the aggregated consciousness of the whole brain.

A more accomplished morphologist might be excused for not being able to distinguish the ideas of will and force, for misconceptions similar to this have been shown even by better-schooled men. Philosophers and physicists have attempted to explain the distant action of bodies upon each other through presumably empty space by means of a will dwelling within the atoms. A wonderful will, indeed, that must always belong to two!—that must will whether it wills or not, and that in the direct ratio of the product of the masses, and the inverse ratio of the square of the distance!—a will, the projected subject of which must move in a conic section—a will that reminds us of the faith that can move mountains, but which has never been taken account of in mechanics as a cause of motion.

At all events, the opposition that has been offered to my assertion of the incomprehensibility of consciousness on a mechanical theory, shows how mistaken is the idea of the later philosophy that that incomprehensibility is self-evident. It appears, rather, that all philosophizing upon the mind must begin with the statement of this point, and thus with one of my corresponding arguments; if mechanical consciousness were comprehensible, there would be, in the strict sense, no metaphysics.

A more recent effort to enlarge the barriers of knowledge and throw light upon the nature of matter proceeds from the Scottish mathematico-physical school, from Sir William Thomson and that Mr. Tait whose chauvinism renewed the dispute over Leibnitz's part in the discovery of the infinitesimal calculus, and who went so far as to call Leibnitz a thief, and to whom, therefore, the honor of being named in this hall does not properly belong. Sir William Thomson and Mr. Tait believe that certain important peculiarities that we must ascribe to atoms may be derived from the remarkable properties which Herr Helmholtz has discovered in the vortices of fluids. While it would be rash lightly to reject this theory because it may fall short on some points, it can be safely asserted that it is as little competent as any of the previous theories to reconcile the contradictions which our understanding encounters in its efforts to comprehend matter and force. It, moreover, acknowledges the second of the difficulties that oppose our conception of the world, by granting that the vortex-movement either has existed from eternity or has arisen through a supernatural impulse.

We may count and distinguish seven of these difficulties, of which I call those transcendental which appear insurmountable when we

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come to meet them in considering the ascending development of nature.

The first difficulty is the existence of matter and force, and is in itself transcendental.

The second difficulty is the origin of motion. We see motion arise and cease; we can conceive matter at rest, and motion appears to be something casual to it. It does not satisfy our demand for a causal agency to think of matter evenly distributed in illimitable space and at rest for endless time. Unless we admit a supernatural impulse, a sufficient occasion for the first motion is lacking. Or, if we imagine matter as in motion from eternity, we give up the elucidation of the point. I regard the difficulty as transcendent.

The third difficulty is the origin of life. As I have often said, I see no ground for considering this difficulty transcendent. When matter has once begun to move, worlds may originate; under suitable conditions, which we can as little imitate as we can those under which a multitude of inorganic processes take place, the peculiar condition of the dynamic balance of matter which we call life may also be produced. If we admit a supernatural act, one such act, creating the animated matter, is enough.

The fourth difficulty is offered by the apparently teleological arrangement of nature. Organic laws of formation can not work adaptively unless matter was created with adaptive purpose in the beginning; and they are inconsistent with the mechanical view of nature. This difficulty is, however, not absolutely transcendent, for Mr. Darwin has pointed out in his doctrine of natural selection a possible way of overcoming it, and of explaining the inner suitableness of organic creation to its purposes and its adaptation to inorganic conditions through a concatenation of circumstances operating by a kind of mechanism in connection with natural necessity.

I have already, on a similar occasion to the present, considered in this place the degree of probability that belongs to the theory of selection. "We might always," I said, "while we hold to this theory, have the feeling of the otherwise helpless sinking man, who is cleaving to a plank that just bears him up even with the surface of the water. In the choice between the plank and destruction, the advantage is decidedly on the side of the plank." The fact that I compared the theory of selection to a plank on which a shipwrecked man seeks deliverance excited so much delight in the camp of the other side that they, in the pleasure of repeating it, made a straw of the plank. There is, however, a great difference between a plank and a straw. The man who is dependent on a straw sinks; a common plank has saved many a man's life. Thus the fourth difficulty is no longer transcendent when it is earnestly, thoughtfully met.

The fifth difficulty is the origin of simple sensations, and is quite transcendent.

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Recollecting how I have showed the hyper-mechanical nature of this problem, and consequently its transcendence, it may be profitable to consider how Leibnitz does this. He makes the bare assertion in many places in his writings that consciousness can not arise through any forms and movements, or, as we would now say, through any arrangements and movements of matter. In his "Nouveaux Essais sur l'Entendement Humain," he lets his advocate of sensualism, Philalethes, say, almost in the words of Locke, whose views the work otherwise opposes: "It may be proper to lay more stress on the question whether a thinking being can proceed from an unthinking one without sensation and consciousness, like matter. It is tolerably clear that a material particle can never bring about anything by itself, or impart motion of itself to itself. Its motion must either have existed from eternity, or have been imparted to it by a superior being. But, even if it were from eternity, it could not beget consciousness. Divide matter as if in order to animate it, into as small particles as you will; give them whatever figures and motions you will; make them into balls, cubes, or cylinders, whose dimensions shall reach only a thousand-millionth part of a philosophical foot. However small the particle may be, it will produce on other particles of the same order no different influence from that which bodies an inch or a foot in diameter exercise upon each other. We have the same right to expect to produce sensation, thought, consciousness, by the combination of gross particles of matter of the right shape and mode of motion, as by means of the most minute particles. The latter meet, jostle, and resist each other just as the coarser particles do, and they can do no more. But if matter could immediately and without instrumentality, or the help of forms and movements, create of itself out of itself sensation, perception, and consciousness, that would have to be an inseparable attribute of matter in all its parts." Theophilus, representing the Leibnitzian idealism, approves this conclusion as well founded and just, and says that he is of the opinion of its originator, that "there is no combination or modification of the particles of matter, however small they may be, that can beget perception; for, as can be clearly seen, the gross parts can not do it, and all the processes in the small parts are proportional to those in the gross ones." In his "Monadology," Leibnitz says more briefly: "We are constrained to confess that perception and whatever depends upon it are inexplainable upon mechanical principles; that is, by reference to forms and movements. If we could imagine a machine, the operation of which would manufacture thoughts, feelings, and perceptions, and could think of it as enlarged in all its proportions, so that we could go into it as into a mill, even then we would find in it nothing but particles jostling each other, and never anything by which perception could be explained." Thus, Leibnitz has reached the same conclusion as we. Yet we may remark on this point, first, that Locke's demonstration as accepted by Leibnitz has lost its validity through the prog-

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ress of science; for, according to our present views, we do at least come to a point where matter displays new properties under excessively fine division, as in the cases of diffusions, chemical processes, crystallization, and in organisms. It is remarkable that it never occurred to Leibnitz or Locke that it is by no means all the same whether charcoal, sulphur, and saltpeter lying together are in large lumps or ground down in definite proportions to the fineness of gunpowder. The mechanical performance of similar machines never bears a proportionate relation to their size. If matter thus exhibits different modes of action according to the degree of its division, why may it not even think under a still finer division? It will be best to put away the explanations of these philosophers, and rest upon the simple declaration that consciousness can not be explained as the result of any arrangement or motion of the physical atoms of matter.

I have to say, besides, that we can not at present go further with Leibnitz. He concludes, from the incomprehensibility of consciousness from a mechanical basis, that it is not produced through material causes. We are satisfied with recognizing the incomprehensibility, which we may illustrate by saying that it is of a similar character with the impossibility of understanding why the twitching of the trigeminal nerve provokes infernal pains, while the excitation of certain other nerves is pleasant. While Leibnitz rejected consciousness in the soul-monads imparted to the body, and supposed a series of dream-pictures corresponding with the events of the body to pass along in it under God's direction, we are accumulating the proofs that consciousness is bound to material antecedents.

I name—not with full conviction—as the sixth difficulty, intelligent thought and the origin of language. An immense gap indeed exists between an amœba and a man—between a new-born child and a man; but it may be filled to a certain extent by transitions. The theory of knowledge apparently requires only memory and the power of generalization to make the way from simple sensation to the higher degrees of mental activity. Great as is the leap still to be taken between the faculties of the highest animal and those of the lowest man, the difference between them, consciousness being once given, is of quite another kind from that which opposes the mechanical explanation of consciousness. The latter problem and the former one are incommensurable. Therefore, to use Strauss's notation again, if problem B is solved, problem C does not seem to me to be transcendent. Problem C, however, is closely connected with another problem, the seventh and last one in our series—the question of the freedom of the will.

It is natural that all the problems enumerated here should have busied mankind as long as it has thought. The constitution of matter, the origin of life and language, have been subjects of disquisition among all civilized peoples at all times. Yet only a few minds have advanced to these questions, and the report of the discussions of them

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has seldom passed beyond the halls in which they were carried on. It has been different with the question whether man is free in his acts, or is driven by an unavoidable compulsion. This question—touching every one, apparently accessible to every one, intimately connected with the fundamental conditions of society, reaching to the depth of religious convictions—has played a part of immeasurable importance in the history of thought and civilization, and the stages of the development of the human mind are plainly reflected in the discussion of it.

Classical antiquity did not rack its brains very much over this problem. Neither the idea of an inviolably binding law of nature nor that of an absolute control of the universe existing in the general ancient view of the world, no ground was offered for a conflict between free-will and the governing principle of the world. The Stoics believed in a fate, and therefore denied free-will. The Roman moralists, from ethical considerations, set up the doctrine of freedom again on a natural subjective basis. "*Sentit animus se moveri*," Cicero remarks in the "Tusculans"; "*quod quum sentit, illud una sentit se vi sua, non aliena moveri.*"

It was Christian dogmatism that fell into the darkest self-dug pits over this question. The hopeless, entangling controversy about free-will and predestination has dragged along from the fathers of the Church through all the schools of doctrine and thought to the Reformers, and from them on. God is almighty and all-knowing; nothing comes to pass that he has not willed and foreseen from eternity. Therefore, man is unfree; for, if he had done otherwise than as God had foreordained, then would not God have been almighty and all-knowing. Thus it does not lie within man's will whether he do right or sin. How, then, can he be responsible for his acts? How can it agree with God's justice and goodness that he punish or reward men for acts which are fundamentally God's own acts? Such is the form in which the problem presented itself to those minds. The doctrine of original sin, the questions of redemption through merit or through the blood of the Saviour, by faith or by works, and of the different kinds of grace, were complicated in a thousand ways with that dilemma itself, already fruitful in subtilties, and the cloisters of Christendom resounded from the fourth to the seventeenth century with disputations about determinism and indeterminism. Perhaps there is no subject of human thought concerning which more has been written. The contest was not always confined to books, but often culminated in bitter accusations of heresy with all their horrors.

How differently is the problem of free-will regarded in our time! The persistence of energy proves that force ever arises or is extinguished as little as matter. The condition of the whole world, even of a human brain, at each instant, is the absolute mechanical result of the condition in the previous instant and the absolute mechanical cause of the condition in the following instant. That in a given instant one

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or the other of two things may happen, is unthinkable. The brain-molecules can only move in the determined way; and, if one of them should wander from its place or path without an adequate cause, it would be as great a wonder as if Jupiter should break out from its orbit and throw the planetary system into confusion. If, as monism conceives, our conceptions, efforts, and volitions are really incomprehensible, yet necessary and unequivocal companion-manifestations of the movements and environments of our brain-molecules, there is evidently no freedom of the will. To monism the world is a mechanism, in which there is no place for free-will.

Leibnitz was the first to whom the material world was presented in this form. His mechanical view was quite the same as ours. He was acquainted with the persistence of energy, although he was not able to follow it through all the molecular processes, as we are, and stood toward collective molecular processes as we stand toward single ones. Inasmuch as Leibnitz also firmly believed in a spiritual world, brought the ethical nature of man within the circle of his views, and was on the best of terms with positive religion, it is well to inquire what he believed concerning free-will, and how he was able to reconcile it with the mechanical view of the world.

Leibnitz was obliged by his whole teaching to be an absolute determinist. He accepted two substances as created by God, the material world and the world of his monads. One can not act upon the other, but the processes go on in both under an unalterable, foredetermined necessity, quite independent of each other, but keeping an exact, harmonious step; the mathematically calculable oscillations of the world-machine, and, in the soul-monads appertaining to each animated individual, the conceptions that correspond with the apparent sensual impressions, volitions, and conceptions of the host of the monad. The very name of pre-established harmony, which Leibnitz gives to his system, excludes freedom. The conceptions of the monads being mere dream-pictures without mechanical cause or connection with the bodily world, it was easy to explain the subjective conviction of freedom by supposing that God has so ordered the flow of the conceptions of the soul-monad that it believes it is free to act.

On another occasion Leibnitz more closely followed the customary line of thought in allowing to man an appearance of freedom behind which a secret compelling impulse is concealed. Considering in his "Theodicy" the famous paradox, attributed to Buridan, concerning

> ". . . the old gray friend
> Which between two bundles of hay"

miserably starved because everything was alike on both sides, and he, as an animal, had no free-will, Leibnitz admitted that, if the case were possible, one would have to decide that he would allow himself to die of hunger; but he held that the case was fundamentally an instance

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of the impossible, unless God should bring it about designedly; for the whole world could not be so halved by a perpendicular plane bisecting the ass lengthwise that all should be equal on both sides. Neither the parts of the world nor those of the ass could be so laid out. "There would also always be many things within the ass and without him which, although we may not remark them, would eventually determine him to turn to one side or the other. Although man is free, which the ass is not, the case of a perfect balance of the motives for two determinations appears to be impossible in him also; and an angel, or God, would always be able to provide an occasion for the conclusion taken by the man, even though, on account of the far-reaching concatenation of causes, that occasion is often very complicated and incomprehensible to ourselves."

Leibnitz availed himself of his optimism to find a place in determinism for the responsibility of man and the righteousness of God. Carrying out a fiction of Laurentius Valla, he describes in his "Theodicy" how sad it was for Sextus Tarquinius to be obliged to commit offenses for which punishment could not be spared him. Many worlds were possible in which Tarquinius might have played a more or less respectable part, have lived happily, and even have died in honor, full of years and lamented; but God was constrained to create this world, in which Sextus Tarquinius should be a villain, because in his foresight it would be the best, and the good would be in it, on the whole, at the maximum.

Monism can not derive any benefit from this idea, which, though consistent with itself, is decidedly arbitrary and bears the stamp of the unreal, and it must seek for itself its own position with reference to the problem of free-will. When one has resolved to declare the subjective feeling of free-will a delusion, it is as easy to reconcile apparent freedom with necessity on monistic principles as by extreme dualism. The fatalists of all periods have found no difficulty in it; and the feeling that was described by Cicero may be disputed away by one possessing a moderate dialectic versatility. Even in dreams, we feel free, while the phantasms of our sense-substances are still playing with us. We know now, of many acts that are apparently performed deliberately because they seem to have a purpose, that they are the involuntary effects of certain arrangements of our nervous system, of the reflex mechanism, and of the so-called automatic nerve-centers. When we watch the flow of our thoughts, we soon remark how independently of our will fancies come, pictures shine out and are extinguished. Need our supposed willful acts really be much more voluntary? If, moreover, all our sensations, efforts, and conceptions are only the product of certain material processes in our brain, then the molecular movement with which the volition to raise the arm is connected and the material impulse that causes the raising of the arm in a purely mechanical manner correspond, and there is no obscurity about it.

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Obscurity comes over the view when the physical sphere is exchanged for the ethical. It is easy to admit that man is not free, but acts as the tool of hidden causes, so long as his conduct is indifferent. Whether Cæsar in thought put on his right or his left *caliga* first was all the same; in either case, he went out with his boots on. Whether he crossed the Rubicon or not, on that hung the world's history. So little are we free in some unimportant matters, that one acquainted with human nature can predict with surprising certainty which card out of several laid down under certain conditions we will take up first. But even the most decided monist could hardly adhere to the earnest purposes of practical life in the face of the idea that all of human existence is a *fable convenue* in which mechanical necessity awards to Caius the part of a traitor, and to Sempronius that of a judge; and therefore Caius is taken to execution, while Sempronius goes to his breakfast. We are not troubled that so many letters in every hundred thousand miscarry because they are not directed; but it stirs our moral feelings to think that, according to Quetelet, so many persons in every hundred thousand are to become thieves, murderers, and incendiaries; for it is painful to have to feel that we are not criminals only because others, instead of ourselves, have drawn the black lots that might have fallen to our share.

Less known than the metaphysical efforts to reconcile free-will and the moral law with the mechanical order of the world are the mathematical essays directed to the same end that have lately been put forth in France. They are related to the unsuccessful attempt of Descartes to explain the working of the soul upon the body, of the spiritual upon the material substance. While Descartes held that the quantity of motion in the world was constant, and did not believe that the soul could produce motion, he nevertheless thought that the soul might determine the direction in which motion should take place. Leibnitz showed that not the sum of motions but the sum of motive forces is constant, and that also the sum of the directive forces, or of the advance in the line of any axis projected in space, continues the same. He, therefore, called the algebraic sum of all those axes parallel components of all mechanical movements. According to the last point, which was overlooked by Descartes, the direction of motion can not be determined or changed without a corresponding expenditure of force. However small we may imagine this expenditure of force to be, it forms a part of the mechanism of nature, and can not be ascribed to the spiritual substance.

The deceased mathematician, Cournot, M. de Sainte-Venant, and Professor Boussinesq, of Lille, have undertaken to break the bands of mechanical determinism by showing that motion can be produced, or the direction of motion can be changed, without the expenditure of force. Cournot and M. de Sainte-Venant have applied the idea of release (*Auflösung*, Fr. *décrochement*), which has long been current in

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the German physiological school. They believe that the force necessary for the release of absolute motion may be not only relatively very small, but even equal to nothing. M. Boussinesq has indicated certain differential equations of motion, the integrals of which permit singular solutions of such a kind that the sense of further motion becomes equivocal or quite indefinite. An example of this kind is the case in which a grave point at the periphery of a perfectly smooth paraboloid, having a perpendicular axis and its apex pointing upward, retains, in ascending in a plane drawn through the axis, the tangential velocity which it had acquired in falling to the same place. It then reaches the apex with a velocity of zero, and remains there till it pleases some directing principle residing there to give it an impulse in a required direction, which, although it is equal to nothing, shall yet be competent to let it glide down the paraboloid again.

Cournot believed that the releasing force, equivalent to zero, M. Boussinesq that the integral, with singular solutions, was needed as a means of explaining, in connection with the directing principle, the diversity and indeterminableness of organic processes. The German physiological school, accustomed to see only simple mechanism in organisms, hesitates to make friends with this conception, fearing, notwithstanding the protestations of its friends, that the vital force that is always, under one form or another, coming to the surface in France might be lurking behind the "directing principle." I may remark here that M. Boussinesq misunderstands me when he makes me say in the "Grenzen des Naturerkennens" that an organism is distinguished from a crystalline form only by its greater complication. On the contrary, I attach importance to having precisely designated the condition in which are grounded all the sensible differences that have caused mankind to recognize, although the same forces rule in both, two distinct kingdoms in living and inanimate nature. This condition is, that, in the inorganic individual, the crystal, matter exists in stable equilibrium, while in the organic individual a more or less complete dynamic equilibrium sways the matter, sometimes with a positive, sometimes with a negative balance. While the stream of matter coursing through the animal promotes the conversion of potential into kinetic energy, it also explains the dependence of life upon external conditions, the integrating stimulus of the older physiology, and the perishability of the organism as opposed to the eternity of the crystal lying inert in itself.

In our opinion, the theory of an unconscious life can subsist without a forking integral and without a directing principle. On the other hand, it is doubtful if anything can be gained in the controversy bebetween free-will and necessity with these aids or with the theory of release. M. Paul Janet's report to the *Académie des Seiences Morales et Politiques* admits the possibility of a mechanical indeterminism on the authority of the three mathematicians. But, when the hypothesis

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that the releasing force may be infinitely small passes to the assertion that it may be really null, it seems to make an unwarrantable use of a process in the infinitesimal calculus which is usual under quite different conditions. The former statement can only mean that the releasing force may be vanishingly small in comparison with the released force. The force of the wing-flapping of a crow which starts an avalanche thus vanishes in the face of the force of the avalanche as it finally plunges through the valley; that is, the former may be neglected in the measurement of the latter, because the influence it exerts can not be indicated by any figures, and because it may fall within the range of errors of observation. But, however insignificant, as regarded from the valley, the wing-flapping above may seem in comparison with the mad force of the avalanche, it is still, there, a blow which corresponds with the raising of a definite weight to a definite height. By the nature of the escapement, the releasing and the released force are independent of each other, connected by no law. Hence it is inaccurate to say that "the ratio of the releasing force to the released force approaches zero," without adding that this depends on an accidental increase, so far as relates to the former, of the latter; as in our example, the wing-stroke being the same, the increase depends on the greater height, steepness, and smoothness of the mountain-slope, on the ever-mightier piling up of snow, etc. So little can the releasing force be in itself really null, it can never, unless we deny the releasing, fall below a certain something (*Schwellenwerth*) capable of an expansion that is dependent on circumstances. Therefore, to explain by the aid of the principle of escapement how a spiritual substance can effect material changes, is not to be thought of.

As to the solution proposed by M. Boussinesq, the grave point remains at the stationary position simply in unstable equilibrium, and it was not necessary to raise it by integration to calculate the consequences of that situation. The case, in fact, differs only in its abstract form of expression from Buridan's or Dante's paradox, which may be so formulated that the hungry creature—

> "*Intra duo cibi distanti e moventi*
> *D'un modo*—"
>
> ("Between two kinds of food, both equally remote and tempting")—

is in unstable equilibrium. No "directing principle" of immaterial nature is competent to move the grave point at the apex of the paraboloid in the slightest degree; a mechanical force, though it be ever so little, is necessary even upon a wholly frictionless surface. If this could be a force equivalent to nothing, then our second transcendental difficulty, of the origin of motion, would disappear at once; for an impulse equivalent to nothing would never be wanting.

M. Boussinesq also brings up the question of what would be the consequence of the reversal of all the motions of the world. If we

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could imagine the mechanism of the world to consist only of reversible processes, and that at a given instant the motions of all the particles of matter were reversed as a ball is knocked back, then the history of the material world would play itself over again backward. All that now happens would come to pass again after its time in the inverse order: the hen would become an egg again, the tree would grow backward into a seed, and after an infinite time the cosmos would be resolved again into chaos. What processes would now attend the reverse movements of the brain-molecules? If mental conditions depended only on arrangements of atoms, then with the same arrangements the same conditions would return, leading to surprising results; among them, that, always at the instant before we contemplate anything, the counterpart of it would happen. We may, however, spare ourselves from estimating the possibilities thinkable here. The crank of the world-machinery could not be thus turned backward. The motion of masses, for instance, which has been converted by friction into heat, could not be changed back again into the same amount of similarly adjusted, opposite-faced motion. The reversed world is a bit of impossible mechanical fancy-work, from which nothing can be drawn respecting the origin of consciousness and free-will.

Our seventh difficulty becomes no longer a difficulty, provided we determine to deny free-will, and to declare the subjective feeling of freedom a delusion; but otherwise it must be regarded as transcendent; and it is but a poor consolation to monism that it sees dualism entangled in the same net the more helplessly as it lays more stress on ethics. In this sense I once wrote, in the preface to my "Untersuchungen über thierische Elektricität" ("Researches on Animal Electricity"), the words upon which Strauss now appeals against me: "Analytical mechanics reaches to the problem of personal freedom, the solution of which must remain an affair of the abstractive faculty of each individual." But afterward—and I make no secret of it—the day of Damascus came to me. Repeated reflections on the subject of my public address, "Ueber einige Ergebnisse der neueren Naturforschung" ("On some Results of the Later Natural Philosophy"), led me to the conviction that at least three transcendental problems precede the problem of free-will, viz., besides the problem of the origin of matter and force, which I have previously defined, that of the first motion and that of the first sensation, in the world. That the seven world-problems have been counted out and numbered here as if in a mathematical book of examples, has come to pass in consequence of the scientific *divide et impera*. We might combine them into a single problem—the world-problem. The mighty thinker whose memory we honor to-day believed that he had solved this problem. He had arranged the world to his satisfaction. Could Leibnitz, standing on his own shoulders, take part in our reflections to-day, he would surely say with us, "*Dubitemus.*"

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HOW ANIMALS BREATHE.

By HERMAN L. FAIRCHILD.

I.

ANIMAL COMBUSTION.—Within every living organism there are two opposing forces. The "vital force," which produces all the phenomena of life, holds the material elements in unstable relations—against their will, so to speak—and it is antagonized by the natural chemical affinities of the elements, which tend to break down the organic compounds and rearrange the elements in more stable form. This decomposition takes place in some degree during the life of every organism, and when life ends, or when the vital force ceases to act, it rapidly destroys the structure.

The waste matter resulting from this disintegration must be immediately removed from the body of the living animal, otherwise it clogs and poisons the system. The method of its accomplishment is one of the most admirable functions of the animal economy. To remove the effete matter in the natural liquid or solid state would be very exhausting; consequently it is burned, and the gaseous products of its union with oxygen are then easily carried away. Literally speaking, this makes a furnace of the body of every animal; and the most pressing and ceaseless demand of the system is for oxygen to support its fires. Respiration is hence an absorbing and excreting process, whereby oxygen is received and carbonic acid and water removed. It thus becomes a measure of the amount of combustion.

In the "cold-blooded" animals respiration bears a direct proportion to the activity and the heat of the body, as the former causes a metamorphosis and waste of tissue, and the latter always aids decomposition. The fact is one of common observation. It is well illustrated in the quickened breathing of a tired animal, and in the almost entire suspension of respiration in the hibernating state. The respiration of a "cold-blooded" creature is increased by artificial heat. In



FIG. 1.—COBITIS FOSSILIS. It swallows air-bubbles which pass through the intestine, where the mucous membrane takes up the oxygen for respiration.

extremely hot weather frogs may have to leave the water entirely, and fishes come to the surface to procure air. Reversely, frogs can be kept for years in a state of suspended animation by a low temperature, and revived by warming. Some low animals can survive freezing or

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drying for an indefinite time; and, under such conditions, the waste of the tissues must be entirely suspended.

In "warm-blooded" animals — birds and mammals — a constant body-temperature, independent of the surrounding atmosphere, is maintained by the immediate use of the food as fuel. Consequently, in a warm atmosphere less internal combustion is required than in a cold one, and the respiration of birds and mammals is therefore inversely proportionate to the external temperature, although directly proportionate to the activity of the animal.

This constant body-temperature is the reason of the difference in the kind and quantity of food required according to season or latitude. While the people of the tropics subsist chiefly on vegetable food, which supplies little fuel, but on the contrary much fluid to cool the body by evaporation, the inhabitants of frigid regions use carbonaceous foods affording the greatest proportion of fuel.

Experiments tend to prove that human respiration is, as would theoretically be expected, less rapid in the tropics than in the cold regions. Every traveler knows that a less amount of food is required. But on the contrary, and for the reason above stated, respiration in the cold-blooded animals is more rapid in the tropics, and the quantity of food is greater.

Physiological Principle.—The process of respiration is in principle an interchange of gases between the fluids of the structure and the external medium, air or water. It should be unnecessary to say that aquatic animals do not breathe water, but the air which is absorbed by the water. This exchange is effected by the physical action known as osmosis. It is a question whether vital influence has any part in the process. The principle is identical in all creatures, air-



Fig. 2.—Holothuroidea (*Thyone papillosa*). (After Forbes.)

breathers and water-breathers—those which have special fluids, or blood, and those having none. It applies to plants also, as far as they have a true respiration.

In bringing the internal and the external fluids adjacent, Nature in this function, as in all others, is nicely economical of power. In "water-breathers" the blood, when existing, is commonly sent to the surface of the body, and a slight movement of the water produced—sufficient to renew that in contact with the respiratory organs. But "air-breathers" always draw the mobile atmosphere inward to the blood.

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RESPIRATION OF PLANTS.—The leaf-respiration, so called, of plants is not an excretory process, but rather a nutritive one. In effect it is precisely the reverse of true respiration. It is a deoxidizing process —separating the components of carbonic acid under the influence of the sun's rays, and depositing the carbon; whereas respiration is an oxidizing process—the production of carbonic acid. However, during germination and flowering, and in darkness, decomposition takes place within the plant, resulting in the production and elimination of carbonic acid—a true respiration.

Many biologists now hold that there is a constant decomposition of crude nutriment in the interior of plants, and therefore a slight respiration, but that it is masked by the more prominent nutritive process. The leaves are commonly, but wrongly, called the lungs of the plant, for their chief function, as we observe, is not respiration, but nutrition. It were more correct to regard them as the stomach of the plant.

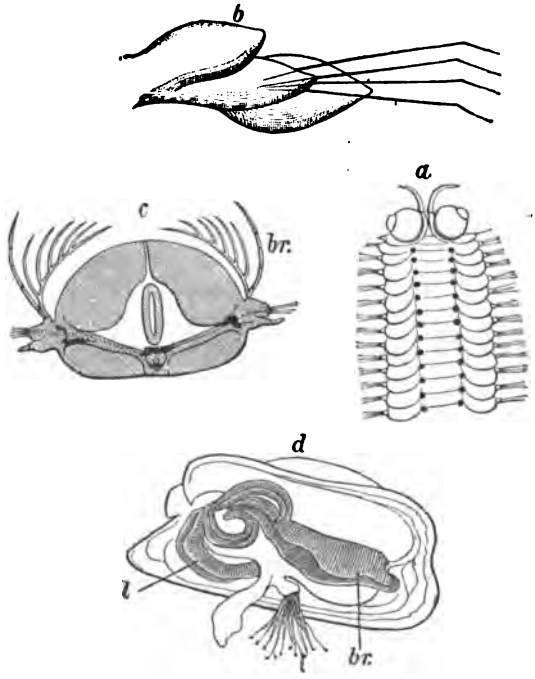


FIG. 3.—GILLS, *a*, *b*, *c*, OF ANNELIDA; *d*, OF A BIVALVE MOLLUSK. *a*, *Nauphanta celoæ* (Greeff), enlarged to three diameters, with broad gill-fins. *b*, foot of *Vanadis ornata* (Greeff), with two broad gill-fins. *c*, section of a segment of *Eunice*; *br*, the ramified gill-appendages of the rudimentary foot. *d*. *Mytilus edulis*, with *br*, the gill-folds, and *l*, the lips separated from them.

ORGANS OF RESPIRATION.—As the function of respiration is so simple in principle, being a single physical action, it can be conducted almost anywhere in the body, or wherever the blood can be conveniently exposed to the surrounding medium. The nature of an animal, as regards other less easily modified functions, and its peculiar circum-

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stances, may therefore greatly determine the character of its breathing-organs. So it results that these organs, in the various groups of animals, are exceedingly diverse in form, structure, and position. They are much more diverse, indeed, than are the organs of any other function, and any classification now possible is quite arbitrary.

In purpose, however, or *physiologically*, all breathing-organs are simply an expansion of surface for the more rapid aëration of the circulating fluids. And in origin, or *morphologically*, they are fundamentally a modification or development of the skin ; being developed either primarily, i. e., directly from the skin itself, or secondarily, i. e., from the alimentary canal, which is itself so derived.

The following tabular classification shows the general morphological character of the respiratory organs in the primary groups of the animal kingdom. While correct in the main, it does not cover all exceptional cases, but fairly exhibits the development of the organs and the "differentiation" of the function from the lowest to the highest animals. Except in the vertebrates no regard in this table is paid to any distinction between air and water breathing.

In explanation : A stands opposite the mode of respiration which is *characteristic* of the group beneath which the letter occurs ; and the diminishing degrees in importance of the various methods are indicated by the small letters according to the alphabetical order : but of course the same letter is not of equal value for different groups of animals.

The reader will observe the common use throughout the whole animal kingdom of the skin unmodified. Also that the special organs of the invertebrates, which number more than nine tenths of the whole, are quite limited to modifications of the skin ; while those of vertebrates belong only to the alimentary canal. The description to follow will adhere to the order of the table :

RESPIRATION BY—		Lower Protozoa (Rhizopoda).	Higher Protozoa (Infusoria).	Lower Radiata (Coelenterata).	Higher Radiata (Echinodermata).	Articulata.	Mollusca.	Vertebrata. Pisces.	Amphibia.	Reptilia.	Aves.	Mammalia.
Special Organs, developed from	Food-tract. } Lungs. Gills.				e	e		b A	A c	A	A	A
	Skin (immense variety of organs).				A	A	A					
General Surfaces of body without any important modification.	Food-tract.....		b	A	b	d	d	c	d			
	Skin.....		A	b	c	b	b	d	b	c		e
Entire Substance of body. Respiration without organs.	.....	A										

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Respiration by the Unmodified Skin and Food-Tract.—The general surface of the body has in all soft-skinned animals an aërating or respiratory action; and the simplest expression of *organs* is found in those animals where the body-surface is the only breathing-organ. But a simpler expression of the *function* is shown in an amœba, for example, where by the amœboid movements every part of the structureless body eventually becomes surface, and is brought into immediate contact with the water. The amœba has no permanent skin, and no organs of any kind; consequently it breathes without special organs, and the other nutritive functions are equally destitute of them.

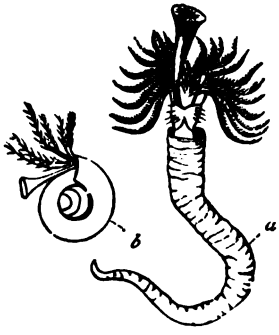


Fig. 4.—Tubicola. *a*, *Serpula contortuplicata*, showing the branchiæ and operculum; *b*, *Spirorbis communis*.

Many animals of higher groups breathe mainly or entirely by the skin. Among articulates, the leech and earth-worm are examples. In these a net-work of minute blood-vessels is spread beneath the delicate skin, thus bringing the blood into proximity with the water or air. The lowest crustaceans, and some sea-snails, and sea-spiders also, respire by the skin alone.

Most amphibians use the skin largely in respiration. In cold water, frogs will breathe entirely by the skin, and can not be killed by forced immersion, so long as they are provided with food. Even at ordinary

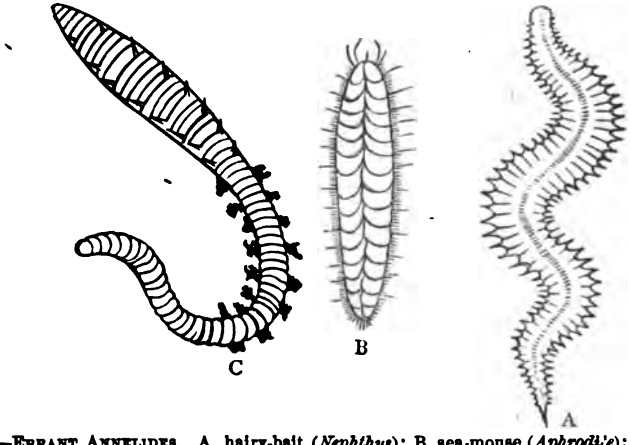


Fig. 5.—Errant Annelides. A, hairy-bait (*Nephthys*): B, sea-mouse (*Aphrodite*); C, lob-worm (*Arenicola*). (After Gosse.)

temperature, it is easier to drown some fishes by preventing them from reaching air than it is to suffocate frogs under the same conditions; yet the former have only gills, and the latter lungs alone. The hell-bender, found in our Western rivers—the largest American salaman-

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der—breathes entirely by its skin under ordinary circumstances. To expose more surface, the skin is greatly expanded, lying in ugly folds; while, to renew the contiguous water, the body is frequently arched and rolled from side to side, which motion, together with the aspect of the creature, has given it the above expressive name.

As the outer surface of the animal body may without any special modification have a respiratory function, so we find the same to be true of the food-canal. The body-cavity of the polyp and jelly-fish, with its tubes and branches, has in previous articles been described as the organ of digestion, circulation, and respiration in common.* Many

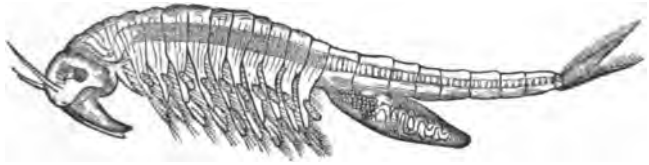


FIG. 6.—PHYLLOPODA. Fairy Shrimp (*Chirocephalus diaphanus*). (After Baird.)

annelids breathe partly by currents of water passing through the intestine. A slight modification of the lining of the food-tract is found in the larvæ of the dragon-flies, which, living in water, have respiratory villi in the rectum; and the sea-cucumber has foliated processes in its stomach, bathed by water-currents, which doubtless have a respiratory function.

Many fishes swallow air as an aid to respiration. In the loach (*Cobitis fossilis*), and numerous others, it is certain that this air traverses the stomach and intestines.

SPECIAL ORGANS OF THE SKIN.—Of the special breathing-organs we will first consider those which are developed directly from the skin. They are especially characteristic of the invertebrates, as they include all the special respiratory apparatus of that division of the animal kingdom, whether adapted for water or air, and they are not found beyond this group.

AQUATIC ORGANS OF THE SKIN.—The higher radiates and the lower articulates possess an arrangement of tubes and vessels known as the "water-vascular" or "aquiferous" system. Although the relation of these vessels to the circulation is not fully determined, it is probable that they are chiefly or entirely for the purpose of conveying water inward, and thus constitute respiratory organs. They are rendered necessary because of the undeveloped condition of the blood-circulating system. Like other cavities, they are only an inflection of the surface-tissue.

This aquiferous system is of very great complexity and variety, and full description is impracticable. It is at once greatly developed in the sea-urchin and star-fish; and is especially complex in the sea-

* Other articles in comparative physiology are contained in the "Monthly" of April, June, and September, 1880; and August and September, 1881.

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cucumber, where it is connected with gill-like appendages about the mouth. The intestinal worms and other annelids possess this style of breathing-organs. Later we shall find in the insects a similar and perhaps homologous system for conveying air.

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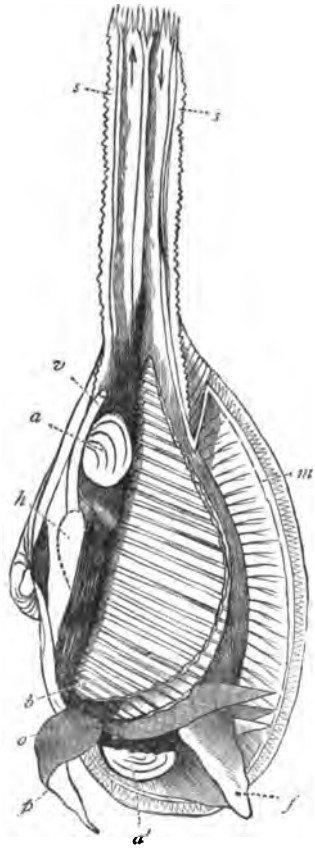


FIG. 7.—ANATOMY OF A BIVALVE MOLLUSK (*Mya arenaria*). The left valve and mantle-lobe and half the siphons are removed. *s s*, respiratory siphons, the arrows indicating the direction of the currents; *a a'*, adductor muscles; *b*, gills; *h*, heart; *o*, mouth, surrounded by (*p*) labial palpi; *f*, foot; *v*, anus; *m*, cut edge of the mantle. (After Woodward.)

Most aquatic invertebrate animals which have a true circulating fluid send this to expansions of the skin to be there oxygenated by the surrounding water. This is termed "branchial" respiration. The branchiæ or gills may be wholly exposed and external to the body, or may be contained in suitable cavities. They may develop on any part of the body; and they exhibit a great variety in many respects. With this system is frequently found some special accessory apparatus for producing and regulating a flow of water over the gills.

The sea-worms have a great variety of external gills developed immediately from the skin. Renewal of water is secured by cilia which cover the body or even the gills. These branchiæ are finely shown in the common *Serpula*, where they form a crown of scarlet plume-like about the mouth. The *Arenicola*, or sand-worm, has two rows of crimson rosettes along the sides of the body. The *Eunice*, *Nereis*, and sea-mouse, are other worms possessing beautiful arborescent fringes of branchiæ.

As the crustaceans, excepting a few of the lowest, are covered with a hard shell of dead matter, they can not respire through the skin, and hence of necessity require special organs. These are commonly leaf-like expansions, usually attached to the locomotive or other appendages; the purpose of such attachment being to secure rapid change of the surrounding water. In some groups, the entire limb becomes foliaceous and respiratory, so that it is literally correct to say that the fairy shrimp breathes with its legs. Other forms, including the sand-hopper, whale-louse, and fresh-water shrimp, breathe by vesicles or bladders attached to the limbs. The water-fleas, as *Cypris* and *Cyclops*, so common in our fresh waters, have their branchiæ attached to the jaws. Many forms, among which are the king-crab, or *Limulus*, and

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the group of isopods, respire by foliaceous or feathery appendages beneath the abdomen.

The higher crustaceans—crabs, lobsters, and shrimps—have arborescent gills inclosed in cavities on the side of the thorax. They are at-

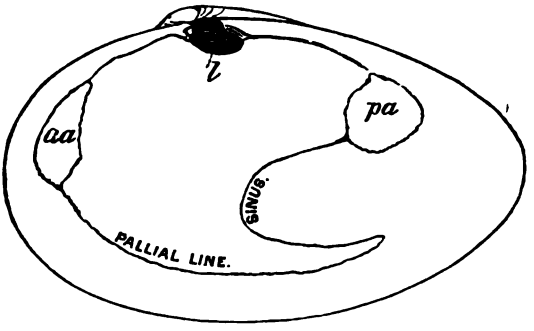


FIG. 8.—RIGHT VALVE OF A COMMON CLAM. (After Morse.)

tached to the bases of the legs, but the motion of the latter would here have little effect to renew the water. This is accomplished by a curious valve placed in the excurrent orifice of each chamber, which resembles in principle the screw-propeller of a steamship. The observer will find the excurrent orifice at the side of the mouth, and the incur-



FIG. 9.—DORIS, OR SEA-SNAIL. (After Carpenter.)

rent orifice between the edge of the shell and the bases of the legs. Curious combs and brushes are provided to keep the gills clean and the filaments separate.

Bivalve mollusks, as clams, mussels, scallops, etc., have gills made of foldings of the "mantle" or skin. (See Fig. 10, page 467, of the August "Monthly.") There are generally two for each side of the

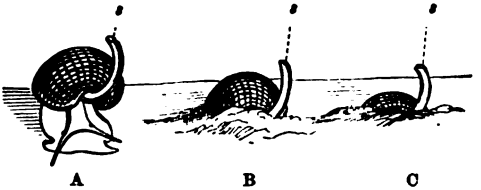


FIG. 10.—A, the snail crawling upon the surface of the mud; B, the same slightly buried; C, the same nearly buried; the siphon, *s*, is seen curved upward. (After Morse.)

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body ; and their form has given to this class the scientific name *Lamellibranchiata*—plate-gills. The water bathing the gills is constantly renewed by means of *cilia*." Wonderful, indeed, is the elaborate mechanism employed to effect the double purpose of renewing the re-

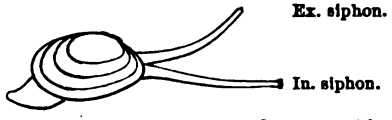


FIG. 11.—LAMELLIBRANCH, SHOWING TWO SIPHONS. (After Morse.)

spired fluid and feeding the helpless inhabitants of these shells. Every filament of the gill-fringe, examined under a powerful microscope, is found to be covered with countless cilia, in constant vibration, causing, by their united efforts, powerful and rapid currents. . . . So ener-

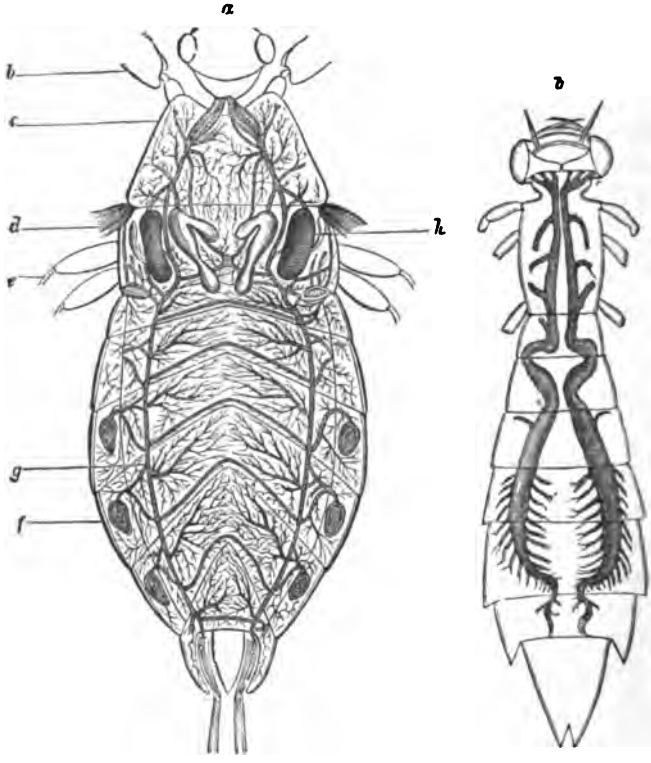


FIG. 12.—TRACHEAL SYSTEM INDICATED WITHIN THE OUTLINE *a* OF A WATER-BUG, *b* OF THE LARVA OF AN ÆSCHNA. The tracheæ are shaded.

getic, indeed, is this ciliary movement over the entire extent of the branchial organs that, if any portion of the gills be cut off with a pair of scissors, it immediately swims away, and continues to row itself in

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a given direction as long as the cilia upon its surface continue their mysterious activity." *

In the oysters and scallops, the mantle is open, exposing the gills; while the mussels and giant *Tridacna* have the mantle closed but pierced with two apertures for the reception and expulsion of water. The remaining lamellibranchs, which include the common hard clam, razor-shell, pholades, and teredo, have long inhalent and exhalent tubes, called *siphons*, which enable the creature to burrow in the sand and still obtain water. The two siphons may be separate or united, and are retractile. The presence of such tubes can be determined by examination of a dead shell; as the muscles which retract the siphons produce an indentation or "sinus" in the "pallial line."

Perhaps the most conspicuous and beautiful gills are those possessed by the naked sea-snails or "sea-slugs." They are situated on the back and sides of the body, and are frequently retractile. In the *Doris* they have a flower-like or star-shaped arrangement. In the *Eolis* they are papilliform and tufted, along the sides of the animal, or they may be tree-like as in the *Triton*, or feathery in other forms. The *Aphysia*, or sea-hare, has the gills placed on the back and protected by a fold of the mantle. The *Phyllidia* have them as a fringe along each side of the body, and covered by a projecting fold of the skin; while the *Limpet* and *Chiton* have leafy gills forming quite an entire circle about the body, and also covered by the mantle.

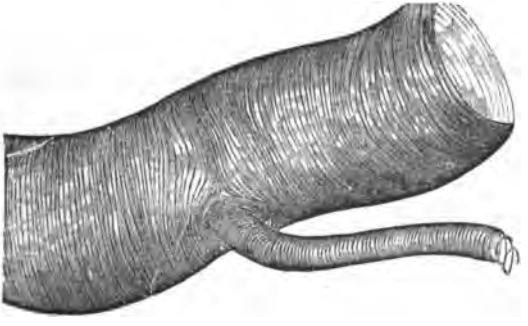


FIG. 13.—AIR-PIPE OF FLY.

The sea-snails having shells carry their gills in cavities in the side of the neck, and may or may not have siphons. The possession of the latter is shown by a notch in the aperture of the shell.

All the mollusks mentioned thus far are sluggish animals, with little need of rapid respiratory changes of the blood. But the highest of mollusks, the cephalopods, or devil-fishes, are active and muscular creatures—the most powerful of invertebrates. They have accessory hearts to accelerate the flow of blood through the gills, which are large and plumose, and contained in a cavity. Water is freely sup-

* T. Rymer Jones, "The Animal Creation," page 194.

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plied to the gill-chamber by the open mantle; but, by the contraction of the latter, the water is forcibly expelled through a tube termed the "funnel." This expulsion of water from the branchial chamber is their chief means of locomotion.

AËRIAL ORGANS OF THE SKIN.—Special organs developed from the outer surface of the body and adapted to air-breathing are confined to



FIG. 14.—SPIRACLE OF COCKCHAFER-GRUB.

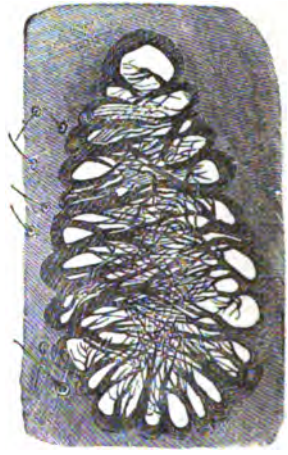


FIG. 15.—SPIRACLE OF FLY.

the articulates and mollusks. None are found in the radiates, this great division being wholly aquatic.

Although the crustaceans always possess gills, and are theoretically classed as water-breathers, yet certain species live entirely on land, and some are even killed by long immersion in water. The gill-chambers of the land-crabs are proportionately very large, exposing more surface to the air, and the openings are small to prevent evaporation. Some species inhabit the highest ground of West India islands, but they seek damp or sheltered places, and possess some means of keeping the gills moist, either by carrying a small quantity of water, or by a secretion of the sponge-lining of the chamber. Structurally these organs are gills, but functionally they are true lungs.



FIG. 16.—SPIRACLE LEATHER-COAT.

Another crustacean, the wood-louse (*Oniscus*), lives in damp places, and breathes air by foliaceous gills beneath the abdomen.

The only groups of articulates wholly air-breathing are the myriapods, insects, and arachnids. The myriapods show a transition from the skin-respiration of the leech and earth-worm to the air-tubes of the insect. The latter possesses the most peculiar and effective system for aëration. As in

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the annelids a complex system of tubes conveys water to the tissues, so in the insects all parts of the body, and the nutritive fluid, are bathed by air admitted through a complex tube-system. So complete is the aëration of the whole structure, that practically the blood of an

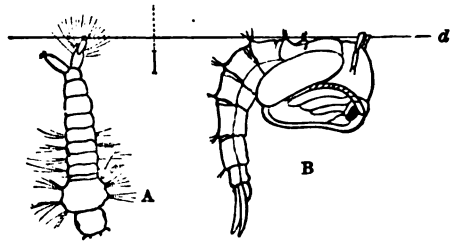


FIG. 17.—A, lava; B, pupa of a mosquito. *d* represents the water-line. (After Morse.)

insect is wholly arterial. The necessity for this lies in the slow and imperfect circulation, coupled with an unparalleled activity.

The air-tubes, "tracheæ," traverse every part of an insect's body, even the brain and eye, and form the nervures or frame-work of the wings, where they are sheathed by another tube conveying blood. They are prevented from collapsing by a mechanism, one of the most admirable and exquisite found in nature. A delicate, elastic thread is wound in a close spiral between the two membranes of the walls of the tubes—a contrivance which we have imitated in the flexible gas-tube of a drop-light.

The openings to the tracheæ, termed "spiracles" or "stigmata," are generally located on the sides of the abdomen and thorax, a pair for each segment, and exhibit great variety and adaptation to their purpose. So constructed as to admit air, they exclude water and dust, and can be opened and closed at the will of the creature. Sometimes they are a mere slit, like a buttonhole. In the soft-skinned larvæ they are kept open by a horny ring. The aperture is sometimes protected by interlacing hairs; sometimes it is grated, or in other species closed by a thin membrane pierced by innumerable small pores—a real sieve. A drop of oil placed upon the abdomen immediately fills the spiracles and smothers the creature.



FIG. 18.—GRUB OF CHAMELEON-FLY.

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The change of air is produced in the tracheal system by the enlargement and contraction, or bellows-action, of the abdomen, the segments sliding in and out with a telescopic movement, very perceptible in the larger insects.

Many insect larvæ live in water, but are still air-breathers. The mosquito is an example. Here the eighth joint of the abdomen sends off a long tube, crowned at the extremity with feathery bristles, which are brought to the surface of the water to seize a drop of air. With this the larva descends and the repellent action of the setæ prevents the water from dissolving it. Some water-larvæ have tubes several inches long. Other larvæ, destitute of tubes, have the spiracles at the posterior end of the abdomen. In the pupa state the mosquito has two respiratory tubes on the back of the thorax.

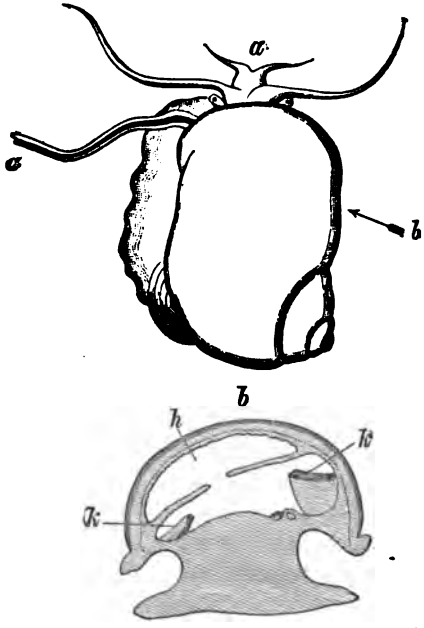


FIG. 19.—GILL-LUNGS OF AMPULLARIA. *a*, *Ampullaria insularum* (D'Orb.). *a*, long respiratory siphon; *b*, section in the direction of the arrow *b*; *h*, the upper lung-cavity; *k*, branchial cavity with the right and left gills; the cavities communicate by a passage in the center of the dividing wall.

The aquatic larvæ of the dragon-flies (*Libellulidæ*) have, as already mentioned, hair-like processes, "villi," of the lining of the rectum, which absorb air from the water and convey it into the tracheal system. It is difficult to determine if such larvæ should be regarded as aquatic or aërial. Certainly in their habits, and in their method of procuring oxygen, they are aquatic and possess gills. But the oxygen is not immediately given to the blood in the villi, as in true gills, but is conveyed through tracheæ just as in adult insects. On the latter account these larvæ are generally considered aërial.

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Adult water-insects carry air into the depths of the water by holding it under the wings or legs, or by the minute hairs which cover the body. This frequently gives them the silvery appearance of a globule of mercury, and sometimes renders the creature so buoyant that it has to descend by muscular effort—swimming downward, or crawling down a plant-stem.

Insects of powerful flight have sacs developed on the tracheæ, which doubtless serve to store air, and also to render the body lighter.

Spiders lack the tracheæ, but have the spiracles opening directly into sacs. These are various in structure, sometimes folded like gills, or in other cases cellular, like a rudimental lung in structure.

Among mollusks only the true snails are air-breathing, and some of these inhabit water. They have organs resembling those of the spider, concentrated into a single sac. This is lined with blood-capillaries and constitutes a true external lung. The orifice opens on the right side of the neck, and can be closed by a circular muscle.

In the pond-snails we have a clear illustration of the identity in principle of air and water respiration. For, in the *Lymneæ*, the sac, which in the early stages of the animal breathes water alone, can suddenly change to a lung, and thereafter breathe only air. And in specimens from deep water the change may occur in the adult animal. The *Ampullariæ* have the breathing-sac partially divided into an upper or air chamber and a lower or gill cavity; using first one and then the other, or breathing air and water alternately at intervals of a few minutes.

DREAMS AND THE MAKING OF DREAMS.

By J. MORTIMER GRANVILLE, M D.

DREAMS are night-thoughts, unchecked by the judgment and uncontrolled by the will. It is not true that we do not reason in dreams, that the exercise of the judgment is wholly suspended, and that the will is entirely powerless or ceases to act. These faculties are not altogether in abeyance, but they doze while the subordinate powers of the mind—those which play the parts of picture-carriers and record-finders—ransack the treasures of memory and mingle together in the direst confusion old things and new. Imagination is not active, but it remains just enough awake to supply the connecting links which give seeming continuity to those parts of the phantasmagoria which we chance to remember on recovering perfect self-consciousness, and which, being remembered, we call "dreams." No one remembers more than one dream, unless he has roused from sleep more than once. This experience has led to the inference that dreams only occur at the

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moment or in the act of awaking. There are dreams which take place in the process of returning to consciousness—for example, those instantaneous scenes and spectacles which are suggested by the sound or feeling that rouses the dreamer; but, in result of a long and close study of the subject with a view to discover the nature of dreams, and the laws of dreaming, for medical purposes, in connection with the treatment of sleeplessness, I am persuaded that dreams occur in the course of sleep and are wholly forgotten.

That they do not and can not take place in deep sleep is probable, because deep sleep is general sleep, and when this state prevails the subordinate faculties are sleeping, and the pictures and records which compose dreams are not disturbed. To understand dreams we must understand sleep, and it is because the two phenomena have not hitherto been studied together that so little is generally known about either.

Sleep is a function or state in which the particular part of the organism sleeping *rests:* whether it is wholly inactive depends on the degree of rest it enjoys. Every part of the organism sleeps, and the totality of the sleep-state depends on the fact of all the important parts sleeping at the same time. If some remain awake—perhaps busy with an unfinished task, or setting about one which the will has foolishly imposed on one of the lower faculties before itself going to sleep, or, it may be, too worried to take natural rest—then the unrest of the busy or distressed faculty or faculties will render the sleep as a whole incomplete, and the repose of the actually sleeping faculties disturbed. Natural sleep is simultaneous sleep of all the faculties of body and mind; and the secret of sleeping soundly and restfully consists in so ordering the life that the higher intellectual powers, the powers of automatic activity, the senses, the muscular system, and the viscera—principally the stomach—may all be ready and able to sleep at the same time. This can only be accomplished by making the act of sleep a thing done periodically, with that rhythmical regularity which Nature loves and on which the smooth working of the machinery of life depends. When sleep is natural, in the sense of being complete, dreaming is, as we have said, improbable, if not impossible; and the measure of dreaming is therefore—inversely—the measure of the integrity of the sleep enjoyed. A great dreamer can not be in good health, or, to use a familiar expression, he "can not have all his wits about him" when he is awake. Every faculty—by which I mean, every part of the organism which performs a distinct function—must sleep; and, if it be healthy, it will sleep at regularly recurring periods. It follows that a dreamer who is not unhealthy—a *rara avis*—must have formed the habit of allowing his faculties to sleep separately; some being on duty, or watching, while others rest. As a matter of fact, most persons form this habit to some extent, and therefore the majority dream. For example, the man who works with his brain often takes little muscular exercise, and

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his apparatus of motion rests and doubtless sleeps while his mental faculties are in full action. It may happen that the development of this habit of separate sleep is carried to such an extent that the several centers of the brain habitually take their rest independently of each other, and at different times. The clerk will doze as he adds up his column of figures; and the copyist will go on transcribing while his centers of thought and imagination sleep. Conversely, the lower and automatic centers of the brain—the senses—may sleep while the higher centers are awake. Much of the so-called "abstraction" and "absence" of mind we notice in ourselves and others is due to this cause. The brain-worker gains credit for being lost in thought when he does not perceive some object which ought to impress him strongly through one or more of the senses; the farmer toiling over his fields, the hunting-man weary with his day's work, the soldier exhausted by the toil of the march, will sleep so far as one set of faculties, or one part or system of the organism, is concerned, while the others are not only active, but so controlled that the subject of this partial sleep may walk or ride or go through evolutions while his mind sleeps. In short, it is possible, and easy, to fall into any habit of this class, and the inevitable consequence will be that only some of the faculties, or parts of the organism, are ready to sleep when night comes round, while those which remain awake will be unrestful and disturb the others so that they can only doze. In this state of matters, dreaming is an unavoidable experience. Meanwhile, the most highly developed and dramatic dreams occur to those whose sleep is so partial that part only—and, as it would often seem, a small part—of the brain sleeps at any time; or, perhaps, I ought to say, at night—because it not unfrequently happens that those who dream much by night do not dream when they sleep by day. This variety of partial sleep, which tends to sever the natural connections between the several component parts of the mind, is injurious, and therefore it is, as I have remarked incidentally above, that great dreamers are, as a rule, unhealthy. It is easy to see how this must be. If the intellectual faculties are, so to say, broken up in such a way that when some are active the others are sleeping, the checks and restraints which the several parts of the mind naturally impose on each other are wanting, and any one of the faculties may become exaggerated in the exercise of its functions. The practice of dreaming will then extend to the day, and the mind may—especially if there be any inherited and constitutional lack of cohesion among the intellectual faculties—become disorganized. This is a contingency, or more than a contingency—let us say, a probability—against which the dreamer of particularly "worked-up" or realistic and elaborate dreams should be on his guard. It does not, however, follow from what I have said that the most *coherent* dreams are the worst, because the judgment may be simply dozing, and able to correct the scene or story as it passes through the mind. In that case, the sever-

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ance between the higher and lower faculties will not be so great as when the incongruities of the dream are unchecked, and yet the pictures and thoughts present to the mind are especially clear and strong in their outline and coloring. Intensity without coherence is, as a rule, worse than an equal amount of vivid dreaming with more connectedness of thought. We now know something, though a very little, in truth, about dreaming, and we may pass to the consideration of our proper subject—dreams and the making of dreams.

Dreams are re-collections, in the strict sense of that word. The pictures which have been put away in the chambers of mental imagery, the thoughts which have been recorded, as all thoughts are recorded, by the molecules of the brain in the act of thinking, the impressions left by perceptions made by the organs of sense, and by conceptions originated by the faculties of mental sensation, impressions of feeling, together composing the records of experience, are brought out of their holes and corners, and, as it were, thrown crudely before the mind. There is seldom any clear evidence of order in the arrangement, but there is no reason why, if the collecting faculty be thoroughly awake, it should not follow beaten tracks, and arrange the pictures and records it reproduces in their natural sequence. Moreover, there is that association of ideas which forms the basis of memory, and this will almost necessitate a certain amount of connection between the elements of the most chaotic dream. All that seems to be original in a dream is due to the kaleidoscopic effect of throwing the materials of which the scene is constituted into new and startling combinations. We know how much of novelty may be produced in the accidental combinations effected by shaking together some dozen particles of colored glass, or other small objects, in a kaleidoscope. The variety will be greater and the new combinations more surprising in the throwing together of memories in a dream, because the natural associations help to give *vraisemblance* to the effect, and the imagination, which is seldom wholly asleep, gives finishing touches to the panorama as it proceeds. Much less, however, is due to the intervention of fancy in a dream than is commonly supposed. The great majority of the results produced are caused by the overlapping of pictures, the entangling of threads of thought, and the distortion of the original connections between ideas, pictures, and records of impressions which have either been received or put away together, or connected in previous dreams. For dreams are often, wholly or in part, reproductions of former dreams, and in process of years a mind may become expert in, or habituated to, the experience of a particular class of night-visions and night-thoughts. Dreams may be roughly divided into four classes: 1. Those of the present; 2. Those of the past; 3. Those of the future; and, 4. Dreams which would appear to be simply heapings together of inchoate ideas and mind-pictures, without either time, order, method, or reason. On each of these classes of dreams there

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is something to say, but it must be said briefly, and rather by way of suggesting inferences to other minds than in argumentative support of my own conclusions.

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First, as to dreams of the *present*—it is important to note that, though these are seldom precisely what they seem, when there is a tendency to employ very recent mental pictures, records, and impressions as the material of dreams, the faculty engaged in dream-making is either jaded or lethargic. Thus we get the same result, as regards the constituents of the dream, from two opposite causes. When that part of the brain which performs the function of re-collecting the records of memory is very weary—perhaps too distressed by excessive or disorderly work to sleep—it worries the mind with the subjects of immediately previous attention, being unable to leave them, and busying itself with them in a purposeless and distressful way, as a somnambulist or very sleepy person labors at a task he is unable to leave. The result will be a dream consisting of thoughts and scenes and impressions of the scenes which, as it were, cling to the mind and will not be dismissed. There are, doubtless, especial states of the mind, or its organ, the brain, which may be loosely described as "sticky," and which create a strong tendency to dally with objects of thought, and hold impressions of the senses before the consciousness longer than is necessary, instead of putting them away promptly in the memory. We know how the clumsy-fingered or bewildered workman clutches his tools and hangs over his task instead of using each tool deftly, doing each stroke of work cleanly, and passing on to something else. The same faults of method are to be recognized in the operation of many of our mental faculties, and this is one cause of dreams constructed of recent materials. Dreams of this class, as would naturally be expected, are deficient in that characteristic which is due to an active play of the dream-making faculty with the materials it employs, namely, the quality of "originality." They are apt to be little more than worrying recitals of the words spoken, the books or letters read, and reproductions of the scenes and impressions of the previous day, without much modification or embellishment. When reminiscences of this nature occur at night in the false sleep that mocks real rest, they are likely to be exaggerated and intensified in an extraordinary and generally painful degree, simply because the mind is isolated by sleep from its immediate external surroundings, and all the energy of consciousness it evolves is, so to say, turned in on itself. Dreams of the present, produced by lethargy or exhaustion of the faculty which collects and reproduces the pictures and records of memory, are generally distinguishable by their tumultuous or oppressive character. The faculty is, as it were, overburdened by the subjects it strives to manipulate. It can neither bring them fully and clearly before the consciousness, nor can it remove them at pleasure. The mind does not so much itself hold them as feel oppressed by their presence. It

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would fain be rid of the thoughts and scenes pressed on its attention, not because they create a painful interest, but because they bore it. On the other hand, dreams of the present, which are more directly due to the general state of mind previously described, take an agonizing hold on the consciousness, and will not be shaken off, so that it struggles to be free as in a state of mental nightmare. Dreams of the present which are produced by a lethargic rather than an exhausted state of the faculty that makes them, are characterized by the slow progression of scenes and the tardy flow of thoughts rather than repetition. The consciousness seems to be in a dreamy condition, while some slow and stupid exhibitor is unfolding a story or panorama lazily. The resulting feeling is one of simple fatigue from loss of rest, rather than the head- and heart-aching, as from worry and prolonged irritation, which follow on dreams of the present that have been produced in the ways already indicated. It may be set down as a rule, that dreams of the present are of graver import as clews to the mind-state than the other classes of dreams on which we must now bestow a few moments' attention.

Dreams of the past and future do not call for detailed consideration, and may be most conveniently noticed together. When the faculty which makes dreams dives deeply among the lumber for its materials, it is either very active, and probably not sufficiently worked in the waking hours, or it has not much interest in recent events, because these have not made a very strong impression on the mind. It often happens that at a period of life when there is not any particularly keen interest in the present, the dreams are of the past. When a man is growing old, he dreams of his early life, not merely because there is in all respects a tendency to revert to the beginnings of life when the power of vitality is on the wane, but because there is a loss of interest in the present. The heat of the struggle is over, and the emotions are no longer as active as they were, so that self-consciousness comes to be increasingly a retrospect of experience. Dreaming only occasionally of the past may be the simple result of the association of ideas, the dream really consisting in a present recollection of records relating to the past: but I am now speaking of the habitual reproduction of long-past and possibly forgotten pictures and records of memory in dreams. Dreams of the future are, for the most part, anticipations arising out of the affairs of the present. They are, properly speaking, forebodings, or eager foretastes, of the dreaded or desired issue of plans and experiences which belong to the present. There is no reason to suppose that the mind is capable of prophesying while the supreme cerebral centers sleep. Most of the so-called dreams of the future are really vaticinations of the imagination while on its way to sleep or slowly emerging from the state of self-forgetfulness.

The inchoate dreams which approximate to paroxysms of delirium constitute the fourth class into which I have divided these experiences.

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They are often exceedingly distressing, and bespeak a troubled or disorderly state of mind, but they are not, in themselves, so threatening to mental health as certain varieties of the dream of the present, to which we have already adverted. Dreams consisting of disconnected and fantastical pictures and ideas are commonly of short duration, and occur more frequently in the act of going to sleep than in that of awaking. They may be amusing or annoying; and they are not uncommonly the causes of bad sleep—or, more accurately speaking, of delay in going to sleep. The brain is awakened by the merriment or the disgust occasioned by these dreams. Sometimes the would-be sleeper rouses himself by laughing at the grotesque imagery presented to his mental vision, or the strange ideas which occur to him. The mind may be so disturbed by these awakenings that sleep becomes impossible. Probably the most common cause of this class of dreams is an undue excitement of the organs of sense immediately before going to bed. Such dreams occur after visits to the theatre, reading novels, or hearing music late in the evening. They also frequently follow gay and dissipating scenes or experiences. The sense-organs are over-excited, without being wearied, or so much agitated that they can not rest. Except when they indicate a generally excited brain, dreams of this class are not of great moment, and are easily obviated by giving the mind regular and methodized work, which lowers the excitement and induces moderate fatigue without distressing it. Sufferers from this trouble may generally cure themselves by reading aloud some not very exciting but sufficiently interesting book for half an hour before retiring to rest. The aim should be to give the mind a subject of thought with which it may engage its attention, and shut out the troublesome crowd of imaginings which obtrude the moment the head is laid on the pillow and the eyes are shut.

It follows from these general considerations, that dreams are made out of the pictures and records of thought, that the making of dreams must be, to a much larger extent than we are wont to suppose, under the control of the will. The difficulty of believing this to be the truth lies in the fact that the will is not able to call up or prevent a particular dream or class of dreams. The making of dreams is not an affair of *now*, at any period of life. The material employed in their production is the stock of pictures, impressions, conceptions, and feelings previously accumulated. Meanwhile, he who would dream pleasantly in adult life must see to the material with which he stores his mind in youth; while, in the heyday of manhood, we are heaping together the material of dreams for old age. The mind is not conscious—or does not notice—one half the impressions it receives from its surroundings. To this circumstance, in fact, is due the surprise with which we view, as for the first time, many of the unconsciously received or treasured impressions which are reproduced in dreams, and hence the feeling that they are *original*. It is not, therefore, possible to prevent the

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accumulation of pictures and records which we would gladly eliminate from the stock material of dreams; but much may be done to improve the store as a whole by feeding the mind with wholesome and healthy thoughts and impressions. He who makes it a rule through life—beginning early in youth—to take care that what he puts away in his mind and accumulates is, as far as may be possible, a treasure of pure and good materials, will do much toward making the dreams that haunt his sleep in the later years of life not only tolerable, but, so far as night-thoughts can subserve any useful or beneficial purpose, improving. There can be no question that pleasant dreams sometimes afford relief to the mind, especially when they occur on awaking, or when they blot out the disagreeable impressions of the day, and facilitate the process of passing into a state of natural and complete sleep. Such dreams do not last long, and are seldom so intense as to distress the faculties. There is always a danger, in light sleep, of the senses being partially awake to surrounding impressions, and making them the pegs on which to hang a dream. It is, therefore, important to secure the most peaceful and negative conditions for sleep. Dreams are often made by the externals of the sleeper. To avoid this contingency, the sleeper should train his senses to disregard the external when composing himself for sleep. This is not difficult to do if the mind is set resolutely for a few nights in succession to shut out or ignore the impressions that strive to attract it through either or all of the senses. It is happily not required of us to know the way in which we accomplish all the acts we perform; and, in respect to some, it is better not to be too curious concerning the means if we gain the end. In regard to dreams and the making of dreams it will, however, be found an advantage to be fairly well-informed.—*Gentleman's Magazine.*

SANITARY RELATIONS OF THE SOIL.*

By Dr. MAX VON PETTENKOFER.

II.

WATER plays quite as important a part in the soil as air. Obviously, no organic life, no organic change, can be conceived of without water; and we ourselves consist three parts in four of water. Therefore it may be inferred that change in the moisture of the soil must have a certain influence on its organic and organized constituents, and on the organic life within it. Two degrees of moisture in the soil may be especially distinguished: one in which air and water both

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occupy the pores, and one in which the pores are quite filled with water excluding the air. In the former case we may speak of soil-moisture (*Bodenfeuchtigkeit*), in the latter of ground-water (*Grundwasser*). In many cases, but not universally, the transition from soil-moisture to ground-water is very plainly indicated.

The coincidence of the existence of ground-water with the prevalence of typhoid has been a constantly recognized fact since 1856. It was discovered by Buhl, has been tested by Seidel according to the law of probabilities, and has been followed out and confirmed down to the present day by Port for the garrison at Munich, and by Ziemssen for the avenues of the civil hospitals; by whom it is shown that, when the amount of ground-water is above the average, fewer, when it is below the average, more, cases of typhus appear. The same law was discovered by Virchow for the fluctuations of typhus in Berlin. The lowest degree of saturation exists in Berlin during the later summer and the fall, in Munich during the winter, and the seasons of typhus are correspondingly different in the two cities: the latter part of summer and the fall in Berlin, winter in Munich. When the summer is unusually dry at Munich, summer epidemics prevail there also.

That the cause of these conditions is not the ground-water in and of itself, but the moisture in the overlying strata and the processes dependent upon it, is very plainly shown by two facts: first, that some typhus-centers have a porous soil but no ground-water; and, second, that the level of the ground-water may be raised and depressed by artificial means, as by damming, pumping, or draining, without any notable influence being produced upon the prevalence of typhus. The first case occurs in places where on account of the steepness of the descent, or of any other cause, no ground-water collects on the lower impervious strata; the second case, where the level of the ground-water is within the mark of the flood-height of a river. In Munich, for example, it was necessary on one occasion, in order to carry on some excavations in a part of the city near the Isar, to leave a gate in the river open for several months, so that the water sunk more than a metre. No increase of typhus was observed; and when the gate was closed, and the water was allowed to rise again to its original height, the typhus did not diminish. A coincidence with the prevalence of typhus appears only when the variations in the level of the ground-water proceed from the saturation or the drying-up of the strata lying above it. I have always regarded the state of the ground-water only as the best and plainly visible sign or index of the rhythm of the soil-moisture in the overlying strata.

Macpherson, Lewis, and Cunningham have shown beyond a doubt that the cholera fluctuates in its home in India, like abdominal typhus with us, inversely with the annual amount of rain and of saturation of the soil. It behaves in the same way with us. The remarkable division of the cholera into a summer and a winter epidemic, which was

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observed in Munich in 1873 and 1874, can be explained only by reference to the conditions of the soil as to moisture. The epidemic began at the end of an abnormally dry July, prevailed with extraordinary violence till the beginning of August, became stationary about two weeks afterward, and seemed wholly to have disappeared at the end of October, only to break out anew with greater violence in November after a long spell of dry weather, and continued till the end of April, 1874. The city of Augsburg, nine miles from Munich, suffered more severely in proportion than that city in 1874, but was quite free from cholera in 1873, notwithstanding many cases were introduced. It had thirty per cent more rain in that year than Munich.

I can not go further into the consideration of these circumstances; I only cite them as evidence of the influence of moisture in the soil so far as it is measurable by the proportion of ground-water present. We are more nearly concerned with the relation of the soil to the water which we apply to our own use, which we draw from wells and springs, to water as a vehicle conveying matters out from the soil. When typhus or cholera rages epidemically in any place, two parties immediately set up a contention as to whether the epidemic influence proceeds from the water or the air. It must be admitted henceforth that either is possible, that a so-called sickly soil can impart its noxious properties equally to the water and to the air it contains, but it may also be that only one of these ways is possible as to certain matters and lower organisms. Observation and experiment must decide upon that. Most physicians have hitherto considered that infection was probably most directly conveyed through the water, and the so-called drinking-water theory has been developed from this view. It has, however, been ascertained that the best known infectious agent in the soil, the *Bacillus malariæ*, which Klebs and Tommasi-Crudelli have discovered and studied in the Roman fever-districts, can not live without air. These investigators found that the malarial poison was not communicated to the water that stood over a richly malarious mud. Tommasi says, in his latest work on the Roman malaria and the ancient drainage of the Roman hills, that "the *Bacillus malariæ* is preeminently an air-living organism." Among the conditions favorable to its propagation in a malarial soil—which need not be a swamp-soil—Tommasi specifies a temperature of about 20° C. (68° Fahr.), a moderate degree of steady moisture, and the direct action of the oxygen of the air on all parts of the mass. He says further, "The lack of one of these conditions is enough to cause a suspension of the development of the spores and of the increase of the malarial ferment." If any one, however, believes that this organism must also remain inoperative when it passes into our blood because that is a fluid, he should be reminded that it makes a great difference whether we put such organisms, taken from their airy nests in a moist soil, into cold water, or into warm blood where air is supplied to them from the corpuscles.

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We can not, indeed, answer, with the results of experiment and microscopical investigation, questions respecting the infectious diseases with the specific germs of which we are not acquainted, but we may be guided in the matter by other facts. Naegelli says: "Contagion-fungi can keep up their peculiar activity in water only for a short time. The purer it is the less food they find in it; they are very soon removed by exhaustion in clear spring-water; and, even in water that contains food for them and where they can multiply fast, degeneration quickly sets in, and they are changed into common ferments."

Inasmuch as we are not acquainted with the germs of typhus and cholera except through their infectious operation, we can not, so long as we use at the same time the air and the water of the infected place, decide whether the epidemic germ is imparted to us by the water or by the air. If only one of the elements could be used while the other could be entirely excluded, we might anticipate a time when investigation should bring us to a decision on the subject. Many cases are now known where cholera and typhus have run their course without any part of the local water having been used as drinking-water, but not a single case where the local air was excluded while the local water was used. A severe epidemic of typhus that prevailed in the city of Basle last fall and winter enforced the lesson that not even the purest water, brought from far away in the Jura, could afford protection against those diseases. With this fact the probability, in cases where the epidemic influence can be ascribed to both the air and the water, that it exists in the water, falls to a minimum. We may then ask, Why might not the infection in these cases have been brought out from the soil by the air? It is not my intention to argue here, where discussion is not possible, against the drinking-water theory; I only call attention to the fact that the most convincing proof of it is wanting. My disbelief in it, however, does not prevent my desiring pure and abundant water for all dwelling-places of man, for we need it, not only as a means of protection against typhus and cholera, but for the daily use of sick and well; not only for the sake of cleanliness and for food, but also as a luxury.

The examination of the fungoids has brought out many facts of great hygienic importance, among them some that concern organic life in the soil. I acknowledge the fact gratefully, but can not abstain from indicating a few points which show the necessity of being guarded in practical hygiene against too hasty conclusions. Mycology would assume more than belongs to it, if it should imagine that hygiene was first placed on a scientific foundation or that it first reached a scientific standing when the cultivation of bacteria was begun, or that it had nothing more to do in the future than to look into the microscope and work with the steaming-pot and wadding-stopper. The professional hygienist has still much else to do; but if he keeps himself familiar with the results of the investigation of the germs, then

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we may have another hygienist who shall make as beneficial a use of them as the surgeon Lister has made of the investigations of Pasteur and others in his antiseptic bandage. The mycologist did not deduce the ultimate practical results—that belonged to the surgeon; and on this ground I believe that the hygienist is not yet a superfluous piece of furniture.

The mycologists have told us, for example, that particular solutions and concentrations of the same are essential for certain ferments or certain of their properties, and that they thrive weakly or not at all in fluids otherwise constituted. A fluid may contain all the necessary constituents, but be too diluted or too concentrated. We may consider all putrefaction and decay of suitable substances, the refuse of our households, the waste water with which we irrigate and manure the soil, as affording food-fluids for the lower organisms. Then we might think—and the like has been thought and said—that dirt is not dangerous to health if it is only properly concentrated. It has been asserted that there is much more dirt in the country and in the villages where citizens go—as they say—to get the air, than in the city. A closer investigation would, however, show that there is a real difference between the city and the village, between country life and city life, but not between the consequences of filth in the city and in the country. Cleanly kept houses are healthier than dirty ones, even in the country. The villages, however, are only apparently filthier than the cities. Indeed, the great density of the population of the cities is in itself like a concentration of the filth, and the scattering of the dwellings in the country is like a dilution of it. In the villages the manure-heaps are on top of the ground and open to the air, which, ventilating them freely, effects a salutary dilution and change: in the cities we do not bring the dirt out into the yard, but we deposit it by the walls of our houses; we do not let the free atmosphere work upon it, but try to keep it away from the air as much as possible by inclosing it in pits which are well covered and arched over, but are connected with the house by invisible pipes and canals. We let nothing escape into the free air, but believe that we need not regard what reaches the ground under the house and the air within the house. In the cities we insist very much on outward cleanliness, that the dirt must not be exposed, and cover it up beautifully in our houses and yards, so as to make the impression that there is none, as a dirty skin and foul linen may be covered by handsome outer garments.

Admitting that there may be a kind or amount of concentration of filth in the soil that will prevent the growth of certain ferments, as the development of fermenting bacteria and fungoids is prevented in fruits by seething them in concentrated sirups, hygiene has yet to ascertain how highly concentrated filth in the soil must be to prevent the ferments in it that contribute to cholera and typhus from being effective. It should also be borne in mind that even if a sufficiently

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high degree were reached at any place on the premises, as, for example, in a cesspool, that concentration would cease and a favorable degree of dilution would take its place, somewhere in the neighborhood, at a greater or less distance from the focus of filth. We should therefore always insist upon the degree of cleanliness which we understand to promote the greatest possible prevention and dilution of filth, as our hygienic aim; and we shall furthermore do well, if we remove not only from our houses, but from the neighborhood, and keep removed, all that seems to us to be dirt, and offends our innate æsthetic feelings.

The mycologists have further taught us that no germs escape from fluids and moist objects by mere evaporation, but that they only pass into the air in the form of dust, or when gases are generated and puff out, or when something adheres to things that are washed with such moist objects. We might be tempted to conclude from this that nothing more is necessary, to make and keep our abodes free from disease, than to keep everything properly moist. But, aside from the fact that damp houses and damp soils are positively disadvantageous to health, it would not be possible to maintain such a degree of moisture or other conditions that it should never be too dry, that there should never be any spurts of gas, and that no germs should ever be washed off. We can judge of the uselessness of such efforts from the fact that no one has ever found air, either out-of-doors when it has rained incessantly for a long time, nor in a house where it is still moist, that was free from mold. We attach more importance to the fact, likewise established by mycologists, that all germs flourish only in fluids and damp media, and that moist walls, not dry ones, become moldy.

If moisture really afforded protection against the escape of germs, we might imagine the drains and sink-holes connected with our houses to furnish the best kind of drainage, because they are always moist, and contribute something to the required moisture in the soil. I consider these sinks close to the house to be dangerous neighbors, even when they are designed only to carry off rain-water. I proceed upon the time-honored experience of physicians that certain malarious diseases prevail most actively in damp spots in houses and villages situated in hollow places or at the foot of slopes, after inundations. A sink is an artificial trough, an artificial flood-region for each house, into which is concentrated the drainage from the roof and from the surrounding ground. By it a certain part of the house-ground is exposed to occasional floods, which can have no other results for the house than the occasional inundations in a larger region have for the places lying within it. When such pits are unavoidable, it is well to have them as far as possible from the house; but it would be better to conduct the water coming from the roof or elsewhere to some place where it can no longer prejudice our health. I look upon the removal or great diminution of these sinks as constituting the chief advantage of the sewerage of cities. The hygienic value of sewerage may have been

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sometimes exaggerated—there was a time when many believed that it would remove all sickness, and it would not be surprising if the reaction against this exaggeration should lead to an undue depreciation—but it is an established fact that every city that has completed a well-flushed system of sewerage in connection with house-drainage has gained in health, and that its death-rate, especially from diseases connected with the soil, has diminished. I mention the reports, on the frequency of typhus before and after sewerage, of John Simon for the English cities, of Varrentrapp for Frankfort-on-the-Main, and of Lievin for Dantzic. We hear, indeed, that the general prevalence of typhus has ceased, and that its disappearance in these cities is wrongly placed to the credit of costly sanitary works; but the coincidence must be full of significance to every unprejudiced person that the disappearance of typhus in different cities has not taken place simultaneously and in the same degree, but has generally begun with the introduction of water-works and sewers. In Hamburg, for instance, improvement began to be evident in 1848, and in Dantzic in 1872. If now we conclude that the *genius epidemicus* has undergone a change, this genius must have manifested a wicked partiality for Hamburg and a devilish maliciousness toward Dantzic, to have kept the latter city so long in his claws. Soyka recently communicated to the meeting of the German Sanitary Union a statistical report respecting the typhus in Munich, in which the influence of sewerage was set forth in the plainest manner, perhaps more plainly than it has been done in any other case. It is known by long experience in this city that abdominal typhus, when it is epidemic, prefers certain quarters, including sewered and unsewered parts alike, and that it spares certain quarters, including sewered and unsewered parts alike; showing that the disease is generally connected with the local situation, not with the existence or non-existence of sewers. Now, Soyka has found that between 1866 and 1880 typhus diminished in the unsewered and the old and badly sewered parts of the city, in round numbers, only ten per cent, in the favorably situated and well-sewered parts about twenty per cent, in the unfavorably situated but well-sewered parts about forty per cent. That the wonderful result in the last case was accomplished by sewerage becomes obvious when it is considered that in it an otherwise fertile typhus-field, in which more seed was to be destroyed, had to be dealt with. Such facts make it very hard for the opponents of sewerage to continue to deny its hygienic advantages.

A well-regulated system of sewerage with adequate flushing not only promotes the removal of much filth, but also effects a great dilution of all soluble and floating dirt, and contributes toward rendering it harmless and effecting its complete destruction. The opponents of sewerage insist that it is impossible to construct a perfectly tight system of sewers. This is not essential; it is enough to reduce the quantity of impurities penetrating into the soil, so far as they are of

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an organic nature, to so low a degree that they shall be quickly changed and rendered harmless by the soil. The ground has a certain power to purify itself.

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Falck made the discovery not long ago that water containing infectious matter, formed and unformed ferments, organic poisons, etc., ran off pure after having been filtered through very thin beds of sand. At first, the ground only absorbs, as, for example, finely pulverized coal removes matters from fluids; but Soyka has found that under conditions of sufficient dilution and exposure to air a real destruction of the absorbed organic matter also takes place, so that even substances that are otherwise unchangeable, as, for instance, strychnine, are as completely destroyed by it as if they had been burned in the fire. This explains why the soils of many places that have been inhabited from the earliest times so frequently look to the naked eye, when they are dug over, like virgin soils. Traces of impurity are visible only in places where more is demanded of the ground than it can perform. It is therefore not surprising that the ground under the sewers of Hamburg does not appear to have been contaminated to any great extent. Wolffhügel's investigations, on the other hand, show that the ground under cesspools and drains, in which filth accumulates in a more concentrated form than in flushed sewers, presents a very different appearance. Professor Hofmann's most recent investigations in the soil of the streets of Leipsic show that the ground under the bottom of even badly built sewers is much cleaner than that over their tops or that under the pavements.

Very instructive are the researches of Emmerich, showing that various kinds of foul water, which are sure to kill when injected under the skin of rabbits, become harmless as soon as they are shaken up with common sand, or if they are diluted with a certain proportion of pure water.

Every foul soil which we cease to pollute purifies itself again in the course of time, and every clean soil, to which no more impurity is introduced than it can work up, remains clean. It is certainly interesting that this purification of the ground is dependent for the most part on the activity of the lowest organisms, as has been proved with reference to the conversion of nitrogenous organic matters in the ground into nitric salts, or to what is called nitrification, by the researches of Schlösing and Müntz. We know as little of the nitrifying germ in the ground as we do of the cholera and typhus germs, but we can and must judge of it by its works. We learn from its operations that the representatives of the lowest organic life, of the cell-life, perform not merely injurious but also very useful functions, that they are not merely noxious or poisonous plants; and we need not be surprised if a later age, when more has been learned in these matters than is now known, shall cultivate the useful bacteria, and make war only upon the injurious ones.

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As there are soils which are more easily nitrified than others, so there are those which more readily bring forth disease than others; and it is the duty of hygiene to search further into the biological processes going on in the ground. We are still very far from the end: a boundless sea of probabilities lies before us; but that need not prevent our weighing anchor and spreading sail.

Hitherto we have allowed ourselves to be guided in hygienic practice and technics predominantly by the feelings, instincts, and what we call common sense, and have only very recently begun to establish our practice, which is, indeed, very primitive, on a scientific and experimental footing. Dirt and impurity have till now been somewhat indefinite conceptions. We use the terms whenever our innate or cultivated sense of cleanliness is unpleasantly affected; they are generally called out by impressions on our sense of smell, taste, or sight. What we call cleanliness plays an important part in daily life, in a similar manner to that which conscience, the sense of right and wrong, partly innate, partly inculcated, plays in our moral life. Just as it can be regarded as a fact that conscientious men as a rule accomplish more and better than unconscientious, so cleanly men as a rule are healthier and live longer than uncleanly men. As conscience is more or less developed in different degrees of human civilization, so also is the sense of cleanliness. Under the guidance of analogous feelings, we have instinctively and empirically found out what it is to our advantage to eat and drink, and how we should clothe ourselves, before these subjects could be dealt with scientifically.

Our established hygiene also was probably based in the first instance chiefly on the suggestions of feeling. Those who are moving in the new scientific direction should guard against considering all that is not scientifically confirmed as wrong and unfounded, but they should also not hesitate to subject established rules to a thorough scientific and experimental criticism. This will necessarily teach us that mere feeling has dictated much to us that rests upon false suppositions, and can either be omitted or must be changed. Practice or technics always precedes science. Our branches of trade and industry also began on empiric roads, and were carried on in them for thousands of years; but how greatly have they been changed, improved, and simplified, and how many new branches have arisen since we began to apply the sciences of physics, chemistry, and mechanics to them!

Hygiene, or the science of health, has a widely extended field of labor in laying a scientific foundation for our sanitary regimen. Even if in many cases it only shows that all is not as it has heretofore been supposed to be, that has its great practical value. What harm did it do to medical practice that the Vienna medical school in its day showed up the errors of the then prevailing views, and radically assailed the practice founded upon them which had been adopted for

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centuries? An analogous example in contemporary hygiene was afforded at the meeting of the German Public Health Association, when Hofmann and Siegel showed by the light of experimental researches and exact observations that our church-yards and burial-grounds, provided the soil is in a proper condition, and a proper, easily applied restorative treatment is adopted, are not so detrimental to the ground-water and air, and consequently to the health of persons living near them, as has been heretofore believed, but that the water from wells inside of the church-yards is generally purer than that in the inhabited places around them, so that in this respect we have more to fear from the living than from the dead. We are injured by our method of burial quite as little as we were injured when systematic blood-letting in inflammatory diseases was abandoned in consequence of the observations of Skoda and Rokitansky.

It will not be otherwise with hygienic practice than it has been with therapeutics, if we now begin to apply a scientific method to it. May the medical faculties and the government speedily grant means to do it! The most beneficial practical results will not fail to be realized.

LONGEVITY OF THE OYSTER.

By Professor SAMUEL LOCKWOOD.

IT is proposed to give an account of an interesting determination of the extreme age of a pair of venerable oysters which have just come into my possession. They were given me by a professional oyster-grower, Captain T. S. R. Brown, of Keyport, New Jersey, and belong to a planting in which he was concerned thirty years ago. The young oysters were obtained from Virginia, and planted in Raritan Bay, Keyport. At the proper time the crop was taken up and sent to market. In all such cases there are leavings or escapes from the dredging. The bottom being too hard, the bed was abandoned and never planted again, and these oysters were found there a few days ago. They are not "naturals" or natives, but simply naturalized "Virginies," a distinction which a practical oyster-raiser will make unerringly. Any one examining the shells would infer the nature of the bed whence they were taken, for the outer edges of the "shoots" or layers are smooth, as if worn by a gentle motion on a compact sandy bottom. The shells are large, though not larger than or even as large as many often seen in market; but the latter, if "primes," have been of much quicker growth, and the mollusk is larger and finer. In a word, they are many years younger than the pair I am considering, and were grown on a softer bed, and one which was for them in every way a richer feeding-ground. The two oysters in question measure,

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one seven inches long and three and a half wide, the other seven and a half inches long and four inches wide. The shells are quite heavy, and for their size the oysters are not so large as might be inferred; but they were eaten, and the verdict was that one was good and the other fair. As this was the judgment of an oyster-raiser, it had special value. The age of an oyster may be reckoned by counting the lines in the depression or groove of the hinge of the bivalve. These lines truly indicate the layers or annual shell-growths, being really the anterior extremity of the annual shell deposits. But the lower shell of an oyster, that is, the valve in which the animal lies when the shell is in normal position, is the deeper and heavier of the two, and, as its annual shell-layers correspond in number with those of the upper valve, it follows that they must be proportionally thicker. Hence the result is that the hinge-groove of the lower valve is longer than that of the upper valve, because the lines which are the extreme edges of the layers are thicker than the lines in the upper groove. Wherever the oyster has room and fair conditions this is the necessary law of its growth, viz., for gravity's sake the ponderosity is given to the lower valve; also for the comfort and growth of the animal, as it secures it a normal position and the proper trough or cradle in which the mollusk can grow. When oysters are excessively crowded they will grow standing on end, that is, side by side, with the nib or wide end uppermost, thus producing those worthless, elongated forms known in some localities as "strap-oysters" and "stick-ups."

Being interested in these specimens as uniques, to me at least, I was concerned to see if the natural record would tally with the well-authenticated tradition of their age. To shorten the story, I will give the method of examination of but one of them. In this instance the distal end, that is, the oldest parts of the hinge-grooves, were coated with the skeletons of bryozoa, hence the line-record was partly obliterated, so that a clear count could only be got from the near end of the groove. Fortunately, the lines were so uniform in thickness that the estimation was reduced to a simple question of proportion. By actual measurement the length of the upper groove was one and a half inch, and that of the lower one was two and a half inches. Now, in the upper groove there were five of these annual layer-lines in a quarter of an inch, and in the lower groove there were, as nearly as I could make out, three lines and a third of a line in a quarter of an inch, which would give thirty of these annual lines for the upper groove and thirty in the lower groove, all which would tally with the tradition that the bivalve was thirty years old.

Two points are established by the above: first, the great longevity of the oyster; the specimens were in excellent condition, and there was nothing about them to disprove the belief that, if allowed to lie undisturbed, they might have lived and grown ten years longer; and second, that an oyster may be good and palatable food at a great

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age. I have seen old oysters obtained from newly discovered and crowded beds that as food were literally worthless; but the specimens discussed were not found in such conditions.

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It is fortunate for science when some intelligent man like Captain Brown puts the student in the way of a fact so interesting; and that interest grows into an intense enjoyment when the tradition is ratified by a reading of Nature's own writing. I remember the case of an oyster-grower at Keyport, who noticed that a fine "prime" oyster was spoiled for market because the dredge had broken a piece, measuring three quarters of an inch, off the nib, so that the mollusk itself was exposed. This was in October. He took the broken oyster and put it in the water by the side of a pile. Next summer he examined it, and found that the animal had completely repaired his house, thus establishing two important facts—the great damage which the mollusk can repair, and the time needed for the reparation.

A GLIMPSE THROUGH THE CORRIDORS OF TIME.*

By ROBERT S. BALL, LL. D., F. R. S.,

ANDREWS PROFESSOR OF ASTRONOMY IN THE UNIVERSITY OF DUBLIN, AND ROYAL ASTRONOMER OF IRELAND.

YOUR committee has done me much honor by inviting me to deliver the first lecture in this large and very beautiful hall. In accepting the task I was aware that it involved a great responsibility, but I had various grounds of encouragement. I remembered that I was not coming among you as a stranger, and I knew that I had a subject worthy of a memorable occasion. I would I were equally confident of my ability to do justice to so noble a theme.

The lecture bears the somewhat poetic title of "A Glimpse through the Corridors of Time." A poetic title has been chosen, because, if I can properly exhibit the subject, you will see that it appeals powerfully to the imagination as well as to the reason. I shall invite you to use your imagination to aid in looking back into the very remotest recesses of antiquity. And when I speak of antiquity I do not mean the paltry centuries with which our historians have to deal. The ancient days to which I refer are vastly anterior to those of the "grand old masters" and those of the "bards sublime." Nor do we even allude to the thousands of years which have elapsed since Babylon and Nineveh were splendid and populous cities. Even the noble pyramids of Egypt are but of yesterday when compared with the æons of years which must pass before our review.

The most ancient human monuments that now exist can not, I sup-

* Lecture delivered at the Midland Institute, Birmingham, October 24, 1881.

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pose, be more than a few thousand years old. Five thousand years nearly exhausts all historical time. Ten thousand years certainly does. Though we have no earlier historical record, yet other records are not wanting. Geology tells us that ten thousand years is but a mere moment in the span of the earth's history. We learn from geology that even the career of man himself has lasted far more than ten thousand years. Yet man is but the latest addition to the succession of life on the earth. For the chronology of the earlier epochs of the earth's history we require majestic units to give adequate expression to our dates. Thousands of years are not sufficient, nor tens of thousands, nor hundreds of thousands. The course of geological time is to be reckoned in millions of years.

The corridors of time through which I wish to give you a glimpse are these dignified millions. Yet our retrospect will only extend to a certain definite epoch in the past history of our earth. We speak of nothing anterior to the time when our earth assumed the dignity of maternity, and brought forth its first and only child. We shall trace the development of that child which, though millions of years old, is still in dependence on its parent. We shall describe the influence of the parent over the child, and the not less remarkable reaction of the child upon the parent. We shall foreshadow the destiny which still awaits the mother and child when millions of years shall have elapsed.

At the time of its birth the earth was not, as we see it now, clothed with vegetation and teeming with animal life. It was a huge inorganic mass, too hot for life, perhaps hot enough to be soft or viscid, if not actually molten. The offspring was what might be expected from such a parent. It was also a rude inorganic mass. Time has wrought wondrous changes in both parent and child. Time has transformed the earth into an abode of organic life. It has transformed the earth's offspring into our silvery moon.

It will be my duty to sketch for you the manner in which these changes have been brought about. To a great extent we can do this with no hesitating steps; we are guided by a light which can not deceive. It is the light of mathematical reasoning. These discoveries are of an astronomical character, but they have not been made by telescopes. They have been made by diligent labors of the most abstruse kind. The mathematical astronomer sits at his desk, and not in an observatory. He has in his hand a pen, and not a telescope. Before him lies a sheet of paper, and not the starry heavens. He is no doubt furnished with a few facts from observation. It is his province to interpret those facts, to inform them with life, and to infer the unknown from the known. It is thus discoveries are made which are the sublimest efforts of human genius.

The argument on which I invite you to follow me is founded on a very simple matter. Many of those present go every summer to the sea-side. Those who do so are well acquainted with the daily ebb and

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flow which we call the tides. Even the children with their spades and buckets know how the flowing tide will fill their moats dug in the sand and inundate their mimic castles. In the ebb and flow of the tide we have a mechanical engine of mighty power. I hope this evening to point out the wonderful effect which tides have had on the earth in times past, as well as the effect they will exercise in the future. It is the tides which are to reveal to us a glimpse through the corridors of time.

The cause of the ebb and flow of the tide has long ceased to be a mystery. In the earliest times it was noticed that the tides were connected with the moon. Pliny and Aristotle both refer to the alliance between the tides and the age of the moon. It is well known that the tides on our coasts sometimes rise to an unusual height. Those who dwell on low ground adjoining tidal rivers are painfully aware of this fact by the floods which are often produced. Such occurrences generally take place at the time of new moon or of full moon. At first quarter or last quarter the tides are even below the usual height. A fisherman who has to regulate his movements by the tides will know full well that at certain times the tides rise higher and fall lower than at other times. He brings his boat out on the falling tide, he brings it back on the rising tide, and, when making the harbor after a night's fishing, it would be natural to hear him say, "Oh, we shall run in easily this morning, there is a strong tide, the moon was full last night." Or if he had to cross a dangerous bank he would soon learn the difference between the spring tide and the neap. Fishermen are not much addicted to abstract reasoning. For many centuries, perhaps indeed for thousands of years, observant men might have known that the moon and the tides were connected. But they did not know any reason why this connection should exist. I dare say they did not even know whether the moon was the cause of the tides or the tides the cause of the moon.

Nor is it easy to explain the tides. We were all taught that the moon makes the tides. Yet I can imagine an objector to say, If the moon makes the tides, why does it give Bristol a splendid tide of forty feet, while London is put off with only eighteen? The true answer is, that the height of the tide is largely affected by local circumstances, by the outline of the coasts, by estuaries and channels. It is even affected to some extent by the wind. Into such details, however, I do not now enter: all I require is, that you shall admit that the moon causes the tides, and that the tides cause currents. In some few places the currents caused by the tides are made to do useful work. A large reservoir is filled by the rising tide, and as the water enters it turns a water-wheel. On the ebbing tide the water flows out of the reservoir, and again gives motion to a water-wheel. There is here a source of power, but it is only in very exceptional circumstances that such a contrivance can be worked economically. Sir W. Thomson, in his ad-

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dress to Section A of the British Association at York, went into this question in its commercial aspect. At present, however, we may say that the power of the tides is as much wasted as is the power of Niagara. Perhaps, when coal becomes more scarce and when the means of distributing power by electricity are more developed, the tides and the great water-falls will be utilized; but that day will not be reached while coal is only a few shillings a ton.

Though we have not yet put the tides into harness, yet tides are not idle. Work they will do, whether useful or not. In some places the tidal currents are scouring out river-channels; in others they are moving sand-banks. From a scientific point of view the work done by the tides is of unspeakable importance. To realize the importance, let us ask the question, Whence is this energy derived with which the tides do their work? The answer seems a very obvious one. If the tides are caused by the moon, the energy they possess must also be derived from the moon. This looks plain enough, but unfortunately it is not true. Would it be true to assert that the finger of the rifleman which pulls the trigger supplies the energy with which the rifle-bullet is animated? Of course it would not. The energy is derived from the explosion of the gunpowder, and the pulling of the trigger is merely the means by which that energy is liberated. In a somewhat similar manner the tidal wave produced by the moon is the means whereby a part of the energy stored in the earth is compelled to expend itself in work. I do not say this is an obvious result. Indeed, it depends upon a refined dynamical theorem, which it would be impossible to enter into here.

But what do we mean by taking energy from the earth? Let me illustrate this by a comparison between the earth rotating on its axis and the fly-wheel of an engine. The fly-wheel is a sort of reservoir, into which the engine pours its power at each stroke of the piston. The various machines in the mill merely draw off the power from the store accumulated in the fly-wheel. The earth is like a gigantic fly-wheel detached from the engine, though still connected with the machines in the mill. In that mighty fly-wheel a stupendous quantity of energy is stored up, and a stupendous quantity of energy would be given out before that fly-wheel would come to rest. The earth's rotation is the reservoir whence the tides draw the energy they require for doing work. Hence it is that, though the tides are caused by the moon, yet whenever they require energy they draw on the supply ready to hand in the rotation of the earth.

The earth differs from the fly-wheel of the engine in a very important point. As the energy is withdrawn from the fly-wheel by the machines in the mill, so it is restored thereto by the power of the steam-engine, and the fly runs uniformly. But the earth is merely the fly-wheel without the engine. When the work done by the tides withdraws energy from the earth, that energy is never restored. It

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therefore follows that the energy of the earth's rotation must be decreasing. This leads to a consequence of the most wonderful importance. It tells us that the speed with which the earth rotates on its axis is diminishing. We can state the result in a manner which has the merits of simplicity and brevity:

"The tides are increasing the length of the day."

This statement is the text of the discourse which I am to give you this evening. From this simple fact the new and wondrous theory of tidal evolution is deduced. A great scientific theory is generally the outcome of many minds. To a certain extent this is true of the theory of tidal evolution. It was Professor Helmholtz who first appealed to what tides had already done on the moon. It was Professor Purser who took an important step in the analytical theory. It was Sir William Thomson's mathematical genius which laid the broad and deep foundations of the fabric. These are the pioneers in this splendid research. But they were only the pioneers. The great theory itself is chiefly the work of one man. You are all familiar with the name he bears. The discoverer of tidal evolution is Mr. G. H. Darwin, Fellow of Trinity College, Cambridge.

It would be impracticable for me now to go into the actual mathematical calculations. I shall rather endeavor to give you an outline of this theory, shorn of its technical symbols. I think this can be done, even though we attempt to retain the accuracy of mathematical language. Nor would it be fair to throw on Mr. Darwin or the other mathematicians I have named the responsibility for all I am going to say. I must be myself responsible for the way in which those theories are set forth, as well as for some of the deductions made from them.

At present, no doubt, the effect of the tides in changing the length of the day is very small. A day now is not appreciably longer than a day a hundred years ago. Even in a thousand years the change in the length of the day is only a fraction of a second. But the importance arises from the fact that the change, slow though it is, lies always in one direction. The day is continually increasing. In millions of years the accumulated effect becomes not only appreciable but even of startling magnitude.

The change in the length of the day must involve a corresponding change in the motion of the moon. This is by no means obvious. It depends upon an elaborate mathematical theorem. I can not attempt to prove this for you, but I think I can state the result so that it can be understood without the proof. If the moon acts on the earth and retards the rotation of the earth, so, conversely, does the earth react upon the moon. The earth is tormented by the moon, so it strives to drive away its persecutor. At present the moon revolves round the earth at a distance of about 240,000 miles. The reaction of the earth tends to increase that distance, and to force the moon to revolve in an orbit which is continually getting larger and larger.

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Here, then, we have two remarkable consequences of the tides which are inseparably connected. Remember, also, that we are not enunciating any mere speculative doctrine. These results are the inevitable consequences of the tides. If the earth had no seas or oceans, no lakes or rivers; if it were an absolutely rigid solid throughout its entire mass—then these changes could not take place. The length of the day would never alter, and the distance of the moon would only fluctuate between narrow limits.

As thousands of years roll on, the length of the day increases second by second, and the distance of the moon increases mile by mile. These changes are never reversed. It is the old story of the perpetual dropping. As the perpetual dropping wears away the stone, so the perpetual action of the tides has sculptured out the earth and moon. Still, the action of the tides continues. To-day is longer than yesterday; yesterday is longer than the day before. A million years ago the day probably contained some minutes less than our present day of twenty-four hours. Our retrospect does not halt here; we at once project our view back to an incredibly remote epoch which was a crisis in the history of our system.

Let me say at once that there is great uncertainty about the date of that crisis. It must have been at least 50,000,000 years ago. It may have been very much earlier. This crisis was the interesting occasion when the moon was born. I wish I could chronicle the event with perfect accuracy, but I can not be sure of anything except that it was more than 50,000,000 years ago.

I do not admit that there is anything discreditable about this uncertainty. Do you not know that our historians, who have records and monuments to help them, are often in great confusion about dates? I am not going to find any fault with historians. They do their best to learn the truth; but I can not help reminding you that they are often as much in the dark about centuries as the astronomers are about millions. Take, for example, the siege of Troy, which Homer has immortalized, and ask the historians to state the date of that event. Some say that the siege of Troy was 1184 B. C., others that it was 900 B. C.; both are equally uncertain. Schliemann says that he found the remains of the town burned down, but that no one knows who did it or when it was done. Others, again, say that there was never any siege of Troy at all.

A recent instance which has attracted great and deserved attention is Schliemann's discovery at Mycenæ of what he considers to have been the tomb of Agamemnon. The tomb certainly did contain the remains of some mighty man, if we may judge by the hundred-pound weight of gold ornaments which were found there. Most people think that these tombs, whosesoever they were, date from at least 1000 B. C. On the other hand, some very high authorities regard the monuments as the tombs of northern invaders who came into Greecc 500–600 A. D.

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Here, then, we have a range of some 1,500 years for the date of the tombs, and no dates between these two are possible. I am sure I do not pretend to decide between them, or even to have an opinion on the subject; but I can not help saying that in one respect the astronomers are better off than the historians. The historians can not even agree whether Schliemann's gold ornaments are B. C. or A. D. Astronomers are, at all events, certain that the date of the moon's birth was before the present era.

At the critical epoch to which our retrospect extends, the length of the day was only a very few hours. I can not tell you exactly how many hours. It seems, however, to have been more than two and less than four. If we call it three hours we shall not be far from the truth. Perhaps you may think that, if we looked back to a still earlier epoch, the day would become still less and finally disappear altogether! This is, however, not the case. The day can never have been much less than three hours in the present order of things. Everybody knows that the earth is not a sphere, but that there is a protuberance at the equator, so that, as our school-books tell us, the earth is shaped like an orange. It is well known that this protuberance is due to the rotation of the earth on its axis, by which the equatorial parts bulge out by centrifugal force. The quicker the earth rotates the greater is the protuberance. If, however, the rate of rotation exceeds a certain limit, the equatorial portions of the earth could no longer cling together. The attraction which unites them would be overcome by centrifugal force, and a general break-up would occur. It can be shown that the rotation of the earth when on the point of rupture corresponds to a length of the day somewhere about the critical value of three hours, which we have already adopted. It is therefore impossible for us to suppose a day much shorter than three hours. What occurred prior to this I do not here discuss.

Let us leave the earth for a few minutes, and examine the past history of the moon. We have seen that the moon revolves around the earth in an ever-widening orbit, and consequently the moon must in ancient times have been nearer the earth than it is now. No doubt the change is slow. There is not much difference between the orbit of the moon a thousand years ago and the orbit in which the moon is now moving.

But when we rise to millions of years the difference becomes very appreciable. Thirty or forty millions of years ago the moon was much closer to the earth than it is at present; very possibly the moon was then only half its present distance. We must, however, look still earlier, to a certain epoch not less than fifty millions of years ago. At that epoch the moon must have been so close to the earth that the two bodies were almost touching. I dare say this striking result will come upon many with surprise when they hear it for the first time. It was, I know, with great surprise that I myself read of it not many

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months ago. But the evidence is unimpeachable, and it is, indeed, wonderful to see how such information has been gained by merely looking at the ripples of the tide.

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Everybody knows that the moon revolves now around the earth in a period of twenty-seven days. The period depends upon the distance between the earth and the moon. The time and the distance are connected together by one of Kepler's celebrated laws, so that, as the distance shortens, so must the time of revolution shorten. In earlier times the month must have been shorter than our present month. Some millions of years ago the moon completed its journey in a week instead of taking twenty-eight days as at present. Looking back earlier still, we find the month has dwindled down to a day, then down to a few hours, until, at that wondrous epoch when the moon was almost touching the earth, the moon spun round the earth once every three hours.

It would require the combined powers of a poet and a mathematician to portray the scene with becoming dignity. I have only promised to give you that glimpse along the Corridors of Time which I have myself been able to obtain. The scene is laid in the abyss of space; the time is more than 50,000,000 years ago; the *dramatis personæ* are the earth and the moon.

In those ancient times I see our earth to be a noble globe, as it is at present. Yet it is not partly covered with oceans and partly clothed with verdure. The primeval earth seems rather a fiery and half-molten mass, where no organic life can dwell. Instead of the atmosphere which we now have I see a dense mass of vapors, in which perhaps all the oceans of the earth are suspended as clouds. I see that the sun still rises and sets to give the succession of day and of night, but the day and the night together only amount to three hours instead of twenty-four. Almost touching the chaotic mass of the earth is another much smaller and equally chaotic body. Around the earth I see this small body rapidly rotating. The two revolve together as if they were bound by invisible bands. This smaller body is the moon. Such is the picture which I wish to present to you as a glimpse through the Corridors of Time.

I have hitherto refrained from introducing any merely speculative matters. If we can believe anything of mathematics, anything of dynamics, we must admit that the picture I have attempted to outline is a faithful portrait. The only uncertain elements are the date and the periodic time. I do, however, now propose to venture on one speculation in which Mr. Darwin has indulged. I propose to offer a suggestion as to how a small body came into this most remarkable position close by the earth, and how its motion was produced.

We have hitherto been guided by the unerring light of dynamics, but at this momentous epoch dynamics deserts us, and we have only probability to guide our faltering steps. One hint, however, dynam-

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ics does give. It reminds us that a rotation once in three hours is very close to the quickest rotation which the earth could have without falling to pieces. As the earth was thus predisposed to rupture, it is of extreme interest to observe that a cause tending to precipitate such a rupture was then ready to hand. It seems not unlikely that we are indebted to the sun as the occasion by which the moon was fractured off from the earth and assumed the dignity of an independent body. It must be remembered that the sun produces tides in the earth as well as the moon, but the solar tides are so small compared with the lunar tides that we have hitherto been enabled to neglect them. There could, however, have been no lunar tides before the moon existed, and consequently in the early ages before the moon was detached the earth was disturbed by the solar tides, and by the solar tides alone.

The primeval earth thus rose and fell under the tidal action of the sun. Probably there were no oceans then on the earth; but tides do not require oceans, or even water, for their operation. The primitive tides were manifested as throbs in the actual body of the earth itself, which was then in a more or less fluid condition. Even at this moment bodily tides are disturbing the solid earth beneath our feet; but these tides are now so small as to be imperceptible when compared with the oceanic tides.

At the remote epoch of which we are speaking the solar tides were very small, as they are at present. Yet, small as they are, there was a particular circumstance which may have enormously increased their importance. The point to which I refer can be illustrated very simply. We have here a weight of fourteen pounds freely suspended, and here I have a small wooden mallet which barely weighs half an ounce, yet, small as this mallet is, I can make the heavy weight swing by merely giving it blows with the mallet. Let me try. I give the weight blow after blow. I hit it as hard as I can, yet the weight hardly swings. I have not yet been successful. The art of succeeding is merely to time the blows properly; this I am now doing, and you see the weight swings in an arc which is steadily augmenting.

We therefore see that a succession of impulses, in themselves small, can yet produce a great effect when they are properly timed. In the present case the impulses should succeed each other at the same interval as this pendulum requires for one to-and-fro oscillation. The time therefore depends on the body struck, and not at all on the body which gives the impulses.

Just as this pendulum swings with a definite period, so the vibrations of the primeval earth had a certain period appropriate to them. Suppose that the liquid primeval globe were pressed in on two quadrants and drawn out on the two others, and that the pressures were then released. The globe would attempt to regain its original form, but this it could not do at once, any more than the pendulum can at once regain its vertical position; the protruded portions would go in,

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but they would overshoot the mark, and the globe would thus oscillate to and fro. Now, it has been shown that the period of such oscillations in our primitive globe is about an hour and a half, or very close to half the supposed length of the day at that time. The solar tides, however, also have a period half the length of the day. Here, then, we have a case precisely analogous to the fourteen-pound weight I have just experimented on. We have a succession of small impulses given which are timed to harmonize with the natural vibrations. Just as the small-timed impulses raised a large vibration in the weight, so the small solar tides on the earth threw the earth into a large vibration. At first these vibrations were small, but at each succeeding impulse the amplitude was augmented until at length the cohesion of the molten matter could no longer resist: a separation took place: one portion consolidated to form our present earth; the other portion consolidated to form the moon.

There is no doubt whatever that the moon was once quite close to the earth; but we have to speculate as to what brought the moon into that position. I have given you what I believe to be the most reasonable explanation, and I commend it to your attention. There are difficulties about it, no doubt: let me glance at one of them.

I can easily imagine an objector to say: "If the moon were merely a fragment torn off, how can we conceive that it should have that beautiful globular form which we now see? Ought not the moon to have rugged corners and an irregular shape? and ought not the earth to show a frightful scar at the spot where so large a portion of its mass was rent off?"

You must remember that in those early times the earth was not the rigid, solid mass on which we now stand. The earth was then so hot as to be partially soft, if not actually molten. If, then, a fragment were detached from the earth, that fragment would be a soft yielding mass. Not for long would that fragment retain an irregular form; the mutual attraction of the particles would draw the mass together. By the same gentle ministrations the wound on the earth would soon be healed. In the lapse of time the earth would become as whole as ever, and at last it would not retain even a scar to testify to the mighty catastrophe.

I am quite sure that, in so large and so cultivated an audience as that which I am now addressing, there are many persons who take a deep interest in the great science of geology. I believe, however, that the geologist who has studied all the text-books in existence might still be unacquainted with the very modern researches which I am attempting to set forth. Yet it seems to me that the geologists must quickly take heed of these researches. They have the most startling and important bearing on the prevailing creeds in geology. One of the principal creeds they absolutely demolish.

I suppose the most-read book that has ever been written on geology

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is Sir Charles Lyell's "Principles." The feature which characterizes Lyell's work is expressed in the title of the book, "Modern Changes of the Earth and its Inhabitants considered as illustrative of Geology." Lyell shows how the changes now going on in the earth have in course of time produced great effects. He points out triumphantly that there is no need of supposing mighty deluges and frightful earthquakes to account for the main facts of geology.

Lyell attempts to show that the present action of winds and storms, of rains and rivers, of ice and snow, of waves and tides, will account for the formation of strata, and that the gentle oscillations of the earth's crust will explain the varying distribution of land and water. In this we can to a great extent follow him. I am quite satisfied with the oscillations in the land. If the land rises an inch or two every century in one place and falls to the same extent elsewhere, all that is required has been explained. Nor do I feel at present disposed to question his views as to rivers or to glaciers, to rains or to winds. There is, however, one great natural agent of which Lyell does not take adequate account. He does not attach enough importance to the tides. No doubt he admits that the tides do some geological work. He even thinks they can do a great deal of work. The sea batters the cliffs on the coasts, and wears them into sand and pebbles. The glaciers grind down the mountains, the rains and frosts wear the land into mud, and rivers carry that mud into the sea. In the calm depths of ocean this mud subsides to the bottom; it becomes consolidated into rocks; in the course of time these rocks again become raised, to form the dry land with which we are acquainted.

The tides, says Lyell, help in this work. Tidal currents aid in carrying the mud out to sea; they aid to a considerable extent in the actual work of degradation, and thus contribute their quota to the manufacture of stratified rocks. Such is the modest *rôle* which Lyell has assigned to the tides, and no doubt the majority of geologists have acquiesced in this doctrine. Nor can there be any doubt that this is a just view of tidal action at present. That it is a just view of tidal action in past times is what I now deny. Lyell did not know—Lyell could not have known—that our tides are but the feeble surviving ripples of mighty tides with which our oceans once pulsated. Introduce these mighty tides among our geological agents, and see how waves and storms, rivers and glaciers, will hide their diminished heads.

I must attempt to illustrate this view of tidal importance in ancient geological times. Let me try by the aid of the tides to explain the great difficulty which every one must have felt in regard to Lyell's theory. I allude to the stupendous thickness of the Palæozoic rocks.

Look back through the Corridors of Time in the manner in which they are presented to us in the successive epochs of geology. We pass rapidly over the brief career of prehistoric man; then through the long ages of Tertiary rocks, when the great mammals were devel-

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oped; back again to the much earlier period when colossal reptiles and birds were the chief inhabitants of the earth; back again to those still earlier ages when the luxuriant forests flourished that have given birth to the coal-fields; back once more to the age of fishes; back finally to those earliest periods when the lowest forms of life began to dawn in the Palæozoic era.

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As we date remote ages astronomically by the distance of the moon, so we date remote ages geologically by the prevailing organic life. It is a great desideratum to harmonize these two chronological systems, and to find out, if possible, what lunar distance corresponds to each geological epoch. In the whole field of natural science there is no more noble problem. Take, for example, that earliest and most interesting epoch when life perhaps commenced on the earth, and when stratified rocks were deposited five or ten miles thick, which seem to have contained no living forms higher than the humble Eozoön, if even that were an organized being. Let us ask what the distance of the moon was at the time when those stupendous beds of sediment were deposited in the primeval ocean. We have in this comparison every element of uncertainty except one. The exception is, however, all-important. We know that the moon must have been nearer to the earth than it is at present. There are many very weighty reasons for supposing that the moon must have been very much nearer than it is now. It is not at all unlikely that the moon may then have been situated at only a small fraction of its present distance. My argument is only modified, but not destroyed, whatever fraction we may take. We must take some estimate for the purpose of illustration. I have had considerable doubts what estimate to adopt. I am desirous of making my argument strong enough, but I do not want to make it seem exaggerated. At present the moon is 240,000 miles away; but there was a time when the moon was only one sixth part of this, or, say, 40,000 miles away. That time must have corresponded to some geological epoch. It may have been earlier than the time when the Eozoön lived. It is more likely to have been later. I want to point out that, when the moon was only 40,000 miles away, we had in it a geological engine of transcendent power.

On the primitive oceans the moon raised tides as it does at present; but the 40,000-mile moon was a far more efficient tide-producer than our 240,000-mile moon. The nearer the moon the greater the tide. To express the relation accurately we say that the efficiency of the moon in producing tides varies inversely as the cube of its distance. Here, then, we have the means of calculating the tidal efficiency for any moon-distance. The 40,000-mile moon being at a distance of only one sixth of our present moon's distance, its tidal efficiency would be increased $6 \times 6 \times 6$ fold. In other words, when our moon was only 40,000 miles away, it was 216 times as good a tide-producer as it is at present.

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The height to which the tides rise and fall is so profoundly modified by the coasts and by the depth of the sea, that at present we find at different localities tides of only a few inches and tides of sixty or seventy feet. In ancient times there were no doubt also great varieties in the tidal heights, owing to local circumstances. To continue our calculations we must take some present tide. Let us discard the extremes just indicated and take a moderate tide of three-feet rise and three-feet fall as a type of our present tides. On this supposition, what is to be a typical example of a tide raised by the 40,000-mile moon? If the present tides be three feet, and if the early tides be 216 times their present amount, then it is plain that the ancient tides must have been 648 feet.

There can be no doubt that in ancient times tides of this amount, and even tides very much larger, must have occurred. I ask the geologists to take account of these facts, and to consider the effect—a tidal rise and fall of 648 feet twice every day. Dwell for one moment on the sublime spectacle of a tide of 648 feet high, and see what an agent it would be for the performance of geological work! We are now standing, I suppose, some 500 feet above the level of the sea. The sea is a good many miles from Birmingham, yet if the rise and fall at the coasts were 648 feet, Birmingham might be as great a sea-port as Liverpool. Three quarters tide would bring the sea into the streets of Birmingham. At high tide there would be about 150 feet of blue water over our heads. Every house would be covered, and the tops of a few chimneys would alone indicate the site of the town.

In a few hours more the whole of this vast flood would have retreated. Not only would it leave England high and dry, but probably the Straits of Dover would be drained, and perhaps even Ireland would in a literal sense become a member of the United Kingdom. A few hours pass, and the whole of England is again inundated, but only again to be abandoned.

These mighty tides are the gift which astronomers have now made to the working machinery of the geologist. They constitute an engine of terrific power to aid in the great work of geology. What would the puny efforts of water in other ways accomplish when compared with these majestic tides and the great currents they produce?

In the great primeval tides will probably be found the explanation of what has long been a reproach to geology. The early Palæozoic rocks form a stupendous mass of ocean-made beds which, according to Professor Williamson, are twenty miles thick up to the top of the silurian beds. It has long been a difficulty to conceive how such a gigantic quantity of material could have been ground up and deposited at the bottom of the sea. The geologists said, "The rivers and other agents of the present day will do it if you give them time enough." But, unfortunately, the mathematicians and the natural philosophers would not give them time enough, and they ordered the geologists to "hurry

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up their phenomena." The mathematicians had other reasons for believing that the earth could not have been so old as the geologists demanded. Now, however, the mathematicians have discovered the new and stupendous tidal grinding-engine. With this powerful aid the geologists can get through their work in a reasonable period of time, and the geologists and the mathematicians may be reconciled.

I have here a large globe to represent the earth, and a small globe suspended by a string to represent the moon. At the commencement of the history the two globes were quite close; they were revolving rapidly, and the moon was constantly over the same locality on the primeval earth. I do not know where that locality was; it was probably the part of the earth from which the moon had been detached. No doubt it was somewhere near the equator, but the distinction of land and water had not then arisen. Around the primeval earth the moon revolved in three hours; the earth also revolved in three hours, so that the moon constantly remained over the red region. This I can illustrate by holding the small globe which represents the moon in one hand, and making the large globe which represents the earth revolve by the other.

This state of things formed what is known as unstable dynamical equilibrium. It could not last. Either the moon must fall back again on the earth, and be reabsorbed into its mass, or the moon must commence to move away from the earth. Which of these two courses was the moon to take? The case is analogous to that of a needle balanced on its point. The needle must fall some way, but what is to decide whether it shall fall to the right or to the left? I do not know what decided the moon, but what the decision was is perfectly plain. The fact that the moon exists shows that it did not return to the earth, but that the moon adopted the other course, and commenced its outward journey.

As the moon recedes, the period which it requires for a journey round the earth increases also. Initially that period was but three hours, and it has increased up until our present month of six hundred and fifty-six hours.

The rotation of the earth has been modified by the retreat of the moon. Directly the moon began to retreat, the earth was no longer under an obligation to keep the same face thereto. When the moon was at a certain distance, the earth made two rotations for every revolution that the moon made. Thus, as I carry the small globe round the large globe, the latter makes two revolutions for one revolution of the small globe. Still the moon gets farther and farther away, until the earth performs three, four, or more rotations for each of the moon's revolutions. Do not infer that the rate of the earth's rotation is increasing; the contrary is the fact. The earth's rotation is getting slower, and so is that of the moon; but the retardation of the moon is much greater than that of the earth. Even though the rotation of

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the earth is much more than the primitive three hours, yet that of the moon has increased to several times the rotation of the earth.

The moon recedes still farther and farther, and at length a noticeable epoch is reached, to which I must call attention. At that epoch the moon is so far out that its revolution takes twenty-nine times as long as the rotation of the earth. The month was then twenty-nine times the day. The duration of the day was less than the present twenty-four hours, but I do not believe it was very much less. The time we are speaking of is not very remote, perhaps only a very few million years ago. The month was then in the zenith of its glory. The month was never twenty-nine times as long as the day before. It has never been twenty-nine times as long as the day since. It will never be twenty-nine times as long as the day again.

Resuming our history, we find the moon still continuing to revolve in an ever-widening circle, the length of the month and of the day both increasing. The ratio of the day to the month was still undergoing a change. When the moon was a little farther off, the earth only revolved twenty-eight times instead of twenty-nine times in one revolution of the moon. Still, the velocity of the earth abates until it only makes twenty-seven revolutions in one revolution of the moon. This is an epoch of especial interest, for it is the present time. In the present order of things the moon revolves round the earth once while the earth rotates twenty-seven times. This has remained sensibly true for thousands of years, and no doubt will remain sensibly true for thousands of years to come, but it will not remain true indefinitely. Wondrous as are the changes which have occurred in times past, not less wondrous are the changes which are to occur in time to come. The tides have guided our gropings into the past; they will continue to guide our researches to make a forecast of the future.

Farther and farther will the moon retreat, and more and more slowly will the earth revolve. But we shall not pause at intervening stages; we shall try to sketch the ultimate type to which our system tends. In the dim future, many millions of years distant, the final stage will be approached. As this stage draws nigh, the rotation of the earth will again approach to equality with the revolution of the moon. From the present month of twenty-seven days we shall pass to a month of twenty-six days, of twenty-five days, and so on, until eventually we shall reach a month of two days, and lastly a month of one day. When this state has been attained the earth will constantly turn the same region toward the moon. I do not know what is the locality on the earth which is destined for this distinction.

Here you see that the first state and the last state of the earth-moon history are in one sense identical. In each case the same face of the earth is constantly directed toward the moon. In another way, how different are the first stage and the last! At the beginning the day and the month were both equal, and they were each three hours.

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At the end the day and the month will be again equal, but they will each be 1,400 hours. The moon will then go round the earth in 1,400 hours, while the earth will rotate on its axis in the same time. In other words, the day is destined in the very remote future to become as long as fifty-seven of our days. This epoch will assuredly come if the universe lasts long enough. When it has come it will endure for countless ages. It would endure for ever if the earth and the moon could be isolated from all external interference.

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We heard a great deal a few years ago about the necessity of shortening the hours of labor. I wish to point out that the social reformers who are striving to shorten the hours of labor are pulling one way, while the moon is pulling the other. The moon is increasing the length of the day. The change will be very gradual, but none the less is it inevitable. Where will the nine-hours' movement be when the day has increased to 1,400 hours? This will be a very serious matter, and there is only one way by which it can be avoided. The question is one rather for engineers than for astronomers; but I can not help throwing out a suggestion. My advice is: Anchor the moon, and keep it from going out. If you can do this, and if you can also provide a brake by which the speed of the moon can be controlled, then you will be able for ever to revel in the enjoyment of a twenty-four-hour day.

Should this engineering feat never be accomplished, then we have only the 1,400-hour day to look forward to. Nor is there anything untoward in the prospect, when we take natural selection as our comforter. By natural selection man has become exactly harmonized with his present environment. No doubt natural selection moves at a dignified pace, but so in all truth does tidal evolution. Natural selection and tidal evolution have advanced *pari passu* through all the past millions of geological time. They will advance *pari passu* through all the ages yet to come. As the day lengthens, so will man's nature gradually change too, without any hardship or inconvenience. All that is necessary is plenty of time. Should we think it a hardship that our children should have a day of twenty-four hours and one second instead of twenty-four hours? That the day enjoyed by our grandchildren should be a second longer than the day of our children? That the day of our great-grandchildren should be a second longer still, and so on continually? This would be no inconvenience whatever. No one except the astronomers would be able to detect the change, and daily life would be unaltered. Yet, carry on this process for only 150,000,000 years, and we shall find that the whole change of the day from twenty-four hours to 1,400 hours has been accomplished. The actual rate of change is indeed much less than this, and is at present so small that astronomers can hardly even detect it.

Our remote posterity will have a night 700 hours long, and when the sun rises in the morning 700 hours more will elapse before he can

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set. This they will find a most suitable and agreeable arrangement. They will look back on our short periods of rest and short periods of work with mingled curiosity and pity. Perhaps they will even have exhibitions of eccentric individuals able to sleep for eight hours, work for eight hours, and play for eight hours. They will look on such curiosities in the same way as we look on the man who undertakes to walk a thousand miles in a thousand hours.

I am beyond all things anxious to give you the impression that I am not indulging in any mere romance. No doubt the various figures I have mentioned are but estimates. They may be found to require correction—perhaps large correction; but the general outline of the theory must be true. Should any traces of doubt still linger in the mind of some prejudiced person, let me finally dissipate them. Perhaps some caviler may say: "Where are the proofs of all this action of the tides? How do you know that the tides are sufficiently powerful to produce such changes?" I believe I have shown this abundantly, but some people require a great deal of conviction. I have therefore kept my best argument for the end.

For an overwhelming proof of tidal efficiency I shall summon the heavens themselves to witness, and I shall point to the stupendous task which tides have already accomplished. As the moon has made and is making tides on the earth, so the earth once raised tides on the moon. These tides have ceased for ages; their work is done; but they have raised a monument in the moon to testify to the tidal sufferings which the moon has undergone. To that monument I now confidently appeal. The moon being much smaller than the earth, the tides on the moon produced by the earth must have been many times as great as the tides on our earth produced by the moon. It matters not that the moon now contains no liquid ocean. Nor does it matter whether the moon ever had a liquid ocean. In very ancient days the moon was not the hard, rigid mass which it now appears. Time was when the volcanoes raged on the moon with a fury which nothing on our earth at present can parallel. The moon was then in a soft or a more or less fluid condition, and in this viscous mass the earth produced great tides.

Great tides in truth they were, for the earth is eighty times as heavy as the moon. On the other hand, the moon is only one fourth the diameter of the earth; so that the actual height of the tides on the moon would be still many times as great as the tides on the earth. When the moon was nearer to us, as it was in early ages, those tides were still greater. Think for one moment of what a lunar tidal wave of such magnitude would be capable! This wave is perhaps of molten lava; it would tear over the surface with terrific power, and anything that friction could accomplish that great current would do. That tidal current has done its work; even if the moon were fluid at the present day, it could no longer be distracted by tides.

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Remember, it is not the mere presence of the tide which produces friction. It is the action of the tide in rising and in falling which accomplishes the work. If, therefore, the moon moved so that it was always high tide at the same place, the tides could produce no further effect. The spot where the tide is high on the moon is the spot which is toward the earth. It hence follows that the action of the tides will cease when the moon constantly directs the same face to the earth. The moon has thus at length gained a haven of rest from a tidal point of view. No doubt the moon has a high tide and it has a low tide, but those tides no longer ebb and flow: the moon has succumbed to the incessant action of friction, and has assumed the only attitude which can relieve it from incessant disturbance.

For many centuries it had been an enigma to astronomers why the moon should always turn the same face to the earth. It could be shown that there were many million chances to one in favor of this being due to some physical cause. The ordinary theory of gravitation failed to explain the cause. Every one had noticed this phenomenon. Yet the explanation was never given till lately. It was Helmholtz who showed that this was a consequence of ancient tides, and this simple and most satisfactory explanation had been universally accepted. The constant face of the moon is a living testimony to the power of the tides. What tides have accomplished on the moon is an earnest of what tides will accomplish on the earth.

In the great conflict of the tides the earth has already conquered the moon, and forced the moon to render perpetual homage as a token of submission. Remember, however, that the earth is large and the moon is small. Yet, small though the moon is, it gallantly struggles on. "You have forced me," cries the moon to the earth, "to abandon the rotation with which I was originally endowed; you have compelled me to rotate in the manner you have dictated. I will have my revenge. It is true I am weak, but I am unrelenting; day by day I am exhausting you by the tides with which I make you throb. The time will assuredly come, though it may not be for millions of years, when you shall be forced to make a compromise. When that compromise is made the turmoils of the tides will cease; our mutual movements will be adjusted. With equal dignity we shall each rotate around the other; with equal dignity we shall each constantly bend the same face to the other."

There is another point to be considered. We must not forget that there is a sun in the heavens as well as a moon. The sun also produces tides in the earth. Those tides were much smaller than the lunar tides, so that we could afford to neglect them. But we have seen that the lunar tides will gradually decrease to nothing. It behooves us then to consider what the solar tides can effect which shall be worthy of our attention. In a lecture which I gave here some years ago, I made allusion to the discovery of the satellites of Mars.

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I mentioned that one of the satellites of Mars presented a phenomenon unparalleled in the solar system. The satellite revolved around Mars in a period of seven hours, while Mars himself rotated on his axis in a period of twenty-four hours. We here actually find the moon of Mars rotating around Mars in much less than one of Mars's own days. This was a most curious and unexpected circumstance, but the observations of the discoverer, Asaph Hall, placed the great fact beyond any doubt. The mystery has now been explained. It is due to the action of the solar tides on Mars. Nay, more, we can actually foresee that at some incredibly remote future time our earth and moon are destined to present the same movements which have seemed so anomalous in Mars.

Left to themselves the earth and the moon would have remained for ever in the condition of compromise. The moon would have revolved round the earth in 1,400 hours. The earth would have rotated on its axis in 1,400 hours also. But now the solar tides intervene. They have little effect upon the moon ; it revolves as before, but the solar tides begin to retard the earth still further. Instead of a period of 1,400 hours, the earth will have a still longer day, so that finally the moon revolves more rapidly around the earth than the earth rotates on its axis.

It seems to me that the episode I have mentioned is one of the most interesting in the whole of modern astronomy. We have first a most delicate telescopic discovery of the tiny satellite of Mars and of its anomalous movements. We then have a beautiful explanation of how this anomalous motion has arisen from the action of solar tides. Finally, we have in this miniature system of Mars a foreshadowing of the ultimate destiny of our earth and our moon.

Do I say the ultimate destiny? Nothing is ultimate in nature. The moon and the earth would have come to an amicable and a final agreement had they been let alone. But now the sun has intervened and disturbed the earth's rotation. The truce once broken, the moon again produces tides on the earth, the earth reacts on the moon, and a whole chain of complicated movements are the consequence. I shall not now attempt to trace the further progress of events.

I have dealt with very large figures in this lecture, and perhaps I have taxed your imagination by my demands that you should conceive of periods of tens of millions of years. Yet, after all, let us look at the results in their true proportion, compared with the universe in which our lot has been cast.

Truly we have been engaged with a very trifling matter. Is not our earth one of the most insignificant bodies in the universe? And our moon is much smaller still. Nor is it even the life-history of our earth that we have been considering, it is merely a brief episode in that history. What are the periods of time we have been discussing when compared with those infinitely longer periods during which the

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solar system has been evolved? Even the solar system is but one out of one hundred million such systems, each of which has its own life-history. Viewed in their true proportions, the phenomena I have described are but of infinitesimal importance, and the time they have occupied is merely ephemeral.

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No doubt we have only dwelt upon the tides on the earth and the tides in the moon, which have been of such infinite importance. But do not suppose that tides are confined to the earth and to the moon. So far as we know, every body in the universe is capable of producing, and actually does produce, tides in every other body. Every planet throbs in response to the tides produced in it by every other planet. Every star has a distinct tidal wave produced in it by every other star. You may say that such tides are infinitesimal, but you must remember that infinitesimal causes, sufficiently often repeated, can achieve the mightiest effects.

We know that tides have wrought our solar system into its present form; and are we to say that the wondrous powers of the tides have no grander scope for their exercise? I prefer to believe that tides operate far and wide through the universe, and that in the recognition of the supreme importance of tidal evolution we mark a great epoch in the history of physical astronomy.—*Nature.*

EPIDEMIC CONVULSIONS.*

By DAVID W. YANDELL,
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EXTRAORDINARY interest was excited in the popular mind of Kentucky, at an early day, by a form of convulsive disease, which, though it had been witnessed elsewhere in the world, had never before assumed a shape so decidedly epidemic. Among the Camisards, or French prophets, who appeared in the mountains of the Cevennes toward the close of the seventeenth century, the subjects, when about to receive the gift of prophecy, were often affected with trembling and fell down in swoons. When the fit came, no matter where they were, they fell, smiting their breasts with their hands, crying for mercy, and imprecating curses on the Pope. They were finally, after an obstinate struggle, put down by their insane persecutor, Louis XIV.†

Epidemic convulsions prevailed in Scotland, half a century later.

* The larger part of the materials contained in this paper were collected by my father, the late L. P. Yandell, M. D., and were intended to be embraced in the "Medical History of Kentucky," a work on which he was engaged at the time of his death. I have done little more than arrange and place them in their proper chronological order.—D. W. Y.

† "Encyclopædia Americana," article "Cevennes."

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Multitudes, under pungent preaching, were violently agitated, uttering loud cries, shaking, trembling, bleeding at the nose, the minister promoting the uproar by urging them not to stifle their convictions. The shriek, or the shout, it is stated, never rose from one, but that others joined the outcry.* The early career of John Wesley is well known to have been marked by similar disorders. In his journal he records numerous instances of men and women dropping to the ground under his preaching "as if struck by lightning," ten or a dozen praying at once. They had also prevailed extensively in New Zealand half a century before they became epidemic in Kentucky. The elder Edwards has left an instructive account of the bodily agitations which accompanied the revivals of religion from 1735–'42. Many instances are given of fainting, falling, trance, numbness, outcries, and convulsions, and he relates that some of the subjects lost their reason.† The epidemic of Kentucky spread more widely, and persisted for a longer time, as well as in more extravagant forms. It continued to reappear for several years, and involved a district of country extending from Ohio to the mountains of Tennessee, and even into the old settlements in the Carolinas. Lorenzo Dow relates that, at a religious meeting in the court-house of Knoxville, when the Governor of Tennessee was present, he saw one hundred and fifty people "jerking" at one time. But at other places the frenzy reached a greater height. It was computed that, at a religious meeting in Kentucky, not less than three thousand persons fell in convulsions to the ground.

The extraordinary religious excitement in which these nervous disorders took their rise commenced in Logan County, Kentucky, under the preaching of Rev. James McGready, described as a man of "hideous visage and thunder-tones," with a highly impassioned style of eloquence.‡ The excitement abated soon, but was renewed in a more intense form three years later, and continued to grow and deepen until it reached its height about the year 1800. Its effects were described by this fiery preacher as at that time "exceeding everything his eyes had ever beheld upon earth." Families came in wagons, forty, fifty, and one hundred miles to attend the meetings, and it became necessary to establish camps for their accommodation. These camp-meetings generally continued four days, from Friday to Tuesday morning, but sometimes they lasted a week. One succeeded another in rapid succession, and thus the fervor of religious feeling was kept up. The woods and paths leading to the camp-ground seemed alive with people. "The laborer," says Dr. Davidson, in the work just quoted, "quitted his task; age snatched his crutch; youth forgot his pastimes; the plow was left in the furrow; the deer enjoyed a respite upon the mountains; business of all kinds was suspended; dwelling-houses were deserted; whole neighborhoods were emptied; bold hunters, and so-

* Rees's "Cyclopædia," article "Imitation." † Edwards on "Revivals."

‡ Dr. Davidson's "History of the Presbyterian Church in Kentucky."

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ber matrons, young men, maidens, and little children, flocked to the common center of attraction; every difficulty was surmounted, every risk ventured, to be present at the camp-meeting."

The concourse became immense. At one of these assemblages the attendance was computed at twenty thousand souls. And here were united all the elements best suited to stir the emotional nature of man and to derange his nervous system. The spectacle at night, as Dr. Davidson depicts it, was one of the wildest grandeur. With great beauty of description he says: "The glare of the camp-fires, falling on a dense assemblage of heads simultaneously bowed in prayer, and reflected back from long ranges of tents upon every side; hundreds of candles and lamps suspended among the trees, together with numerous torches flashing to and fro, throwing an uncertain light upon the tremulous foliage; the solemn chanting of hymns swelling and falling on the night wind; the impassioned exhortations, the earnest prayers, the sobs, shrieks, or shouts, bursting from persons under intense agitation of mind; the sudden spasms which seized upon scores, and unexpectedly dashed them to the ground—all conspired not only to invest the scene with terrific interest, but to work up the feelings to the highest pitch of excitement."* To these circumstances, that tended so powerfully to excite the nervous centers, we have to add others which gave intensity to their effect. The meetings were protracted to a late hour in the night, keeping the feelings long upon the stretch. A reverent and general enthusiasm ascribed the bodily agitations to a mysterious, divine agency. The preaching was fervid and impassioned in the extreme. Many of the preachers, unable to control their emotions during the sermon, went around in "a singing ecstasy," shouting and shaking hands with others, as much excited as themselves. In this way everything was done to "heap fuel on the fire," and it was at such meetings that thousands fell in convulsions to the ground.

Some of the actors in these strange scenes have left records of the state of their minds, which show that they were in a condition bordering on insanity, if not actually insane. One of them relates that, while under conviction on account of his sins, he went about the woods for two years, through rain and snow, "roaring, howling, praying, day and night." And when light and hope broke in at last upon his mind, which he describes as a "rushing, mighty wind, that descended from heaven, and filled his whole being," he went shouting over the encampment all night and a great part of the next day. He continues: "I now made the mountains, woods, and canebrakes ring louder with my shouts and praises than I once did with my howling cries; I never fell on my knees in secret but the Lord poured out his power, so that I shouted out aloud. Sometimes I shouted for two or three hours, and even fainted under the hand of the Lord. I was ready to cry out at the name of Jesus. The brightness of heaven rested continually upon

* Dr. Davidson's "History of the Presbyterian Church in Kentucky."

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my soul, so that I was often prevented from sleeping, eating, reading, writing, or preaching. I would sing a song, or exhort a few minutes, and the fire would break out among the people. I have spent nine nights out of ten (besides my day meetings, and long, hard rides) with the slain of the Lord." *

Granade is the preacher who gives this description of himself, which is also descriptive of his times. He was a stormy orator who drew great crowds wherever he went. He admits that he went by the name of "the distracted preacher," but says that at one of his meetings "the people fell as if slain by a mighty weapon, and lay in such piles and heaps that it was feared they would suffocate, and that in the woods." So violent was his manner, stamping with his feet and smiting with his hands, that he often broke down the stands erected for him in the woods. Once, it is told of him, he was addressing a class-meeting in the upper story of a dwelling-house, when the room below was crowded with worshipers, and, being in what the historian calls "one of his big ways," he exclaimed, "I feel like breaking the trigger of hell!" and at the same time gave a tremendous stamp with his foot which actually broke one of the joists. The people below, hearing the sudden crash, ran screaming to the door, some of them really imagining, as the writer of all these events relates, "that hell had overtaken them." †

Granade was of an excitable temperament and vivid imagination. His person was commanding, and, with a sounding voice and most impassioned manner, his oratory produced startling effects.

Another feature of these excited meetings, which served still further to intensify the feelings of the people who attended them for days and nights together, was the part taken in them by children. Nothing was more affecting to the congregations than the sight of a little boy or girl on a log or stump, passionately exhorting the multitude. Thus, a boy, who appeared to be about twelve years of age, is described as having retired from the stand at Indian Creek, Ohio, during the sermon, and, mounting a log and raising his voice to a high pitch, soon had nearly all the congregation with him. "With tears streaming down his cheeks, he cried aloud to the wicked, warning them of their danger, denouncing their certain doom if they persisted in their sins, expressing his love for their souls, and desire that they should turn to the Lord and be saved." A man on each side held the boy up, and he spoke for about an hour. When quite exhausted, and language failed to give utterance to his emotions, the little orator raised his hands, and, dropping his handkerchief wet with tears and perspiration, cried out, "Thus, O sinner, shall you drop into hell, unless you forsake your sins and turn to the Lord." At that moment, the writer of this account continues, "Some fell like those who are shot in battle, and the work spread in a manner which human language can not describe." ‡

* McFerrin's "Methodism in Tennessee." † Ibid. ‡ Ibid.

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McNemar instances boys of eight and ten years, and the Rev. John Lyle mentions one of seven, who called on sinners to repent, with an eloquence singularly overpowering. Possessed by one dominant idea, the people gave themselves up to the wildest enthusiasm, and it was no uncommon thing for them to spend the whole night in religious orgies such as have been described.*

The spectacle of persons falling down in a paroxysm of feeling was first exhibited at Gasper River Church, in one of McGready's congregations in the summer of 1779. The movement proved highly contagious and spread in all directions. After a rousing appeal to the feelings of the listeners, and especially during spirited singing, one and another in the audience would fall suddenly to the ground and swoon away. Not only nervous women, but robust young men were overpowered. Some, continues the historian, fell suddenly as if struck by lightning, while others were seized with a universal tremor before they fell shrieking.† Dr. Blythe, who often witnessed scenes of this sort, assured Dr. Davidson that he had once felt the sensation himself, and only overcame the tendency to convulsion by a determined effort of his will. A few shrieks never failed to put the assembly in motion, and set men and women to falling all around. A sense of "pins and needles" was complained of by many of the subjects, and others felt a numbness of body, and lost all volitional control of their muscles. It soon grew into a habit, and those who had once fallen were ready to fall again under circumstances by no means exciting. Women who had suffered repeated attacks sometimes fell from their horses on their way to or from the meeting-house, while relating their past religious exercises.

The condition in some of the subjects was cataleptic, lasting generally from a few minutes to two or three hours; but in a few cases it continued many days. Others were violently convulsed as in hysteria or epilepsy, "wrought hard in fitful nervous agonies, the eyes rolling wildly." Most were speechless, but some were capable of conversing throughout the paroxysm. The extremities were cold; the face was pale or flushed, the breathing hard. Sensibility was annulled. Mr. Lyle, one of the prominent preachers of the times, having been furnished by Dr. Warfield with a vial of hartshorn, applied it to a stout young man who was lying flat on his back, and, inadvertently, let some of the fluid run into his nostrils; but he took not the slightest notice of it.‡ Others who fell hard to the ground, or in running encountered stumps or trees, felt no pain from the violence. So many fell at Cabin Creek camp-meeting, it is related, that to prevent their being trodden upon "they were laid out in order on two squares of the meeting-house, covering the floor like so many corpses. At Paint Creek Sacrament two hundred were estimated to have fallen; at Pleasant Point three hundred were prostrated; while at Cane Ridge, as has

* Davidson, *op. cit.* † Lyle's "Diary." ‡ Davidson's "History."

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been stated, the number who fell was believed to have reached three thousand.

The "jerks," as they were termed, presented some novel and remarkable features. Their first occurrence is reported to have been at a sacramental meeting in East Tennessee, where several hundred people of both sexes were seized with this strange, convulsive movement. The Rev. B. W. Stone has left a vivid description of it. Sometimes, he says, the subject was affected in a single member of his body, but at others the spasms were universal. When the head alone was affected, it would be jerked from side to side so quickly that the features of the face could not be distinguished. When the whole system was affected, he continues, "I have seen the person stand in one place, and jerk backward and forward in quick succession, the head nearly touching the floor behind and before. All classes, saints and sinners, the strong as well as the weak, were thus affected. I have seen some wicked persons thus affected, and all the time cursing the jerks, while they were thrown to the earth with violence." *

The first form in which these spasmodic movements made their appearance was that of a simple jerking of the arms from the elbow downward. When they involved the entire body, they are described as something terrible to behold. The head was thrown backward and forward with a celerity that alarmed spectators, causing the hair, if it was long, "to crack and snap like the lash of a whip." †

The most graphic description of the "jerking exercise" was written by the Rev. Richard McNemar, an eye-witness of the frenzy, as well as an apologist, believing it to be a display of Divine favor. In his "History of the Kentucky Revival" he says: "Nothing in nature could better represent this strange and unaccountable operation than for one to goad another, alternately on every side, with a piece of red-hot iron. The exercise commonly began in the head, which would fly backward and forward, and from side to side with a quick jolt, which the person would naturally labor to suppress, but in vain; and the more any one labored to stay himself, and be sober, the more he staggered, and the more his twitches increased. He must necessarily go as he was stimulated, whether with a violent dash on the ground, and bounce from place to place like a foot-ball, or hop round with head, limbs, and trunk twitching and jolting in every direction, as if they must inevitably fly asunder. And how such could escape without injury was no small wonder to spectators. By this strange operation the human frame was commonly so transformed and disfigured as to lose every trace of its natural appearance. Sometimes the head would

* McFerrin's "Methodism in Tennessee."

† Dr. Davidson, who relates this singular fact, felt it necessary to authenticate the statement by referring to eye- and ear-witnesses of its reality. I remember to have heard my grandmother describe, when I was but a little boy, the same thing as occurring in a woman at a camp-meeting near her home in Tennessee, in 1810.

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be twitched right and left to a half-round with such velocity that not a feature could be discovered, but the face appeared as much behind as before. Head-dresses were of little account among the female jerkers. Handkerchiefs, bound tight round the head, were flirted off with the first twitch, and the hair put into the utmost confusion; this was of very great inconvenience, to redress which the generality were shorn, though directly contrary to their confession of faith. Such as were seized with the jerks were wrested at once, not only from under their own government, but from that of every one else, so that it was dangerous to attempt confining them or touching them in any manner, to whatever danger they were exposed. Yet few were hurt, except such as rebelled against the operations through willful and deliberate enmity, and refused to comply with the injunctions which it came to enforce."

The same writer gives the history of a case of jerks as follows, and no case could illustrate more strikingly the nature of the affection:

A young man, of a pious family, the son of a tanner, feigned sickness one Sunday morning to avoid going that day to camp-meeting. He kept his bed until he was assured that all the family, except a few negro children, had left the premises, and was much pleased at the success of his stratagem. As he lay quietly in his bed, his thoughts naturally turned to the camp-meeting in progress. The assembled multitude, excited, agitated, convulsed, rose up vividly before his mind. All at once, while occupied with the scene, he felt himself violently jerked out of bed, and dashed round the walls in a manner utterly beyond his control. Prayer, he remembered, was deemed efficacious in such circumstances, and he fell upon his knees in the hope that it would prove a sedative in his case. It turned out as he hoped, and he returned to bed, happy at finding the spirit exorcised. But the enemy soon returned; the jerks were as bad as ever, but were again allayed by prayer. Dressing himself, he now went to the tan-yard, and set about currying a hide to occupy his mind. He rolled up his sleeves, and, grasping his knife, was about to commence the operation, when suddenly the knife was flirted out of his hand, and he was jerked violently backward, over logs and against fences, as before. Gaining relief by resorting once more to prayer, he ventured to resume his occupation, but was again seized with convulsions, and at last forsook the tan-yard and betook himself to strong cries for mercy, at which he was found engaged by the family on their return from the meeting in the evening.*

Another characteristic example is related by a writer in the "Gospel Herald"†:

A gentleman and lady of some note in the fashionable world were attracted by curiosity to the camp-meeting at Cane Ridge. They indulged in many contemptuous remarks on their way, about the poor

* Davidson, *op. cit.* † "History of Methodism in the United States."

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infatuated creatures who rolled over screaming in the mud, and promised jestingly to stand by and assist each other in case that either should be seized with the convulsions. They had not been long on the ground, looking upon the strange scene before them, when the young woman lost her consciousness and fell to the ground. Her companion, forgetting his promise of protection, instantly forsook her and ran off at the top of his speed. But flight afforded him no safety. Before he had gone two hundred yards, he too fell down in convulsions, "while a crowd flocked round him to witness his mortification and offer prayers in his behalf."

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These nervous disorders assumed many other grotesque forms besides those which have been described. The subjects often rolled over and over on the ground, or ran violently until worn out with the exertion. Hysterical laughter was another modification. Instances of laughter were only occasional at first, but it grew, until in 1803 the "holy laugh" was introduced systematically as a part of religious worship. Sometimes half the congregation, apparently in the most devout spirit, were to be heard laughing aloud in the midst of a lively sermon. As the excitement grew, the infatuated subjects took to dancing, and at last to barking like dogs. McNemar says they actually assumed the posture of dogs, "moving about on all-fours, growling, snapping the teeth, and barking with such an exactness of imitation as to deceive any one whose eyes were not directed to the spot."* Nor were the people who suffered so mortifying a transformation always of the vulgar classes; persons of the highest rank in society, on the contrary, men and women of cultivated minds and polite manners, found themselves, by sympathy, reduced to this degrading situation.

The "barks" were looked upon at first as a chastisement for remissness of duty, and the only way to escape them was to engage in the holy dance. But, from being regarded as marks of guilt, these wretched exercises came to be esteemed "tokens of Divine favor, and badges of special honor."† With these manifestations the insanity reached its height in about three years after it began to show itself.

It was one of the popular beliefs of the times that certain instincts or conditions of the system would avert these nervous attacks. Thus it was held that a woman with a child in her arms, or conscious of approaching maternity, was in no danger. But there was no truth in the supposition. The maternal instinct, at least, had no protective efficacy. An instance is related where a woman mounted the stand, with an infant in her arms, for the sake of a better prospect, and that being suddenly seized she fell backward, dropping her child. Some one fortunately saw the danger in time to seize and save the child before it fell to the ground.‡

A large proportion of the members of every congregation had power to resist the convulsive tendency. In a great majority, no such

* Davidson. † Ibid. ‡ Ibid.

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tendency probably existed; but where there was a conscious impulse toward the convulsions it could be restrained by most persons before it had been yielded to too long. Dr. Blythe had but little of the disorder in his church. He discountenanced the wild enthusiasm from the beginning, and threatened to have any one who became convulsed turned out-of-doors. The religious frenzy soon began to abate when the clergy set their faces against the stormy exercises. Rev. Joseph Lyle, on the second Sabbath in July, 1803, preached in his church a significant sermon on "Order." The congregation had come together expecting the usual displays of feeling; but though some were angered by his doctrines, and some strove to promote the confusion of intermingled exercises, only a few "fell," and, altogether, moderation triumphed. This was the first sermon preached against the fanaticism.

It is a remarkable fact that, notwithstanding the intensity and duration of this nervous disorder, no instance is recorded in which permanent insanity resulted from it. Such results were to have been expected; insanity is mentioned by Edwards as having attended the excitement in New England, and it may be that reason was dethroned in some whose cases have not become matters of history. In a few years, after a sounder public opinion began to assert itself, instances of the disorder had become rare, but it was many years before the epidemic entirely ceased.

As to its nature, there was but one opinion among medical men from the beginning. All referred it to a derangement of the nervous system. Dr. Felix Robertson, of Nashville, described the affection in his thesis, published in Philadelphia, in 1805, as a form of chorea. In some cases it took the form of that disease. In others it bore a stronger resemblance to epilepsy; while in a greater number it partook rather of the character of hysteria. It was eminently sympathetic in its nature, as has been so often remarked of these affections. The convulsions once started in a congregation spread quickly through it, until all the fit subjects were convulsed. Repetition greatly increased the proneness to the disorder, which was invited by the masses on the supposition that it was a true religious exercise.

These perverted muscular movements all come under the head of morbid reflex action. By the continued religious fervor, the central portions of the brain, the immediate seat of emotion and feeling, became inordinately excited. The impression, transmitted downward to the spinal cord, threw the muscles of voluntary motion into convulsions. Sensibility, which has its seat in the sensory ganglia, was generally annulled. When the hemispheres became involved, the subjects fell into a state of unconsciousness or coma. In this abnormal condition of the nervous centers, the bare recollection of the distressing scenes was sufficient in many cases to excite the convulsive movements. The former belong to sensori-motor actions; this last is an example of ideo-motor movement; instances of which are afforded by the act of

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vomiting, which may be caused by the recollection of disgusting sights or odors. The principle of imitation accounts for the rest. The great nervous centers, in multitudes of people, being in a state of polarity, any unusual exhibition of feeling would throw the more excitable into spasms; and the affection would then spread by sympathy, as hysterical convulsions and chorea are known to spread among girls at boarding-schools. And, as fear has checked these, the epidemic convulsions were checked by reason and common-sense, and finally ceased under the law which limits all violent action.—*Brain.*

EXTENSION OF THE SIGNAL SERVICE.

By Professor JOHN TROWBRIDGE.

THE Signal Service of the United States performs a great service to science by inculcating the value of scientific investigations. Observations in meteorology were formerly buried in the proceedings of learned societies, and met the eyes only of a few scientific men: now they are discussed at the breakfast-tables of a million people. The departments of physics in our universities and technical schools have reason to thank the Signal Service for leading the public mind to see the importance of physical investigations to the ordinary pursuits of mankind. He, however, who endeavors to raise money at the present time to equip a physical laboratory in connection with a university, will find that the Signal Service still has work to do among the practical business-men of this country—men whose successful prosecution of their commercial enterprises depends upon the economical use of steam, upon careful scientific consideration of atmospheric changes, conditions of heat and moisture, and sanitary laws. There are men of this class who accept what they call progress, without inquiring into the causes of it, and who have never thought of physics as a science to which business is indebted for its successful prosecution. "What is meant by the word physics?" asks the man who consults the paper to discover if the storm-center which has been developed in Texas, and whose progress has been telegraphed, will probably strike his steamship, which is off Cape Hatteras. This steamship has recently been fitted up with the most approved compound engines, which have been perfected by the labors of those physicists, Rankine and Thomson. "What is meant by the word physics?" asks the manufacturer, with a telephone to his ear, listening to a response from his factory. The solicitor for the endowment of a physical laboratory has the satisfaction, even if he fails to obtain a subscription, of feeling that he is a public educator.

It is very probable that any plan for the extension of the Signal

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Service would meet with opposition, even among those who would be most benefited by such extension. Yet the demands of science are daily becoming more inexorable, and the progress of meteorology toward the stand-point of an exact science is assured by the labors of those who have charge of the Signal Service.

At one time most of our American colleges and universities conducted meteorological observations. These observations were industriously made and conscientiously carried on, but were very much like private measurements of rain-fall and barometer heights—notes of the first coming of the golden robin in spring—and journals of cold or hot days. Meteorological observations which are not taken simultaneously over extended areas are of little value, save to the compilers of local almanacs. The Signal Service, having relieved four universities of their onerous meteorological responsibilities, doubtless feels indebted to them for pointing the way, and would be grateful if the universities could lead them one step higher, since it is one of the functions of a university to be always a little in advance of the ruling conditions of popular knowledge. Some plan of co-operation might be devised, by which the universities and colleges along our Atlantic sea-coast could aid the Signal Service in testing the value of more delicate investigations upon atmospheric changes than can be carried on at the present Government stations. Harvard University, Yale, Columbia, Princeton Colleges, the University of Pennsylvania, and Johns Hopkins University could, doubtless, provide suitable rooms and experienced assistants for testing the value of simultaneous observations upon various phenomena which are not at present taken into account in weather predictions. We judge at present of climatic changes by observations above-ground; it may be that the presence of earth-currents of electricity, of fluctuations in the earth's magnetism, of waves of heat through the superficial layers of the earth, may reveal important factors in announcing meteorological changes. Simultaneous observations, upon the slight earthquake-shocks which are continually pulsating beneath the apparently calm surface upon which our great cities are built, may have important relations to conditions of heat and cold. The mere mention of these unobserved phenomena is sufficient to show the state of our ignorance, and to lead us to expect that investigations in physical laboratories will be of practical value in leading the Signal Service to extend its usefulness.

The electrical state of the air is supposed to have great influence upon the proper conditions for fair weather and for storms, and to also affect the states of health and disease; but no definite information has been collected which bears upon these points. The Signal Service would aid the science of meteorology very greatly by extending observations on the electrical state of the air over large areas of territory.

The apparatus for studying the electricity of the atmosphere is

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probably the most delicate and refined of any in the subject of electricity. Sir William Thomson's electrometer is an admirable instrument, wonderful in its details and in its scientific plan. It can be used, however, by any intelligent observer. In principle it consists merely of a suspended aluminum needle which swings between four hollow quadrants. The needle is put in constant contact with the inner coating—which consists of sulphuric acid—of a Leyden-jar, by means of a small wire suspended from the needle. The diagonal quadrants are connected. If one pair is put in connection with the ground and the other pair connected with the body whose electrical state is to be tested, the aluminum needle by its deflection indicates the kind and amount of the electrical state. The needle is provided with a mirror, which allows its deflections to be observed by means of the reflection of a point of light. Although the principle is simple, yet the means for obtaining complete insulation and for keeping a constant charge in the needle are quite complicated. The Leyden-jar can be charged by means of a small Holtz machine, or by means of an induction-coil. A still better method of charging has been adopted by the Continental physicists: this consists in the employment of a miniature water-battery of five hundred or a thousand cells. Small glass vials, similar to those used by the homœopathists, are filled with distilled water, are placed in a wooden box, and are well insulated from each other. A sheet of zinc and copper are soldered together along their edges, and then cut into small couples of zinc and copper. These cells are coupled *seriatim*, or, as it is usually termed, for intensity. The entire battery need not occupy a space of more than a foot and a half square, and can be made even more compact. The statical charge at the terminals of this miniature battery is strong, and a Leyden-jar or a condenser can be easily charged by connecting one terminal of the battery to the inner coating of the condenser and the other to the outside coating. The electrometer-jar is charged, therefore, in this way, by being kept permanently connected with this battery.

The apparatus for collecting the charge of the air, in order to affect the charged needle, consists of an insulated tin can filled with water. The water is allowed to flow from this can by means of an horizontal glass tube, which is drawn out to a comparatively narrow orifice. The can is then connected by an insulated wire to one pair of the quadrants of the electrometer. Since the original charge of the can and the water—all objects are necessarily charged with electricity to a greater or less extent—is dissipated by the flow of the water, the electricity of the air continually renews this loss, and the tin can finally takes the charge of the air in which it is placed. This method is very sensitive, and will detect discharges of lightning by a throb of the electrometer-needle even when the thunder-storm has not yet appeared above the horizon. A method of obtaining continuous registrations of the deflections of the electrometer-needle is necessary. This can

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be accomplished by receiving a spot of light, which is reflected from the mirror attached to the needle, upon a cylinder covered with sensitized paper. This cylinder is made to slowly revolve by clock-work, so that twenty-four-hour observations can be obtained. Nothing is so characteristic of modern methods in physical science as continuous registration of physical phenomena. Early observers were forced to content themselves with scattered observations taken at different intervals, and important variations might occur at the times when no observer was watching the apparatus. Now the movements of the human heart can be recorded by a little apparatus which will combine in one curve a thousand continuous observations, and the slightest anomalous fluctuations can be studied from the record which is obtained.

Provided, therefore, with these modern and more refined means of observation, we are in a condition to study the fluctuations of that subtile manifestation of energy which is ever present in the air, and seems to lurk in all matter. The influence of the electrical state of the air upon atmospheric changes is doubtless far-reaching. We are accustomed to think of thunder-storms as the only manifestations of atmospheric electricity; but there are influences which it exerts, more silent than those which are announced by the crackle of lightning, yet none the less extended. A pretty experiment, described by Lord Rayleigh, illustrates the effect of electricity upon the coalescence of rain-drops. A narrow stream of water is allowed to issue from a reservoir and form a parabola, which strikes the ground in drops about four feet from the orifice. When this is a fine stream, it breaks up into a shower of drops at about two feet from the orifice. On rubbing a bit of sealing-wax with a cloth, and presenting the rod of sealing-wax near the stream, the drops immediately cease to separate, and the stream is continuous from the orifice to the point where it strikes the ground. This is a very striking experiment, and undoubtedly has a bearing upon the formation of large drops of rain, which are often noticed during a thunder-storm after a discharge of lightning. Instead of a rod of sealing-wax, a piece of writing-paper can be readily charged by placing it upon a table and rubbing it vigorously with the palm of the hand.

None of the theories which endeavor to explain the source of the electricity of the air are satisfactory. Professor Tait, in a recent lecture, is of the opinion that evaporation is the source. Under the influence of the sun's heat, this operation of nature is conducted on an immense scale, and seems to him to be competent to furnish the supply of atmospheric electricity.

It is maintained by others that the atmosphere of the earth has a permanent charge, which it received in the beginning, or which was developed by cosmical changes; and this charge manifests itself here and there, and fluctuates under different conditions of heat and moist-

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ure. Mr. Aiken has lately broached a novel theory of the formation of fogs and rain-clouds, which also has an important bearing upon the theory of atmospheric electricity. He believes that dust, or impalpable saline particles, are necessary for the formation of clouds. Without dust, or these particles, we should always have cloudless skies. To prove this theory, he caused water to evaporate in two receivers, the air in one of which had been passed through cotton-wool and other media, to intercept the dust; in the other the air contained dust. The usual fog which is perceived when water is suddenly evaporated under a receiver was absent in the receiver whose air had been deprived of its dust, but was present as usual in the other receiver. Various experiments of the same nature were tried. Fog suddenly formed in the dust-deprived air of a receiver if a bit of wood was burned, and thus caused to throw off small particles; burning sulphur was very active in producing these fogs. The fogs of London are thus partially caused by the consumption of coal and the evolution of sulphurous gas, and the fogs along the sea-coast by the saline dust formed from the spray.

If this theory is a correct one, our views of the electrical charges upon different layers of air must be modified to a considerable extent. Some experiments are now being made in the Physical Laboratory of Harvard University to test the inductive capacity of dust-films, and also to trace the fluctuations in the electric spark when it is caused to pass through air deprived of its dust, and air which contains impalpable matter. In order to add to our knowledge of the electrical conditions of the air, simultaneous observations are needed at a large number of stations. The cost of fitting up such stations would not fall short of six hundred dollars for each station, and the services of experienced observers would be necessary. It is not likely that the United States Government will establish such stations unless it can be shown that observations upon the electrical state of the air are important in predicting the path of storms. In the mean time, the various colleges in the different States might, by some system of co-operation with the Government, undertake such observations, since there are in nearly every college rooms and observers at command. As soon as it became apparent that the observations thus taken were of value, the interests of commerce would demand that they should become a part of the regular work of the Signal Service.

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THE FUNDAMENTAL PROBLEMS OF PHYSIOLOGICAL CHEMISTRY.*

By Dr. EDMUND DRECHSEL,
PROFESSOR OF MEDICINE AT LEIPSIC.

WHEN the science which endeavors to determine the phenomena of life and their connection was enabled to employ more exact expedients for its observations, the influence which the chemical process exerts on that of life became known. The physical apparatus of the body are preserved in the aggregate state and form, which are necessary for the performance of their functions by a definite chemical composition of the organs and the fluids which saturate them; and the source of the power required by the living body for its movements is to be sought for in the destruction of the compounds of which it is composed. This statement is not only justified by the axioms of science, but it is also confirmed by experience. For, even where the best methods of chemistry are deficient, we meet with phenomena, the appearance of which can only be explained by chemical decomposition. The substances of which the muscle is formed and the manner in which they are arranged are still imperfectly known; of the chemical process which takes place in the sarcous elements, when a muscle passes from rest to the contracted state, we know scarcely anything; still, we can not doubt for a moment that the muscle owes its form to its composition, and its motion to a change of the latter. This is shown by the fact that even by a slight change, which we may produce in the chemical constitution, though it be only a change in the amount of water or salt in the muscle, its elasticity, its sensibility, its ability to raise weights, is affected. By comparing the composition of the muscle, recovered after long repose, with that of the muscle tired by exertion, we immediately see that a change has taken place in it. The same may be said of the nerve, which has hitherto offered almost insurmountable obstacles to chemical examination; for how can its tiring be explained except by a chemical change of its mass? All doubt must here be removed on considering the electric change which accompanies every excitation of the nerve, for the differences in the electric tension, which appear in this momentary phenomenon, give distinct evidence of a chemical change.

For a complete understanding of these phenomena, an exact knowledge of the chemical processes in the organism is essential. At present we do not possess this; nevertheless, it is well worth the trouble to examine how far we have advanced in this direction; what requirements are to be fulfilled for further investigations; and in what man-

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ner we are to proceed in order to arrive at the object to be accomplished.

For a series of the most important disclosures, we are indebted to those investigations which have been devoted to the life-processes of the lowest organisms, consisting of single cells. Not that we have here progressed any further than elsewhere, but we have attained the certainty that the most important processes take place in the cells themselves, and that substances are formed which are able to produce powerful chemical changes. The processes to be first considered are those included under the general name of fermentation.

The first known process of fermentation is that which cane-sugar undergoes. A fungus, the so-called yeast, converts the sugar into glucose, and then decomposes this into alcohol and carbonic acid, with the simultaneous formation of small quantities of other products, such as succinic acid, glycerine, etc. The amount of yeast is not increased unless other substances, particularly nitrogenous organic and certain inorganic salts required in building up the body of the cells, are present. From this it appears that various chemical processes take place within the cell, the most striking of which is the decomposition of the sugar. How this takes place is a question which has been largely discussed. From the circumstance that carbonic acid and alcohol are produced in such proportions that the quantities of carbon, hydrogen, and oxygen contained in them are just sufficient to form the sugar, one might suppose that the decomposition is very simple; but, notwithstanding all attempts, the same reaction has never been produced without the aid of yeast. Two hypotheses have been proposed to explain this phenomenon: the one assumes that the yeast-cell contains a ferment which splits the glucose directly into carbonic acid and alcohol, the same as invertin changes cane-sugar into dextrose and lævulose; the other, on the contrary, considers the decomposition of the grape-sugar as an effect of the vital action of the yeast-cells, comparable to the conversion of albumen into carbonic acid, water, and urea in the organism of mammals.

In order to form an opinion of the value of these hypotheses, we will briefly indicate the points of view whence they have been projected. In the first theory consideration is given chiefly to the similarity which the outward appearance of the yeast fermentation has with certain chemical processes, such as the decomposition of sugar by invertin. In both cases the presence of a small amount of yeast or invertin suffices to decompose a comparatively large quantity of sugar, without any apparent change being produced in the yeast or in the invertin. This has given rise to the supposition of the existence of an alcohol ferment in the yeast; a theory which will be verified, when the suspected ferment shall be separated from the yeast, as has already been done with the invertin. All experiments, however, which have been made in this direction have resulted negatively, and hence the

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supporters of this hypothesis have been obliged to resort to the theory that the ferment in question is so readily decomposed that it can not be isolated. The other hypothesis is based upon the failure of all attempts to prepare the alcoholic ferment, and therefore assumes that such a ferment does not exist in the yeast, but, that the sugar is decomposed in the yeast-cell in the same way as the albumen is decomposed in the organism of the mammalia. The fact that a small amount of yeast can by degrees decompose a large quantity of sugar is of no more account than that a dog, for instance, can by degrees decompose many times his own weight of albumen. The fundamental difference between the hypotheses, therefore, is, that one assumes the presence of a ferment, while the other denies it.

The former hypothesis was fully justified as long as the nature of yeast and the ferments of the present were unknown; but, since we know the latter as definite chemical compounds, which are also active without the cell, and do not require this for the development of their activity, we must strictly distinguish between their action and that which we see produced only by the living organism or cell. The latter is not at all to be considered the effect of fermentation, until actual evidence of the presence of a specific ferment is furnished. A simple consideration will show that the decomposition of the sugar, as the result of the vital action of the yeast-cell, may well be compared to the conversion of albumen into carbonic acid, water, and urea, in the higher organisms. If we assume the body of a mammal, a dog for instance, to be reduced to the size of a yeast-cell, without any change in its organization, we would manifestly obtain a microscopic organism, which would act on albumen in the same way that yeast acts on sugar. Its anatomy would be as inaccessible to us as that of the yeast-cell, for the organs would appear to us as dots and threads, similar to the grains which we find in the cells. The changes of the gases in the blood, together with the processes which take place in the intestines or in the liver, and which have so often been made the subject of the most thorough investigations, would be beyond the reach of our methods and we could only determine that these organisms have the power to convert comparatively large quantities of albumen into carbonic acid, water, and urea, with the absorption of oxygen—in short, the process would be similar to that of yeast fermentation. If we had chickens and snakes in the same diminutive state, we should find that they would produce uric acid instead of urea. It would be in vain to attempt to separate from these organisms a ferment which would convert albumen into carbonic acid, water, and urea, or uric acid, with the absorption of oxygen.

The fact that sufficiently reduced dogs and chickens would represent two different ferments shows clearly that the differences which are observed between yeast, the lactic ferment, and the butyric ferment, may be considered due to the inner organization of these most

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minute beings. The supposition that one variety of bacteria can produce lactic acid, another butyric acid, a third caproic acid, has recently been stigmatized as "superstition"; but it was forgotten that the cells of the hog's liver produce a different acid from that obtained from the liver of a goose, ox, or man—a fact which evidently is of the same order as that given for the bacteria.

Another point deserves our special attention—the inner organization of the single cells, and the organisms composed of them. Since our present means are insufficient to distinguish this with certainty, we consider the cell or living protoplasm as being without structure. This reasoning is untenable, as it is only supported by the imperfection of our apparatus and methods; on the contrary, other weighty facts are in favor of the presence of such an organization. Above all, it is to be emphasized that within each living cell a number of chemical processes are constantly taking place simultaneously, all of which are necessary for the existence and vitality of the cell. These processes are of so different a nature that it is difficult to believe that they take place within a perfectly homogeneous mass. It seems much more simple and natural to suppose that each of the reactions takes place separately, which could be most readily effected by an internal organization of the cell. The peculiar figures which have been noticed in the division of the cells also speak in favor of this, as do the differences in their exterior forms, which are always governed by the inner organization; the variations in the further development, and particularly the effect on the surroundings, are also in favor of this view. How can we perceive that the bacteria of ordinary putrefaction are comparatively harmless, while the bacteria of splenitis are so destructive, unless we seek the cause in the peculiar inner structure?

Hence the chemical processes within the living cell are of two kinds: those in which ferments take part, and those in which they do not. The ferments are definite chemical compounds, which are able to decompose large quantities of other substances without undergoing any apparent change themselves. The manner in which this takes place is not yet explained, but we have reasons for comparing these processes with others in which a small quantity of one body, e. g., sulphuric acid, gradually converts a large quantity of another, e. g., alcohol, into ether and water. In this case the sulphuric acid acts like a ferment on the alcohol, and the similarity is so striking that it has been attempted to explain both in the same way. Formerly it was supposed that the simple contact of one body with another was in many cases sufficient for complete decomposition, and contact action, produced by the so-called catalytic force, was spoken of. Later it was found that in the above example the sulphuric acid first combines with the alcohol to form ethylsulphuric acid, which is afterward decomposed with a fresh quantity of alcohol into ether and sulphuric acid. Accordingly, the action of every ferment must be considered as consist-

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ing of at least two reactions, in the first of which the ferment forms with the substance to be decomposed a compound which is split up in the second with the regeneration of the ferment. This has not been experimentally proved for the real ferments, but it explains these processes so simply and completely that its correctness can not be doubted.

These processes of fermentation have an extraordinary distribution, for not only do the individual living cells produce ferments, but also those which form parts of complicated organisms. This is especially the case with those cells which are often united in enormous quantities to form a larger organ. I will recall the salivary gland, the peptic gland, and the pancreas, whose secretions are exceedingly rich in ferments. This is of the greatest importance for the economy of the animal organism, since it permits a considerable performance with a comparatively small expenditure of means.

I wish to call attention to another important peculiarity of the processes of fermentation—that is, to their sensibility to foreign influences. Some will only take place in a completely neutral or slightly alkaline solution, others only in a slightly acid solution; they all progress most rapidly at a certain temperature, and even slight deviations from the most favorable conditions are sufficient to sensibly retard the action of a ferment or to completely arrest it. The pepsin of the gastric juice acts exclusively in acid solution (best in hydrochloric acid); hence, if the gastric juice contains no free acid or only an organic acid, such as lactic acid, the pepsin will produce no effect on albumen, or only in a slight degree.

Although I have just described this sensibility as a peculiarity of the process of fermentation, it is not to be inferred that it is noticed here exclusively; on the contrary, we find it in all chemical processes, only in a less degree. How many reactions take place only at a given temperature, or at a given degree of concentration? Creatine, for instance, when boiled with baryta-water, is partly decomposed into urea and sarcosine, and partly into ammonia and methylhydantoin; and it is evident that the possibility of splitting up in different directions is increased with the size of the molecule. In the organism a large number of bodies are present which have a very complicated structure, and are therefore readily decomposed. They have an ephemeral existence only, but are, nevertheless, of the greatest importance in the economy of the whole. Most of them are unknown to us, but in some cases they have been successfully isolated. I will only mention glycogen, the discovery of which is several decades old, and the purple of the retina, which has only lately been recognized. All such complicated compounds, having a high molecular weight, are capable of furnishing very different products of decomposition under slightly modified conditions. If, therefore, the decompositions in the organism should always take place in the same manner, the governing conditions must be exceedingly constant. Every product of decomposition, which is

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not to be directly excreted, is further employed in the organism, and exerts an influence on the chemical processes taking place, and may therefore produce disturbances in them. An example will explain this: In a large number of mammals the glycocol formed in the organism is not separated by the kidneys under ordinary circumstances; but a quantity of benzoic acid taken with the food is sufficient to fix the glycocol with the formation of hippuric acid, and to separate it in this form. These and similar facts, which can be mentioned in large numbers, have a very important signification, for they give the strongest support to the assertion that the chemical process in the animal body may be considerably changed by apparently slight circumstances. If we accept this, and consider the occurrence of substances still unknown, and present, perhaps, only in very small quantity in the animal organism, we will obtain a hint as to the explanation of effects which many foreign substances produce, though in very small quantities, on the organism. Who does not know the action of strychnia, curarine, prussic acid, and similar poisons?

As our knowledge of these poisons has increased, we have found that they never act on the whole organism, but always on particular organs or groups of organs; these may be the nerves, the muscles, the glands, or only a portion of them. While the curarine paralyzes all voluntary muscles, the heart perceives nothing of its effects; on the other hand, the poison of the fly-agaric—muscarine—paralyzes the heart, but not the voluntary muscles. Strychnia acts only on certain portions of the spinal marrow, opium only on parts of the cerebrum; phenomena which remain completely unintelligible until we attempt to explain them from a chemical point of view, and assume that, at the points accessible to the action of these poisons, there occur, in very small quantities, substances which are of the highest importance to the vital action of the organism, and which are decomposed by them. Of course, chemistry has not yet shown us any essential difference between striped and unstriped muscles, between brain and the spinal marrow, or between the different parts of these organs; but, as the observation of certain lines in the spectrum has led to the discovery of new elements, so may the action of these poisons, at some future time, serve as a guide in searching for these suspected substances.

The chemistry of the animal body is not simply confined to the formation and decomposition of definite chemical compounds; the organism also makes use of certain physical phenomena which are inseparably connected with the chemical, namely, the electric and the thermic. The former take part in the excitation of the nerves, perhaps also in some of the chemical processes; the latter are to be considered as the source of heat in warm-blooded animals as well as of the mechanical force developed by the different muscles. These important facts throw light on the total character of the chemical

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processes; for, if the organism is able by their use to keep its own temperature at a higher point than that of its immediate surroundings, and also to develop mechanical force, then, if not all, at least a majority of these processes, are accompanied by a rise of temperature. As is well known, however, the highest temperatures are obtained by combustion—that is, by the combination of other bodies with oxygen. Since oxygen is continually inhaled and consumed by animals during life, we are obliged to consider this as the source of heat and force. We have here a problem which is open to discussion, namely, whether the energy liberated by the combustion was originally contained in the oxygen or in the other substances. It appears as if the latter assumption was generally accepted; at least, statements are often met with, such as, for instance, that coal contains the heat of the sun which has been stored up during thousands of years. Although we can not, at present, with the means at our disposal, definitely solve this problem, it can at least be shown that the statement has little in its favor. The decomposition of carbonic acid by the influence of the light and heat of the sun is effected in such a manner that the carbon is employed in the formation of the compounds of which the plant is built up, while the oxygen escapes into the atmosphere. Now, we know that solids contain the least energy, because it must be supplied to them in the form of heat in order to convert them into the liquid or gaseous state, while, on the contrary, heat must be withdrawn from gases to condense them to liquids or solids. Oxygen is one of the most permanent gases, and must therefore possess an enormous amount of energy, while carbon, on the other hand, being one of the most difficultly diffusible and volatile bodies, can only contain a little energy. This makes it extremely probable that the force of the sun, taken up by the plants, is not stored in their bodies, but in the free oxygen of the atmosphere. Hence the latter is to be considered as the inexhaustible source of power on which man and animals draw, and in the carbon we possess a valuable aid for making this energy, contained in the oxygen, available.

After this digression, let us return to the chemical processes in the animal body. The production of heat and mechanical force, as well as the large quantity of oxygen consumed, indicates that the greater part of these processes must consist of oxidations, and accordingly we find that, among the products of excretion, carbonic acid and water form the principal parts, two bodies which can not be further oxidized. Besides these (to which sulphuric acid and phosphoric acid may be added), other substances are excreted in small quantity, which admit of further oxidation, but which have not suffered it in the organism. I will only mention urea, uric acid, and creatinine. All these compounds are products of chemical action, and the question is raised, How are they produced in the body? to what reactions do they owe their origin? to a single one, or to a whole series? Here we

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must confess we have no answer, save in exceptional cases. Wherever matter is found definitely arranged, it is also accompanied by effects dependent upon the arrangement; platinum, zinc, and sulphuric acid, when connected in a proper manner, form a galvanic element and give rise to a galvanic current. Similar relations exist in the animal body; here we also find the constituents in a definite arrangement which we term organization, and by means of which the body has control over such peculiar conditions that we can not, or at best only in rare cases, imitate them in the laboratory, and produce the same reactions as are produced by the body. Although we have been taught, by the celebrated discovery of the artificial production of urea by Wöhler, that the compounds occurring in the organism may also be produced out of the body, this and similar experiments have given no explanation of the manner in which the reaction takes place in the organism. Neither have those experiments been explained in which, after the introduction of certain substances into the body, new compounds, not ordinarily present, are found in the excretions. These investigations have, however, considerably increased our knowledge, by showing beyond a doubt that intermediate products are formed in the body, which are generally directly decomposed, and therefore withdrawn from observation, but which can be fixed by the introduction of foreign material, and so protected from further decomposition. How they are produced or fixed is not explained by these experiments; even if we assume, for instance, that the two components unite, with the elimination of the elements of water, we have not the slightest idea how it is effected. Numerous experiments, in which the amount of substances taken up and excreted by the organism were determined, have given valuable results, but not in regard to the reactions taking place in the body. The chemistry of the living body shows the peculiarity that all reactions take place at the temperature of the body, which is quite low, without the intervention of strong reagents in the ordinary sense. If we wish to produce similar reactions outside of the organism, we generally employ a high temperature and substances which would destroy the organism itself. For instance, to prepare hippuric acid from benzoic acid and glycocol, in the laboratory, it is necessary to heat both for some time to 160°, while in the body it is only necessary to dissolve them in blood, and pass the solution through a kidney, when a combination is effected. A problem is here presented, the solution of which is of the greatest importance to physiological chemistry, and which must, therefore, be attempted with all perseverance. It is no longer sufficient to show that certain substances are changed in the animal body, and give rise to the formation of others, nor does it suffice to make the synthesis which the cell produces, by any means whatever, but we must endeavor to work under similar conditions and with the same means as the body itself. We must make our experiments at the temperature of the body, we must employ no reagents

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whose presence would be injurious to the organism, we must also take into consideration that we may not be able to attain our object by a single process, but by a whole series of altogether different processes —only by a most careful observation of all these points can we arrive at results which will allow us to draw conclusions with reference to the corresponding processes in the body.

It may appear remarkable that, in the syntheses which have been made, these conditions were not considered; but it must not be forgotten that a chemist makes a synthesis for its own sake, unconcerned whether he attains his result in the same manner as the organism. He can only attempt the solution of this question when he knows the steps by which the structure is built up. But in this respect we are still far behind, for our knowledge of the chemical properties of the bodies which we find in the organism is still very incomplete. The substances which are most important in the economy of the organism, the albuminoids, notwithstanding the labor and time employed, are very little known, and the same may be said of other substances, such as the bile, the nerve-substance, etc. We do not even know whether the albuminoids and similar compounds have ever been obtained in a pure state; their composition is, therefore, only approximately known; the question, whether the ash which they leave on burning is an essential constituent or an impurity, still remains undecided, and a good method for separating the different members of larger groups is a pious wish. The changes and decompositions of these substances are only known in general; in many cases we know the final but not the intermediate products, which are of the highest importance, as, without doubt, the organism operates with these. Here, above all, it is necessary to throw some light on the obscurity which surrounds this problem, and the necessity will best be shown by an example. If albuminoids are treated with digestive ferments, or with dilute acids, there is at first produced a series of peculiar compounds still similar to the albuminoids, called peptones. If the latter are exposed to the action of strong acids or alkalies, they are finally decomposed into amido acids; at the same time carbonic acid, ammonia, oxalic acid, and other simple compounds, are formed in small quantities. Although completely justified in assuming that the elements of water have been taken up in these processes, it is not positively known in what relation the peptones stand toward the albuminoids; whether the peptones produced from various albuminoids are different or identical, or whether only one or several peptones are produced from each albuminoid; whether they are crystallizable or not; whether the peptones are directly decomposed into amido acids, or whether further intermediate products are formed—in short, we are only beginning those investigations which promise to give the most important results.

Fortunately, the organism also contains more simple compounds, which are well known, and the formation of which can be discovered

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more readily. One of the most important of these is urea, and by this we can show that the problem is capable of solution. The high physiological importance of this body is due to the fact that it contains the greatest part of the nitrogen introduced with the food, and removes it from the body. Its composition is very simple, its synthesis has been effected in many ways, and there appears to be no difficulty in explaining its formation in the animal organism. At first it was supposed that it is formed by direct oxidation of the albuminoids, but all attempts to prove this experimentally have failed. Later it was found that nitrogenous bodies, other than albuminoids, particularly the products of decomposition of the same, such as glycocol, asparagin, even ammonia, were converted into urea in the organism; and, as glycocol and ammonia each contain only one atom of nitrogen, while urea contains two, evidently by synthesis. Accordingly, two hypotheses were proposed to explain the formation of urea in the organism: the one assumed that by the oxidation of the nitrogenous bodies cyanic acid is first formed, which, combining with ammonia, forms ammonium cyanate, and is transformed into urea; the other, which is principally based on the experiments in which ammonium carbonate is introduced into the organism, assumed a separation of water from this salt, which would of course give urea. But neither of these hypotheses is tenable: for, on the one hand, no chemist has ever obtained cyanic acid by the oxidation of nitrogenous substances under the conditions which are found, or may at any rate be assumed, in the organism; on the other hand, the ammonium carbonate which is introduced with the food can not be resorbed as such, for it is decomposed by the acid juices of the stomach, neither can this substance be formed in the organism from carbonic acid and ammonia. From the facts which have been observed, however, a third hypothesis may be deduced which is more probable than either of the former. It has been shown that by the oxidation of nitrogenous organic bodies, particularly glycocol, leucine, and tyrosine, in alkaline solution and at a blood-heat, carbonic acid is always formed; also that, by the union of carbonic acid and ammonia in aqueous solution and in presence of the strongest bases, carbonic acid is produced. We must therefore assume that in the blood or in other parts of the body, wherever nitrogenous compounds are oxidized, carbonic acid is constantly formed. From this salt the formation of urea must take place by the elimination of water, a reaction which has long ago been effected by heating the salt to 140° with absolute alcohol. In the organism this elimination of water must evidently take place in a different manner, and especially at the temperature of the body. This may be effected in two ways: either the water is eliminated as such, or its elements are removed one after another by two different reactions. The latter assumption is the most probable, for it will make it readily perceptible that the reaction takes place in an aqueous solution. If it is asked in what manner the

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oxygen and the hydrogen may be removed from the ammonium carbonate, the simplest answer will be that the hydrogen is removed by oxidation and the oxygen by reduction. Experiment has confirmed my expectations. If an aqueous solution of ammonium carbonate is submitted to electrolysis, reversing the current and employing platinum or graphite electrodes, small quantities of urea are formed, which may be isolated and identified as such with certainty. By the evolution of hydrogen and oxygen, alternately at short intervals, the hydrogen is removed by oxygen, and the oxygen is eliminated by hydrogen, and urea remains.

Since both oxidation and reduction are continually taking place in the body, the solution of the question how urea is formed is given, viz., from the ammonium carbonate which is first formed it is produced by further oxidation and reduction.

Here we have urea produced without the body, under conditions which may be assumed to exist within; above all, the temperatures were such as are noted in animals. For this reason this synthesis is particularly adapted to show an acceptable process of the formation of urea in the organism. The question, by what means the organism effects the oxidations and reductions, whether electrolytically or chemically, of course, remains unanswered, but this will also be solved as soon as the processes taking place in the animal system are better known.

This synthesis also distinctly shows what developments physiology is to expect from pure chemistry. The experiments made on animals, by which the conversion of ammonia into urea in the organism was first established, did not teach a single fact which would have indicated that this conversion is the result of two directly opposite processes. This supposition was arrived at, independently of the experiments with animals, by purely chemical considerations, and it was simply necessary to furnish the experimental evidence of their correctness. In this, as in all similar cases, the physiological experiment will disclose the occurrence of synthesis and decompositions; and it will be the province of pure chemistry to discover the ways and means by which the organism produces the results. Both physiological and chemical experiments will have to be jointly and yet independently made, if the chemistry of the living organism is to be established.

Though we must confess that our knowledge of the chemical processes in the animal body is still very incomplete, we must recognize that the investigations made in this direction have given us much information. Though the substances which react on each other are known in the fewest cases, we have obtained hints regarding the manner in which they react. It has been shown why we are obliged to assume that oxidation takes place. We are also acquainted with processes which indicate reduction, others in which decomposition takes place with the assimilation of water, or synthesis with the elimination

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of water. Indigo blue is reduced to indigo white, potassium ferricyanide is reduced to the ferrocyanide, potassium bromate and iodate are reduced to bromide and iodide; glycogen is converted into sugar with the assimilation of water, albumen into peptone, and then into amido acids and other products. Hippuric acid is formed, with the elimination of water, from benzoic acid and glycocol.

But we ask in vain: What is it that effects these reductions? how does the pepsin act? how do benzoic acid and glycocol combine? Here is a field in which chemistry must cultivate independently, not as the servant of physiology, for the fruits of the labor will be of equal value to both sciences. Whatever difficulties this problem may produce, we are certain that its solution is within our reach. It was different when, where now we see groups of atoms acting upon each other in a definite manner, irritability or an incomprehensible life-force was permitted to rule. Then the future was without prospect; no vulnerable point seemed exposed for the attack of genius. At present we may say, that which is ponderable can be weighed, and that which proves to be an individual can be isolated. After, however, the analysis is once completed, synthesis will be close at hand.

A BOTANIST OF THE NINTH CENTURY.*

By C. HARTWICH.

THE contemplation of the progress of science in our days shows us a whole host of zealous investigators bringing stone after stone to raise to a prouder height the structure of knowledge whose richly diversified pillars and towers, seemingly disposed without order, all contribute to the common design. From this view we readily turn to the foundations and basement-stones of the edifice, which, gray and weathered as they seem to be, yet form the basis of the heaven-aspiring building. Our greatest interest is enlisted in the story of the men who, amid the general perversion of manners and contempt for all learning of the middle ages, lived for knowledge in their study-rooms or shut up in silent cloisters. Although they did not make any great discoveries, they still endeavored to keep alive the little flame which yet shone weakly from the intellectual fires of antiquity. Still more fascinating are such views in the case of men who came out into the life of the times, and, with their sharp minds schooled in the philosophy of the ancients, entered actively into the often erratic course of the world, and by word and writing presented themselves undismayed before those in power—here checking the spirit of boundless avarice and wild excess,

* Translated for "The Popular Science Monthly" from "Die Natur."

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there defending the oppressed. It is with a man of this kind, the Abbot Rabanus Maurus Magnentius, of Fulda, that we have to do in this essay. After the fall of the Roman Empire the spirit of knowledge became quite extinct, except for a few Greek minds in the Eastern Empire, and in England and Ireland, where gentler manners followed the introduction of the Christian faith and the Latin language, and learning gained a place of refuge; and the knowledge of antiquity spread after Archbishop Theodore and his deacon, Hadrian, founded the school of Canterbury about 680. At last, also, a short but relatively bright period of scientific awakening broke over Central Europe during the reign of Charlemagne, who strove to increase culture and learning in his own land and to introduce them into the countries that he acquired, and for that purpose called learned men to his court, among them Alcuin of England. The cloister schools prospered greatly under Alcuin, and some among them cultivated knowledge with quiet assiduity in the midst of the decline that set in soon after his death. Of these was the cloister of Fulda, to which our Rabanus Maurus was attached. He was born at Mayence, of an old noble family, in 774 or 776, and entered the cloister of Fulda as a *puer oblatus* (destined for the Church) when nine years old. He acquitted himself so well here that the Abbot Ratgar, in 802, sent him to the celebrated Alcuin at Tours to finish his education. Rabanus resided there a year, a favorite pupil of Alcuin's, who, according to the custom of the time, gave him the surname of Maurus. On his return to Fulda, Ratgar appointed him chief of the cloister school, which became famous under him. Soon afterward, however, the abbot changed his mind very suddenly, prohibited studies, and set the monks at manual labor in building churches. A poem written by Rabanus at this time has come down to us, in which he bewails the loss of his books. The monks soon became disgusted with this rude treatment, and complained of Ratgar to the Emperor, who removed him. Eigil was appointed to succeed him, and restored Rabanus, whose intimate friend he was, to his school. Monks came to Fulda from great distances to learn Rabanus's method of teaching, and his scholars were sought for on all sides, so that he soon became known as the first teacher in Germany. Rabanus himself became Abbot of Fulda after Eigil's death in 822.

Under his lead Fulda reached the height of its fame, and no other German cloister, except perhaps Reichenau, could compare with it. He committed the school to the care of his pupil Walafriedus Strabus, author of a work, "De Hortulo," in which twenty-three plants of the author's garden are celebrated in hexameter verses, and in the performance of his duties as abbot himself had but little time to devote to study. Politics claimed much of his attention, and in the contentions which arose for the throne of the empire he defended the cause of Louis against his son, composing in view of the strife a work

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on the duties of children to their parents, and afterward supported the pretensions of the claimant, whom he considered the rightful heir, without regard to the probable result of the contest. He laid aside his office in 842 and retired to private life, where he employed his time in the composition of his most important work, "De Universo." He was, however, permitted to remain at this congenial pursuit only till 847, when he was chosen Archbishop of Mayence, and was confirmed by the Emperor Louis, notwithstanding he had been a steadfast adherent of his brother and adversary Lothair. He died in the possession of this office in 856, leaving his books to be divided between his beloved Fulda and St. Alban's monastery at Mayence.

It is now time to estimate the value of the life of Rabanus to science, and especially to botany. In the long period between the irruption of the barbarians and the revival of learning in the fifteenth century, three persons whose labors were independent of each other stand especially prominent—Rabanus Maurus, the Abbess Hildegard of Bingen, and Albertus Magnus. The two latter were superior in originality to the other, but Rabanus was the first German who took the pen and endeavored in his work, "De Universo," to make accessible to his contemporaries what the ancients knew.

Of course, he worked in the spirit of his times, and the theologian is constantly appearing between his lines, endeavoring to keep what he might write in accord with the Holy Scriptures. The principal authority from which he drew was the "Origines" of Isidore of Seville, who himself again drew chiefly from Pliny. His work considers in twenty-two books the following subjects: 1–5. Theology; 6. Man and his parts; 7. Kindred, longevity, marriage, death, monstrosities, and beasts of burden; 8. Other animals; 9. Astronomy and meteorology; 10. Chronology and festivals; 11. Water; 12–14. Geography; 15. Philosophers, poets, sorcerers, and heathen; 16. Languages, civic and military ordinances; 17. Mineralogy; 18. Measures, weights, music, and medicine; 19. Agriculture and plants; 20. War, armor, and the theatre; 21. Arts and trades; 22. Household and farming implements. After the fashion of his time, he gave more attention to the mystic meaning of the objects of nature than to their real properties, and attached the greatest importance to the explanation of names, in which so curious ingenuity was employed as to justify the quoting of a few specimens: Death is called *mors quod amara sit*, or in English because it is bitter; the horse is called *equus*, because only those horses are harnessed together that are alike in size and color (*æquare*); the panther has received that name because he is a friend of all (*πάντων*) animals; the swan is called *olor*, because its feathers are entirely (*ὅλος*) white; the ivy is called *Hedera*, because it is given to kids (*hædis*) for food; the willow is called *Salix* (*quod celeriter saliat*), because it springs up or grows fast. Rabanus adhered quite closely and uncritically to his originals, and it therefore gives us no surprise

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to find in his work many of the fables of the ancients. These fables, indeed, endured long after his age, and even as late as the beginning of the seventeenth century editions of Egenolph's formerly very popular book of plants appeared, containing the time-honored stories of the basilisk, griffin, dragon, phœnix, etc., almost in the words of the originals, with each animal represented in a neat woodcut. The botanical part of the work of Rabanus particularly claims our attention. We have examined this, not in the entire work, but in a later compendium of the scientific parts made by Stephen Fellner, at Fulda, who in his review described two hundred and sixteen plants as having been mentioned by Rabanus. I have compared these descriptions with the table of plants described by Isidore of Seville, as given in Meyer's "History of Botany," and have found that the latter has fifty plants more than Rabanus, of which a few, however, are synonyms, and should not be counted to his credit. On the other hand, Rabanus has a few plants that I have not found in Isidore, such as lychnis, lichen, corchorus, fœnum, linum, byssus, farrago. The lichen is, as Fellner declares, *Marchantia polymorpha*. Fœnum is, according to Fellner, *Fœnum græcum*. Fellner identifies byssus with *Gossypium herbaceum*, but translates it in another place by wool, while the text says of the plant: "Byssus is a kind of flax. It is very soft and white; it arises out of the earth, is deprived of its moisture by several protracted processes, and is formed into a handsome cloth." Does not this all agree with asbestus? The account continues, however, "Purple is made of it—a cloth for kings—by dyeing it with the blood of a certain sea-shell animal"; and the ancient name for cotton cloth was generally byssus. Asbestus appears again among the minerals as amianthus; but its application to the manufacture of cloths is not mentioned, except with reference to its incombustible quality, where it is said, "Cloth which is in contact with it resists the fire." Fellner defines farrago as a mixture of various forage-grasses. Some of the plants have not been correctly identified by Fellner. Rabanus in the beginning speaks of the distinction between a tree and a herb, which he regards as consisting only in a difference in age, for a tree, he says, can be developed out of a carefully cultivated herb. In the next chapter he treats of the improvement of trees, of grafting, and budding. The third chapter considers the parts of the tree: the root, which is supposed to reach as deep into the ground as the stem rises above it; the stem, crown, flowers, and fruits, which last he distinguishes as hard-skinned or nut-like, and soft-skinned, like the apple. The fourth chapter relates to the vine. This is the only plant of which a measurably comprehensive description is given, and I will therefore quote from the account, omitting the explanations of the names: "The vine consists of the stock and its shoots. The ends of the branches, the younger shoots, are driven back and forth by the wind. The branches have curled tendrils, by means of which they can cling to the trees,

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and thereby put themselves in a condition to resist the attack of the wind, to support the fruits, and to spread themselves out. Those stocks that bear fruit are called *palmites*, the fruitless ones *spadones*. The leaf of the vine serves to protect the branches from cold and heat, and to defend the clusters against injury. The clusters are composed of fat and juicy berries hanging from the comb." The different kinds of fruits, pulse, field-plants, and kitchen-garden vegetables are then described.

The next division treats of the habitat of plants, and shows how each plant prefers a particular kind of soil, whence one will succeed better on one kind of soil, another on a different kind, and neither will do well in a situation badly adapted to it.

Descriptions are afterward given of plants coming under other heads than those above mentioned—those whose fruits are fit for food: the oak, beech, *Phœnix*, *Pomaceæ*, Syrian bean, fig, cherry, mulberry, almond, cherry, *Ceratonia*, pepper (with a recipe for detecting adulteration), *Nardus crocus* (saffron); those which are antidotes to poison: the walnut (*Nux*), radish (*Raphanus*), celery, rue, oleander, germander; medical plants: myrtle, sage, hyacinth, lettuce, thyme, aristolochia, *Prunus*, *Solanum*, mallow, mint, ceterach, saxifrage, dictamus, wormwood, spurge, fennel, ivy, madder, hellebore, heliotrope, thistle, maiden-hair, borage, cinnamon, cyclamen, mandrake, poppy; poisonous plants: hemlock, water-hemlock, hyoscyamus, aconite, *Ocimum*, basil (if one pulls up a handful of basil, he says, all the scorpions in the neighborhood will come around); resin- and gum-bearing plants: the pine (which affords amber), cedar, pistachio, olive, *Docema*, *Populus*, Boswellia, balsam-tree (with a recipe for the detection of adulterations), liquidambar, convolvulus, ferula; timber-trees: spruce, cypress, juniper, persimmon, linden, willow, poplar, oak, larch, aquilaria, box.

The scope, arrangement, and method of treatment of the several parts of the work differ but little from those of the botanical department, which we have thus briefly reviewed.

We close with a return to the figure with which we began. Rabanus is not one of the grand towers of the temple of Science at which posterity will gaze admiringly, nor is he one of the massive buttresses whence numerous shafts and points arise; we should rather compare him to one of the solid stones that are sunk one upon the other into the soft ground to be hardly ever seen again by the eyes of men—one of those who in quiet, busy toil have laid the foundation among the people which now bears so mighty a structure. Such men will always be worthy of our esteem, and should be gratefully remembered by us. Rabanus was one of the most eminent among these men. He was incontestably the most learned man of his times; and he was the first German who ever wrote on science.

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WILD ANIMALS AS MAN'S ASSOCIATES.

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By Professor EDWARD S. MORSE.

IT would be a curious study to ascertain at what time certain wild animals came to be associated with man. We do not mean those which have become domesticated, though many of these run back far beyond the historical epoch. By wild animals we mean those which, still continuing in a wild state, build their nests or construct their burrows near, or within, the habitations of man.

The first advances in this direction must have been made by certain members that differed slightly, in their impulses, from others. It might have been the more courageous and intelligent ones, which, not fearing the presence of man, and recognizing the advantage to be gained in the greater abundance of food, selected human habitations as their abiding-places; or it might have been individuals so stupid as not to be aware of the possible danger of man's proximity, and thus unwittingly selected places in or about his dwellings.

The birds that nest in our trees we generally protect through humane or selfish motives, while with the rats, mice, and certain insects, we keep up a perpetual warfare. Yet, that these latter animals survive, indicates that, in spite of this opposition, the favorable conditions must outweigh the adverse ones, otherwise they would soon be exterminated.

A special investigation in regard to birds would be of great interest. The change that has taken place in the habits of birds in forsaking the forests and fields, and building their nests in the trees of towns and villages, must have occurred since the first settlement of this country by Europeans. After the incoming of each species from the wilderness their increase must have been rapid, as the favorable conditions far outbalanced the unfavorable ones. Not only does the bird secure a certain immunity from danger, in the shape of predatory birds like the hawk, but it finds itself in the midst of a plentiful supply of insect-life, which has in turn been lured from the wilderness, and which has developed with frightful rapidity, owing to the dense crops which man raises, and which were not always to be destroyed by every forest fire or persistent drought. Many species have been forced in by the destruction of large tracts of forest, which compelled them to seek other food, or become extinct. The destruction of forest-trees still goes on in this country with criminal celerity, and new insects injurious to vegetation will be added from year to year.

Audubon somewhere remarks that in passing through a dense forest it was the rarest thing to hear the notes of those song-birds most familiar to him, and he could always recognize his approach to a village by the notes of those birds which most commonly frequent our trees and fields. It is known historically when the cave-swallow first

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commenced to change its abode from cliffs to the more convenient and protective eaves of barns. Professor A. E. Verrill, in a paper on this subject in the "Proceedings of the Boston Society of Natural History" (vol. ix, page 276), records numerous examples of their first appearance about man's habitations in the East and West, and is inclined to the opinion that, "when this continent was first settled by Europeans, the cliff-swallow inhabited the whole of its breadth wherever there were extensive limestone cliffs suitable for the building of its nests; and that as civilization advanced toward its native haunts, and suitable buildings became accessible to it, it gradually abandoned the cliffs, and, increasing in numbers to a greater extent than before, on account of the protection invariably furnished by man, it gradually spread over New England and the other Northern States, where hitherto there had been no cliffs suited to its wants. In thus extending its range it probably advanced both from the western and from the northeastern parts of the country, both these regions abounding in high limestone cliffs, which are entirely wanting in New England."

A little more humanity on the part of boys, a suppression of the bird-devouring instincts in the cat, and new birds will seek the companionship of man. In Japan, owing to the gentle behavior of the people, the crow has full liberty to go where he likes. As a consequence, the densely populated cities swarm with the noisy fellows. They repay the kindness shown them by acting as scavengers. Every bit of organic matter, which in its decay might pollute the air, is seized upon by the crows and devoured; and thus it is that, by this and other means, the death-rate in these large cities, under the hot sun of latitude 35°, is lower than that of Salem, Massachusetts—for example, in latitude 42°, with its reeking bodies of filthy water. With us the crow has been driven away by constant hard usage, and now it is one of the most wary of birds. In Japan, a crow that has no timidity will, on the whole, get the most food for itself and offspring, and thus stand a better chance of surviving and raising its progeny. Here the same attribute would almost surely lead to its destruction.

It is curious to observe how soon this fear in animals may be excited by the pressure of destructive agencies. More curious still is it to note the fact that insects may be affected by it. I have repeatedly observed that, in places where the common house-flies are undisturbed, individual flies may be caught with ease. At Penikese Island I recall this peculiarity as particularly marked. The movement of the hand in the effort to catch them was invariably too quick. A friend of mine has observed the same peculiarity concerning the house-flies in a country church. They could easily be touched with the finger. It is plainly obvious that the alert flies would be the ones to escape, and, thus surviving, would perpetuate their peculiarities, while the stupid ones would be the first to perish in any attempt to get rid of them. The house-rat under the same selective action has, by continual survival from the

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quick-witted ones, become synonymous with all that is crafty and cunning.

We commenced this article mainly to call attention to some facts concerning a certain kind of ant, which must have attracted the notice of others before. It is difficult, at first, to see what special advantages can offer to the little yellow ants that persistently, year after year, construct their burrows under our brick pavements, and use these thoroughfares for their promenades and hunting-grounds. One would consider that such regions would be almost the last places these intelligent little insects would select. Many of them must be crushed daily beneath our feet, and their little hillocks and annular tumuli trod upon or swept away. Side-walks which are much traveled on are often selected by these industrious and courageous little fellows, and here they burrow beneath the bricks, and heap up their moles undaunted by the frequent demolition of their work, and the death of many of their comrades. It is obvious that the advantages must outweigh the disadvantages, otherwise the ants could not long survive, and continue their work, as they do from year to year.

We know well enough the unfavorable conditions to which they are subjected: the crushing steps of busy feet; the wheels of boys' velocipedes, and children's hoops; the sweeping-broom, a very scourge of destruction; deluges from the garden-pipe, which to them must be Noachian, and the occasional trailing of a long skirt, with the devastating effect of a typhoon and sirocco rolled into one. All these must invariably destroy many lives and demolish many an earth-work.

Among the conditions that these ants require for their perpetuation and increase are, first, soil in which they can easily burrow their nests and galleries; second, substances which may be heated by the sun, and beneath which they may bring their pupæ, or partially developed offspring, in order to hasten their more rapid development. It is said that colonies of ants have constructed their nests in or near fire-places that they might avail themselves of the artificially heated bricks of the hearth for this purpose. In pastures ants often construct their galleries beneath large stones, and bring their pupæ up from the burrows below, placing them just beneath the stone which has been heated by the sun, and which retains the heat for a considerable time after the sun sets. It is a common experience in turning over stones in the pastures to find the galleries just beneath densely crowded with pupæ, and when the ants are surprised in this way they show great solicitude in their efforts to remove the pupæ to a place of safety. It is astonishing to see how quickly many hundreds of pupæ are removed to the burrows below. In using the brick walks of cities, the ants find the most suitable conditions for their burrows, as it is customary to bed the bricks in a layer of sifted gravel, and the ants, in mining into this material, are not interrupted by the obstacles they would naturally encounter in other deposits. The bricks

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become heated with every day of sunshine, and thus the ants find all the conditions necessary for the rapid development of their pupæ.

Of equal importance is the fact that an abundant supply of food is ready at hand in their hunting-grounds—food already slaughtered for them—so that they are saved the time and trouble of overcoming and destroying their prey. Not only are they certain to secure the caterpillars, worms, and a variety of insects which are crushed by passing feet, but also the crumbs dropped by children, or swept from the houses, as well as the banana- and orange-peel, peach- and cherry-stones, and the like, which often litter the sidewalk. Here, then, is a variety of food to supply their tastes, and, when not otherwise engaged, they may be seen tearing off the fruit-fibers from some cherry-stone or apple-core, or tugging away busily at some maimed or crushed insect or caterpillar. In selecting proper places to build their nests, they choose, if possible, those which are neither damp nor liable to inundation. If the sidewalk, they secure a level territory from which the rain runs away as fast as it falls. With all these favorable conditions they manage to survive and flourish, despite the frequent choking up of their passage-ways, and the many deaths, by crushing, of their workers.

Thus it is that what seems to us a very precarious and unfavorable region in which to live, the ants continue to occupy from year to year, and to increase in numbers. The struggle for existence is well illustrated by this example, and it would be interesting to know just how many footsteps a day they can endure and yet survive. A densely traveled thoroughfare will be found to support but very few ants' nests, and these are upon its borders, while one less traveled, if it is comparatively dry and not heavily shaded by trees, will be found infested with them.

The mud-wasp which plasters its cells under the roofs of barns, garrets, and sheds in Northern New England, parallels the eaves-swallow which constructs its mud-nests beneath the eaves of barns. Here the brighter individuals show great judgment in selecting places removed from leaks in the roofs. We have observed many remarkable selections of building-sites among these insects, and doubtless numerous interesting facts await the patient study of these curious animals.

THE PHILADELPHIA ACADEMY.

By J. S. KINGSLEY.

IN a Canadian journal devoted to science there appeared, not long ago, an article entitled "The First and most Profound of Savants," and old Father Adam was intended by this superlative title, for did he not give to every animal a name? What a pity it is that these Adam-

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itic appellatives have not descended to our day, since for years naturalists have been inflicting long Latin cognomens on all animals and plants coming under their observation, and it would almost seem as if the supply of names would be exhausted long before the things to be named!

Ever since the time of Adam men have enjoyed a contemplation of the created things which surround them, and have formed collections of minerals, plants, or animals, varying in size from the few "curios" on the mantel-piece of a back-country parlor to that most wonderful display contained in the British Museum. Our records of the museums of antiquity are very meager, and but little can be told concerning them. Noah's collection in the ark can hardly be considered in this connection, as it was formed with an entirely different end in view. Solomon possibly had a collection. The temple of the oracle at Delphos had many curiosities brought as votive offerings from foreign lands. Apollonius saw with surprise in India trees bearing the different kinds of nuts he had before seen in the temples of Greece. The museum at Alexandria contained the largest collection of books in antiquity, but whether it contained productions of nature is not known. Alexander the Great commanded all sailors and traders to bring the peculiar productions of the countries they visited to Aristotle; Apuleius made a collection of the fossils of the Gætulian Alps; while the Emperor Augustus had a large cabinet of curiosities from all parts of the then known world.

One reason why the ancients were deficient in museums was the lack of efficient methods of preserving the various forms of life: covering a body with wax or honey was not the best manner imaginable of rendering an object either interesting or instructive; and so it was that not until the discovery of alcohol and the manufacture of glass bottles that museums became of much importance. Another fact that also had much to do with the entire absence of any collection from the third until the sixteenth centuries was that all studies of nature were regarded as strongly savoring of infidelity, and were therefore to be discountenanced. So it was that not until the revival of letters were museums known in the Christian era.

In the seventeenth and eighteenth centuries every prince of Europe felt it incumbent upon him to be a patron of learning, and, with the object of advancing the knowledge of nature, formed a cabinet in which were mingled in the most absurd manner Chinese mermaids, pebbles from the Holy Land, birds from the Orient, and coins from ancient Rome. Every prince also deemed it his duty to employ some scrivener to write, in that quality of Latin which has justly been styled "piggish," descriptions of the various curiosities thus brought together; and these lucubrations, embracing fact and fiction curiously mingled, were published with all sincerity in ponderous tomes illustrated with rude figures which, by a severe strain of the imagination,

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might be supposed to resemble something, but generally not the thing intended. But with the gradual intellectual development of the world these collections became more and more systematic and useful, and the resulting publications acquired a higher character, discarding fiction and old wives' tales, and presenting only facts acquired by observation. About the middle of the last century arose a man, Carl Linné (or Carolus Linnæus), abundantly blessed with the powers of generalization, who, by introducing system into the previous chaotic mass, placed the study of nature on a firm foundation; and from his time the progress of natural science has been astonishing. Naturalists immediately arose in all parts of the civilized globe, collectors were sent to those parts which were so unfortunate as not to be civilized, and soon almost every city in Europe boasted a museum.

America, however, was a young country, and, between its wars with the Indians and with England, its settlers had but little time to devote to study. An occasional naturalist from Europe landed on its shores to explore its wonders, and isolated persons made collections, which were duly forwarded to the Old World. It was not until some time after the Revolution that America possessed a single museum. Probably the first was Peale's Museum, in Philadelphia, which was established in the last century, and where might have been seen side by side a mastodon and a machine for producing perpetual motion. The Museum of the East India Marine Society, at Salem, Massachusetts, was begun but a few years later, and until a dozen years ago retained many of the characteristics of those comparatively primitive times.

Leaving these early museums, with their lack of system, the first which was strictly scientific was that of the Philadelphia Academy of Natural Sciences, and to give a brief account of that institution is the object of the present paper.

Before the War of 1812 Philadelphia was the only city in the Union which could make the slightest pretensions to being a scientific center; the Bartons, Bartrams, and Muhlenberg, were enthusiastic botanists; William Maclure had just published his "Geology of the United States"; and Alexander Wilson had just begun his "American Ornithology," which was left unfinished at the author's death. During the year 1812 several young men occasionally met for the purpose of mutual amusement and instruction, and at one of these meetings the project of a scientific society was proposed, discussed, and finally (January 12, 1812) Drs. Gerard Troost and C. M. Mann, and Messrs. Jacob Gilliams, John Shinn, N. D. Parmentier, and John Speakman, met at the house of the latter and instituted the Academy of Natural Sciences of Philadelphia. Thomas Say joined them a few weeks later, but has always been regarded as one of the founders.

Dr. Troost was a native of Holland, and for a time was a pupil of the celebrated mineralogist, the Abbé Haüy. Subsequently he was sent by Louis Bonaparte, then King of Holland, to Java as naturalist,

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but the ship on which he took passage was captured by a French privateer, and he was made a prisoner. On regaining his liberty he started for the New World, landing in Philadelphia in 1810, and soon engaged in the manufacture of alum. He accompanied Maclure to New Harmony (of which more anon), and, on the failure of the community, became professor in the university at Nashville, and subsequently was appointed State Geologist of Tennessee, a position he held until a year before his death, which occurred in 1850.

William Maclure, the pioneer American geologist, was a Scotchman by birth. He came early in life to Philadelphia, where by a successful mercantile life he acquired an ample fortune. He spent several years in travel, hammer in hand, exploring every State and Territory from the Gulf of St. Lawrence to Florida. The results of these excursions were embodied in the first paper on American geology ever published, which appeared in the "Transactions of the American Philosophical Society" in 1809. At the time of the foundation of the Academy he was on a geological trip, but as soon as he returned he became a member, and from that time until his death retained a lively interest in its welfare and prosperity. He gave largely of books, specimens, and money, his donations of the former amounting to over 5,000 volumes, and of the latter more than $25,000. Mr. Maclure was eminently a philanthropist, but, like many others of similar disposition, was rather visionary. He entertained the idea of educating all mankind, of establishing a university where all human knowledge should be taught, and was also a firm believer in, and strong advocate of, the "community system"; and, with these ideas predominant, he persuaded Troost, Say, and Lesueur to accompany him to New Harmony, Indiana, where his Utopian plans were to be carried into execution. But man is liable to err, and internal dissensions and legal difficulties soon caused the community to break up. Maclure died shortly after in Mexico.

Thomas Say was born in Philadelphia in 1787, and in his early years attended a private school some miles out of the city, where, owing to the inefficiency of his instructors, he acquired but little except a most intense dislike to all polite literature. His father, seeing that his tastes were anything but literary, apprenticed him to an apothecary, and afterward he entered into partnership with John Speakman in the drug-business. This partnership was peculiar in the disinterestedness with which it was conducted. Speakman alone attended to the business, that his partner might devote all his time to the pursuit of science. But the firm of Speakman and Say came to an untimely end by indorsing for unfortunate friends. After the failure, Say took up his quarters in the rooms of the society, making his bed beneath the skeleton of a horse, and living for several years on bread and milk, with an occasional chop or egg, during which time his food did not cost on the average twelve cents a day. Say, as has been stated, accompanied

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Maclure to New Harmony, where he remained as agent after the failure, until his death in 1827. Thomas Say was the father of American entomology, and his papers on other departments of zoölogy were numerous and valuable.

The first meetings of the Academy were held at the house of Mr. Speakman, and afterward a few occurred in a public-house known as the "Mercers' Cake-Shop," but, as custom demanded that all frequenting the place should become patrons, and fearing that the society would forsake the paths of science and degenerate into a gastronomic club, more secluded quarters were secured over a millinery-store on Second Street, near Race, and there was formed the nucleus of the present large library and collections. Dr. John Barnes was the first member elected, and it is related that, on the occasion of his first taking his seat as a member, the seven founders, who had constituted themselves a committee of management, withdrew to transact some business, leaving him alone to constitute a meeting of the Academy. In the first year of its existence the society came in possession of the Seybert collection of minerals, at a cost of $750.

The growth of the collections soon demanded increased accommodations, and a larger room was hired, on the opposite side of the street, which was occupied until August, 1815, when the society moved into a building erected for them on Arch Street, near Second. In 1817 a charter was obtained, and the same year the publication of a journal containing the scientific papers presented to the Academy was begun. In 1826 the library and museum had again outgrown their quarters, and the Swedenborgian church, at the corner of Twelfth and Sansom Streets, was purchased and adapted to the needs of the society at a cost of about $6,000. Several members opposed the purchase of this property, and Mr. Maclure, when called upon to subscribe, at first declined, giving as a reason his belief that the "community system" would prevail, Philadelphia be deserted, and that those who lived long enough would "see the foxes looking out of the windows." He eventually gave several hundred dollars. This building was occupied by the Academy fourteen years, when a return of the old trouble, a lack of room, necessitated a new building, which was accordingly erected on the corner of Broad and Sansom Streets, and first occupied in February, 1840. Seven years later it was found necessary to enlarge the building, to accommodate the Duc di Rivoli collection of birds, numbering 12,000 specimens, which were presented by Dr. Wilson, who also bore the expense of the enlargement. The building was again enlarged in 1854–'55, the expense being borne by subscription. In 1868 a lot was purchased on Nineteenth, Race, and Cherry Streets, containing more than an acre, at a cost of $65,000. The corner-stone of a new building was laid with appropriate ceremonies October 30, 1872. The society held their first meeting in this edifice January 11, 1876.

The portion of the building at present erected and occupied by the

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Academy forms not quite a third of the contemplated structure. It is built in what is called the collegiate-Gothic style of architecture, of a green serpentine, with light-brown sandstone trimmings. This wing is one hundred and eighty-six feet long and seventy-five feet broad. The basement is devoted to storage, with rooms for a taxidermist and a printing-office. On the ground-floor and its galleries are the library, studies, rooms for artists, a bindery, a smoking-room, the herbarium, and collections of insects and microscopes and microscopic slides. The library is one hundred and thirty feet long and thirty feet wide between the ends of the cases, with a gallery at the height of ten feet, and contains the largest collection of works on natural history—over 26,000 volumes—in America. The floor of the library is used for the meetings of the Academy, and will seat over four hundred people. From the entrance on Race Street, two short flights of stairs bring one to the museum, a hall extending the whole length and width of the building, with two wide galleries, giving a floor-space of more than three fifths of an acre. The whole is fairly lighted by windows in the sides and by a lantern sky-light eighty feet in length. The whole building is fire-proof, is heated throughout by steam, and was erected at a cost of nearly a quarter of a million dollars.

A description of a museum is by no means an easy task, even in the case of a small collection; but, when the number of specimens is as large as in the present instance, it is only possible to enumerate a very small proportion of the many treasures. On entering the hall, the visitor sees almost immediately in front of him, towering to a height of fifteen feet, a skeleton of *Hadrosaurus*, a kangaroo-like reptile from the greensand of New Jersey; around this are assembled a polar bear, a rhinoceros-skeleton, two or three whale-skeletons, the frame of a gorilla, a stuffed giraffe, and another in the condition Sydney Smith wished to be in in hot weather, divested of flesh, and sitting, or rather standing, in its bones. The table-cases and some of the upright cases near by are filled with fossils, while in the wall-cases on the south side of the building is displayed the ghastly collection of skulls, about twelve hundred in number, which is not excelled anywhere in the world. The upright cases on the north are occupied by the mammals, while the wall-cases contain the fishes. Two flights of stairs at opposite ends of the hall give access to the galleries, the railing-cases of which are occupied by the minerals. The first gallery is the most attractive to the ordinary visitor, as almost every case is devoted to the enormous collection of birds, over 30,000 stuffed specimens being displayed, while many thousand skins are packed away in drawers. Of this large number, 27,000 specimens were the gift of one person, the late Dr. T. B. Wilson, of Philadelphia. The collection is the third largest in the world, being excelled only by that of the British Museum and one in Vienna. Besides the collection of the Duc di Rivoli, mentioned before, it contains the collection of 2,000 specimens for-

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merly owned by the distinguished ornithologist, John Gould, and which formed the basis of his magnificent work on the birds of Australia. Here may be seen a specimen of the great auk, of which only two other specimens exist in America, and less than a dozen in the whole world. There is also an egg of the same bird, there being but one more in this country. And, while mentioning the eggs, we would say that the collection of these fragile objects is not excelled in Europe, embracing as it does 5,000 specimens, representing 1,323 identified species. The crabs, lobsters, and shrimps occupy cases beneath the windows of the galleries, over 1,000 different kinds being exhibited. On the second gallery are the shells, the largest collection in the world, both in species and in specimens. The largest single donation to this department was the collection of George W. Tryon, Jr., of over 100,000 specimens, illustrating over 10,000 species. Of the fresh-water mussels alone, 783 different kinds are on exhibition. The collections of star-fishes, sea-urchins, and corals are on this floor, but, though large, are excelled by those of several institutions in the United States.

Owing to the destructive action of light, the insects are not displayed, but are kept in two rooms connected with the library. Over 70,000 different species and hundreds of thousands of specimens represent the insect world. The herbarium is also very extensive, and occupies two rooms opposite to those devoted to insects.

The Academy holds its regular meetings every Tuesday evening, at which times papers giving an account of original investigations are presented, and remarks are made on various scientific subjects. Besides these regular meetings, members who are interested in special subjects have associated themselves in "sections," which meet at stated intervals. Four of these sections now exist, devoted respectively to microscopy, conchology, botany, and entomology. The Academy maintains two series of publications, while the conchological and entomological sections have at times published their scientific proceedings separately. The total publications of the Academy and its sections numbered, July, 1876, 3,681 pages and 404 plates quarto, and 20,752 pages and 499 plates octavo.

This magnificent museum and library is a monument to the generosity of comparatively few of the citizens of the "City of Brotherly Love." With the exception of exemption from taxation, not one cent has the Academy had from city or State. General funds it has none, its running expenses being paid by the annual dues of the members and the proceeds of a small admission-fee (ten cents) to the museum. Its special funds realize about $600 a year for publication, and $1,800 for the library. There is also a scholarship fund which pays two or three students twenty dollars a month while pursuing studies at the Academy.

The object of this rather statistical sketch is not only to give an account of one of the most prominent scientific organizations in the

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country, but also to encourage the people of other cities to do likewise. There is not a place of 20,000 inhabitants in the country which should not be able to support a scientific society, and, though time would be required to accumulate such a library and such collections as those owned by the Philadelphia Academy, still no one should be discouraged, since no beginning could be more humble than the one we have described. Science is becoming every day more prominent in our country, and our colleges are rapidly giving it that preference which has been accorded to the dead languages in the past, and this is a change for the better, for it is a fact that the American mind is a practical one. The number of young men who attend our colleges to-day is relatively smaller than it was a hundred years ago; and even of college students a large proportion become farmers or physicians, or follow mining, manufacturing, or mercantile pursuits, and to them science is of far more practical value than the wars of Cæsar or the "Birds" of Aristophanes. The field of science is an expensive and difficult one for the isolated student to explore. Specimens are requisite and books are necessary, and these are most readily obtained by a co-operation of all who are interested, and this very co-operation for this purpose is the foundation of all scientific societies.

A LITTLE MATTER.

By A. E. OUTERBRIDGE, Jr.

THE original investigator in Nature's domains may not inaptly be likened to a pioneer who penetrates the primeval forest, and by the aid of his keen hatchet hews down the obstructions, marking out first a narrow path in the wilderness until he reaches a favorable camping-ground. He then clears a space, admitting sunlight and air; meanwhile, he is perhaps unconscious of, or indifferent to, the approaches of other adventurers, until, little by little, the clearings encroach upon each other; cultivated fields, orchards, vineyards, and gardens appear; the face of the landscape changes, and its every aspect becomes familiar, so that we cease to wonder at its sometimes strange and novel features.

This analogy is not a mere fancy; all the advances in scientific knowledge have been made in little detachments. Narrow lines of investigation have been projected and explored by patient toilers who dig out a few roots here and there, which are carefully garnered until their genus can be determined by further study. In this way, separate facts are being constantly stored up, to be collated and classified at a proper time.

The ideas which have prevailed in the past, in regard to the nature

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of the ultimate particles of matter out of which worlds are formed, reveal the speculative tendency as well as the intellectual status of the human mind in different epochs of the history of civilization. The present era might be designated as an interrogatory age, for the evident tendency is to question eagerly, to accept nothing on the evidence of tradition, and but little, comparatively, on the merits of faith.

Plausible explanations of various phenomena have so often been accepted with confidence, only to be overthrown and supplanted by others equally unstable, that the mind has become suspicious, and demands the most rigid physical tests to corroborate new theories. The experimental feature of scientific study has thus attained an importance and perfection never before approached, and this cause largely contributes to popularize even the most abstruse subject of inquiry. The object of this brief paper is to present, albeit in a feeble manner, the claims of one of these little paths of knowledge to the exploration of the general reader, who, like the summer tourist, sometimes prefers to leave the beaten track, to enjoy the novelty of a rougher road.

The learned judge who, being requested to define the distinction between mind and matter, replied, "One is no matter, the other—never mind," solved the difficulty in a terse if not very satisfactory or exhaustive way. The question, "What is matter?" is one that has exercised the intellects of the profoundest thinkers in all ages, and the conundrum is, apparently, as far from being definitely answered in this nineteenth century as in the classic days of the Greek philosophers. It would seem, indeed, that the modern views of matter, based upon strictly scientific data and mathematical reasoning, have approached very closely to those propounded by the Attic philosophers, which were evolved purely from the inner consciousness of the poetic sages, the ancient theories being rather expressions of sentiment or feeling than of observed realities or facts. We may find a parallelism to this in the grand musical compositions of the old masters: knowing nothing of the modern science of music or the laws of acoustics, they felt and recorded harmonious combinations which are now shown by analysis to conform to most rigid mathematical laws. The poetical fancies of Lucretius on "The Nature of Things," which have been preserved to us through a lapse of two thousand years, will receive new interest in the light of modern scientific revelation.

The delicacy of the apparatus devised by physicists and the refinement of experimental demonstration rendered possible thereby are among the greatest marvels of this wonderful age. The physicist is pushing his researches into paths which but a few years since were thought to be for ever hidden somewhere in the vast realm of the "unknowable," and the boundary line between so-called physical and metaphysical science is continually narrowing. Just as the skilled mountaineer or the aëronaut ascends gradually into the rarefied upper atmosphere, in order that the system may accommodate itself to its

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new environment, so the philosopher has advanced, step by step, until he seems almost to have grasped the ultimate particles which constitute the physical basis of the universe, and to have rendered visible to mortal unaided eyes particles of matter which are not only invisible by the aid of the most powerful microscope, but are too infinitesimal even for the mind's eye to conceive.

When that marvelous little instrument called the spectroscope was devised, it seemed that man had invaded fairy-land and stolen "a trap to catch a sunbeam," for such it is, in very truth: not only does it catch the dancing sheaf of light, but spreads it out into a band of exquisite colors and exhibits to our fascinated gaze Nature's palette of purest tints, out of which is woven the whole fabric of the gorgeous sunset, the variegated flowers, the bright plumage of the birds, the iridescence of mother-of-pearl, the sparkle and hue of gems, and, indeed, every variety of color in nature or in art.

But this little instrument is still more wonderful, for it combines with its qualities of a trap the advantages of a balance which we may suppose is fine enough for the most fastidious fairy to weigh the nectar distilled in the dew-drop, or other delicacy of the season.

Our ideas of weight and size are purely relative, and that which seems a small or light object, from one point of view, may become large and heavy by a different comparison. To most of us, perhaps, a "grain-weight" suggests a little thing; we know that the apothecary and a few other small dealers split up the grain into halves, quarters, tenths, and perhaps even hundredths, but then we regard them as homœopathic visionaries and laugh at their absurd little pellets; yet, strange to say, there is a vanishing-point in our minds, which, if an object is small enough to pass, it becomes larger and more important by reason of our astonishment and wonder at its minuteness: the most ordinary specimen under the microscope is an evidence of this, but when we realize that the ability of the spectroscope to reveal small particles of matter begins where the finest microscope searches with its highest power in vain, that the grain of matter may be divided, not merely into hundredths, or thousandths, or tens of thousandths, but into millionths and tens of millionths, and that a single one of these particles may be readily detected by this little searcher and held up for our inspection, our wonder and amazement enhance our respect for its occult powers. The astronomer tells us that a comet often throws out a tail longer than the distance between the earth and the sun, and broad in proportion; yet the matter forming this tail is so attenuated that, if properly compressed, a gentleman's portmanteau, possibly his snuff-box, might take it in.* Yet we have merely to point this little tell-tale at the comet, and, presto! we know what the matter is. Think of it! Not merely can we grasp infinitesimal particles at our hand, but we may sweep the firmament, gather up the star-dust and tell its composition.

* See "Fragments of Science," Tyndall, p. 444.

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But we have not yet reached the end of our excursion; indeed, we have only entered the threshold of the scientist's sanctum, and the wonders of the arcanum eclipse those of the portico. That mysterious agency or force called electricity has been utilized, not merely for the benefit of bulls and bears, or for hundreds of utilitarian purposes with which we are familiarized every day, but it has been used as a fairy-finger to probe Nature's hidden structure, and, as it were, enable us to *feel* what the spectroscope has revealed to sight.

Then, again, appliances for obtaining little samples of "stellar space" in the interior of glass bulbs—bottled vacuity—which we may examine at our pleasure, are in themselves curious. Think of a bulb about the size of a cricket-ball containing only one ten-millionth part of one atmosphere, and that part being subdivided into millions and millions and millions of individual portions, and these particles being captured and made to do visible, tangible work; think of a miniature engine with a propeller-wheel being made to revolve and a little railway run by projecting these minute particles against the driving-wheel; think of a piece of refractory metal like platinum being so terribly battered by hitting it in rapid succession with a charge of these little molecules that it is made to cry out in fervent heat, to glow with a bright light, and, if this molecular bombardment is continued, even to melt before it like wax; think of the commonest and most uninteresting materials, like burned oyster-shells, being made to shine with a luminosity rivaling the "great carbuncle," or the famous "Kohinoor"; of little pieces of glass outvying the finest emeralds, rubies, and sapphires, when under this marvelous influence—then, we will be ready to admit that, while we work-a-day, matter-of-fact people may not understand the motive that induces the original investigator to plod on in his narrow path, continually prying into some seemingly trivial corner of Nature's vast store-house of knowledge, we can nevertheless appreciate and enjoy the beautiful results which modern Science has to offer as rewards to her votaries, and we can not too greatly venerate the genius of those who could conceive the possibility of such results, and possess the ability to produce them.

VIBRATION OF ROCKS IN PATAPSCO VALLEY, MARYLAND.

By FREDERIC GARRETSON, M. D.

THE valley of the Patapsco River, through which the Baltimore and Ohio Railroad passes, presents many interesting subjects to the student of physics and of geology. After passing the junction of the Washington branch at the Relay House, eight miles west of

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Baltimore, the alluvial plain gives place to a narrow valley with steep and wooded hills on either side, and walled with conglomerate or metamorphic rocks. Above Ilchester, a few miles farther up the valley, begin the beds of solid granite, which are excavated by several quarries near Ellicott City, fifteen miles from Baltimore. It is worthy of observation that these granite beds are replaced, a few miles above, by separate rocks composed of the ingredients of the granite, or resulting from their decomposition. In the cuttings of the railroad five miles above Ellicott City, large masses of nearly pure silica are found, and in the same vicinity feldspar is abundant. The mica is sufficiently stratified to furnish a supply worth working for market; and asbestos, in more or less advanced stages of formation, is quarried to some extent for purposes not requiring a perfect fibrous structure. Kaolin of very good quality is found, but has as yet been little worked. These rocks will at some future time well repay exploration.

The object of the present paper is to record a phenomenon observed at Ellicott City, which lies in a narrow and deep valley, nearly at a right angle to the Patapsco, which is here a stream of some sixty yards in width, flowing very rapidly over a broken and rocky bed. About an eighth of a mile below the town, the turbulent stream enters a straight channel with a comparatively even bottom, and flows for nearly half a mile with steady current and a depth of three to six feet. The river is then checked by the dam of a large mill, and presents a fall of about ten feet, with a sheet of water seldom more than six inches in depth pouring over the edge of the dam.

The stream is here over sixty yards wide, and the body of falling water produces a sound which can not be heard more than four hundred yards below, or half that distance above the dam. The impact of the fall is so trifling that it causes no perceptible vibration in the immediate vicinity. Yet, in the valley where Ellicott City is built, more than half a mile above the fall, the houses on either hill-side, which have foundations deep enough to reach the granite bed-rock, are subject to occasional vibrations which shake their walls and cause a continuous rattling of the windows. This effect has, of course, been ascribed by the people, in an indefinite way, to the river, but it was some time before I collected the physical data for the explanation which is here offered.

In making the investigation, it was observed that the current of the river above and near the town was broken by rocks, and, although rapid, could produce no rhythmic vibrations because of the irregularity of its impacts. The apparently quiet flow of the stream below did not seem to offer any solution of the problem, and the fall of water over the dam had evidently a very trifling force of impact. But a more careful observation of this little water-fall convinced me that it was the motive power. First, a peculiar shimmer in the reflection of light from the edge of the dam, and on nearer approach a distinct

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rhythm in the movement of the falling water, were observed. This was found to occur only at certain times. If the river was either too high or too low, the water poured over the dam with regular and uniform motion and sound; when the vibration of the houses occurred, the pulsatory movement of the falling water was also noticed.

The vibrations of the water were estimated at eight or ten per second, or about half of the number required to give the lowest continuous sound. These facts being established, it still remained to account for the enormous mechanical effect necessary to produce the vibration of distant buildings.

The long stretch of steadily flowing water above the dam, whose sloping edge only partly arrested its course, suggested the divided current of air thrown into the pipe of an organ. And, as the small column of air in the pipe, when thrown into vibration, is known to produce in some cases a perceptible tremor in the massive walls of a church, it is probable that a column of water half a mile in length, when in rhythmic vibration, would have a mechanical effect in proportion to its mass. But, in order that such vibration of a considerable body of water should be produced, a peculiar combination of physical conditions must exist, and this I have never observed in any other place.

Of course, the fall of such masses of water as pour over Niagara and other great cataracts will cause a tremor of the earth to a certain distance. But this is due to the simple mechanical force of impact, and is in relation to that force only. The phenomenon which I have described is intermittent, and that fact points to the conclusion that it is due to a definite relation between the vibrations of the river and what may be called the key-note of the bed-rock over which it flows.

The distance to which such motion may be transmitted will, of course, depend upon the mass of water in vibration. The direction will depend upon the continuity of the underlying rock. Where this is broken by seams, the vibrations will cease, and therefore the line of these remarkable tremors affords an indication of the structure of the granite bed which is the basis of the picturesque hills around Ellicott City.

M. SAINTE-CLAIRE DEVILLE.

HENRI-ÉTIENNE SAINTE-CLAIRE DEVILLE, one of the most distinguished of French chemists, was born at St. Thomas, in the Antilles, of French parents, March 11, 1818, and died at Boulogne-sur-Seine on the first day of July last. He went to France while still a boy, with his brother, Charles Deville, the meteorologist, and had his attention drawn early in his career in school to chemical studies, which were then enjoying high credit under the brilliant results

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of the investigations of Thénard, Gay-Lussac, Chevreul, Dumas, Balard, and Pelouse. It is said that he hesitated at first between science and music, but was finally attracted to chemistry by the lectures of Dumas; and, on leaving college, he constructed a laboratory at his own expense, and pursued his researches without either master or pupils for nearly nine years. He was not more than twenty years old before he marked his place in science by an original work, the scale of which he enlarged in the following years, exhibiting in it so many proofs of an inventive and clear mind that he was sent to Besançon to organize the newly-created faculty of sciences in that city, and became its dean—at the age of twenty-six years. Here, on invitation of the municipal council, he undertook the analysis of the waters of the river Doubs, and of the numerous springs around the town. Applying new and more exact methods, he ascertained the presence of nitrates and silicates in all the waters—facts which were afterward confirmed by Boussingault, and shown by him to have an important bearing on agriculture. This analytical talent out of the usual line, says M. Pasteur in his funeral eulogy, which was one of the features of Deville's genius, never abandoned him; and, "if you review the field of his persevering labor as a whole, you will find it marked at every step by evidences of a passionate seeking for the most perfect analytical methods. That rigor of analysis, which is the probity of the chemist, . . . Deville communicated to all his pupils, and it may be seen to shine in the labors of all those whom he inspired—of Debray, Troost, Fouqué, Grandeau, Hautefeuille, Gemez, Lechartier, and many others."

In 1851, when thirty-three years old, Deville succeeded Balard in the chair of Chemistry in the Higher Normal School in Paris, where he worked at tasks which have led to the enrichment of wealthy manufacturers, and with an ardor which made the laboratory of this institution a central point of chemical investigation for all Europe as well as for France, for the modest salary of three thousand francs, or six hundred dollars. In 1854 he assumed, in addition to his work here, the duties of a lectureship, which fourteen years later became a full professorship, in the Sorbonne.

M. Deville's first researches were in organic chemistry, and began to attract attention in 1840, when he published a remarkable study of turpentine-oil and various derivatives of the terpenes, the carefully tabulated results of which form the chief basis of our knowledge of the different isomeric states of this group. It was followed in 1842 by a research on toluene, which has had an important bearing in the researches on the aniline colors.

He soon afterward turned away from this branch of the science to devote himself to mineral chemistry, in which, says M. Pasteur, he for thirty years held the scepter in France and Europe.

His first great discovery in this department was announced in 1849, when he demonstrated the existence of anhydrous nitric acid, and de-

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scribed its preparation by the action of chlorine on silver nitrate, and its properties. The possibility of the existence of monobasic acid anhydrides had previously been disputed. In 1852 he published in the "Annales de Chimie et de Physique" an important paper upon the metallic carbonates and their combinations, and in 1853 he discovered a new method of mineral analysis. In 1855 he began the famous research on metallic aluminium, which proved, says his biographer in "Nature," to be one of the crowning features of his life-work. He was furnished the means by which he was enabled to carry his experiments to success by Napoleon III, who was looking forward to the application of the qualities of a metal of so light a specific gravity to the making of armor and helmets for the French cuirassiers. The anticipation proved to be a mere dream, and impracticable; but the ambition in which it was bred was caused for once to minister to the lasting benefit of mankind. With the means thus furnished, M. Deville was able to carry on his experiments on a large scale, and so rapidly that even in the same year in which he began he displayed at the exhibition in Paris massive bars of the metal, that had hardly been seen before in a pure state. The study of this metal and of its metallurgical production, as well as of the various compounds of aluminium, carried out during a series of years, forms, says "T. H. N." in "Nature," one of the most remarkable and complete contributions made to inorganic chemistry within a recent period. The metal is now prepared in one English and two French establishments according to Deville's perfected process, which consists essentially in heating the double salt (chloride) of aluminium and sodium with metallic sodium, fluor-spar or cryolite being added as a flux, and is used for a variety of objects where lightness, strength, and freedom from oxidation are demanded, and in many valuable alloys, of which it forms the essential part. It has not come into as extensive use as Deville hoped it might, for it is still too high in price and is hard to weld. The operations with aluminium have resulted in building up other industries, such as the production of bauxite and cryolite, and the manufacture of metallic sodium, the price of which sank in ten years from two thousand francs to fifteen francs per kilogramme. In 1863 M. Deville, in connection with Caron, applied his aluminium method to the manufacture of magnesium, and made it possible to produce that metal in commercial quantities. With Debray he carried on exhaustive researches from 1859 to 1862 on the metals of the platinum group, in which he applied the oxyhydrogen blow-pipe on a large scale to the fusion of platinum, now for the first time accomplished. This led him to operations at higher temperatures than had ever before been attained, except perhaps casually, involving the artificial production of crystalline minerals, which has since been carried out by other chemists to a larger extent, and numerous determinations of the vapor densities of bodies that are ordinarily solid, like the chlorides of aluminium, iron, and va-

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rious rare metals, by means of which the molecular weights of various compounds have been satisfactorily ascertained.

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M. Deville's highest title to honor, says M. Würtz, rests upon his having introduced to science the idea of dissociation as a particular method of decomposition, the understanding of which has rendered the grandest services to theoretical chemistry. Decomposition was believed, previous to his researches in this line, to be a simple phenomenon, taking place and being repeated with each body at a fixed temperature. M. Deville has shown that it is not always so, but that decomposition is accomplished in certain cases by degrees, within certain limits of temperature, in such a manner that it is arrested at a given temperature, by the establishment of an equilibrium between the decomposing body and the products of its decomposition. The principle explains a variety of occurrences among thermal phenomena that have hitherto not been accurately accounted for, and may be defined, says "Nature," "as the property of many compound bodies to undergo partial decomposition under the influence of heat in confined spaces, until the liberated gas or vapor has attained a certain tension, greater or less, according to the temperature. So long as this temperature remains constant, no further decomposition takes place, neither does any portion of the separated elements recombine. If the temperature be raised, decomposition recommences, and continues until a higher tension of the liberated gas or vapor, definite for that particular temperature, is attained. If the temperature falls, recomposition ensues, until the tension of the residual gas is reduced to that which corresponds with the lower temperature. The enunciation of this simple but far-reaching principle has thrown light upon a number of phenomena, such as the formation of minerals, the apparent volatilization of solids, etc.; and has been the fruitful source of countless novel discoveries."

Other researches with which M. Deville's name is associated are those on boron, which he prosecuted in company with Wöhler in 1857, on the preparation of silicium and its compounds with copper (1863), a new calorimeter, on the changes attendant upon the mixture of liquids (1870), and the examination of a large variety of minerals and natural products. A few years ago he was appointed on the commission to prepare the international normal standard of the measure of a metre, and acquitted himself of the task allotted to him with characteristic devotion to the interests of science.

His simplicity was the predominant quality in M. Deville's character, and distinguished him alike in his social relations and in his scientific labors. He kept away from the theoretical disputes in which many of his colleagues were too prone to indulge, finding abundant employment for his own resources "in attacking the still unsolved problems of inorganic chemistry"; and he is said to have gone so far as to declare the whole theoretical tendency of modern chemistry, the

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atomic theory not excepted, to be a superfluous speculation. His methods, his apparatus, and the few fundamental principles he has enunciated, were all alike simple. He was much beloved by his students, and was devoted to them. Though the labor of drilling the pupils of the Normal School year after year in the same elementary principles must have been irksome in the extreme, he was always kind and just, always ready with counsel and help. His proverbial tenderness toward candidates in the public examinations is illustrated by an anecdote:

"Let us see, monsieur," he asks; "of what is water composed? . . . Of o—?"

"Xygen," the pupil replied.

"And what else? . . . Of hy—?"

"Drogen," added the candidate.

"That is right, monsieur. Thank you."

M. Pasteur describes him as small in stature, with a high forehead, lively eyes, and an impulsive walk; a man who might have compared the beating of the blood in his veins to that of the waves in the river Rhône.

M. Deville's chief works include his contributions to the "Annales de Chimie et de Physique" concerning the properties of aluminium and his experiments with it; a comprehensive work on the same subject ("De l'Aluminium, ses Propriétés, sa Fabrication"), published in 1859; a report on the fusion of steel in the reverberating furnace without using a crucible (1862); and his large work on the metallurgy of platinum and the metals that accompany it (1863). Among his more important contributions to the Academy of Sciences are papers on the three molecular states of silicium and a memorandum on the production of high temperatures.

M. Pasteur relates that at one time, when he thought that he himself was about to die, M. Deville rallied him by telling him that he must live to pronounce his funeral address. The duty was beautifully fulfilled by M. Deville's fellow-worker in the fields of investigation. On the 5th of July last, M. Pasteur pronounced an affectionate funeral eulogy on his deceased colleague, beginning with the appropriate apostrophe: "Thy sympathetic features, thy gayety of spirits, thy frank smile, the sound of thy voice, still go with us and live among us. The ground that bears us, the air we breathe, the elements which thou didst love to question, and which were always so docile in answering thee, could tell us of thee if there were need of it. The entire world knows the services thou hast rendered to science, and, beyond the mountains and the seas, every man who is interested in the progress of human thought wears mourning for thee."

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ENTERTAINING VARIETIES.

—— *Four-footed Outlaws.*—"France must elevate her soul to the height of the situation," wrote Louis Napoleon after the battle of Gravelotte. She didn't; but the *instincts*, as we are pleased to call the talents of our dumb fellow-creatures, seem really able to adapt themselves to any possible emergency. In the border-lands of culture, in the Jura, the Cheviot Hills and the Adirondacks, there are deer and foxes that can not be outwitted by ordinary means, and succumb only to an in-pre-calculable combination of circumstances. Among the half-wild cattle of the Texas frontier there are individuals whom the Genius of Civilization has given up for lost, human ingenuity being no match for such instincts as theirs. Even in the Belgian Ardennes, where every acre of woodland is under the control of professional foresters, a runaway pony managed to elude his pursuers for more than eight years. His haunts were pretty well known, experience and emulation had sharpened the wits of his persecutors, but all plans to recapture him went somehow aglee—he was not only cautious but caution incarnate the quintessence of his five senses seemed concentrated on the problem of preserving his liberty. A single glance enabled him to distinguish harmless bipeds from dangerous or suspicious ones; old crones in quest of their milch-cows, and berry-gathering boys, he simply ignored; but at the approach of a game-keeper he instantly vanished from human sight or at least out of rifle-range. He used to make his headquarters in the dense pine-jungles of the Sambre highlands, but in night-time he sometimes revisited the glimpses of the moon on business that finally brought him to grief. After he had repeatedly stampeded the mares of a highland stud-farm, the proprietors put a price on his head, and—*ne Theseus quidem contra plures*—the wary outlaw was at last shot near the Col de Grappe, on the border of Lorraine.

—— *A Paragon of Ugliness.*—The ancient Huns seem to have been the ugliest of all the ugly races of Central Asia; and the homeliest individual—with one exception—was probably the "veiled Prophet of Bokhara," Mullah Ibn Said, the repulsiveness of whose features was so overpowering that he did not dare to show himself without a mask, for which he afterward substituted a golden veil, whence his surname, Almukana—"The Veiled One." Yet his biographer, Ibn Chaldir, assures us that an elder cousin of Almukana, who proudly disdained to hide his face, exceeded him not only in erudition but also in ugliness. This man, called Kofta Ben Lukas, and famous as a philosopher and grammarian, must actually have been the *ne plus ultra* of homeliness. He was an accomplished teacher of languages, but the only pupils he could procure at the Lyceum of Bagdad were adult males, of exceptional fortitude, all others being overcome by the terrors of his presence. When Almohadi, the Caliph, inquired after the best teacher of the Persian language, the name of Ben Lukas was mentioned among those of the highest merit, but when further inquiries proved this worthy to be identical with the formidable licentiate of Bagdad, Almohadi, who wanted the instructor for his own son, was earnestly advised to alter his choice, as a prince of such tender years would surely succumb to nervous prostration at the first grammatical interview. The Caliph ridiculed these fears, and ordered the grammarian to report at his court; but no sooner had

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Kofta Ben Lukas made his salaam to the Commander of the Faithful, than he was presented with a purse of four hundred and fifty golden denari, and offered fifty more if he would leave the capital before night. He had been summoned through a misunderstanding, they told him, and the Caliph did not wish it to become public that by his mistake an illustrious scholar had thus been foolishly interrupted in his studies.

—— *Marshal Vendôme.*—If cynicism had not ceased to rank as a branch of philosophy, France could boast of having produced the greatest philosopher of the last twenty centuries. Louis-Joseph, Duke of Vendôme, great-grandson of Henry IV, was a man of principles. He used to take a bath on the first day of every month, and during the remaining four weeks avoided water in every form—his toilet-articles being limited to a jackknife and a piece of beeswax. On the day of the monthly purification his rooms were also cleansed, his study with a broom and his bedroom with a shovel, for a pack of hunting-dogs shared his couch and often reared their progeny under his bed. The destruction of all earthly laundries would not have shaken the peace of his manly soul; his underwear consisted of a buckskin shirt and short socks of the same material, his bed of a bunk and three blankets, one of them rolled up in the shape of a pillow. At the table of the Comte d'Amblève he often gorged himself till he could hardly rise from his chair; but at home he used to avoid that difficulty by taking his meals in bed, and there were weeks when he did not leave his bed at all. Brushes, combs, looking-glasses, marriage-rings, prayer-books, handkerchiefs, soap and wash-basins, were luxuries the noble warrior managed to dispense with; ceremonies were his grand aversion, and the demerits of the frail sex the subject of his daily anathemas. But this man, whom the priests accused of all the vices mentioned in Peter Lombard's revised catalogue, was a Mars on the battle-field, the idol of the army, and, in the opinion of Prince Eugene, the one soldier who could have saved France if the petticoat-government had not thwarted him.

—— *Curious Predictions.*—Mother Shipton, too, has foundered on a cliff that is strewed with the wreck of numerous vaticinations. On this side of the Indus, it seems, Messiahs are not sufficiently encouraged to venture upon a second advent. "This whole business of the Delphic fraternity," says Professor Hegel, "is nothing but *Scheiben-schiessen im Nebel*—target-practice in a fog." Still, it must be admitted that some of the marksmen have scored remarkable hits. Not all prophets have "prophesied after the event," for it can not be denied that, eight years before the birth of Napoleon Bonaparte, the author of the "Contrât Social" (Jean Jacques Rousseau) recorded in print the following *augurium:* "J'ai un présentiment que la Corse produira un homme qui étonnera le monde"—("I have a presentiment that Corsica is going to produce a man who will astonish the world)." Napoleon himself believed in omens and portents as firmly as any Roman Cæsar, and openly professed his confidence in certain lucky days (the 2d of December and 24th of October, for instance). He confessed to Las Casas that in the night before the battle of Leipsic he was on the point of revoking all his orders and abandoning his position, having been seized with a sudden misgiving, which only the stronger fear of ridicule helped him to overcome; and after his Russian campaign he certainly had some excuse for being a little superstitious. In the winter of 1807 the arbiter of Europe took it into his head one day to consult the famous *clairvoyante* Lenormand, whose feats in "astrology" were setting all Paris agog. The Pythoness told him that his fears of another outbreak in Austria were unfounded. "Your power has not culminated yet,"

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she said, "your star will keep in the ascendant for another five years; but after that it will decline and be eclipsed for ever." The downfall of the Roman Empire was foretold by many portents and prodigies, of which even the elder Pliny enumerates a long list; and the testimony of numerous Spanish historians makes it certain that long before the birth of Columbus the ancestors of Montezuma were frightened by an ominous prophecy which presaged the overthrow and total ruin of their nation. Strange men, cunning, strong, and altogether invincible, were to come from the *East* and consume the race of the Aztecs as the hoar-frost of the Cordilleras is consumed by the morning sun. Lord Bacon's *bonmot* respecting forebodings might be applied to this kind of prophecies, that "a man troubled with misgivings has commonly good reasons to expect things to go amiss"; but, even in the noontide of prosperity, such omens of a sudden night have now and then appeared. King Rodrigo, a year before the altogether unexpected invasion of the Saracens, had a vision that "prostrated his mind like a sentence of death," and on the battle-field of Xeres, when squadron after squadron of his iron-clad warriors was borne down by the onset of the Moslem fanatics, he turned to the Bishop of Toledo with the words: "*Está venido!*—it has come! These horses and these riders I saw approaching in my trance a twelvemonth ago; they are going to overtake me now."

—— The principal literary event in the interest of popular science in Mexico is the issue of a "Pocket-Cyclopædia of Useful Knowledge" ("Enciclopedia Manual de Ciencias útiles," three vols., Puebla, Manzanares & Co., 1881)—a publication which seems to enjoy an increasing popularity, though the editor has been unable to deprecate the hostility of the orthodox press. "The eminent publishers have discontinued the sale of transparent French cards," says the "Correo Nacional," "but we should like to know how and where they would draw the line which makes immoralities detestable in colored lithographs, which are endured in the form of black types on the pages of the 'Enciclopedia.' Don Yriarte, the editor of that publication, affects to doubt the fact that King Philip II possessed a duplicate skeleton of St. Laurentius, and plainly insinuates that '*at least*' one of those relics must have been spurious. History proves that the skeletons in question were originally owned by ecclesiastical establishments of the highest respectability, and we need hardly remind our readers that the Bishop of Velez Malaga recognized the miracle of the dualism as a special dispensation of Divine Grace. Don Yriarte's views are therefore utterly untenable, and valuable only as an additional proof of the immoral tendency of his writings." "In his article on 'Church Government' and the 'Sequestration of Ecclesiastical Domains,'" says the "Espectador," "the editor of the 'Enciclopedia' quotes the speeches of Emilio Castelar and others of his class, while such writers as the Duke of Braganza y Nunez (author of the 'Sacred Petticoat of Santa Eulalia') have never been permitted to offer their views. Nay, in a review of the 'History of International Statistics,' Don Yriarte has no hesitation in illustrating the applications of the 'Rule of Three' by certain formulas whose promulgation would be so directly subversive of the chief dogma of the Trinitarian Church that we must decline to sully these pages" (*contaminar estas páginas*) "by quoting them. We, with thousands, pray that the re-establishment of the Holy Inquisition may put a stop to such outrages on the interests of the national Church—unless the 'Enciclopedia' will revoke its atheistical teachings, and become such an organ of science as the great body of intelligent Mexicans will admit with confidence into their homes."

F. O.

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—— The letters of Sir Charles Lyell have just appeared, in two solid volumes, and contain much that is interesting. The following extracts are from those written about 1830, when he was bringing out the first edition of his "Principles of Geology," and advocating what was at that time the heresy of uniformity against catastrophe in the earth's great geological changes:

—— "I shall be glad to hear your honest opinion of the work, regarded as one comprehensible to the uninitiated. I am afraid that what delights my friend Scrope more than all—the honest history of the Mosaico-geological system—will hurt the sale. D'Aubisson said this morning: 'We *Catholic* geologists flatter ourselves that we have kept clear of the mixing of things sacred and profane, but the three great Protestants, Deluc, Cuvier, and Buckland, have not done so; have they done good to science or to religion? No; but some say that they have to themselves by it. Pray, gentlemen, is it true that Oxford is a most orthodox university?' 'Certainly.' 'Well, then, I make allowances for a professor there, dividing events into ante- and post-diluvian: perhaps he could get no audience by other means.'"

—— "I have just had this morning a famous geologico-botanical discussion with Professor de Candolle, and am almost certain that my spick-and-span new theory on this subject will hold water."

—— "Considering that no lectures on geology are authorized in the Sapienza (Rome), I was amused at the late French embassador, Count de Rayneval, having made a splendid collection of tertiary fossils in the hill of the Vatican, which he and Ponza are preparing for publication. They are curious, and intermediate it seems between Miocene and Pliocene. For five years they have worked away under the Pope's window, to throw light on the earth's antiquity."

—— "Longman has paid down five hundred guineas to Mr. Ure, of Dublin, for a popular work on geology just coming out. It is to prove the Hebrew cosmogony, and that we ought all to be burned in Smithfield. So much the better. I have got a rod for the fanatics from a quarter where they expect it not. The last Pope did positively dare to convoke a congregation, and *reverse* all that his predecessors had done against Galileo, and there was only a minority of one against; and he instituted lectures on the Mosaic cosmogony to set free astronomy and geology. How these things are so little known in Paris and London Heaven knows. They are golden facts, and I find the state of the question here to shame the Granville-Penn school of England."

—— "Some thirty years ago I was told at Bonn of two processions of peasants who had climbed to the top of the Petersberg, one composed of vine-dressers, who were intending to return thanks for sunshine and pray for its continuance; the other, from a corn district, wanting the drought to cease and rain to fall. Each were eager to get possession of the shrine of St. Peter's chapel before the other, to secure the saint's good offices, so they came to blows with fists and sticks, much to the amusement of the Protestant heretics at Bonn, who I hope did not by such prayers as you allude to commit the same solecism occasionally, only less coarsely carried out into action."

—— "*Cuvier* is in great force, and gave a famous *soirée* the other day. He has been chosen by the ministers to defend their municipal law in the tribune: two months of his time will thus be lost to science. He talked to me of the Catholic question, our corporation rights, etc., and not a word could I get on

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natural history. Yet this year he has come out with four volumes on fish, and eight more will appear in two years. He has received between £2,000 and £2,200 for it, whereas no other person in Paris could persuade a librarian to publish one volume for nothing. He is also publishing another edition of his 'Règne Animal,' and other things. He has been very obliging to me, for, on my applying for casts of animals for Mantell, who has been begging in vain for a long time, he gave me an order for whatever I liked; so I have sent off from the museum a huge box with casts of *every* thing."

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—— "I got into *Cuvier's sanctum sanctorum* yesterday, and it is truly characteristic of the man. In every part it displays that extraordinary power of methodizing which is the grand secret of the prodigious feats which he performs annually without appearing to give himself the least trouble. But, before I introduce you to his study, I should tell you that there is first the museum of natural history opposite his house, and admirably arranged by himself; then the anatomy museum, connected with his dwelling. In the latter is a library disposed in a suite of rooms, each containing works on one subject. There is one where there are all the works on ornithology, in another room all on ichthyology, in another osteology, in another *law* books (!) etc., etc. When he is engaged in such works as require continual reference to a variety of authors, he has a stove shifted into one of these rooms, in which everything on that subject is systematically arranged, so that in the same work he often takes the round of many apartments. But the ordinary studio contains no book-shelves. It is a longish room, comfortably furnished, lighted from above, and furnished with eleven desks to stand to, and two low tables, like a public office for so many clerks. But all is for the one man, who multiplies himself as author, and, admitting no one into this room, moves as he finds necessary, or as fancy inclines him, from one occupation to another. Each desk is furnished with a complete establishment of inkstands, pens, pins to pin manuscripts of the same work, etc. There is a separate bell to several desks. The low tables are to sit to when he is tired. The *collaborateurs* are not numerous, but always chosen well. They save him every mechanical labor, find references, etc., are rarely admitted to the study, receive orders, and speak not."

—— "*Brongniart*, who in imitation of Cuvier has many clerks and *collaborateurs*, is known to lose more time in organizing this auxiliary force than he gains by their work, but this is never the case with Cuvier. When I went to get Mantell's casts, I found that the man who made molds, and the *painter* of them, had distinct apartments, so that there was no confusion, and the dispatch with which all was executed was admirable. It cost Cuvier a word only."

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CORRESPONDENCE.

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THE DURATION OF HUMAN LIFE.

Messrs. Editors.

I HAVE read with great interest an article having the above title, by M. De Solaville, in the November issue of "the Popular Science Monthly." As the article is so conclusive as to the average age of man, with one singular exception in relation to the patriarchs, living before the flood, it has taxed the ingenuity of many able as well as serious minds to account for the wonderful discrepancy in this case. Buffon has given, as the writer quotes him, the reason of this difference to be, that "before the flood, the earth was less solid, less compact than it is now. The law of gravitation had acted for only a little time, the productions of the globe had less consistency, and the body of man, being more supple, was more susceptible of extension. Being able to grow for a longer time, it should, in consequence, live for a longer time than now." Hensler, he tells us, has given a different reason, referring the apparent conflict to the different modes of dividing time. Voltaire rejected, on the authority of the writer, "the longevity assigned to the patriarchs of the Bible," but accepts without question the longevity ascribed to certain men in India, who reached the age of one hundred and twenty years.

On a full examination of the question of patriarchal longevity, the disparity of their ages to those of later times disappears. A very slight error in the translation of the Hebrew numbers has led to all the apparent disparity. The age of the antediluvians was not to exceed one hundred and twenty years. Genesis vi, 3: "And the Lord said, my spirit shall not always strive with man, for that he also is flesh, yet his days shall be an hundred and twenty years." This was the regular good old age of men with special variations, both before and for some time after the days of Abraham.

In reading *concrete numbers* the Hebrews gave the larger number first, thus: Ninety *and* seven for ninety-seven, forty *and* seven for forty-seven. The reversal of this rule in the translation of Genesis v, 3-5, as an illustration, will show the error in all similar cases. "Adam lived a hundred and thirty years and begat a son," etc. This is correct, according to the rule; Seth was born when Adam was one hundred and thirty years old, and was his last child. But if the rule were here reversed, as it is in the authorized version in the fifth verse, it would read thus: Adam lived thirty hundred years, and begat a son! This shocked the consciousness of the Christian translator, and he was driven to the true rule of the Hebrew uses in case of *concrete numerals*.

In the fifth verse we have the force of the violated rule, thus: "And all the days that Adam lived were *nine hundred and thirty years, and he died*" / A. V. The true reading by the rule would be, "And all the days of Adam, which he lived, were a hundred years, and thirty and nine years, and he died," making the entire age of Adam one hundred and thirty-nine years, instead of nine hundred and thirty years.

It will be seen, on examination, that concrete numeral adjectives, in Hebrew as in other languages, agree in number with their nouns. In the case cited in the A. V. the *nine* is made to agree with *hundred* in the singular and not with *years* in the plural. The error is seen at a glance, for the difference between "*nine* years" and "*nine hundred* years" is too great to be overlooked in any careful translation of a sacred book. The translator assumed that *nine* here agreed with *hundred*, when it had no such agreement; hundred in the text is itself a concrete numeral, and separately agrees with years, meaning a hundred of years. At the date of this writing the Hebrews had no means of writing "nine hundred," or any number of hundreds above one, without repetition or circumlocution. There were then none of the masoretic points in use. In the case of the age of Terah, the father of Abraham, the translators have made the attempt to make two hundred out of one hundred in the word *mathim* [מאתים], used in the plural as it might be to agree with years, thus making Terah two hundred and five instead of one hundred and five years old, at his death; holding the theory that the word *mae* (or one hundred) would, in the plural, *mathim*, make two hundred. This is contrary to all rule. The Hebrews could, by pluralizing a numeral, less than ten, add tenfold to the unit, thus: hemosh, *five;* hemoshim, *fifty*. This rule, applied in the case of Terah, would make him ten times one hundred and five years old, or one thousand and fifty years old. In the case of Terah the historic record conclusively contradicts the translation, and hence demonstrates the rule that pluralizing one hundred does not, in the Hebrew tongue, make two hundred,

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while as to all numerals between *two* and *ten* the rule might apply thus: Shelesh, *three;* sheleshim, *thirty;* and in like manner to ten. With these corrections, referring to the ages of the patriarchs before the Noachian deluge, the article of M. De Solaville would show a wonderful uniformity in the age of man since the dawn of history.

From Adam to the flood the ages would read as in the table below, subject to a few uncertainties in the numbers *below one hundred*, as the numerals are sometimes pluralized for purposes of agreement, when they were not increased tenfold. These cases are not always certain; the table to the flood is substantially true.

The table is added, giving the ages of each at the time of his death:

1. Adam,	189	years and	not	930	years.
2. Seth,	121	"	"	912	"
3. Enos,	114	"	"	905	"
4. Cainan,	119	"	"	910	"
5. Mahalaleel,	122	"	"	895	"
6. Jared,	117	"	"	962	"
7. Enoch,	114	"	"	365	"
8. Methuselah,	124	"	"	969	"
9. Lamech,	117	"	"	777	"
10. Noah,	159	"	"	950	"
Averages,	120 + years		"	858 years.	

Should the editors of "The Popular Science Monthly" publish this note, it might be the means of calling the attention of the revisers of the Old Testament to the examination of cases of apparent errors in the reading of Hebrew numbers. The late Dean Stanley, for years before his death, insisted that the numbers in the Old Testament were, in many instances, entirely too high. The correction of these apparent errors, the Dean believed, would relieve the Bible of many objections now urged against this important record of ancient times.

Most truly yours,

CHARLES S. BRYANT.

ST. PAUL, MINNESOTA, *October* 28, 1881.

THE COPYRIGHT OF IRVING'S WORKS.

Messrs. Editors.

THE last issue of the "Monthly" contains, in an article by Mr. B. V. Abbott on the "Progress of Copyright Law," a paragraph in regard to the copyright on Irving's works, which seems to us calculated to convey an erroneous impression.

Mr. Abbott, intending to paraphrase the decision of the judge in our suit to restrain the publication, under the title of "Irving's Works," of a volume containing only a portion of Irving's earlier and unrevised writings, says, "Now that any one may publish Irving's works," etc.

It is not the case that any one may at present publish Irving's works. His latest writings, including the crowning work of his life, "The Life of Washington," and including the only revised and authorized issues of his earlier volumes, are still protected by copyright.

The words of the judge had reference simply to the material comprised in the volume whose publication we sought to restrain. This contained only the earlier and unrevised writings (in some cases reprinted from their original issue as "magazine" articles), which were no longer protected by copyright.

Our application was based on the ground that it was an attempt to deceive the public to offer for sale as Irving's works something that was very different from the revised and complete works as known and published for many years, and that, so far as such volume, under such misleading title, was sold, it was an injury to the property of Irving's nieces, who are the owners of his copyright.

For the support of this claim, however, the court decided that the legal grounds were insufficient. Requesting the favor of the publication of this explanation, we are

Yours respectfully,

G. P. PUTNAM'S SONS.

NEW YORK, *January* 9, 1882.

EDITOR'S TABLE.

THE PRACTICAL STUDY OF MIND.

THE progress of knowledge and inquiry is every day bringing into clearer practical contrast the two methods of studying mind: that which regards it as an abstraction, known only in consciousness, or the metaphysical method; and that which regards it as the endowment of an organic structure by which mental phenomena are determined, or the physiological method. The former refuses to recognize the corporeal substratum of mental effects as essential to its inquiries; the latter holds it to be the foundation of mental science. Both resort to introspection, or the study of psychical processes in consciousness, as a legitimate source of knowledge; but, while the metaphysician will go no further, the scientific

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psychologist holds that the material conditions of mind are of supreme importance to the understanding of its laws. To the metaphysician the brain is a thing of but little interest, which he contentedly leaves to the phrenologist, or he avoids it as opening the dangerous way to materialism; the mental physiologist is attracted to brain-studies because they open the way to the largest truth, because they elucidate the conditions of mental action, connect mind with character, explain individuality, and disclose the laws of improvement on the hitherto neglected side of human nature. Let us here note some of the differences in the practical bearings of these two methods.

If we take the phenomena of mental growth—certainly of great importance—we find that the metaphysician can give us but little help in treating it. Growth is primarily a biological conception, yet mind grows. But mental physiology, or objective psychology, taking into consideration the vital conditions, can deal rationally with psychical development. The subject of mental growth is at the root of education. To the metaphysical teacher, ventilation, exercise, clothing, and diet, as they are material concernments, are of but indifferent moment; while to the well-instructed psychological teacher they are the fundamental conditions of successful work. He knows that he can only cultivate the mind in accordance with the laws of the organism of which it is a part. To the metaphysician, mind is an independent entity in an upper sphere of being; to the mental physiologist, it is the activity of an organized mass of nerve-cells and filaments, charged with blood and carrying on processes of thinking and feeling under the laws of nutrition. If the organization is low, or perverted by hereditary taint, or if the blood is thin or impure, so that the nutritive processes are sluggish or enfeebled, he understands that the bodily growth will be hindered, and mental action correspondingly lowered in vigor.

Another illustration of the contrast of the two methods is furnished by the phenomena of insanity. To the metaphysician in all the metaphysical ages insanity was a sealed book, and by that method would have so continued to the end of time. And this, for the reason that the metaphysician can not or will not recognize in any adequate degree the dependence of psychical effects upon physiological conditions. He refuses to see that it is the brain which, in its health, carries on all the normal operations of mind. He will not have the mental and the corporeal united. He will not degrade the dignity of his subject by mixing it with base material considerations. Hence, of diseased mind and the causes and laws of its morbidity, he knew nothing, and could know nothing. It is to the physician, and not the metaphysician, to the anatomist who studied the structure of the brain, and to the physiologist who studied its functions, and the pathologist who studied its diseases, that we owe all our knowledge of that most practical of all subjects, irregular and abnormal mental action.

And now we have another interesting illustration of the contrast of these two methods of study exemplified in the able work on suicide of Dr. Morselli, noticed in our December number. It is there shown by multitudinous proofs, and it was illustrated in our notice, that the phenomena of suicide observe a regularity to which we give the name of law. But more than this, it is proved that suicidal regularity has an orderly variation—corresponding to variations of external condition—climate, season, country, age, sex, race, cultivation, and social circumstances. The question is, What is the nature of the relation? Nobody will pretend that it is accidental. Is it not, then, dynamic and causal?

Now, the metaphysician can do nothing with the problem, because his

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method of studying mind excludes the corporeal order. To him mind is an abstraction, mysteriously related to matter, but not coerced by it. Mind, he maintains, is free; matter is enslaved by law. Men accordingly kill themselves because they choose to—because they are free agents and depraved beings. On this view the facts can not be explained, and no science of the subject is possible. But, on the other hand, if we take all the elements of the subject into account, if we regard man in the light of common-sense as a unified being, and all mental effects, whether healthful or morbid, as determined by organic conditions, we are then able to understand why the laws of suicide answer to the laws of external phenomena. We can then see how suicide, though a mental phenomenon, may be due to physical causation. When we consider man as a sensitive organism, so delicately constituted as to be acted upon in a thousand ways by the complex and ever-varying forces of nature, it creates no surprise to find that the averages of self-destruction can be predicted from year to year, and even from month to month, in any country and at any season. If we put the concrete brain in the place of the abstract mind, the subject, though closed to metaphysics, is opened to science. For the brain, the most susceptible part of the organism, is liable to be disturbed and morbidly affected both by physical conditions and passional strains. No man now denies that insanity is a corporeal fact—a derangement of the action of the material organ of feeling and thought. We know that suicide is a marked accompaniment of the cerebral disorder of insanity. So marked, indeed, is it that, even where there is no other evidence, it is often held by coroners' juries that the act of suicide presumes mental derangement. But the morbidities of the brain have an infinite series of gradations. Their obscure initiations take the form of cerebral weakness, debility, exhaustion, accompanied it may be by discouragement, depression, and weariness of life, which may impel to suicide, or go on to confirmed melancholia. When we can sufficiently escape from metaphysical prejudice to regard mind as practically but brain activity, dependent upon healthy nutrition and all that that implies, it will mark an epoch in the progress of the science of human nature.

A NEW FEATURE.

We last month began a department under the title of "Entertaining Varieties," intended to be a modified form of the *feuilletons* which have served to increase the popularity and consequently the usefulness of many European periodicals. It will consist of readable miscellaneous fragments of all sorts, but it is not intended to limit it to mere fugitive things, as it may afford a place for continuous papers of a light and entertaining kind.

We are already able to promise something of this sort; and intend very soon to commence the publication of a series of sketches of peculiar interest, entitled

THE MOUNTAINS OF THE MOON;

OR,

TRAVELS AND ADVENTURES OF HAKIM BEN SHEYTAN.

TRANSLATED BY F. L. O., WITH NOTES BY THE TRANSLATOR.

Many strange things have latterly come forth from the recesses of Africa, but nothing more remarkable than these curious revelations. The new chronicle may be very apocryphal, but it is sure to be amusing, and will probably prove also instructive. Hakim Ben Sheytan, we are informed, was a Mussulman doctor of Tripoli, who accompanied a military expedition to the interior of Africa, and by some mischance, straying from his party, found himself in a coun-

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try inhabited by a curious race, called the *Monakas*, or the *Monga Fants*, a people distinguished by their wonderful proficiency in mechanical arts, but still more by their preposterous domestic habits, their singular ideas, and their strange superstitions. The curiosities of *Monakistan* rival the wonders of Houyhnhnm Land, and the narrative of the explorer abounds with incidents and graphic descriptions as well as with scientific intimations that throw a suggestive light upon the origin of the follies and vices of civilized life. The translator is widely known as an original, vivid, and fertile writer, who has the secret of making science attractive, and we venture the prediction that his work will mark a new stage in the history of entertaining literature.

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LITERARY NOTICES.

THE CONCEPTS AND THEORIES OF MODERN PHYSICS. By J. B. STALLO. International Scientific Series. D Appleton & Co. Pp. 313. Price, $1.75.

WE last month called attention to this work as one of the ablest in the series to which it has been contributed. It is not devoted to the extension of any branch of science, but is an inquiry into the validity of some of the conceptions which are commonly accepted as at the foundation of all science. It is therefore, as might be expected, a profound book. Dealing not with the operations or results of the special sciences, but with the laws of thought by which science is created, and showing how radical scientific conceptions require to be still further corrected and clarified, and presenting the case with a closeness of reasoning that can not be further compacted, the volume would be discouragingly difficult but for the perfect art of its exposition and the crystal clearness of its style. It is much easier to characterize this book than to analyze or review it. In a brief notice, we can convey only a general idea of its purpose, and this may perhaps be best done by referring to some of the circumstances in which it originated.

It may be proper to say that the author is a German by birth, and came to this country at about the age of seventeen. He was early familiar with science, and after his arrival in the United States, as we are informed, he lectured on chemistry for some years in an Eastern college. But he at length concluded to adopt the profession of law, and chose Cincinnati as his residence. Pursuing his profession successfully, Judge Stallo became widely known as a gentleman of scholarly accomplishments, of independent opinions, and liberal politics.

But he is also remembered by many as an author, having a number of years ago written a metaphysical treatise of such marked ability for one of his youthful years, that the most brilliant expectations were formed of his intellectual future. But as time passed, and nothing further was heard from him in the way of book-making, it was thought that he had abandoned his scholarly studies and, German though he was, had succumbed to the American passion for money-making. So much, at least, we have heard said by the disappointed admirers of his early work.

Yet Judge Stallo had neither lost his interest in philosophical studies nor relinquished their pursuit. Though business, public duties, and the care and culture of a growing family, had imperative claims, all his leisure hours were given with great assiduity to the work of systematic original inquiry—an inquiry, moreover, that was strictly in the line of his early intellectual efforts.

Our author has therefore not been idle. Yet there were obviously strong reasons connected with the nature of his investigations which compelled delay in the publication of his views. The task which he assigned to himself was not only one that involved comprehensive research and prolonged reflection, but it was the result of a profound revolution in his own mental history. Judge Stallo's two books, though separated in their dates by a generation of time, are far more widely separated in their ideas and purposes. They represent opposite schools of doctrine, opposite poles of thought, and different stages of mental growth in the race. The first was thoroughly metaphysical and the last is even more rigorously scientific. Judge Stallo has

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passed from one method of thought to another by slow processes of intellectual growth which required time as well as exertion, and he has pushed further on in the scientific direction and away from the metaphysical position than perhaps any other writer. How complete has been the revolution in his own mind is well illustrated by a passage in his preface referring to his former work.

He says: "I deem it important to have it understood at the outset, that this treatise is in no sense a further exposition of the doctrines of a book ('The Philosophy of Nature'—Boston: Crosby & Nichols, 1848) which I published more than a third of a century ago. That book was written while I was under the spell of Hegel's ontological reveries—at a time when I was barely of age, and still seriously affected with the metaphysical malady which seems to be one of the unavoidable disorders of intellectual infancy. The labor expended in writing it was not, perhaps, wholly wasted, and there are things in it of which I am not ashamed, even at this day. But I sincerely regret its publication, which is in some degree atoned for, I hope, by the contents of the present volume."

Having slowly recovered from his serious Hegelian attack and mastered in a very thorough manner the principles and methods of modern physical science, it was inevitable that Judge Stallo's attention should be forcibly drawn to the relations of these two systems, and to the question how far science is still dominated by the old metaphysical method. It is his opinion that the metaphysical influence lingers and rules in scientific thought to a greater degree than is commonly suspected. It is generally supposed that physical science, at any rate, has quite freed itself from the mischievous tendencies of metaphysical speculation, and that Newton's admonition to the physicists, "to beware of metaphysics," has been so effectually heeded that this branch of investigation may be taken as illustrating the true scientific method in its purity and perfection. The author of the "Concepts and Theories of Modern Physics" holds that this assumption is but partially true, and the present work is devoted to a comprehensive examination of what may be regarded as basal theories of physics, to the evidence that may be given of their errors, and to tracing out the metaphysical origin of these errors. We can not here do better than to restate his position as given by himself in the preface to his book: "It will be seen at once, upon a most cursory glance at any one of the chapters of this little book, that it is in no wise intended as an open or covert advocacy of a return to metaphysical methods and aims; but that, on the contrary, its tendency is throughout to eliminate from science its latent metaphysical elements, to foster and not to repress the spirit of experimental investigation, and to accredit instead of discrediting the great endeavor of scientific research to gain a sure foothold on solid, empirical ground, where the real data of experience may be reduced without ontological prepossessions. An attentive perusal of these pages will make it clear, I think, that this endeavor is continually thwarted by the insidious intrusion into the meditations of the man of science of the old metaphysical spirit. This fact having been established, it was incumbent on me to ascertain, if possible, its causes and, within the narrow limits at my command, to develop its consequences."

The first or introductory chapter of Judge Stallo's book is devoted to a statement of those theoretical ideas which are maintained to be fundamental in physical science. These involve the mechanical conception of the constitution of matter, or the atomo-molecular theory. A large number of the most authoritative writers are quoted, who agree that, in the language of Du Bois-Reymond, "the resolution of all changes in the material world into motions of atoms, caused by their constant central forces, would be the completion of natural science." The author sums up the doctrine as follows: "The mechanical theory of the universe undertakes to account for all physical phenomena by describing them as variances in the structure or configuration of material systems. It strives to apprehend all phenomenal diversities in the material world as varieties in the grouping of primordial units of mass, to recognize all phenomenal changes as movements of unchangeable elements, and thus to exhibit all apparent qualitative heterogeneity as mere quantitative difference."

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The second chapter is devoted to an exposition of the general principles of the mechanical theory, which may be very briefly summed up in four propositions, as follows:

1. The elementary units of mass being simple, are in all respects equal.

2. They are absolutely hard and inelastic.

3. They are absolutely inert, and therefore purely passive.

4. All potential energy, so called, is in reality kinetic.

In the next six chapters these propositions are taken up in their order, with the view of ascertaining to what extent they are consistent with each other, and how far they serve as explanations of the facts of scientific experience. It here comes out that there is a profound anarchy in the views of the ablest scientists regarding ultimate scientific questions. Judge Stallo discusses the accepted theories with great critical skill and logical force, showing their short-comings and contradictions, and proving conclusively that what is now most needed is a thorough-going re-examination of the grounds of what is currently regarded as established scientific theory.

The eight chapters of the work to which we here refer are worthy of being very carefully studied on their own merits as expositions and criticisms of scientific theory. But the author's analysis brings out a group of errors, of which he finds it necessary to seek the sources and parentage. This opens to him (Chapter IX) the interesting problem of the relation of thoughts to things, the formation of concepts, and the consideration of metaphysical theories. He then passes, in Chapters X, XI, and XII, to an examination of the character and origin of the mechanical theory, and points out successively how it exemplifies four radical errors of metaphysics. The nature of these errors we have no space here to explain, but the author shows that they extend much further in their vitiating influence than to the mechanical theory of the constitution of material nature. In Chapter XIII he still further develops the general argument by explaining how the same metaphysical fallacies that taint our theoretical physics have given rise to modern transcendental geometry and the new doctrine of space, with four or more dimensions. In Chapter XIV this subject of meta-geometrical space is pursued in the light of modern analysis, and by an examination of Riemann's celebrated essay upon this subject. The further ramifications of metaphysical error in science are then followed out in Chapter XV into cosmological and cosmogenetic speculations, with a consideration of the nebular hypothesis. Chapter XVI concludes the work, with a summary of important portions of the previous discussion, and some further interesting reflections on the present attitude of chemical philosophy.

In regard to the atomic theory in chemistry, Judge Stallo does not deny its usefulness as a graphic device for representing chemical and physical transformations. He recognizes it as "a fact beyond dispute that chemistry owes a great part of its practical advance to its use, and that the structural formulas founded upon it have enabled the chemist, not merely to trace the connection and mutual dependence of the various stages in the metamorphosis of 'elements' and 'compounds,' so called, but in many cases (such as that of the hydrocarbon series in organic chemistry) successfully to anticipate the results of experimental research."

But the convenience of hypothetical devices can not prove their truth. In the advance toward higher science, erroneous views are often the efficient instruments of progression. The history of science is full of the utilities of erroneous theory. Early astronomy, as so well shown by Whewell, was mainly developed by the help of the false theory of epicycles. Experimental chemistry, as pointed out by Liebig, originated under the influence of the false notion of the transmutability of the metals; while its later advances were largely due to the erroneous hypothesis of phlogiston. So the atomic hypothesis has carried it on still further, but this no more proves it to be true than it did the preceding hypotheses. The scaffoldings of construction, important, indispensable as they may be, are not to be identified with the edifice.

This scanty outline of the author's argument will serve only to suggest the nature of the problems with which he is engaged. The book must be read deliberately, must be studied to be appreciated; but the students of science, as well as those of meta-

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physics, are certain to be deeply interested in its logical developments. It is a timely and telling contribution to the philosophy of science, imperatively called for by the present exigencies in the progress of knowledge. It is to be commended equally for the solid value of its contents and the scholarly finish of its execution.

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THE FRENCH REVOLUTION. By HIPPOLYTE ADOLPHE TAINE, D. C. L., Oxon. Translated by JOHN DURAND. Vols. I, II. New York: Henry Holt & Co. 1878, 1881. 8vo. $2.50 per vol.

OF the three volumes which are to complete M. Taine's "French Revolution" two are now published, continuing the study which was begun in his preceding work on "The Ancient Régime." The two works form parts of a continuous series, which the author calls "The Origins of Contemporary France." Of this extensive subject M. Taine says that he has limited his treatment, primarily, to the consideration of its governmental aspects. In the work he tells us: "There will be found only the history of public powers. Other historians will write that of diplomacy, of war, of the finances, of the Church; my subject is a limited one."

What are the themes of the two volumes before us? Briefly: the first shows how "popular insurrections and the laws of the Constituent Assembly end in destroying all government in France"; the second, how "a party arises around an extreme doctrine, gets possession of the power, and exercises it in conformity with that doctrine." That doctrine was found in the generalizations of Jean Jacques Rousseau. The philosopher who generalizes must forget a great many facts. In a vein of delicate irony M. Taine says of his countrymen: "Almost all of them, more fortunate than myself, have political principles which serve them in forming their judgments of the past—I had none; if, indeed, I had any motive in undertaking this work, it was to seek for political principles. Thus far I have attained to scarcely more than one, and this so simple that it will seem puerile. It consists wholly in this observation: that human society, especially a modern society, is a vast and complicated thing."

In this order of M. Taine's method; in this limitation to a definite aspect of the phenomena presented; in this avoidance of stock conceptions; and in this perception of the infinite differentiation of the phenomena—we may already perceive that we have come upon something quite different, in the way of written history, from anything that the merely literary method ever presented. M. Taine has spared no trouble to get his facts at first hand. "The most trustworthy testimony is that of the eye-witness, especially when this witness is an honorable, attentive, and intelligent man, writing on the spot at the moment and under the dictation of the facts themselves—if it be manifest that his sole object is to preserve or furnish information." In the national archives M. Taine has had access to a great amount of manuscript testimony of this sort. On the other hand, the Jacobin documents, infinite in quantity, the vast masses of "polemics planned for the needs of a cause," of "eloquence arranged for popular effect," are worthless, except as they show the character of their sources; and yet they must be examined. "Never has so much been said to so little purpose. The historian may read kilometres of it, but he rarely finds one fact, one detail of interest, one document which calls up in his mind a physiognomy, the actual sentiments of either villager or gentleman, a graphic picture of the interior of an hôtel-de-ville or a barrack, of a municipal council-chamber, or of the character of an insurrection."

How has M. Taine applied his methods to the facts thus garnered? In the first place, he has grouped the events of which he treats according to their causal relations, and often, therefore, in anything but the close sequence of dates. Nothing has puzzled his critics so much as this feature of his treatment: his book has been much the worst stumbling-block in the path of the routine reviewers, American and English, that has fallen in their way for years. M. Taine is not now writing a school-book, with a new date for each new paragraph: he is writing for readers to whom a formal knowledge, at least, of the most important crises in modern history is a matter of course. To recite dates in sequence is, indeed, not only the schoolmaster's idea of history: it

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is the old, popular, easy way, which nearly all the English historians have followed until very recent times. In France, Montesquieu was probably the first great writer who saw that the schoolmaster's idea of history, as a series of dates, and the merely literary man's idea of history, like Carlyle's, as a succession of tableaux, were alike insufficient. Burckhardt, in his recent history of the "Italian Renaissance," seized the true idea; to discriminate, namely, the important lines of tendency in the given era, and to group the facts which bear upon each line, whether causally or consequentially. Burckhardt has pushed the method perhaps too far, making his work as much a group of essays as a history. But M. Taine keeps to clearly discriminable phases of the movements which made up the great Revolution; as indicated, for instance, in the book-divisions of these two volumes: I. "Spontaneous Anarchy"; II. "The Constituent Assembly"; III. "The Application of the Constitution"; IV. "The Jacobin Conquest."

We have dwelt thus long upon M. Taine's method because it is a feature which has been appreciated, so far as we know, by none of his critics in America—a country little given to historical studies; and, also, because that method is clearly associated with modern English philosophy. It remains to ask what M. Taine's conclusions are upon a theme which has occupied and baffled so many English historians before him.

As a visible thing the French Revolution began with the dearth of crops in 1788–'89. The "Reign of Terror" included the sixteen months from March, 1793, to July, 1794. The Revolution ended in October, 1795, with the suppression, by Napoleon, of the insurrection of the sections against the Convention. The present narrative includes the events of 1792. Under the old *régime*, two acres out of every five in France, as Voltaire expressed it, were in the hands of the clergy; and those two acres were generally the best of the five. A half of the peasant's earnings, or more, went to the church, the nobility, and the state. That was the substantial grievance which prepared the way for the Revolution. But other countries have had equally substantial grievances without any subsequent revolution. What, then, determined the Revolution of 1789?

By far the most important second cause, as a determinant, was a single book, Rousseau's "Contrat Social." That book was a triumph of the literary method in social science; it made the worse appear the better reason, and with such lucidity, such fatal persuasiveness, as even France had never known before. In a few words the orators—the mass of the people could not read—had made its principles familiar throughout France. The "Social Contract" defines the modern citizen by "eliminating the differences which distinguish a Frenchman from a Papuan, a modern Englishman from a Briton in the time of Cæsar. The resulting essence is very meager: it is 'a being with a desire to be happy and the faculty of reasoning'"—after Jean Jacques Rousseau. The French agitators consider the nation as composed of twenty-six millions of equal, free, and independent entities of this description, without obligations, institutions, or history; and free at any moment to make a social contract, *de novo*, of their own. Physical oppression, followed by this intellectual hallucination, disintegrated the most elaborate social structure of modern times. The fabric stood after it had lost the power to sustain itself, awaiting the first chance shock to topple it over. That shock was given by the failure of the crops in 1788, and the consequent half-starvation of the laboring-classes. The Revolution, begun in moderation, went rapidly on to madness; the power fell into the vilest hands. The general course of events is summarized in M. Taine's comparison as follows:

"A workman, overtaxed, in misery and badly fed, takes to drink. After a few years his nervous system, already weakened by spare diet, becomes over-excited, out of balance. An hour comes when the brain, under a sudden stroke, ceases to direct the machine; each limb, acting separately and for itself, starts convulsively. Meanwhile, the man thinks himself a millionaire, or a king; he sings and shouts; he drinks more than ever. At last his face grows dark; radiant visions give way to monstrous phantoms; he sees nothing but menacing figures, murderers ready to cut his throat. Then

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he makes a spring: in order that he may not be killed, he kills. No one is more to be dreaded, for his delirium sustains him; his strength is prodigious. . . . So France, exhausted by fasting under the monarchy, made drunk by the drug of the 'Social Contract,' and other fiery beverages, is struck by paralysis of the brain. She is about to enter upon the period of somber delirium. Behold her capable of daring, suffering, and doing all, capable of incredible exploits and of abominable barbarities."

It remains only to add that Mr. Durand's translation aims primarily at accuracy, but that he has preserved much of the effectiveness, also, of M. Taine's vivid style.

THE HARROWGATE WATERS: Data, Chemical and Therapeutical, with Notes on the Climate of Harrowgate. By GEORGE OLIVER, M. D. London: E. Lewis. Philadelphia: Presley Blakiston. Pp. 224.

HARROWGATE is a kind of British Saratoga, having within a district of two miles eighty medicinal springs, no two of which are alike, and some of which are asserted to be, both from a chemical and from a therapeutical stand-point, unrivaled elsewhere. For these, and for certain climatal advantages ascribed to the place, it is claimed to be far superior to all other English health resorts. The volume, which is addressed particularly to medical readers, aims to give a scientifically correct account of the qualities of the waters, the diseases they are good for, and the most efficient methods of application.

REPORT OF THE COMMISSIONER OF EDUCATION FOR THE YEAR 1879. Washington: Government Printing-Office. Pp. 757.

THE commissioner is able to report a continually increasing demand upon his office for information, the present demand being greater than ever before. The multitude of details embraced in the report do not admit of collation into a paragraph, and we can only refer to a few isolated facts. The colored schools numbered 14,472, and their pupils 700,360, of whom 1,933 were college and 903 were professional students. Normal schools were established in all the States except Delaware, Florida, and Nevada; and they sent out during 1879 3,347 graduates. The Kindergartens were increasing, but under private enterprise, while the attempt to introduce them into the public-school system was attended with embarrassment. The condition of scientific and technical schools was promising; and the institutions, having excited the people to an appreciation of scientific methods and processes in their application to agriculture and the mechanic arts, were rising in favor. Regarding original investigations and publications by professors in American schools, the commissioner remarks that "it is a matter of just pride that our institutions are extending their activities in this direction, and that their publications and their positive contributions to the progress of science receive honorable recognition from the scholars of other nations."

MECHANICS' LIENS, HOW ACQUIRED AND ENFORCED. A Treatise referring to and citing the latest Statutes and Decisions, and designed for General Circulation among Lawyers, Builders, Mechanics, and Owners. To which is added an Appendix of Forms. By JAMES T. HOYT, of the New York Bar. New York: P. F. McBreen. Pp. 310. Price, $2.25.

THE subject of this book is of immediate interest to every property-owner and every workman, for every owner's property may become the object of a lien, and the workman of nearly every class may be in a position to hold a claim of that nature. It is therefore important to both classes to be able to know what a lien is, under what conditions it may exist, and what is the law relative to it. This the book aims to tell, as briefly as is possible consistently with giving a satisfactory statement. The author has examined more than a thousand legal authorities on the subject, and has arranged the whole mass of information which he has collected covering the whole case, so far as has been decided, in chapters, each of which covers a particular department. The points are presented briefly and clearly, and each one is enforced by a reference to the particular law or decision by which it is made effective. The work has been prepared with especial reference to the city and the State of New York, but the principles it embodies are of general application.

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REPORT UPON UNITED STATES GEOGRAPHICAL SURVEYS WEST OF THE ONE HUNDREDTH MERIDIAN, in charge of First-Lieutenant GEORGE M. WHEELER, Corps of Engineers, U. S. Army, under the Direction of Brigadier-General A. A. HUMPHREYS, Chief of Engineers, U. S. Army. Published by authority of the Secretary of War. Vol. VII, Archæology. Washington: Government Printing-Office. Pp. 497, with 22 Plates.

THIS volume, which is put forth in a style and with a character of illustration worthy of the work to which it relates, and of the government under which the work is carried on, includes reports upon the archæological and ethnological collections from the vicinity of Santa Barbara, California, and from ruined pueblos of Arizona and New Mexico, and certain interior tribes, which have been prepared by Mr. Frederick W. Putnam, of the Peabody Museum, assisted by Drs. C. C. Abbott, S. S. Haldeman, A. C. Yarrow, and Messrs. H. W. Henshaw and Lucian Carr; and an appendix of Indian vocabularies, revised and prepared by Albert S. Gatschet. The vocabularies have been gathered from forty distinct localities, and are divisible into seven distinct stocks. The entire contribution represented by the book, says Lieutenant Wheeler, "has resulted from the incidental labors of members of several expeditions, and but points the way to a large and almost untrodden field of research among aboriginal remains."

ENGLISH HISTORY FOR STUDENTS: Being the Introduction to the Study of English History. By SAMUEL R. GARDINER, Hon. LL. D., Professor of Modern History in King's College, London. With a Critical and Biographical Account of Authorities, by J. BASS MULLINGER, M. A., St. John's College, Cambridge. New York: Henry Holt & Co. Pp. 424. Price, $2.25.

IN the first (Professor Gardiner's) part of this volume are considered the growth and development of English civil and political institutions from their origins; which origins, as the introductory chapter shows, are ultimately found at the beginnings of history. The principle is kept in view throughout that the bearing and meaning of every event are largely determined by the events that preceded it, and that it in turn exerts its influence on the events that follow. "By knowing this relation, the inquirer learns not merely what took place, but why it took place." Moreover, "the personalities of history are not merely figures flitting across a stage, of whom it is enough to learn the motives and the actions. They are themselves the result of causes which existed generations before they were born, and influence results for generations after they die." We can not, therefore, "study a generation of men as if it could be isolated and examined like a piece of inorganic matter," but must bear in mind that it is a portion of a living whole which is under observation. Professor Gardiner regards his part as really an introduction to Mr. Mullinger's account of authorities, which forms full half of the volume. It has been Mr. Mullinger's aim in this part carefully to distinguish the contemporary sources of information for each period from the sources of later times, and to supply, where practicable, such an amount of comment as will enable the student to form a fairly accurate notion of each author's value as an authority.

FIRST ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL SURVEY TO THE HON. CARL SCHURZ, SECRETARY OF THE INTERIOR. By CLARENCE KING, Director. Washington: Government Printing-Office. Pp. 79, with Map.

THE present report reviews the operations of the survey during 1879–'80 in the four geological districts into which Mr. King has divided his work, and which are described in the text and clearly defined in the map as the divisions of the Rocky Mountains, the Colorado, the Great Basin, and the Pacific. Special attention is given to some particular feature or features in each district, so that the report may be regarded as consisting in large part of monographs on Leadville, Lake Bonneville, the Uinkaret and Grand Cañon districts of Colorado, and the San Francisco, Eureka, and Bodie districts of California and Nevada, and the Comstock Lode, each by the assistant geologist in whose particular field the subject fell. Information of a general character respecting mining resources and industries has been derived from officers of the Census Bureau, whose co-operation Mr. King enjoyed, and is added to the special

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reports. A plea is made for the extension of the system of Government surveys over all the States—a step which political economists would deprecate, and which men of science are not disposed to believe would be of any real advantage to the cause they serve.

A MANUAL OF SUGAR ANALYSIS: Including the Applications in General of Analytical Methods to the Sugar Industry. With an Introduction on the Chemistry of Cane-Sugar, Dextrose, Levulose, and Milk-Sugar. By J. H. TUCKER, Ph. D. New York: D. Van Nostrand. Pp. 353. Price, $3.50.

THIS book supplies a want, there being no work in English that treats of sugar analysis, and only a few scattered and incomplete dictionary articles. Yet a great amount and variety of analytical work are required for the various interests connected with sugar, and it is not always convenient for the chemist to have to depend upon German and French treatises, numerous and good though they may be. The author, in endeavoring to fill this gap in chemical literature, has brought the matter up to the present time, and believes that he has given fuller treatment to some points than can be found elsewhere.

BOOK OF THE BLACK BASS: Comprising its Complete Scientific and Life History, together with a Practical Treatise on Angling and Fly-Fishing, and a Full Description of Tools, Tackle, and Implements. By JAMES A. HENSHALL, M. D. Fully illustrated Cincinnati: Robert Clarke & Co. Pp. 463. Price, $3.

THE author is regarded as an authority on the black bass, and is an expert angler. He has apparently embodied in this volume all the lore on the subject, giving the color of justice to the publisher's assertion that it is the most complete and exhaustive monograph ever published upon any game-fish. The fish itself deserves the most respectful treatment, for it is a game-fish of the highest order, is pre-eminently American, inhabits the whole United States east of the Rocky Mountains, except New England and the Atlantic waters of the Middle States, and is found also in Eastern Mexico. Its scientific treatment has hitherto been unsatisfactory, for different authors have not been able to agree as to whether there should be two or four or more species, in what the specific differences should consist, and what the names should be. The author gives one hundred and thirty-two pages to the consideration of what has been written on this subject, and adds his own views that there are two species, the large-mouthed (*Micropterus salmoides*) and the small-mouthed (*Micropterus dolomieu*), which are apt to sport into indefinite varieties. He gives his own descriptions of the fish and its habits, and fills half the volume with descriptions and suggestions respecting bass-fishing tackle, and the methods of fishing.

AN ARTISTIC TREATISE ON THE HUMAN FIGURE: Containing Hints on Proportion, Color, and Composition. By HENRY WARREN, K. L., author of "Artistic Anatomy," etc. Edited by SUSAN N. CARTER, Principal of the Woman's Art School, Cooper Union. New York: G. P. Putnam's Sons. Pp. 82. Price, 50 cents.

A MANUAL of suggestions, adapted to practical application, in one of the most important departments of art. The author seeks to point out errors in the present systems of drawing the figure—errors arising out of unconsidered conditions of placement and pose; to explain what is natural and what is merely conventional. Color and *chiaro-oscuro*, handling and manipulation, are touched upon. Generally, enough is attempted to set the student thinking upon the best means of economizing the time which he has at his disposal.

THE WANDERING JEW. By MONCURE DANIEL CONWAY, author of "Demonology and Devil Lore." New York: Henry Holt & Co. Pp. 292. Price, $1.50.

MR. CONWAY in this work considers the legend of the Wandering Jew in all the forms which it has assumed in different countries. As reasons for undertaking the work he offers: no other treatise on the same subject exists in our language; in the pamphlets that have appeared in other languages, the relations of the legend with Eastern mythology have been little considered, and its connection with Hebrew and Christian mythology almost ignored; and those studies of it which he has read consider it mainly as a curiosity. "But the

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subject," he adds, "as it appears to me, possesses a larger significance. Even the poems and romances it has suggested fail to render the still, sad music of humanity pervading the variations of the folk-tale itself." He regards the legend as a kind of a mirror, "wherein may be seen by reflection things that few eyes can look upon directly"—among them an aspect in which Christianity has appeared to believers of former generations. From the immediate subject he is led to a consideration of the character, condition, and probable destiny of the Jewish race and religion.

AN INTRODUCTION TO THE SCIENCE OF COMPARATIVE MYTHOLOGY AND FOLK-LORE. By the Rev. Sir GEORGE W. COX, Bart., M. A., author of "Popular Romances of the Middle Ages," etc. New York: Henry Holt & Co. Pp. 380. Price, $1.75.

THE purpose of this volume is to give a general view of the vast mass of popular traditions belonging to the Aryan nations of Asia and Europe, and of other tribes so far as the conditions of the subject may render necessary. Its starting-point, says the author, is the principle that "the popular traditions of no one Aryan people can be really understood except in their relations to those of other tribes and nations of the same family, and that the epical and dramatic literature of these races has been constructed from materials common to all branches of the Aryan stock, and furnished by popular sayings, stories, and tales, many of which have never had the good fortune to be more than the talk of nurses and children." An immense number of stories are condensed or referred to in illustration of these views.

PUBLICATIONS RECEIVED.

On the Temperature of Fresh-Water Lakes and Ponds. By Professor William Ripley Nichols. Boston: Press of W. H. Wheeler. 1881. Pp. 28.

Thomas Paine was Junius. Washington, D. C. 1881. Pp. 28.

Thoughts on the Psychical and Physical Forces Physiologically Distinguished. By A. H. Lanphear, M. D. From the "Transactions of the State Medical Society of Kansas." 1881. Pp. 21.

Primer of Logical Analysis for the Use of Composition Students. By Josiah Royce. San Francisco: A. L Bancroft & Co. 1881. Pp. 77.

The Stereoscope and Vision by Optic Divergence. By W. Le Conte Stevens. From the "American Journal of Science," November and December, 1881. Pp. 14. Illustrated.

On Wheatstone and Brewster's Theory of Binocular Perspective. By W. Le Conte Stevens, From the "Philosophical Magazine," December, 1881. Pp. 8. Illustrated.

Atlantic City as a Winter Health-Resort. By Boardman Reed, M. D. Philadelphia: Press of Allen Lane & Scott. Pp. 22.

Classification of the Dinosauria. By Professor O. C. Marsh. From "American Journal of Science." 1881. Pp. 6.

Circulars of Information of the Bureau of Education, No. 4. 1881. Education in France. Washington: Government Printing-Office. 1881. Pp. 144.

Address of the Hon. George B. Loring before the Cotton Convention in Atlanta. Washington: Government Printing-Office. 1881. Pp. 35.

Annual Report of the Chief Signal Officer of the Army for the Year 1881. Washington. 1881. Pp. 86.

Materia Medica as a Science. By J. P. Dake, M. D. Philadelphia: Press of Sherman & Co. 1881. Pp. 25.

The Genesis and Distribution of Gold. By Professor J. S. Newberry. New York: Trow Printing Co. 1881. Pp. 14.

The Electrician: A Monthly Journal devoted to the Advancement and Diffusion of Electrical Science. Edited and published by Williams & Co., New York. Vol. I, No. 1. January, 1882. Pp. 16. 50 cents a year.

Garrison in Heaven: A Dream. By William Denton. Wellesley, Massachusetts: Denton Publishing Co. 1881. Pp. 45.

The Names of the Gods in the Kiche Myths, Central America. By D. G. Brinton, M. D. Philadelphia: McCalla & Stavely. 1881. Pp. 37.

Proceedings of the American Society of Microscopists. Fourth Annual Meeting, held at Columbus, Ohio, August 9, 1881. Buffalo: Press of Bigelow Brothers. 1881. Pp. 102. Illustrated.

The Areas of the United States: The Several States and Territories and their Counties. By Henry Gannett. "Extra Census Bulletin." Washington: Government Printing-Office. 1881. Pp. 20. With Map.

The Verbalist. By Alfred Ayres. New York: D. Appleton & Co. 1882. Pp. 220. $1.

The Opium-Habit and Alcoholism. By Dr. Frederick H. Hubbard. New York: A. S. Barnes & Co. Pp. 259. $2.

The Origin of Primitive Superstitions. By Rushton M. Dorman. Philadelphia: J. B. Lippincott & Co. 1881. Pp. 398. $3.

The Science of Mind. By John Bascom. New York: G. P. Putnam's Sons. 1881. Pp. 462. $2.

New System of Ventilation. By Henry A. Gouge. New York: D. Van Nostrand. 1881. Pp. 173. $2.

Documents relating to the Colonial History of the State of New York. Vol. XIII. By B. Fernow, Keeper of the "Historical Records." Albany, New York: Weed, Parsons & Co. 1881. Pp. 617.

Suicide: Studies on its Philosophy, Causes, and Prevention. By James J. O'Dea, M. D. New York: G. P. Putnam's Sons. 1882. Pp. 322. $1.75.

Contributions to North American Ethnology. Vol. IV. Houses and House-Life of the American Aborigines. By Lewis H. Morgan. Washington: Government Printing-Office. 1881. Pp. 281.

Report on the Geology and Resources of the Black Hills of Dakota. With Atlas. By Henry Newton, E. M., and Walter P. Jenney, E. M. Washington: Government Printing-Office. 1880. Pp. 566.

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Value of Soil Analysis.—Professor E. W. Hilgard, in a paper in the "American Journal of Science," on "The Objects and Interpretation of Soil Analyses," accepts as correct the principle that, other things being equal, productiveness is, or should be, sensibly proportional to the amount of available plant-food within reach of the roots during the period of the plant's development, provided that such supply does not exceed the maximum of that which the plant can utilize, when the surplus simply remains inert. For finding the exact value of the soil from analysis, it is necessary, however, not so much to find the actual amounts of the constituents in the soil, as to find the amounts which are accessible to and assimilable by the plants. The problem is, then, to find a solvent which shall as nearly as possible represent the action of the plant itself. Analyses of European soils fail because virgin soils do not exist in Europe, and no generalizations can be drawn from the examination of any spot. In the United States we still have perfectly natural soils in nearly every part of our territory, with the original vegetation, which reveals so much to the farmer, still growing upon them. Professor Hilgard's method of analysis starts from the observation of the productive qualities of the soil as indicated by the native growth. He then tries to ascertain what are the peculiarities of the soil that favor this kind of growth, as distinguished from some other growth on some other soil. As a rule, a soil showing a high percentage of plant-food is fertile; but the converse is not always true; a soil having a low percentage is not necessarily poor. A loose soil, by enlarging the sphere of expansion of the roots may enable them to reach as large quantities of food, even when it is more widely scattered, as they can find in a more highly charged but more compact and less penetrable soil. Hence mechanical conditions should always be taken into account. The analyses so far instituted prove that, other things being equal, the thriftiness or present productiveness of a soil is measurably dependent on the presence of a certain minimum quantity of lime. The evidence on this point is "overwhelming." The lime operates by effecting the more rapid transformation of vegetable matter into active humus, by retaining the humus against the oxidizing influence of hot climates; by rendering minute percentages of phosphoric acid and potash effective; by a tendency to secure the proper maintenance of the conditions of nitrification; and, physically, by promoting the flocculation of the soil. After that of lime, the proportion of phosphoric acid seems to be the most important factor in the productiveness of soils. A certain percentage of potash is required, but it is present in most soils; and Professor Hilgard infers, generally, that "potash manures are not among the first to be sought for after the soils have become 'tired' by exhaustive culture." Iron, in the shape of ferric hydrate finely diffused, appears to be an important ingredient, valuable on account of its physical, and partly also of its chemical qualities. It has a high absorptive power for gases, and soils in which it occurs resist drought better than others; and the universal preference given by farmers to red lands shows the results of experience in this respect. The efficiency of the hydrate depends essentially upon a state of fine division; and when merely incrusting the sand-grains, or aggregated into bog-ore grains, it exerts little or no influence, although the analysis may show a high percentage. On the other hand, ferruginous soils are the first liable to damage from imperfect drainage, overflows, etc.

The Eocene Strata of Alabama.—Mr. Angelo Heilprin has communicated to the Academy of Natural Sciences of Philadelphia an effort to arrange the Eocene deposits of Alabama, determine their depth, and fix their relative position in the geological system. For this purpose he has given comparative reviews of the examinations of various exposures, including the Claiborne Bluff and sections on Bashia Creek, Clarke County, and at points on the Tombigbee River. The Claiborne Bluff was formerly considered to be near the base of the Eocene system, but it appears to be underlaid by the strata which crop out at other points, indicating a thickness of at least 200 feet, if not more, of Eocene de-

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posits beneath it, and a total thickness for the whole system in this region of nearly 400 feet; indeed, Dr. Smith, the State geologist, states that there are good grounds for supposing that tertiary beds exist in the northern part of the State, whose position would be 150 to 180 feet below the Wood's Bluff marl-bed, which is near the base of the Tombigbee beds. The Claibornian bed would then be placed in a position near the top of the series, a position almost precisely similar to that occupied by the Calcaire Grossier (Parisian) of France, and more properly Upper than Middle Eocene. The Alabama Eocene deposits are arranged on this scheme by Mr. Heilprin as follows: 4. "White Limestone" (Jacksonian), but exhibited at Claiborne (upper part of bluff) and at St. Stephen's on the Tombigbee (lower half of bluff), not very abundant in fossils, 50 or more feet; 3. The fossiliferous arenaceous deposit (Claibornian), but shown at Claiborne—subaqueous at St. Stephen's—very rich in fossils, and of the age of the "Calcaire Grossier" of France, 17 feet; 2. Buhrstone (siliceous Claiborne of Hilgard), comprising siliceous clay-stones densely charged with fossils or their impressions, laminated clays, sands, and calcareous deposits, about 250 or more feet; 1. The Wood's Bluff and Bashia deposits (with Cane and Knight's Bluff branches) (Eo-lignite), consisting of alternating dark clays, greenish and buff sands, and numerous seams of lignite, partly very rich in fossils, and, as far as is yet positively known, the oldest tertiary deposits of the State, 50 or more feet. The author intends to discuss in a future paper the relations of these deposits to those of other parts of the United States, and to correlate them, if possible, with the typical Eocene deposits of Europe.

Australian Snakes.—A correspondent of "Land and Water" relates some interesting particulars concerning Australian snakes and their peculiarities. Among the largest is the carpet-snake, or boa, which grows to be ten or a dozen, even eighteen feet long, and as thick as a man's leg, is destructive to poultry, sluggish by day, nocturnal in its habits, and of harmless bite. Most of the black snakes are highly venomous, and one, with a scarlet belly, is very handsome and active. The color of snakes depends upon the season when they change their skins. During the hot season the reptile is far brighter in tint, and far more active and poisonous, than when the temperature is low. The color also varies much with the habitat. Thus, the death-adder is nearly red in a red-soil country, black and gray in black soil, and brown on sand, and is exceedingly sluggish, trusting to the adaptation of his color to the ground he crawls upon for safety. Nothing is more remarkable about snakes than their extraordinary faculty of making themselves invisible. A large carpet-snake can hardly be seen, as he lies along a branch or coiled motionless in the fork of a tree whose bark exactly matches his skin in color. The green tree-snakes are invisible among foliage. "Take your eye for a moment from a snake among bushes or grass, and you will hardly ever see him again." Two yellow snakes lived in the correspondent's house, among the rafters or in the linings of the walls, where their presence was known by the casts of their skins which they left, for two years, without being seen or heard. Evidence of the existence of great numbers of unseen snakes is afforded by the multitude of tracks, which may be seen in the dust of a road following along a water-course. Snakes seldom advance to attack a man, but generally try to get away from him, and go toward him only when he is between them and their place of refuge. The Australian snakes, even the most venomous, can not fairly be called dangerous. The correspondent never knew personally of a case of a bite fatal to human life, though he has often seen the reptiles coil themselves round the legs of horses and bullocks, "with strong presumption in every case of a bite," but never knew of any injurious result. Many cats and dogs, however, learn to kill snakes, "but almost always end by missing their tip once, and fall victims to over-confidence in themselves"; and the blacks eat all sorts, whether venomous or not, provided they kill the former kind themselves.

Hawaiian Leprosy.—Dr. A. W. Saxe has lately made a report to the California State Medical Society on leprosy in the Hawaiian

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Islands, which is partly based on observations made during a visit to the leper settlement on the Island of Molokai in February, 1880. The Hawaiian leprosy does not differ essentially from the disease in Europe and Asia, but its history is known from its origin, and its development there may be traced with greater accuracy of detail than in other countries. It was introduced from China with the coolie-trade, and was first recognized in 1848. Its spread has been furthered by the peculiar habits of the people, particularly in eating, and their close association in their houses, and is contributed to by the exhaustion caused by the use of the intoxicant *kava*. To this may be added impure vaccination, which was practiced indiscriminately by all classes of people in 1852, and the prevalent licentiousness, which is hardly concealed. All observers agree that the disease is hereditary and that death alone ends it. It is established that it is a specific and well-marked disease—not a form of syphilis—that it exists in two varieties, the tubercular and anæsthetic, which may be distinct or associated, that it is not contagious, but is transplantable, and that men are more liable to it than women. The treatment has heretofore been merely palliative, the most useful drug in affording relief being the bark of the hoang-nan-tree. The most effective preventive of the spread of the disease is isolation. Few of the children born of leprous parents survive infancy and none survive adult age. Hence, is suggested the possibility of stamping it out if the lepers can be kept separated from the rest of the population. The population of the Pacific States are in no immediate danger from leprosy, but the increasing intercourse with China and the Sandwich Islands, combined with prostitution, offers a constant menace, and makes vigilance a duty.

The Real Discoverer of Spectrum Analysis.—Mr. Frank Cowan makes, in the "Pittsburg Telegraph," a strong presentment of the claims of the late Dr. David Alter, of Freeport, Armstrong County, Pennsylvania, who died last September, to be regarded as the real discoverer of spectroscopic analysis. Dr. Alter was born in 1807, and manifested at a very early age an interest in the study of electrical phenomena, and later in chemistry. He invented and perfected an electric telegraph in 1836, which, being more cumbrous than Morse's, and even than Wheatstone's, he never attempted to bring into use. He also invented an electrical engine, and published a paper on electricity as a motive power in 1837. His papers on spectrum analysis were published in the "American Journal of Science" in 1854 and 1855, five years before Kirchhoff announced his discoveries. The first paper, published in the number of the "Journal" for November, 1854, was "On Certain Physical Properties of Light, produced by the Combustion of Different Metals in the Electric Spark, refracted by a Prism." After describing the appearance of the light of the sky, of a petroleum-lamp, of a tallow-candle, the flame of alcohol, and the light from heated wire or charcoal as seen through his home-made prism, he gives accounts of the "separate colored bands" which he observed in the spectra of the sparks caused by the break of the galvanic or magneto-electric circuit, from points of silver, zinc, copper, lead, tin, iron, bismuth, antimony, brass, and combinations of metals. The second article appeared in May, 1855, and was "On Certain Physical Properties of the Light of the Electric Spark within Certain Gases, as seen through a Prism." This paper is explicit, and contains a paragraph suggesting the application of the author's discovery to the detection of the elements in the aurora borealis, shooting-stars, and luminous meteors. An abstract of the first paper was published in Liebig and Kopp's "Chemico-Jahresberichte" for 1854. The second article was reproduced entire in "L'Institut," of Paris, in 1856, and in the "Archives of the Physical and Natural Sciences" of Geneva, vol. xxix, p. 151. A full-page extract from it, containing its most suggestive statements, was also published in Kopp and Will's "Jahresberichte" for 1859. Kirchhoff announced his discovery in the year last mentioned.

Organic Remains in Meteorites.—Professor J. Lawrence Smith expresses a strong disbelief in the alleged discovery by Professor Hahn of organic remains in meteoric stones. He says that, although he has probably examined more microscopic plates of

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fragments of meteorites than any other person, he has never discovered anything like organic remains in any of them. Besides, he adds, "the well-known chemical composition of these bodies is averse to the existence of any such remains as are spoken of by Professor Hahn. Were these remains present, we should discover carbonate of lime in their interior. The two or three that have any carbonate of lime were discovered and analyzed by myself, and in those cases the carbonate of lime was an accidental constituent of incrustation deposited on the surface after their fall. In the microscopic examination of the polished plates of meteorites the two predominating minerals, enstatite and bronzite, will, by their fissures and forms, sometimes remind one of vegetable and other organic forms, but the merest tyro of an observer will trace here nothing but a rare resemblance. And, furthermore, the very igneous nature of these minerals precludes the possibility of organic remains, even in terrestrial minerals of a similar kind. Professor Hawes, of the Smithsonian Institution, who is familiar with lithological microscopical researches in Germany, agrees with Professor Smith, describes Professor Hahn as an observer whose "imagination has run wild with him," and regards his observations as not entitled to credit.

Obituary.—American science has lost during the last month two of its most distinguished names. Lewis H. Morgan, the anthropologist, died at his home in Rochester, New York, December 17th, of a complication of disorders, from which he had suffered for several months, at the age of sixty-three years. We have recently (November, 1880) given a sketch of his life, and his principal investigations and writings. His fame has been growing and the influence of his ideas extending for many years; and it has long been usual to see him quoted as an authority whose views were entitled to the highest respect, even when dissented from, in the anthropological discussions of all nations. Professor John William Draper, M. D., LL. D., died at Hastings-on-the-Hudson, January 4th. He was born near Liverpool, England, May 5, 1811, came to the United States in 1833, was graduated in medicine at the University of Pennsylvania in 1836, and began the connection as professor with the University of the City of New York in 1839, which he maintained till the end of his life. He assisted in founding the medical department of the university in 1841. He was closely identified with the progress of chemical science in the United States, particularly in connection with the investigation of the chemical action of light, and of the temperature of incandescence, and in the early history and development of photography. His most noteworthy works were his treatise "On the Forces which produce the Organization of Plants," which marked an epoch in this branch of investigation, and his "History of the Intellectual Development of Europe," which has been translated into nine languages. He also published books on "Human Physiology, Statical and Dynamical; or the Conditions and Course of the Life of Man," "Thoughts on the Future Civil Policy of America," the "History of the American Civil War," and a "History of the Conflict between Religion and Science," all of which have made their mark; and text-books in chemistry and natural history. A fuller account of Professor Draper's life and works is given in the "Popular Science Monthly" for January, 1874, and frequent references to his later labors may be found in subsequent volumes.

Influence of the Electric Light on Plant-Life.—M. P. P. Déhérain has just published the results of the experiments he conducted during the Exposition of Electricity at Paris, on the influence of the electric light upon vegetation. A conservatory was built within the palace, in which plants were disposed in four groups, each receiving a different treatment. One group was deprived of the light of day and was exposed to the electric light all the time; another had the diffused daylight, weakened by having to pass through the glass roofs of the Exhibition Palace, by day, and the electric light at night; a third group had only the diluted daylight by day and was left in the dark at night; and the fourth group, kept during the day in a shaded garden-bed, and was taken into the conservatory and exposed to

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the electric light at night. Some plants, which were taken into the conservatory a few days before the electric apparatus was put in operation, suffered badly from the deficiency of light—much more than the experimenter had anticipated they would. The plants that were constantly exposed to the electric light became marked with spots, and began in the course of eight days to give evidence of having received serious injuries. That the spots were caused immediately by the light and not by the disengagement of nitrous vapors, was shown by the fact that only the leaves and parts of leaves that were exposed directly to the light were touched. This satisfied M. Déhérain that the electric light contains rays that are detrimental to plant-life; and the facts indicate that these rays are the violet ones. A direct trial of the capacity of the electric light to decompose carbonic acid was made, with the result that less gas was evolved from plants continuously exposed within twelve feet of the light for several days than is given out in an hour in the sunlight. Plants that enjoyed the light of the conservatory by day and received the electric light at night, suffered less, but were not healthy. The electric light was inclosed in globes of transparent glass and a new set of experiments was instituted with new plants. The mischievous effects of the violet rays were no longer perceived, but the light was not capable of maintaining a healthy growth. The plants started well, but sent out long, thin shoots, which withered and died. Nothing but barley reached a condition near maturity. None of the plants would bloom; but some of them died at the top and took a new start from the root—to wither and die again. Continued experiments showed that these results were due to the lack of power in the electric light to promote the activity of evaporation required to bring the plants to maturity. The plants that were kept in the weakened, diffused light of the conservatory by day, and in the dark at night, fell into a gradual decay. Those that spent the day in the shade out-of-doors, and the night under the electric light, did better, but not much better, than they would have done if they had been left undisturbed out-of-doors. M. Déhérain concludes that the electric light has sufficient power to keep plants alive that would die in the dark, and that it exerts enough positive influence upon vegetation to account for the seemingly favorable results of M. Siemens's experiments, in which vigorous plants that had the light of day, and would have done well anyhow, were made to do better by being given also the electric light at night.

Word-Blindness.—M. Magnan, in a communication to the Société de Biologie, has related two cases of aphasia complicated with a special phenomenon, to which he has given the name of word-blindness. One case was that of a man who was seized with a right hemiplegia and aphasia after a fall. A month afterward, the patient recovered the power of speech, little by little: he understood spoken language; he wrote, of his own accord or from dictation, but was incapable of reading either print or manuscript, even when the latter had been written by himself; and he could not name letters written upon a board. The second patient presented similar symptoms. He recognized objects which were shown him, but could not name them; could write words thought or heard, but could not comprehend what was written. He had lost the notion of the value of gesticulations. A similar case is reported by M. Brunardel, in which a *post-mortem* examination revealed a disordered condition adjoining the pli courbé. The pathology of the affection is explained by supposing that the communications between the psychic visual center, which is situated about the pli courbé, and the convolutions of Broca, are interrupted. In such a case, the patient can still see, speak, and hear, but can not acquire any new idea through his eyes. "Brain" suggests that since no disease of the eye exists, and the affection is owing to a purely psychic phenomenon, it might be better described as "cerebral word-blindness."

Death of Dr. J. B. Davis.—Dr. Joseph Barnard Davis, an eminent British authority on skulls, died in May last, at about eighty years of age. He made a voyage to the Arctic regions as surgeon to a whaling-ship in 1820, while still a medical student, then settled down in the potteries of Staf-

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fordshire as an apothecary. An accidental conversation with a friend turned his attention to anthropological studies, on which he published several memoirs, more particularly relating to the craniological branch of the subject, the most important of which was perhaps the "Crania Britannica," containing delineations and descriptions of the skulls of the aboriginal and early inhabitants of the British Islands. He was an industrious hunter after specimens, and formed at his house a collection of crania and skeletons larger than the collections in all the public museums in the country put together, and which has been surpassed only in very recent years by any of the Continental collections. The catalogue of this collection, the "Thesaurus Craniorum," published in 1867, contains descriptions and many figures of the specimens, with twenty-five thousand measurements and a large fund of information. The collection was so much increased afterward that a supplement to the catalogue was published in 1875. The two works contained descriptions of seventeen hundred specimens. The collection has been transferred to the College of Surgeons of England.

Congresses of German and Austrian Archæologists.—The Twelfth Congress of German Archæologists met at Regensburg, August 8th, the members having, previous to assembling, visited a local collection of prehistoric and Roman antiquities, illustrating the history of the settlement of the Danube for two thousand years, and listened to an address by Professor Fraas, on the geology and history of Regensburg from its beginning. The report of the general secretary, Professor Ranke, gave a summary of the general progress of archæological science during the year, and referred especially to the exhibition at Berlin, and the publications connected with it, as having increased interest in the science; to Professor Fraas's review of the primitive history of the country in the Stuttgart catalogue; to the results of the Congress at Lisbon, and to the evidence that had been found, in the Iberian Peninsula and Hungary, of a distinct copper age forming a transition to the bronze age. The list of special publications was quite full, and included essays by Tischler, Voss, and Virchow, on sewing-needles, belt-clasps, treasures, and urns; of Liebe on a former submergence of Thuringia; of Mehlis on the discoveries at Kirchheim on the Eck, and the Hermundurs and Thuringians; of Rosenstein on the spread of flints through trade; of Fischer on the traffic in nephrite; of Oehlenschläger and Herzog on the cartography of the discoveries in Bavaria and Würtemberg, and of other writers on single objects of prehistoric research. The study of local names had been advanced by the labors of Buck in Swabia and Schulenberg in Brandenburg, and Voss has made special studies on formulas of incantation and the blessing of swords. Herr von Tröltsch exhibited a series of four elaborate maps of the archæological discoveries in Schleswig-Holstein, in which the several classes of rocks and relics were very distinctly indicated by colors. Professor Schaafhausen reported, upon the progress of the general catalogue of the anthropological material of Germany, that special catalogues of the collections in the principal cities and universities are already completed or in hand, and those of societies and private persons will be taken up next. After spending three days in listening to a series of interesting papers, the members of the association went to Salzburg to meet with their fellow-workers of the Austro-Hungarian Association. The sessions here were more lively, and were marked with greater interest than those at Regensburg, for they were characterized by free discussions of every topic, while the proceedings at Regensburg were confined to the reading of the papers. Count Gundiken Wurmbrand, President of the Austro-Hungarian Association, delivered the opening address, referring chiefly to the Etruscan relics found in Austria, the evidences of Celtic culture on the Danube, and the significance of popular ethnography in prehistoric research. The first day's session was occupied with a very lively discussion of the "Celtic question," that is, the question whether the later Germans were ethnologically identical with the earlier Celts, or whether the two were distinct stems. Other interesting discussions were those concerning the period of the mammoth, and concerning the diluvial human relics found in Stramberg. The reports of the German society stated that it now in-

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cluded fifty-eight local unions or groups, and about twenty-three hundred members.

Development of the Mammalian Foot.—Professor E. D. Cope has suggested as a result of his studies of the feet of the mammalia, that the reduction in the number of toes in the ungulates "is due to the elongation of those which slightly exceeded the others in length, in consequence of the greater number of strains and impacts received by them in rapid progression, and the complementary loss of material available for the growth of the smaller ones. This is rendered probable from the fact that the types with reduced digits are dwellers on dry land in both orders, and those that have more numerous digits are inhabitants of swamps and mud." The cloven-footed animals were mud-dwellers, as a few of them still are, and larger than the whole-footed ungulates; and "the mechanical effect of walking in the mud is to spread the toes equally on opposite sides of the middle line. This would encourage the equal development of the digits on each side of the middle line, as in the cloven-footed types." On the other hand, in progression on hard ground, the longest toe (the third) will receive the greatest amount of shock from contact with the earth, and there is every reason to believe that shocks, if not excessive, encourage growth in the direction of the force applied. The hinge between the first and second series of tarsal bones in cloven feet is also supposed to be the result of strains endured in walking in mud. The variations in the degree of development of the trochleæ, or the prominences forming the tongues of the tongue-and-groove articulations, in different mammalia, also seem to be dependent on the amount and kind of strain to which the limbs are subjected.

The Archæological Congress at Tiflis.—A very interesting Archæological Congress was recently held at Tiflis, which was attended by about eight hundred persons, nearly all from Russia and the Caucasus. Professor Virchow was the most conspicuous foreign delegate. Collections of stone and bronze antiquities and Georgian ornaments were exhibited from Russia, Kuban, and Ossetia, where great numbers of bronze implements, carved hatchets with spiral, zigzag, and animal ornaments, and religious objects belonging to some unknown worship, have been found in recent years. Count Ouvaroff made a communication on remains of the stone period—human skeletons, with stone and bone implements, perforated teeth of animals, and as many as two hundred jade (nephrite) hatchets, the first jade implements observed in graves in Russia, which had been found on the bank of the Angara River, near Irkutsk. In the discussion concerning jade that followed the reading of this paper, M. Moushketoff described the great monolith of jade over the grave of Tamerlane at Samarcand, which is 7·8 feet long, 1·5 foot wide, 1·2 foot high, and weighs about eighteen hundred pounds, or more than twice as much as the largest pieces of nephrite that have been found in bowlders. Professor Samokoff gave an account of his finds in the graves near Pyatigorsk, in the Caucasus. He excavated about two hundred graves belonging to the stone, bronze, and iron periods, and found in the larger graves bronze and stone implements, bones of sheep, and several split human bones that did not belong to skeletons. His conclusion that the Caucasians of the bronze age were anthropophagists was not concurred in by the majority of the Congress. Professor Virchow gave a lecture on the chief problems of the ethnology and archæology of the Caucasus. On the current opinion that the Caucasus was the highway for populations coming from Asia to Europe, he expressed some doubts whether the Caucasian passes could have been crossed by whole tribes at a time when communications were so difficult, and the ice-covering descended lower than now. It would be most important, therefore, to ascertain whether the first inhabitants of the Caucasus came from the north or from the south. He considered that the civilization which the antiquities found in Ossetia represent was far more recent than that discovered by Dr. Schliemann at Troy.

Acoustics in Architecture.—Mr. A. F. Oakey, the architect of the Cincinnati Music Hall, gives some valuable suggestions on "Acoustics in Architecture" in "Van Nostrand's Engineering Magazine." The most essential requisite to a good music hall or

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hall for public speaking is, that it should be, as to its dimensions, in harmonic proportions. By this is meant that the length, breadth, and height of the room should bear some simple, easily determinable proportions to each other; generally one corresponding with the commensurate ratio borne by the intervals between the tones of the musical scale, which is expressible by the numbers from one to six. Harmonic proportions may be represented by the combinations 6 : 2 : 3, 6 : 5 : 3, 2 : 5 : 3, 2 : 2 : 4, 2 : 3 : 4, or others as simple. Angles, being a disturbing element, may be obviated by adopting curved surfaces, but these must not be circular, for we should then have a whispering gallery, nor elliptical, for then the sounds would be concentrated in the foci; but they should be in the shape of a parabola having its focus very near the contour. The seats should rise toward the back of the room, to correspond with the tendency of the sound to rise with the ascending currents of air, and to prevent its being caught in the clothing of the audience. A system of ventilation should be adopted that will rather carry the sound toward the audience than in the other direction. When the amount of space for each person exceeds one hundred and ninety-five cubic feet, the walls and ceilings should be finished with resonant material; where the amount of space is less than this, the finish should present a repellent, hard, and unsympathetic surface like plaster, or like stone if the space is less than one hundred and fifty feet. The obstructions presented by the supporting-posts and the acute angular recesses of galleries may be avoided by constructing the gallery upon a system of curved iron supports beginning on the floor-line against the wall and rising with a gradual parabolic curve outward, the spaces between which should be filled in with wood or plaster surface. In the light of these principles, Mr. Oakey can "see no excuse for building an apartment so that its acoustic properties shall not be as much a matter of course as keeping out the weather." Mr. Oakey also considers the sonority of party-walls, for which he suggests furring, with lathe and plaster and the removal of the bearings of floor-joists from the walls, as cheap and efficient remedies.

Heat and Health.—A sufficiency of heat is one of the most essential requisites to health; and in the administration of heat we have one of the most powerful curative agents. The sun furnishes a constant supply of beneficial warmth, of which we make much less use than we might and ought. Indeed, we too often shun that which we ought to seek, as when we deliberately and at considerable cost darken the rooms into which we ought to welcome the sunshine, or carefully exclude its life-giving rays with umbrellas and parasols. The idea of a sun-cure, which was proposed by one of our physicians several years ago, was one of genuine merit, and has been strongly commended, after several years of observation in the East, by the late Mr. David Urquhart, M. P., and secretary to the British embassy at Constantinople, who has related many incidents illustrating its efficacy. Among them was that of a person who had been advised, at the baths of Gastein, to try air-baths in the neighboring forests. He received considerable benefit from lying undressed in the shadiest part of the forest, but finally concluded to expose himself in the full sunshine. Although he had always supposed that the rays of the sun gave him headache and derangement of the stomach, he found that when entirely exposed he was not unpleasantly affected in any degree, but felt agreeable sensations of genial warmth. If, however, he covered any part of his body, the disagreeable feelings returned, and the covered part became intolerably hot. Occasionally a pricking and itching sensation and redness of the skin suggested the suspension of the baths for a day or two. Dr. Scanzoni, of Wurzburg, explains the freedom under these baths from the pains in the head and stomach which commonly follow exposure to the sun by the fact that the action is diffused equally all over the body, and the circulation is determined in a corresponding manner, instead of being drawn in excess to the head. Dr. Gosse, of Geneva, wrote in 1826 in high praise of the curative properties of heat, which he regarded as working by restoring the action of the skin. The hot-air bath has been used for twenty years in the Newcastle Infirmary with satisfactory results, and has been introduced into several luna-

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tic asylums with most excellent effects in soothing and curing mania and the attendant diseases. Dr. Lockhart Robertson, of the Sussex County Lunatic Asylum, not only recommends it in those cases, but says that he has had several examples of its curative power in the early stages of consumption, and believes that, if used at a sufficiently high temperature, the results would astonish us all. Mr. Urquhart observes that a high temperature is more endurable when the heat is radiant than when it is brought in hot air-currents.

Association of German Naturalists and Physicians.—The fifty-fourth meeting of the Association of German Naturalists and Physicians was held at Salzburg, September 18th to 24th. The first secretary of the association, Dr. Günther, of Salzburg, in his address of welcome, mentioned the fact that Salzburg was the last place of retirement of Paracelsus; and that great physician and naturalist was the subject of a special address by Dr. Kirschensteiner, of Munich, at the closing session. The meeting was divided into twenty-three sections, eleven of which were medical, and seven pertained to natural science. Besides Professor Pettenkofer's paper on the sanitary relations of the soil, which we publish, Professor Weisman read a paper maintaining that in general the duration of life of an individual represents the minimum of time necessary to insure the existence of the species, and is governed by adaptation and heredity. Professor Meyners, of Vienna, in an address on the laws which govern human thoughts and actions, expressed the opinion that the phenomena of bodies do not disclose to us their essence, and that there is only a phenomenon of freedom of will. At the third general meeting, Professor Oppolzer, of Vienna, disputed the sufficiency of the theories of the moon, Mercury, and Encke's comet, based upon Newton's law of gravitation in its present form, and postulated the hypothesis of a cosmic matter surrounding the sun as necessary to complement them and make them sufficient.

Animals and the Telegraph.—M. Nielsen, director of the Norwegian telegraph lines, has just published a curious note upon the impressions that are produced upon animals by the vibrations of telegraphic wires. The posts in the neighborhood of the Norwegian pine-woods, even those which have been freshly impregnated with sulphate of copper, are frequently found to have been perforated by woodpeckers, which, it seems, mistake the humming of the wires for the buzzing of insects. The holes are generally made near the insulators, and a post shown at the Paris Electrical Exhibition had a hole clear through it large enough to insert the whole arm. Bears imagine the humming to be that of bees, and, not finding any sign of a colony above, paw at the heaps of stones at the base of the poles; and, when they can find nothing, vent their spite in a vigorous blow on the ground, to kill the bees that persist in staying hid. The scattering of the heaps of stones around the posts, which is not rare, could not be explained, till some one perceived the marks of the bears' claws where these desperate blows had been given. Wolves are believed to have been frightened away by the lines. While a vote was pending on a grant to a telegraphic line, a member of the Storthing remarked that, while his constituents had no direct interest in the line, they would support the grant, because the wires would drive away the wolves. It is said that, however hungry a wolf may be, he will never go into a spot that is inclosed by ropes stretched on posts. It is a remarkable fact that since the first telegraphic line was established, twenty years ago, wolves have never appeared in its neighborhood.

NOTES.

Professor W. J. Beal, of the Michigan Agricultural College, in a lecture on "The New Botany," gives a description of the old method of teaching that science that reads much like a burlesque—but which we know is too sadly accurate, for persons living have not forgotten how they "studied botany" when they were young—and then sketches the new way in a most attractive style. In the latter, "we study objects before books; a few short talks are given; the pupil is directed and set to thinking, investigating, and experimenting for himself. . . . Before the first lesson each pupil is furnished or told where to procure some specimen for study. . . . For the first recitation each is to tell what he has discovered. The specimens

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are not in sight during the recitation. In learning the lesson, books are not used, for, if they are used, no books will contain a quarter of what the pupil may see for himself." And the professor goes on to describe the particular features of his method in a manner that makes most interesting reading.

THE International Committee of the Red Cross (Geneva Convention) has offered prizes for three essays, designed to constitute a series, on "The Art of improvising Means for assisting the Wounded and Sick of Armies." The three essays will relate, respectively, to methods of treatment, means of transportation, and the improvisation of an ambulance or a field-hospital. The consideration of the subjects must be limited to improvisation, and have no reference to fore-prepared means of assistance. The processes suggested should be illustrated by designs when practicable; and the essays should be full, scientific works, not manuals, and should describe expedients that have been tried and tested for practicability. The papers, which may be in English, German, or French, should be sent in before the first day of April, 1883. The awards will be made by an international jury, and will include a prize of five hundred dollars for the best essay on each of the three topics, if worthy, and one hundred dollars to the unsuccessful competitors.

Two views are held regarding the relative age of the copper-bearing traps of Keweenaw Point, Lake Superior, and the Eastern sandstone: one, that the traps and sandstone are of the same age; the other, that the traps are an earlier formation (pre-Palæozoic), and the Eastern sandstone a later one (Palæozoic). Mr. M. E. Wadsworth, having carefully examined the relative position of the two rocks, finds that the Eastern sandstone underlies the trap conformably, "that is, as conformably as a bed can underlie a lava which has flowed over it," and that, therefore, it must be older in order of time, but of the same geological age with the copper-bearing rocks. Hence, the "Keweenawan series," which has been projected upon the theory that the copper-bearing rocks are the older ones, has no foundation. The balance of evidence in regard to the absolute age of the rocks appears to be with the views of Messrs. Whitney and Foster, that they are of the Potsdam age.

SEUBERT having observed that, in the periodic systems of classification of the metals of Meyer and Mendelejeff, platinum comes before gold, while the received atomic weight, 196·7 to 197·8, puts it after that metal, recently undertook the revision of its atomic weight. Having obtained the pure metal, by Schneider's method, he then, with pure potassium chloride and pure ammonium chloride, prepared the double salts by four methods. The mean value of eight experiments, corrected and reduced to a vacuum, gave 194·34050 as the atomic weight of platinum.

THE Peabody Museum of American Archæology and Ethnology has been forced for lack of means to suspend the explorations it had undertaken. Its last report, however, shows that it has done much good work and made many valuable acquisitions. The largest gift received during the year was a collection of Peruvian relics of all kinds, particularly rich in fabrics and garments, received from Dr. W. Sturgis Bigelow, which, added to the other Peruvian collections, makes this department an imposing one. Dr. Flint has brought from Nicaragua many copies of inscriptions on rocks and caves. Mr. Edwin Curtis has procured many thousand specimens, which are recorded in 1,431 entries, from the mounds of Eastern Arkansas. Numerous other hardly less important acquisitions are noticed. The museum has in press a work by Dr. Abbott, of Trenton, New Jersey, on "Primitive Industry, or Illustrations of the Handiwork in Stone, Bone, and Clay, of the Native Races of the Northern Atlantic Seaboard of America."

PROFESSOR DUFOUR has reported to the Helvetic Society of Natural Sciences an interesting observation of what he considers a new proof of the roundness of the earth, in the deformation of images produced on large surfaces of calm water. It may often be witnessed on the Lake of Geneva, and in the case of ships some miles distant at sea.

PROFESSOR M. E. WADSWORTH, of Cambridge, Massachusetts, recently expressed the opinion, founded on his observations in the region, that the amygdaloid cavities and veins in the Keweenaw Point district of Lake Superior had been filled, by the action of water percolating through the rocks, with mineral matter derived from the adjacent rock. Professor J. D. Dana traversed his view, holding that all changes in the rocks took place before the rocks lost their original heat, and were brought about by means of the moisture inclosed at the time of the eruption, acting generally in the vaporized state. Professor Wadsworth has reiterated his views, with a statement of his reasons for adhering to them, before the Boston Society of Natural History. He claims respect for them because they are derived from personal knowledge of the facts, while Professor Dana's views depend on the observations of others. The discussion involves the question of the extent to which water can permeate rocks.

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MR. WILLIAM H. JOHNSON, B. Sc., has described before the Manchester Literary and Philosophical Society, a series of experiments in the electrical resistance of iron and steel wire, from which he has drawn the conclusion that the amount of that resistance is a measure of the resistance of the iron or steel to tensile strain, and of the amount of combined carbon, sulphur, silicon, and phosphorus it contains.

THE course of instruction in natural history of the Academy of Natural Sciences, of Philadelphia, which was begun in the spring of 1881, was resumed for the present winter in the first week in January. Courses of from twenty-five to thirty lectures each will be given, with practical demonstrations in the laboratory, on "Physiography and Invertebrate Paleontology," by Professor Angelo Heilprin, and on "Mineralogy," by Professor Henry Carvill Lewis. Professor Heilprin's lectures embrace general considerations relative to various features of the earth's structure and history, and the geological and geographical distribution of past and present life, with special attention in the latter half to practical paleontological demonstrations and advanced instructions. Practical work, including the methods of distinguishing minerals by their external and chemical characters, and blow-pipe analysis, is a regular feature of Professor Lewis's lectures.

MR. FREDERICK CURRY, an English botanist, distinguished chiefly for his studies of the fungi, died September 8th, aged sixty-two years. He had been Secretary, and was at the time of his death Vice-President and Treasurer of the Linnæan Society. His valuable collection of fungi is to be presented to the museum at Kew.

PROFESSOR J. P. WICKERSHAM having been commissioned by the National Educational Association to inquire into the efficiency of education as a preventive of crime, reports that in the prisons of Pennsylvania, the colleges and high-schools are most insignificantly and the fairly educated classes only moderately represented, while one sixth of the crime of the State is committed by the wholly illiterate, who constitute only one thirtieth part of the population. He further concludes that about one third of the crime is committed by persons practically illiterate, and that the proportion of criminals among the illiterate is about ten times as great as among those who have been instructed in the elements of a common-school education or beyond.

M. PASTEUR has succeeded in communicating rabies by inoculation from the brain of a dog dead with the disease. He has also found that by trephining a healthy dog and placing in contact with its brain cerebral tissue from an infected animal, not only is the disease communicated with certainty, but the incubative period is in every case reduced to a few days.

THE Surgeon-General of the United States Army reports that the proportion of cases on the sick list of the army last year was 1,768 per thousand of mean strength among the white troops, and 1,984 per thousand among the colored troops. The average number at one time was 44 per thousand of white, and 45 per thousand of colored troops. About one sixth of the number of white and less than one seventh of the colored sick were cases of wounds, accidents, and injuries. The proportions of deaths to cases treated were 1 to 190 among the whites, and 1 to 97 among the colored troops.

M. FATIO explains the theory of disinfection by sulphurous acid by remarking that the vapors of the acid act in two ways on all organisms that depend on oxygen for life, viz., by asphyxiating them through suppression of that element, and by gradually burning them interiorly, the acid being dissolved in their humors or aqueous parts.

A CATALOGUE of the phenogamous and vascular cryptogamous plants of Indiana, prepared by the editors of the "Botanical Gazette" and Professor C. E. Barnes, names 1,432 species, grouped under 577 genera, and is published, though not absolutely complete, to provoke further additions. The flora of the State is divided into four groups, each marked by the physical aspect of the region in which it is found. The regions may be called the "the river-valleys" "the lake-borders," "the prairies," and "the barrens." The prairie plants are disappearing faster than any others under pressure of cultivation. The splendid forests that originally covered the greater part of the State are rapidly disappearing, and a new race of plants is springing up in their place. New species are continually appearing along the rivers and railroads.

ANOTHER prehistoric canoe has been discovered while digging in the old bed of the Rhône, near the bridge of Gardou, France. It is excavated from an oak-log, which has been left with its natural form, except that the ends have been beveled so as to give a sharp form to the prow and stern. Braces were left in hollowing out the vessel, to extend across the inside and strengthen the sides, and five pairs of holes were bored in the side, for oars. The boat is about thirty-eight feet long, three feet wide, and two feet deep, and would probably hold about twelve men. It was considerably decayed, and was somewhat broken in getting it out, but has been deposited in the museum of Lyons in a tolerably sound condition.

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SCIENCE AND THE WOMAN QUESTION.

By Miss M. A. HARDAKER.

ALMOST all social reforms are made top-heavy by a false philosophy. Facts are of easy accumulation, but the scientific rule of deducing no principle which facts will not prove gets but unwilling countenance from reform agitators. The reform philosophy which asks for the elevation of women admits an inferiority of position and power on their part, but at the same time claims that this inferiority is due to temporary causes. It bridges the broad gulf between masculine and feminine achievement by the excuse of a different environment. If the difference is, indeed, due to temporary conditions, it is, of course, removable by the removal of such conditions. It is the purpose of this paper to consider whether the difference (especially in intellectual power) of the two sexes is attributable to permanent or to temporary conditions. The nearest way of getting at this question is to attack it upon its physiological side.

Students of physiology see that a final and conclusive law can not yet be drawn from differences in brain-weights and measurements, because of the present imperfection of such data. But there is an even broader and better foundation from which to build up a conclusion, and I propose to stand on this more general ground. In order, however, that such physiological details may have due influence upon the general argument, I give a few of the best-established facts. Professor Bastian's work on the brain, published in 1880, sums up his studies of this organ as affected by sex. I condense or quote from him the following statements: "Difference of sex, in its influence over capacity of skull, is often greater than difference of race. . . . Difference of cranial capacity between the sexes increases with the development of the race, so that the male European excels much more

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the female than the negro the negress. The difference in the average capacity of the skulls of male and female among modern Parisians is almost double that between the skulls of the male and female inhabitants of ancient Egypt. . . . The general superiority, in absolute weight, of the male over the female brain exists at every period of development. In new-born infants, the brain was found by Tiedemann to weigh from 14½ ounces to 15¾ ounces in the male, and from 10 ounces to 13½ ounces in the female. The maximum weight of the adult male brain, in a series of 278 cases, was 65 ounces; the minimum weight, 34 ounces. The maximum weight of the adult female brain, in a series of 191 cases, was 56 ounces; the minimum, 31 ounces. In a large proportion the male brain ranges between 46 and 53 ounces, and the female between 41 and 47 ounces. A mean average weight of 49½ ounces may be deduced for the male, and of 44 ounces for the female brain." It is further given, on the authority of Gratiolet and others, that the male brain can not fall below 37 ounces without involving idiocy; while the female may fall to 32 ounces without such a result. All accepted authorities agree that the average male brain exceeds the average female brain in weight by about ten per cent. Professor Thurnam also adds, "The brain-weight of the male negro is the same as that of the female European."

Of *qualitative* differences of brain we know next to nothing; we can not study quality from the physiological side, but are driven to an appeal to the concrete products of brain activity. Yet it is most probable that we may at some time establish an exact correspondence between brain-substance and intelligence, as the size and condition of the lungs yield an exact measure of the breathing power, and as the contractile muscle of the heart measures the quantity of blood ejected at each pulsation. In the case of every other organ of the body we know that there is an ascertainable correspondence between size and condition, and the amount of work which the organ can do. Is there any good reason for making an exception of the brain? The plethysmograph (described in "The Popular Science Monthly" for July, 1880) measures the amount of blood sent to the brain in any particular process of thought, and records the exact time for each process. We shall, doubtless, some time find it to be as complete a physical impossibility for a small and simply organized brain to do a great amount of thinking within a given time as for a small heart to eject a large quantity of blood at each beat, or for small lungs to absorb large amounts of oxygen at each inspiration. Now, if we are not yet certain of the kind and degree of structural differences in the brains of men and women, we still have overwhelming external evidence of the existence of such differences. We have as much external evidence of the superior quality of the masculine brain as of the superior breathing power of the masculine lungs, or of the superior absorbing power of the masculine stomach. We do not examine a muscle to

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ascertain its internal structure. The weight which it will lift, or the distance which it will travel in a given time, is an unfailing index of its quality. If it were possible to collect all the results of the muscular activity of men, from the beginning of civilization until the present, and likewise all the results of the muscular activity of women for the same period, we should reason instantaneously, from these phenomena, to the superior quality of masculine muscle. We should need no resurrection of dead men and women to demonstrate the difference.

Let us now consider with more attention the general physiological law that quantity of power is in proportion to the size of the body. This brings us to the still more fundamental principle of the inseparability of matter and force. A large amount of matter represents more force than a small amount; and this law includes vital organisms as well as inorganic masses. Under proper conditions for test, the amount of power evolved by any vital organism is in direct ratio to the size and weight of that organism. This settles the question of *quantity* of power permanently in favor of man. The weight of all the men of civilized countries would exceed that of all the women by perhaps fifteen or twenty per cent.

Again, it is an accepted truth of modern science that all human energy is derived from the food, and is an exact equivalent of the amount of food consumed and assimilated. The amount of food assimilated by men exceeds the amount assimilated by women by about twenty per cent. This fact has popular recognition in the higher rate of board demanded for men. It inevitably follows that man, as a sex, representing more food-assimilation than woman, must represent more energy *of some kind*. If the collective weights and food-assimilating capacities of men should ever fall below those of women, there would follow a reversal of the present relations; but, while these two facts remain, it follows, with mathematical certainty, that the amount of power evolved by men must exceed that evolved by women. While man eats more, he will stand for more. It may be simply more muscle, but it must be more of something. Scientific students are rapidly coming to the conclusion that the human body is subject to the same laws of the conservation and transformation of energy which pertain to the whole material universe. Power is in direct proportion to size. The kind of power will depend upon the organization. Food converted into muscle will reappear as work; food converted into brain will reappear as thought and speech. We have a right to insist on the legitimacy of judging brain-power by brain-products. We value brains for thought as we value looms for manufacture. A barrel of brains is of no account, unless we can evolve from them a steam-engine or a poem. We have seen it hinted, in a recent essay by Dr. Bedell, of Chicago, that women probably possess a larger amount of actual nervous matter, in proportion to the

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size of the body, than men. Many external facts strengthen this theory. But nervous matter distributed over the body, in the form of threads and sensory ganglia, although it would certainly increase the amount of sensitiveness, by giving more nervous surface in proportion to the entire mass, would tend to create a preponderance of emotion over thought. Very strong probability is lent to this explanation by the liability of women to nervous excitement and disease.

Before dropping the argument from physiology, I wish to refer once more to the necessary relation between size and power. Let us suppose two cases for experiment. Let them be respectively that of a man weighing one hundred and fifty pounds, and that of a woman weighing one hundred and thirty pounds. These figures are not far from the average weight of man and woman. In the woman the digestive organs will be smaller; the absorbing surface will be less; the lung-surface will be less; the quantity of blood will be less (and here we may throw in the interesting physiological fact that the solid constituents of the blood of woman are rated about eight per cent less than in man—i. e., the watery ingredient is larger in woman). Now, if we suppose these two persons to be under similar and normal conditions, with each organ bearing a harmonious relation in size to every other—i. e., if the brain of the man have the same proportion to the weight of his body as the brain of the woman to the weight of her body—it inevitably follows (if both assimilate proportionate amounts of food in a given time) that more blood will be sent to the brain of the man within a given time than to the brain of the woman in the same time. Consequently, the man will do more thinking in an hour than the woman. Nor will the woman ever be able to overtake the man in the race of thought, any more than she can overtake him in the amount of circulation; for his brain is of exactly the same *quality* as hers, but it is larger.

In order to see more clearly the importance of the factor of *time* in this calculation, as well as to get a clearer understanding of the law of the transformation of energy, let us make the further supposition that a pound of bread is gradually converted into vital energy in both these organisms. In the first place, the capacity for mastication and deglutition will be smaller in the woman. She will not be able to swallow her pound of bread in the same time as will the man. But supposing that he gave her this advantage (since it would depend on his will), yet, when the pound of bread had been transferred to the respective stomachs, the smaller lining membrane of the woman's could not secrete as much gastric juice in a given time as the man's; and as she could make no gain in time from his generosity (for the bread would have passed beyond the control of his will), she could not possibly get her bread digested and absorbed in so short a time as he. His blood could furnish the intestinal juices, reabsorb them with the food in solution, and go about some other work, while hers, with just as much work

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to do and fewer hands to do it with, can not possibly keep pace with his.

If, now, we may further suppose this pound of bread converted into its equivalent of thought, it is evident that a pound of bread will represent as much thought in a woman's brain as in a man's; but, as her smaller organs refuse to assimilate as fast as his, the larger organism will have a permanent advantage over the smaller one in the element of time. Any other conclusion than the one just stated implies a contradiction of the established relations of matter and force, and there is a general historic corroboration of this idea in the actual record of sex activity. Women have done something of nearly everything that men have done, but they have come later and with smaller offerings. The time-factor is one which we are bound to include in casting up our column of probabilities for the future intellectual equality of the sexes. If our facts are reliable, and the reasoning correct, it must be admitted as proved that the factor of size has given man a superiority over woman, which he will always retain while he retains his larger body and brain. The absolute gain in time which his greater size has given him can not be set aside, unless he should cease to be the medium of transformation of energy, and should wait a few centuries for woman to overtake him, as he might have waited for her to swallow her pound of bread. But even supposing such an impossibility, and granting that she should once overtake him (in the factor of *time*), so that the two sexes could start fairly in the race of progress, the man would immediately dart ahead again by virtue of his larger size and consequently greater capacity for transforming energy. But any such supposition as an even chance for the two sexes must remain an absurdity. Unless woman can devise some means for reducing the size of man, she must be content to revolve about him in the future as in the past. She may resist her fate, and create some aberrations in her course, but she will be held to her orbit nevertheless.

The argument from physiology has still another element of strength. The perpetuation of the human species is dependent on the function of maternity, and probably twenty per cent of the energy of women between twenty and forty years of age is diverted for the maintenance of maternity and its attendant exactions. Upon the supposition that woman's mental endowment were exactly equal to man's, the amount diverted to maternity must be continually subtracted from it, so that any original equality of intellect would certainly be lost through maternity. This diversion of power would also occur in the years of highest physical vigor. This period in man is that of most active intellectual development, because the physical basis of intellectual energy is most abundant in these years. Consequently, his period of greatest intellectual gain corresponds to her period of greatest loss.

To make this position more intelligible, let us suppose the number of men and women in the world to be exactly equal. Let us further

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suppose them to be of exactly the same weight; and let us add the condition of exactly the same quantity and quality of brain in both. The one sex would have exactly the same capacity for transforming energy as the other, and this would be the ideal condition of things for which the reformers plead. But, so soon as a single child is born, a certain amount of woman's energy is transformed and imparted to a new individual. The development of the individual woman holds a constantly inverse ratio to the multiplication of the species. The maintenance of intellectual equality between the sexes is impossible, because it is only supposable by the creation of impossible conditions. If our original men and women, who were in all respects equal, had no offspring, the equality would continue for a generation, until the species should have disappeared with the death of the last of these hypothetical beings.

By reflecting that no such original equality ever existed, but that, on the contrary, a considerable physical superiority has been the possession of man from the beginning; by remembering that, in the perpetual struggle for existence, man's physical and intellectual faculties have been stimulated to the utmost in gaining the means of life for himself and for his weaker mate and offspring; and by considering how large an amount of woman's energy must be diverted from intellectual pursuits to the function of maternity—we see that the conditions of intellectual development are vastly in man's favor. We also see that the main features of these original conditions are permanent conditions of human life on the earth. Woman's inferior size and power will forbid her becoming the successful rival of man in the struggle for existence. Consequently, she will miss the powerful intellectual stimulus which this competition creates among men. Lastly, while society continues to exist, she will always be obliged to expend a large proportion of her energy in the function of maternity. All these enumerated and inevitable facts bear upon her chances of intellectual growth, and have a tendency to widen the intellectual gulf between herself and man. Mr. Darwin, in his "Descent of Man" (vol. ii, p. 313), after enumerating the causes which strengthened the differences in mental power of the sexes, adds, "It is, indeed, fortunate that the law of the equal transmission of characters to both sexes has commonly prevailed throughout the whole class of mammals; otherwise, it is probable that man would have become as superior in mental endowment to woman as the peacock is in ornamental plumage to the peahen."

It is not unlikely that the still imperfectly known laws of heredity have increased the intellectual endowment of the male, for Mr. Darwin finds a general law of transmission in the line of sex. If, too, we accept Mr. Spencer's proof of the inverse ratio between individuation and multiplication, we see that intellectual mothers will have fewer daughters than unintellectual ones; so that the chances of transmission

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of intellectual qualities in the female line will be lessened as culture increases among mothers. Accordingly, the intellectual tendencies which might have been acquired by the short and easy method of heredity will have to be acquired by the slower processes of application. This, again, will require the expenditure of a proportionately larger amount of energy in women than in men, supposing that men have a higher average of intellect through heredity. Moreover, the probabilities of marriage, or, at least, of early marriage, are lessened in cases of intellectual women; so that the chances are, not only that intellectual women will have few daughters, and so be unable to add to the general average of female intellect by sex-transmission, but also that they will be unable to add anything whatever to the sum of hereditary intellect in either sex.

Man has two powerful advantages over woman: the admitted superiority in the size and weight of body and brain, and the certainty of the continuance of conditions which insure that superiority, for the conditions of masculine superiority are the very ones upon which the preservation of the species depends. The necessary outcome of an absolute intellectual equality of the sexes would be the extinction of the human race. For, if all food were converted into thought in both men and women, no food whatever could be appropriated to the reproduction of the species. But, as an actual fact, women do not consume so much food as men; nor can they do so while their average size remains so much smaller. Moreover, of this smaller amount of food consumed by women some must always be spared for the continuance of the race; so that the sum total of food converted into thought by women can never equal the sum total of food converted into thought by men. It follows, therefore, that *men will always think more than women.*

Nevertheless, if it could be shown that the energy derived from food in men were an energy of inferior *quality*, women might gain a compensating factor in quality of thought. By the consent of competent judges, the reasoning power and the creative imagination are the highest and most complex forms of brain-energy. We have the most abundant evidence that, while man possesses both these powers in large amount and of superior quality, woman possesses them in much smaller amount and of inferior quality; so that the distinction of exceptional women, of whom a list could be made, would add little to the general low average of feminine power. We hear the power of *intuition* quoted as a higher one than reason. Women possess this power in a higher degree than men, and are sometimes rated above them in consequence of it. Very little study has been bestowed on this faculty, which has been the occasion of so much self-congratulation to women. But there is considerable evidence that it is acquired by heredity, that it is closely akin to instinct, and that some modification of it is the common possession of women, children, and the lower animals. It is possessed in

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a lower degree by men, but has escaped registration as a masculine trait. In his classification of the mental powers of the two sexes, Mr. Darwin puts observation, reason, imagination, and invention as those especially selected in man, and likeliest to be transmitted to male offspring. He also says: "It is generally admitted that with woman the powers of intuition, of rapid perception, and perhaps of imitation, are more strongly marked than in man; but some, at least, of these faculties are characteristic of the lower races, and therefore of a past and lower state of civilization."

MUSCULAR EXPRESSION OF NERVOUS CONDITIONS.*

By Dr. FRANCIS WARNER.

COARSE or extensive paralyses, such as involve one or both sides of the body, and other profound disturbances of the muscular system, have received much attention from clinical and pathological observers, and by the accumulation of their joint observations much knowledge has been gained as to the symptoms that result from lesions of the brain. This should encourage us to observe in all cases the conditions of the muscles, knowing that the movements correspond to certain states of the moto-centers, and looking upon such nerve-conditions as indications or expressions of the states of those centers. All expression of feeling is effected by muscular action, whether it be by words, by facial movement or gesture, movements effected by voluntary muscles; or expression may be produced by dilatation of the pupil, erection of the hair, or disturbed action of the heart, these being due to the conditions of inorganic muscular fibers. I have been accustomed to regard the nerve-muscular condition of "nervous cases," when seeking definite signs by which to describe them, in the light of the principle that movements depend upon nerve-muscular stimuli originating in nerve-centers. Examples may easily be given, showing how we commonly judge of the state of the nervous system by muscular conditions. Note the stooping attitude and spiritless gait of a tired man as compared with that of the same individual when rested and refreshed. Incipient intoxication is indicated by a reeling gait, unsteady hand, and muscular tremor. Expression may be indicated by the position of the head, which is seen firmly upright in defiance, drooping in shame; is commonly held on one side in nervous women and girls convalescent from chorea, the first example cited of an asymmetrical gesture. The artist's brush or pencil, the sculptor's modeling-tool and chisel, the pianist's and violinist's finger-touch, indicate the training

* Abstract of articles published in "Brain."

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and actual condition of the working of his brain. The educated and refined singer trains and refines his whole mind, i. e., his brain, and is well aware that his "whole soul," as he may express it, comes out in the action of the muscles concerned in producing his song and musical notes. In the infant the condition of the nervous system is best recorded in terms of nerve-muscular phenomena. It laughs, and is playful; reflex action is well marked when a finger is placed in the child's mouth. The eyes are moved and directed toward any object looked at; these are conditions of healthy action. It is well known that in the convulsive state the fists are often closed, with the thumbs turned in. All these examples of expression are nerve-muscular conditions; the movement, the attitude, the gait, result from states of the brain or spinal cord.

The normal movements of the eye are seen in the varying conditions of the pupil under the influence of light, in the changes accompanying accommodation for near and distant vision, and in the turning of the eyes in any given direction, a movement in which the parallelism of the axes of the organs is usually maintained. Each of these movements is supposed to be governed by a particular brain-center; and the convergence of the lines of the axis which takes place when the eyes are called upon to look at some very near object involves a complicated association of muscular conditions. The associated movements of the eyes may be completely lost in deep anæsthesia from chloroform, in coma from alcoholism, or in the profound sleep of infants. If, in an adult deeply under the influence of chloroform, the eyelids be gently raised, the pupils will be seen minutely contracted, often to a pin-point, the eyes having at the same time lost the parallelism of their axes. One eye may move upward or outward, while the other remains quiet, or moves in a different direction or at a different pace, thus causing a temporary and varying strabismus. Usually these movements are confined to the horizontal plane; less commonly the eyes assume a different level, one being in the horizontal plane while the other is turned downward. In these cases the coordination of the movements is restored with returning consciousness.

Loss of associated movements may sometimes be easily detected in very weakly infants while awake and sucking at the bottle, and in cases of meningitis and other conditions of coarse brain-disease; and sometimes appears to be chronic in paralyzed or partly paralyzed and idiotic persons. Many of the lower animals have the power of moving either eye separately and independently, a fact which leads to the suggestion that the brain-center that co-ordinates the movements of the two eyes may be looked upon as one more recently developed in the ascent of man.

In nystagmus, a disease in which the eyeballs oscillate rapidly, usually in an horizontal, rarely in a vertical direction, the parallelism of the axes is generally maintained. In one recorded case, the eyes were capa-

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ble of being turned slightly to the right, not at all to the left; yet, when an object on which the eyes were fixed at a distance was gradually brought close to the face, the eyes converged upon it, the right eye moving about fifteen degrees to the left to bring the line of its axis upon the object. Such an affection may be accounted for on Ferrier's theory by supposing that one of the brain-centers controlling the horizontal movements of the eyes had been destroyed. Most of the ordinary movements of the eyes in health are probably horizontal, and are least voluntary; and because they are very simple, and do not involve movements of the muscles of the eye, they are regarded as the least intellectual. The vertical movements are more complex, calling special muscles into play, and may, therefore, be considered more intellectual. From direct observation, it appears to me that intellectuality is represented by the movements of the eyeballs in their orbits. When an individual in looking at an object moves the eyes by the action of the recti muscles so as to direct them towards it, the movement is more intellectual than when the head is turned so as to direct the eyes in the required direction. A bright, healthy, well-developed infant turns its eyes well in the orbits in looking about; not so a dull, wasted child. Again, intellectual people usually move the eyes in their orbits in looking at any object; the low and vulgar often move the head in the direction required. The movements of the face, like the other forms of expression by muscular action, are generally symmetrical. Asymmetry is, however, seen in facial palsy, in sneering, and occasionally in the one-sided grimaces of very nervous people. Certain commonly marked lines in the face—horizontal and vertical lines in the frontal zone, the naso-labial grooves, the lines of the upper and lower lips, and the positions of the angles of the mouth—exist as the result of the puckerings produced by muscular action. Among the facial muscles, intellectuality appears to be most commonly expressed in the frontal and middle zones, and by the action of the corrugator and orbicularis-oculi muscles. It has been possible among out-patients to accept the facial appearance as a physical sign of mental as well as of physical and organic suffering. In cases where the muscular expression has been marked, some painful condition and some source of anxiety or mental distress has almost invariably been found. A person suffering from headache, or who "looks as if he had a headache," presents an appearance of depression, heaviness, fullness about the eyes, especially about the under eyelid; the orbicular muscle and adjacent parts are flabby, with the skin hanging loosely. If the patient can be induced to laugh, the muscle recovers its tone, the skin is tucked well in against the eyeball, and the appearance of depression or expression of headache is lost for a time. The life of the eyes is given, not by the eyeball, which is almost wholly lacking in expression, but by the conditions of the eyelids and of the muscles that move them, and in some degree by the muscles which

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move the eyeballs. The action of the muscles about the angles of the mouth is affected by a very moderate amount of brain disturbance. The value of the study of the nerve-muscular conditions of the face is finely illustrated in the case of the passive, expressionless face which may be woke up, "lighted up," made to express the whole soul in the face simply by conditions of the tension of the facial muscles resulting from the mental state. Thus, often, great and pleasing beauty is seen in faces unattractive when at rest. Conversely, some faces are beautiful in their passive condition, but lack expression and interest when in action from mental work; women having such faces talk but little. Surely from these two conditions it is suggested that the passive form and color of a face are qualities not so great, not so mind-indicating, as the mobile expressions produced by muscular tension.

Probably the most expressive of the muscles of the upper extremity are those that move the fingers, or which produce the "finer movements," motions in small arcs, as distinguished from the "coarser movements," or those that are made from the shoulder or the elbow. It is, of course, in the free or disengaged hand that we must look for examples illustrating the condition of the brain which governs it. If the muscles be employed in some definite act, such as holding an object, or in an act of manipulation, such as sewing, then the movements are directed to accomplish the aim attempted, and are not simply indicative of the condition of the brain, as may be the case with the free hand when unconsciously expressing the mental condition by gesticulation. When, on the contrary, the hands are left free and disengaged, as the hand of the orator, which unconsciously expresses by its position or movement the general mental state of the speaker, we have in this muscular movement an expression of the man's mind. It is as unreasonable to look for the state of the mind to be expressed in the position and action of the hand engaged in definite, voluntary, purposive acts, as to look in the face when the sun is shining full in the eyes, or the lips are engaged in eating, or other movements affecting the regularity of the breathing. Still it is true that in either case the manner of performing the act may be indicative of the mental state, but the muscles of the face or hand are not engaged in expressing the mental state.

In art of the present day we but seldom see the hands represented as disengaged; usually they are painted or sculptured holding some object, or resting on some part of the figure; such are hands engaged or resting from labor, or performing some act of toil, not engaged in expressing some action of the mind.

When a very nervous child, or one convalescent from chorea, holds out its hands in front on a level with the shoulder, and with its fingers spread out, we commonly see the nervous hand. As the palms are turned down, the wrist droops slightly. The metacarpo-phalangeal joints are moderately extended, the first and second internodes being

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either flexed or kept straight. The thumb is simply extended backward, and somewhat abducted from the fingers; and a twitching of the fingers is frequently observed.

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The energetic or powerful hand is the reverse of this, and is probably seen in life only under certain conditions of the mind, producing what we call "mental states," or states giving energy and the feeling of strength.

The most natural position of the hand is that of rest, and here analysis shows all the joints in flexion. The hand may be seen in perfect rest during sleep, or when the man is resting, engaged in quiet, unexciting conversation.

The antithesis of this is a hand in general extension or ortho-extension. The term ortho-extension is used to imply that the joint is so far extended as to place both the bones constituting the joint in the same straight line. If extension be full or complete, the bones form an obtuse angle with each other.

In the "ortho-extended hand," the axes of the metacarpal bones (hand-bones) and of the digits are in the same plane with the bones of the fore-arm, and the position is represented in which a strong man naturally holds out his hand when requested to put it forward. A healthy child, when it runs in its play or to meet a friend, commonly holds out its arms, the hands assuming the "energetic position"; and this, as the result of observation, is, I think, characteristic of a healthy, nerve-muscular condition; healthful children in pictures by the best masters are often thus represented. When a child is in a state of convulsion it is well known that usually the hand is closed, with the thumb turned in upon the palm, the fingers being flexed around it. Such a position of the hand in a child when ill is very indicative of a state of the nervous system predisposed to convulsions.

Equally characteristic with the passive positions of the hands are the muscular movements of the fingers—twitching, tremors, and rhythmical movements. These conditions have been more fully studied and described than the characteristic passive positions (postures), and they have long been considered as visible muscular conditions expressive of the states of the nerve-centers. The varieties of finger-twitching may be described as—1. *Flexor-extensor*, the primary movement being that of flexion, followed by a secondary extension movement. This may be seen in a variety of cases, and in particular is seen in what is called "picking the bedclothes" in the typhoid state preceding fully developed coma. 2. *Extensor-flexor*, the primary movement being that of extension, followed by a secondary flexor movement. This is common in the slighter forms of chorea and in nervous children; such twitches usually constitute the *subsultus tendinum* so indicative of exhaustion in the course of typhoid fever. 3. *Abductor-adductor* twitches, the movements consisting in lateral separations of the fingers, followed by their being drawn together again.

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The movements of the head—aside from those due to movements of the cervical spine—may be classified as those of flexion and extension; the bending forward and backward of the head; of rotation, in which the head remains erect; and of inclination or the depression of one or the other side. Flexion and extension of the head are of frequent necessity and physiological import; rotation is frequently necessary to move the eyes toward an object looked at, or to direct the ear toward a source of sound. Inclination is, I think, often of other significance: it sometimes indicates weakness, it is more frequently seen in young girls and weakly persons than in strong men. Inclination, with rotation to the same side, with slight flexion, is a position of the head very commonly seen in choreic girls, and then often accompanies an awkward, ill-balanced position of the spine. Inclination of the head, with rotation to the opposite side, and slight extension, is indicated by Sir Charles Bell in his figure in "Adoration." In seeking general information as to the signs of cerebral adequacy in an infant—that is, whether the infant has a good sound brain, probably capable of development—we always notice whether it can hold its head up, whether it usually keeps its head erect while sitting up.

Tooth-grinding, which is common in nervous children and among lunatics, champing of the jaws, and trismus, are signs of disordered conditions of the fifth nerve. The violent motions of the tongue seen in chorea and whooping-cough, the tremulous tongue of alcoholism and paralyses, indicate affections of the seventh nerve. Affections of the pneumogastric may produce palpitations, irregularities of organic action, the bronchial spasm of asthma, and functional aphasia.

It is a matter of very common experience that children and adult patients "hold themselves awkwardly"; stoop, or otherwise give the spine and trunk an ill-balanced position, due to want of nerve-muscular energy, and characteristic of the condition of exhaustion and weakness. Doubtless there is much expression in a torso; in many cases a weakly condition is indicated by a stooping attitude, with a lolling over to one side. It is difficult to indicate in precise terms the positions and movements of the spine, and perhaps this is one reason why so little is known about the action of the muscles of the back. With regard to the lower extremities, the gait and manner in walking may be characteristic of brain or cord disease. Conditions affecting the muscles of both lower extremities are usually dependent upon disease of the cord, and most of the signs by which spinal disease may be localized are derived from examination of the muscles of the legs. Reflex actions are also used as a means of localizing and ascertaining the condition of the nerve-centers, and here, again, visible muscular conditions are the indices.

The significance of the action of muscles as indicating brain conditions has long been dwelt upon by writers. Camper, who wrote in 1821, has shown that the Laocoön presents evidence of how deeply the

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ancients had investigated the influence of pain as expressed in the figure and the muscles. Further on he quotes from the words of Paulo Somazzo's work, "Dell' Arte della Pittura," published in 1531, a passage describing the influence of the passions upon the muscles of the face, and still more minutely the different postures and contortions of the body. John Bulner, in his work entitled "Significative Muscles of the Affections of the Mind," published in 1649, expressed the opinion that every motion of the mind is indicated by a corresponding motion of the muscles, saying: "When we assent, affirme, yield, grant, vote, confirme, confesse, admit, allow, or approve of a thing, etc., we are wont to nod or bend our head forward, the naturall reason of which motion in these, seems an approving, which is made by the Imagination, seeing, or hearing, somewhat done or said which accordeth very well, and this power remaineth in the Braine or forehead part of the head where in the cell and Seat of the Imaginations lieth. When any of these things give it contentment, suddenly it moveth the same, and after it all the muscles of the body."

There is in the subject before us a field for observation and description in which the artist and the physician may work together, observing and analyzing, with as much exactness as may be, the mode by which the varying conditions of the brain and mind are indicated to our eye, and may therefore be described by words, and by drawing or sculpture. We must study man in all aspects of the case, and when we see in the face, limbs, or body indications of his brain or mental condition, we should analyze and describe—first, the position of features and parts as we see them, then the muscles which produce those positions or movements, knowing that the muscular condition which has produced the movements or positions is the result of the state of the corresponding nerve-centers. It has been said that a man's face is an index of his mind, and this is true; for all the varying changes of expression in the face (except those of color) are due to changes in the facial muscles, and these solely depend upon changes in nerve-cells. The knowledge that we already possess of the nerve-centers is from observation of the condition of the muscles. In a given case, by comparing the state of the muscles during life as they may be affected with paralysis or spasm with the brain-lesion found after death, and by collecting and comparing many cases, it has been found that destructive or irritative lesions of certain parts of the brain cause paralysis or spasm of a certain set of muscles corresponding. It is probable, then, that by carefully continuing these methods of examination—that is, by describing with accuracy all states which are indicated by conditions of the muscles—we may add still more to our knowledge of the functions of different parts of the brain, and gain a further insight into the pathology of that large group of nervous centers termed functional.

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SIR CHARLES LYELL.

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SIR CHARLES LYELL.

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BY PROFESSOR GRANT ALLEN.

SIX years after Sir Charles Lyell's death, his sister-in-law, Mrs. Lyell, has given the world his letters and journals in two bulky but vastly interesting as well as really valuable volumes. The book is not exactly a biography in the ordinary sense, for the editor's part has been confined to a few stray connecting paragraphs of the baldest explanation; nor is it a deliberate autobiography, for Lyell was far too unobtrusive of his own personality to sit down and write at full length about himself; but it is unconsciously autobiographical for all that, consisting of letters extending over more than half a century, and enabling us to trace in minute detail the gradual unfolding of their writer's ideas. As a study in psychological evolution these volumes are invaluable; they set before us vividly the prior causes which produced Lyell, the environment which affected him, and the influences which molded or developed his inherent faculties. Their interest is thus rather social and personal than merely geological; it is Lyell the man, not simply Lyell the writer, that they paint for us with such graphic fidelity.

Whence did he come? What conditions went to beget him? From what stocks were his qualities derived, and why? These are the questions that must henceforth always be first asked when we have to deal with the life of any great man. For we have now learned that a great man is no unaccountable accident, no chance result of a toss-up on the part of Nature, but simply the highest outcome and final efflorescence of many long ancestral lines, converging at last toward a single happy combination. Whatever he possesses he has derived in the main from his ancestors, though he may possibly add some few elements himself by functional use; and it is not, perhaps, too much to say that the most richly endowed natures must necessarily derive many of their separate endowments from very different preceding strains. In Lyell's case the ancestral facts are clear and simple. His father was a Lowland Scotch laird, a man of cultivation and refinement, with tastes wide enough to embrace both literature and science. He was a botanist of some distinction, of whose researches into the cryptogams Humboldt himself spoke with favor; and later in life he became an enthusiastic Dante scholar, collecting every known edition, and publishing numerous translations from the Florentine poet. Thus the father already foreshadowed the special combination of tastes to be found in the son. His mother came from a good Yorkshire family—the Smiths of Maker Hall, in Swaledale—and we can well believe Mrs. Lyell's statement that she was a woman of sound sense, for all her children seem to have inherited more than their father's share of

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intellect and vigor. Charles was the eldest of ten, having two brothers and seven sisters. All were able, but he was the ablest. The first-born of a wealthy and cultivated family, with ample means and ample leisure, endowed by nature with literary and scientific potentialities, brought up in the stimulating atmosphere of his own home, of Oxford, and of the London literary world, surrounded from his childhood upward by men of science and men of letters, it would have been strange if Charles Lyell had not turned out exactly such a man as we all know him to have been. He was predestined for his work by the inevitable forces of his own constitution and the environing society, and he was admirably fitted beforehand for the work he had to do.

"Unencumbered research," as Mr. Sorby calls it, is, in fact, the key-note of Lyell's history. Like most other of our greatest scientific generalizers, he was brought up in an easy position, which enabled him to devote his life to science alone, without troubling his brain about the often absorbing question of the bread-supply, that wastes the best years of so many lives fit for better things. He came to us from the eighteenth century. CHARLES LYELL was born at Kinnordy, in Forfarshire, his father's estate, on November 14, 1797. But the real home of his childhood was Bartley Lodge, in the New Forest, which his father leased for twenty-eight years shortly after Charles's birth, though the family often returned for a time to Kinnordy as their summer quarters. The fragment of early autobiography which Lyell wrote years after for his future wife gives us some pleasant glimpses of the boy's life among the big trees and shady avenues of the Hampshire woodland. He felt the charm of nature and the open air from his childhood upward. He knew every clump and every single tree in the park, and to each one he gave a separate name. At Old Sarum, whither he used to go on half-holidays from his school at Salisbury, he loved already to break the flints from the chalk to see which had crystals of chalcedony in the middle, and which had white cores of sparkling quartz. Even then, before he was eleven years old, he had taken to collecting beetles and butterflies, finding out their names from the entomological books in his father's library. This free life in the New Forest must have formed such a preparation for his future work as could have fallen to the lot of very few boys in England; nowhere else, perhaps, in this over-tilled kingdom could he have formed so just an idea of what Nature left to herself is like—though even the New Forest looks but an artificial thing, after all, beside genuine native primeval woodlands. Moreover, he luckily escaped the conventionalizing and stereotyping drill of our public schools; he was never put through one of those dismal mills for crushing out individuality, into which we turn most of our best material, so as to grind it down to the Procrustean measure of Ovidian elegiacs and Æschylean trimeters. He went to three small private schools, first at Ringwood (close to home), then at Salisbury (where

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"we had the very best boys in Wilts, Dorset, and Hants"—a touch of a sort that dies out of his letters or journals with the course of time), and finally at Midhurst, in the very heart of the Weald of Sussex. He was thus spared the brutal influence of "compulsory football," which would have been substituted for the pursuit of nature in a modern public school. His tutors, indeed, shook their heads at his solitary ways, but they only gently hinted that they were unmanly. Our enlightened modern head masters would have severely reprimanded him for "loafing."

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On the other hand, the boy's school-training laid the foundation for that wide and general culture which was afterward so markedly to distinguish him, even among the cultivated scientific men of his own time. The danger of becoming a narrow specialist, with no eye for anything on earth except the last rare thing in ammonites, was obviated in great part by the direction given to his natural tastes at Midhurst. He "had a livelier sense than most of the boys of the beauty of English poetry," he tells his wife, long after. "Milton, Thomson, and Gray were my favorites, and even Virgil and Ovid gave me some real pleasure, and I knew the most poetic passages in them." Scott dazzled his boyish fancy as he dazzled all the world while the present century was in its teens; and when a school competition was proposed for the best English verse in the ordinary heroic decasyllabic couplets, Lyell Senior boldly sent in his copy in the metre of the "Lady of the Lake," and won the prize, too, in spite of innovation attempted and rules openly infringed. Some burlesque Latin hexameters which he wrote about the same time lingered in his memory till past middle life—an epic suggested by the Batrachomyomachia, and devoted to the draining of the play-ground pond, much infested by predaceous water-rats. Such things are small in themselves, no doubt; every promising lad of literary tendencies at every big school has done the very same in his time, without setting the Thames on fire, after all; but they are valuable as marking the specific admixture which made Lyell something other in after-life than the mere bone-hunter or snail-catcher of scientific societies. Heaven forbid that our future geologists should all be cast in the uniform mold of the classical tripos!—but there was a certain tinge of the humane letters about these *savants* of the last generation which relieved them from the chilliness, the austerity, and the want of human interest that many people notice as a defect among the average scientific men of the present day.

At seventeen—young even for those days, I fancy—Lyell went up to Oxford. His college, Exeter, was still almost exclusively a west-country one, and west-countrymen were not popular nor remarkable in the university for polished manners. He tells his father a mythical story how some Devonshire man at Exeter was asked by the examiners, "Who was Moses?" "Moses," says the examinee, "I knows nothing about Moses; but ax me about St. Paul, and there I has 'ee."

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Good evidence how long provincial prejudices lingered in Oxford, as they still linger about the Jesus Welshmen and the Balliol Scots. The letters from college (anno 1817) are amusingly old-fashioned in their eighteenth-century echoes. They are written stiffly in the literary style of the past generation, with Horace deliberately dragged in, thus:

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"Hunc varum distortis cruribus."—*Sat.*

But we are gainers hereby in the end; for Lyell's epistolary style, thus developed, was very different from the hasty manner of the present day, based upon the post-card and the telegraph-form.

It was at Oxford, too, that Lyell discovered geology, hitherto to him a *terra incognita*, or, rather, *inopinata*. He attended Buckland's lectures, and seems at once to have been converted to the new love, the insects being henceforth almost entirely deserted, or, at least, relegated to the second place. One of his long vacations was spent at Yarmouth with the Dawson Turners; and already we see the theory of "causes now in action" fermenting in his eager brain. He visits the alluvial delta of the Yare, finds evidence of ancient channels blocked up by the shingle which so diverted the course of the river, learns that Norwich was a great port in mediæval history, and, putting two and two together, comes to the natural conclusion that the changes in that part of the coast were very recent, and were due, not to one of the then fashionable cataclysms, but to river-silt still in course of deposition. "Cromer, Bakefield, Dunwich, and Aldborough," he says, "have necessarily been losing in the same proportion as Yarmouth gains." The bent was there even at this early date; and it is the bent that makes the man. The old drastic cosmogony was trembling to its fall; the germs of evolutionism were already in the air. Catastrophes, special creations, deluges, and the rest, though backed by the great name of Cuvier, had had their day. Lyell was to be one of the first to discover the cumulative value of the infinitesimal. From the first, his thoughts pointed in that direction; and though he did not know to what grand results the system was to lead us in the hands of Darwin—though, indeed, he was slow to accept the results when flashed upon him too dazzlingly at last—yet it is interesting to observe how throughout he keeps a keen eye upon all the crude theories that make in the same way, such as that of Lamarck, who from the beginning exercised an obvious fascination upon his kindred mind.

Toward these final results Lyell's own work led slowly up. Perhaps it is not too much to say that in future ages, when the origin of the great uniformitarian system of interpreting nature is looked back upon with impartial eyes, four prominent names will stand out as representative of the evolutionary movement in the judgment of posterity. The first is that of Laplace, who applied it to the origin and development of sidereal systems; the second is that of Lyell, who applied it

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to the origin and development of the surface of our own planet; the third is that of Darwin, who applied it to the origin and development of the phenomena of life; the fourth is that of Herbert Spencer, who applied it to the origin and development of the phenomena of mind, besides working up all the scattered elements of the system into one complete and harmonious whole. To pretend that Lyell stood up to the level of the other three would be passing the love of biographers: his work neither required nor engaged such high synthetic powers as theirs. But, without the first two, the revolution accomplished by the last two could never, perhaps, have been successfully carried out.

While at Oxford, too, general culture is not neglected. We find Lyell criticising Mr. Coleridge's new poem of "Christabel," writing some mild verses of his own on Staffa, which he had just visited with his father (better mild than none), and not quite successfully trying to take an interest in his tutor's lectures on the Ethics, where every Oxford man can surely afford him the most heart-felt sympathy. In 1818 he made a vacation tour through France, Switzerland, and Italy, observing and learning much, and interesting himself in art and society. He sees the Dranse in flood, and pores over the pictures of the Pitti Palace and the domes of Venice. Coming home, he went in for classical honors, and took a second in 1819. In after-life he evidently regretted the sort of teaching he had got at Oxford as much as most other men do; yet it left some good effects, apparent enough in all his subsequent work.

Law was to be his profession: so he went to Lincoln's Inn and made a beginning of reading. But luckily his eyes were weak, and he was sent abroad again for a trip to Rome. Here he devoted himself to the Forum Romanum and the Vatican, and left no time for geology —good education for his future work. Next, he is back in England, and down at Romney, with a friend. What luck for one of his bent: Yarmouth and Romney, the two great modern districts of England, the exact places to see geology now at work under one's very eyes! Here comes one of the jarring passages again: "The back door, opening into the farm-yard, betrays [his friend's father] to have been the farmer turned gentleman, not the gentleman turned farmer. How short and direct is the road through Eton and Oxford from the grazier on Romney Marsh to the fine gentleman!" But even here the better nature comes out on second thoughts—"or, to speak plainly, to the real gentleman in ideas, manners, and information." In the earlier letters there is a good deal of this sort of thing—talk of "good company," "my father's head livery-servant," and so forth; but we are still in the year 1822, and great allowances must be made for the son of a Scotch laird, living in the midst of the Tory society of the Regency, and hardly daring to trust his own native Liberal promptings. In politics he was Liberal from the first, though never a sound Radical; and in social matters the tone of his letters widens out steadily

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with time, till after his first American trip he comes back, say his friends, "*ipsis Americanis Americanior.*"

Lyell's was a life of smooth success. It is wholly wanting in anything like plot-interest, because all honors came so easily to him. In the year in which he took his degree he was made a fellow of the Linnæan and Geological Societies. In 1823 he became secretary of the latter. Already he is a fast friend with Buckland and Mantell; and his sisters are his helpers in keeping his museum and the confidantes of his scientific theories or discoveries. About this time he makes many journeys to Paris, becoming familiar not only with French as a language, but with such men as Cuvier, Humboldt, Brongniart, and Constant Prévost. He mixes in all the best *salons* of that shameful period. Some of his letters are guarded, lest he should be "treated like Bowring, with the Bastile"; but, when he gets a chance of sending a sheet or two otherwise than by post, his pictures of the faithless, cynical, bigoted, irreligious Paris of the Restoration are vivid and graphic in every line. Humboldt confides to him his notions about Cuvier, who has dabbled in "the dirty pool of politics":

His *soirées* are mostly attended by English (says Humboldt); the truth is, the French *savants* have in general cut him. His continual changing over to each new party that came into power at length disgusted almost all, and you know it has been long a charge against men of science that they were pliant tools in the hands of princes and ministers, and might be turned which way they pleased. That such a man as Cuvier should have given a sanction to such an accusation was felt by all as a deep wound to the whole body. And what on earth was Cuvier to gain by intermeddling with politics? . . . You well know with what contempt the old aristocracy of all countries are apt to regard all new men of whatever abilities. *We* feel that but too much in Germany; but *here* it is a principle of party to carry such prejudices to the utmost length. Cuvier's situation was a proud one while he stood in the very foremost rank of men of science in France; but when he betrayed the weakness of coveting ribbons, crosses, titles, and court favor, he fell down to the lowest among his new competitors.

However, after saying so much at second-hand, Lyell adds his own opinion that Cuvier is more liberal and independent than most Frenchmen. He dares to speak well of Napoleon, the sun that has set:

We must not forget (he says) that Baron Humboldt and he are the two great rivals in science, for Laplace and the mathematicians do not come in contact with them. Humboldt's birth places him on the vantage-ground; and Cuvier perhaps tries to compensate this by a little political power. As for his *ratting* so often, *defendit numerus;* what French politician could throw the first stone at him? Humboldt's family is noble and ancient in Germany; his elder brother a man now in great power there. His talents entitle him to regard with the contempt which he expresses, and I have no doubt feels, mere rank; but we may say of him, as Chateaubriand said of our English peers, that he is well aware that, while he gets too liberal, he is in no danger of losing the station and the advantages which his birth insures for him.

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The young English visitor saw all that was worth seeing in this profoundly rotten society. Making every allowance for good introductions and a less crowded stage of European life than ours, the ease with which he got to know everybody seems nowadays almost incredible. At the door of the observatory he meets Laplace, "a very fine-looking old gentleman"; and he is shown over the building by Arago in person. Madame Pichon, a famous beauty, who sat for Gerard's "Psyche," admits him to her *salon*. Férussac shows him all his snail-shells, and tells him some things about geology that he did not know before, together with many baseless theories, which his good sense cavalierly rejects. He sees something of the intriguing great world, too; some of the chameleon-colored politicians, the scheming *abbés*, the fashionable Ultras, and the still more fashionable Ne Plus Ultras, as he once calls them. "Every other man one meets is either minister or ex-minister. They are scattered as thick as the leaves in autumn, stratum above stratum." He is full of interest, too, in social and political questions; writes with acuteness anent the system of subdividing the land, discusses the centralizing tendency introduced by Napoleon, and is keen about the pensions bestowed on Pairs de France by the Bourbons *durante bene placito*—a gift which, he says, neither blesses him who gives nor him who takes it. As yet he has done nothing serious in the way of book-making; but who would exchange such preliminary training as this for the very best and carefullest field drudgery of the mere cut-and-dried technical geologist?

However, he was not idle all this time. On the contrary, he was running up and down and to and fro upon the face of the earth, inspecting its crust everywhere, with an eye to future results; and to run to and fro was of course a far more difficult thing in the twenties than it is in these later days of easy locomotion. His letters are full of his observations taken in on the spot. Now he is down in the Isle of Wight, examining the cliffs from Compton Chine to Brook, and surprised at the careless way Buckland "galloped over the ground"—"he would have entirely overlooked the Weald clay if I had not taken him back to see it" (clearly what satisfies the Bridgwater treatises and the dean in the way of research will not satisfy this very heterodox young man); now he is investigating the tertiaries of the Paris basin at Bas Meudon; and now again he is down at Lyme Regis, classic land of geologists, watching Mary Anning, the self-taught fossil-finder, unearthing the skeleton of a "superb ichthyosaurus." Every letter almost teems with new facts or discoveries; and Lyell's ears are open for everything new in the geological line from the ends of the earth inward.

In 1825 his eyes had so far recovered that he was called to the bar, and went the Western Circuit for two years. He was but a dabbler at the law, however, and fortunately never gave up to the Queen's Bench what was meant for mankind. In 1826 he was elected to the

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Royal Society, ætatis twenty-nine. A year later, his review of Scrope's book on Auvergne, in the "Quarterly," clearly showed the line that he meant henceforth to adopt. He came forward as the champion of the views set forward by Hutton and Playfair—views which he was to modify profoundly, to make his own, and to stamp with the seal of universal scientific recognition. About this time he conceived the plan of the "Principles of Geology," his first epoch-making book. Shortly after, he went abroad with Murchison to France and Italy, collecting material for the great work. His letters home bristle with amusing sketches of his Sicilian experiences, for Sicily was then even more impassable off the grand route than it is now; and he often had to rough it in strange quarters. He has a keen eye for the ludicrous side of things, and tells many odd stories of men and manners. "This, signor," says his cicerone once, "is the wife of Pompey the Great, named after Pompeii; she is weeping her husband's death, who was killed at the siege of Troy." At Girgenti he sees "a droll sight. Fifteen orphan boys were paraded before the statue stark naked on a windy day, and then clothed by the bishop in the name of the king." He has time, too, besides climbing Etna, and noticing such things as the signs of the rise and fall on the famous temple at Pæstum, to look at Giotto's frescoes, and to observe much about men and politics. At the end of his tour he writes from Naples to Murchison (who had not accompanied him so far):

> My work is in part written, and all planned. It will not pretend to give even an abstract of all that is known in geology, but it will endeavor to establish the principle of reasoning in the science; . . . that no causes whatever have, from the earliest time to which we can look back, to the present, ever acted, but those now acting; and that they never acted with different degrees of energy from that which they now exert. I must go to Germany and learn German geology and the language, after this work is published, and before I launch out into my tables of equivalents. . . . This year we have by our joint tour fathomed the depth and ascertained the shallowness of the geologists of France and Italy as to their original observations. We can without fear measure our strength against most of those in our own land, and the question is whether Germany is stronger. They are a people who generally "drink deep or taste not." Their language must be learned; the places to which their memoirs relate, visited; and then you may see, as I may, to what extent we may indulge dreams of eminence at least as original observers.

It is a great thing that Lyell was able thus to devote himself entirely to his work, and to spare no expense or trouble that would render him more competent rightly to perform it. "I shall never hope to make money by geology," he said; and again, "I will waste no time in book-making for lucre's sake." To travel everywhere and see everything with his own eyes was his great idea: "We must preach up traveling, as Demosthenes did delivery, as the first, second, and third requisites for a modern geologist." In 1830 the first volume

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of the "Principles" came out, and immediately achieved a marked success. No sooner was his book published, than he was off to the Pyrenees, and dashing down in his impetuous way into Catalonia. Here he mixes up in his letters the volcanoes of Olot and the salt-mines of Cardona with much amusing chat about the peninsularity of the Spaniards and the odd people he met *en route*. On his way back through France, he comes across the tail-end of the Revolution of 1830. At Perpignan he sees the cross removed from the cathedral, and hears a bystander indulge in the exquisitely French reflection: "*Chacun a son tour; le bon Dieu a eu le sien.*" Next year he is off to Germany, inspecting the volcanic region of the Eifel. About the same time he accepts the professorship of Geology in King's College, offered him by three bishops, who knew not what they did; for Conybeare vouched for his orthodoxy. Even then Conybeare must have been satisfied with very little. Lyell did not keep the chair, however, as it interfered with his schemes of traveling and original research. So he returned immediately to his tours, much to the ultimate advantage of science, and no doubt to the great satisfaction of the hesitating episcopal triumvirate.

During all these bachelor years Lyell was daily mixing with the most cultivated society of the time. In every letter half a dozen well-known names catch the eye at once. On one page, he is dining at Craig Crook Castle with Francis Jeffrey, "a great treat," and meeting "Mr. Maculloch, who gave the celebrated lectures on political economy in town last summer, which I attended"; on another, he is breakfasting at Lockhart's with Sir Walter Scott, "a far more genteel-looking man than Phillips has represented him in his portrait"; and on a third, he is at Cambridge, playing whist with Copley, Master of the Rolls, afterward Lord Lyndhurst, and chronicling only "a stiff bow" from highly-aristocratic young Lord Palmerston, who must then have been strangely different from his later easy-going self. Mrs. Somerville was always a close friend, and he even chaperones her to a Sunday evening "At Home" at Sir George Phillips's, where they meet Yankee novelist Cooper, politico-economical Mrs. Marcet, ethical Mackintosh, poet Rogers, Benthamite Dumont, Conversation Sharp, Sir Walter himself, and a dozen other assorted notabilities. Sir John Herschel, too, was an equally early ally, to whom many of the letters are addressed. Lyell is very catholic. He goes to hear Paganini, not enthusiastically; and then he goes to kirk to hear Chalmers, and retains enough of the Scotchman about him to characterize the sermon as "a very long discourse, but admirable." This catholicity comes out in far stronger relief in his letters than even in his published works, which stick comparatively close to the matter in hand. One sees it over and over again in such little touches as his first notion that he might write the "Principles" as conversations on geology, in the form of "a dialogue like Berkeley's 'Alciphron,' between equals." How many geologists of

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the new school have ever heard of the 'Alciphron,' or even know Berkeley in any other way than through one eternal quotation from "Don Juan"?

In 1831 the journal written for his future wife begins, so that we may conclude he was then or thereabout first engaged. In 1832 he married. His wife was a daughter of Leonard Horner, and a lady of tastes very similar to his own. Perhaps one may hint that all the ladies of Lyell's family were a trifle more learned than all the world would care for: it must have been rather a strain to live up to such a constant stimulation in the home circle; and most men would hardly wish to fill their letters to their wives with highly interesting details of dip, strike, and horizon. But this is a matter of personal taste. Lyell seems to have been one of the giants who can stand such incessant high pressure; and he was probably all the happier for his well-assorted marriage. He himself seems strongly to have believed that bachelorhood was not good for the cause of science.

The summer of 1834 was spent in Scandinavia. Lyell was delighted with all that he saw in this new field. "There is much doing here which is unknown in England and France," he writes from Copenhagen. "I am more than ever struck with the extreme slowness with which science travels, what with multiplicity of languages, *douanes*, etc." If even Lyell felt this, though he spoke English, French, and Italian fluently, German well, and Spanish a little, how much must it stand in the way of lesser people, with smaller means and narrower accomplishments! After seeing Denmark from top to bottom, he crossed to Malmö and Lund, and did the Peninsula pretty thoroughly. At Stockholm, Berzelius took him in hand and gave him the cream of all he knew; at Upsala, it seems a strange link with the infancy of science to read that the daughters of the great Linnæus himself showed him over their father's garden. Conversation was limited to German, eked out, when needful, with Latin, which Lyell often found of service as a *lingua franca* in out-of-the-way places; but educated Scandinavians usually speak English so well that even the most helpless foreigner is seldom at a loss. He seems to have been as pleased with the peaceful and simple descendants of the wickings as most other people, and to have returned to Scandinavia with special pleasure on future visits. In 1837 he took his wife with him, and made further investigations on the geology of the Baltic basin, which stood him in good stead in his later works.

Naturally, as he grew older, after the "Principles" and the "Elements" had made their mark, he became an authority, and saw even more of the best intellects of the time than before. His correspondence with Mr. Darwin—not yet the apostle of evolution—seems to date from this period, and the allusions to London society crowd more and more thickly on every page. The tone, however, remains unchanged. Not a trace of narrow specialism anywhere. We get long accounts of such

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events as a party at Milman's, where Rogers and Whewell discuss Pope, and where Milman gives the fresh opinion of a contemporary on Macaulay's "Bacon." To follow him in all his wanderings after the age of railways would be impossible: a run across to Spain, Italy, or Scandinavia, seemed to him merely an ordinary bit of his week's work. In 1841, however, he took a more ambitious trip across the Atlantic to lecture at the Lowell Institute, and then traveled through much of the United States and Canada. Geologically, he was deeply impressed by the great scale of the phenomena he saw, the vast lakes, the enormous glacial deposits, the immense subterranean forests; socially and politically, the trip left lasting effects upon his tone of mind. Singularly unprejudiced to start with, he met American society frankly and cordially, and judged both its merits and defects with somewhat lenient impartiality. But his kindliness was not the result of mere unobservant and uncritical good nature. He kept his eyes open, as usual, to all the main sociological factors, and rightly remarks that many Englishmen set down much to American political institutions which is really due to American circumstances—abundant land, free elbow-room, and constant European immigration, often of the poorest and most ignorant class. On the other hand, when he crosses the border at Niagara, he sees the weak points of the colonial system on the north of the Great Lakes keenly and acutely:

> You and I would hear more in good society here (in Canada) in one week (he writes to Leonard Horner), which we should consider narrow-minded and prejudiced and ungenerous to foreigners, in matters of politics, religion, and political economy, than we heard in nine months in the United States; for they have here all the Kleinstädterei of a colony and the enmity of the borderer, added to everything that you might disapprove of which they bring from home.

This is less true now than it was then, but there is still much truth in it; and it is painful to think that we have condemned Canada to such a poor and petty mock-national existence for forty years longer, since Lyell wrote, merely for the sake of our own meaningless imperial claim, which nobody ever seriously means to assert, but which everybody pretends to believe is vastly important. The interesting thing to note here, however, is the fact that Lyell should have come to so definite and just a conclusion after only a few weeks' sojourn in a new country. It is one of the many proofs of his keen practical penetration which lie scattered over every page of his memoirs and journals.

Perhaps the chief visible results of this first American trip was the formation of a close friendship with Mr. Ticknor, of Boston—a member of the well-known publishing firm—to whom many of his letters are henceforth addressed. They are among the most interesting he ever wrote, containing expressions of broad general opinions, which would hardly be needed in writing to European friends. Some of

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them are very characteristic at once of his wide tolerance and his marked tendency toward conciliation and compromise. For example, he writes once:

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The time may be nearer than some think, when we shall have all sects endowed, which I trust will happen, instead of none being so. But, at all events, I abhor the political disaffection created in Ireland, Scotland, and England by the exclusive privileges of Church of England ascendency. It is really the power which is oppressive here, and not the monarchy, nor the aristocracy. Perhaps I feel it too sensitively as a scientific man, since our Puseyites have excluded physical science from Oxford. They are wise in their generation. The abject deference to authority advocated conscientiously by them can never survive a sound philosophical education.

He made altogether four voyages to America, always with an increasing sympathy for whatever is best in American life. Slavery troubled him much. He saw that the slaves were fairly well treated; that they worked lightly, fed well, enjoyed themselves hugely, and were profoundly careless about their own condition. He thought that, "if emancipated, they would suffer very much more than they would gain," and just at first he was half disposed to palter and parley with the accursed thing. But more thinking brought him back to himself; and, when the War of Secession came, he was firm as a rock on the right side, when all English society was going steadily wrong. No political movement of his time seems ever to have interested and excited him so much.

"If the result of the struggle," he writes to Mr. Ticknor in the very thick of the war, "could be the abolition of slavery by the year 1900, it would be worth a heavy debt and many lives, at any rate when one thinks of what most wars are waged for, not but that the Union alone is worth a long fighting for." And the longest letter, I think, in the whole correspondence, is one to his friend Mr. T. Spedding, defending his faith in the North against adverse criticism—a manly, noble, outspoken letter, which by itself sufficiently stamps its writer. A few condensed extracts are well worth making:

I admit that every people have the right of rebellion or revolution whenever they are oppressed. . . . But, so far from having any just grounds of rebellion, the South had been dominant to the last in foreign and domestic politics, had always had the lion's share in the choice of Presidents and other civil appointments. . . . In short, they rebelled simply because Lincoln's election showed them that the Republican party were at last determined to resist the extension of slavery into new Territories. . . . If such men as Gladstone and Earl Russell had been only six weeks in the United States, they would never have said what they did. . . . Lincoln and his colleagues are not the sort of men that you and I would put into a Cabinet, so far as their conventional manners are concerned; . . . but, after all, are Lords Palmerston, Clarendon, and some others, men of higher principle than Lincoln, or as high? I am intimate with men equal to any here in literary attainments and in polish of manners, and of independent fortune, in the United States, whom I used to wish to see in power

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instead of the coarser class into whose hands the reins of government have been placed. But these men and the majority of capitalists would, I am sure, have knocked under to the South, and the slave-owner would have made a compromise by which his institution would have been more rampant than ever. If slavery, which was more injurious to the white man than to the negro, and which to a certain extent poisoned the political institutions of the North, . . . is got rid of, it will be owing to a very extended suffrage among a class which has had much instruction, for working-men, but to whom the aristocracy of wealth and refinement were not prepared to make great sacrifices for such an object.

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In a man of Lyell's antecedents and position, such reasoning is both brave and unexpected. I regret to say he observes in the same letter that he would rather fight for any number of years than let Ireland be "independent," though he admits that the Irish might make out a fair case for "repeal." Like most English Liberals, he can be just and sympathetic to Venetians, Poles, Hungarians, and negroes, but can not go quite so low as Irishmen.

So much by anticipation. A life like this is so full of real triumphs that one almost forgets to mention such a small matter as that in 1848, when at Kinnordy, "he rode over the hills by Clova and Loch-na-gar to Balmoral, when he had the honor of being knighted by the Queen." He was Englishman enough to appreciate the distinction, as well as the baronetcy which followed it later on. Nor was he insensible to the blandishments of royalty: he records the doings of little princes and princesses, when he happens to meet them, a trifle too much in the style of the special correspondent, and he details his conversations with a distinguished personage somewhat more fully than their intrinsic nature really demands. But there is not much of this sort of thing: as a rule, when he mentions a man, it is because the man is worth mentioning. The life in London during the years of full maturity is even richer in reminiscences of famous people than the earlier days. Dining at Hallam's, the great subject of conversation is the vacant editorship of the "Edinburgh"—Longman closeted for hours with Macaulay, and Jeffrey strongly opposed to letting the control go from Auld Reekie. Breakfasting at Rogers's, the veteran poet tells him how he knew a boatman who used to ferry Mr. Alexander Pope across the river at Twickenham, how Chantrey once came to his house as a workman, at five shillings a day, to receive orders for some ornamental drawing-room furniture, and how he still possessed the identical table at which Addison wrote his "Spectator" papers. Now it is "Ruskin, who was secretary of our Geological Section"; now it is "a friend of mine, Huxley, who will soon take rank as one of the first naturalists we have ever produced"; and now it is "young Geikie, . . . certainly the coming geologist and writer." His eye for men was very keen, and his predictions have almost always turned out to be correct. Of Agassiz, just settling in Boston, he says: "He will

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be the founder of a school of zoölogy (for he has many pupils) of a high order. His enthusiasm is catching, especially when he has a good soil to work upon." Nor do his interests narrow at all with years. "I sat long before the Madonna di San Sisto to-day," he writes from Dresden, "and can feel its beauty." At Madeira, Teneriffe, the Grand Canary, and Palma, he enlarges his notions by new sub-tropical experiences. But the great scientific and philosophical revolution of the present century burst upon him, after all, half unprepared. He has long ago demolished the Mosaic cosmogony; he is deeply interested in Bishop Colenso; he has already strong views as to the antiquity of man; and yet Mr. Darwin's "Origin of Species" comes across his horizon at last almost like a thunder-clap. The truth is, he was committed to the opposite belief, and he was old for a sudden revulsion. He accepted the new creed, indeed, slowly and cautiously, but he had a struggle for it, and it cost him hard.

Lyell's attitude toward the grand theory of the origin of species by descent with modification was, indeed, in many ways a singular one; and these letters throw much light upon the evolution of his ideas with regard to it. Though his own views as to uniformitarianism and the antiquity of man might seem naturally to lead toward the acceptance of the development hypothesis—for it is much more difficult to imagine creation taking place in the midst of an ordinary physical series of events than to imagine it taking place in order to restock a world desolated by a divinely ordered cataclysm—he formally rejected the theory as broached by Lamarck, and he hesitated for some time to accept it as altered and amended by Darwin. Indeed, to the last he was but a lukewarm convert. Unless my memory misleads me, I have heard Mr. Herbert Spencer say that the true test whether a man was an evolutionist in fiber or not was to be found in the question whether he accepted evolution before Mr. Darwin had made its *modus operandi* intelligible. There are men who rejected the doctrine of special creation on evidence adduced; and there are men who never for a moment even entertained it as conceivable. These latter may not always have seen the πῶς of evolution, but they always saw the ὅτι. Judged by such a standard, Lyell occupies a middle position. From his earliest days he seems to have hankered after some such naturalistic explanation of life, and yet to have feared cordially to accept it. In 1827 Mantell sent him Lamarck, when he was on circuit at Dorchester. He writes back shortly after:

I devoured Lamarck *en voyage*, as you did Sismondi, and with equal pleasure. His theories delighted me more than any novel I ever read, and much in the same way, for they addressed themselves to the imagination, at least of geologists, who know the mighty inferences which would be deducible were they established by observations. But, though I admire even his flights, and feel none of the *odium theologicum* which some modern writers in this country have visited him with, I confess I read him rather as I hear an advocate on the wrong

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side, to know what can be made of the case in good hands. I am glad he has been courageous enough, and logical enough, to admit that his argument, if pushed as far as it must go, would prove that men may have come from the orang-outang. But, after all, what changes species may really undergo! How impossible will it be to distinguish and lay down a line beyond which some of the so-called extinct species have never passed into recent ones!

The last two sentences show how, even then, Lyell was trembling upon the brink of the truth. He had got in the thin end of the wedge; he was prepared to admit the first infinitesimal in the long series whose sum makes up at last the difference between himself and the amœba: and yet he refused to go any further.

Time after time, for many years, we find the same thing cropping up again. The question is always before him, though he wavers much in the way he regards it. It seems to fascinate him and draw him on; even when he is fighting against it, it appeals to him as the natural complement of his other beliefs. In 1830 he writes to his sister from Paris:

This morning all my Etna shells were examined; out of sixty-three only three species not known to inhabit the Mediterranean, yet the whole volcano nearly is subsequent to them, and rests on them. They lived, on a moderate computation, one hundred thousand years ago, and, after so many generations, are quite unchanged in form. It must, therefore, have required a good time for orang-outangs to become men on Lamarckian principles.

Any one can see the falsity of this reasoning, which would imply an absolute uniformity in the rate of change in nature everywhere. A little later, in 1836, he writes to Sir John Herschel:

In regard to the origination of new species, I am very glad to find that you think it probable that it may be carried on through the intervention of intermediate causes. . . . An insect may be made in one of its transformations to resemble a dead stick, or a leaf, or a lichen, or a stone, so as to be somewhat less easily found by its enemies; or, if this would make it too strong, an occasional variety of the species may have this advantage conferred on it; or, if this would be still too much, one sex of a certain variety. Probably there is scarcely a dash of color on the wing or body of which the choice would be quite arbitrary, or which might not affect its duration for thousands of years.

In some ways this is marvelously near Darwin; but in others it differs *toto cœlo;* for Lyell does not see that these variations could arise "spontaneously," that is to say, in the ordinary course of small differences of antenatal conditions; he sets them all down directly to "the Presiding Mind." Nor does he see that they might result at last in the production of new species. Indeed, the context, which I have suppressed, takes off much from the superficial air of anticipating Darwin, which the passage nakedly quoted undoubtedly bears. A year later he tells his sister—

The latest news is that two fossil monkeys have at last been found—one in India, contemporary with extinct quadrupeds, but not very ancient, Pliocene,

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perhaps; another in the south of France, Miocene and contemporary with Paleotherium. So that, according to Lamarck's view, there may have been a great many thousand centuries for their tails to wear off, and the transformation to men to take place.

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In 1854 he notes, after an evening at Mr. Darwin's, how Sir Joseph Hooker astonished him with an account of that strange orchid, Catasetum, which bears three totally distinct kinds of flower. "It will figure," he says, "in C. Darwin's book on species, with many other 'ugly facts,' as Hooker, clinging like me to the orthodox faith, calls these and other abnormal vagaries."

Two years later, speaking of the wingless beetles of Madeira, he asks, "Was it not foreseen that wings would only cause them to be blown out to sea and be drowned?"

Soon after, meeting "Huxley, Hooker, and Wollaston at Darwin's," he is constrained to ask, "After all, did we not come from an orang?" At last the "Origin of Species" comes out, and bit by bit Lyell is compelled to give in. Even then he can reconcile himself but slowly to the new creed. "I plead guilty," he writes to Sir Joseph Hooker, "to going further in my reasoning toward transmutation than in my sentiments and imagination, and perhaps for that very reason I shall lead more people on to Darwin and you than one who, being born later, like Lubbock, has comparatively little to abandon of old and long-cherished ideas, which constituted the charm to me of the theoretical part of the science in my earlier days, when I believed with Pascal in the theory, as Hallam terms it, of 'the archangel ruined.'" To Mr. Darwin himself he writes that "the descent of man from the brutes takes away much of the charm from my speculations on the past relating to such matters." In the end he comes to the conclusion, as he idiomatically puts it, that "we must go the whole orang"; for that old mode of envisaging the facts clings to him to the last. Finally, he writes: "The question of the origin of species gave me much to think of, and you may well believe that it cost me a struggle to renounce my old creed. One of Darwin's reviewers put the alternative strongly by asking whether we are to believe that man is modified mud or modified monkey."

I have illustrated this matter thus fully because it is one which very clearly shows the weak side of Lyell's intellect. With all his breadth of mind and freedom from prejudice, he was not ever one of those who really get to the very deepest bottom of things. His tendencies were all in the right direction, and his instinct inclined him always to the true solution; but he did not build himself up a set of first principles to start with, firmly based upon a philosophical foundation, and make these the fixed criteria of his judgments throughout. His was too English a mind for that. He clung to all old beliefs as long as possible; he parleyed and temporized with the enemy; he was for effecting a compromise wherever he could, a patched-up *modus*

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vivendi which had to be tinkered anew at every fresh discovery. To the very last his acceptance of evolution was but half-hearted; he never came out and gave it the right hand of friendship fearlessly; he was always making reservations and starting difficulties, although his own beliefs fell short of it in places only by an infinitesimal fraction. "No miracle and no catastrophes in the cosmical system," he seems to say from time to time; "no miracle in the evolution of our planet; no fresh creations *en bloc* to repeople a desolate world; but just a very tiny miracle now and then, somewhere behind the scenes—a single new species to be created at a time, very unobtrusively, in Australia perhaps or St. Helena—that is all I ask." Whereas a thoroughly logical mind, a mind of the very highest order, would have said even before Darwin: "Creation can have no possible place in the physical series of things at all. How organisms came to be, I do not yet exactly see; but I am sure they must have come to be by some merely physical process, if we could only find it out." And such a mind could not fail to jump at the Darwinian solution the moment it was once fairly presented to it.

At the same time it would be unjust to deny that Lyell possessed and retained throughout life an unusual plasticity of thought and modifiability of opinion. It was no small thing that long after his sixtieth year he should have had the courage formally to recant in print the condemnation of "transformism" in his earlier works, and to accept, however unwillingly, the theory that he had so often and so deliberately rejected.*

A somewhat ungenerous critic has lately declared that Lyell often shut his eyes when brought face to face with evidence adverse to his own views. These letters abound in proofs to the contrary. Twenty years before the publication of the "Origin of Species," he writes on another subject to Sir John Herschel:

> I am very full of Darwin's new theory of coral islands, and have urged Whewell to make him read it at our next meeting. I must give up my volcanic crater theory for ever, though it costs me a pang at first, for it accounted for so much—the annular form, the central lagoon, the sudden rising of an isolated mountain in a deep sea, all went so well with the notion of submerged, crateriform, and conical volcanoes, of the shape of South Shetland, and with an opening into which a ship could sail. . . . Yet, spite of all this, the whole theory is knocked on the head, and the annular shape and central lagoon have nothing to do with volcanoes, nor even with a crateriform bottom.

The same spirit comes out in many other places. "I am sure I have no *objection*," he says in one place about some disputed Old Red

* It is curious to note, however, that he never seems quite fully to have realized the immense difference between Mr. Darwin's view and Lamarck's. *A priori*, creation is from the first unbelievable; but, as a matter of evidence, Lamarck failed to make evolution comprehensible, while Mr. Darwin succeeded in doing so. Hence he was able to convert many who, like Lyell, were hanging back and waiting for *a posteriori* proofs. Yet Lyell himself never wholly recognized the difference.

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fish-scales, "for I would as lief start with vertebrated animals and fresh water as with a universal ocean and the simplest forms of animal life." Perfect loyalty to fact, a complete readiness to accept anything, provided it can be shown to be true, marks Lyell's procedure throughout. It is very clearly seen in the last great work of his life, the "Antiquity of Man." As a matter of taste, it is obvious that Lyell did not relish the application of evolutionism to his own species. But he found that the facts compelled him, and he gave in. No book ever published—not even the "Origin of Species" or the "Descent of Man"—did so much to shake the common belief in the origin of our race: so far as all thinking Europe was concerned, Lyell simply demolished the current cosmogonies. More than that, by incorporating in the book Professor Huxley's remarks about the Neandearthal skull and much similar matter, he advertised the new creed in the animal origin of man with all the weight of his European reputation. The last years of his life were almost wholly spent in investigating this question of antiquity. Fifty years before, when he was at Oxford, he noted the occurrence of certain "pear-shaped flints" at Norwich, which he supposed must have "owed their shapes entirely to animals"; and all through his life he had been especially interested in the glacial period and its remains, the border-land where geology merges imperceptibly into archæology and history. But from the Darwinian era onward he turned his attention almost entirely to the question of antiquity. He inspected everywhere, and got abundant specimens from abroad, at times not without ludicrous difficulties. Dr. Falconer had procured him a fine cast of a fossil rhinoceros; at Naples the police voted it an infernal machine, and confiscated it accordingly. After a time it was restored, but the priests kept Dr. Falconer's osteological notes, which they declared to be treasonable, as no doubt they were from an ecclesiastical point of view. After some years spent in hunting palæoliths and weighing evidence (which involved some heavy field-work for so old a man, in the Bedford drift, the Liége and Maestricht caves, and so forth), the "Antiquity of Man" finally appeared in February, 1863. In three months he had sold five thousand copies, a remarkable success for such a book. It was his last great serious work. The remaining years of his life, though still actively spent, were devoted mainly to reconsideration and revision of what had been already done.

In February, 1875, his great and useful life closed quietly and worthily. In reviewing the seventy-eight years of his labors, it is impossible to avoid seeing throughout how admirably his opportunities were adapted to the work he had to do. He was the right man, to start with; but the lines also fell to him in the right places. With equal abilities, equal ardor, and equal singleness of purpose, he could not have done so much without the happy conjunction of circumstances as well. On the other hand, the lesson of his valuable life

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throws only into stronger relief the utter waste of powers and opportunities on the part of most other Englishmen in like positions. Ninety-nine people out of a hundred, put in Lyell's place, would have been nothing better than masters of fox-hounds or slaughterers of tame pheasants. When one thinks of the life-work performed by such men as Lyell and the great band of thinkers to which he belonged, one sees only the best side of wealth and position: one feels for a moment half inclined to thank the constitution of things as they are here in England for the chance it offers to such broad-minded and comprehensive workers as these. But then one thinks also of the extraordinary rarity of men who so make use of their opportunities, who regard their wealth as anything more than an easy means of the vulgarest personal gratification. It is lamentable to remember all the thousands of conservatories all over England in each of which, without perceptible difference to the owner, a few useful experiments might be tried, a few valuable observations made; and yet how many of them are ever used for any other purpose than to provide distorted flowers for a dinner-table, for a lady's hair, or for a fop's button-hole? We must congratulate ourselves if now and then, at rare intervals, we get a single Lyell out of all this mass of wasted humanity. After all, that result is in itself a great thing. We have always enough of narrow specialists in science, men valuable and important in their own way, though that is not the highest way; but we have never too many of the great co-ordinating and organizing intelligences, who take the scattered strands of scientific thought, and weave them together into one consistent and harmonious whole. Among such men as these Lyell stands well to the front, though not exactly in the very first rank.—*Fortnightly Review.*

TO EAT AND TO BE EATEN.

By CHARLES MORRIS.

NATURE has many of what we are accustomed to call the small economies of life. She does nothing without a purpose, and she has a horror of waste. In the world of living beings, particularly, is she careful of her materials. It is no easy lift to bring matter up to the organic level. She has to call in the sun to her assistance, and get their united shoulders under the load, ere it can be raised to the required height; and she can not afford to let it down again while there is any pith left in it.

It is interesting to follow her through this portion of her housekeeping, and watch the care with which she gets all the life-force possible out of her organic stock in trade, letting not a crumb go to

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waste. She invites a guest with a special appetite for every morsel—guests furnished with teeth to rend, nip, and gnaw, claws to tear, augers and chisels to bore and gouge, saws, drills, punches, and suction-tubes—that no fragment of the feast shall be left on the unswept tables.

There are guests of every shape, size, and description, alike only in the one particular of being normally hungry. Like the sitters-down at a public dinner, they all seem to have been saving up appetite for the occasion. Some there are, indeed, of such omnivorous tastes that we would be quite willing to have them left out from the general invitation. But that is not Dame Nature's way. Every crumb must be eaten; and we know little of her facility of invention if we imagine that she can not find a tooth for every hard morsel. She is ready for any such emergency, and you will be bound to find some queer creature gnawing away at the indigestible fragment with as much zest as if it were a dish fit for a king.

Let us take a sly glance in at Nature's kitchen and watch her guests at their meal. We shall not call it breakfast, dinner, supper, or lunch, for there is no such formal division. It is a whole-day feast, and a whole-night feast, too, for that matter. The tables are always spread, the guests always hungry; they crowd in from high-ways and by-ways; always one ready to take up every vacant knife, fork, and spoon; or to plunge in with fingers, teeth, and claws, in the true primitive fashion.

Nature does her cooking by sunlight. The great, glaring sun is her cook-stove, and by its aid she concocts, from such materials as water, carbonic acid, and ammonia, various palatable dishes, such as sugar, bread, fruits, greens, and a host of similar delicacies.

"There is your dinner," she says, "make yourselves at home." And so they do, without waiting to hear the dinner-bell; rich and poor, high and low; the dainty epicureans confining themselves to the fruits and seeds; others feasting on the green leaves and the lush grasses. But these are only the nobility, those who sit above the salt. The commonalty are more greedy and less particular. They bore in and saw in and dig in. Leaf and flower and fruit, branch and stem and root, each has its epicures. Some take a mean advantage by laying their eggs in the heart of rosy apple or luscious pear, so that their babes may revel in a perfect mountain of provender. There they lie, odd little white worms, like the chap who wished that Lake Superior was all ice-cream, and he plunged into its midst and condemned to eat his way out.

It has been no trifling task to lift that lofty tree or that broad field of waving grain up out of the lifeless world, and Nature is bound to make it pay its full duty to the world of life before it drops back again. It is her business to set going all the variety and abundance of life possible, and tree, grass, and grain must furnish food for

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those high-strung creatures who can not, like these plants, live on rock, dust, water, and air, but must have their victuals ready cooked and served.

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Look at the throng of vegetarians! Here is man, daintily plucking the luscious fruits and juicy berries, the rich seeds and fat roots, and extracting sugars and wines, vinegars and spices, to make his meal palatable. Yonder are the hosts of the cloven-footed, perfectly content to grow fat upon leaves and grasses. And here are armies of humbler guests—cherry-pecking birds, honey-sucking bees, leaf-eating grubs, that convert the waving banner of a leafing tree into one great spider-web, and then perchance go to sleep in hammocks of silk; carpenters and miners who bore into the hard wood itself, and leave behind them long, winding galleries that look like the lanes and alleys of an Old World city; locusts, army-worms, and potato-bugs that ruin man's harvests; and millions of centipeds and millepeds, ticks, mites, and gnats, that suck the living juices and fatten on the palatable meat of the tree.

But all this is only the beginning of the feast. What we call death is only, in another sense, the spring-tide of life. The leaves fall and rot, the grass decays, but not to return to the inorganic world. They are dished up as food for new waving fields and flaunting leaves. In the chemical balance of Nature part of this nutriment bears down its side of the scale into the lifeless world, yielding force to lift the nutriment in the other scale back again into the circle of life.

And when the great tree dies, what then? Its dead body is but a vast nursery of life. The long, lithe, twisting and clinging parasites, that have drunk its blood while alive, are replaced by flat lichens, umbrella-like fungi, and luxuriant mosses, which feast on its decaying trunk; while borers, chiselers, and miners do their part in transforming the great dead mass again into living forms.

And when it drops into a heap of decaying vegetable flesh, what new hosts of life batten upon it! And when the earth takes back the ruins of the dead giant beneath her generous breast, it is not to keep them there. They have too much vitality left for that. They climb to the air and the sunlight again in grasses and ferns and airy little plants. They blossom into flowers, eye-gladdening, honey-yielding, color-mad clumps of bloom, from which not alone the bee drinks sweets.

Thus is the fallen tree transformed into multitudinous life, bursting above the soil in new generations of beauty, until scarce a shred remains that does not live again. And creeping rootlets of trees hunt these last fragments underground, and crawling, flexible worms eagerly swallow the earth itself, and digest from it the stray crumbs of the old tree that are mixed throughout the soil.

Nor have we yet got to the bottom of this cycle of vegetable life. There are worlds, solar systems of life beneath all this, dwelling far

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below the reach of the eyesight of man. Let some of the decaying stuff fall into standing water, and there, under the hot summer sun, slowly dissolve. Put, then, a single drop of this water under the microscope, and let us try to rediscover the fibers and flesh of our tree. Lo! instead of this dead matter we behold a swarming, writhing, twisting, shooting, creeping sea of life, thousands, millions of living forms into which Nature has transformed her seeming organic waste: the rod-like bacteria, the boat-like diatom, the globe-like volvox, the line-like algæ among vegetables; and among animals the arm-making amœba, the whip-lash monad, the shelled and twisted foraminifera, the strangely-varied infusorian; there, where to the unaided eye all seemed death and stagnation, lies a bewildering phantasmagoria of created things, life crowding in indescribable multitudes and numberless variety out of the heart of death, the eaters and the eaten in innumerable profusion. Such is the full cycle of the life of our tree; such the boundless variety produced by Nature's economical administration of her materials.

But let us not imagine that we have yet exhausted the subject. Nature is in no readier mood to waste animal than vegetable food. It also must do its duty in widening out the circle of life. Animals prey on animals. Alive and dead they are eaten and re-eaten. Animal, like vegetable life, is turned again and again into new life, until every atom of it has had all its vitality squeezed out, and has fallen, bit by bit, back into the inorganic world.

The carnivora equal, if they do not exceed, the herbivora in number. The flesh which the latter has formed out of plant material the former rends and consumes, turning it into new animal forms. And so the endless metempsychosis of life goes on, the great preying upon the small, the greater upon the great, and man indiscriminately upon all, little that is eatable escaping his omnivorous appetite.

It is all one to Nature. She is determined that there shall be no waste, that none of her laborious efforts to build the organic out of the inorganic world shall be for naught, and that the utmost abundance and most endless variety of life shall flow into being out of the bosom of the inanimate.

It is not alone the battle of the great upon the small, the strong upon the weak. The small as well make their harvest upon the bodies of the great. As minute plants feed upon great trees, so do the midges upon the giants of the animal world.

Insects are not content with preying upon one another—spiders dragging their nets through the air for unwary flies, ant-lions digging sand-craters for curious ants, ichneumon-flies nestling their young in the bodies of fat caterpillars—but they prey as persistently upon the world of giant animals.

Look at these minute pests of man, for instance. How little Nature seems inclined to exempt her best and highest from the inexorable

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law of to eat and to be eaten! The name of the creatures, who fondly imagine that this fair human form was spread as a banquet for them, is legion. Gnats, ticks, lice, mites, flies, fleas, mosquitoes, form a few of our temperate host, while in torrid regions they swarm in tenfold profusion and variety, causing the happy dwellers in the land of eternal summer to spend a considerable portion of their lazy days and nights in the monotonous labor of scratching, slapping, squirming, and perhaps occasionally swearing their jaw-breaking oaths at the torments which surround them.

And inside as well as outside man is a harvest-field for the midges. Worms of unpleasing variety infest him in every organ, troubling not alone the digestive region, but lying hid in the firm flesh, the brain, even the eye. And that minute but multitudinous creature with which a pork diet furnishes him—the trichina—makes the whole body its home, and literally eats him up alive.

Nor has our economical mother Nature more mercy on her other gigantic creatures than upon man. They are all the prey of some special insects or other parasites. And not alone the great, but the small, for we perceive creatures visible only under the microscope that form the homes of still smaller parasites. It becomes, indeed, an unpleasant wonder what marvelous adaptations of animal life have been formed apparently for no other purpose than to batten and fatten upon and make miserable all larger creatures, for whose greater size they make up by vaster multitudes.

It is economy all. There must be no waste of organic material. If some suffer thereby, it is their misfortune. The law can not be set aside for special purposes. There are no good ends ever gained without certain unpleasant drawbacks. The end here to be gained is life—abounding, immeasurable life. To reach this result, no organic force can be spared, and if some have to scratch and squirm, still it will be found here, as in all Nature's economies, that the evil is small, the good attained great. She works by law alone, and a law of Nature is never laid aside because it happens to tread on some crippled creature's corns. Law is immutable, and will inevitably crush every laggard who is not strong enough or quick enough to get out of its path.

And when the animal dies, it dies not to drop at once into the dust whence it sprang. Its dead flesh is too valuable life-building material to be allowed to escape Nature's uses in any such hasty fashion. Complete death can only be reached by the road of life. The mineral world is too far off to be arrived at by a single downward step. Successive steps are necessary, and every step is a living form. What we call fermentation in plants is but a growth of new plants out of the stuff of old ones. And putrefaction in animals is but another form of the same process.

As we have seen a host of plants growing out of the ruins of the

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dead tree, so we now perceive a host of animals growing out of the ruin of their dead predecessor. What is not otherwise devoured serves as a receptacle for the eggs of insects, and it soon swarms with grubs and maggots, destined eventually to sail in winged lightness in the air, without a hint in their aërial grace that their floating life had this unpleasant source.

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And they shall be eaten—and their eaters eaten; and thus the organic world, which grew up by this devouring process from the smallest plant to man, slowly drops back by form after form through the lower world of animals and plants, until every grain of vitality is sucked out of it, and it falls at last, utterly juiceless and lifeless, into the mineral world from which it came.

Such is Nature's most striking economy. Such the work she gets from the subscriptions from the lower world, ere they are paid back into the treasury whence they were drawn. They form the coin of life, passing from hand to hand, and abraded by every touch, until utterly worn away, and needs to be replaced by new coins from the organic mint.

And there is yet another feature in this round of economies with which we may safely close our review. Nature not only provides us with new food, but makes our old nutriment do duty again and again, ere every possibility of use is squeezed out of it. Thus the nitrogenous material of the body, which is thrown into the circulation by waste of the muscles, does not appear to be at once carried out of the body as useless refuse. It is too precious to be so lightly thrown away. On the contrary, it is probably worked over again in the blood, a portion of it becoming mineral matter, and yielding force to lift another portion into the condition of nutriment. A similar process of reemployment of nitrogenous material takes place in vegetables. Thus, a part of the coin is worn off, and the remainder paid back into the bank of life for its existing value. And so it may be paid back again and again, until it is all lost in this successive wear and tear, and the mineral world gets its own again.

This is Nature's thrifty housekeeping. Not an ounce of force is wasted. All the possible life in organic material is worked out of it ere it can escape. And even those vegetable forms that have avoided this process by being turned into stone have but temporarily locked up their forces, which flow out eventually in the form of light and heat, to invigorate, vivify, and gladden the world of living beings.

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MATERIALISM AND POSITIVISM.

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By W. D. LE SUEUR.

MATERIALISTS and positivists are commonly classed together by those who have never well understood what either materialism or positivism really is. Positivism is supposed to be materialistic because it fails to call in spiritual existences in explanation of phenomena—because, in other words, it stops short at facts, and does not seek to search out ultimate causes. The people who draw this inference take for granted, apparently, in their ordinary thinkings, that all facts must be facts of matter, and that those who confine themselves to facts must consequently be materialists. There is, therefore, really a fundamental materialism in the very criticism that fastens upon positivism the charge of materialism. Let us, however, look a little more closely into materialism considered as a mode of philosophical belief.

What do we mean by matter? First of all, it is obvious that we mean something that is objective to the mind or thinking faculty—something the mind finds upon its path, as it were, and that is the source to it of certain definite impressions. All impressions made upon the mind do not, however, equally connect themselves with the idea of matter. Some, of course, do not so connect themselves at all. When we are struck by the generosity or baseness of an action, or feel the influence of character, or experience the pleasure of harmonious or the pain of discordant relations, our consciousness is in no way concerned with matter. There might be no such thing as matter in the world, for aught we know or care about it at such moments. Yet our impressions have the very highest degree of definiteness. But even impressions made directly on our physical senses do not all, with equal force, bring the conception of matter before the mind. The word "phantasm" bears witness that visual impressions do not always convey a belief in the existence of the external reality called matter. It means, literally, "an appearance"; but it has come to mean an appearance void of all substantive reality. There is the same implication when we speak of "rubbing our eyes" to make sure that we see a thing. The sense of hearing is, in like manner, sometimes distrusted; and it may be said that, if we lived in a world in which our only knowledge of objective existence was through sights and sounds, our idea of matter, if we had one at all, would be very different from what it actually is. There is, however, another sense, the testimony of which is held to be surer than that of any other, the sense of touch. Sight may deceive, hearing may deceive; but what we can touch and feel is real. Here we find the true basis of the popular idea of matter—that which can be *felt;* that which resists our muscles. It is true

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that in this case, also, we are thrown back upon subjective impressions, or, in other words, upon mental experiences; but these experiences have at once a certain breadth and a certain intimacy about them, which leads us in general to give them the preference, and to make what seems to be the source of them our very type of reality, to which we apply the special name of *matter*.

Considering the subject further, we perceive that sight and hearing are, strictly speaking, specialized forms of the sense of touch—forms so specialized that their fundamental similarity to touch is commonly lost sight of. There is, therefore, no good reason for treating their revelations as less founded on reality than those which we owe to muscular sensation; yet, for all that, matter, to the popular mind, will always be something which directly appeals to the sense of touch.

We may now begin to see what materialism is. Materialism is a form of belief, or mode of thought, which in all things prefers to rest on the evidence of the broadest impressions of physical sense, and which suspects, where it does not deny, the reality of aught that can not be brought to the test of sense-impression. It objects to advancing beyond the primary elements of consciousness; and any steps which it takes in the region of mental or moral phenomena it takes grudgingly and with a constant dread lest it should be led to recognize as real anything that can not be *felt* as we feel sticks and stones. The materialist has to live as other men, and, where his theories are not at stake, he will use ordinary human language as freely as others. He will talk of hope and fear, of love and hatred, of ambition and apathy, of honor and disgrace, of character and motive and principle, as if he knew what he meant, and as if the words he used answered to certain realities of human life. But, once touch his theory, and he will seek to drain these words of all meaning, or else fall back upon vague talk about "modes of matter."

Materialism is the refuge of minds that have been immaturely freed from spiritualism, or perhaps we may more fitly say, spiritism. By spiritism we mean that undeveloped condition of the mind in which hypothetical existences are required at every turn to account for observed phenomena, in which the mind can not bear to be left alone with facts. The child learning to walk holds by its mother's finger; the mind learning to think uses such hypotheses as it can construct, and for physical acts it frames spiritual antecedents. The child who thinks it can walk before it really can, and leaves its mother's finger, finds itself compelled to creep along by the wall. In like manner the materialist who has let go his spirit hypotheses is compelled to creep along by the wall, to rest upon something *hard*, in order to steady his steps. Divert his attention, and he will walk for a while with his hands free; but, remind him where he is, and he totters back in a moment to his tangible support.

The positivist, on the contrary, is a man who has learned to walk

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alone. He asks only support for his feet; and *that* he finds in the instinctive confidence in his physical and mental powers, with which, in common with other men, he is endowed. To the positivist a fact is a fact, wherever and in whatever guise he meets it. And all facts stand to him upon an equal level in point of authority. Having learned to dispense with the spirit hypothesis, he has learned to dispense also with bad metaphysics, particularly with the bad metaphysics that lie at the foundation of materialism. He repudiates the idea that a superior degree of reality attaches to *hard* things, and he bewares of drawing the metaphysical conclusion that tangible things constitute the stuff of the universe. A hard thing is well in its way: so is a soft thing; so is an impalpable thing. What the universe is ultimately made of he does not inquire, because he knows the inquiry is vain. He is content with facts, and to him a fact is *whatever produces a complete and definite impression upon the mind.* He does not make his own mind the measure and test of all possible existence, but he holds that it is the measure and test of all things that concern him. There may be things of which he knows and can know nothing, but he indulges in no speculations in regard to these—his duty being, as he conceives, to apply himself assiduously to the knowable order.

To the positivist, I have said, all facts are of equal authority; and, in order to decide what is a fact, and what therefore he should treat as a reality, he merely asks, Is it capable of definitely affecting my mind? Whatever stands definitely related to the mind is a fact, and has all the reality that can be discovered in anything whatsoever. All we can say of a piece of granite is that it definitely affects the mind; we know it as so-and-so. Whether it be, as Mr. Herbert Spencer maintains, but the representation of an unknowable reality, the positivist does not inquire: enough for him that he is able to cognize it under certain definite forms. But what we here say of a piece of granite, which would be the materialist's choice illustration of real existence, we may say equally of an action, a word, a thought, an impulse, a characteristic, a tendency. These are all facts, capable of definitely affecting the mind, and often affecting the mind more intimately and powerfully by far than tangible objects. What is it in my friend that is of most concern to me? His bodily frame? By no means. He could not exist without a bodily frame, any more than he could walk without ground to walk on. But his bodily frame may have nothing in it to please the eye, or in any way to arrest attention. The color of his hair, his weight, or even his stature, might change materially, and the difference to me would be little more than if he had changed his clothes, provided the disposition of his mind, those mental and moral qualities that had won my regard, had remained unchanged. In this case, disposition, a thing wholly impalpable, is of vastly more account to me, as an element in my environment, than the whole assemblage of physical properties and qualities represented by

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my friend's bodily structure. Now, the difference between the materialist and the positivist lies just in this, that the former is embarrassed at the decided effects which he sees produced by impalpable things, while the latter escapes such embarrassment entirely, simply by not having set up any arbitrary standard of what constitutes reality. The materialist does not want to recognize anything as real that does not more or less resemble his piece of granite, that does not affect the tactual sense; while the positivist is content to recognize all things as real that reveal their existence to the mind by affecting it in a definite manner. He cordially admits that the piece of granite does this, but he says also that a thousand things that have no analogy with it whatever do it as well.

Some people, chiefly materialists, will heedlessly say that this is idealism. But they are totally mistaken. Idealism consists in affirming reality of the mind and denying it to objective existences, or in affirming that the apparent distinction between subject and object is unreal and illusive. The positivist does neither the one nor the other. He simply abstains from setting up an arbitrary standard of reality. He talks neither of mind-stuff nor of world-stuff; such talk, indeed, he can not help regarding as *all* stuff. He *knows* that he knows and that he feels, and that there are certain definite sources of knowledge and feeling. He perceives that he has an environment upon which he can act, and which reacts upon him. That environment is a very complex one, answering to the complexity of his own nature. There is nothing within him, indeed, that has not some answering element without. Regarding him first as an animal, he has a nutritive system, which has its answering external realities; he has a nervous and muscular system, to which the outward frame of things in like manner responds. Taking a higher point of view, he has intellectual faculties which lay hold of the relations of things in the outer world; he has an emotional nature, with moods that vary according to the nature of the stimulus they receive; he has social faculties and propensities that find exercise in the domain of society; he has powers of moral judgment that recognize, apart altogether from the verdict of society, the essential moral qualities of actions. To each range or level of function in the individual man there are corresponding realities in the outer world; and it is to be observed that what are realities to one set of functions are not realities in the same sense to any other. The nutritive quality of an apple is not a reality to the muscular sense, nor is the weight of the apple which is cognized by the muscular sense a reality to the nutritive function. The test of reality is, we thus see, the existence or non-existence of definite relationship. To illustrate the same form further, we may observe that the physical properties of bodies are not realities to the intellectual faculty that investigates their spatial or numerical relations. The weight of a statue, or the chemical composition of the marble or bronze of which it is made, is

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not a reality to the æsthetic sense. The emotional nature finds its realities in the things that kindle emotion, not in those that furnish matter for intellectual exercise or for physical sensation. Who can ever forget those exquisitely simple words of the poet Tennyson?—

> "And the stately ships go on
> To their haven under the hill;
> But oh, for the touch of a vanished hand,
> And the sound of a voice that is still!"

The vanished hand, the silent voice, are here but symbols of a thousand clustering associations dear to the heart in past times, and dear to the heart still. The physical sensation is the *nexus* of things that no physical methods could possibly enable us to understand, things known only to the emotional nature. The touch or the voice that thrills one human being will be wholly indifferent to another—will, in fact, rank only as a mere physical sensation. The heart of a mother would be rent by the cry of her child in pain or in danger; but what would that cry be to a devouring beast? It would have no relation, except as a definite volume of sound, to anything in the beast's nature, and therefore, in all the elements that would speak to a human—to say nothing of a mother's—heart, would be non-existent.

It is, however, when we consider man in society that the range of impalpable realities becomes widest, and embraces facts of the deepest import; and just as society becomes more complex does this truth assume deeper significance. In a society like ours, at every step a man takes through life, he encounters forces as real as those of physical nature, but whose seat is in social institutions and in the dispositions of individual men. There are ambitions, interests, customs, prejudices, conventionalities, and a thousand intangible forms of social force, that all react upon the individual man like so many conflicting winds and currents. The individual can and does react against these, and herein he differs from a wave-tossed vessel; but, steer his course with as firm a hand and as steady an eye as he may, the great composition of social forces will powerfully affect the line of his movement.

The great practical defect of a materialistic philosophy is that it leads its adherents to underestimate all forces and influences that can not be reasoned about as we reason about the laws of matter. The materialist rests by preference on a relatively low plane of thought; and he is at a great disadvantage when he has to deal with matters that lie in a higher plane. But many are materialists in this way who would utterly repudiate materialism in theory. In other words, there are many whose methods of judgment are wholly unsuited (through excess of simplicity) to questions involving the higher human motives, or the less obvious conditions of human happiness. Many a man has made a disastrous business failure through a too materialistic way of looking at things. He wants money, let us say, for his business; he

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finds a partner who has money, and the importance which he attaches to this obvious and, so to speak, palpable condition, leads him to overlook the less obvious but equally important conditions of character, compatibility of disposition, and business aptitude. He finds to his cost in a short time that these things should not have been overlooked. Men, again, who have unlimited faith in the power of statute law to work moral reforms are so far materialists. Their trust is really in physical force. The whole school of political economists have helped to cultivate materialistic modes of thought, by making abstractions of all the influences that modify the working of their so-called economic laws. The truth of the matter is, that the moral condition of society at any given time profoundly modifies the whole course of business. Paralyze confidence between man and man, and the whole commercial and industrial world falls out of gear. Restore confidence, and the wheels of exchange once more begin to move. In a thousand ways, that people with materialistic modes of thought are apt to overlook, tangible results depend upon intangible causes, or are governed by intangible conditions. A true philosophy bids us always to try and rise in our speculations to the level of the phenomena with which we have to deal, and always to beware of denying or ignoring the complexity of a problem merely to indulge our intellectual indolence. Materialism, according to Comte's definition, is essentially *the habit of judging things from too low a plane*, and this is the sense in which I use the word throughout this paper. To suppose that any particular grossness attaches to matter is a conception worthy only of the moles and bats of philosophy. Before we could affirm grossness or anything else of matter we should have to get some of it, and compare it with something that was not matter, but which yet could be legitimately compared with it. Until this feat is accomplished, it would be well for all sensible people to refrain equally from praise and from abuse of matter. What there can be no risk of error in assuming is, that the exercise of certain faculties gives us the conception we have of matter, and that the exercise of other faculties gives us mental experiences of quite a different order. The materialist insists upon the convertibility of all experiences of the latter kind into experiences of the former kind. The positivist, on the contrary, feels under no obligation to perform any operation of this kind; and fails to see how he would be advantaged if he could or did perform it. He is content to believe that we are in no less real a world when we are dealing with human affections and passions, with social laws and forces, and with spiritual results in general, than when we are occupying ourselves with things that appeal directly to the outward senses, and that give us our impressions of form, color, and weight.

It has thus, I trust, been made apparent why the positivist would refuse to be called a materialist, and why he would equally object to be spoken of as an idealist. He is the only man, as it seems to me,

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who takes the world exactly as he finds it; and who, upon principle, abstains at once from unfounded affirmations, unsupported judgments, and unanswerable questions. His business, as he conceives it, is to regulate his life, and help others to regulate their lives, by *realities;* and a thing to be a reality to him does not need to be a stone-wall.

THE SIRENS OF THE SEA.

By W. H. LARRABEE.

THE sea is inhabited by three families of mammalian animals, which, though they may be so "very like a whale" as to have been sometimes spoken of together as cetaceans, are quite distinct in their structure and habits, and show evidences of distinct origin. They are the cetaceans, including the whales, dolphins, and porpoises; the pinnipeds, including the seals, sea-lions, and walruses; and the sirenians, including the manatees and dugongs. The affinities of the cetaceans are not exactly known, but it is certain that they are creatures of a very different sort from the animals of the other two classes; the pinnipeds are closely allied to the bears, dogs, and cats. Both these classes are carnivorous. The sirenians are herbivorous pachyderms, whose nearest analogies must be sought among the hogs, tapirs, and particularly in the hippopotamus.

The manatee, or sea-cow, is the most widely diffused of the sirenians, and, being American, has the first claim to consideration. Its various species are found along the coasts and in the rivers and inland lakes of tropical America; the length of the entire opposite coast of Africa, around the Cape; and as far north up the Mozambique coast as the Zambesi River; in the upper Niger River; in Lake Tchad; in the East African Lake Shirwa; and in the Tana Sea, in Abyssinia. Agassiz has termed the animal the modern representative of the dinotherium, and it is most probably the creature which Columbus mistook for a mermaid. It grows to be sometimes as long as seventeen or twenty feet, but generally not more than from eight to twelve feet, and to weigh from one to three or four tons, having a body the shape of an elongated barrel, slightly flattened above and below, with two fore-limbs, but no sign of hinder extremities, and an horizontally flattened or spatulate tail of about one fourth the extent of the body. Its skin is much like that of the hippopotamus, and is very sparsely covered with hair. Its fore-limbs are set far forward, are more free in their motions than those of the cetaceans, and may be used as claspers, flexed over the chest, for swimming or dragging the animal along the bottoms, or up the banks of the rivers in which it feeds, and to assist in the prehension of food. The finger-bones may be felt

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through the skin, with which they are connected; but no evidence of digital organs is outwardly visible, except the rudimentary nails on the edges of the flippers. The flippers, flexible and possessing much of the power of the hand, have given the animal its name, from the Latin *manus*, a hand. The head is conical, with a fleshy nose,



FIG. 1.—MANATEE.

like that of a cow, and large nostrils, and appears as if joined immediately on to the body, without visible neck. Anatomy furthermore shows that one of the cervical vertebræ, of which there are generally seven in mammals, including the dugong, is wanting. The mouth is small, and without front teeth, but is provided with two mobile, lateral, bristle-covered pads, with which it seizes its food quite dexterously. The mammæ are on the breast, and so resemble those of the human being as to make it easy to believe that the fable of the mermaid was derived from this animal.

The manatees feed in herds on the bottoms of rivers and the shallow waters along the shore, where they browse on algæ and aquatic herbs. They associate together in the most peaceable manner, and show a great community of feeling. They combine for defense when attacked, taking especial care of their young, by putting them in the center of the group, and, it is said, showing so much intelligent sympathy as to try to pull out the weapon from one of their companions which may have been struck with a harpoon. It is, indeed, a great shame to attack them wantonly, for no animal is more gentle and inoffensive, or more easily domesticated; but their flesh is excellent food, being much like pork, and is, moreover, allowed by the church to be eaten as fish on fast-days, and must, therefore, be considered legitimate prey for man. These animals are the most numerous inhabitants, after the turtles, of the waters around Greytown, Nicaragua,

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and are actively pursued by the Indians. The largest and best-known species is the Florida manatee, which inhabits the Gulf of Mexico and West Indian waters; the South American species is smaller, and the African the smallest of all.

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The dugong is the congener of the manatee in the Indian Ocean and the Australasian waters. It is as large as the manatee, and visibly different. Its head is small in proportion to the body, and is separated from it by a slight but distinct cervical depression; its skull is short, and its snout terminates abruptly in a large, thick upper lip, looking "something like the trunk of the elephant cut short across"; its tail, horizontally flattened, like that of the manatee, is forked or crescent-shaped, instead of being entire, as with its congener; and its flippers are destitute of any traces of nails. The eyes are small, and are furnished with a third eyelid or nictitating membrane. For the rest, we let an English writer, who examined one of the animals at the hunting-grounds in Moreton Bay, Australia, describe him:



FIG. 2.—DUGONG.

"Now I could understand," he says, "why one person had told me the dugong was like a whale; another, that it resembled a seal; a third, that it was not unlike a porpoise. The animal was in some sense a reminder of them all, but really not to be compared with either. It was, perhaps, likest a seal of elephantine proportions; and a baby dugong that had been taken from one of the prizes over which the carrion-birds were fighting and squabbling, and that had been kept for dispatch in spirits to England, would very well pass for a member of the seal family. A tour round the mature specimen had to be twice repeated before I could see my way to a clear comprehension of its 'points.' Its dull-brown body was like a large cylinder, tapering off toward the head and great paddle-shaped tail. Ears there were none to speak of. The eyes were tiny, and three parts buried. The two flippers, considering the size of the animal, were remarkably small. The most prominent feature was the head, which terminated in a solid, square-cut upper lip, that warranted its comparison with a bullock. Being a female dugong, there were neither teeth nor tusks in the upper jaw, but a couple of small tusks of good ivory had been that morning taken from one of the bulls already operated upon. The inside of the mouth was lined with a rough apparatus, like a worn-down scrubbing-brush. The dugong, in short, is a vegetarian of the strictest order;

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and the stomach of our dead friend contained an immense quantity of vegetation cropped during the night from the bottom of the sea. It was the most curious example of a ruminating (herbivorous?) mammal I had ever seen. The skin was bare and slightly wrinkled, though at a distance it appeared to be quite smooth."

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The dugong's nostrils are displayed upward; its lips have a horny edging which assists it in tearing sea-weeds from the bottom; and the forward part of its snout is covered with soft papillæ and a few stiff bristles. It often comes to the surface to breathe, and utters a peculiar cry, which our English writer, who heard it, describes as "a plaintive appeal, as if a child half awakened had softly moaned, and turned over to sleep again. I looked around," he adds, "in time to see a clumsy, grayish-brown head silently thrust above the surface, and, without leaving a sign, as silently disappear."

This animal has become the object of a thriving industry, the chief seat of which is at Moreton Bay, Queensland. Every part of the creature is marketable, and the pursuit and capture are easy and safe—too much so, probably, for the permanence of the trade. The flesh is eatable as beef, veal, or bacon, either of which it may be made to resemble; the head can be cooked into a delicious brawn; the flippers, a good deal boiled, make capital soup; the bones are dense, close-grained, and capable of taking a high polish, hence adaptable to a variety of uses; the ivory tusks are in request for knife-handles; the skin is good to make a jelly "as acceptable and beneficial to invalids as calf's-foot," and for leather; and the fat is rendered at Moreton Bay into a palatable and wholesome oil.

The dugong-hunting season at Moreton Bay, where the animals are supposed to resort from tropical seas to give birth to their young, lasts through the winter weather. The submarine pastures upon which they feed, says a writer in the "Gentleman's Magazine," "lie at a depth of from eight to fourteen feet, and the favorite grounds are banks protected from the sea, in bays and straits. They graze in company, and feed down the herbage so close that they leave a well-defined track to indicate their movements. The black fellows, who love occupation of this kind, if any, peer over the gunwale of the whale-boat into the clear water, and are unerring authorities, telling at once when the monsters passed that way though it were a week previously, and giving a shrewd guess as to their present whereabout." The animals are then tracked up, and strong nets, presenting a wall specified in one instance as fourteen feet high and a hundred and fifty yards long, are placed so as to intercept them as they go browsing up to their feeding-grounds. The dugong, in happy innocence, eats greedily of the succulent growths, clearing its way in the most workmanlike manner, when it is suddenly stopped by this strange barrier. Being a remarkably timid creature, it takes fright, loses its presence of mind, and gets hopelessly entangled. "Now and then a dugong is found

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wrapped round as with the folds of a hammock, and the net has to be cut away piecemeal. As often as not, the dugongs thus drown themselves by frantic efforts to escape, but where a partial entanglement permits them to follow their instinct and come to the surface, they are taken alive. In the morning the boat cruises round to see how the nets have fared and to secure the game. . . . The dugongs that are found alive in their captivity struggle desperately. As a rule, they are as harmless as vegetarians are usually supposed to be, the only known breakers of the peace being a couple of bulls fighting over a sweetheart, or a frantic mother maddened by danger to her offspring. Nevertheless, although the dugong is by nature mild-mannered, and innocent of the wiles by which a Greenland whale sends a boat spinning into the air with all hands, the men prefer to give the netted individual a wide berth. Nor would it be the correct thing to slaughter it on the ground, lest the blood should attract a legion of sanguinary sharks, whose attacks would cause a speedy loss of the booty. The dugong, still floundering, is therefore hauled ashore, and a long knife applied to the throat puts an end to its career." Harpooning has been practiced, and is much liked by the blacks, but is discountenanced because it tends to drive away the animals.

"When the dugong was hauled up on the sandy slope, a line was cut down the belly and the skin was taken off in one piece, and spread out to be used as a receptacle for the meat as it was hewn from the carcass. As it happened to be a fair-sized skin, it required two men to carry it. We were afterward shown a hide that was an inch and a half thick at the back, though the thickness had gradually diminished toward the under part of the body." The hide is not, however, composed of gross material, but is really quite delicate.

The flesh "is cut off the carcass in flitches and slabs, and from the same animal is taken meat resembling beef, veal, and bacon. I have eaten it in each form, and can testify to its excellence, and to the way in which it has been palmed off upon knowing men as prime fillets of beef, cutlets of veal, and rashers of superior bacon. If the dugong is not properly fat, it is turned chiefly into bacon; should it, however, present a layer nearly two inches thick, the snow-white fat is used for a more important purpose. The lean flesh, beef-like in the mature and veal-like in the young animals, is eaten fresh or salted for food. The bacon-flitch in size, color, and streakiness, if hung in an English pork-butcher's shop, might easily be taken for a section of the side of a true Wiltshire hog; and the only difference detected in the eating would be, in the dugong, an absence of the strong flavor too often found in pork; and a mature dugong, twelve feet long, or thereabout, would weigh nearly a ton. It is worth mentioning, too, before passing from the flesh of this animal, that the meat from the calf is always the best, and that it is recommended by the faculty to consumptive persons, by reason of its undoubted strengthening qualities."

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The oil, which is extensively manufactured at Moreton Bay, possesses all the medicinal qualities of cod-liver oil without its unpleasant taste. In its pure state it can be taken without disagreeing with the most sensitive stomach. "I have myself," says our English writer, "used it instead of butter with toast; have eaten delicate pastry made from dugong-lard; have fried fish with it; and, as a consequence, have never since ceased to wonder that some better effort is not attempted to make it more widely known. Consumption, the scourge of the old country, finds an unfriendly atmosphere in Queensland, where I have known consumptives, landing with the disease to all appearance hopelessly advanced, become in a few years healthy if not robust, yet, even there, the most marvelous effects are attributed to dugong-oil in cases of rheumatism, and wasting as well as ordinary consumption. . . . I have known ladies, who shuddered at the bare notion of swallowing oil, derive benefits from its adaptation to all manner of culinary purposes."

Dr. Hobbs, of Brisbane, who first introduced the oil, received a medal at the Paris Exhibition of 1855 for his product. The manufacture afterward fell into other hands, and the short-sighted managers, rather than admit that the supply could not be equal to the demand, adulterated the pure product with unsavory shark-oil. Then they were astonished and indignant that they received no more orders from the old country.

Because the sirenians live in the sea, the first inclination of naturalists, before they had become fully acquainted with the family, was to classify them with the whales. A better knowledge of them has proved that this arrangement, unless it is safely qualified, is misleading. Professor Owen says on this subject: "The whole of the internal structure in the herbivorous cetacea differs as widely from that of the carnivorous cetacea as do their habits; the amount of variation is as great as well could be in animals of the same class existing in the same great deep. The junction of the dugongs and manatees with the true whales can not, therefore, be admitted in a distribution of animals according to their organization. With much superficial resemblance, they have little real organic resemblance to the walrus, which exhibits an extreme modification of the amphibious carnivorous type. I conclude, therefore, that the dugong and its congeners must either form a group apart or be joined with the pachyderms, with which the herbivorous cetacea have most affinity."

Professor H. C. Chapman, of Philadelphia, who has dissected a male and a female hippopotamus, has discovered several analogies in structure between the manatee and that animal. He remarks that in observing the manatee that lived for several months in the Philadelphia Zoölogical Garden, the manner in which it rose to the surface of the water to breathe reminded him often of the hippopotami that he had watched in the Zoölogical Garden of London and the Jardin des

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Plantes in Paris. The slow way in which the animals rose to the surface, the motionless poise of the almost sunken body, the nostrils often just appearing at the surface, were very much alike in both animals. The stomach of the manatee resembles that of the hippopotamus in an atrophied condition; the sexual vesicles are found in both the hippopotamus and the manatee; the placenta of the hippopotamus offers points of resemblance with that of the dugong; and the brain of the hippopotamus, besides its typical relations to those of the pachyderms and ruminants, has also affinities with that of the manatee. "Beginning with the pig, we pass by an easy transition to the peccary, which leads to the hippopotamus, and thence, in diverging lines, to the ruminantia on the one hand and the manatee on the other. Paleontologists have not discovered a form which bridges over the gap between the hippopotamus and the manatee, but it will be remembered that certain fossil bones, considered by Cuvier to have belonged to an extinct species of hippopotamus (*H. medius*), are regarded by Gervais as the remains of the *Halitherium fossili*, an extinct sirenian, of which order the manatee is a living representative. . . . I do not mean to imply that the manatee has necessarily descended direct from the hippopotamus, though extinct intermediate forms may in the future show this to be so, for possibly they may be the descendants of a common ancestor. . . . It seems to me, however, that the only explanation of the structure of the living forms, and of the petrified remains of the animals referred to in these observations, is the hypothesis of there being some generic connection between them." Some writers have regarded the dugong as the behemoth of the Scriptures, which ate grass like the ox, and whose bones were as bars of iron, although the identity is more frequently ascribed to the hippopotamus. Since they are both so much alike, either animal will do. "It is true," says our English writer, "that the dugong does graze on submarine pastures, and that his bones ring as hard as steel when struck; but the reference might be held to apply equally well to the *Halicore tabernaculi* of the Red Sea, which bears a rough resemblance to its Australian relative."

Rüppel has suggested that the curtain with which the Israelites were ordered to veil the tabernacle was made of the skin of the dugong; but it is hard to imagine how a hide an inch thick could be adapted to such a purpose.

Another member of the family of the sirenians (*Rhytina stelleri*) was found by the Russians in Behring Strait in 1771. The mariners of Behring's second expedition, who were shipwrecked there, lived principally off its flesh for nearly a year. It is said that the animal was so hotly pursued afterward by hunters that it was exterminated in seventeen years, and no specimen has been seen since. Baron Nordenskiold, however, in his "Voyage of the Vega," adduces evidence to prove that a specimen of this animal was seen twenty-seven years

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ago, although there is little doubt that it is now extinct. The Baron, moreover, does not believe that its extinction was due to destruction by the hunters, but that it was a survival from a past age, doomed to

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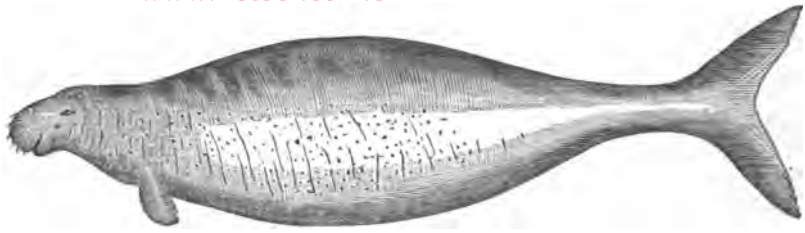


FIG. 3.—RHYTINA STELLERI, RECONSTRUCTED.

extinction, which overtook it when it was driven from its pastures on the shore of Behring Island. It attained a length of twenty-five feet, and had a skin composed of horny tubes, sometimes an inch long, wrinkled like the bark of a tree, which served to protect it from the ice and rocks on which it fed. It had no teeth, but its jaws were covered with an undulating surface of horny, tubular matter; and it was a vegetable-feeder, resembling in habits and qualities the other members of the family.

THE MACHINERY OF ELECTIVE GOVERNMENT.

BY PROFESSOR GOLDWIN SMITH.

IT is not necessary, for the purpose of this paper, to enter into any comparison between hereditary and elective government. Manifest it is that the era of elective government has come. In the communities of the New World, the latest development of humanity, the hereditary principle, has failed to take root; the monarchy of Brazil being merely a European dynasty in exile, the life of which hangs by a thread. In the Old World dynasticism is plainly in a state of decadence, the forms surviving longest, as might have been expected, where the substance had been most completely abolished. The era of elective government has come, and in the wise ordering of it, so as to give public reason the upper hand, and to reduce as far as possible the influence of passion, class interest, selfish ambition, faction, and corruption, lies the political hope of the world. If hereditary monarchy and aristocracy are dead or doomed, dead also is the light hope of the Revolution that all the evils of government would be swept away and the reign of reason and justice at once opened, if only monarchy could be overthrown. The divinity of the people has proved almost as unlike reality as the divinity of kings. It is time that the form of government should, if possible, be settled, and the political revolution

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brought to a close; the prolongation of the struggle, with all the appeals to passion and other sinister motives which it involves, is seriously affecting character and collecting difficulties round the government of the future, while a deeper and more momentous revolution, in the religious and social sphere, threatens the stability of civilization, and demands with increasing urgency the attention of the world.

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It is needless to say that the forms of government are not all. Constitutions, however wisely framed, will not work without political character; nevertheless, constitutions are most important, and their influence in forming political character is not small. The adoption of elective government in any shape implies of course that the people have arrived at a certain stage of intelligence and self-control. In what are called the South American republics the attempt to introduce elective institutions among Spanish creoles and Indians has totally failed, and the result is a series of dictatorships, the offspring of usurpation, which are little better than leaderships of a human herd. A sudden introduction of elective government into Russia would, in like manner, probably result in anarchy. On this subject the world has received lessons which reaction has exaggerated to the extent of almost denying the usefulness of wisely ordered institutions, as though blind habit and prejudice alone were trusty guides, and reason, sovereign in all other spheres, were excluded from the highest.

Strict definitions of government and enumerations of its functions are of little value. It may be described, practically, as the organization of the community for such objects as are best attained by common action; a definition which will include national defense and protection of life and property always, but also such other objects as circumstance and the conditions of the nation internal or external may from time to time suggest: centralization being at one time good, while, when a system has been set on foot and the people trained for it, the moment for decentralization may arrive, individual action being as a rule preferable because it calls forth more public virtue and raises the character of the citizen.

In such a paper as this, all that can be done is to present the chief points as they have been brought before the writer's mind by seeing the working of elective government in three countries—Great Britain, the United States, and a British colony. This object will be secured even if none of the writer's opinions, which are stated with unavoidable brevity, should commend themselves to the reader.

The chief points are party government, the expediency of a second Chamber, the mode of electing the Legislative Assembly, the constitution of the Executive, and the franchise. The consideration of these at least suffices for the present. On the horizon there are perhaps symptoms of a still greater change. Parliaments are losing much of their importance, because the real deliberation is being transferred from them to the press and the general organs of discussion by which

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the great questions are virtually decided, parliamentary speeches being little more than reproductions of arguments already used outside the House, and parliamentary divisions little more than registrations of public opinion. It is not easy to say how far, with the spread of public education, this process may go, or what value the parliamentary debate and division list will in the end retain. If monarchy is primeval, parliaments are the offspring of the middle ages, and for them too the sand in the hour-glass of history runs. But this is a problem which belongs to the future.

At present party it is that governs, though under different sets of forms. In England it governs under the forms of King, Lords, and Commons; in the United States under the forms of President, Senate, and House of Representatives, together with the State Executives and Legislatures. In England and the United States alike it is supreme. It elects the members of all the Legislatures, since it controls the nominations, without which no candidate can go with a chance of success to the poll. It appoints the executive, which is a committee of its leaders, and the composition of which always depends on the fortunes of the party conflict; it supplies the working organization of the Legislature, a reorganization of which in England or elsewhere will be attempted in vain without a solution of this preliminary question. Why is it that the work of De Tocqueville, with all its philosophy and its literary beauty, is practically so little instructive and so seldom quoted in the United States? Because he studied the forms, not the forces, which are the parties. Why is it that the Senate of the United States, designed specially to embody the federal principle, while the House of Representatives embodied the federal and national principle, has not corresponded in action to that design? Because the same parties control both Houses and the State government at the same time. Congress, in truth, is now little more than a place for formally ratifying and recording the decisions at which the party having the majority has arrived in caucus, where the only real deliberation takes place. As the minority in caucus is bound by party law to vote with the majority in the legislative hall, it often happens that a small minority of the whole Legislature passes a law or carries an election. Take away party, and we see that the whole of the present system of parliamentary government would crumble. We have, then, at once to ask what party is; upon what basis of reason or public morality it rests, and whether it can last. Burke says:

> Party is a body united for promoting by their joint endeavors the national interest upon some particular principle on which they are all agreed. For my part I find it impossible to conceive that any one believes in his own politics or thinks them to be of any weight who refuses to adopt the means of having them reduced into practice. It is the business of the speculative philosopher to mark the proper ends of government. It is the business of the politician, who is the philosopher in action, to find out proper means toward those ends, and to employ

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them with effect. Therefore every honorable connection will avow it is their first purpose to pursue every just method to put the men who hold their opinions into such a condition as may enable them to carry their common plans into execution with all the power and authority of the state. As this power is attached to certain situations, it is their duty to contend for those situations. Without a proscription of others, they are bound to give to their own party the preference in all things; and by no means for private considerations to accept any offers of power in which the whole body is not included; nor to suffer themselves to be led or to be controlled, or to be overbalanced in office or in council by those who contradict the very fundamental principles on which their party is formed, and even those upon which every fair connection must stand. Such a generous contention for power on such manly and honorable maxims will easily be distinguished from the mean and interested struggle for place and emolument. The very style of such persons will serve to discriminate them from those numberless impostors who have deluded the ignorant with professions incompatible with human practice, and have afterward incensed them by practices below the level of vulgar rectitude.

Such is the vindication of party by a public man who himself broke away from party, outraged connection, and vainly attempted to disguise his secession by an appeal from the living Whigs to the Whigs who were in their graves. It clearly implies that the community is divided by a difference of opinion, not only on ordinary matters and points of current administration, but on some question of fundamental character and of paramount importance. Nothing less can make the submission of the individual intellect and conscience to party discipline rational or moral. In the absence of such a question, party is faction, the ruin of all commonwealths. Is the stock of such questions inexhaustible? In Canada it is already exhausted, and the two parties there are simply two factions, fighting for place with the usual weapons, and poisoning the political character of the people in the process; no man of sense cares a farthing which of the two, as a party, is for the time being in the ascendant; but every man of sense perceives that if the faction fight continues to rage much longer it will bring disaster on the country. As the earth—according to astronomers—sees in her satellite, of which the atmosphere is exhausted, what her own eventual condition will be, so England may see in her colony what her party government will be when the list of organic questions comes to an end. In the United States, party had its origin in the conflict between Federal unity and State right; then slavery sheltered itself behind State right as a rampart against legislative abolition, and the party conflict raged on the double issue with increasing heat, till it burst into the flame of civil war. Now, though the memory of the war lingers, though there is still a feeling that its issues may possibly be revived, though the negro's liberty of suffrage remains a subject of contention, though a solid South is the core of the Democracy, the parties are evidently breaking up. In each of them, particularly in the Republican party, there is a split wider than the interval of opin-

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ion which divides the two parties from each other. Civil-service reform, the burning question of the hour, divides the Republicans into two bitterly hostile sections, while it unites the reform Republicans to the reform Democrats; and free trade, the question next in importance, though less burning, is equally regardless of the party lines, the Republicans of the West being commonly free traders, while among the Democrats of Pennsylvania there has always been a protectionist element strong enough to prevent the party as a whole from moving effectively in favor of free trade. Thus in the United States too, the death of party as a connection sustained by distinctive principle, and the survival of mere faction, seem to be in sight. In England, no doubt, there are still organic questions, such as the extension of the franchise, the Established Church, and the House of Lords; yet even in England the symptoms of dissolution have begun to appear, and in the last century there was an interval of political stagnation during which the party system degenerated into a struggle for power carried on between unprincipled connections with the usual accompaniments—intrigue, calumny, and corruption.

There are some, including grave historians, who fancy that party has its everlasting source and justification in a natural line dividing the political temperament of mankind. But can anybody seriously maintain that a thing so multiplex, varied by such infinite shades, and so mutable, even in the individual man, as temperament, is capable of this sharp and permanent bisection? Can any instance be named in history of a party founded on temperament, not on interest or connection? In politics, as in other things, age, no doubt, as a rule, is cautious, and youth hopeful; yet what reactionists are more violent than the younger members of an aristocratic faction? Is not this evidently a theory of human nature constructed to underprop a falling system? And be it observed that, to make the system work, there must be two parties, and two only. If parties multiply, as multiply they do, and will do in increasing measure, parliamentary anarchy must ensue, and the Government will be left without a sufficient basis. In France the number of fractions, each of which is really a separate party, has for some time past rendered ministries rickety and short-lived. In Italy, to give Government a sufficiently broad foundation, a double ministry, the Cairoli-Depretis, was formed, but with no satisfactory result. The German Parliament is split into at least six parties, not one of which has anything like a majority. In England the unity of what is called the Liberal party, and with its unity its ability to sustain a government, are now in great measure lost, as would appear at once if the commanding influence of its present chief were removed. The Tory party preserves its solidity, but this is because it is a party of interest, the tendency of which is always to unite, while the tendency of opinion is to divide, and to divide in proportion to the activity of intelligence and the amount of moral independence; so that one necessary result

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of the system is to give class-selfishness a great and ever-increasing advantage over patriotism and conviction. The quicker the intellect and the stronger the conscience of the nation become, the less practicable will be the mode of government which we are told is alone possible, and destined by an inherent necessity of human nature to endure to the end of time.

Even in its best estate, when there are organic issues, issues which create genuine enthusiasm and raise the combatants above the meanness of faction, is party a good government? Is not the possession of power and place always present as a motive warping the conduct of the leaders on national questions? Does not sheer passion always rage among the rank and file? Is not corruption an almost indispensable instrument of party organization? The bribe may be money, it may be patronage, it may, when the support of rich men is to be gained, be titles and social grade; but is not bribery in some shape always there? Let the main object of association be ever so important, must there not be always, to preserve discipline and beat the enemy, a terrible sacrifice of conscience and of freedom of opinion? Is not legislation, on the most vital subjects, apt to be governed, not by regard for the public good, but by the exigencies of the conflict and the necessity of keeping up the ministerial steam, or raising an agitation to drive opponents from power? It was not an American adventurer, but a British nobleman of ancient lineage and enormous wealth, the vaunted pattern at once of the Conservative sentiment and the personal honor which is supposed to go with aristocracy, who was ready to take such a leap in the dark as household suffrage for the purpose of dishing the Whigs. At this moment is not party trying to cut the sinews of a government which is struggling against a great public peril? It is scarcely possible for statesmen under such a system to give their best energies to the work of legislation and government; their minds must be constantly occupied with strategy, and they are now being called upon in this country, by the increasingly demagogic character of their position, to spend their parliamentary vacation, not in recruiting their working powers and storing thought, but in the delivery of stump-speeches. Stump-oratory is, indeed, in a fair way to supersede statesmanship, for the masses who are now enfranchised care comparatively little about great questions; they want a leader who will fill their imaginations: this a striking stump-orator does, and to him, therefore, though in every essential respect he may be the worst of pilots, the helm of state is likely to be consigned. Perhaps even his influence will be less pestilent than that of the master of tactics and intrigue. Party has served its purpose in history; it has been the rough and questionable, yet perhaps indispensable instrument of progress in England, the agency by which, through a long and intermittent series of struggles, the supreme power has been transferred from the Crown to Parliament,

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and from the House of Lords to the House of Commons; but to rest in it as the permanent form of government would be to proclaim that the final state of society is unarmed civil war—civil war unarmed, yet with a perpetual liability to become armed, as it did in the United States twenty years ago. Combination for the attainment of particular objects or reforms, whether political, moral, social, or sanitary, is of course an undying necessity; but it is limited by the object sought; it involves no submission to conscience, nor even of the understanding except in the choice of means; it does not corrupt; it need not inflame; it furls its standard and disbands when the battle is won. As to connection, what Burke's ideal of it was he best could tell; what it was in the flesh we learn plainly enough from the parliamentary history of his time. But neither combination nor connection, in any moral and rational sense of the term, has anything to do with a system of government which perpetually sets up the great offices of state as the prizes of a contest between two organized factions, to one of which each citizen is bound to adhere, owing to his party an allegiance in fact higher than that which he owes to his political conscience or to the state.

It is almost killing the slain, otherwise we might ask in conclusion, supposing the whole community to be convinced of the wisdom and justice of a certain course of policy, is a moiety of it still to take the wrong side for the purpose of keeping up the balance of party forces without which the party system can not subsist; without which, in truth, a party government becomes of all governments the least responsible? Such an agreement as would be fatal to the standing organization of civil discord is by no means out of the question; to it tends the advance of political science and of the scientific spirit generally, which, gradually making its way in all spheres, is not likely to leave politics untouched. In England at this moment the nation at large is Liberal, though in various degrees, and pretty well united in favor of the modern and against the mediæval principles of government; while the continuance of a division depends mainly on the existence of one or two special interests, such as the territorial aristocracy and the beneficed clergy of the Established Church. In fine, as has already been said, the best and indeed the only possible form of government, if the advocates of party are to be believed, is one the foundation of which must inevitably be weakened by every advance of the public intelligence, and which the attainment of truth on the great political questions will bring utterly to the ground.

What, then, is the alternative? The alternative, supposing the elective principle to be accepted, is obvious. It is the regular election of the Executive Council by the members of the Legislature. This would be simply the elective counterpart of the Privy Council, appointed under the monarchical system by the king, which is still the legal executive of England. Renewal by installments would keep the

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Executive Council always in sufficient harmony with the Legislature. But the Legislature and the Executive would be set free each of them to perform its proper functions. The Legislature would no longer be hampered by the fear of overturning the Executive; the Executive would be stable, and would discharge the duties of administration and police steadily and without fear about its own existence. At present in France, executive government, the sport of factions and of sections of factions, is utterly unstable, and can hardly assure the necessary protection to the citizen, much less engage his full confidence and his hearty allegiance. No longer would half or more than half the public men of the country be employed in propagating discontent, or a moiety of the nation be in a state of moral insurrection against the government which ought to be the object of its united loyalty and support. It is true that the criticism of an organized opposition would be withdrawn, but that criticism is always passionate and unjust; it is, in fact, not criticism but attack; and the fullest opportunity of fair criticism in an open Legislature would remain. Of the bribery, whether coarse or refined, which is now employed to hold together a following, there would be no need, the tenure of office being secured by law. Under such a system evil motives and influences would not be excluded; they can not be excluded from any system founded on human nature; but they would not be an inseparable part of the polity, and their sway would be diminished by every improvement in the political character of the nation.

Responsibility would not be impaired, inasmuch as an office would be intrusted to each minister only for a term, after which he would have to answer for his conduct, while the Legislature would retain the power of censure, and in extreme cases of impeachment and removal. There would be no majority to vote black white under a false sense of honor for the purpose of shielding a criminal of its own party. The election of the Executive by the Legislature is the natural application of the elective principle of government. Nor can it be said to be wholly novel. It has been tried in Switzerland, though it is true that Switzerland being not merely a nation with a federal structure like the United States, but a union of really different elements, German, French, and Italian, her case is peculiar, and her example must be used with caution. It may be said to exist, though in an irregular and objectionable shape, in England, since the ministry is virtually designated by the vote of the House of Commons.

Another advantage of the regular election by the Legislature to the offices of Government might be the choice of ministers with reference to their departmental aptitudes, in place of the pitchforking system which the necessity of finding places for all the leaders at present entails. Nor need there be much fear of want of sufficient harmony in a board which would have common administrative duties, common pride in their successful performance, and the union

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of which would not be tried by differences of opinion about measures of legislation. The state would not be deprived, as it is now, of the services of a first-rate administrator, say of finance or of foreign affairs, because he happened to be in the minority on some legislative question. It is very well for Burke to say that men of the other connection are not to be proscribed; but proscribed under the party system they are and must always be.

Ought there to be a second Chamber? That there ought, is an article of the political creed formed on a supposed inspection of the British Constitution. Imitation of the British Constitution, without discriminating between forms and realities, has led Europe a strange dance. Great Britain can hardly be said to have a constitution in the proper sense of the term. She has a series of enactments, from the Great Charter to the Bill of Rights, limiting the power of the Crown and securing the liberty of the subject. Apart from this she has nothing but a balance of political forces, determined by a long struggle, if balance it can be called, when the political power of the Crown has been reduced almost to nothing, and that of the Lords to a fragment of what it once was, since they can make no permanent stand on important questions themselves, though a stand may be made by the representatives of their order and interest in the House of Commons. There are traditions, no doubt, which in England herself have been fixed by long practice and handed on by a group of political families, notwithstanding which some important points, such as the rights of the House of Commons with regard to the approval of treaties, are still in an unsettled state; but out of England these traditions fail, and, when Canada is set to govern herself according to "the well-understood principles of the British Constitution," it soon appears that these principles are not so well understood, or at least not so religiously observed, by colonial politicians struggling for place, as by the members of the Carlton and the Reform Club. The written constitutions which all the nations of Europe have framed for themselves embody the forms not the realities of parliamentary government in England. They give the appointment of ministers to the king; the consequence of which, in Spain for example, is that the stress of the struggle for power rests just where British practice forbids it to rest, that is to say on the Crown; and every change of ministry is accomplished by an intrigue of the palace or an insurrection. A group of conspirators forces itself upon the monarch, and then, there being no political life in the nation, nominates a Parliament of its own followers, sometimes so far forgetting constitutional decorum as entirely to leave out the opposition; and this is called an adoption of the British Constitution.

The House of Lords has been everywhere taken for a second Chamber or Senate. It is nothing of the kind. It is one of the estates of the feudal realm, reduced by the decay of feudalism to comparative impotence, such influence as it retains being that, not of legislative au-

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thority, but of hereditary wealth. It has never acted as what it is imagined by the political architects of Europe to be, an Upper Chamber revising with maturer wisdom and in an impartial spirit the hasty or ultra-democratic legislation of the more popular House. It has always acted as what it is, a privileged order in a state of decay and jeopardy, resisting as far as it dared each measure of change, not political only, but legal, social, and of every kind—*habeas corpus*, reform of the criminal law, abolition of the slave-trade, and a cheap newspaper press, as well as extension of the franchise—because change in whatever line threatened directly or indirectly its own existence. So far from being a Senate, it deliberately declared that it was not and would not be made a Senate, by refusing to let a life Peer take his seat.

The Upper Chamber or Senate is of course intended to have a character of its own distinct from that of the Lower House, otherwise the institution would be futile. The House of Lords has a distinct character with a vengeance, and shows it on all occasions; but this nobody proposes to reproduce, modern society having decidedly pronounced both against hereditary legislation and entailed estates. What, then, is the distinction to be? Of what special elements is the Upper Chamber to consist? This is what no political theorists tell us, while they all busy themselves in devising modes of appointment or election. Whether this or the other mode of production is the best, it is impossible to judge, unless we are told what is the thing to be produced. Is the Senate to be a house of old men? If so, it will have the weakness of age, it will be ridiculed and despised. Is it to be a house of the rich, that it may specially protect the interests of property? If so, it will be odious, and expose to political as well as social attacks the very interest which it is set to guard. Is it to be a house of superior wisdom and character? If so, the popular house will be bereft of its natural moderators, and delivered over to the passion and impulse which it is the object of the institution to control, while, its voice being the more direct expression of the national will, it is sure, in any collision, to carry the day. This was seen in the case of Cromwell's attempt to relieve his government from the stress of conflict with the House of Commons by reviving the Upper House, the only result of which was that the Lower House was left leaderless, and the two fell foul of each other. The very existence of an Upper Chamber is found, in the United States for example, to increase the recklessness of the Lower Chamber, which feels itself at liberty to do what is popular at the moment, leaving it to the Upper Chamber to prevent mischief by the exercise of its veto. A Senate nominated, as is that of the Dominion of Canada, by the Executive, besides being an outrage on elective principle, is a nullity, though with a lurking possibility of misuse under the party system and in a country where politics are fierce and constitutional tradition weak, as was seen when the Provincial Senate of Quebec was used for the purpose of a sort of *coup*

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d'état by a party which wanted to drive the Government to a dissolution. Any notion that a nominated Senate will be the serene abode of high character, or special knowledge, or commercial authority, such as shrinks from electoral contests, is belied by the experience of Canada, where the Senate is a mere infirmary for superannuated partisans, especially for such as have spent money for the party elections. Where the Senate is elective, and the authority of the nation is divided, in whatever proportions, between the two Houses, collision is certain to ensue, sooner or later; as it has in Victoria, as it did in France when, on the famous 16th of May, the country was in this manner brought to the verge of revolution. Collision is not the calm review of legislation, nor has it any tendency that way; its tendency is to political convulsions. Political convulsions are the almost inevitable result of an attempt to divide the national will and to make it manifest itself through two independent organs, sure soon, if it were only from corporate jealousy, to become antagonistic. Where harmony has been preserved, it has been due to the ascendency of the same party in both branches of the Legislature, a condition of things which is always precarious, while, if what has been said of the party system generally is true, that system can not be relied on as the sustaining or controlling force of any polity for the future. The whole theory of mechanical checks and balances, however consecrated, is unsound; it belongs to the times of jealousy between monarchs and their subjects; the hope of a commonwealth lies in the more genial policy of disposing all its members to the common good. Methods of securing deliberate action may be devised in the interest of all; but no ingenuity can really devise a method of permanently dividing the national will and making it check itself.

To secure deliberate action, the first thing necessary is to have the wisest men of the country in that assembly which represents the will of the nation. But haste may be also prevented, and time given for reflection and for change of mind, by arrangement of the forms of legislation. It might be desirable even to confer a suspensive veto for a short period on a stated minority. Such an expedient would at least be more effective than the obsolete veto of the Crown, and less disturbing to the political frame than a collision between the Commons and the Lords, out of which the only way is a coercive dissolution of Parliament in the midst of a boiling agitation, or a swamping creation of Peers.

The question whether an individual chief of the state is necessary concerns most the American Republic. It is at present complicated by the exigencies of party, which requires a chief—as an army requires a general—though such a minister as Lord Aberdeen was hardly more than the president of a council. In Switzerland—an example which, for the reason already given, is always to be cited with reserve—there is only a titular President of the Federal Council,

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without personal power or a prominent place in the minds of the people. The belief in the necessity of an individual chief seems to be a tradition of monarchy. In framing their institutions the founders of the American Republic, though they substituted election for inheritance, and introduced the federal element, were guided by the principles which Montesquieu and other political philosophers of the time supposed themselves to have educed from the practice of the British Constitution. In the place of the king, whom they imagined to be the real ruler, though he had already become a figure-head, they put an elective chief magistrate, and they jealously guarded what they had been taught to regard as the palladium of liberty, the separation of the executive from the legislative, though, had their eyes been strong enough to look through the haze of constitutional fiction, they would have seen that the Legislature in England was all the time appointing and removing the executive, and appointing and controlling the judiciary to boot. The elective presidency is an almost unmixed evil, and an evil of the most formidable kind, especially since the multiplication of patronage has enormously augmented the magnitude of the prize and the number of the place-hunters whose fortunes are staked on the election. It involves the commonwealth perpetually in troubles like those of a disputed succession. It fills the country with the turmoil of a contest which now extends over at least two years of every four, and disturbs commercial and industrial as well as public life. It keeps party passions always at fever-heat. It breeds ever-increasing swarms of wire-pullers, intriguers, office-seekers, and political vermin of all kinds. It brings every dangerous question to a head; it did this in the case of the slavery question, which, in the absence of the artificial crisis produced by a presidential election, might possibly have dragged on and found a gradual and peaceful solution. A dispute as to the result of the election is always possible; it occurred between Hayes and Tilden, and then, too, infuriated partisans began to lay their hands on the hilts of their swords, though the good sense of the nation at last prevailed. Finally, the position of an elective President with personal power, but holding office only for a term, is a standing incentive to encroachment. The ambition of an ex-President, excited in this way, is now riding the country like a nightmare; and nobody can doubt that the aim of the men about him is to place him in the office for life, an object which, if they succeed in again re-electing him, they will not be unlikely to attain. That the people of the United States will ever with eyes open revert to the hereditary principle can not be believed by any one who has not persuaded himself that hereditary government is an everlasting ordinance, to which all who have strayed from it are sure to come back in time. But a lapse into a dictatorship, and from a dictatorship into something like a dynasty, would not be utterly impossible, if the foreign element, untrained to self-government, should become proportionally too large,

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and serious troubles of any kind should at the same time arise; it would be very far from impossible, if, in addition to the foreign element, female suffrage should be introduced. Nothing is really needed, at least in ordinary times, but a titular President of the Executive Council to represent the commonwealth on occasions of state. In the civil war Lincoln was, perhaps, useful as a chief, holding by tacit consent a sort of dictatorship during the season of peril; but institutions are not made for civil war, and a provision might easily be framed enabling the Legislature in case of great public peril to confer on the executive council increased authority for a limited time, somewhat after the fashion of the Roman dictatorship, which worked well enough during the healthy period of the republic.

Now comes a momentous question. Ought the election to the central Legislature by the people to be direct or indirect; in other words, ought the members of the central Legislature to be elected by the constituencies at large, as they are now in England and other countries under parliamentary government, or by the members of local assemblies elected in their turn by the people? The writer of this paper is a hearty democrat, and profoundly convinced that the people, with all their passions and defects, will on the whole vote right whenever they see their way. He is persuaded that the great obstacle to voting right, as well as to doing other things that are right, is selfishness, and that this prevails fully as much among the rich as among the poor; indeed, among the rich it is almost erected into a principle, under the pretext of defending the rights of property, as though the rights of the destitute did not require much more to be defended. He is not actuated, therefore, by any conservative prejudice in saying that to him the system of having a central Legislature elected directly by the constituencies at large seems to have decisively failed. There are two points in the process of election, the nomination and the voting. The second point only has engaged the serious attention of statesmen, whose minds have been occupied entirely with problems as to the qualifications for the franchise, the distribution of seats, and the question of the ballot. It is in the first part of the process that direct election has broken down. The people, if left to themselves, will choose rightly between two candidates; but who is to choose the candidates? The people at large can not select from any extensive area; a common man does not see over a hill, much less can he perform the task which Mr. Hare's plan would set him, of picking out the persons of greatest eminence from the whole nation—a process which would infallibly degenerate into a vast party ticket. On the other hand, the worthiest are not very likely to nominate themselves, though the least worthy are. The practical result is that the nominations are everywhere usurped by party organizations and their proprietors, by caucuses and wire-pullers, whose fell ascendency, complete in the United States and Canada, is being very rapidly extended in this country.

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The nominations carry with them the elections; the constituency at least has nothing left it but the choice between the two candidates whom the wire-pullers are pleased to set before them, and whose first qualification is of course entire subserviency to party, if not to something narrower still. Nor is there any visible way of breaking out of this fatal circle, which grows continually stronger and more confined. If an independent candidate attempts to offer himself, the wire-pullers on both sides practically combine against him as an interloper and a leader of rebellion against party discipline. The range of their unbeneficent agencies is, moreover, daily extending and affecting every part of public life. It is needless to say that a conclave of Tory squires is just as much a caucus as a Liberal "three hundred." Trusty managers of their own immediate concerns common men will manage to pick out of those with whom they are in daily intercourse, and whose characters they thoroughly know. In Canada persons qualified to judge say that the local elections, where party does not interfere, are good, and best where the area is smallest. An assembly consisting of the chosen men of each locality will be more intelligent than the body of its constituents, and at each remove upward a step in intelligence is gained. The increased importance given to the local assemblies would raise their character by inducing better men to come forward, especially in the cities. Nor, with a limited body of primary electors, is there much practical difficulty about the nominations. A college of electors, called into existence for a single term, such as that which formally chooses the President of the United States, of course becomes a nullity: the result is a mandate: but this would not be the case with a standing assembly, electing periodically members of a central Legislature. The Senate of the United States, elected by the State Legislatures, may safely be said to be in average ability decidedly above any other legislative assembly in the world, and would be an admirable government if party would let it alone; while the House of Representatives, elected directly by the people, is not only inferior to the Senate in every respect, but is a body the meeting of which is by all good citizens justly regarded with dismay, while its departure is welcomed as a deliverance. The primary electors, instead of losing by the change, would gain a real power of indirect election, whereas the apparent power of direct election which at present they possess is an illusion, the reality having been filched from them by the caucus, which is always in the hands of a ring. A wise arrangement of local institutions on the elective principle would of course be the basis of the system, as it is the indispensable training-school of the people in self-government. The elections to the central Legislature, party being out of the way, ought to be by installments, a mode which would allow the steady inflow of public opinion, and at the same time prevent cataclysms such as now attend general elections, which are usually decided by some special agitation or an ex-

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citement of feeling on one question, to the neglect of the more general interests of the commonwealth. The term for which each member of the central Legislature was elected would be fixed, and there would be an end of the ministerial prerogative of dissolution, which has run into grave abuse, and may run into graver abuse still, if ministers are allowed to dissolve whenever they think they are sure of winning the elections, and thus to perpetuate their tenure of power. The election of a central Legislature by local Legislatures, and the installments, would no doubt be a tame affair compared with the turmoil of a general election under the present system; and those who think that turmoil is life will at once reject the proposal: to the writer, after observing the politics of a colony and of the United States, as well as those of England, the reverse appears to be the case. Turmoil and healthy political life seem to him totally different things. Mere saving of expense is not a paramount object, but the corruption as well as the enormous waste of general elections would be at an end. Nor is there much danger of stagnation: the world is in a fair way to have agitating questions enough, without breaking heads for Blue and Yellow.

Bad influences—vanity, intrigue, pique, self-interest, corruption, narrowness of view and motive—can not be excluded by any conceivable machinery from any human assembly. But the members of a local council, electing members of the national Legislature, would at least be acting under the eyes of the community, and with something of the responsibility which attaches to the exercise of a personal trust. They would usually have too much largeness of view to vote against an eminent man because he had promoted co-operative stores, or because he had gone wrong on the dog-tax. Nor in any reasonably moral community would they be likely to take direct bribes. It is time, however, as every one who lives under the rule of colonial politicians knows too well, that political corruption, in high places as well as in low, should be distinctly stamped as a crime, and brought under the regular cognizance of justice. It is just as capable of definition and of proof as any other crime, and assuredly it is not the least heinous in the list. For this purpose, as for the trial of contested elections, a tribunal is needed free from partisan influence and open for the reception of charges brought against men in public trusts by any citizen, with proper safeguards, of course, against wantonness or malice. Impeachment is obsolete, and an investigation undertaken by Parliament under the party system becomes a faction-fight. It seems incredible that the framers of constitutions for colonies teeming with corruption should have failed to make any provision for the trial of political offenses.

If we are asked whether it is at all likely that the plan of indirect election will be adopted, the vote for the supreme Legislature having been once ostensibly given to the people at large, we say at once that

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at present it is not. The world will have first thoroughly to learn by experience that the existing system is, or tends more and more to become, government by and for the wire-puller, not by or for the people. France is apparently about to make an experiment in the opposite direction, by the adoption at Gambetta's dictation of the *scrutin de liste*. But this is a warning to the rest of the world, the object of the measure evidently being not to improve the elections, but, by canceling all those local influences which on the whole are the healthiest, to render a particular politician more completely master of France.

Representation of minorities seems to have done but little good. The result is a torpid compromise which is likely to continue notwithstanding a change of sentiment in the constituency, because it is the object of all the three members, and especially of the holder of the minority seat, to avoid a contest, so that positive misrepresentation as well as political deadness may be the result. The minority member is nailed to his seat, and can neither take office nor retire, except at a general election. All complicated arrangements are apt to harbor wire-pulling, for the wire-puller, even if he is baffled at first, soon learns the trick. The only measure of this kind which appears to promise real improvement is the adoption of the second ballot when no candidate has polled an absolute majority at the first. This would give opinion, which is apt to split into sections, a fairer chance against a compact interest, and render it possible for an independent candidate to come forward with some prospect of success. At present the wire-pullers invariably succeed in persuading the people that their votes, if given for an independent candidate, will be thrown away.

Experience seems distinctly to have shown that, to make an assembly deliberative, its numbers must be limited. In a Parliament of six hundred or a thousand members, volleys of argument or invective may be exchanged between the two sides of the House, but deliberation is impossible. More than two hundred can hardly take counsel together. There is the resource of grand committees, which, however, is not available with party government, unless the committees are so arranged that the dominant party shall have a majority in each of them. Unless this is done, the full House will be always redebating and reversing the decisions of the grand committee.

With such a mode of election to the central Legislature as has been suggested, it will be safe to combine a widely extended suffrage. It will be safe, and it will be politic. For the instructed and reflecting few, a demonstration of political utility may suffice: proved expediency secures their allegiance; but, to engage the loyalty of the many, it is necessary that government should be administered in the name of an authority to which their hearts as well as their understandings bow. Such an authority in by-gone times was the king; such an authority now is the whole nation. No one who was in the United States at the time of the civil war could fail to see what immense strength that

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Government derived from the breadth of the basis on which it rested, and from the universal feeling that it was in the fullest sense the Government of the people. It was enabled in this way to put forth a power which no autocracy could have put forth. Many Americans, it is true, will tell you that universal suffrage is a failure, and that it is the great danger of the state. But they overlook the fact that the danger arises not from universal suffrage by itself, but from universal suffrage in conjunction with party government and direct elections. It is as the tool of faction and its demagogues that the rowdy is politically formidable. Universal suffrage, however, in America, is no doubt to-day a very different thing from what it was when the great majority of the people were substantial farmers, and almost all of them were holders of property, responsible, settled in their habitations, and of English blood. No absolute rule can be framed for all countries, nor even, supposing that such a rule could be laid down, would it be practicable everywhere to get up the hill again, when once you have gone down, and withdraw powers once granted to the multitude. Property qualifications are odious, and, where power is in the hands of the people, to be odious is to be weak. On the other hand, an education qualification is not odious; the writer, at least, has always found that artisan audiences receive the mention of it with favor; it is most reasonable, since a man can hardly give an intelligent vote, or do himself and his concerns anything but mischief, by voting without the common organs of intelligence; nor does there seem to be any insuperable difficulty in the way of ascertaining that an applicant for registration is able to read and write, or at least to read. Writing, perhaps, ought hardly to be required, for the horny hand of the farm-laborer may lose that faculty without default of brain or heart. Under a complete system of popular education, if we ever arrive at it, the school-certificate might be the qualification. All voters ought also to be liable to every civic duty, such as that of national defense, and that of serving on juries, if the system of jury-trial is retained on its present footing. If a sifting process is necessary, let it be one of self-disfranchisement by refusal of equitable conditions, rather than one of disfranchisement by exclusive legislation; the popular feeling that government rests on the broad basis of equality and justice will be less impaired. The sentiment of monarchies and aristocracies has been studied; it is now time to study the sentiment of republics. A good deal of sifting, and, on the whole, of the right kind, would probably be done by abstention, when there were no longer organized factions to marshal the irresponsible, and march them to the poll. As the possession of a vote excites interest in public affairs, the suffrage has a certain educating power, though by no means so great a power as some sanguine advocates of extension have maintained. A consideration, perhaps, of not less importance is that, under a thoroughly popular system of suffrage, the holders of property and the highly educated are spurred by regard for

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their own safety, if not by any more generous motive, to "educate their masters." If they knew their own moral interest, they would prefer this necessity for exertion to the torpid security afforded by what is called a strong government to wealth and pleasure. After all there will be risks, great risks, in popular institutions; but, as experience shows, nothing like so great as those which attend arbitrary power. At all events, feeble barriers merely chafe the popular flood; the only chance of safety lies in frankly embracing the democratic principle and framing securities for the ascendency of public reason over cupidity and passion, not in the interest of an upper class, but in that of the whole community.

There is a wide difference between the case of political and that of municipal suffrage. This is a point of the highest importance in America, where the cities are vexed and pillaged by a brood of municipal demagogues, such as the late Mr. William Tweed. Legislatures, in regulating the municipal suffrage, have forgotten the great change which the cities have undergone. In the middle ages they had a political life of their own, and as the antagonists of the rural aristocracy played a distinct part in political development. This belongs to the past; a city is now little more than a densely peopled district requiring a special administration. Moreover, the great merchants who were the leaders and magistrates of the cities in former days do not now live in them, but in villas outside them, nor do they seek city offices; the guilds are dead; the people, even in the same street, know little or nothing of each other. All unity is gone; there is only a human sand-heap, among the grains of which moves with sinister activity the ward politician. The chief, almost the only function of a city government in these days, is to raise and expend money; in equity and reason, therefore, the franchise ought to be in some measure proportioned to the amount of the contribution; it ought to follow the rule of joint-stock companies, rather than that of political communities, in which the poorest man's rights and liberties are of as much value as those of the richest. Nor is the present system in any way favorable to the poor, who are led by the petty bribes offered them by sharpers or rings, and by appeals to their class passions to vote for public plunder. The money goes into the pockets of the Tweeds; and nowhere are the health and comfort of the poorer citizens less cared for than in cities which are under the government of these rogues. A strong, permanent, pure, and enlightened administration, of a thoroughly business and scientific character, is what is needed by the people of every city, and by the inhabitants of the poorest quarters most of all.

Of the question of female suffrage the writer has spoken elsewhere.* The spheres of the two sexes, as he believes, are, like their

* In an article in "Macmillan's Magazine," which at the request of some members of the House of Commons was reprinted, and was circulated by them among the members of the House.

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natures and gifts, coequal but distinct, and incapable of identification unless women can take what is now the work of men, and men can take the work of mothers. Law, even in the most civilized states, rests at bottom upon the force of the community, and the force of the community is male. Enactments made by those who had not power to execute them would be futile. Would the men allow the women to vote them into a war, say in defense of a romantic Queen of Naples, or some other darling of female fancy? Would they execute upon themselves the severe laws which women are threatening to make against them in matters connected with the relations of the sexes? If they would, the tyranny of man must be a fable. But if decrees were not carried into effect, and laws were not executed, the government would fall. In domestic life, though a character at least as high as the political is formed, political character is not formed. What would be the condition of a nation in a dangerous crisis like that of secession in the United States, or even the Irish crisis here, if its policy were swayed to and fro by the emotions of the women? The advocates of women's suffrage hardly realize the fact that they are turning government over into female hands; yet in the United States, where the franchise is personal, the female voters would at once outnumber the male; and in England it is well understood that the limitation to widows and spinsters is merely put forward as a mask. The next step would be a demand of eligibility to Parliament and to political office, which is probably the personal aim of some of the female leaders (one of whom, indeed, wanted to be a candidate for the presidency), and could not consistently be refused. But could women in office ever be made accountable like men? A sex which is not thoroughly justiciable can not be made thoroughly responsible; and, when women have interfered in politics, their want of a restraining sense of accountability has appeared. Henrietta Maria, by the indulgence of her feelings, hurried her husband and the country into a civil war, as Margaret of Anjou had done before her; Marie Antoinette, by a similar outbreak of passion, precipitated the French Revolution; and the Empress Eugénie, with fatal truth, called the German War her own. That women can not take part in the defense of the country is an argument which may have been pressed too far; yet they are hereby rendered untrustworthy counselors in questions of peace and war. Some who know the Southern States well say that if the women could have had their way there would very likely have been a renewal of the civil war. The whole history of female government leads to conclusions adverse to the change; the reign of Elizabeth herself, now that we know what she really was and did, as decisively as the rest.

Neither men nor women can plead natural right against the good of the community; the community is the ordinance of nature. Men were not invested by nature with political liberty; they won it by

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efforts in which multitudes of them have perished, and they have shared with their families all its substantial advantages. As they have fought, so they have legislated, for their wives and children as well as for themselves. For their wives and children as well as for themselves they have reclaimed the earth, made it fruitful, and bridged the sea. What Mr. Mill calls slavery has, in the main, been the guardianship of affection, a guardianship with which the women could not have dispensed, though the conception evidently never entered Mr. Mill's mind. If the man has had authority over the woman, the woman has had authority over her child. The indissolubility of marriage, which Mr. Mill calls slavery, and which is his capital grievance, is at least as much a restraint upon the roving passions of the man as upon the affections of the woman; in truth, the very fact that man has instituted monogamy and made marriage indissoluble is the most conclusive answer to Mr. Mill's charge. So far from women not being able to get justice in a court under the existing law, the difficulty is to get justice against a woman, and both in America and in England male legislatures have been passing laws respecting the property relations of married people, which in effect release the wife from all the obligations and liabilities of matrimony, leaving the husband as fast bound as ever. American ladies who demand that marriage shall not be a union, but only "a copartnership," would soon flinch from the consequences of their own principle. That domestic outrage exists in barbarous classes is too true; and it is committed as often perhaps by women against children as by men against women, though the complaints of the children are not so often heard; but fifty votes given to the unhappy victims would not correct the brutality of a savage home. The women who head this movement do not really want equality; they want and expect to retain, with political power and freedom from marital control, all the present privileges of their sex. They do not want to be thrust to the wall by male strength in a struggle for existence, to have the penal law extended to them in all its severity, or to be compelled to do the rough and dangerous work of the world. But they will find that they can not have both equality and privilege, or at once renounce and retain the guardianship of affection. Chivalry may linger, as sentiments do linger, for a season; but it will soon fall into the grave of the conditions on which it depends. Perhaps the sex generally will find that they have paid dear for the fancy of the few who wish to enter into public life.

What would be the effect of public life on female character, and the effect of female intervention on the character of public life, are questions upon which some light has been thrown by our actual experience since the commencement of this agitation. About the most violent and scurrilous production which has appeared in the American press for many a day was a series of letters written by a female politician; and it is remarkable that her object was to defend the system of favor-

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itism and jobbery in the exercise of patronage against administrative reform.*

The most important point remaining is the ballot, which has now been pretty well tried. The notion that it would specially favor Liberalism is at an end. It annuls all pressure, that of the trades-union or the social circle, as well as that of the landlord or the customer. On the other hand, it affords a cover for individual follies and for all the motives which shun the light. It has failed to baffle the wire-puller for the reason already mentioned; he always succeeds in convincing the mass of electors that a vote given for any but a regular party candidate will be lost. Probably the balance of advantage is on the side of allowing a man to give free expression to his real sentiments, whatever they may be; the result is then trustworthy, and the general action of the voters as citizens will be in accordance with their votes.

That the British Constitution is unwritten, and therefore elastic, may be the boast of Britons, but, like many things which are the boast of Britons, it forms no precedent for other nations. For reasons before given, unwritten traditions or understandings are valid only in these islands. In new-born democracies nothing will prevent the militant politician from using for his own behoof and for the discomfiture of his opponent all the powers which the letter of the law puts into his hands, the sacred principles of the constitution notwithstanding; and thus we find a lieutenant-governor of a province turning out the ministry of the majority in order to transfer the provincial patronage to the hands of his own party on the eve of a general election, and the Senate of the same province withholding the supplies as an ordinary

* The suffrage movement is, in the United States at all events, only part of a movement against the limitations of sex, against the bondage of matrimony and the burdens of maternity. Those who are thus striving to break up the political unity of the family are assailing its integrity in other ways by separating as much as possible the interest of the wife from that of the husband, and teaching her to regard him not with confidence but with jealousy. The writer has heard in several quarters that some of the female leaders of the movement do all in their power to deter young women from marriage. The name of John Stuart Mill, on the banners of the movement, indicates its real character, and shows that it extends to the general status of women. If it spreads in America, the consequence will be, that the Anglo-American race will be supplanted by the Irish and Germans, whose women are loyal to sex, true to the family, and good mothers, while all the Irish and half the Germans belong to a Church by which the family has always been upheld.

What nobody will deny is that the question is one of the most tremendous significance. The family is more important than the state to human character and happiness; and while the state may be regenerated by the family, the family can not be regenerated by the state. Levity, therefore, and concession to vague sentiment are criminal. Man, as the responsible holder of political power, is bound to decide unselfishly and generously; but he is bound to decide carefully and wisely, in the interest of his partner as well as in his own. In England Conservatism has of late been led into strange ways. If, instead of allying itself with beer and ignorance against intelligence, or stirring up war passions as revolutionary as they are wicked and destructive, it would take to guarding property and the family, its just influence in the state would be increased.

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stroke of party warfare, when it wanted to upset a government which had a majority in the other House. A young commonwealth requires a written constitution, and a strict one. Moreover, the document, which becomes a political bible, is an instrument of no small power in educating the citizen, and has a conservative influence of the best sort over his mind.

The only point of first-rate importance which remains is the amendment of the Constitution. This ought to be distinctly vested in the nation at large, the sovereignty of which ought to be unequivocally proclaimed; and a mode should be provided by which the sovereign can exercise the power. An elective assembly will not terminate its own existence, or even pass a measure of reform affecting the position of a large portion of its members, if it can help doing so, any more than a king will abdicate of his own accord. The more vicious it is, the less amenable to opinion it will be. The English Parliament in 1832 did not voluntarily reform itself; reform was forced on it by the nation, which threatened it with violence if it held out longer. In 1867 it was let through a trap-door. The more insufferable the American House of Representatives becomes, the more tenaciously will it cling to its evil existence: and electing members pledged to consent to the submission of an amendment for its reformation or abolition would be a desperately difficult process for the people, when the organizations are in the hands of the politicians. The only visible remedy would be revolution: and a revolution, though not a bloody one, would apparently be inevitable if the British nation were to make up its mind to abolish the veto on national legislation at present possessed by the six hundred privileged families represented in the House of Lords. The object might be attained by providing that it should be lawful at any election of representatives for the electors to inscribe on the same ticket a requisition for the submission of a constitutional amendment, and that the Legislature should be bound to submit the amendment to a *plébiscite*, if a certain proportion of the electorate had supported the requisition. No one who is familiar with the character of democracies, and knows the extent of the *vis inertiæ* which prevails in them, will deem the power likely to be too frequently used.

The writer, let him say once more, is fully aware that much of what has been said will to many seem undeserving of practical consideration. He knows well that party government, a second Chamber, and direct election of the central Legislature by the people at large, are regarded as immutable ordinances of nature. Yet this does not shake his conviction that a single central assembly elected by the members of local assemblies, and itself electing the executive, will after sufficient experience be the form finally assumed by elective governments.—*Nineteenth Century.*

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SOUND AND RADIANT HEAT.*

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By Professor JOHN TYNDALL.

THE Bakerian lecture of 1881 before the Royal Society opens with a brief reference to the researches of Leslie, Rumford, and Melloni. The labors of Tyndall and Magnus, as far as they bear upon the present subject, are then succinctly sketched, their points of difference being signalized and briefly discussed. This preliminary sketch is wound up by a reference to a recently published paper by Lecher and Pernter, who, while supporting the lecturer in the matter of gases, dissent from him in the matter of vapors. These investigators are especially emphatic in affirming the neutrality of aqueous vapor to radiant heat. Following Magnus, they refer Tyndall's results to vapor-hesion, that is to say, to the condensation of the vapors on the surfaces of the plates of rock-salt used to close the experimental tube, and on the interior surface of the tube itself.

In November, 1880, the lecturer's investigations in this field were resumed. Former experiments were repeated and verified with divers sources of heat, and with experimental tubes, some polished within, and others coated inside with lamp-black. The results obtained with the one class of tubes are substantially the same as those obtained with the other.

But even a coating of lamp-black may be supposed to reflect a certain amount of heat, hence the desirability of an arrangement whereby internal reflection should be entirely abolished. This was accomplished in the following manner: A spiral of platinum wire, rendered incandescent by a voltaic current of measured strength, was chosen as source of heat. An experimental tube thirty-eight inches long and six inches in diameter had two circular apertures at its ends, closed by transparent plates of rock-salt, three inches in diameter. The tube was furnished with three cocks—one connected with a Bianchi's large air-pump, another with a purifying apparatus, while through the third vapors and gases could be admitted. Prior to entering the tube, the calorific rays were sent through a very perfect rock-salt lens, by means of which an image of the spiral was formed on the most distant plate of rock-salt. To obtain the image with clearness, the spiral was first rendered highly luminous, and afterward reduced, by the introduction of resistance, to the required temperature. In this way a calorific beam was sent along the axis of the experimental tube without at all impinging upon its interior surface. No reflection came into play; no absorption by hypothetical liquid films, coating the internal surface,

* Abstract of the Bakerian Lecture of 1881, delivered by Dr. Tyndall, F. R. S., on the "Action of Free Molecules on Radiant Heat, and its Conversion thereby into Sound."

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could occur; and yet experiments made with this arrangement entirely confirmed the preceding ones, wherein by far the greater quantity of heat which reached the pile had undergone reflection.

When the source of heat was changed to a carefully worked cylinder of lime, a portion of which was rendered incandescent by an ignited stream of coal-gas and oxygen, the results were confirmatory of those obtained with the spiral. The order of absorption in both cases was the same, the only difference being that the fractional part of the total radiation absorbed in the case of the lime-light was less than that absorbed in the case of the spiral.

To condense the radiation from the lime-light, concave mirrors were sometimes employed, and sometimes rock-salt lenses. The results in both cases were identical.

An experimental tube of the dimensions here given was employed by the lecturer to check his results more than ten years ago. Its interior surface was rough and tarnished, and when warmed dynamically by the entrance of a gas its power as a radiator enabled it to disturb, to some slight extent, the purity of the results. To obviate this, the experimental tube recently employed was provided with an internal silver surface, deposited electrolytically and highly polished. By this arrangement the radiation of the tube itself, as well as its absorption, was rendered quite insensible.

The rock-salt plates used to close the experimental tube, and on which liquid films are also alleged to be deposited, remain to be examined. In this case also an *experimentum crucis* is possible. If the observed absorptions be due to such liquid films, then the separation of the salts more widely from each other, the space between them being copiously supplied with vapor, ought to produce no effect; but if the absorption, as alleged by the lecturer, be the act of the vapor-molecules, then the deepening of the absorbing stratum ought to produce an augmented effect. For many gases and some vapors this problem was solved as far back as 1863. By means of an apparatus then described, polished plates of rock-salt could be brought into contact with each other, and then gradually separated, until the gaseous stratum between them was some inches in depth. With sulphuric-ether vapor, the distance between the plates being one twentieth of an inch, an absorption of two per cent was observed. With a thinner stratum, or a weaker vapor, even this small absorption vanished; while in passing from one twentieth of an inch to two inches the absorption rose from two per cent to thirty-five per cent. Such experiments, recently verified, entirely dispose of the hypothesis that liquid films were the cause of the observed absorption.

The vapor-hesion hypothesis involves the assumption that liquids exert on radiant heat an absorbent power which is denied to their vapors. It assumes, in other words, that the seat of absorption is the molecule considered as a whole, and not the constituent atoms of the

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molecule. For, were the absorption intra-molecular, the passage from the liquid to the vaporous condition, which leaves the molecules intact, could not abolish the absorption. So far back as 1864 the lecturer had proved that when vapors, in quantities proportional to the densities of their liquids, were examined in the experimental tube, the order of their absorptions was precisely that of the liquids from which they were derived. This result has been recently tested and verified in the most ample manner by means of the apparatus in which internal reflection never comes into play. It furnishes, therefore, the strongest presumptive evidence that the seat of absorption in liquids and in vapors is the same.

As a problem of molecular physics it was, however, in the highest degree desirable to compare together *equal* quantities, instead of proportional quantities, of liquids and vapors. Highly volatile liquids alone lend themselves to this experiment, for only in the case of such liquids can vapors be obtained sufficient, when caused to assume the liquid form, to produce layers of practicable thickness. Two cases, however, have been very fully worked out, the substances employed being the hydride of amyl and sulphuric ether. Careful and exact experiments, many times repeated, lead to the result that when the number of molecules traversed by the calorific rays in the vapor is the same as that traversed in the liquid, the absorptions are identical. In the silvered experimental tube, which, as stated, is 38 inches long, hydride of amyl vapor, at a mercury pressure of 6·6 inches, is equivalent to a liquid layer one millimetre in thickness, while a vapor column of sulphuric ether, of the same length, and 7·2 inches pressure, would also produce a liquid layer one millimetre thick. The experiment has been made with the utmost care, both with the lime-light and the incandescent platinum, with the result that it is impossible to say that there is any difference between the vapor absorption and the liquid absorption. In the face of such facts the vapor-hesion hypothesis, as an explanation of the results published by the lecturer, can not be sustained.

On the 29th of November, 1880, he had the pleasure of witnessing, in the laboratory of the Royal Institution, the experiments of Mr. Graham Bell, wherein a concentrated luminous beam, rendered intermittent by a rotating peforated disk, was caused to impinge upon various solid substances, and to produce musical sounds. Mr. Bell's previous experiments upon selenium naturally led him to conclude that the effect was produced by the luminous rays of the spectrum. The contemplation of these experiments produced in the lecturer the conviction that the results were due to the intermittent absorption of radiant heat. He was experimenting on vapors at this time. Substituting in idea gaseous for solid matter, he clearly pictured the sudden expansion of an absorbent gas or vapor at every stroke of the calorific beam, and its contraction when the beam was intercepted. Pulses far

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stronger than those obtainable from solid matter would probably be thus produced, which, when rapid enough, would generate musical sounds. The intensity of the sound would, of course, be determined by the absorptive power of the gas or vapor.

This idea was tested on the spot. Placing sulphuric ether in a test-tube, and connecting the tube with the ear, the intermittent beam was caused to fall upon the vapor above the liquid. A feeble musical sound was distinctly heard. Formic ether was tried in the same way, and with the same result. Bisulphide of carbon was then tried, but the vapor of this liquid proved incompetent to generate a musical sound. These results, which were in perfect accordance with those previously enunciated by the lecturer, were first made public during a discussion at the Society of Telegraph Engineers on the 8th of December, 1880.*

It was obvious, however, that the arrangement of Mr. Bell—a truly beautiful one—was not suited to bring out the maximum effect. He had employed a series of lenses to concentrate his beam, and these, however pure, would, in the case of transparent gases, absorb a large portion of the rays most influential in producing the sound. The lecturer, therefore, resorted to lenses of rock-salt and to concave mirrors silvered in front. He employed various sources of heat, including that of the electric lamp. The lime-light he found very convenient. With the lime-light and concave mirror, sounds of surprising intensity were produced by all the highly absorbent gases and vapors. Among gases chloride of methyl was loudest. Conveyed directly to the ear by a tube of India-rubber, the sound of this gas seemed as loud as the peal of an organ. Abandoning the ear-tube, and choosing a suitable recipient for the gas, the sounds were heard at a distance of twenty feet from their origin. As regards intensity, the order of the sounds in gases corresponds exactly with the order of their absorptions of radiant heat.

Among vapors sulphuric ether stands highest, this result being in part due to the great volatility of the liquid. But the intensity of the sound is by no means wholly dependent on volatility. The specific action of the molecules on radiant heat is as clearly shown in these experiments as in those previously conducted with the experimental tube and thermopile. Upward of eighty vapors have been tested in regard to their sound-producing power.

With regard to aqueous vapor, whose action upon radiant heat even the latest publications on this subject describe as *nil*, it was especially interesting to be able to question the vapor itself as to its absorbent power, and to receive from it an answer which did not admit of doubt. A number of bulbs about an inch in diameter were placed under the receiver of an air-pump, with a vessel containing sulphuric acid beside them. When thoroughly dry they were exposed to an in-

* See "Journal of Telegraph Engineers."

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termittent beam. . The well-dried air within the bulbs proved silent, while the slightest admixture of humid air sufficed to endow it with sounding power. Placing a little water in a thin glass bulb, and heating it nearly to its boiling-point, the sounds produced by the developed vapor are exceedingly loud. The bulbs employed in these experiments are usually about a cubic inch in volume. They may, however, be reduced to one fiftieth or even one one-hundredth of a cubic inch. When a minute drop of water is vaporized within such little bulbs, on their exposure to the intermittent beam loud musical sounds are produced.

It is to be borne in mind that the heat employed in these experiments, coming as it did from a highly luminous source, was absorbed in a far smaller degree than would be the heat from bodies under the temperature of incandescence.

To render the correlation of sound-producing power and athermancy complete, all the gases and vapors which had been exposed to the intermittent beam were examined as to the augmentation of their elastic force through the absorption of radiant heat. A glass cylinder, four inches long and three inches in diameter, had its ends closed with transparent plates of rock-salt. Connected with this cylinder was a narrow U-tube, containing a colored liquid which stood at the same level in the two arms of the U. The cylinder could be exhausted at pleasure or filled with a gas or vapor. When filled, the sudden removal of a double silvered screen permitted the beam from the lime-light to pass through it, the augmentation of elastic force being immediately declared by the depression of the liquid in one of the arms of the U-tube and its elevation in the other. The difference of level in the two arms gave, in terms of water-pressure, a measure of the heat absorbed. With the stronger vapors it would be easy with this instrument to produce an augmentation of elastic force corresponding to a water-pressure of a thousand millimetres. As might be expected, the intensity of the sounds corresponded with the energy of the absorption, varying from "exceedingly strong," "very strong," "strong," "moderate," "weak," to "inaudible." In this connection reference was made to the interesting experiments of Professor Röntgen, an independent and successful worker in this field.

In conclusion, the lecture draws attention to the bearing of its results upon the phenomena of meteorology. The views of Magnus, regarding the part played by mist or haze, are referred to, and attention is directed to various observations by Wells, which are in opposition to these views. The observations of Wilson, Six, Leslie, Denham, Hooker, Livingstone, Mitchell, Strachey, and others are referred to and connected with the action of aqueous vapor upon solar and terrestrial radiation. Many years ago the lecturer sought to imitate the action of aqueous vapor on the solar rays by sending a beam from the electric light through a layer of water, and afterward examining its spectrum.

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The curve representing the distribution of heat resembled that obtained from the spectrum of the sun, the invisible calorific radiation being reduced by the water from nearly eight times to about twice the visible. Could we get above the screen of atmospheric vapor, a large amount of the ultra-red rays would assuredly be restored to the solar spectrum. This conclusion has been recently established on the grandest scale by Professor Langley, who, on the 10th of September, wrote to the lecturer from an elevation of twelve thousand feet on Mount Whitney, "where the air is perhaps drier than at any other equal altitude ever used for scientific investigation." An extract from Professor Langley's letter will fitly close this summary: "You may," he says, "be interested in knowing that the result indicates a great difference in the *distribution* of the solar energy here from that to which we are accustomed in regions of ordinary humidity, and that, while the evidence of the effect of water-vapor on the more refrangible rays is feeble, there is, on the other hand, a systematic effect, due to its absence, which shows, by contrast, its power on the red and ultra-red in a striking light. These experiments also indicate an enormous extension of the ultra-red spectrum beyond the point to which they have been followed below, and, being made on a scale different from that of the laboratory—on one, indeed, as grand as Nature can furnish—and by means wholly independent of those usually applied to the research, must, I think, when published, put an end to any doubt as to the accuracy of the statements so long since made by you, as to the absorbent power of this agent over the greater part of the spectrum, and as to its predominant importance in modifying to us the solar energy."

EFFECTS OF LIGHTNING ON ROCKS AND SOIL.*

By STANISLAUS MEUNIER.

THE effects of lightning on the tops of mountains are often very intense. Among them have been cited such works as the transportation of large masses to a considerable distance. They also frequently include the development of high degrees of heat. The clearest possible proof of this fact is afforded by the superficial fusion of rocks, even of such refractory ones as granite and other crystalline stones. Laussure long ago described vitrifications of this kind on the summit of Mont Blanc; Ramond has found them on the Pic-du-Midi, and Humboldt in Mexico; and the characters they exhibit are everywhere uniform.

The vitrifications are generally only a few tenths of a millimetre thick, but they sometimes extend over surfaces of nearly a square

* Translated from "La Nature."

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metre, on which the rock appears to be veneered with a kind of gray or yellowish enamel, in which bubbles or swellings several millimetres in diameter may be distinguished. The specimen represented in Fig. 1, which is exhibited in the geological department of the museum at

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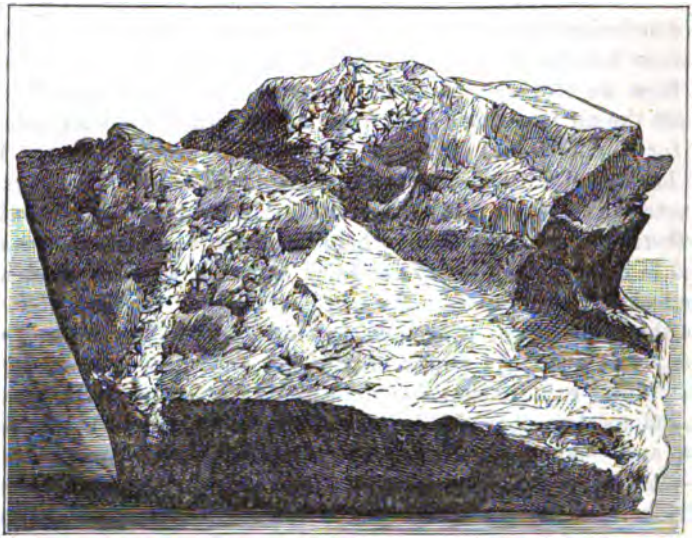


FIG. 1.—BLOCK OF DIORITE FROM THE PIC-DU-MIDI, SHOWING ON ITS SURFACE A MELTED AND VITRIFIED TRACK PRODUCED BY THE PASSAGE OF LIGHTNING. (From a specimen in the Museum; figure one fourth the natural size.)

Paris, was found on the top of the Pic-du-Midi by MM. Baylac and Albert Tissandier. It is of special interest. The rock is of a granitoid diorite, that is, a mixture of triclinic feldspar and hornblende amphibole. The melted portion does not constitute a veneer, as in the examples previously mentioned; it is a track exactly marking the course of the electic spark and ramifying as it did. The vitrified portion extends along the natural external surface of the rock, and then plunges into a fissure, within which it disappears. In this respect the fulguration is extremely like another accident which is known under the name of fulgurites or fulminated tubes, splendid specimens of which may be seen at the museum. As the two cuts in Fig. 2 show, there are irregular tubes, the substance of which, a kind of natural glass, is the product of the solution of siliceous sands that have been struck by lightning. The tube is smooth within, but rugose on the outside, on account of the agglutination of imperfectly melted particles of sand. Fulgurites are generally ramified at their lower end. Their interior diameter varies from a millimetre to five centimetres, or two inches; and their length, which is variable, may reach ten metres, or more than thirty feet.

These curious accidents do not seem to have been remarked before 1711, when Hermann observed them in Silesia; since then all the mu-

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seums have secured specimens of them for their collections. It is hard to get large ones, and they command a high price. At first, their true nature was misapprehended. They were regarded successively as incrustations formed around roots that had disappeared; as the cells constructed by worms of extinct species; and as a kind of stalactites. Hentzen seems to have been the first one who attributed them to light-

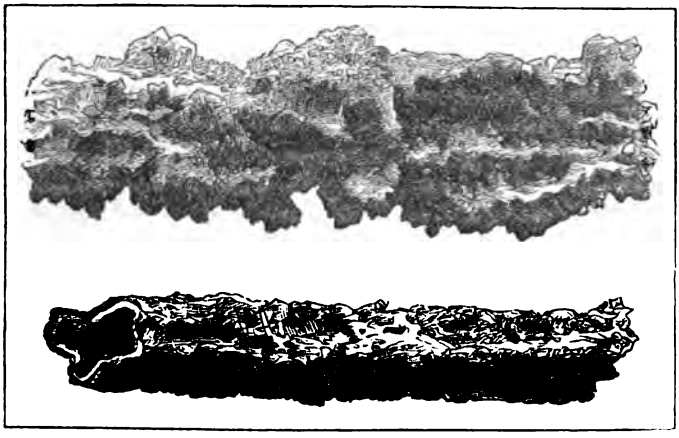


FIG. 2.—FULGURITES. Tubes produced by the vitrification of sand by the passage of lightning through the soil in the deserts of Poland. (From a specimen in the Museum; figure one third the natural size.)

ning; and his opinion has been shown to be correct by Blumenbach and by Tiegler. More recently, Nature has been caught in the act; that is, fulgurites have been found in sand which was still hot, at the spot where the lightning had been seen to strike. Besides, several experimenters, as Beudant, Huchette, and Savart, have obtained tubes analogous to fulgurites by discharging the great electrical battery of the Conservatoire des Arts et Métiers through beds of pounded glass, or of sand mixed with sea-salt to make it more fusible. Fulminated tubes are found principally in places where beds of sand lie upon a soil which contains water, and is consequently a conductor of electricity; for example, at certain points in Silesia, in Eastern Prussia, Poland, Cumberland, and Brazil.

LONGEVITY OF PLANTS.*

BY F. HILDEBRAND.

THE extremes between which the duration of the lives of plants varies are widely removed from each other. On one side, we may see plants that begin and close their lives within a few hours or days; on the other side, plants, the lives of which may be estimated

* Translated from "Das Ausland" for "The Popular Science Monthly."

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by the hundred or thousand years. The differences appear conspicuous, not only in the view of the whole vegetable kingdom, but also in single divisions of the same, and whether high or low forms are included. Inasmuch as these conditions are generally known and may be observed by every one who looks into the fields and woods, it may be of some interest to consider more closely the great diversities in the length of the life of plants. Such a consideration will afford a higher interest if we institute in connection with it a comparison of the manner in which the longevity of plants is related to their various systematic affinities; and further, if we include in our survey the question whether the different classes of longevities stand in immediate juxtaposition, or whether there are transitions between them. The results of the latter study will then lead us to the inquiry, by what causes the different periods of life are determined, and how they have been developed.

We begin with a comparison of the life-term and the manner of vegetation of the plant. The shortest periods are found in the cryptogams, among the lower algæ, the growth of which, taking place in an homogeneous and uniform element, water, renders any considerable differentiation of the single organs unnecessary, and thus makes it possible for the whole course of life to be gone through in much less time than can be done in the case of the more complexedly organized air-living plants. In some of the simplest algæ the individual, consisting of a single cell, splits into two new cells which are, or quickly grow to be, like the mother, in form, at least; the life of the mother is ended by the formation of its two children, and these in their turn go on to another division and end their lives in the same manner. So short a period of life, lasting for only a few hours or days, is not known in any phanerogamous (or flowering) plant, not even among those which grow entirely in the water. The more complicated structure even of the simplest phanerogam requires at least several weeks before it can bring its fruit to a sufficient degree of maturity to cast its seed—the essential condition which the plant must fulfill before it can bring its life to a close without endangering the continuance of the species. In the short-lived cryptogams, propagation and the end of life come together. The same is the case with a large part of the phanerogams, while other plants, both cryptogams and phanerogams, do not close their lives with a single propagation of posterity, but repeat their fruit-bearings after definite periods of different lengths. Once-fruiting plants may bear seed either in the first or the second year and then die, or after a series of years, as in the case of the American aloe, while the several-times fruiting ones may bear either in the first or second year, or after several years, and then not die; and a number of degrees of transition occur between all of these life-methods. We turn now to a closer consideration of the causes of the differences.

In the simplest plants, consisting of a single cell, no differentiation

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of the parts can be perceived. Food is taken in on all sides alike, and is worked up in the whole plasma of the cell and applied to the growth of the cell-body, to the multiplication of cells by division, or is stored up as reserve food. This is possible because the cell either lives continuously in a uniform element, water, or, if it dries up, simply suspends its life while the dryness continues. The simplest structure, a uniform medium, the most speedy performance of the functions of life, and the shortest life-term, thus go together. Now, take a plant which no longer consists of a single cell, but is a structure of a larger or smaller number of different cells, which no longer lives in a uniform, constant element, but has its body partly in the ground and partly in the air, so that it is exposed to all the changes to which those elements are subject. In this case a complete differentiation of the organs for different life-functions, of which there is no need in the one-celled plant, becomes essential. There must be a root to take up fluid food; leaves to absorb gaseous matters and elaborate them under the influence of light into new substances to be applied to the growth and strengthening of the plant or to be stored up in particular parts as reserve food; and, besides, particular organs, distinct from the food-organs, for propagation, of the most complicated character, such as are not needed in water-plants, where cross-fertilization, so difficult to secure in the free air, is easily and directly effected. Furthermore, since plants rooted in the ground can not move about, the advantage which change of place offers to the extension of the species is compensated for by the seeds and fruits being endowed with peculiar arrangements by means of which they can spread their kind through a wider circle.

Evidently, all these organs can not be formed in a few days, but a considerable time is needed to bring their development and the fruiting process to perfection. Additional complications now enter into the life-relations of the plant. While the fruit-organs perish, when they are separated from the stem at maturity, the life of the plant itself does not necessarily cease when they are dropped, but has a possibility of continuance dependent on a variety of conditions, the chief of which is, whether the other organs have been exhausted or not.

The prolongation of life is also affected by a great number of outer conditions. The plant has to be subjected to the changes of the seasons; it has to struggle for support in competition with other plants; it has to deal with animals, some of which are beneficial, some damaging to it; and it may or may not find a sufficiency of food in the soil in which it is trying to grow. With respect to all its external relations, it must have the faculty of adapting itself, by extending its organs in one or another direction. And this adaptation is complicated by the fact that it has to be modified to meet different conditions, at different stages of development, and that the plant can flourish only when all its stages of growth are simultaneous with favoring outward circumstances, and can be completed while these continue.

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These inter-relations of outward conditions and internal adaptiveness bring their advantages and their disadvantages. It is an advantage to annuals that they require only a short part of the year for their full development, and their existence is not endangered by winter frosts or the heats of tropical dry seasons; also that the abundance of seed, which the devotion of their whole life to one effort makes them capable of producing, enables them to spread very rapidly, and occupy all favorable situations in a few generations. It is, on the other hand, a disadvantage that they have to conquer their ground every year, and the tenderness of the structure of their parts above-ground renders them liable to destruction by animals while they have not vigor enough to send forth new shoots. Their continuance is also sometimes endangered by the occurrence of an exceptional season too short for them to mature their fruit.

The least advantageous habit is that of those plants that grow for several years, and produce fruit but once, and it is of the rarest occurrence. Exceedingly well off are tuberous and bulbous plants, whose under-ground perennial organs are protected from the influence of climate and the attacks of animals, have stored in them quantities of reserve food, and are fitted to send out new shoots as soon as favorable weather sets in, and to mature their fruit in a very short season. Hence we find such plants common where the seasons of growth, whether on account of the frigidity or the dryness of the climate, are shortest. They also seem to prevail where the climate is moderately moist and warm; and nearly all water phanerogams are of this class.

It is to the advantage of woody plants that they do not have to build up every year so much of the scaffold on which their flowers and fruits are to grow. If they have evergreen leaves, these contain, at the end of the season, a quantity of reserve food fit for assimilation, and are ready to go to work absorbing more immediately on the opening of a new season. They have also the title of possession in the struggle with other plants, and are protected against animals. They are, however, more exposed to injury from changes of climate than other plants.

Thus, each life-habit has its advantages and its disadvantages; and we may conclude from this that a change from a long-lived to a short-lived form, or the reverse, may take place in consequence of adaptation to changes in outer circumstances. The origin of new habits depends, however, not on external circumstances alone, but upon a certain disposition in the plant, by means of which it is able to adapt itself to new conditions.

The climate has the most important influence upon vegetation, especially upon its endurance and its life-habits; for temperature, moisture, and light are the conditions on which the life of the plant depends in all its stages; and the movements of the air have also their effect upon its existence. When the climatic conditions change, the plant must

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accommodate itself to the change, and must thereby, directly or indirectly, suffer a modification in the length and kind of its life. The soil also, and changes in its condition, have their influence, and surrounding plants and animals have their effects, all of which the plant may feel and show very plainly.

Evidence that the causes which we have only briefly touched upon here play a part in determining the duration of the life of different plants is afforded by cultivation and by the geographical distribution of species. It is well known that when plants are taken into cultivation, and exposed to different temperatures, different degrees of moisture, and different soils from those they have been accustomed to, and direct attacks are made upon their growth, they often suffer changes of one kind or another, and the duration of their life especially is affected. Modifications of external influences may be brought about partly by sowing the seed at different seasons from the usual one, partly by artificial stimulation, pruning, manuring, withholding moisture, etc. The object in these processes has generally been to make the plant go through its course faster, so as to secure an earlier blooming or fruiting; and its life has been shortened without that being the real intention. The other object, of prolonging the life, is also desirable; and there are numerous examples in which the life of plants may be lengthened or shortened by different modes of cultivation.

Particularly interesting examples of the evolution of different life-terms are exhibited in the geographical distribution of plants. If we consider the whole earth as to its climate, we shall observe that in a few regions near the equator, that have a uniform climate, plants will grow all the year through without manifesting any periodical preferences. This is the case, for example, east of the Andes in Northern Brazil, in Guiana, and in Java, where the vegetation is green and blooms continuously, where most species become woody, and nearly all live long and bear fruit often; while the short-lived, once-fruiting species retire to the background. In other tropical regions, where a periodical climate is produced by differences in the moisture of the atmosphere, the long-lived plants prevail, and the ground is so occupied with them till the coming on of the dry season that the short-lived kinds can not find room upon it. The case is different in those regions where spots become barren of vegetation in consequence of the parching heat. Then, when the rainy season sets in, the annuals quickly spring up between the bulbous and tuberous herbs that are able to keep their places through the drought. The short-lived species are of most importance where a warm season alternates with a cold one, and the warm season lasts long enough for them to go within its term through the whole cycle of their life, from their seed-time to the ripening of their fruit. As the warm season becomes shorter the number of annuals is reduced, until finally, when the summer is not long enough for any of them to perfect their seed, they

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disappear altogether. Thus the persistent, often-fruiting species gain the monopoly on high mountains and in Arctic regions, but with the difference that in some districts they maintain themselves above-ground through the whole year without protection against the climate, while in others they exist through a long period of rest, protected against the injurious effects of the cold by means of their perennial parts under the soil or under the cover of an effective shelter.

Without attempting a closer review of these relations, or of the development of different life-terms in the successive periods of the development of the earth's surface and of the vegetable kingdom, we come to these comprehensive conclusions: A plant has to pass through two phases, one of vegetation, the other of propagation, both of which are conditioned upon the supply of food. In the simplest instances these phases are exhibited in one and the same cell, which, absorbing the food, elaborates it for its own growth, and gathers so much force that two new individuals are produced by division while the mother-plant ceases, by this fact, to be. In another yet similar manner is accomplished the life of those plants which in their complicated structure present an extreme contrast to the simple cell. In this case also the whole feeding of the plant is performed with the sole object of adapting it to the purpose of propagation; but the end is reached in various ways and times, while the attainment of it is not always accompanied with the end of life. Some plants proceed in uninterrupted growth from their origin to the end of the propagation, collect forces on forces, and die exhausted as soon as propagation is accomplished. Others can not reach maturity by a short stage, but require a longer time for gathering their forces. This enforcement is gained either in an uninterrupted course, or, as is more frequently the case, by a series of alternate periods of growth and rest, followed by a period of vigor, when maturity of the fruit is at last reached and the plants die from exhaustion. A third group reach the stage of propagation after a shorter or longer period without giving up their whole strength to the formation of seed, but apply a portion of the nourishment they receive to the formation of perennial organs by the aid of which they continue to grow and become fruitful again, and competent to repeat the same processes an indefinite number of times.

Seeing different plants thus attain very different ages, we naturally inquire what are the causes of the diversity. They depend partly on the adaptation to external conditions induced by climate, soil, and environment, all of which, especially climate, determine the life-habits of plants in various ways, and seem also to affect the length of their life. But these external conditions can not of themselves force the plant to adapt itself to them; it must itself have a fitness to react upon influences acting upon it from without. This is really the case in various degrees, for the variability which a species exhibits by its individuals in different directions extends to the length and the manner of its life,

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and attests the faculty it has of suiting itself to those external conditions which are most favorable to its life-habits. We see also how the plants of the earth have undergone improvement in regard to the length of their life under the influence of external conditions and by means of their power of variation, and can conceive how development of this kind can and will go on; for a cessation of the process is not possible.

It is true that not only certain species but whole genera and whole families as well appear now to be firmly fixed as to their life-habits and the longevity of their individuals; such plants, in view of the certain mutability of external conditions must either become migratory, or, if they can not change, must eventually give way to better adapted kinds. Other species, on the contrary, are capable of improvement; their individuals vary among themselves as to the habit and duration of their life, easily adapt themselves to changing conditions, and are able to adopt other life-habits. These changes in life-habit are accompanied step by step by a morphological adaptation of the organs, and thus from species having a definite term of life may be developed new species with other terms of life. The formation of annual species appears especially to be making a progress which began when a periodical took the place of a uniform climate. These species are, on account of the abundance of their rapidly maturing fruit, capable of a rapid improvement, and have had their spread facilitated since the appearance of man, who by his methods of cultivation makes the ground fit for them in places where they otherwise would not thrive.

SODA, A REMEDY FOR BURNS AND SCALDS.

By F. PEPPERCORNE, L. R. C. P.

ACCIDENTAL burns and scalds, even when not very severe, extensive, or dangerous, commonly cause so much pain for an indefinite time, depending probably as to duration and severity a good deal on the age of the sufferer, and on the greater or less degree of sensitiveness of the individual's skin or constitution—not forgetting the feverish reaction, and the dangerous internal secondary inflammations that are apt to follow in some cases—that any easily applied and quickly available remedy and relief, without perhaps the immediate necessity of calling in professional assistance, will be acknowledged as a boon by most persons; and especially so, when it is remembered that the sooner the agonizing burning pain in the part can be allayed, the less chance there is of dangerous secondary effects, besides sloughing, etc., so severely trying to children and old persons.

The usual first applications to these painful injuries, whether so-

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called *popular* remedies, or such as are usually recommended by members of the profession, are numerous enough, but can not unfortunately hitherto be considered as generally successful in giving certain and speedy relief from pain, and, too often, intense suffering. One friend will recommend that the parts be covered with flour from the dredger; another will advise fine cotton-wool, or wadding; another, starch in powder, or soap, or treacle, or the so-called Carron-oil, etc.; but hardly one of such applications can be said to give more than very uncertain or temporary relief from pain, although, perhaps, by occupying the attention of the sufferer, they may in this way prove of some *mental* benefit during his sufferings—being indeed employed really for want of anything better—although, in fact, some of these applications, such as treacle, flour, starch, etc., prove so disagreeable in their after-effects, being often difficult to remove and renew, as to add frequently to the poor patient's depression and suffering, owing to their adhering to the injured parts in dry cakes very irritating to the raw surface.

It is now many years ago (see the "London Medical Gazette" of March, 1844) that the author of this paper, while engaged in some investigations as to the qualities and effects of the alkalies in inflammations of the skin, etc., was fortunate enough to discover that a saline lotion, or *saturated* solution of the bicarbonated soda in either plain water or camphorated water, if applied speedily, or as soon as possible, to a burned or scalded part, was most effectual in immediately relieving the acute burning pain; and when the burn was only superficial, or not severe, removing all pain in the course of a very short time; having also the very great advantage of cleanliness, and, if applied at once, of preventing the usual consequences—a painful blistering of the skin, separation of the epidermis, and perhaps more or less of suppuration.

For this purpose, all that is necessary is to cut a piece of lint, or old soft rag, or even thick blotting-paper, of a size sufficient to cover the burned or scalded parts, and to keep it constantly well wetted with the sodaic lotion so as to prevent its drying. By this means, it usually happens that all pain ceases in from a quarter to half an hour, or even in much less time.

When the main part of a limb, such as the hand and fore-arm or the foot and leg, has been burned, it is best, when practicable, to plunge the part at once into a jug, or pail, or other convenient vessel filled with the soda lotion, and keep it there until the pain subsides; or the limb may be swathed or encircled with a surgeon's cotton bandage previously soaked in the *saturated* solution, and kept constantly wetted with it, the relief being usually immediate, provided the solution be saturated and cold.

What is now usually sold as bicarbonate of soda is what I have commonly used and recommended; although this is well known to

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vary much in quality according to where it is manufactured—but it will be found to answer the purpose, although probably Howard's is most to be depended on, the common carbonate being too caustic. It is believed that a large proportion of medical practitioners are still unaware of the remarkable qualities of this easily applied remedy, which recommends itself for obvious reasons.—*The Practitioner.*

THE GULF STREAM AND THE PANAMA CANAL.

By JAMES GEIKIE, F. R. S.

NONE of the great "rivers of the ocean" has been so frequently and carefully studied as the Gulf Stream of the North Atlantic. Its course, its depth and breadth, its temperature, etc., have all been laboriously investigated, while its influence on the climate of North-western Europe has formed a very fruitful subject of discussion. The origin of the stream is well known. The Caribbean Sea and the Gulf of Mexico are full-charged with the heated waters of the great equatorial current, and it is from this broad and deep reservoir that the famous Gulf Stream issues by the Straits of Florida to flow in a north-easterly direction toward the coasts of Europe. At the narrowest place in the straits the stream measures 30 statute miles in breadth and 1,950 feet in depth, but it gradually widens as it passes north until it spreads out over an enormous area. It has been perfectly well ascertained that the superficial stratum of the ocean throughout the whole vast space between the great Bank of Newfoundland and the coasts of France has a higher temperature than the normal of those latitudes, and is flowing persistently in a northerly and northeasterly direction toward the coasts of Greenland, Iceland, and Spitzbergen. It is doubtful whether all this body of heated water has passed through the Straits of Florida, and some physicists have maintained that only a very insignificant portion indeed has actually streamed out of the Gulf of Mexico. These writers have, therefore, held that a stoppage of the Gulf Stream would have only an infinitesimal effect upon the general temperature of the North Atlantic and the climate of North-western Europe. This view, however, has been completely overset by Dr. Croll, whose estimate of the enormous heating power of the Gulf Stream is now very generally accepted. According to this eminent physicist and geologist, the total quantity of heat conveyed by that current is probably equal to that of a stream 50 miles broad and 1,000 feet deep, flowing at the rate of four miles an hour, and having a mean temperature of not less than 65°—a temperature which gradually falls as the current goes north until it is cooled down to at least 40°. This estimate gives us 5,578,680,000,000 cubic feet of water per hour, and

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consequently the total quantity of heat transferred from the tropics by this current amounts to 154,959,300,000,000,000,000 foot-pounds per diem. Even if we reduce this estimate one half, the stoppage of the Gulf Stream would still deprive the Atlantic of a quantity of heat equal to one fourth of all that is received directly from the sun by that area.

It is beyond doubt, therefore, that the passage of so great a body of heated water into the North Atlantic, over the surface of which it spreads for so many thousands of square miles, must have a most powerful influence on the climate of those regions to which its heat is brought by prevalent winds. This is the case more especially with France, our own islands, Norway, the Faröes, and Iceland. With us the prevalent winds are westerly and southwesterly, and these, as they sweep across the Atlantic, filch warmth and moisture from the Gulf Stream, which they part with as they pass over us in their course toward the northeast. How very materially our climate is thus affected will be readily seen if we compare the mean winter and summer temperatures of places in the same latitudes of North America and Europe. Thus at Bordeaux, in north latitude 44° 50′, we have a winter temperature of +41° Fahr., and a summer mean of +69·1° Fahr., while at Halifax (Nova Scotia), in the same latitude (north latitude 44·39°), the winter mean is +22·6°, and that of summer +63·5°. Again, at Killybegs (Ireland), in north latitude 54° 38′, the winter temperature is +41·4°, and that of summer +58·7°—the winter and summer means of a corresponding latitude on the Labrador coast being +5° and +49° respectively. Once more, at Wick (north latitude 58° 25′) the winter temperature is +38·5°, and that of summer +56·5°, while at Hebron (Labrador), in north latitude 58° 16′, we get a winter mean of −5·1° and a summer mean of +46·1°. Now, were the Gulf Stream to be stopped, the temperature of the maritime regions of Northwestern Europe would probably fall as low as that of corresponding latitudes in America. In the event of that stream being diverted out of the North Atlantic, the polar currents flowing south would of course occupy the greater portion of the oceanic surface to the west of us, and hence our west and southwest winds would be cold and ungenial. Were such a catastrophe to happen, we may be sure that the Scandinavian Peninsula and a large part of our own islands would not be habitable by civilized man, while Iceland would become as inaccessible as Franz-Josef Land is now. Our own shores would be frost-bound for a large part of the year, and perennial snow and glaciers would appear in our mountain districts. On the other hand, if we could suppose the body of warm water now flowing into the North Atlantic to be largely increased in volume, there can be just as little doubt that the climate of Northwestern Europe would be much improved, and even Spitzbergen and Nova Zembla might be rendered fit abodes for civilized communities.

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Strange as it may appear, the records of geology assure us that such changes in the climate of Northwestern Europe have actually happened within a comparatively recent period—certainly within the human epoch. Thus it has been well ascertained that at a time when rude tribes of men, unacquainted with the use of metals, were hunting reindeer in Southern France, a vast area in Northern Europe was buried under a great sheet of ice—a veritable *mer de glace*—like those ice-sheets which cover up such extensive areas in the Arctic and Antarctic regions. Had any one at that time approached the shores of Northwestern Europe, he would have encountered, some fifty miles outside of the present western shores of Ireland and the Hebrides, a vast vertical wall of ice, like that which confronted Sir J. Clark Ross, Commodore Wilkes, and the Challenger expedition, and barred all approach to the Antarctic pole. Could our voyager have surmounted the Scoto-Hibernian ice-wall, he would have discovered that he stood on the verge of an interminable plain of snow and ice, extending eastward as far as the eye could reach. Here and there upon the far horizon he would have observed a few inconsiderable rocky hills, representing the upper portions of our highest mountains—for the ice which then buried our low grounds was not less than three thousand feet thick. Had he advanced inland until he reached those rocky heights he would have found the icy plain sweeping away in all directions, and bounded only by the horizon ; and had he continued his journey toward the east, across what is now the German Ocean, he would have encountered nothing to break the monotonous level until he approached a low line of snow-covered hills and mounds, marking the site of the ice-drowned Scandinavian Peninsula. After attaining these hills, had our imaginary wanderer now shaped his course toward the south, he must next have traversed a distance of more than five hundred miles before he reached the termination of the ice-sheet in Saxony. During this extraordinary condition of things the Arctic-Alpine plants and animals (which are now characteristic of lofty elevations in Central and Northwestern Europe, and of the low grounds of the higher latitudes) occupied the low-lying plains and valleys of middle Europe, a flora like that of Lapland growing in South Germany, Switzerland, etc., and pines and spruce-firs flourishing in Northeastern France, while reindeer, glutton, Arctic fox, lemming, marmot, and others were the prevailing animals of those regions. When we think of the conditions which now obtain in Europe, can we conceive of any stronger contrast than that which is suggested by the few facts which are here summarized? Instead of the splendid navies of war-ships, ocean-liners, and other craft which now crowd its waters, the English Channel had formerly its fleets of ice-floes, and the walrus haunted the coasts of Northern France. When such extreme conditions obtained, it can hardly be doubted that the Gulf Stream, as we know it now, had no existence in the North Atlantic.

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Now let us look at another picture of the past, but still within the human epoch. There was a time, then, when the European climate was so genial that many delicate southern species of plants flourished luxuriantly in regions where they can not now exist. Thus, in the neighborhood of Paris, the fig-tree, the Judas-tree, the laurel of the Canary Islands, and other southern species, found a congenial habitat. The Canary laurel does not grow farther north now than Toulon, on the borders of the Mediterranean. It flowers in winter, and repeated frosts would, therefore, prevent it reproducing its kind. That this plant formerly flourished near Paris is thus a striking proof of changed climatic conditions; we can not doubt that at one time the winters in Northern France must have been extremely genial. Moreover, we know, from the character of the plants with which the Canary laurel was associated in that region, that the climate must have been exempt from extremes—the summers were neither so dry nor so hot, and the winters were very much milder. The land and fresh-water shells which were contemporaneous with that remarkable flora in Northwestern Europe tell precisely the same tale, and this is still further illustrated and confirmed by the character of the mammalian fauna. Among the commoner animals at that time occupants of England, France, etc., were hippopotami, elephants, rhinoceroses, lions, tigers, hyenas, etc., and vast numbers of cervine and bovine animals which still occupy the temperate latitudes of Europe. That such genial climatic conditions were due in large measure to a great increase in the volume of warm water flowing into the North Atlantic seems just as certain as that the Arctic climate of the Glacial period was largely induced by a very considerable decrease, or even an entire stoppage, of that heat-bearing current. The presence of many Mediterranean shells in the ancient raised beaches of Scandinavia, the occurrence of mussel-banks in the coast-lands of Spitzbergen, the appearance here and there off the coast of Scotland, the Faröes, and Iceland, of southern species of shell-fish, and the presence of isolated colonies of southern mollusks in the Gulf of St. Lawrence, are all indicative of a former much greater influx of warm water into northern regions than is now the case. Those remarkable colonies of southern species are living evidence of the last epoch of extremely genial conditions experienced in Northwestern Europe—an epoch during which great forest growths overspread wide regions in the north—covering the British Islands, the Inner and Outer Hebrides, the Orkney and Shetland Islands, all Norway up to the extreme north, and most extensive areas which to-day lie submerged in the sea.

Thus, it will be seen how greatly the climate of Northwestern Europe has been, and may yet again be, modified by changes in the flow of the Gulf Stream. Now, if we glance at a map of America, it will be observed that only a narrow neck of land separates the Gulf of Mexico from the waters of the Pacific, and it is conceivable that,

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were this isthmus to be submerged, the great body of heated water, that at present finds its way north through the Straits of Florida, might flow directly into the Pacific Ocean. There is no evidence, however, to show that the barrier of Darien has been thus submerged within any recent geological period, and consequently the great changes of climate referred to above could not have been brought about in this way. They were most probably induced, as Dr. Croll has shown, by a remarkable series of physical mutations, which accompanied and were caused by the last great increase in the eccentricity of the earth's orbit. As the next period of high eccentricity will not occur for many thousands of years, we need have no apprehension that we shall be deprived of the genial influence of our friendly Gulf Stream in the immediate future. And when we reflect upon the magnitude of the submergence of Central America which would be required to divert that stream into the Pacific, we may be equally reassured that we are not likely to suffer from its loss in our day, for, before it could be sensibly diminished in volume by this means, the Isthmus of Darien would need to be sunk to a depth of not less than 800 feet, and perhaps even 1,000 feet. We may therefore contemplate with perfect composure the formation of any number of canals across that isthmus. The great work of the famous French engineer will have as much effect upon the Gulf Stream and the climate of Northwestern Europe as the emptying of a teapotful of boiling water into the Arctic Ocean would have in raising the annual temperature in Greenland.—*British Trade Journal.*

RECENT WONDERS OF ELECTRICITY.*

By W. H. PREECE, F.R.S.

I OUGHT to commence, if I carried out the customary practice, by addressing the audience as ladies and gentlemen, but to-night I much prefer commencing with boys and girls, because the two lectures that I am about to deliver to you are really intended to be addressed to the youngest members of the society. I would first direct your attention to the fact that this hall is illuminated by electricity, and, although I do not intend in any way to refer to the electric light to-night, it is my intention, step by step, to lead you up to it, so that, when we part this day week, I hope and trust to be able to let you depart with a thorough and complete knowledge how electricity works and how it produces these marvelous effects. To accomplish this object there are two things most essential: the first is, that I, your lecturer, should be perfectly clear in my definitions, and simple in the

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language I use; the second is, that you should devote to me your very earnest and best attention, and strive all you can, by thought afterward, to understand what I mean. I shall use, doubtless, unconsciously, a great many words that are new to you, but which are to me just as familiar as household words. I will, however, try to explain them, and endeavor, if I can, to let those words impart to you the very idea that they conjure up in my mind. At the commencement, there are two words in very common use that many of you have heard over and over again, but which convey, in the way I shall use them, perhaps a different conception. These two words are "work" and "energy." I can readily imagine that one of you boys may say, when I call your attention to the words "work" and "energy," "Why, what nonsense to talk to me about work! Have I not been working as hard as ever I can during the past term to gain a prize, and have not I exercised all the energy I possess to distinguish myself in my class?" But the words "work" and "energy" applied in that sense are applied in a mental sense, and not at all in the physical sense in which I shall use them. Now, I dare say many of you live in town; some may live in the country; but, whether you live in town or country, you all know what a garden is, and what a gardener does. Suppose a gardener, with a ton of gravel in front of him, were told to move that gravel to a height of three feet. He would go to work with his spade; he would move shovelful after shovelful from the ground-line up to the three-feet height, and after he had moved the whole of it you might readily imagine that he would be a little fatigued. Now, whenever a person does anything which causes fatigue, he does what we call work. The gardener, in lifting the gravel, would perform an amount of work which is capable of being measured. I will give you another illustration. Supposing some of you boys were put beside a pile of cricket-balls, and for a wager or prize you were called upon to throw the balls as fast and as far as you could. A good thrower would perhaps throw the first ball eighty yards, he would throw the second ball seventy-five yards, the third seventy yards, the fourth sixty-five yards, and so each ball that he threw would go a less and less distance, until he had no strength left, and he could throw no more balls. Now, that boy would have done work; something would have passed out of him into the balls; he has, as it were, passed something that belonged to him into the cricket-balls, and as a result he feels fatigue through the loss of this something. Take another illustration: Supposing two crews agree to row a race. They start full of life and full of energy; they pull with all their hearts and might, and arrive at the goal, in common language, thoroughly pumped out. Something has gone out of them into the boat. That which has gone out of the crew, and out of the boy who threw the cricket-balls, is what we call energy, and what they have done is to do work upon the boat. Another example is in the case of foot-ball. A boy kicks a foot-ball and makes a splendid goal. To do

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that he has sent something out of his body into the ball which hurtles through the air past the goal, and the game is won. In all these illustrations something is done which results in fatigue, work is performed and energy is lost; in fact, work done means energy applied, and energy applied means work done. As mental energy is our capacity for learning lessons, for going through examinations, and that kind of thing, so the energy of the kind I speak of is the capacity for doing absolute physical work. The generality of this energy is immense. It is a difficult thing to grasp the fact that there is something in existence that we can not feel, that we can not touch, and that we can not see, but which gives us all the force and all the power we possess. The earth as it moves around the sun and the earth as it daily rotates upon its own axis are instances of the existence of this energy; in fact, every kind of change produced in the condition of matter, whether it be in its physical state or in its position with reference to fixed objects, means energy gained or energy lost. The energy gained or lost is the quantity of work done on a body, or done by that body; so I want you to grasp, if you possibly can, the fact that every case of motion on this earth—even the sound of my voice, as I now speak to you—is due to the exercise of this particular energy. Lecturing, for instance, is a considerable exercise of energy. A man can lecture pretty well for an hour; he can lecture not quite so well for two hours, but the best lecturer in the world can scarcely keep at it for three hours without losing all his energy, and, like the crew in the boat, being thoroughly pumped out. This energy—or work done, as I have said—is measurable. The gardener who moves his ton of gravel three feet high has done an amount of work that any boy can calculate who will reduce one ton to pounds, and multiply that sum by three. He will then have obtained 6,720 what we call foot-pounds. One pound raised one foot high is the common and ordinary unit of work; 33,000 pounds moved one foot high is called a horse-power, and the horse-power is the mode by which the power of steam-engines is measured. One steam-engine is known from another by its being able to exercise ten, twenty, or fifty horse-power; and so, whether it is merely the lifting of gravel—or a small tube, such as I have here—throwing a cricket-ball, moving a boat, or working a steam-engine, it can all be measured by this simple unit of foot-pounds. Two other terms are necessary in order to make you comprehend what energy is. Energy is found in two conditions—called "potential" from its position, and "kinetic" from its motion. The potential form of energy is that which exists in the form of a wound-up watch-spring: you wind up the spring of your watch, and by doing so you pass something from your body into it—you transfer energy from your own body into the watch, the spring is wound up, and the watch thereby can be kept going for twenty-four hours or more from the storage of energy imparted to it. A clock, again, will go for eight or fourteen days by your wind-

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ing up the weight until you impart to the clock energy in this potential form of sufficient power to keep a clock going for a fortnight. In gunpowder there exists a splendid example of the storage of energy. It remains quiescent until heat is applied, when its potential form of energy is at once transformed into its active or kinetic form, impelling a cannon-ball or bullet with tremendous force. Coal, again, is a grand store of energy. All our steam-engines employed in manufactures are set going by the energy that is stored up in coal. This energy has remained stored up in coal for millions of years in the bowels of the earth, it is brought to the surface, and is there used to produce power in the innumerable ways with which you are acquainted. Take food—I had a very good chop just now that supplied me with a store of energy which will enable me, for one hour at least, to talk to you; and, had I not had that chop, I do not think I could have talked to you for more than half an hour, instead of the three quarters more that I hope I may yet be able to get through. I have given instances of energy in its potential form. We will now take one or two instances of it in its kinetic form—that is, when it is in a state of motion. A moving cricket-ball is a good example of kinetic energy. In its passage through the air it possesses kinetic energy, and should the ball catch your head you know pretty well what is the effect. A steamship moving and a running railway-train are kept in motion by the energy imparted to them from coal, and we know what tremendous energy a steamship or a railway-train has, as when a collision occurs there is a terrific smash-up. Our earth is another magnificent store of energy in its rotation every twenty-four hours; a portion of this energy it gives up in the shape of tides. Our tides abstract energy from the earth, which is gradually robbing the earth of its motion, and the result is that our day is getting longer and longer. If any of you live a million years, you will probably find that the day will be a minute longer than it is now!

Such being the two general forms of energy, I want next to give you two or three ideas of the forms in which this mysterious energy appears. I had intended to bring a familiar toy, a humming-top, before you, to show you the energy it contained when spinning: but we have other illustrations of various kinds. Take a piece of a very dangerous material called sodium, a beautiful white metal, of which I have a quantity in a bottle here, put it on a piece of blotting-paper, and then place it on top of the water contained in this glass vase: you will see that the sodium possesses energy in itself in a potential form. The moment it is brought in contact with the water, the oxygen of the water unites with the sodium and produces the effects of heat, light, and sound, the result of the chemical energy of the sodium in its potential form being brought into the active or kinetic form by mere contact with the water. Another instance: Here is the dome of a bell, which I strike with a mallet or hammer, and thereby impart

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energy to it, and it sets the whole air of this room in motion, and every tympanum of every ear present is struck by the little bullets of air that are thrown into vibration, and the result is the effect called sound. As another illustration, I will take coal. I take a small piece of coal and warm it in an iron cup, so as to cause it to give out a little kinetic energy in the shape of heat, and, on placing it in this jar of oxygen [experiment performed], you see that the mere insertion of coal, slightly heated, in an atmosphere of oxygen, produces a most brilliant effect, which is the result of the conversion of the potential energy existing in the carbon, or coal, into the kinetic energy seen in the shape of motion, heat, and light. We have even more brilliant effect of this conversion of potential into kinetic energy. Here is a piece of magnesium wire which, when heated [light applied], has its potential energy converted into kinetic energy, and a most brilliant light is the result. But we need not go to light, and we need not go to heat, for instances of energy. I have shown you that energy is a form of motion; that it is so found in sound, heat, and light; but we also have energy as magnetism. There is a little toy-duck floating on the basin of water before me, and I merely hold in front of it a magnet, when you will see that a sort of affection is set up between the duck and the magnet, by the duck following the motion of the magnet round the basin. That is another form of energy. The last form of energy that I wish to draw your special attention to is that due to electricity. You have all seen the vivid flashes of lightning and have heard the dreadful roar of thunder; in those two effects we have energy. It is in its potential form when it exists in a charged cloud, and in its kinetic form when that charged cloud gives its charge up to the earth, and in flying to the earth produces that dreadful effect that we call lightning, with its accompaniment, the roar of thunder. Thus, you have illustrations of energy in its different forms, electrical, magnetical, chemical, heat, light, and motion.

Now comes the question, How is this energy transferred from place to place? You may have all stood upon the sea-beach and have seen the waves dashing upon the rocks, and sent up in the air in white and brilliant spray. You have seen the waves rolling over and over again in glorious breakers upon the sands. You have probably seen wrecks dashed to pieces by the force of waves, all which effects are the result of energy which has been imparted to the water by a storm miles and miles away, the energy of that storm having been transferred by the waves of the water till it meets with the resistance of the shore and produces those effects I have mentioned. Again, energy is transferred by air-vibrations. The explosion of a gun can be heard to a distance of twenty to twenty-five miles; and instances are known where the bombardment of a town has been heard at a distance of one hundred miles. It is well known that the roar of the cannon at Waterloo was heard on the English coasts, at a distance of over one hundred

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miles. Again, we have energy transferred from the sun to the earth by that thin, almost immaterial, subtile medium called the ether, by means of which we have motion transferred from the sun to the earth, which gives us at one moment light, at another moment heat, and at a third moment those effects that result in photographs. Energy is also transferred through matter in the shape of heat. I touch the lamps before me and feel them warm because the heat of the incandescent material which they contain has thrown the molecules of the covering glass into vibration, and that vibration imparts a vibration to my hand that gives the sensation of heat; and if I were to put a poker in the fire—which, no doubt, all of you have done—it would be found in a very short time that the heat of the fire had been transferred through the poker to your hand. Electric currents are a form of energy which is driven through matter. Electricity is transferred, principally, through metals; some of them transfer it with great alacrity—for instance, silver and copper. There are, on the other hand, materials, such as dry wood, glass, gutta-percha, India-rubber, and such like, that scarcely will allow any electrical energy whatever to pass through them; and the result is that bodies are divided into two classes, the one called *conductors*, that conduct electricity away, and the other called *insulators*, which prevent electricity from being conducted away. If you have noticed the telegraph-wires passing through the country, you will have seen that they are suspended on little earthenware knobs (there are specimens of the various kinds in use on the table for inspection), which are employed because they resist the passage of the electrical energy through them, and consequently the electrical energy must flow through the wire which they suspend to the distant end, where it is wanted to do work and produce desired effects.

We have now to consider the motive agency. I ought to have said at the first starting, as every boy fresh from school will know, *ex nihilo nihil fit*, from nothing nothing is created, and therefore there can be no effect without its cause There can be no wind without a difference of pressure in the atmosphere to cause motion of the air. At the present moment I can feel a draught, which is due to a higher pressure above and a lower pressure below on the other side of the door, and the air is circulating over my head from the higher to the lower pressure. The chimney-draughts are produced in a similar manner. Why are meteorologists able to tell us that there is a gale coming? Because they know that there is a higher pressure at one spot than there is on another; and where there is a difference of pressure there must be motion of air. So with water at different levels. The tendency is to produce a common level, and the passage of water from the higher to the lower level produces motion and energy. Tides are simply the result of the effort to produce equilibrium in the sea after it has been attracted in different directions by the force of the sun or the moon. Rivers flow because the water high up in the mountains is at a higher

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level than the ocean, and the purpose of their flowing is to produce equilibrium, or an equality of level. Heat circulates in our rooms because a higher temperature exists in the fire than in the walls. In the electric lamps before me there is a very high temperature, because the carbon is maintained in a very high state of incandescence, and on the approach of my hand, which is of a lower temperature, toward the lamp, instantly there is a passage of heat from the high to the low temperature, and I feel that heat striking my hand exactly in the same way that I feel the draught (before mentioned) on my shoulders. Lastly, take electricity. We can not speak of the level of electricity; we can not speak of the pressure of electricity, in the same sense that we can speak of the pressure of liquids. We can not speak of the temperature of electricity; but there is a peculiar condition of electricity analogous to all three, analogous to pressure, temperature, and level, and that peculiar quality or condition is called potential. When we speak of electricity of a high potential, it has exactly the same meaning as high level of water, or of high temperature, and wherever two differences of potential are produced, separated by a conductor, electricity flows. Having said so much, perhaps too much, I want to speak to you about the production of electricity. Having shown you the various forms of energy, how it is transferred, and why it is transferred, I want now to say something of the production of electricity. You know very well that a lump of coal is a store of energy; that is evident by placing it in the fire. There are certain contrivances by which electricity can be produced from coal, but the effects are difficult to show to an audience. So we will take zinc, which, for the purpose, is better than coal. Zinc is a grand store of energy in its potential form. Here is a piece which I take up and place in a glass jar, and in that same glass jar I put a piece of carbon. I then place water in the jar, and, if I added to the water a little sulphuric acid, I should produce a galvanic battery; there would be a difference of potential, of which I just spoke, between the zinc and the carbon, which leads to the production of a current of electricity when the zinc and carbon are joined by a conductor. I have forty of these cells, or a battery, down-stairs, and I have two wires connected with its two ends, now in my hands. I know my battery is all right because, you see, when I bring the ends of the wire into contact with each other sparks are produced, which show that electricity is passing. I will not explain those sparks to you to-day, because I wish to talk to you about electro-magnetic effects of electricity and how they are utilized. The first is the production of magnetism. I have here an electro-magnet, which is simply a bar of iron enveloped by an insulated copper wire, and a poker. A poker can be utilized for a great many purposes, but my present purpose is to place it on the large electro-magnet before you. So long as the battery wires are not joined to the wire around the electro-magnet, and, consequently, no current is passing, you see that

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I can raise the poker from its position without difficulty; but, now I join on the wires connected with the battery to the coil of the electro-magnet, the poker is attracted with greater force than my strength can overcome. The effect is more perceptible by the use of nails instead of the poker. When the current is on you see that, owing to the attraction of the nails by the magnet, I am able to build up an ornamental triumphal arch of nails, but, directly I take off the current, the magnetism ceases, and the nails succumb to the force of gravity, and fall to the floor. I have here the parts of an electro-magnet disjointed, which I will put together to illustrate the utility of this power of attraction. I place the iron bar surrounded with wire on the table, and, on holding nails to it, you see it possesses no attractive power. If I let the current pass from the battery through the coil, the iron is magnetized, the attractive action is immediately set up, and the nails are attracted. Now, suppose I want to utilize this power to ring this bell—the dome which I struck a short time ago—I place the hammer (which is attached to a piece of iron in position to be attracted similar to the nails, so as to imitate the motion of my wrist) in front of the electro-magnet; I then place the bell-dome on its rod, so that the hammer, when drawn forward, will fall upon it; and, as you will see, the arrangement is complete in that simple form, for each time a current is sent the iron armature is attracted by the magnet bringing with it the hammer which strikes the bell by its forward motion. This is the principle on which all electric bells are constructed. A similar arrangement is employed for giving alarms in case of burglary. A small switch arrangement is attached to the frame-work of the bed-room-door [a small door so fitted was exhibited]; this switch is put on on going to bed, and, should the door be opened by any one during the night, a succession of currents of electricity are sent to a bell, which continues to ring till attended to, and it would be a bold burglar who dared to carry on his nefarious business under such a din. A modification of this arrangement can be adapted to innumerable purposes. In America, where servants are not so plentiful as in England, necessity has compelled the employment of electricity for domestic purposes, to a far greater extent than in England. In nearly every town in America, systems of wires extend to almost every house, in the hall of which is a small instrument [one was exhibited], on the dial of which divisions bear the various words—messenger, carriage, *coupé*, express-wagon, doctor, police, fire, and two or three other things, and on turning the instrument pointer to any division, and drawing down a spring, a call is sent to the central office or bureau, and the instrument there indicates the service required and at what house, and the request is carried out at once. While traveling in America, I was once afraid that I should not have time to reach the nearest telegraph-office, to dispatch a telegram in reference to an appointment; and, on mentioning my concern to the lady in whose

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house I happened to be, she put her little instrument to "messenger," sent the current by pulling down the spring, and in two minutes a messenger was at the door waiting to convey my message to the telegraph-office. Time passes terribly quick, and my energy is gradually disappearing, so that I shall have to pass over some of the things I wanted to show you, such as the process of engraving by the electro-magnetic system; how toys were moved, boats made to swim about, and birds to sing. At the recent Paris Exhibition, the varied applications of electricity were simply wonderful and amusing. I have no doubt we shall have a great many of them exhibited, shortly, at the Crystal Palace, where I hope some of you may be able to go before your return to school. I will now show you how this system of producing electro-magnetism can be utilized for telegraphic purposes. On the table are fixed two complete sets of telegraph-instruments, very close to each other, but the set on the right hand belongs to one station, and that on the left hand to another station. You may fancy that the instrument which I touch, on the left, is in London, and that which Mr. Cordeaux touches, on the right, is in Liverpool. For every current of electricity I send from London, I do a little work in Liverpool, and that results in motion, producing sound. The mere depression of my "key" produces electro-magnetism in Liverpool, which attracts a piece of iron and produces a sound. [Illustrated by working the instrument.] The battery attached to my key is in London, and the depression of my key sends on a current which arrives at Liverpool, produces magnetism and sound. By depressing the key rapidly or slowly the sounds may be made correspondingly short or long. [Illustrated.] By an arrangement of dots and dashes, the letters of the alphabet are represented, and experienced clerks can read off the sounds and translate them with astonishing rapidity. To illustrate this to you, I will ask your secretary to write down a short sentence, unknown to my assistants, which shall be sent by one of them, Mr. Cordeaux, on one instrument (supposed to be in Liverpool), and read off by Mr. Cooper on the other instrument (supposed to be in London). [The secretary then handed in a slip of paper to Mr. Preece, and the message it contained was read off by Mr. Cooper, "A merry Christmas to the juveniles."] That is the operation of telegraphy. The sounds are read off as clearly as ordinary spoken language, though mistakes are sometimes made. For instance, a party of young school-girls, out for an excursion once, wished to advise their schoolmistress of their safe arrival at a certain point, and sent the message, "Arrived all right"; but the schoolmistress was horror-stricken to read the message as delivered to her, which read "Arrived all tight." Telegraphically, the difference between the two messages is not great, for the letter *R* is represented by two dots and a dash, while *T* is represented by a dash. Another error in transmission was where a message, "Five fathoms and four feet is ample

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for my wants," was delivered "Five fat sows and four feet"; a cricketing message from Lord's, "Jack, bring up two ground-men," was delivered "Jack bring up £2 10s." And, at the time that Commodore Goodenough was appointed to a station in Australia, the message received was, "A commodore has been appointed good enough for the Australian colonies." The system of telegraphy I have just shown is the ordinary one-way method; but it is possible to send two messages in the opposite direction at the same time upon one wire, and this I can make clear, without going into a detailed explanation, by asking Liverpool to send dashes or long sounds to me while I send dots or rapid sounds to him. [This was done.] We go still further, and send four messages in opposite directions, at the same time upon one wire; that is called quadruplex telegraphy. But the acme of telegraphy has been produced in this country by the Wheatstone automatic apparatus. I have a complete set of this apparatus before me. In it the messages are prepared by being punched with little holes (as you now see being done), and I now hold a slip of paper bearing perforations representing the alphabet, which look very much like the patterns used in the Jacquard loom for lace-making. The perforated paper is put in the transmitter, which sends on currents of electricity, representing the holes upon it; these currents of electricity are received by a "receiver," by which they are made to represent dots and dashes recorded on a long slip of green paper, and these dots and dashes indicate to the clerk at the receiving station the message sent. The peculiarity of this instrument is its rapidity, for, by it, instead of being only able to send from thirty to forty words a minute (the limit of the human hand) from 250 to 300 words a minute can be transmitted. At the present moment, there is not a town in this country, where a daily paper is published, that is not in direct communication with London, and receives its intelligence by means of apparatus of this description. Whatever news it is, whether an account of the Canonbury Railway accident, or a panic that may have happened this afternoon in some theatre, or something else now going forward to the country papers, it is being sent by means of this perforated paper and automatic instrument. Those who are interested in the apparatus will be able to examine it closely at the end of the lecture; but it is impossible for me to describe it minutely now, because it would occupy more than one lecture to understand the whole working of the system. It is most extensively employed in this country, where the growth of telegraph business has been enormous. I spoke in somewhat glowing terms of the duties and doings of this automatic apparatus when in Paris, and my Parisian friends rather doubted my statement. However, I induced the French Government to send an officer over to England to examine for themselves the working of this instrument, and to my great pleasure when he came here he found that my statements were under the mark, and only a few days ago,

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when an experiment was tried, to satisfy the French gentleman, we were able to transmit, on a wire between London and Glasgow, no less than 352 words a minute. The growth of telegraphy in this country has been enormous. In 1869 there were only 2,000 offices open, there are now 5,500; there were then only 6,000,000 messages sent a twelvemonth, there are now 30,000,000; the income in 1869 was £700,000, it is now £1,600,000; the number of newspapers and clubs supplied with news was then only 173, it is now 803; and there are 326 towns now being supplied with news direct from London. In regard to submarine cables, I have here a box of specimens of the various types of cable laid down, which is well worth examination. Submarine telegraphy has increased during the ten years, from a few hundred miles of cable, to 70,000 miles, which now engirdles the world. There are many other applications of electricity besides telegraphy, such as, for instance, railway-signals. A railway accident recently occurred at Canonbury, where three or four trains were huddled up in a tunnel. I do not know much about the system of signaling used on that railway, but I know a good deal of the system of signaling in use on the London and Southwestern Railway and other lines. The principle of the "block" system is simply that a railway is supposed to be divided into certain sections of a given length, and no two trains are allowed, or ought to be allowed, to be in one section at the same time. If, for instance, the section be a tunnel, such as at Canonbury, and two trains are allowed on it, the risk of collision is great, as recently proved; but, if the block system be thoroughly and efficiently carried out, there ought to be no such accidents. Some twenty years ago, after a good deal of talking, writing, and persuading, I induced the London and Southwestern Railway to adopt the block system. The system in use on the London and Southwestern Railway is my own. A complete set of apparatus is before you, and I will explain its working. A little semaphore is in front of the instrument, which, when down, indicates that all is clear, and, when up, that there is danger, and the train must stop. Suppose the instrument near me is at Waterloo Station, and the other one near Mr. Goldstone is at Vauxhall. That represents a section of the railway, upon which we want to allow one train only at a time. To ascertain if all is clear at Vauxhall, I send a warning signal of two beats given twice, indicating "A train is coming," which is acknowledged by a signal of one beat from Vauxhall; my semaphore arm is down, telling me that the line is clear, and I let the train go on, sending a signal of two beats [this was done] to Vauxhall, to tell him that the train is in. Vauxhall raises the semaphore behind the train to prevent me from sending on another, and I acknowledge his signal, by giving one beat of the bell. The train is now proceeding; the semaphore arm at this end is up, protecting the train, and I can not, I dare not, send another train until I know that the one now going on has arrived at Vauxhall. It is now

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supposed to have done so, and he sends three beats upon the bell, which lowers my semaphore arm and tells me "Line clear," and that the apparatus is in working order. On such a system the traffic of a railway can be conducted day by day, and hour by hour, with safety to the public, and with satisfaction and certainty to the railway interest. One other illustration that I must give you, of the application of electricity, especially as my store of energy is not yet exhausted, is the telephone. One of the most beautiful things at the Paris Exhibition was the transmission of music, by means of the telephone, from the Opera-House to the Exhibition Building. At the Opera-House several microphones were fixed upon the stage, and at the Exhibition Building telephones were fixed in rooms into which visitors could go, and, by applying the telephones to their ears, could listen to the overture of the orchestra, or the singing or talking of the performers, as also the hum of the ballet-girls behind the stage. The effect was something startling. I remember one night seeing a Frenchman put the telephones to his ears, and the moment he heard the sounds he threw down the instruments, and rushed out of the room, saying, "*C'est terrible, c'est terrible!*" The Christmas holidays have prevented my having similar arrangements for this lecture, and the best thing I could get ready is a telephone circuit between this hall and a neighboring room. I will call up and ask my assistant to play something on a cornet. [The cornet was heard playing quite distinctly.] That is an instance of what I wished to illustrate to you at the commencement; we have a bugler, full of energy, who blows into his bugle, the energy of which takes the form of sound; the sound-waves, or vibrations, strike the top of the telephone-case, and set a microphone in vibration, which causes currents of electricity to pass along the wire from the instrument at the other end to the one before you. In the receiving instrument the currents sent by the microphone take the form of electro-magnetism, and reproduce the vibration of the microphone upon a disk in front of the electro-magnet, and so we get reproduced in the same form the energy set in motion at the other end, after having passed through various stages. The motion of the cornet is transferred, first, into the motion of the disk, then into the electrical form of energy, then into that of electro-magnetism, then back again into motion, and, finally, to your ears; and you will easily understand from this that electric currents are merely one form of energy. I intend to pursue this subject next time, and show you how electricity is produced in other ways, and how it breaks up chemical compounds into their separate parts; how electro-plating and silvering are done; and, finally, I will show how it produces the beautiful Edison electric light we now have in this room. The elegant chandelier now illuminating this room was made especially for exhibition at this lecture, and was prepared by Messrs. B. Verity and Sons, of King Street, Covent Garden.

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QUACKERY WITHIN THE PROFESSION.

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THE profession is probably unaware of the progress steadily made by medical quackery in its diverse forms and disguises. Quackery which is not medical—in the sense of being practiced by duly qualified men—is undoubtedly an evil, but its consequences are not comparable with the effects of such quackery as is growing apace within our own ranks, and slowly it may be, but surely, undermining the respect and confidence which the profession has hitherto deserved and received from the public. We sometimes wonder that our calling does not command the warm recognition in certain quarters to which it seems entitled. For a sufficient explanation of this default in the estimation of society, let us look to the prevailing and almost daily increasing popularity of "systems" and "cures" tacitly, if not avowedly, supported or countenanced by the profession. There is a sentimental and mock-heroic spirit abroad which burlesques the candor of "truth-seeking," and even mimics the impulses of chivalry. We hesitate to condemn any system, "lest there should be some good in it," and we are too tender-hearted and polite to deal honestly by its promoters, even though we recognize the fallacy of their pretensions, and more than suspect their motives. This is not a faithful line of conduct in reference to our profession, nor is it loyal to science, which is one of the many constituent parts and aspects of truth. We know, or ought to know, that a perfectly just and truthful conception of the science of medicine must bar the recognition of *systems* and *cures* of any class or description. The art of healing is not a system, and can never be made one. It is simply an intelligent application of the laws of health in the remedy of disease. We study the "symptoms" of a malady with a view to the acquisition of precise knowledge as to its nature, course, and rational treatment. We pursue the investigation of disease over the boundary-line of death, and explore the cadaver with a view to ascertain the effect of the morbid state on the organism and to elicit its organic causes, albeit we too commonly confound effects with causes. We test the powers and analyze the constitution of drugs, and we scrutinize and make careful trial of methods of treatment, to obtain a reasonable acquaintance with their natures and actions. In brief, we take any amount of trouble and resort to every means at our disposal to render the principles and practice of our art *rational*. This is our duty, and it is the only method consistent with self-respect and professional integrity; but, if side by side with this policy, we cherish a spirit of credulity which renders us ever ready to countenance systems of which we can know nothing—because there is nothing to know—and take a false pride in showing friendliness to quacks and charlatans, the good work we our-

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selves may do is changed to evil by reason of the actual or implied sanction we give to the bad work done by others. Nothing is so much needed just now as the rise in our midst of a stern and uncompromising apostle of sincerity in science—a man of unpitying animosity to humbug in all its forms, who will not hesitate, at any bidding, to denounce wrong-doing and untruthfulness, let who may be the offender. It is time that a spirit of manliness went out in our ranks to chase away the lying spirit of mock courtesy—the faint-hearted and time-serving sentimentality—which makes us so ready to look kindly on any pretender, and so reluctant to expose any pretense.

There can not possibly be a "system" or "cure" in medicine. There are no rule-of-thumb methods and no *mysteries* in true science. If we do not know what a remedy is, and how it acts, we have no right, as honest men, to employ it. The time has passed for the working of cures by charms and the recourse to nostrums. We pander to the credulity of the unskilled community when we show ourselves credulous. We patronize and encourage quackery when we extend professional recognition to a quack. Every man is a quack—whether qualified or unqualified—who employs a remedy without knowing why, or who adopts a "system" in medicine. The profession must speak out clearly and strongly on this point, and without delay. From the highest places in society to the lowest ranks of the people, there is just now a grievous readiness to "believe in" quacks and quackery. We have ourselves to thank for this most adverse "feeling" and "influence." It is the stirring of the viper we have brought in from the cold, where physicians and surgeons of more robust intelligence than those of to-day left it—the viper we have warmed and fed and brought back to life; and now it is preparing to rise and sting the hand that caressed it. The way to encounter the charlatanry which is making head against science is to be at once more candid and more conspicuously *honest* in our dealings with the public. We must lay aside the last vestige of the robe of mystery, and show by our words and works, our conduct and policy, that medicine is not a science that admits of inspiration, and that the practice of healing is not an art which can be acquired by the unlearned. There is no system or cure, or charm or nostrum, known to the profession; our calling consists solely in the rational study and treatment of disease on common-sense principles. For those who pretend to a sort of inspiration we have no professional friendship; and toward the promoters of systems and 'pathies we can have no leaning, or any feeling other than that of suspicion, if not pity and contempt. They can have no place in our professional intercourse, and we can have nothing to say to them or their work. This is the only sentiment worthy of the medical profession in its dealings with medical quacks, and the time has come when the revival of its old spirit is most earnestly to be desired.—*London Lancet.*

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SKETCH OF PROFESSOR B. A. GOULD.

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By ERVING WINSLOW.

BENJAMIN APTHORP GOULD was born in Boston, September 27, 1824. He is the son of the late Benjamin Apthorp Gould and Lucretia Dana Goddard. His childhood was marked by many precocious indications of genius, which have been laid up in the memory of a united and gifted family, in which his relations, filial, fraternal, and paternal, have been singularly loyal, honorable, and affectionate. When three years old he read easily and with sufficient expression to make it pleasant for others to hear him. At five he made a fair original version of an ode of Horace. As a lad he was very fond of botany. Starting one day with his brother in pursuit of a flower which grew at a great distance from home, the brother returned to his mother after a long absence, asking what was the matter with his companion. He said they had walked a long time, and that then his brother had fallen and was lying on the ground. He was sought in vain: and when he returned home with his specimen it was found that the persevering boy had overtaxed his strength, fainted from exhaustion, and after his recovery had still followed and accomplished his pursuit. When he was ten years old his family were summoned by written invitations to attend a lecture upon electricity which young Gould had prepared, which proved to be no mere childish play, but a well-considered discourse, illustrated by a complete and neatly constructed electrical machine entirely of his own manufacture. He prepared for college at the Boston Latin School, taking high rank, receiving at one time five prizes, among which was the Franklin, then the only gold medal awarded in the school. He graduated from Harvard University at the age of nineteen, and shortly after was appointed master of the Roxbury Latin School—an appointment made by the committee in view of his scholarship, while in ignorance of the fact that he was under twenty years of age, the regulations of the school forbidding the appointment of any one who had not attained his majority. He retained this position for a year, at the end of which time he resigned, that he might pursue his studies in European universities. These occupied about four years, during which he formed friendships with the most eminent scientists of Europe, which lasted with many of them, such as Argelander, Gauss, and Humboldt, until the close of their lives.

Dr. Gould's study of astronomy was pursued under the learned Gauss and in the scientific courses at Paris, and in the observatory there, then under the direction of Arago. On returning to America he was employed to determine astronomically the various geodetic

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stations of the United States Coast Survey. Dr. Gould has proved in his scientific career that he possesses in a rare degree that bold, initiative spirit which is so marked a characteristic of our countrymen. As soon as any progress has been made in any department of science, Dr. Gould has at once turned it to account in his particular domain. Thus, he was among the very first to use electricity for the purpose of determining the differences of longitude, and recording by telegraph the exchange of signals and stellar observations. He had already employed this method, no less exact than rapid, in fifteen series of determinations before its introduction into Europe. Hardly was the transatlantic cable laid, before Dr. Gould started for Valentia, Ireland, and there established the station from which the difference of longitude between Europe and America was determined, and connected the two continents by the most precise observations. The net-work of these determinations thus extended from Greenwich to New Orleans, and covered almost a quarter of the globe. Besides all this geodetic work, Dr. Gould has very largely contributed to the development of pure astronomical science. By his learning, by his publications, by the example he has set in his researches, he has done much to inspire his countrymen with that love of astronomy which is now so widely spread in the United States. Since the commencement of Dr. Gould's career, upward of twenty new observatories have sprung up, which, in the precision of their methods and the closeness of their observations, take full rank with those of Europe. Dr. Gould is not only one of the founders, he is one of the most distinguished masters of the school of American astronomy. He established and supported at his own expense from 1847 to 1861 the first astronomical journal ever published in the United States. Between 1855 and 1858 he organized the Dudley Observatory at Albany, and it was there that the normal clock, protected from atmospheric variations and furnished with barometric compensation, was first used. In his new meridian circle, also, Dr. Gould introduced many improvements of construction, which are to-day in use in all observatories, and it was his clock which gave the time-signals to New York.

From a student and assistant at the Dudley Observatory, a word must be said here of the extraordinary executive power and the personal magnetism which Dr. Gould exercised in his little scientific family. Such a life is always a happy one where a high purpose and unflagging zeal give the key-note, but the kind forethought in every detail of domestic arrangement, the careful insistence on methodical ways in food and sleep at whatever hours they might be sought, in the exigencies of astronomical labor, were invaluable to young men, some of whom were fresh from the safeguards of home. The midnight toils were ever lightened by kind words and encouraging example, the hours at table brightened and instructed, whatever stress was laid on the master by cares within or without; and when the Scientific

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Council assembled, and Dr. Gould was surrounded by Bache and Henry and Peirce and the rest, his loyal assistants found their chief still easily first in wit and learning among the brilliant band. Scattered now in the church, the naval service, college, and business, they look back with affection to those days as among the happiest of their lives, and with gratitude to him whose overwhelming anxieties never relaxed his efforts to make them so.

Dr. Gould's "Catalogue of Fundamental Stars" has been used up to a recent date, not only for the calculation of the ephemerides in the "Nautical Almanac," but also as a basis for all observations made in this country.

In view of the special value of ancient observations, Dr. Gould undertook to reduce and to publish all those which had been made at Paris by D'Agelet between 1782 and 1785. He has also reduced all the zone observations made at Washington from 1846 to 1852, in both these cases rendering great service to the cause of science.

The southern heavens being almost unexplored, and offering a vast field for investigation, Dr. Gould, in entire devotion to the interests of science, and setting aside all personal considerations, unhesitatingly responded to a call from the Argentine Republic. Thanks to his personal qualities and his scientific capacity, he soon acquired the complete confidence of the Government, under whose auspices he founded at Cordoba, between 1870 and 1872, an observatory equipped with the most admirable instruments. Here Dr. Gould, being quite independent, and no longer obliged to divide his energies among many different interests, has undertaken a series of great works of remarkable value. He has just published his new "Uranometry of the Southern Heavens," including all stars visible to the naked eye, the magnitude of each star being determined by not less than four independent observations. In the course of these researches he has found as many variable stars visible to the naked eye as have been discovered to this day in the northern heavens. Other labors under these favorable conditions and based on scientific principles have been devoted to the reformation of the boundaries and notations of the constellations. His Uranometry is as final an authority for the southern hemisphere as that of Argelander for the northern. From the results obtained by Argelander and Heis, combined with his own observations, Dr. Gould has deduced a formula according to which the number of stars increases in proportion to the diminution of their luster, and he has suggested that our solar system is not part of the milky way, but of a stellar system to which about four hundred of the brighest fixed stars also belong, and which bisects the milky way at an angle of about 20°.

It is well known that the object of the zone observations made by Bessel and Argelander was to determine the positions of stars from the first to the ninth magnitude, between — 3° and 80° in the northern

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hemisphere. Dr. Gould has just finished at Cordoba a series of like researches, in the course of which he has taken 106,000 observations of southern zones. Almost at the same time he was engaged in a second series of determinations of great precision, involving 110,000 meridian observations between the equator and the south pole. In this work he determines anew all the co-ordinates of the stars observed at different epochs by Lacaille, Piazzi, Brisbane, Rümker, Johnston, Taylor, Maclear, Ellery, and others. He has also made observations of other stars down to the ninth magnitude, which gave him his fundamental positions. By these three great works he has established certain bases for future research. Henceforth the position of all heavenly bodies may be referred to those of well-determined stars, and, by comparing the co-ordinates of his second catalogue with those obtained in the past by Lacaille and others, important conclusions may be arrived at as to the movements of the fixed stars. Dr. Gould has used photographic processes in the determination of star places with great success, and almost all the star-clusters of the southern heavens can be found in the two hundred plates obtained by him, several of these plates containing about two hundred stars each. This latest work is not yet published, but some of the plates obtained the highest prize at the Philadelphia Exposition.

Besides these great astronomical works, Dr. Gould has done much in quite another line, which can merely be mentioned here. The United States Sanitary Commission has published a work by him of 400 quarto pages, containing the results of physiological observations on over 30,000 men from the point of view of statistical anthropology. The same work contains the results of innumerable experiments made in the Federal army upon 1,300,000 men, with a view to determine human growth between the ages of fifteen and fifty.

The climatic conditions of South America were quite unknown in 1872. Dr. Gould has established a net-work of meteorological stations, extending on one side from the tropics to Tierra del Fuego, and on the other from the Andes to the Atlantic. Observations are now made regularly three times a day in twenty-five stations. One volume in quarto has already been published on the climate of Buenos Ayres, and others are being prepared.

On Dr. Gould's first return home for a short visit, a public reception was arranged for him in Boston in response to the following invitation:

> Desirous of testifying to the honor in which your native country and city hold those great services to science, as observer and investigator, which peculiarly propitious circumstances have led you to offer to our sister republic in South America, under the administration of the distinguished President Sarmiento, as director of the Argentine National Observatory and Meteorological Office; and wishing to meet you on your return home with the friendly sympathy of fellow-citizens, and to hear from your own lips something of the results

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of your labors, we ask you to meet with us at Wesleyan Hall, on Monday, June 22d, at three o'clock, P. M., for this purpose.

We are your obedient servants,

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Charles Francis Adams,	T. W. Parsons,
James Walker,	Theodore Lyman,
George T. Bigelow,	Henry A. Whitney,
Henry W. Longfellow,	James M. Barnard,
Richard H. Dana, Jr.,	George S. Hale,
Charles W. Eliot,	Martin Brimmer,
George M. Lane,	William Gray,
Wolcott Gibbs,	W. G. Weld,
H. L. Eustis,	J. H. Dix,
O. W. Holmes,	Alexander Agassiz,
	and others.

The late Hon. Richard H. Dana presided, introducing an eloquent address by Dr. Gould, and in his words of welcome said:

We have met to express our respect to him for his learning and abilities, and the courageous manner in which he has devoted them to this new field of investigation—banished from home, and from every association which his childhood and manhood had made most dear to him. . . . We feel now that there exists a bond between that great republic of the South and our own—that she has shown the same spirit of enterprise that has caused our own advance—and we rejoice that through their honored President, Sarmiento, the man of science was invited from this country, who should open some of those great fields of exploration for which her wide territory and cloudless skies present such facilities. Our sympathy and our admiration should be expressed toward the people of the Argentine Republic, and we trust that Dr. Gould will give them to understand that the citizens of his native State have a strong feeling of respect and gratitude to them for the paths they have opened and the progress they have made.

It is in these regions, so little known, that Dr. Gould has been laboring for four years, a missionary of science, under strange skies, as well as on foreign soil, among a new people; and on his return to his native town we are met to give him a cordial welcome, to express our pride that he has secured this opportunity to the honor of American science, of New England and of Boston.

Dr. Gould is a member of the Royal Astronomical Society of London, of the French Academy of Sciences, of the Academy of St. Petersburg, as well as of the American Academy of Science, and many other learned bodies. He has given to the world works which will be classical, and in the history of his country his name will stand among those of the most illustrious *savants* who have contributed to the development and advancement of science.

Dr. Gould was married October 29, 1861, to Mary Apthorp Quincy, a helpmate without whom his long expatriation would have been a banishment, and without whose sympathy and active assistance his greatest labors would have been impossible.

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ENTERTAINING VARIETIES.

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THE MOUNTAINS OF THE MOON;

OR,

TRAVELS AND ADVENTURES OF HAKIM BEN SHEYTAN.

TRANSLATED BY F. L. O.

INTRODUCTION.

THE result of the first Tunisian expedition to the interior of Africa is too well known to require here more than a general mention. After the treaty of Khundabad, the commander of the exploring-party tried to reach the Mongha highlands by following the valley of the Bar-el-Nûn, and had already crossed the foot-hills that form the western boundary of the Fant hunting-grounds, when the vanguard of his auxiliaries was routed by an attack of the Galla marauders, who captured sixteen of his companions, including his five Tripolitan merchants, and effected their retreat across the mountains before the arrival of the Khundabad rescuing party. But this very disaster, which defeated the immediate object of the explorers, helped to enlist the aid of the Tripolitan Government, and thus led to the marvelous discoveries of the second expedition.

In the last week of November, 1878, the command of Marut Pasha assembled at Wady el Kamr, where they were joined by a troop of Tunisian volunteers, mostly relatives of the captured merchants. Hakim Ben Sheytan, the medical and *quasi*-scientific *attaché* of the expedition, had been appointed at the special recommendation of the mollah or high-priest of Tripoli, who had also induced the government to furnish the commissary supplies from the Dey's own Beit-el-Habbada or body-guard barracks. The caravan reached Moorzook in midwinter, and, in spite of the doctor's protest, the commander attempted to cross the Bedeyat lowlands before the end of the rainy season. The Harra-Ghul, the terrible jungle-fever of the waddies, broke out before they had reached the Soodan hill-country; the Tunisian volunteers, and at last even the pasha's veterans, were decimated by the epidemic, and upon their arrival at Darfoor all but twenty of them had to be sent to the Arabian hospital. But the instructions were very stringent: the sick were left in charge of a native surgeon, and with twenty-five followers, including Dr. Sheytan and three Darfoor guides, the commander continued his journey to Galla-land. They followed the windings of the Bar-el-Adda, a stream that takes its rise in the Mountains of the Moon, and at last reached the land of the Khundi Fants, and made their way to the chief village, where the news from the frontier

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brought them to a full stop. The Khundi chieftain, however, received them hospitably, and, being on trading terms with the Gallas, offered to mediate the ransom of the merchants. Pending these negotiations, the Tripolitan commander had to go into camp, and now and then led a hunting expedition to the western Sierras, while the doctor tried to requite the hospitality of the Fants by nursing the sick of the chieftain's household. His success gradually extended his practice to a rather undesired degree, since the messengers from the highland settlements kept him nearly all day in the saddle; but during one of these trips Dr. Sheytan crossed the main ridge of the Moon Mountains, and in the ultramontane valleys discovered such a remarkable race of autochthones that he considered the Khundi-town delay the luckiest accident of his life.

The Monakees, or inhabitants of the western Moon Mountains, appear to be unlike any other race of the known world. In mechanical arts advanced far beyond their neighbors, they are at the same time addicted to most preposterous habits and superstitions. With the aid of an interpreter, and his knowledge of the Fant-Arabian dialects, the Hakim interviewed their priests and medicine-men, inspected their dwellings, caves, and temples, and visited many of their outlying villages, and continued his investigations even after his official duties had recalled him to Khundabad. For the Khundi chieftain, in the mean while, had ascertained the whereabouts of the captive traders, and finally effected their release, and after the end of the next rainy season the Tripolitans returned to Darfoor, where the Hakim took charge of the sick, and employed his leisure in writing the chronicle of his discovery. This chronicle, addressed to his kinsman, the mollah of Tripoli, gives a circumstantial description of the Monakee race, their habits, physical peculiarities, and singular superstitions—interpersed with an account of his personal adventures and of the reflections which occurred to him while traveling through their country. "The work abounds with incidents and graphic descriptions," says the reviewer of the first German translation, "as well as with scientific disclosures that throw a suggestive light on the origin of the customs and vices of civilized life." Besides his first professional trips across the frontier, the Hakim seems to have spent nearly eight months among the Monakees, collecting information on all possible topics, interviewing the just and watching the wicked, traveling from village to village, often at the risk of his life, but always sustained by the conviction that "Allah had appointed him to perform this work," and the hope that the world would recognize its importance.

The result has fully justified that hope. Even the first rumor of the discovery created a general sensation at Tunis, and was repeatedly discussed during the October sessions of the Vienna Geographical Society, though it was not yet positively known that the explorer had crossed the western frontier of Khun-Fandistan; but the controversies

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on this point were soon settled by the famous circular of Dr. Reidor, to whom the Tripolitan Government had intrusted the publication of the Hakim's chronicle. As the preliminary account of the *Anabasis* through the Soodan waddies (sufficiently known from the writings of Barth and Burton) is little more than a collection of military march reports, it has not been included in the second edition of Dr. Reidor's translation, and the present brief summary will suffice for the explanation of subsequent events.

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But the chronicle itself is a work of quite a different character, and at once attracted the attention of the scientific public. Its general interest may be inferred from the success of the German * and Spanish † editions, though the speculative portion of the original has been partly omitted in both works, and, strangely enough, especially in the German version, whose (Austrian) expurgators have found it necessary to suppress the most interesting political and ethical reflections. I shall offer no apology for having restored those passages. From European prejudices the author of the "Chronicle" is as free as Hafiz Ben Eddin, but his work is certainly not immoral, and can be called irreligious only where that word has not yet ceased to be a synonym of truth-loving. The commentaries of the Spanish translator have greatly aided me in the exegesis of the Mauritanian idioms; but, where a literal translation would fail to elucidate the ambiguity of certain topographical terms, I have thought it safer to retain the nomenclature of the Arabian text. F. L. O.

THE CHRONICLE OF HAKIM BEN SHEYTAN, THE SERVANT OF ALLAH.

CHAPTER I.

In the Name of the All-merciful, etc., Adna-Mullah Ibn Saddi: To my Father, Greeting and Peace.

Not now, Namullah, nor in weeks of speech and free discourse, could I recount all the hardships of our journey since we parted at El Kamr. And yet I praise the Lord, and through these, and twice as many dangers I would go again, for all the wonders he has thus revealed, and for the ever-memorable manifestations of his judgment upon the impious who violate the laws of his Word, the laws which Nature has proclaimed even to the heathens.

The death of Abu Riyah you will have learned from the pasha's report, as well as the fate of Sheik Hanbal's companions; and I will begin my relation from the Alms-week of the New Year (February

* "Die Wunder des Mond-Gebirges. Von Prof. D. R. Widerleger." 2 vols., sq. 8vo. Vienna, 1881.

† "Las Aventuras de Hakim Ben Sheytan. Por el Dr. S. L. Reidor." 2da edicion. 8vo. Salamanca, 1881.

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9th–16th), when the last messenger departed from our camp at Khundabad.

After the recovery of his imam, Sheik Kedar (the Khundi chieftain) treated me with great kindness, and urged me to remove my tent to his cottage-yard; but I had set my heart on visiting the towns of the Monakees, and the plan moved my soul night and day, especially when the Fanti traders gave me to understand that the emir was anxious to see me, and was going to send me a guide and a traveling present. Our commander considered that report as an idle rumor, but on the last day of the Alms-week our doubts were removed by the arrival of a messenger with a grace-firman (safe-conduct) of the Monghistan emir, whose son had been stricken with a sore disease, and who (supposing that I had entered the service of the Fants) besought the sheik to grant me a leave of absence. My departure was then decided upon. The messenger returned to announce the shiek's consent, and, three days after, the pasha intrusted me to our old guide Abbad, surnamed El Karman ("the Maimed," from the loss of three of his fingers), and we ascended the mountains, by way of the North Pass, where a month ago my companions had captured the strange baboon I sent you with the cargo of the Tunisian traders.

But the weather was now much drier, and I urged the Karman to speed our march, for my soul had grown restless with wondering expectation. All reports presaged a land of marvels. The texture of the Monakee garments was said to be superior to the best linen of Soodan, and from the excellence of their weapons the Monakees were dreaded as foes, though not loved as allies. Far stranger than all the rumors about the marvels of their country were the doubts about the *humanity** of their race. The perfection of their manufactures inclined some to credit them with superhuman skill, while others argued that their habits and appearance proved them to be an inferior variety of monkeys. My own opinion I shall give by-and-by. Of their skill in textile fabrics I had a proof when the Karman showed me a pair of foot-sacks (*calcetes*, probably a sort of woven gaiters), gay-colored and of great strength, and cheap withal, though not to the weavers; for my guide told me that such goods are manufactured in houses where the air is thick with dust, and where scores of the young Monakees are killed with overwork.

People who treat their own children so unkindly can not be expected to show much mercy to their enemies, and I did not wonder when we passed a field where human bones were bleaching in large heaps—the monuments of a battle in which the Monakees had slain twenty thousand of their neighbors. Still I thought that the cause of the war

* "Menschlichkeit," W.—*Cristianismo*, says Dr. Reidor, probably from an inadvertent confusion of correlative terms. Even in the language of our country-people the two words are sometimes used as interchangeable synonyms, as in the phrase, "He takes his grog just like a Christian"—in referring to the accomplishments of a trained monkey.

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might somehow justify such deeds, but I learned that the sole object of the invaders was the suppression of certain views or doubts about the secrets of a future existence. Their adversaries, it seems, confine their worship to the God of the Sun, while the priests of the Monakees address their prayers to several other deities, especially to the Man in the Moon, whom they call the nephew of Allah. It is true that they also assert the superior sanctity of their nation, and, the Karman's faith being opposed to theirs, I was unwilling to adopt his views on this point; but even before we had entered the dwellings of the Monakees I could not help noticing a peculiar smell in the air, an odor resembling the fumes of the East-Bombay * rum-shops. A few miles farther west we met a poor boy, who took to his heels as soon as he saw us, though the Karman called after him to stop and not to mistake us for Monakees. He belonged to the race of the Musanites, a tribe of dissenters who live here and there in the Monakee settlements, and seem to be treated well enough as soon as they have acquired a certain amount of wealth, though the poor ones are often subjected to gross indignities. Their offense, too, consists only in a difference of opinion. They seem to be a harmless and very industrious sort of people, but they have no great faith in the Moon-man.

We made thirty miles the next day, and toward evening crossed the Monghistan frontier on the west shore of a dry river-bed. I have seen Persia and India, and the palm-gardens of Yemen, but I believe that this country was originally far more favored by Nature: mountains constantly alternate with plains, highlands with terrace-lands, all intersected by lakes and broad river-valleys, and considering the fertility of the soil it seems that Monghistan must once have been a land of transcendent beauty. Once, I say, for the river-beds are now dry; the lakes are bordered with naked rocks. While Shadissa Ibrahim † (may Allah receive his soul kindly!) did his best to redeem our land by planting millions of shade-trees, these unfortunates seem to vie in destroying the last remnants of their woodlands; on all the ridges I saw heaps of felled trees, and in the plains moldering stumps are the only traces of the original forests.

Here, as in India and Darfoor, I have noticed a strange circumstance. As soon as the tall trees (*Hochwald*, W.) disappear, the underbrush becomes thorny; acacias, mimosas, prickly palms, cactus, and camel-thorns are here the only wild-growing shrubs. By this armor of spines Allah seems to protect these poor plants against the hand of the destroyer, though the Turks of Stamboul would probably say that the thorn-trees were there before the destruction began, and were able to hold their ground while other trees perished.‡

* "Bumbad el Shork," East-Bombay, a suburb of sailors and gamblers.

† Ibrahim Pasha.—Mehemet Ali and his son Ibrahim planted 20,000,000 forest-trees in the Thebaïs and along the shore of the Red Sea.—(Marsh, "Man and Nature," p. 189.)

‡ Dr. Reidor understands this passage as an allusion to the Darwinian survival theory,

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The highlands, however, are still pretty well wooded, and there is no lack of game, though the extraordinary shyness of the birds shows that they must suffer much persecution. Of the four-footed animals, too, the smaller ones are more timid and the large ones much fiercer than in our own country; at our approach deer and rabbits fled with incredible swiftness, and, when we went into camp, a troop of baboons up in the rocks kept up a continuous sort of coughing bark, like enraged watch-dogs. The Karman told me that the Monakees kill them without mercy, and I must own that they are certainly very provoking brutes. Yet they are children of our elder mother* and have preserved the knowledge that men have lost by their sins. "They know the way, and teach us without speech," as the poet says; and for days have I often watched them without sating my pleasure. Their inquisitiveness tempted them to approach our camp from behind, and, if we pretended to be otherwise engaged, they came nearer and nearer and diverted me much as I watched them from behind my shawl-tent; but, if my rogue of a guide rose suddenly to his feet, they fled with shrieks that made our ears ache. At last I persuaded the Karman to keep quiet, and just before sunset another troop came down from the cliffs on our right, and tried to steal upon us by crawling along under cover of the bushes and rocks. They walked on all-fours, but now and then one of the old ones would raise himself on his hind-legs to reconnoiter, while the youngsters raced around like frisky puppies. I verily believe that they would have entered our tent if we had continued to keep still; but, seeing that one of the youngsters had approached within a dozen yards of the camp, I made a sudden rush, just as he was in the act of climbing a tree-stump. Before he had reached the cliffs I overtook him, and finding escape impossible he threw himself on his back; and, instead of fighting me when I tried to lay hold of him, he leaped upon my arm, and, hugging it with all his might, began to chatter, very much like a prisoner pleading for mercy. But, when I grabbed him by the neck, his chattering turned into piercing shrieks, that continued even after I had wrapped him up in my shawl. His relatives had rushed up the cliffs like a flock of frightened goats; at the sound of the screams, however, they suddenly stopped, and some of the old males began to move upon our camp with hoarse yells that often resembled the challenge of a human voice.

They had advanced within half a stone's-throw, when the Karman whispered to me that in Kapibad† I could buy young monkeys by the dozen, and that we had better let this one go. As the noise was grow-

but Professor Widerleger is probably right—that it refers merely to the ridicule which the metropolitan Turks are apt to visit upon the theological speculations of the Arabs.

* "Beni abd'il Kabira," *hijos de la prima madre;* a term derived from the writings of the Sufist mystics.

† The chief town of Monakistan.

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ing deafening, I concluded to follow his advice; so, taking the youngster out, I put him on the ground and gave him a slap as a hint to be off. At first he did not stir, though he kept up his screams; but, seeing me retire behind the tent, he ran for his life and soon rejoined his relatives.

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As soon as the old ones caught sight of him they stopped their yelling, and, crowding around him, seemed to examine him very carefully, after which the whole troop wheeled around and rushed away much quicker than before, as if they had not overcome their natural fear, and risked their lives merely to save the youngster's—which shows that these animals treat their young ones more kindly than the Monakees (with all their gods) treat their children.

The next morning we started at sunrise and ascended the slope of a mountain whose rocks were covered with creepers,* bearing clusters of sweetish berries. To the production of these berries, and a broad-leafed weed (both used for the purpose of intoxication), the Monakees devote a considerable portion of their arable territory, which seemed the more surprising as I was informed that thousands of their poor live in bitter want of their daily bread. Yet the luxuriance of those noxious weeds proves their planters to be expert husbandmen, and they can certainly not be reproached with laziness, whatever may be their other vices.

After a march of three or four hours we reached the southern slope of a harrat,† and I beheld now for the first time one of those famous rock-kraals of Monghistan, a sort of city, crowning the brow of a distant hill. The houses looked like white dots on the blue heights, but even at this distance I could distinguish a peculiar kind of conical castles that towered high above all other buildings. These piles, the Karman told me, were temples of the Moon-man—mosques, so to say—some of them so elaborately finished that they had cost wagon-loads of money, and the labor of countless masons. Their very dimensions attested the skill of the architects; but I marveled that people who could do so much for the moon had done so little for their earth; the valley at the foot of the harrat was in a wretched condition, a sheer quagmire, studded with lagoons and reed patches, though a little drainage would have turned those bogs into fertile fields.

Still, Allah has not withdrawn his hand from this country, and at the bank of a little creek farther below I saw bottom-lands that would support more trees to the acre than our poor waddies on a square mile. And even the driest valleys abound with water-signs; if these poor people had learned the *sheriat-wakil*,‡ every field of their country would be blessed with good wells.

* "Schling-Pflanzen," twining plants or vines.

† *Harrat*, from *harr*, heat or fire. A mountain of igneous rocks, a basalt-hill.

‡ Sheriat-wakil, the "water-place science." Pallas says that the Arabian well-finders eschew the tricks of the divining-rod mystics, and follow a system of practical rules that

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Before we reached the top of the next ridge the heat of the day obliged us to halt in the shade of a rock-tomb; but curiosity soon got the better of my fatigue, and after a short rest we continued our march toward a river-valley, where we expected to meet the first living Monakees.

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—— *Curious Matrimonial Anomaly.*—Hassanyeh Arab wives enjoy at times "a freedom from the ties and responsibilities of the marriage state unknown, I believe, to any other race in the world." When the parents of the man and woman meet to settle the price of the woman, the price depends on "how many days in the week the marriage tie is to be strictly observed." The woman's mother first of all proposes that, taking "everything into consideration, with a due regard to the feelings of the family, she could not think of binding her daughter to a due observance of that chastity which matrimony is expected to command for more than two days in the week." After a great deal of apparently angry discussion, and the promise on the part of the relatives of the man to pay more, it is arranged that "the marriage shall hold good, as is customary among the first families of the tribe, for four days in the week—viz., Monday, Tuesday, Wednesday, and Thursday; and, in compliance with old-established custom, the marriage rites during the three remaining days shall not be insisted on, during which days the bride shall be perfectly free to act as she may think proper, either by adhering to her husband and home, or by enjoying her freedom and independence from all observation of matrimonial obligation." —*Spencer's "Descriptive Sociology."*

—— *A Healthy Climate.*—Papua is the paradise of birds, Natal of large quadrupeds, Surinam of snakes, Java of butterflies, but Borneo of crocodiles. On a river-island, hardly a mile in length, Professor Keppel counted not less than 740 of these eupeptic pets. But the climate in which, as reported several years ago, things have got most mixed, is New Holland, where it is summer when it is winter in Europe, and *vice versa;* where the barometer rises before bad weather, and falls before good; where the north is the hot wind and the south the cold; where the humblest house is fitted up with cedar and mahogany, and myrtle is burned for fuel; where the swans are black, and the eagles white; where the kangaroo, an animal between a squirrel and a deer, has five claws on its fore-paws, and three talons on its hind-legs, and yet hops on its tail; where the mole lays eggs and has a duck's bill; where there is a b rd with a broom in its mouth instead of a tongue; where there is a fish one half belonging to the genus *Raia* and the other half to that of *Squalus;* where the pears are made of wood with the stalk at the broader end; and where the cherry grows with the cherry-stone outside.

apply to every kind of soil or rock. They have an endless list of "signs"—"indications," as our gold-hunters would call them. Every tribe has its professional sheriat-nebbed; and where a committee of these experts fail to find water there is a strong presumption that Allah must have withdrawn his hand, as from the deserts of Western Hadramaut, where on an area of nine thousand square miles an artesian explorer might bore through to the antipodes without attaining his object.

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EDITOR'S TABLE.

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SCIENCE AND PARTY GOVERNMENT.

IT would be hard to name two subjects which, in the general apprehension, are further removed from each other than those associated in this title. That science may in some way have possible relations with government and politics is vaguely believed by many, because they often hear the expressions "science of government," "political science," etc. But, as nothing is ever heard of any such thing as "party science," political partisans naturally conclude that, whoever else may be disturbed by this intrusive influence, they, at all events, may give themselves no trouble about having to reckon with it. But they repose in a false security As civilization goes on and the laws of its progress are better understood, it will be found that science has more and more to do with government, and, therefore, with the methods and practices by which government is administered.

This matter is dealt with incidentally in the able article of Professor Goldwin Smith, on "The Machinery of Elective Government," herewith reprinted, and which will repay attentive perusal. The writer has familiarized himself with the workings of the elective system, in various conditions and in its most advanced forms, as illustrated in England, Canada, and the United States, and he discusses it with the discrimination of a critical observer, and the freedom of an independent student of public affairs, who is but little trammeled by patriotic prejudice. The import of the question at the present time is thus stated: "The era of elective government has come, and in the wise ordering of it so as to give public reason the upper hand, and to reduce, as far as possible, the influence of passion, class interest, selfish ambition, faction, and corruption, lies the political hope of the world."

But Professor Smith then proceeds to show that, though the era has arrived, the thing it has brought is very different from the thing expected. It was long believed that if the rule of monarchs could be got rid of, and the rule of the people established, all the evils of bad government would be swept away. But experience has not justified this pleasing anticipation. The king has disappeared, and the people are assumed to be sovereign, but misgovernment continues, with even an aggravation of some of its worst vices. Our country revolted against hereditary rule, and put in its place elective government by the people; but, instead of a true elective system, giving fair expression to the popular will, we have got party government ruling systematically by caucus machinery, and defeating both the will of the people and the proper objects for which government exists.

Professor Smith characterizes government by party as a vicious agency, and enforces his view by convincing illustrations of its working in different circumstances; he also points out the policy which he thinks will have to be adopted if the evils of the system are to be abated or remedied. Of this policy we express no opinion: what most concern us here are the defenses that are offered for the continuance of party government; and our interest in these defenses is chiefly because of the scientific considerations they involve.

We are told that political parties are the necessary means of carrying on free popular government, and that they are but combinations of men united to achieve important measures of national

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policy. The vindication of party by Edmund Burke has become classical, and Professor Smith quotes him as thus defining it: "Party is a body united for promoting by their joint endeavors the national interest upon some particular principle on which all are agreed." But this ideal of a political party is far enough from corresponding to the present reality; and it is an ideal now becoming increasingly impossible of realization. Instead of rallying around principles and carrying them out to victorious application, our parties eliminate them as incumbrances and impediments to success. In popular politics, questions of principle have been found simply "unavailable." Questions of political principle are never raised except to be settled, reduced to practice, and passed by. Conflicts of this kind must be ever coming to an end; but the end of conflict is the death of the parties to it. By the instinct of self-preservation, therefore, political parties will not identify themselves with transient measures the success of which destroys them. Politicians want perpetual power, and, although they talk principles abundantly in their convention-platforms, it is only for effect—they are not to be hampered by them.

But there are other and deeper reasons why questions of principle can not be made the basis of party government, and reasons to which every succeeding year lends additional force. The theory implies that there are, and will always continue to be, great issues of practical moment on which the people will so divide as to perpetuate the party system. But there is by no means an interminable supply of such fundamental questions as will serve the purpose; and as we have seen, under an honest pursuit of the policy, they become fewer and fewer. Professor Smith assures us that in Canada the stock of serious political issues is already exhausted, and that consequently "the two parties there are simply two factions fighting for place with the usual weapons, and poisoning the political character of the people in the process." But, if we have similar results in this country, it is certainly not from lack of paramount questions of public interest not yet settled. The difficulty is, that the community can not be bisected on such questions, as required by practical partisanship. That system demands that the people shall be divided, and remain divided into proximately equal parts that shall be totally opposed to each other, one half denying all that the other half affirms. It is founded upon disagreement, and implies that radical and comprehensive disagreement shall be the normal and permanent thing.

But it is no longer possible to constitute political parties on this basis. The whole tendency of modern ideas is in the opposite direction. The scientific spirit of the age is a force to be here counted on, and it is an agency that leads men to agreement. The increase of knowledge and the progress of intelligence, by settling principles and harmonizing opinions, must more and more disconcert party arrangements. As men learn to think for themselves, and prize truth as the object of honest thought, they will not range themselves on questions of principle in ways to suit party manipulators. No man can study political and social principles in the true scientific spirit without acquiring earnest and conscientious convictions, which will make him more and more revolt against the insincerity and utter hollowness of our partisan politics. There may be scientific men who are also party politicians; but it will generally be found that in such cases their science is far removed from the sphere of political thought.

The scientific spirit is, therefore, in broad and clear antagonism to the partisan spirit in politics, and, as the law of science is progress, who shall assure us that this is not the agency

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that may ultimately destroy the pernicious system now so widely deplored, but from which escape is generally held to be most hopeless? Professor Smith well observes: "Such an agreement as would be fatal to the standing organization of civil discord is by no means out of the question; to it tends the advance of political science and the scientific spirit generally, which, gradually making its way in all spheres, is not likely to leave politics untouched. . . . In fine, as has been already said, the best and indeed the only possible form of government, if the advocates of party are to be believed, is one, the foundation of which must inevitably be weakened by every advance of the public intelligence, and which the attainment of truth on the great political questions will bring utterly to the ground."

FREE CIRCULATING LIBRARIES.

In that great work of popular education to which the present age is committed, the importance of books and libraries is sufficiently recognized, although the practical measures for making these instrumentalities available are, as yet, far from being perfected. The object has hitherto been, rather to get together extensive collections of books, with as many as possible that are rare and expensive, and place them in monumental buildings, that may be at the same time ornaments to the town and memorials of the munificence of founders and donors. Such institutions are invaluable, but they are by no means adequate to do the most important work which libraries are capable of accomplishing. They meet the wants of scholars, of people of leisure and cultivation, and they are also generally available to all classes who prize books sufficiently to take a certain amount of trouble in obtaining them. But there is a very large portion of the population in cities who from various causes are practically hindered from making use of these large libraries. To multitudes the expense of membership is a serious objection, and there are other multitudes who are both capable of reading and willing to read, but who do not care enough about it to make the little effort necessary to render such libraries useful to them. They are indifferent, perhaps dull, and can only be reached by removing every possible impediment to the procurement of books; and it is this class, moreover, which most needs the improvement that may be obtained by habitual reading. Of our common-school system this, at any rate, may be said, that it teaches the mass of the people to read, and thus brings them to a point where further cultivation is possible; but if it has been necessary to resort to compulsory education to overcome the disinclination for even learning to read, it is surely a matter of moment to make the utmost possible provision for the general encouragement of the habit of reading as a means of continued mental cultivation.

Influenced by such considerations, a few persons have recently combined, in New York, to take an efficient step in this direction. They began in a small and experimental way, but the results of the trial they have made have been in a high degree satisfactory and promising. Rooms were taken in Bond Street, and a few books collected—some by purchase and some by donations—to be lent out free of expense to anybody and everybody who wished them, the only requirement being that some reference should be given, to satisfy the librarian that the borrower had a fixed residence. It was no sooner known that books were thus obtainable, than the applications for them increased until they met the full measure of the supply, and the effort was proved in every respect successful. In the report of the trustees, recently issued, it is said:

> The library now contains 5,085 volumes. A very large proportion of these have been contributed by friends of the library, and

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probably one third of the whole number have no contemporaneous value, and are rarely used by the patrons of the library. It is nevertheless found that the whole number of volumes circulated during the year is 69,230; and, assuming that the number of available books in the library is 4,000, these figures would show that each volume has been circulated over seventeen times. This percentage of usage is most gratifying, and, when compared with the returns from other libraries, may justly be pronounced extraordinary. It also appears that but sixty-four per cent of the circulation is of works of fiction—a much smaller percentage than in other libraries; while out of the whole number of books circulated during the year but *six volumes have been lost*.

The reading-room is also a demonstrated success. The total number of readers was 9,605, and they are found chiefly to belong, together with the great majority of the patrons of the Library, to that very class in the community which it is most desirable to furnish with wholesome intellectual food, and which it was hoped might be reached by this library, namely, young persons of both sexes between the ages of fourteen and twenty-one years. The publication of bulletins—that is, lists of works, or newspaper and magazine articles, upon the more important subjects which from time to time come before the public—has been continued, and the suggestions made in them are found to be quickly and generally used.

So unexpected and so encouraging are these results that they have naturally created a desire to extend the benefits of the undertaking, and it has accordingly been proposed to carry out the plan systematically by the establishment of free circulating libraries in various parts of the city, so as to make them readily accessible to all the population. In regard to this project, it is further remarked in the report:

The trustees have carefully considered what has seemed to them as the best means of conducting the work of the society, and have decided upon a general system by which the most good should result to those requiring their aid. It is proposed to establish small libraries, located in the centers of the poorest and most thickly-settled districts of the city. The books are to be selected with special reference to the wants of each community, carefully excluding all works of doubtful influence for good. Reading-rooms would be attached to each circulating library; and, as the libraries are to be small, readers will be able to receive more than the usual attention at the hands of the librarians.

In furtherance of this idea, a public meeting was recently held in the hall of the Union League Club, presided over by the mayor, in which several of our most eminent public men made interesting addresses upon the subject. Dr. Hall gave the project his cordial approbation, and spoke ably and impressively of the need there is to carry out, on a liberal scale, an enterprise that will be productive of great good and of good alone. He referred to the discontent and agitation among the poorer and laboring classes which are liable to take a dangerous form under the misguiding influence of visionary social theorists, and for which the only remedy is the wider diffusion of sound information among the people. Mr. Joseph Choate also spoke effectively in behalf of the enterprise. He called emphatic attention to the destitution of wholesome reading-matter on the part of the great mass of the city population, and which is but very partially realized by people who have been brought up in the midst of a superfluous abundance of books. He showed how inadequate, and impracticable for popular use, are our present library facilities, and he made a vigorous appeal for the opening of the free circulating libraries on Sunday—the only leisure day of the working-classes, and the day on which they are most exposed to the temptation of questionable places of resort. Other speakers followed, urging the claims of this popular library system upon the attention of men of wealth, and asking for it so generous a support that the trustees will be able to carry out their plan promptly and effectively.

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HENRY W. BELLOWS.

THE death of Dr. Bellows, so unexpected, and while yet apparently in the full vigor of his remarkable powers, is not only a painful shock to his numerous friends, but will be widely felt as a public calamity. He has been for many years prominent and influential in the management of important philanthropic movements, and he has also been the virtual head of perhaps the most cultivated, and certainly the most liberal, of the religious denominations of the country. We have no design here to give any account of his life and labors, the task having been already well performed by the newspaper press. But there was one aspect of his mental character to which it may be proper for us to bear testimony.

Dr. Bellows was a man of great independence of thought, and, though practically the leader of a religious sect, and profoundly interested in maintaining and extending its organizations, he was yet deeply interested in the most radical tendencies of inquiry. He sympathized with the spirit of thoroughgoing research in every field of investigation, with an assured faith that, so long as truth is earnestly sought, the results must always be beneficent and valuable. In a very recent conversation with him, he spoke of having read with great pleasure, and a very considerable degree of accord, the new work of Renan, "Marcus Aurelius," the last of that author's series on the "Origins of Christianity." He also referred to Spencer's "Data of Ethics," which he had carefully read at the time of its appearance, and expressed much interest in the author's further elucidation of the subject. He said, in substance: "I accept that work as a very important contribution to ethical science, and I am fundamentally in agreement with it. There are parts of it that need further clearing up, and that I could better appreciate if I were more familiar with the scientific evidence of the doctrine of evolution. But Spencer's main position, that morality must be grounded in nature, and its principles confirmed by an extending knowledge of nature, it seems to me, is impregnable; and he has certainly gone far toward constructing a stable basis of ethical doctrine."

We mention these facts to show that Dr. Bellows did not share the alarm felt by many at the progress of rationalism; that he was hospitable to advanced opinions, even in his own sphere of thought, and welcomed and prized them as hopeful indications of a sound and healthful progress in the higher departments of philosophic inquiry.

LITERARY NOTICES.

URANOMETRIA OF THE SOUTHERN HEAVENS. Brightness and Position of Every Fixed Star down to the Seventh Magnitude, within One Hundred Degrees of the South Pole. By BENJAMIN APTHORP GOULD. With an Atlas. Buenos Ayres: Paul Emile Conti. New York: D. Appleton & Co. Pp. 383. Price, $20.

IN the excellent sketch of Dr. Gould which we publish, a reference will be found to his recent contributions to the astronomy of the southern hemisphere. At the invitation of the Argentine Republic he established and assumed charge of the observatory at Cordova in 1870, and took with him from this country four assistants to aid in carrying out the grand project of fixing the positions and grades of brightness of all the southern stars visible to the naked eye at his station. The work thus taken up was an extension to the southern heavens of the system of observations made by Argelander, of Bonn, upon the northern heavens, and published in 1843 in his celebrated "Uranometria Nova." The work of Argelander represents 3,256 stars from the first to the sixth magnitude, which are to be seen above the horizon of Bonn. Dr. Gould's problem was to extend this enumeration over the whole southern sky, keeping accurately to Argelander's standard. But the extraordinary transparency of the southern atmosphere makes visible grades of stars which can not be seen in the North;

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that is, stars can be seen at Cordoba, which have less than four tenths of the light of the faintest of Argelander's stars. There are 10,649 stars visible to the naked eye at Cordoba, and of these 8,198 are given in the catalogue and in the maps of Dr. Gould.

The work before us consists, first, of a full description of the methods of observation and the stellar phenomena of the southern heavens, and this is followed by a tabulated catalogue of the stars. It is accompanied by a large atlas of fourteen charts, which "gives an exact pictorial representation of the state of the sky at the epoch of the work. Besides giving a representation of the isolated stars, the shadings and gradations of the milky way are given with the greatest detail from repeated observations and revisions."

These stellar maps, though South American work, are executed with great beauty and perfection. The obstacles in the way of their production were very formidable, and the genius of Dr. Gould is perhaps as much seen in the skill and perseverance with which he overcame them as in the scientific faithfulness of the labor and the artistic finish of the machanical results. The whole of the printing was executed at a distance of 500 miles from Cordova, and the proofs, frequently requiring three and four corrections, had to be passed backward and forward with long delay, so that the project, which should have been completed in 1877, actually required two years longer. The quarto volume containing the catalogue is in the Spanish and English languages, side by side in double columns.

The production of such a work, of course, involved very heavy expenses, which were liberally met by the Argentine Government. A few copies have been left on sale with D. Appleton & Co., at a comparatively nominal price, for the use of such observatories, libraries, and astronomers as may desire to procure them.

AN EXAMINATION OF THE LAW OF PERSONAL RIGHTS, TO DISCOVER THE PRINCIPLES OF THE LAW. By A. J. WILLARD. New York: D. Appleton & Co. 1882. Pp. 429. Price, $2.50.

THIS is a work written by a lawyer, and, it may be assumed, written mainly for lawyers, although it claims to have an interest for a wider circle of readers. There are two great categories of law: those regularities of process in things around, which we call laws of nature and which execute themselves; and those rules of conduct laid down by civil authorities as laws of society, and which are executed by the machinery of government. The term law, as thrice used in the title-page of this book, belongs to the latter category—that is, to statutory regulations. Now, it has ever been a problem of great interest to find out the relations which these two systems of law sustain to each other, and this seems to be the fundamental question to which Judge Willard has addressed himself in the preparation of this volume. Although, as a discussion of the principles of personal rights, and the general policy of law in connection therewith, the treatise has practical claims upon the legal profession; yet its broader interest is to be found in the author's attempt to affiliate the system of law upon the natural conditions of society. The idea of the law which the work endeavors to bring into view and illustrate, by an examination of the present body of law, is that legal ordinances are but a formulation of those habits of a community that are essential to the continuance of social life. Judge Willard repudiates the idea, which he holds to be widely entertained, that law is nothing more than a set of merely arbitrary rules. "In every community of men," he says, "the habits of its individuals constitute a general law. These habits have been mainly derived by heredity, modified by various means. Certain tendencies have taken forms more or less developed in their habits, and still continue to operate as modifying causes in the further development of habit. So far as these habits are essential to maintain the social state, and attain its ends, they are imperative, or assume the form of law—that is, are embodied in the common will. Beyond this there must be an authority to select the means of maintaining the society, and the ends it shall pursue, and to prescribe the conduct of individuals in reference to the community and to each other. This is the public law of society. Though recognizing that law is a growth, the author is not here concerned with tracing out its

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development, and showing how successive forms grew out of those preceding, but with showing that the present body of law conforms in its essential features to the fundamental requirements of the social state of man. It is impossible to sum up in any satisfactory way the theoretical reasons of so comprehensive a work within the limits of a book notice. We can only say that the writer claims to occupy new ground, and to place the subject of public law on the same footing as the natural sciences. Certainly no task is more important than to show that the system of enactments by which society is regulated and the conduct of individuals controlled is not arbitrary, irrational, and chaotic. But the chief value of Judge Willard's book will no doubt be found in its usefulness to the students of law. He deals with a long series of specific subjects presented in forty chapters, and covering the whole comprehensive ground of personal rights and social obligation. The first chapter is on the origin of law, and the next on the nature and origin of rights, obligations, and powers. Chapter X takes up the science of law, Chapter V is devoted to the "proper subjects of contracts," and the following chapters develop the conditions of contracts in various aspects. In succeeding chapters a great variety of subjects are treated, throwing light upon the legal position of the individual, and the latter portion of the work is much devoted to what may be called the modern liberties, or those higher prerogatives of the citizen which it is the object of free governments to secure. In the closing chapters, marriage, the family, and communal associations are considered; and the final discussion treats of the liberty of judgment and the liberty of self-gratification. Judge Willard has not given us a book of formal erudition; it contains no notes, and we have not observed that it refers to any authorities. It is rather an analytical work, occupied with the development and application of principles.

THE FIRST-BOOK OF KNOWLEDGE. By FREDERICK GUTHRIE, F. R. S. New York: G. P. Putnam's Sons. Pp. 130. Price, $1.

OF this little book we can say emphatically, Yes! and No!

It is a most interesting and readable compend of information on all kinds of familiar objects, such as we find in and around the house, and that everybody ought to know about. The subjects are selected with excellent judgment; the knowledge is important and trustworthy; and it is simply, concisely, and agreeably presented. In all these respects the volume is a model; and, when we add that there are questions at the end of each chapter to help the teacher, and that the teacher is exhorted to bring as many of the objects into the school-room as possible, for the inspection of the children, and to add as many questions as may be to those already given, it will naturally be asked, What more can be required?

Certainly nothing more is required on the accepted school-book standard; but we question the validity of the standard. The book is made on the old theory of pouring the facts into the little mental pitchers until they are full. But that is not the true idea of education; and therefore, as a "First-Book," it starts wrong. A book treating of "objects" that does not provide, first of all, and as the essential thing, for the active effort of inquiry on the part of the pupil, and that he shall find out the properties of objects for himself, fails of its purpose as a means of education. Such failure has, of course, been the rule in our past school-history; but it can be no longer excused, and we confess to some astonishment that a book of this quality should emanate from a distinguished professor in a "normal school of science." South Kensington is getting behind the age if this is the best that its "normal science" can do.

ECCE SPIRITUS. A Statement of the Spiritual Principle of Jesus as the Law of Life. Boston: George H. Ellis. Pp. 238. Price, $1.25.

THIS work has largely in view the discrepancies between the theological and the scientific thought of the age. The author distinguishes three types of religious thought. The first type is illustrated in that class of persons "who ensconce themselves in a quiet corner of the church, away from the din of the controversies which distract the age," and who are indifferent to the vast changes that have come over the modes of thought; the second type in the class who stand at the other extreme, ac-

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knowledge no authority outside of matter and the mentality that is coextensive with it, reject faith, and rest content in the nice processes of rationalization; and the third type, in a class between the other two, who, satisfied with neither of the above positions, "are rationalistic in method and in sympathy with every negative result that has been wrought out by the study of the facts, and yet unwilling and unable to rest there. With no fear of science, and all due respect for its wonderful work of revelation, they are conscious of something in them more real in fact, and more satisfactory in recognition, not yet accounted for. Whatever the failure of current Christianity to harmonize these two apparently antagonistic positions, they are not wholly without hope of a possible meeting-ground between faith and fact." To those persons especially, who constitute a large proportion of earnest, thinking people all over the world, the book is directed.

THE LAND OF THE WHITE ELEPHANT: SIGHTS AND SCENES IN SOUTHEASTERN ASIA. A Record of Travel and Adventure in Burma, Siam, Cambodia, and Cochin-China. By FRANK VINCENT, author of "Through and Through the Tropics," etc. New and enlarged edition. New York: Harper & Brothers. Pp. 375. Price, $3.50.

THE present edition is about one half larger than the original work, which was already fairly well known as a most agreeable and life-like account of the countries to which it relates, of their geographical characteristics, people, governments, customs, and antiquities. The most valuable part of the added matter is that included in the third chapter of the supplement respecting Cambodia, of whose ruins, attesting to the former existence of a high civilization, Mr. Vincent's was already the most satisfactory and adequate, and the first account, except a too brief reference in the book of Mrs. Leonowens, that has been published in the United States. Concerning the interest attached to these ruins Mr. Vincent says, in a private note, that "not even the excavations which have shown to us the buried cities of Greece and Cyprus have thrown more light upon the perfection attained by Eastern art than have the splendid and stupendous ruins found in the interior of Indo-China. But, though the degree of Oriental art has thus been made plain, absolutely nothing is known concerning the people to whom the original structures are due." Since he first made known to his countrymen the character of these ruins seven years ago, he has devoted much time and study to the general subject of Indo-Chinese antiquities, with special reference to the solution of the problems when and by whom the Cambodian cities were built; where the homes of the descendants of their builders are now; and to what form of worship their temples were dedicated; and the results of his researches are set forth, in a condensed form, in the chapter we have mentioned. He assigns a late date (the fourteenth century) to the building of the Nagkon Wat, believes that it was intended for Buddhist worship, and suggests that the Cambodian monuments and those of Yucatan, between which there is some resemblance, may have been contemporaneous, and possibly the work of branches of the same race. Other theories look for a connection between Cambodian and ancient Assyrian works; and it is evident, from what Mr. Vincent says, that, until further and more exact explorations are made, there will be no end to the conjectures for which some plausible support may be found. This only makes it the more desirable that the works should receive immediate scientific attention.

THE HONEY-ANTS OF THE GARDEN OF THE GODS, AND THE OCCIDENT ANTS OF THE AMERICAN PLAINS. By HENRY C. McCOOK, D. D., author of "The Agricultural Ant of Texas," "The Mound-Building Ant of the Alleghanies," etc. Illustrated with Thirteen Plates. Philadelphia: J. B. Lippincott & Co. Pp. 188. Price, $2.50.

DR. McCOOK started in 1879 to observe the honey-ants in New Mexico, but found them in the Garden of the Gods, in Colorado, and stopped and studied them there. He is able to extend the territory of their natural habitat, so that it shall include Mexico, New Mexico, and Southern Colorado. The characteristic of the species is that, in one of the castes or worker forms, the abdomen is distended to the size and form of a currant or small grape, and is entirely filled with grape-

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sugar or honey. These ants apparently prefer elevated situations, but doubt is thrown over this by their having been mentioned as seen at Matamoras, which is but little above the level of the sea. Their nests are built on the tops of the ridges, and are marked externally by small moundlets of gravel six or seven inches in diameter, and two or three inches high; internally they present ramifications of galleries and enlarged chambers in several stories, within which the honey-bearers exist, clinging to the roof of the vault. The honey is gathered by another class of workers from the galls of a species of oak, where Dr. McCook found it in the shape of globules which had been exuded from the gall, and is conveyed to the honey-bearers by regurgitation. It is "very pleasant, with a peculiar aromatic flavor, suggestive of bee-honey, and quite agreeable." Dr. Loew also describes it as having an agreeable taste, slightly acid in summer from a trace of formic acid, but perfectly neutral in autumn and winter. The sirup extracted from the ants had an odor like that of the sirup of squills, and dried, when heated, into a gummy mass, which quickly became soft by the absorption of water from the atmosphere, and the alcoholic solution of which had the smell of perfumed bay-rum. The honey is gathered by the Mexicans and Indians, is eaten freely and regarded as a dainty morsel, and is fermented into an alcoholic product. It can never be got in large enough quantities to make it of economical value, even if that were desirable. The ants, showing the same traits as all other species that have been observed, take most excellent routine care of the honey-bearers and of the larvæ, but seem wholly indifferent to occasions calling for care or sympathy which happen to be out of the regular line. Their chambers are constructed with the architectural skill that is shown by their making the floors perfectly smooth, so that their progress and work shall be facilitated as much as possible, and by their making or leaving the roofs rough, so that the honey-bearers may cling more securely to them. The occident ant is the most numerous species of animal on the Western Plains, and, after the prairie-dog, affords the most prominent marks of its presence everywhere on their surface; yet Dr. McCook's memoir, forming the second half of this volume, is the first that has been published about them. Their habits are similar to those of the harvesting ant of Florida, the agricultural ant of Texas, and some harvesting ants that have been observed in Pennsylvania and New Jersey. They have been found from Brookville, Kansas, to Reno, Nevada, through twenty-one degrees of longitude, and range probably from 32° to 45° north latitude. They build their nests, which are marked by elliptical cones sometimes ten inches or a foot high, in slopes and flats, avoiding the ridges. The mounds are surrounded by cleared spaces which are sometimes ten feet or more in diameter, and appear to have been purposely stripped of vegetation, while the surrounding grass is penetrated by paths leading out. All of the mounds are covered with pebbles of the nature of the gravelly soil in which they stand, which appear to be collected by the ants and brought to the spot, if necessary. One of the insects was observed to carry a stone of six times its weight over a space of three hundred times its length and up inclines. These ants are evidently harvesters, gathering seeds and storing them in their nests, which are chambered under-ground, sometimes to a depth of eight or nine feet, and are not essentially different in their interior construction from those of the honey-ant. Dr. McCook observed them gathering seeds of the sunflower, of a euphorbia, of an amaranthus, of the gramma-grass of the country, and of other plants. Their nests are infested by six or seven species of parasitic ants, toward which they show no liking, but no particular hostility, of two of which, the erratic ants and the fetid ants, an interesting account is given. Dr. McCook confines himself to relating and illustrating the facts he has observed, leaving inferences to be drawn by others; and he has made a valuable addition to the literature of a subject that engages the attention of the most distinguished naturalists.

SUICIDE: STUDIES ON ITS PHILOSOPHY, CAUSES, AND PREVENTION. By JAMES J. O'DEA, M. D. New York: G. P. Putnam's Sons. 1882. Pp. 322. Price, $1.75.

THE author defines suicide as the intentional destruction of one's own life, and excludes from the category deaths from acts

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or lines of conduct which, howsoever much opposed to self-preservation, are not intended to destroy life. The questions relating to it are partly social, partly medical. It presupposes two necessary conditions: 1. Moral and physical impressions derived from without; and, 2. On the part of the recipient of these impressions, a nervous impressibility, which not only magnifies and distorts them, but which gives them a dangerous power to affect his happiness. Hence the causes of suicide naturally fall under two main divisions—the external or social, and the internal or personal. The general external causes exist everywhere and under all circumstances, and have their sources in extravagant religious and moral beliefs. Special external causes comprise all those various circumstances and accidents which result from the relations of individuals to each other in society. The internal or personal causes include ill health, insanity, and temperament. All these influences are set forth in the present volume. For the prevention of suicide, the author proposes legal measures, religious and moral training, and medical advice and treatment.

THE NATURE AND FUNCTION OF ART, MORE ESPECIALLY OF ARCHITECTURE. By LEOPOLD EIDLITZ, Architect. New York: A. C. Armstrong & Son. Pp. 493. Price, $4.

MR. EIDLITZ is an architect whose works attest his accomplishments and his competency to discuss the subject. He believes that, while all other branches of art are alive and advancing, something is wrong in the condition of that branch to which he is devoted; that, while the mechanic art of building never stood higher than now, architecture itself, alone of the arts, is silent, or rather has ceased to speak of living ideas. To inquire into the causes of this condition, and to define the nature and function of art in general and of architecture in particular, so as to show how it may again become a living and creative art, is the object of this volume. Mr. Eidlitz combats the idea that taste is the quality which enables men to produce works of art, or even to judge them, or that common sense alone is a safe guide. In all other branches of knowledge, study and acquaintance with technical principles are considered essential to even a fair degree of proficiency. So it is with architecture. The evil effects of too great reliance on taste, and too little attention to training, are illustrated in the ill-adapted buildings that we meet everywhere and that are still growing up around us, the multiplicity of which gives point to the author's remarks respecting the present condition of the art, that "it appears to be the accepted opinion that the sole function of architecture as an art is to make monuments pleasant to behold; that this may be done in any way which to the author of the monument may promise good results; that it is useless to seek for a clew to all this in the organism of the monument itself, or in the nature of the idea which has called it into existence, or to seek to establish an organic relation between the ornament and the structure. That such a looseness of definition of the nature of architecture," he adds, "must lead to false conceptions and to other illogical reasoning must be apparent." Mr. Eidlitz's own view is, that it is the province of architecture to express ideas by structures—a principle that may be illustrated by showing that "if a man tries to build a house which shall be as good as he can afford to make it; if he does nothing for show, and everything for structural integrity; if he builds it so that it may serve his purpose—then his house will be a monument to his purpose." In order to create a monument it is necessary that its author should be conscientious, and that he should respect the thing he is doing. He should not resort to mechanical expedients, no matter how sound in themselves, because they are desirable only on economical grounds, if they are lacking in, or detrimental to, clear art expression. Self-denial should be exercised in refraining from unmeaning display for the sake of show; there is no beauty but that which results from a forcible, clear, and successful expression of the idea in matter, and this must depend on the amount of character in various features of the structure. And, finally, "in creating a monument, the problem is mainly to give expression to the acts performed within its walls, which is done by giving the structure a form which will correspond with the groups performing those acts, and to its parts such masses, modeling, carved and color decora-

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tion as will express precisely the degree of stability, dignity, and elegance which corresponds with the import of the acts to be expressed." The architecture of the past, the vague ideas of writers, and the aimless practices of the present, are reviewed and criticised in the light of these fundamental principles, and the conclusions are reached in the end that the dilettantcism of modern architecture must be rooted out before the art can revive and exercise a wholesome influence on society; it must be understood that "the road to architecture is long, tortuous, and thorny, and not a well-paved highway upon which man may amble into fame"; false taste has had its day, and *style* must also be cast off, when "nothing will be left but to pursue architecture pure and simple."

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DANGERS TO HEALTH: A PICTORIAL GUIDE TO DOMESTIC SANITARY DEFECTS. By T. PRIDGIN TEALE, M. A., Surgeon to the General Infirmary at Leeds. Third edition. Philadelphia: Presley Blakiston. Pp. 170. Price, $3.50.

THE author, having discovered and rectified numerous defects in his own house, and having traced illness among his patients to carelessness and dishonesty in drain-work, became "indignantly alive to the fact that few houses are safe to live in." He was convinced also that a large fraction of the incidental illness suffered in England, including much childbed illness and some of the fatal results of surgical operations in hospitals and private houses, were the direct result of drainage defects. He then sought for the most impressive way of describing faults of this class to the public, and chose that of pictorial representation. The result is this work, which contains seventy plates representing nearly as many important faults to which domestic sanitary arrangements are liable, with letterpress explanations of the same, as well as of some other faults not so susceptible of pictorial representation. The illustrations are designed to give the most forcible expression possible of the fact to be told, and are clear and distinct as to their meaning. Three of the drawings are designed as hints toward securing adequate ventilation and the exclusion of dust.

A STUDY OF THE PENTATEUCH, FOR POPULAR READING. By RUFUS P. STEBBINS, D. D., formerly President, Lecturer on Hebrew Literature, and Professor of Theology, in the Meadville Theological School. Boston: George H. Ellis. Pp. 233. Price, $1.25.

THIS book embraces the substance of some articles which were published in the "Unitarian Review" in 1879 and 1880. The first paper is a review of the attacks of Dr. Kuenen, one of the most brilliant and reckless of the Dutch rationalistic critics on the authenticity of the Old Testament Scriptures. The other essays embody the author's own examination of the books of the Pentateuch, with reference to their authenticity, in respect to the external evidence, or that afforded by the references to them and quotations from them made by a succession of Hebrew writers from David to Josephus; and the internal evidences, or those afforded by the style and methods of expression of the books themselves, and the allusions contained in them as indicative of the time when they were composed. The definite conclusion is reached that the Pentateuch is substantially of the Mosaic age, and largely, either directly or indirectly, of Mosaic authorship.

THE OPIUM-HABIT AND ALCOHOLISM. A Treatise on the Habits of Opium and its Compounds, Alcohol, Chloral-Hydrate, Chloroform, Bromide of Potassium, and Cannabis-Indica. By Dr. FRED. HEMAN HUBBARD. New York: A. S. Barnes & Co. Pp. 259. Price, $2.

IT is believed that the opium-habit is increasing in the United States with frightful rapidity. It has spread much faster since the introduction of the hypodermic syringe, and has reached an extent which is partially represented by the payment of five million dollars annually for the drug, and by the estimate that there are now not less than 500,000 consumers in the country against 225,000 in 1876. The object of the author of this work has been to place in the hands of the profession a carefully arranged analysis of the peculiar physical condition induced by the indulgence of the habit, with descriptions of the symptoms that appear and the changes that take place under treatment. This is done by the presentation of accounts

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of typical cases. The effects of stimulants on the functions of the system, and certain diseases, are also considered. And, as relating to the same class of habits or affections, the author also discusses the dementing effects of bromide of potassium when taken habitually, and the treatment of the "bromide-habit," the treacherous and subtile tendencies of chloral, chloroform and the means of warding off its dangerous effects, and the pathology and treatment of dipsomania. The subject of favorable surroundings for patients while undergoing treatment is also considered, and the inquiry is made why, as the author believes, "inebriate asylums and sanitariums have made so signal a failure in their efforts to reform the fallen." The book has neither table of contents nor index.

THE AUTOBIOGRAPHY OF MARK RUTHERFORD, DISSENTING MINISTER. Edited by his Friend REUBEN SHAPCOTT. New York: G. P. Putnam's Sons. 1881. Pp. 218. Price, $1.

AN uncompleted story of the life and troubles of a man who appears to have been of morbid disposition, who was always struggling with doubts, the victim of questions coming up in the course of his discharge of his duties, which he could not solve. The regulation theological education which he received at the seminary of his sect was not adapted to its immediate purpose, much less to enable the student to face the popular and speculative thoughts of the day. He was, therefore, thrown upon the world unprepared to engage in its intellectual struggles, and was perpetually tormented by the presentation of difficulties "which haunted his whole existence and prevented his enjoyment of it."

THE LEAGUE OF THE IROQUOIS, AND OTHER LEGENDS FROM THE INDIAN MUSE. By BENJAMIN HATHAWAY. Chicago: S. C. Griggs & Co. 1882. Pp. 319. Price, $1.50.

THE author believes the legends of the Indians embody the essentials of religious truth, and are to them what the Eddas were to the Scandinavians, their mythology to the Greeks, the story of Buddha to the Hindoos and Mongolians, and the teachings of Christ to the Christian world. He finds in them a central idea, of a Divine Man of miraculous birth and superhuman attributes, who was sent among the red-men from the Great Spirit to subdue the monsters of the forest and rivers, and teach them their arts; and that it is right to judge the character and capacity of the Indians in the light of this conception as we measure civilized peoples by their highest attainments in art, science, and literature. The present collection of poems is an attempt to give in an intimately related series of pictures the story, as embodied in the Iroquois tradition, of the origin of the confederation, "and, especially, all that relates to the part the great personage of Indian mythology—Ha-yo-went-ya—took in the formation of the league."

ZOÖLOGICAL ATLAS (including Comparative Anatomy), with Practical Directions and Explanatory Text, for the Use of Students; 231 Figures and Diagrams. By D. MCALPINE, F. C. S., author of a "Biological Atlas," etc. Vertebrata. Edinburgh and London: W. & A. K. Johnston. 1881. Twenty-four Plates, with Explanations.

THE object of this work is to help the student in the explanation and dissection of the leading forms of animal life. It is intended to be employed on the principle laid down by Professor Macalister, of Dublin University, that "it is only by the examination of specimens that any knowledge of the science worth acquiring can be obtained, and the function of a book is to assist in practical study." The illustrations, which are colored, represent the various points to be noted in the dissections, showing the details of anatomical structure and their relations, and are accompanied by suitable and brief explanations. The six types of vertebral life are represented by a specimen selected with reference to its convenience of size for handling and the facility of procuring it; the cartilaginous fishes by the skate, the bony fishes by the cod, the tailed amphibians by the salamander, reptiles by the tortoise, birds by the pigeon, mammals by the rabbit. The plates in their several series show the external and internal characters of the animals, the skeleton, nervous and sense organs, alimentary system, the circulatory, respiratory, and other organs.

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THE VERBALIST: A MANUAL DEVOTED TO BRIEF DISCUSSIONS OF THE RIGHT AND THE WRONG USE OF WORDS. By ALFRED AYRES. New York: D. Appleton & Co. 1882. Pp. 220. Price, $1.

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THERE can be no doubt concerning the importance of using the right words in the right places; and any guide which approaches the subject in the right way and in the right spirit is of value. Mr. Ayres has given such a guide. He does not assume to be an authority, but a student of authorities and a representative of them. Following a strictly alphabetical arrangement of words and topics in regard to which a wrong usage exists or authorities differ, he gives in brief what the authorities declare about each, with their differences where they differ; and, while he does this with apparent impartiality, he is not afraid to add his own view, which, so far as we have noticed, is the one agreeable to reason and common sense. As a whole, "The Verbalist" is equal to the best of the small works in this department.

NEW SYSTEM OF VENTILATION, WHICH HAS BEEN THOROUGHLY TESTED UNDER THE PATRONAGE OF MANY DISTINGUISHED PERSONS. A Book for the Household. Fourth edition, enlarged, with New Illustrations. By HENRY A. GOUGE. New York: D. Van Nostrand. 1881. Pp. 176.

MR. GOUGE'S system of ventilation has been in use for several years, and has given general satisfaction as a cheap, simple, and effective method of solving the problem. It is adapted for any of the twenty or more kinds of buildings and apartments which he enumerates in his title-page, and can be applied with but little alteration of plans. The present volume gives an explanation of its operation, and a selection of miscellaneous paragraphs on the need of ventilation, good and bad ventilation, and the defects of modern buildings and modern life generally in respect to the subject.

CELESTIAL OBJECTS FOR COMMON TELESCOPES. By the Rev. T. W. WEBB, M. A., F. R. A. S. Fourth edition, revised and greatly enlarged. New York: Industrial Publication Company. Pp. 493.

THIS work appears to be one of great value to amateur astronomers. Its purpose is to furnish the possessors of ordinary telescopes with plain directions for their use, and a list of objects for their advantageous employment. It begins with a description of the telescope, especially of ordinary telescopes (refractors of from three to five inches aperture, and reflectors of a little larger diameter), and directions for their practical care and use, after which are given descriptions of the sun, moon, planets, comets, and of the double stars, clusters, and nebulæ coming within the range of the class of observations contemplated. The account of the moon is accompanied with a large sheet-map, on which every point and object is distinctly marked and numbered, and that of Mars by a polar map of similar character. The chapter on double stars, clusters, and nebulæ, is arranged by constellations, under the head of which each object is specifically and separately located and described.

THE LABOR QUESTION, OR AN EXACT SCIENCE OF EQUIVALENTS; AND ALSO CONTAINING A NEW THEORY OF COSMOGONY. By AMICUS HUMANI GENERIS. Chicago: The Chicago Legal News Company. Pp. 186.

THIS is an example of the kind of work that an active mind of some ability may produce without having any of the knowledge that is gained by investigation and careful study. It offers a mixture of native ideas, some of which are good, with the utmost confusion of all that is taught by history and science. The author assumes that the great evils that afflict the world are land tenure, rents, interest, and the price of stocks—that is, all that furnishes the capital on which labor depends; and that it is the duty of labor to destroy these and establish a kind of communism. With all this he has some sound ideas on free trade and tariffs, and the spirit in which trades-unions ought to be managed.

ELEMENTS OF QUATERNIONS. By A. S. HARDY, Ph. D., Professor of Mathematics, Dartmouth College. Boston: Ginn, Heath & Co. Pp. 230.

THE object of this treatise is to exhibit the elementary principles and notation of the quaternion calculus, so as to meet the wants of beginners in the class-room; and to give them such a conception of the value and beauty of this instrument of research as

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may lead them to follow the more extended application of its principles in the works of the original and leading authors.

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PUBLICATIONS RECEIVED.

Report of the Joint Standing Committee on Water, on the Impurity of the Water-Supply of Boston. With the Report of Professor Ira Remsen on the Subject. Boston: Rockwell & Churchill. 1881. Pp. 22.

The Brain of the Cat. Preliminary Account of the Gross Anatomy, with Four Plates. By Burt G. Wilder, M. D. Read before the American Philosophical Society, July, 1881. Pp. 38.

A Theorem on Planetary Motion; or Sunshine and Shadow. By Clark Roberts, M. D. St. Louis: Slawson & Co., printers. 1881. Pp. 32. 25 cents.

Transactions of the New York Academy of Sciences, October, 1881. Pp. 20.

Drug Attenuation. By J. P. Dake, M. D. Nashville: Haynes & Co., printers. 1881. Pp. 35.

The Debt to Africa. The Hope of Liberia. By A. N. Bell, M. D. Reprint from "American Church Review." 1881. Pp. 28.

Sur la Distribution de l'Énergie dans le Spectre Solaire normal. Par M. S.-P. Langley. Paris: Gauthier-Villars, printers. 1881. Pp. 5.

The Indian Question. G. W. Owen. Ypsilanti, Michigan. 1881. Pp. 24.

Forestry Bulletins, Nos. 1, 2, 3, 4, and 5. Issued by the Census Office, Department of the Interior, Washington, D. C. 1881.

An Abstract of the Results obtained in a Recalculation of the Atomic Weights, by F. W. Clarke, pp. 12; and Some New Compounds of Platinum, by F. W. Clarke and Mary E. Owens, pp. 5. Reprints from "American Chemical Journal."

Twenty-sixth Annual Report of the Director of the Astronomical Observatory of Harvard College. By Edward C. Pickering. Cambridge: University Press. 1882. Pp. 16.

The Palæolithic Implements of the Valley of the Delaware. From the "Proceedings of the Boston Society of Natural History." Cambridge, 1881. Pp. 25.

Boulder County as it is. By John K. Hallowell. Published by the Colorado Museum of Applied Geology. Denver, 1882. Pp. 19. 15 cents.

On a New Substance resembling Dopplerite from a Peat-Bog at Scranton. By Henry Carvill Lewis. Read before the American Philosophical Society. 1881. Pp. 6.

No more Free Rides on this Jackass, or Protection Forever and Everywhere. By Frank Rosewater. Cleveland: Published by the Author. 1882. Illustrated. Pp. 160. 50 cents.

More Public Parks: How New York compares with other Cities. Published by the New York Park Association. 1882. Illustrated. Pp. 23.

Descriptions of some New Ichneumon Parasites of North American Butterflies. From the "Proceedings of the Boston Society of Natural History." By A. S. Packard, Jr. 1880. Pp. 38.

On the Microscopic and General Characters of the Peach-Tree affected with the "Yellows." Reprint from the "American Naturalist." By W. K. Higley, of Geneva, Wisconsin. 1881. Pp. 24.

First-Book of Knowledge. By Frederick Guthrie, F. R. S. New York: G. P. Putnam's Sons. 1882. Pp. 130. $1.

Publications of the Massachusetts Institute of Technology, and of its Officers, Students, and Alumni, 1862–1881. Compiled by William Ripley Nichols, S. B. Boston: A. A. Kingman. 1882. Pp. 50.

The Q. P. Index Annual for 1881. An Index to "The International Review," "The Popular Science Monthly," "The Century," "Lippincott's," "The Nation," "The Atlantic," "The Living Age," "Harper's," and "The Eclectic," for 1880–'81. Bangor, Maine: Q. P. Index, publisher. 1882. Pp. 56.

The Prevention of Syphilis: An Address read before the Philadelphia County Medical Society, December 14, 1881. By J. William White, M. D. Reprinted from the "Philadelphia Medical Times." 1882. Pp. 20.

The Anatomy of the Mouth-Parts and of the Sucking Apparatus of some Diptera. By George Dimmock, of Cambridge, Massachusetts. Boston: A. Williams & Co. 1881. Pp. 50. With Four Plates and Explanations.

Statistics of the Iron and Steel Production of the United States. Compiled by James M. Swank, Secretary of the American Iron and Steel Association, Special Agent of the Census. Washington: Government Printing-Office. 1881. Pp. 160.

The Viscosity of Gases at High Exhaustions. By William Crookes, F. R. S. From the "Philosophical Transactions of the Royal Society." 1881. Pp. 60. With Four Plates.

Elementary Lessons in Electricity and Magnetism. By Sylvanus P. Thompson, B. A., D. Sc., Professor in University College, Bristol. London: Macmillan & Co. 1881. Pp. 446. $1.25.

Experimental Researches into the Properties and Motions of Fluids, with Theoretical Deductions therefrom. By W. Ford Stanley. London: E. & F. N. Spon. New York: 446 Broome Street. 1881. Pp. 550.

Transactions of the Medical Association of Georgia. Thirty-second Annual Session. 1881. Edited by A. Sibley Campbell, M. D. Augusta: Joseph Loveday. 1881. Pp. 314.

Measurements of the Force of Gravity at Tokio and on the Summit of Fujinoyama. By T. C. Mendenhall, Ph. D., Professor of Experimental Physics in Tokio Daigaku. Tokio, Japan: Published by Tokio Daigaku (the University of Tokio). 2541 (1881). Pp. 17.

Geology of the Environs of Tokio. By David Brauns, Ph. D., M. D., Professor of Geology in Tokio Daigaku. Tokio, Japan: Published by Tokio Daigaku. 1881. Pp. 84. With Eight Plates.

Tokio Daigaku (University of Tokio). The Calendar of the Departments of Law, Science, and Literature. 2540–'41 (1880–'81). Published by the University, Tokio, Japan, 2540 (1880).

Lectures on the Origin and Growth of Religion, as illustrated by some Points in the History of Indian Buddhism. By T. W. Rhys Davids. New York: G. P. Putnam's Sons. 1882. Pp. 263. Price, $2.50.

The Universe: or, The Infinitely Great and the Infinitely Little. By F. A. Pouchet, M. D. Sixth edition. Illustrated by 270 Engravings on Wood. New York: G. P. Putnam's Sons. 1882. Pp. 564. $3.75.

An Elementary Treatise on Electricity. By John Clerk Maxwell, M. A. Edited by William Garnett, M. A., Oxford (Eng.). At the Clarendon Press. 1881. Pp. 208, with Six Plates. $1.90.

Sensation and Pain. By Charles Fayette Taylor, M. D. New York: G. P. Putnam's Sons. 1881. Pp. 77. 75 cents.

Aspasia. A Romance of Art and Love in Ancient Hellas. By Robert Hamerling. From the German, by Mary J. Safford. New York: William S. Gottsberger. 1882. Two vols. Pp. 685. $1.75.

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Opium-Smoking in America and China. A Study of its Prevalence and Effects. By H. H. Kane, M. D. New York: G. P. Putnam's Sons. 1882. Pp. 156. $1.

Elements of Orthoëpy, consisting of the most Essential Facts and Principles. By C. W. Larison, M. D. Published by the author at Bingoes, New Jersey. 1881. Pp. 139.

Sewer-Gases: Their Nature and Origin, and how to protect our Dwellings. By Adolfo de Varone, A. M., M. D. Second edition. Revised and enlarged. New York: D. Van Nostrand. 1883. Pp. 145. 50 cents.

Books of All Time. A Guide for the Purchase of Books. Compiled by F. Leypoldt and Lynde E. Jones. New York: F. Leypoldt. 1883. Pp. 60.

A Reading Diary of Modern Fiction. Containing a Representative List of the Novels of the Nineteenth Century, etc. New York: F. Leypoldt. 1881. Pp. 150, with blanks.

The Actual Lateral Pressure of Earth-works. By Benjamin Baker, M. Inst. C. E. New York: D. Van Nostrand. 1882. Pp. 180. 50 cents.

The Mother's Guide in the Management and Feeding of Infants. By John M. Keating, M. D. Philadelphia: Henry C. Lea's Son & Co. 1881. Pp. 118. $1.

POPULAR MISCELLANY.

Fifty Years' Study of the Distribution of Plants.—Sir J. D. Hooker devoted his address, as President of the Geographical Section of the British Association, to a review of the progress that had been made during the last fifty years in the study of the geographical distribution of living (particularly of vegetable) forms. The germ of this study is to be found in an idea attributed by Humboldt and Forbes to Tournefort, that in ascending mountains the vegetation gradually approaches that of the higher latitudes. Humboldt began his botanical studies early in life, and in his "Prolegomena," published in 1815, endeavored to determine the proportions which the species of certain large families, or groups of families, bear to the whole number of species comprising the floras in advancing from the equator to the poles, and in ascending high mountains. He observed that some kinds of plants increase relatively to others in going from the equator to the poles, others diminish, while some are strongest in the temperate zones, decreasing in both directions. No material advance was made, however, toward improving the laws of geographical distribution so long as it was believed that the continents and oceans had experienced no great changes of surface or climate since the introduction of the existing assemblages of animals and plants. This belief was dispelled by Lyell, who showed, from the examples of Sicily and some of the mountain-regions of Italy, that a fauna may be older than the land it inhabits. Darwin conceived the same idea from comparisons of the living quadrupeds of Asia and America; and it was confirmed by the discovery of Arctic plants on the mountains of the temperate zone. The first attempt to press the result of geological and climatal changes into the service of botanical and zoölogical geography was made by the late Edward Forbes, who communicated to the British Association a study of the distribution of endemic plants, particularly those of the British Islands, considered under this aspect. This paper shows that Forbes was profoundly impressed with the belief that the conditions of geological connection and climate were the all-powerful controllers of the migrations of animals and plants, and induces Professor Hooker to pronounce its author "the reformer of the science of geographical distribution." Before the doctrine of the origin of species by variation and natural selection was published, all reasoning as to the distribution of species was subordinated to the idea that they were permanent and special creations. The modes of dispersion had been traced, but the origin of representative species, genera, and families, remained an enigma. The existence of the same kinds in different places could be accounted for only on the supposition that these different places presented conditions so similar that they favored the creation of similar organisms; and this failed to account for identities occurring where there was no discoverable similarity of physical conditions, and their failing to occur where the conditions were similar. Under the theory of modification of species after migration and isolation, the representation of similar species in distant localities is only a question of time and changed physical conditions. New data for the study of the past and present physical geography of the globe were afforded by the discovery in the Arctic regions of fossil plants of types corresponding with those which are now found only in warm temperate zones, which dates from 1848. These fossils proved not only to belong to genera of trees common to the forests of all the three northern con-

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tinents, but to include also what are now extremely rare and even local genera. These results opened up a new channel for investigating the problem of distribution, and it was first entered by Dr. Asa Gray, who pursued it with brilliant results. Professor Blytt, of Christiania, in his essay on "The Immigration of the Norwegian Flora during Alternately Rainy and Dry Periods," invoked the glacial period to account for the dispersion of Arctic plants, dealt with a rising land, and assumed that immigration took place overland, as Mr. Forbes had done in the case of British vegetation; but he also found another powerful controlling agent, in alternating periods of greater moisture and comparative drought, of which the Norwegian bogs afford ample proof. The phenomena of distribution in the southern hemisphere are more difficult of explanation. The so-called Antarctic flora is now confined to the mountains and southern islands of the temperate zone, nowhere crosses the parallel of 62°, and is uniform around the globe. The temperate flora is fourfold, presenting more differences as between the three continents and New Zealand than do the floras of the northern continents. These plants have their representative species and genera on the mountains of the tropics, each in its own meridian only, and there meet immigrants from all latitudes of the northern hemisphere. No direct proof has been discovered that the southern plants originated in the south, but reasons exist for supposing that the southern flora came from the north temperate zone. Mr. Thistleton Dyer has maintained that the floras of all the countries of the globe may be traced back at some time of their history to the northern hemisphere, and that their present peculiarities in affinity and specialization are the natural results of the conditions to which they have been subjected during recent geological times, and supports his view with plausible arguments. A very similar view has been held and published by Count Saporta in his essay "L'ancienne Végétation polaire." Mr. Wallace independently advocates the view of the northern origin of the floras and faunas of the world in his "Island Life." The later works on geographical distribution include Mr. Wallace's "Geographical Distribution of Animals," Professor A. de Candolle's "Géographie Botanique," Dr. Grisebach's "Die Végétation der Erde," and Mr. G. Bentham's addresses before the Linnæan Society in 1869, 1870, and 1872.

Indian Burial-Caves. — Dr. Edward Palmer, who has been working under the direction of the Peabody Museum of Archæology of Cambridge, Massachusetts, has explored several caverns in Southwestern Coahuila, Mexico, that were long ago used as burial-places by the Indians. These caves have been mentioned by a few writers, and stories have been told by people who visited them or heard of them, nearly half a century ago, of the immense number of mummified human bodies that they contained. Since then the caves have been worked for niter, and thousands of the mummies have been burned. Dr. Palmer has found a considerable number of the bundles undisturbed, and has brought them to Cambridge. Each bundle contains the bones of one or more human skeletons and ornaments, implements, small baskets, articles of clothing, and other objects. The resemblance of the mummies with those found in the caves of Kentucky and Tennessee is of particular interest. Among numerous objects of art from the collection which Dr. Palmer exhibited at one of the meetings of the Boston Society of Natural History were parts of a fringed skirt, on the edge of which feathers had been fastened; a feather headdress, braided sandals, and pieces of finely and evenly woven cloth in different-colored patterns. Many of the things are not like those used by the Indians of the present day; and not a thing derived from Europeans has been found, so far as can be learned, in any of the caves. Dr. Palmer therefore thinks that the bodies were placed where they were found long before the Spanish conquest of the country.

Hope for Sufferers by Heart-Disease. — According to Dr. J. Milner Fothergill, the views of the medical profession as to the prospects for the future of cases of valvular disease of the heart are undergoing very considerable changes, in a direction opposite to the hopelessness with which they have been regarded in the past. Not every murmur which may be heard over the

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heart is a sign that the patient is destined to a sudden death from the action of the cause that produces the sound, nor is it always evidence of organic cardiac disease. It is a grave symptom, but its importance may be and often is exaggerated. It is only probably produced by deformity in the cardiac valves; but anæmic, aortic, and, still more, pulmonary murmurs, are now generally recognized. The late Dr. Latham carefully discriminated between grave and comparatively trivial injuries to the mitral-valve curtains by endocarditis, and held that there were three divisions of cases of permanent unsoundness of the heart remaining after endocarditis: 1. Cases in which, besides the permanent endocardial murmur, there is no other symptom referable to the heart; 2. Cases in which, besides the murmur, there is occasional palpitation; and, 3. Cases in which, besides the murmur, there is constant palpitation. The typical cases of the text-books, where there is a series of morbid sequelæ gradually descending more or less swiftly, all belong to the third division. Dr. Fothergill has cases in his own practice of mitral murmurs which have existed for sixteen, fourteen, twenty-seven, and thirty-eight years, without developing any very alarming symptoms, and reports the death, between the writing and publication of his article, of a case of aortal regurgitation—a rapidly fatal form of disease—which had not perceptibly advanced during twenty-five years of excessive activity. He also notices cases of aortic obstruction of fourteen, sixteen, and eleven years, of which the first only has as yet died. In conclusion, he observes that under proper treatment, by which the prospects are profoundly affected, and with care, a life of activity is practicable in many cases, provided bodily exertion be avoided, or exercised moderately.

Recent German Archæological Discoveries.—Dr. Mehlis read a paper before the recent Congress of German Archæologists upon the human skeleton that has been found at Kirchheim, on the Eck. The skeleton lay in a north-and-south direction, with a polished stone hatchet on its breast, and around it were quite handsomely adorned potteries and broken bones of the musk-ox, aurochs, cow, dog, wild-boar, and sheep. The bones indicated a man of middling vigor, the skull approached in build the Engis and Niederingelheim skulls, and was strongly dolichocephalous, prognathous, and furnished with powerful jaw-bones. Dr. Vater described an interesting collection of objects which had been found early in August in digging for the foundations of a military building at Spandau. While digging in the moor at the entrance of the Havel into the Spree, the workmen came upon a pile-dwelling in which were bones of animals with a small, roundish skull of a high type, and bronzes in good condition: three swords, six celts, a knife, five lance-points, a ball of sandstone, several bits of horn, a grinding-stone, and a canoe ten feet long dug out from an oak-log. The metallic objects are much rusted, and of a northern type in form. The swords are distinguished by their typically short hilts. Dr. Gross exhibited a number of articles that he had dug from the mud of the Bieler Lake at Corcelette, among which were bronzes which had evidently been made on the spot, armlets, finger-rings, buttons, celts, molds for casting, a rude copper axe, horn lance-points, and a veritable lump of tin. Some of the earthen vessels represent pleasing types recalling Grecian patterns; others, dishes, have been painted in yellow, red, and white designs, and others bear a wave-ornament that appears to have been laid on with tin, in the same way that many of the lower Italian vials are adorned with stripes of gold. The latest excavations of Gross show that wood, horn, clay, iron, copper, tin, bronze, and amber, were used as materials, while gold and silver were still wanting. The marks of the use of the wheel in making the potteries indicate that a tolerably high state of civilization had been reached at this period, which, by all the evidence, must be fixed at a time before the Romans.

Prevention of Damp in Buildings.—M. G. Phillippe, civil engineer of Rouen, France, has considered the subject of damp in buildings, in papers that are reviewed in "Van Nostrand's Engineering Magazine." Damp is caused in buildings by the presence of water in the atmosphere and the soil, combined with the porosity of building mate-

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rials, which absorb it. Its effects are to cause disintegration of masonry, the decay of timber, the development of saltpeter on walls, and injury to the health of the inhabitants of the buildings, with damage to the decorations of the walls and to furniture. Remedies to prevent and cure it may be applied to both the causes by: 1. Employing suitable materials for cellars and other parts of buildings below or on the level of the soil; 2. Inserting damp-courses to stop the upward progress of damp; 3. Applying preparations to protect the face of the exposed wall from the weather, or to prevent damp in the wall from affecting an apartment; and, 4. Adopting precautions against infiltration. Concrete, covering the whole ground-area of the future building with a layer four inches thick, forms the most thoroughly sanitary foundation. Well-puddled clay is also good and inexpensive, but is not effective in old buildings. The porosity of materials has been obviated by injecting them with gas-refuse, by immersing or washing them in solutions of soap and alum successively, by plunging them into a solution of silicate of potash, and by painting them with gas-tar. Mortars are made impervious by mixing them with cement. Parquets may be preserved by laying them upon bitumen. Ventilating bricks, which are made in France twice as large as common bricks, admit air to the interior of walls, and thus keep them dry. Under the Joumet patent, ventilable and perfectly dry floors and areas are made by laying the cement around pipes, which, being drawn out, leave the foundation penetrated by tubes. Conduits are made with the glyco-metallic liquid, or with gutta-percha. The stone settings of windows should be made moisture-proof, and leaden gutters on the inside, to catch the moisture that drips from the glass, will be of service. Slates should be hung on the Fourgeau or Chevreau hooks, with which the damp-admitting holes required when nails are used can be dispensed with. Finally, drains from closets should be furnished with ventilating pipes.

Are Marriage and the Family in Danger?—Certain magazinists, croaking preachers, and foreigners who look at American society through telescopes leveled at Utah and Chicago, have sounded a cry of alarm that the marriage institution and the purity of the family are decaying in the United States. Their assertions are founded on the frequency with which divorces are sought in some places where the process is made particularly easy. Granting that divorces are too freely given, and that the appetency for divorce indicates that something is wrong in the morals of the parties: have the alarmists ever stopped to inquire what are the moral characters of the parties aside from the fact of the divorce suit, or whether their morals would probably be any better if there were no possibility of divorce? And have they ever reflected upon the preponderating numbers of American married people who never think of applying for divorce, but are striving with all their might to build up and maintain a pure and healthful family life, and would continue to do so even if it were as easy to get a divorce as to buy a pair of boots? The very facts the alarmists cite show that there is no relation whatever between facility of divorce and moral laxity. In Maine, divorce is of the easiest—the court grants it at its discretion—yet no man in his senses will say that society in Maine is a whit less pure than in New York, where divorce is of the hardest to get. South Carolina allows no divorces, while North Carolina has a divorce law that is singularly lax, yet no difference can be perceived in the morality of the two States. Boston, where divorces are quite numerous, is quite as moral, to say the least, as Paris, where no divorce is allowed. An increase in the number of divorces is not observed in the United States only, but is receiving attention in countries where laxity can not be predicated of the laws. It is the case "enormously," according to the confession of the "Pall Mall Gazette," in England. In France, legal separations have gone up from 1 to 370 marriages in 1840–'50, to 1 in 152 in 1860–'70. In Belgium the ratio of divorces has risen from 1 in 576 couples in 1840, to 1 in 200 in 1874.

Biology in Public Schools.—Mr. George W. Peckham, of the Milwaukee (Wisconsin) High School, has told how he has succeeded in teaching biology to his classes of boys and girls. Two years' experience convinced

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him that imparting the power "of repeating classifications of animals with all the appropriate definitions" had nothing to do with communicating genuine knowledge. He prepared a series of laboratory notes sufficient for the dissection of a few plants and animals, and used Huxley and Martin's text-book, after it was published, as a laboratory guide. The school board provided eight Beck's students' microscopes, and, he says, "we begin with the study of the torula; we then take in succession the following organisms: protococcus, amœba, bacteria, mold, stone-work, ferns, flowering plants, infusorian fresh-water polyp, clam, lobster, and frog. We devote to laboratory one hour daily for seven months. At the end of the course come morphological and physiological generalizations. Our classes number about eighty, and are divided into working sections of sixteen each. The average age of the students is sixteen years, rather more than half of them being girls. I have found the students eager and enthusiastic, and the large majority of them regret the untimely end of their study of biology," which is limited by the procrustean regulations of the school-course.

Nature of Diphtheria-Poison.—Drs. H. C. Wood and Henry Formad, co-operating with the National Board of Health, have been studying the nature of the diphtheritic contagium. They began with inoculating rabbits, under the skin or in muscles, with diphtheritic membranes taken from the throats of patients in Philadelphia. Not diphtheria but tuberculosis followed as an indirect and not a direct result of the inoculation, the relations between the two diseases seeming to be only apparent. When the false membrane was inserted into the tracheas of the rabbits, severe trachitis was produced, with an abundant formation of false membrane, identical with that of diphtheria. It was shown by further experiments that the production of false membrane involves nothing specific, but that any trachitis of sufficient severity is accompanied by it. The product differs from that of true diphtheria only in its containing fewer micrococci. Diphtheritic poison was next obtained from Ludington, Michigan, where a severe epidemic was raging. Inoculations with this matter, whether made under the skin, in the muscles, or in the trachea, were all followed by similar results, namely, a quick affection, a rapid spread of the local symptoms, and death; and the blood, examined during life or after death, was found to contain micrococci precisely similar to those found in the Ludington cases; and in a few instances the plants were found in the internal organs and the bone-marrow. The urine of patients suffering from malignant diphtheria is full of micrococci, and is even more deadly in its effects than the membrane. When cultivated, micrococci from Ludington grew rapidly up to the tenth generation, and those from Philadelphia ceased their growth in the fourth or fifth generation, while those taken from a furred tongue, which showed similar shapes, never got beyond the third transplantation. The conclusion was drawn that the micrococci found in ordinary sore-throat and those of diphtheria differ only in their reproductive activity. When rabbits were inoculated with cultivated micrococci, diphtheria was produced with the second generation, but never with any later product. Diphtheria may be self-generated whenever conditions arise within the body or act upon it from without competent to stimulate the inert micrococci in the mouth into active ones.

Scientific and Popular Experiments in Pathology.—Mr. John Simon, D. C. L., LL. D., in his address before a section of the International Medical Association, on "State Medicine," has forcibly presented the duty of the state to facilitate and encourage scientific researches into the causes of disease. All that we know or can know on this subject, he maintains, is and must be learned by experiment. The experiments that give us the teaching we seek are of two kinds: scientific experiments, carefully prearranged and comparatively few, performed in pathological laboratories, and for the most part on other animals than man; and "the experiments which accident does for us, and, above all, the incalculably large amount of crude experiment which is popularly done by man on man under our present ordinary conditions of social life." Thus, in regard to Asiatic cholera, we have the scientific infection experiments of Professor Thiersch

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and others, performed on a few mice; and, on the other hand, the popular experiments which were performed on a half-million of human beings in London during the cholera epidemics of 1848–'49 and 1853–'54 by the water companies. M. Villemin has gained information of incalculable value concerning the causes and nature of tubercle from his laboratory experiments on other animals than man, and has been followed by others who have developed and extended his discoveries. Professor Gerlach, of Hanover, has in a similar manner studied the transmissibility of tubercle from animals to man by eating their flesh and drinking their milk. The popular experiments, performed by milk-dealers serving their customers, which lead us to suspect that tuberculosis might be transmissible through milk, are performed daily upon thousands of human beings: "The scientific experiments which have made us certain of the fact were conclusive when they amounted to half a dozen. Thus, without making any account of the relative value of human beings and animals, the scientific experiments are vastly more economical than the popular. They have the further advantage of being precise and exact, while the popular experiments very often have in them sources of ambiguity which lessen their usefulness for teaching." The principal problems to be solved in preventive medicine are how, by cross-breeding or otherwise, to convert a short-lived or constitutionally enfeebled stock into a long-lived or vigorous one, which has hardly yet become a practical question; and how to avoid or resist the extensive interferences which shorten life, on which much has been learned by vivisection, and more remains to be learned. Of the investigations in the latter line which have led to results of momentous value are cited the diversified researches of Pasteur and others on germs, and their specific applications to the diseases of domestic animals and man; Drs. Klebs and Tommasi Crudelli's examinations into the intimate cause of marsh-malaria; Dr. Grawitz's studies of the conversion of ordinarily harmless microphytes into agents of deadly infectiveness; Dr. Lister's application of Pasteur's discoveries to the antiseptic treatment of wounds; Professor Semmer and Dr. Krajewski's discovery of inoculation against septicæmia; and Dr. Schüller's contributions to the treatment of tubercular and scrofulous affections, on the basis of their microphytic origin. No work has been performed of more promise to the world than these various contributions to the knowledge of disease, its cure and prevention; and they are contributions which from the nature of the case have come, and could only have come, from the performance of experiments on living animals.

A Dangerous Tendency in Science.—Mr. W. Spottiswoode, in his president's address before the Royal Society, has sounded the note of alarm against an evil that has begun to affect science, and may result in harm if it grows. Research, he suggests, is being drawn into the hurry that characterizes other departments of life in our generation, and the glamour of sensational fame is too apt to blind the eye to the light of the solid honor which is the real and best reward of science. "Apart from other reasons, the difficulty, already great and always rapidly increasing, of ascertaining what is actually new in natural science; the liability at any moment of being anticipated by others, constantly present to the minds of those to whom priority is of serious importance; the desire to achieve something striking, either in principle or in mere illustration—all tend to disturb the even flow of scientific research. And it is, perhaps, not too much to say that an eagerness to outstrip others rather than to advance knowledge, and a struggle for relative rather than absolute progress, are among the most dangerous tendencies peculiar to the period in which we live." Happily, this tendency has not yet become general in science, and Mr. Spottiswoode's calling attention to it may go far toward providing a cure for it.

The Supposed Volcanoes in Central Asia.—The existence of volcanoes in Central Asia was formerly generally recognized on the authority of Humboldt. As the vast regions included in that country have become more accessible to Europeans, many of the supposed volcanoes have been proved to have no real existence, and the investigations of Russian explorers have resulted in showing that what in many in-

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stances were regarded as volcanoes were merely extensive fires of stone-coal. Muschketoff maintained, in 1876, that there was no recent volcano in the country except, perhaps, Mount Baishan. Two years later General Kolpakoffsky endeavored to solve the question relative to that mountain, but his expedition failed to reach it. Last year he had better success, and a dispatch was read from him at the meeting of the Russian Geographical Society, on October 29th, stating that he had found the apparent volcanic phenomena there also to be caused by a stone-coal fire, that had been burning so long a time that no one could tell when it had begun. Opposite to Baishan is Mount Kiuntag, where the fire has ceased. The slopes of Baishan are marked with holes from which smoke and sulphurous gases stream out, and the fire in the interior is attended with a great noise. The question of the existence of volcanoes in Central Asia appears to be decided in the negative by this report, which also strengthens the theory that the action of volcanoes is chiefly due to water; for the supposed volcanoes in the interior of Asia, now known not to exist, afforded the only exceptions to the rule that all volcanoes are situated near large masses of water.

Reversion of Domesticated Animals to the Wild State.—The Hon. J. D. Caton has been taking some notes, during a sojourn in the Sandwich Islands, on the tendency of domesticated animals, when left to go wild, to revert to the habits, forms, and colors of their wild ancestors. "With the exception of the goose and the duck, nearly all the animals which have been introduced into the islands, as well as those which were then held in domestication, have reverted to the wild state. Among them are the ox, the horse, the goat, the sheep, the hog, the dog, the cat, the turkey, the peacock, and the barn-yard fowl. The greatest physical degeneracy was observed in the wild horse and the wild sheep. The latter are small, gaunt, and long-legged, with a scant and coarse pelage. The ox, in about seventy-five years, while it has not changed much in color and form, has become wild and wary, and very fleet in running over the lava in the mountainous regions which it selects as its home. The wild goats are very numerous, cautious, and difficult to approach, and are mostly white, but some are party-colored. The hog in a single generation "changes in form, color, and habit, from the staid and quiet porker to the fleet and fierce wild boar"; and one imported boar is told of that changed immediately after escaping from a ranch, and became as wild and fleet almost as a deer, with a thin body and arched back, and legs that appeared to be much longer, while he more slowly assumed the dark, sandy color of the wild boar. Turkeys also began quickly to take on the color and shape of the wild turkey. Wild barn-yard fowls fifty years after escaping, occupying an extensive elevated or mountainous wooded country, are the most wild and wary animals in the district, have a faculty of disappearing without noise at daylight, after having made the forest vocal with the crowing of the cocks, and have diminished in size, and become of a uniform buff-color. Judge Caton announces his conclusion in the "American Naturalist," in which his notes are published, that the tendency common to most animals to return to the wild habit, the form, and the coloring of the original species, is possibly strongest in those cases where the animal has been most recently reclaimed from the wild state, or where the change produced by domestication has been most rapid.

Safety on Suburban Railroads.—Two recent railway accidents have forcibly directed attention to the necessity of providing more efficient means of protecting passengers who have to travel on lines whose trains run with excessive frequency, as on the suburban railways of large cities. A train on one of the London railways and a train on the Hudson River Railroad were stopped casually—the first in a tunnel, the other at the end of a curved cut. The signals failed to be given to following trains, which came along in less than five minutes. In both cases hind cars were destroyed, and several persons were killed, and others—sixty in the London accident—hurt. The blame in both cases is attached to the signals or the signal-men. No system of signals can be devised that will be infallible, but those we have can be made better and

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the method of using them may be vastly improved. The frequency of trains can not be diminished, but will have to be increased as the number of suburbans who do business in the cities increases. The only certain means of obtaining greater security seems to lie in increasing the number of ways out of the city; and, as there is a limit to the number of new railroads that can be built in such places, the way out may at last have to be sought in introducing steam tramways and steam-carriages on common roads. The London "Spectator" says that the present prohibition of these two forms of locomotion is "so absolute and so unreasoning as to operate as a direct check upon invention."

Spontaneous Combustion of Coal.—Seventy cases of spontaneous combustion of coal are recorded as having taken place among 31,116 ships in 1874. The combustion may go on so slowly that the rise of temperature will amount to only a few degrees, and probably always occurs where coal is heaped up in large quantities. Mr. W. Mattieu Williams has been led to the conclusion, by experiments in distilling inflammable hydrocarbon from cannel-slack, that it takes place in some degree in all cases where coal is exposed to the atmosphere. The yield of gas, which was at first good, continuously diminished, and at last became ruinously small, the slack at the bottom of the heaps being little better than coke. Soon after this, the railway to the colliery siding took fire under the rails from the oxidation and heating of the slack with which it was ballasted. The loss from this oxidation is greater in fine coal than when the mineral is in large lumps, because a greater proportion of surface is exposed. The liability to slow combustion varies with the quality of the coal, and is greatest in "brassy" coal, or coal that contains pyrites.

Egyptian Marriage and Animal-Worship.—M. Revillout has been struck, in examining some ancient Egyptian marriage settlements, with the predominance which was given to the wife in the family. In a deed of the time of Ptolemy Philadelphus, the groom, describing himself as the son of Pchelkons, "whose mother is Tahret," saith unto the woman Tarreteus, daughter of Relon, whose mother is Tarreteus, "I have accepted thee as my wife," and afterward, "I will establish thee as my wife." The preliminary "acceptance" mentioned here was a marriage for a year of probation, like the "hand-fasting" for a year, with power at the end of the year to break the contract, that used to prevail among the Highlanders of Scotland, and analogies to which may be found among some other people. An important point to be noted in the deed is the naming of the mothers of both contracting parties as a fact which, in itself, demonstrates the importance of the woman in the family, and as a survival of the time when family names were derived, not from the father, but from the mother. After accepting and establishing the woman as his wife, the man, among other things, promised to pay certain damages if he should take another wife, and gave the woman a kind of mortgage on all his property. Thus, in another deed, one Petoupra assigned to his wife, Neshorpchrat, "not only his house and all his landed property, present and future, but likewise his silver and copper money, his title-deeds and documents concerning his property. . . . He leaves himself absolutely nothing"; and the only clause in his favor was, that his wife should provide for him while he lived, and pay for his funeral liturgies, and for embalming his body when he died. This is not a singular instance. The Egyptian bridegroom, moreover, took his wife's name, and the sons, instead of being called after their fathers, were designated by the names of their mothers. A writer in the "Saturday Review" regards this custom, in connection with animal-worship, as originating in the same principle. The worship of animals, while nearly universal as a whole, was local as to each sacred animal. An animal that was worshiped in one place was hunted down in another, all over the country. These animals were probably originally selected and made peculiar to distinguish the families and stocks of the people, like the *totems* of our Indians, and the corresponding customs among the Australians and some African races. "There is scarcely a quarter of the globe where the tribes of contemporary savages are not divided into stocks, each of which, like the Egyptians, reveres a sacred animal or plant,

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from which, like the Egyptian towns, it is named, and (as the Egyptians did) it refuses to eat that animal or plant. Further—and this is the essential point of our explanation—among the tribes which act thus, the mother is the permanent element in the family, and the children (as the Egyptians did) derive their names, not from the father, but from the mother's family." Among most of the purest races the various stocks which worship the different animals are scattered through all the local tribes. But in China, the worshipers of each animal, or at least the people who derive their name from him, are gathered together, as in Egypt, into local aggregates. Thus, the Egyptian marriage customs and the Egyptian animal-worship both seem susceptible of explanation as relics of savagery preserved into the midst of civilization by the extraordinary tenacity of Egyptian conservatism.

A Glossary of Microbes.—Mr. W. Hamlet gives the following classification of the microbes (microscopic organisms of fermentation and disease): 1. Microbes which appear as points are called *monads*, *monera*, or *micrococci*. They are motionless, and may be regarded as the spores of other microbes. 2. Motionless linear microbes—the *Bacteridians* and the *bacilli*. To them belongs *Bacillus anthracis*. 3. Cylindrical mobile microbes, having rounded ends or contracted in the middle so as to form an 8, are the *bacteria* proper. Among them is *Bacterium termo* of putrefaction, the commonest of all. 4. Flexuous mobile microbes. They look and act like eels, and differ but little from the equally active bacteria. They are the *vibrios*. 5. Spiral microbes, resembling a cork-screw, and mobile; *Spirilla spirochetæ*. Their presence in human blood appears to be connected with intermittent fever. 6. Microbes with heads, very active, having globules larger and more refractive than the rest of the body at one or both ends. These globules are apparently spores ready to be detached from a bacterium—*Bacterium capitatum*. Besides these six principal states, the microbes form agglomerations or colonies that often notably change the aspect of the elementary cells, and which have received various names. Agglomerations in microscopic masses, surrounded by a jelly that sticks them together and deprives them of motion, are called *zoöglœa*. A non-gelatinous membrane formed of motionless bacteria is a *mycoderma*. Bacteria attached end to end in a string form filaments of *leptothrix*. A number of spherical micrococci joined one after another form the string of round grains called a *torula*. A considerable number of species may be included in each of these divisions; and there does not appear at present any way to distinguish by sight a disease-producing bacterium from a harmless one.

Circulation of Blood in the Brain.—Signor Mosso, who has been engaged on the subject for six years, has published some new observations on the different conditions of the circulation of the blood in the brain. He has had the privilege of observing three patients who had holes in their skulls, permitting the examination of the encephalic movements and circulation. No part of the body exhibits a pulsation as varied in its form as the brain. The pulsation may be described as tricuspid; that is, it consists of a strong beat, preceded and followed by lesser beats. It gathers strength when the brain is at work, corresponding with the more rapid flow of blood to the organ. The increase in the volume of the brain does not depend upon any change in the respiratory rhythm; for, if we take the pulse of the fore-arm simultaneously with that of the brain, we can not perceive that the cerebral labor exercises any influence upon the fore-arm, although the pulsation in the brain may be considerably modified. The emotions have a similar effect upon the circulation of the brain to that of cerebral labor. Signor Mosso has also observed and registered graphically the variations of the cerebral pulse during sleep. Generally the pulses of the wrist and the brain vary oppositely. At the moment of waking, the pulse of the wrist diminishes, while that of the brain increases. The cerebral pulsations diminish as the sleep grows deeper, and at last become very weak. Outward excitations determine the same modifications during sleep as in the waking state, without waking the sleeper. A deep inspiration always produces a diminution in the volume

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of the brain, in consequence, probably, of the increased flow of blood into the veins of the thoracic cavity; the increase of volume in the brain, when it takes place, is, on the contrary, due to a more abundant flow of arterial blood to the encephalus.

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NOTES.

ACCORDING to Professor Cope's "Review," members of the order of *Rodentia* were very abundant during the White River and Truckee (Miocene) epochs in North America. They are referable to thirty-one species and eight genera, of which three genera—*Sciurus*, *Hesperomys*, and *Lepus*—still exist in the regions where their fossil remains are found. All the species belong to the three great divisions of the order which now inhabit North America, while the fourth division, *Hystricomorpha*, now very sparingly represented on the continent, has not been detected in the formations in question, but appears in a single species of porcupine in the Loup Fork bed. None of the species are of larger size than their modern representatives, while the beavers, squirrels, and rabbits are smaller.

M. DE QUATREFAGES has called attention to a story told in the "Histoire de la Louisiane" by M. Le Page du Pratz, of a Yazoo Indian named Moncatch Apé, who, before the year 1720, made a journey to the upper Missouri, thence over to the head-waters of the Columbia, in regions then wholly unknown to white men. Reaching a tribe of the Pacific coast, he learned that the Indians were visited regularly every year by white men with long, black beards, who came in fleets of thirty pirogues or more. They were described as stout and short, with large heads covered with cloth, their coats coming down to the middle of their legs, which, with their feet, were covered with a red or yellow dress. Their arms made a great noise and a great fire. M. de Quatrefages believes that those visitors may be identified with the Loo-Choo Islanders.

PROFESSOR RILEY has described a new imported insect which has been found preying upon the clover-fields at Barrington, New York. Its damages were first observed in the latter part of April, when small patches of clover showed the leaves to be badly eaten, and increased till the end of July, when acres of the clover were ruined. The insect continued to lay its eggs till October, a part of them outside the plant, but most of them inside of the old and hollow stems. The insect is a beetle, known as the *Phytonomus punctatus*.

GOVERNOR JOHN POPE HENNESSY, of Hong-Kong, gives a good account of the success which has attended the faithful practice of vaccination among the Chinese of that colony and the neighboring mainland. No port in the world is more liable to a visitation of small-pox; yet the disease never spreads at Hong-Kong. The health-officer of the colony, noticing that nearly all the young Chinese emigrants had vaccination or inoculation-marks on their arms, learned on inquiry that the doctors of the Tung-wa Hospital—a native charitable institution—practice vaccination upon their countrymen in the colony, and send travelling vaccinators over the adjoining provinces of China, using lymph supplied them by the British Colonial Office.

MR. M. E. WADSWORTH, in a communication to the Boston Society of Natural History, has given his reasons for believing that the iron-ores of the Marquette district, Lake Superior, are of eruptive, and not of sedimentary origin, as has been commonly held. He rests his conclusions upon the fact that the jaspilite and iron-ore in this district, while they offer no characters inconsistent with those which known eruptive rocks have, "possess characters which eruptive rocks exhibit, especially in relation to other rocks, and which no sedimentary rock, proved to be such, has been known to have." The particular facts supporting this view are given in the paper.

MR. P. HOGLAN has made experiments toward ascertaining whether calomel is liable to decomposition in the human system, with the production of corrosive sublimate. He has found that calomel may be slowly decomposed and corrosive sublimate formed by the action of water at the temperature of the body, and that the change is accelerated by the presence of citric acid, sodium chloride, or sugar.

THE geological formations of Schuylkill County, Pennsylvania, embrace, according to Mr. P. W. Sheafer's monograph on the subject, the rocks, with an exception or two, from the Oneida conglomerate (Upper Silurian) to the coal-measures. The only formation of importance for its mineral wealth is the last. It rests upon the Pottsville conglomerate (Millstone Grit), which has served as a barrier to protect the coal-deposits from erosion, and which varies in thickness from 675 to 1,030 feet. The coal-bearing strata are 3,000 feet thick at their thickest point, and include, perhaps, thirty coal-beds, of which fifteen are workable and over three feet thick, giving a total of 107 feet of coal. The series can be separated into three divisions by the color of the ash of the coals: a lower or white-ash group, a middle or gray-ash group, and an upper or red-ash group,

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with a still lower red-ash group in the conglomerate.

M. ALFRED GAUTHIER, for many years Professor of Astronomy at Geneva, died December 2d, in the ninetieth year of his age.

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AN English engineer, who bought a boiler sixteen years old, and used it as if its capacity to resist pressure was equal to that of a new and perfectly sound one, till it blew up and caused the death of several workmen, has been sentenced by the court at Leeds to a year's imprisonment for criminal negligence. The "Pall Mall Gazette" declares that the sentence is "severe, as it is probably novel," but can not consider it in excess of the merits.

So far as the Department of Agriculture has been able to obtain information on the subject, 181,583 acres of land in the United States are devoted to the culture of the grape, giving a production of 23,453,827 gallons of wine, of an estimated value of $13,426,174. California leads in respect to both the area planted and the quantity of production, while the industry is not so concentrated anywhere east of the Rocky Mountains as in that State. Yet, while California produces three or four million gallons more than all the other States, the value of the crops of the latter is, in consequence of their greater accessibility to the market, more than twice as great as that of the crop of California.

RECOGNIZING that the zero of thermometers is moved after undergoing sudden changes of temperature, and that it gradually rises during the first few months after the instruments are made, M. Pernet has inquired whether the distance between the "boiling-point" and the "freezing-point" is likewise subject to variations or is constant at all different stages of secular alteration in volume of bulbs. He has found that the distance is constant if the freezing-point is determined immediately after the boiling-point; but that if the boiling-point be determined and a long interval elapse before the freezing-point is determined, there is a considerable error. For a thermometer to read rightly at any particular temperature, it should be exposed for a considerable time to the temperature for which exact measure is desired, or else for a few minutes to a slightly higher temperature.

MR. LAWRENCE BRUNER, of West Point, Nebraska, who has been traveling in the locust-centers of the West and Northwest, with especial reference to investigating the probabilities for another visitation of the pests, reports that there are probably no locust-eggs east of the Rocky Mountains this season, and that, therefore, a general visitation in 1882 is highly improbable.

DR. AMI BOUÉ, who recently died at Vienna, at the advanced age of eighty-seven years, is stated to have been the author of more than two hundred works on subjects related to geology and natural history. He had been for more than fifty years an honorary member of the Geological Society of London, and received the Wollaston Medal in 1847.

THE Nickajack Cave, near the corner of Tennessee, Georgia, and Alabama, which is comparable in dimensions with the Mammoth and Wyandotte Caves, contains like them a fauna with peculiar characteristics. Professor Cope, who recently made two collecting expeditions into it, found abundant traces of human habitation near its mouth: first of the outer world so far within as light from without could be observed; and, farther in, blind crawfish, whose snowy-white forms could be readily distinguished by candle-light in the clear water. Of the five kinds of animals living in the waters of the cave, all but one differ decidedly from those of the caves of Kentucky, Indiana, and Virginia. This indicates, Professor Cope suggests, that these cave-forms are the descendants of different out-of-door species from those of the more northern caves.

PROFESSOR W. K. BROOKS, Ph. D., of Johns Hopkins University, has been awarded a medal of the first class by the Société d'Acclimation of Paris, for his work on the "Development of the Oyster." Professor H. A. Rowland, of the same institution, has been awarded the prize of 1,500 lire which was offered by the Reale Instituto Veneto di Scienze, Lettere ed Arti, for the best essay on the "Mechanical Equivalent of Heat." The essay has been translated into Italian, and will be published by the institute.

PROFESSOR E. D. COPE has described a new saurian (*Champsosauris Australis*), belonging to a genus of uncertain affinity, that has hitherto been regarded as peculiar to the Laramie strata, which is found in New Mexico, in a formation lying below the typical Wahsatch Eocene. Specimens of the genus appear also to have been found by Dr. Lemoine near Reims, in France, in the Suessonian Eocene, associated with mammalia.

M. RENÉ THURY, of Geneva, has communicated some observations on the production of inductive currents by distant lightning. He stretched between the roofs of two houses a wire, one end of which communicated with the ground, while the other end was connected with a telephone. Whenever lightning was perceived at a distance that might reach as far as twenty-five miles, the telephone simultaneously uttered a characteristic sound.

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PROFESSOR LOUIS PASTEUR.

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THE

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APRIL, 1882.

CHINESE IMMIGRATION: A SOCIOLOGICAL STUDY.

By GERRIT L. LANSING.

TO any one who has thought about the Chinese, the contrast presented by a comparison of their civilization with the civilization of the Western nations must have given rise to frequent speculation as to the cause of so great a difference. Should we be brought into communication with another planet, we could hardly expect to find a people more unlike us than the inhabitants of China. They have existed substantially as at present from a time long before a single language existed which is spoken to-day in Europe, and even before our classic dead languages were born. While the tribes, nations, and civilizations of the West have come and gone, the Chinese have remained the same, generation after generation and century after century, content always to live and die in the conditions that Fate has imposed upon them in the Middle Kingdom. A century and a half ago Du Halde wrote of their incurable conservatism, "that they have continued the same with regard to the attire, morals, laws, customs, and manners, without deviating in the least from the wise institutions of their ancient legislators."* And in our time we are told by the Abbé Huc—than whom no one has had better opportunities from which to judge—that "they seem to have been always living in the same stage of advancement as in the present day."† Peaceful occupations, untiring industry, and a careful frugality have characterized the habits of the people in the past as they do in the present. Wars were never justified except to secure peace, and upon the cessation of hostilities the armies eagerly returned to their peaceful pursuits.

The Western nations present a different picture. Our Aryan an-

* "History of China," vol. i, p. 237, folio edition, London, 1738.

† "Chinese Empire," vol. ii, p. 255, London, 1855.

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cestors, wandering with their herds over the plains of Central Asia, encouraged, by the habits and necessities of their lives, that liberty of action and individual freedom which have characterized those of their descendants who by their emigrations have peopled Europe and America. It seems more than probable, also, that this spirit has been strengthened by the natural selection of those individuals as emigrants in whom the feelings of discontent and curiosity were associated with a temperament that neither hesitated through fear nor turned back from obstacles. These it was who braved and triumphed over the natural hardships of an unbroken wilderness and the not less fearful supernatural obstacles which occupy all unknown countries in the minds of uncivilized man. Century after century were these hardy and indomitable characters strengthened by use and transmitted by inheritance. Whether we consider the ancient civilized nations, the rude Germanic tribes, or their modern descendants, illustrations will everywhere be presented of the universal tendency to independence and change among all the Indo-European peoples. We are told by Heeren, in the "Political History of Ancient Greece,"* that, "while Asia, during all the changes in its extensive empires, shows only the continued reproduction of despotism, it was in Europe that the germ of political freedom unfolded itself, and, under the most various forms, in so many parts of the same soil, bore the noblest fruits, which again were transplanted thence to other parts of the world." Similar testimony is borne by Hume to the character of the uncivilized tribes of the north of Europe.† "The government of the Germans," he says, "and that of all the northern nations who established themselves on the ruins of Rome, was always extremely free. . . . The free constitutions then established, however impaired by the encroachments of succeeding princes, still preserve an air of independence and legal administration which distinguish the European nations; and, if that part of the globe maintains sentiments of liberty, honor, equity, and valor superior to the rest of mankind, it owes these advantages chiefly to the seeds implanted by those generous barbarians."

That the modern descendants of these ancient nations and tribes still possess the predominant characters of their ancestors, is sufficiently illustrated by the estimate given by Buckle of his own countrymen. "We, in England," he says, "are a critical, dissatisfied, and captious people, constantly complaining of our rulers, suspecting their schemes, discussing their measures in a hostile spirit, allowing very little power either to the church or to the crown, and managing our own affairs in our own way."‡ By the complete possession of these characters, the American people involuntarily acknowledge their English descent.

It is unnecessary to multiply examples; from the earliest history of our race to the present generation, similar impulses have prevailed

* Oxford, 1838, p. 1. † "History of England," chap. iii, appendix.
‡ "History of Civilization in England," vol. ii, p. 29.

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and have been followed by similar actions. Dissatisfaction with existing conditions has encouraged the spirit of rebellion; oppression has been followed by revolt; the employment of force in the support of injustice has been followed by force in the maintenance of justice. Everywhere appears the spirit of discontent with existing conditions, and constant effort for their improvement.

The difference in the characters of the Chinese and European peoples is older than their histories, as it is the same when their histories commence. It is fundamental, and as immutable as are the physical characteristics of the races—subject to but slight change in long periods of time. The Chinese are constant in their adherence to old-established customs and ideas. The genius of the Western nations is that of change and progress. As the Chinese mandarin confers honors by his rank upon his father, and the European transmits his titles to his son, so in all things the former receives his highest inspiration from the past, the latter from the future.

The cause of this contrast is that underlying the vital question of Chinese immigration; it exists in the different races of the people composing the different societies, and finds its explanation in the operation of the same laws which govern the evolution of all races and species of the animal kingdom.

Considering, then, the Chinese as a race, let us notice some of the laws of development of races and species, for they hold equally well with man as with other members of the animal kingdom. The transmission of race-characters by inheritance is not only strongly persistent and subject to but slight change in long periods of time, but also the development of certain characters is often continued long after they have passed the condition of usefulness. A character, which from selection may have become fixed in a species or race, may also continue in its development from the strengthening tendency of heredity as the race increases in age, and by the development from use of all those parts which give it nourishment.

In the classification of species or races, physical characters alone have usually been employed; but those mental traits which are made manifest in habits and customs, though less easy of observation, are equally constant, and therefore suitable.

The distinguishing characteristics of genera, species, race, or tribe, physical and mental alike, are constant in the order named. As their development is in an inverse order—as slight variation must precede great change and tribes develop before races, races before species, and species before genera—the degree of constancy in all is controlled by the general law that the *inheritance of characters is persistent in proportion to the length of time they have been inherited.* The characters which mark a species are more constant and uniform than those which distinguish races, tribes, or families.

If the Chinese are a different race from the nations of the West,

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we may expect to find among them a different civilization, based upon different mental characters and temperament. If their customs, laws, and government have remained the same from a remote antiquity, we may expect to find them so persistent as to resist all effort at change; and we may find forms, which were anciently of great benefit, still transmitted by inheritance, though they may now have become injurious by interfering with the introduction of new forms of greater utility. These expectations, as will hereafter appear, are fully justified by the facts.

As nations are the necessary product of their parts—as the government is as it is because the people are as they are—it follows that a certain degree of homogeneity is necessary to secure peace and permanence. A majority of the people must have sentiments, instincts, and temperaments, as nearly similar as possible, where a difference in circumstances, occupations, and position is necessary. It is a constant strain upon the coherence of a nation, where the parts are of different civilizations. This would in fact be opposed to the very idea of a nation. As defined by Bagehot,* "a nation means a like body of men, because of that likeness capable of acting together, and because of that likeness inclined to obey similar rules." A nation may, like the United States, be composed of parts of various other nations, but they must be of a common race and civilization. The history of the Indians and the negroes in America too plainly demonstrates the truth that, where the races are different and the societies have different civilizations, rapid assimilation is impossible. As long as such a difference exists there will be a conflict, which can be ended only by the slow process of assimilation by variation of race, or by the extermination of the weaker. The permanence of national structure can be maintained only by the homogeneity of its civilization. "So long," says Spencer, "as the characters of the citizens remain unchanged, there can be no substantial change in the political organization which has slowly evolved from them."† Conversely, it follows that, upon the introduction of inharmonious foreign elements, the society must be proportionately modified. The introduction of the Chinese into our American society would be a union of different civilizations and different races. Each would stand by itself, from being too different to appreciate the other. They would be united only in the common interests of protection to life and property, and would defeat those primary objects by differing so fundamentally as to the method of their accomplishment. Very little assimilation could take place, and, by the law of heredity, the newer institutions would be the more readily changed, the older and more deeply rooted would be the more persistent. If the immigration should be so small—though there are reasons for believing it would not be—that the American population would always be in a large ma-

* "Physics and Politics," p. 21.

† "Study of Sociology," "Popular Science Monthly," vol. ii, p. 263.

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jority, there would still result the establishment of a non-assimilable class, that would be looked upon as an inferior caste, and would be ruled without regard to their wishes or interests. Such a class, in a republican government, would be as much of an anomaly, and as impossible of permanence, as the institution of slavery.

That the evolution of societies is governed by the same general laws which govern the evolution of organisms might be assumed, *a priori*, from the fact that societies are but aggregates of organisms. So, a society itself may be considered as an organism, for its existence as an aggregate necessitates the homogeneity of the parts composing it. The people must be of the same race and civilization, and in their institutions, laws, and customs, represent those instincts and temperaments which are characteristic of their race.

In past ages, war has been the chief means by which different civilizations have been brought together. The customs of the conquerors have been forced upon the conquered, thus leading to the common belief that the force thus employed was the cause of the resulting change in the society. The fact that the conquering race or nation generally prevails by virtue of superior numbers—the most important element, perhaps, in the conquest of a civilization—gives further color to this interpretation. But the numerous instances in which the civilization of the conquered nation is that which has prevailed show that the conquest by armed forces has been followed by a conflict of civilization, in which the dominant form has been determined, not by success in arms, but by persistence of characters, and by the relative number and fitness of the contending societies. That hatred of strange peoples which formerly characterized the intercourse of nations, that was born in ignorance and nourished by wars, has been weakened also by the better knowledge of one another which the same conflicts have brought about. Where formerly was only the crossing of arms is now a growing friendly intercourse. Invasions by armies have been succeeded by peaceful immigrations; but, though the conflict of arms may pass away, the peaceful mingling of nations and races will be followed still by the same conflict of civilizations. This is illustrated throughout the whole range of human history; but it may be sufficient to briefly consider for this purpose two civilizations, which were represented by the most powerful monarchies of the Eastern and Western hemispheres, in which the conquerors in war became the conquered in peace, and in which the mingling of races resulted in the subversion of the higher civilizations. Such was the history of the Romans and the Mexicans.

The civilization of the Romans, to which the modern civilized nations are to so great an extent indebted, has naturally attracted the particular attention of scholars and philosophers. In attempting to account for the fall of that mighty structure, and the following period of ignorance and barbarism, there have been given nearly as many

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reasons as there have been writers. Among the many causes that were more or less instrumental in producing this melancholy page of history, have been noticed the decay of religious faith; the loss of the love of freedom, produced by a system which made half of the population slaves; accumulation of wealth, and destruction of the middle class, the society consisting only of the very rich and the very poor; disinclination to marriage of the Roman citizens, which became so general that the government was led to offer a premium for marriages; and the decimation of the Roman youths by constant wars. In so complicated a problem, in which so many causes have led to the same result, it is necessary, in order to discover the primary and fundamental cause, to rise above those more transitory and local elements which confuse rather than aid the observer. So, if we look above all these, there will appear a further cause—the cause, indeed, of these causes—in the conflict of societies, of different races, or of different civilizations.

In the middle of the second century B. C., the arms of the Roman Republic encompassed the Mediterranean from Carthage to Cadiz; the world obeyed the mandates and bowed to the authority of the Senate and the Roman people. The acquisition, however, of this great power and wealth became the cause of her subsequent weakness and poverty. The victorious arms of the legions were the plowshares which prepared the soil to receive the seed of final dissolution. Of the century following we read, that "the vast admixture of foreign elements produced boundless self-indulgence, and general faithlessness and corruption. New vices were imported, mainly from Greece and Asia, new creeds from all parts of the world."* Prisoners of war were retained as slaves by their conquerors, and to these so many had been added by purchase that, when it was proposed to discriminate the slaves by a peculiar habit, it was justly apprehended that there would be too much danger in acquainting them with their numbers. The slave population in the first century has been estimated to have been sixty million, "and at least equal in numbers to the free inhabitants of the Roman world."† These, by their services, aided the degeneration and hastened the mortality of their masters; they became citizens, soldiers, senators, and emperors. The Romans themselves had become a fast-decreasing minority in their own empire. From the adoption of the luxurious customs of their Oriental provinces, the Roman soldier became too weak to bear the ancient armor. The deserted ranks of the legions were replenished with the hardy barbarians from the frontier provinces. The name of emperor had lost its significance, by his deserting the field for a more easy and agreeable residence in the capital; but his warlike character was redeemed by the accession to the purple of the Thracian peasant Maximin, who during his reign disdained to visit either Rome or Italy.

* Johnson's "Cyclopædia," vol. iii, p. 1707.

† Gibbon, "Decline and Fall of the Roman Empire," vol. i, p. 27.

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In this mighty tragedy the time had come for the final act; the stage was set, and all awaited the entrance of the actors. When Alaric and his savage Goths descended upon Rome, they were met with as little resistance as are the play-warriors upon the smaller stage. The Romans of old were not there to oppose the barbarians; many had been destroyed by wars, "but these," as Draper says, "were an insignificant proportion to that fatal diminution, that mortal adulteration, occasioned by their mingling in the vast mass of humanity with which they came in contact. . . . Whoever inquires the cause of the fall of the Roman Empire will find his answer in ascertaining what had become of the Romans." *

The early union of the neighboring tribes into the Roman state was a union of similar elements, which became strengthened by numbers, without being weakened by conflicting natures. Their subsequent conquest of the Greek colonies gave them an element which encouraged the development of art and learning, and was still of the same race as themselves, with a civilization of a like genius. Thus the Roman state grew in strength as it increased in size. Her victorious arms then humbled city after city, and nation after nation, till the savage tribes of Europe and the civilized nations of Asia and Africa acknowledged the rule of the mistress of the world. Year after year the flower of the Roman youth were marched to her distant colonies and died upon foreign fields; and in return the Gauls and Thracians, Syrians and Egyptians, were brought to Italy and Rome. The art, learning, and civilization of Rome, which had thrived upon their native soil, and had each year grown more deeply rooted, were like plants pulled up and strewed broadcast over the earth, to take root where they could, or to be crowded out by the more vigorous but rank native growth. Those that were left became weakened by the rude foreign growths that were brought and placed beside them. Only an occasional seed was preserved, to finally bear fruit in future ages. The individual representatives of the civilization of Rome were absorbed in the much greater mass with which they had surrounded themselves, as the fresh waters of the river are lost in the greater volume of the ocean.

The Spanish invasion of Mexico affords a similar illustration of the distinctive results following the union of different civilizations. The Mexicans were a homogeneous people, having similar wants, instincts, and capabilities. Undisturbed by foreign influence, they were slowly developing to a higher stage of civilization—a condition of greater good for a larger number. In the sixteenth century there was every indication of an increasing population and an advancing intellectual state. The mixed population to-day of the valley of Anahuac is but a fraction of the numbers who opposed the arms of Cortes. The Spaniards and the Aztecs were too unlike to be brought

* "Intellectual Development of Europe," vol. i, p. 255.

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harmoniously into one society. The government and customs of neither were suited to both. Forced together as they were, there could only result a struggle for supremacy, and the gradual assimilation of the more yielding characters of each. Passions and vices were earlier the habits of mankind than reason and virtues: the former were, therefore, the more constant, the latter the more readily destroyed. The mental characters and customs were more alike also among primitive than among advanced societies, and would more readily assimilate. So we find, for many generations after the union, that the new society is lower in the scale of civilization than were either of the parts which composed it.

Now, after three and a half centuries, the conflicting elements have been so far eliminated, and the remaining parts have become so far assimilated, that the society consists of a people who are of an increasing homogeneity, and which represents a civilization that has been reared upon an Aztec foundation, with a Spanish superstructure.

If, however, these general principles be admitted—that societies by mingling produce a new society having the characteristics of each of its parts, and the persistence of the characters of the respective parts are controlled by laws, the operation of which may be approximately determined by a knowledge of the several societies—it may still be objected that the application of the principles to the influence of the Chinese in the United States would lead to a conclusion favorable to their immigration. Why, it may be asked, is not the civilization of the Chinese one which would affect ours for the better? With an antiquity which fades away in the prehistoric past, it still exists with the apparent vigor of youth, and controls under one government a larger population than has existed in any nation which history mentions. Why are not its antiquity and success an exemplification of the survival of the fittest? We have received from the Chinese silk, tea, and paper; and by the invention of gunpowder and printing they have added to those great agents of civilization, the sword and the pen, a thousand-fold. We have been told that the dream of the Western political reformer was long since realized among this people whom we teach our children to call semi-civilized; that government offices, from the highest to the lowest, the most prized honors and social position, are all based upon an educational qualification. By the adoption of the Chinese system England, and, following her, the United States, are endeavoring to advance the efficiency and to raise the moral and intellectual standard of their civil services. For these and many other products of the civilization of the Chinese they must always command the respect of Christendom. Is not, then, the conclusion justified that, if we have heretofore profited so much from our slight knowledge of that people, we may be indefinitely benefited by their absorption into our body politic?

A reply to these objections can only properly be made by such a

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review of the history and institutions of the Chinese as will indicate the genius of their civilization.

In that period of the existence of the human species when all races were occupied with the common struggle with the elements and with their four-footed rivals, the ancestors of the Aryan and Mongolian, perhaps, possessed no distinguishing characters. If they have descended from a common stock, they separated at a period before the present races of the world had yet become differentiated. There is no evidence which indicates a later connection between our race and the Chinese. Language, the most certain guide to prehistoric history, affords decided testimony to this conclusion. The study of the Aryan family of languages has shown that the complicated forms our words now have in their divisions into parts of speech, in their inflections, in their prefixes and suffixes qualifying the roots, and in the general prevalence of polysyllabic words, are but a development from a form of language in which all words were simple sounds for simple things or thoughts—were monosyllabic.

Long before our Aryan ancestors left their early home in Central Asia and commenced their great Western emigration, our language had passed out of the monosyllabic stage. But the Chinese may be said still to retain its simple monosyllabic form; from which fact it has been thought by some to be "the primitive language." Whitney tells us that "it is a language which possesses neither inflections nor parts of speech, and it has changed less in four thousand years than most others in four hundred, or than many another in a single century. . . . It is, in certain respects of fundamental importance, the most rudimentary and scanty of all known languages."*

The testimony thus afforded by these languages proves, beyond a doubt, that the Aryan race could have had no union with the ancestors of the Chinese later than that remote past when our language was in a like state of monosyllabic simplicity. From that remote time, when the savage ancestors of our race shaped their rude weapons of stone, the Chinese have been developing upon one small portion of the earth—we have spread over much of the rest. They have been comparatively isolated, and their growth has been therefore more homogeneous, constant, and persistent in one type. From the earliest time to the present, the same people, guided by the same impulses and controlled by the same surroundings, have developed in an unbroken course.

As some of the characteristics of families of languages are found to be less variable than many of the physical characteristics of races, the former is a better guide in classifying the human races than the latter. A comparison of the language of the Indo-European peoples with the language of the Chinese affords the strongest reason for classifying them as different races. This conclusion receives constant

* "Language and the Study of Language," p. 334.

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corroboration upon an examination of the civilization of the Chinese, the genius of which is forcibly illustrated in their government and religion.

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The family is the first social aggregate, and the natural head of the family is the head of the primitive society. As families unite together for common interests in defense or attack, one of the heads of the family is chosen as leader of the tribe. A similar union of tribes forms a nation. The paternal form of government thus naturally becomes the form common among early societies. Particularly is this likely to be the form adopted by those tribes whose instincts and surroundings early lead them to an agricultural life. With these the head is not chosen for his bravery and success in arms—which are lessened instead of being increased by his increasing age—but he is chosen rather for his counsel and advice, to which age but adds wisdom and authority.

Early superstitions and religious beliefs receive their form from the same model of the family. The simple interpretation of dreams and various experiences lead the uncivilized man to a belief in the existence of an accompanying spirit, or a double existence. When he calls out among the hills, an answering voice calls back; and, while gazing into the placid waters of the lake, he sees a shadowy image of himself. Thus to him death is but the separation of the body and the spirit; though the spirit still hovers around its former dwelling-place, and retains an interest in the affairs of its former companions. The father, who was the absolute ruler of the family while living, thus carries his authority beyond the grave. At the funeral, as at festivals, food is offered to his spirit; and his favor is solicited and enmity propitiated by offerings and sacrifices. As the spirit of the father becomes the tutelary deity of the family, the spirit of the chief becomes the tutelary deity of the tribe, and the spirit of the king receives the worship of the nation.

This primitive form of religion and government, originating in the smallest social aggregate, is to-day represented in the oldest and largest society upon the earth. The Emperor of the Chinese is the father of four hundred million people; and their universal religion—whatever other forms are observed with it—is ancestor-worship.

The government still maintains its ancient simple paternal form, with only those changes which have been necessary in adapting the family code to so vast a nation. Descending from the imperial throne, the whole government is found to be formed upon the same plan, repeated over and over. The viceroy of a province, the governor of a city, the elder of a village, and the father of a family, are each based upon the extension of the last. This relationship finds recognition in the "Ta Hioh," one of the four classic books of the Chinese, which is summed up as tending to "the improvement of one's self, the regulation of a family, the government of a state, and the rule of an em-

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pire." * The paternal idea is strengthened by education, from the commencement as children to the attainment of the highest literary degrees conferred upon mandarins. In the "Classic of Three Characters," one of four small tracts that are placed in the hands of Chinese children, they are taught that "filial piety and a due regard to elders we consider as holding the first place, the acquisition of knowledge we rank in a secondary place." † Again, in one of those canonical works which form the basis of Chinese education, religion, and government, the opinions of Confucius are recorded upon the same subject. Being asked "whether in the virtue of the sages there was not something greater than filial piety," he replied: "Of all (creatures with their different) natures produced by heaven and earth, man is the noblest. Of all of the actions of man there is none greater than filial piety. In filial piety there is nothing greater than the reverential awe of one's father. In the reverential awe shown to one's father there is nothing greater than making him the correlate of Heaven. ‡ There is in all of their institutions a recognition of the paternal model; it is constantly recited, in their religious worship, in their state ceremonies, in their education, and in their literature. Sir John Davis says: "There is nothing more remarkable in their ritual and in their criminal code than the exact parallel which is studiously kept up between the relations in which every person stands to his own parents and to the Emperor. For similar offenses against both he suffers similar punishments; at the death of both he mourns the same time and goes the same period unshaven; and both possess nearly the same power over his person." *

The genius of the Chinese civilization, which is characterized by the greatest persistence in primitive or early forms, is illustrated equally in their religion as in their government. The two are, indeed, to a great degree united. The duties which are paid by all to their parents and sovereign while living, are continued in their worship after death. As this has been taught by the sages, and forms the foundation of the government, it is allowed by the teachers to be consistent with all forms of faith. Ancestor-worship has thus become the universal religion, to which all newer forms have adapted themselves. All forms of faith are at least tolerated, so long as no organization is affected, or no doctrines taught which are considered dangerous by their strength, or opposed by their influence to the political power. And the strict interference with any attempt by religious societies to usurp any temporal authority has conduced to that common toleration and individual independence of belief which make it possible to accept the not inconsistent parts of various creeds. We are

* Williams's "Middle Kingdom," vol. i, p. 516.
† Morrison's "Horæ Sinicæ," p. 7.
‡ Legge, "Sacred Books of China," "Hsiao King," p. 476.
* Davis's "China," vol. i, p. 24.

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not surprised, then, to read the statement of the Abbé Huc that "the whole nation has proclaimed this famous formula, with which everybody is satisfied—the three religions are one. Thus, all the Chinese are at the same time partisans of Confucius, Lao-tze, and Buddha." * The institutions and faith which were handed down by Confucius have been embraced by the Taoists, Buddhists, Mohammedans, and Christians, in turn. And it may reasonably be asserted that any form of religion which hopes to prevail in China must permit the practice and belief of their popular superstitions. In the seventeenth century, the Catholic Church was flourishing in China, and made—nominally, at least—many converts. As it grew stronger, however, it became less tolerant of these native ceremonies which it had at first allowed. This produced an immediate discussion between the Emperor and the priests. The matter was referred to the Pope, and Clement XI settled the dispute, and his cause, by decreeing that the Chinese ceremonies should not be permitted the proselytes. The Emperor thereupon banished the missionaries, and upward of one hundred thousand souls were lost to the Church.

This remarkable preservation of the most primitive form of government and religion, in so vast and ancient a nation, well illustrates the law of heredity—that characters which have been long transmitted are more persistent than those of more recent origin. All newer forms have yielded to those ancient institutions and beliefs which originated before their civilization, and, aided by unchanged surroundings, have been developed in a nation composed of a homogeneous people and transmitted by inheritance to the present time.

The practical arts of the Chinese, which have added to the comforts and luxuries of the Western nations, from the time of the Greeks to the present day, will appear, upon consideration, to be unchanged in their effects upon our society, either in the event of an entire exclusion or an unlimited immigration of the people. It would be difficult to imagine a nation, existing for forty-five centuries, having any claim to being called civilized, which had not made many useful discoveries and inventions. This would be still more difficult to understand of a people like the Chinese, whose instincts have always directed them in the paths of peace. So we find that, in the course of centuries, they have made no mean progress in the useful arts, however slow that progress may have been. The Western nations seem to have derived their early knowledge of many useful inventions from the Chinese; among these, not the least important are those mighty engines of civilization—gunpowder, paper, and printing. The history of these inventions, however, but adds another illustration to the different characters of the civilizations of China and Christendom. It shows, equally, their continued adherence to old knowledge, with no disposition to improvement; and our inventive and progressive genius, in

* "Chinese Empire," vol. ii, p. 98.

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improving to the highest degree those suggestions which we have received from them.

As they have taught us many useful arts in the past, it is not improbable that we may learn from them still others in the future. But inventions may be adopted by those who wish them; customs are acquired by contact with those who practice them. Arts may be learned from a distance, or by the casual contact of travel, with equal certainty and greater safety than by a union of the societies. Inventions and arts are regulated in their distribution, rather as commerce is, by the laws of supply and demand, than by the involuntary influence of social contact.

The most complete account of the customs and institutions of the Chinese would but add to the testimony here presented of the wonderfully conservative character of their civilization. The development of a society from a single race, under one government, with constantly similar surroundings and but little subject to the influence of foreign races or nations, has produced a homogeneous society, which is constant in the repetition, for generation after generation, of the characters which marked it at its commencement.

The nations of the West, on the other hand, have developed, with ever-varying surroundings, and under the influence of various nations and races. We have our language from India, our alphabet from Phœnicia, and our religion from Israel. Our civilization bears the impress of the various peoples who have spread around the Mediterranean Sea, from the builders of the pyramids of Egypt to the Moorish philosophers of Cordova.

In government, the Chinese have always been well content with a monarchy; with the Aryan nations there has been an ever-increasing tendency to democracy. This difference of civilizations is made intelligible only by that theory which is an explanation also of the physical varieties of races. It is the effect of development through ages, under the influence of different environments. There is more than an analogy between this development of the civilization and the physical characters of a race. It is the same relation that exists between the mind and the brain; they can not be separated. The mental characters which determine the genius of a civilization are thus but a manifestation of the physical organization of the individuals composing the society. The characters of the civilization and of the physical organization must, therefore, be controlled by the operation of the same laws. A change in one is the cause or the effect of a change in the other.

The application of the law of heredity, that older characters are more constant than those of later development, we find is exemplified in the unparalleled persistence of the ancient habits and institutions of the Chinese; and to such a degree is this extended, that it seems an illustration of that persistence of characters, once beneficial, after

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they have become injurious. The paternal system, which in a small and rude society was of the greatest benefit, is now so strongly inherent in the Chinese character as to be an injury to society by retarding its development; and perhaps, also, by preventing the introduction of Western knowledge and arts.

That vital relation which exists between the mind and the body would of itself lead us to expect the operation of the same general laws in social development which control the evolution of organisms. We are led to the same conclusion by an examination of the history of the past and by the social condition of the present. Their operation in the future follows as a necessary corollary. The union of the civilizations of China and America, which differ as their races differ, would produce a society with parts so fundamentally antagonistic that permanent national existence—for which homogeneity is necessary—would be impossible. Assimilation could be effected only by the gradual and slow change of the more yielding characters of each. In the involuntary conflict ensuing, those characters which originated before the dawn of an ancient history, and have been strengthened through the inheritance of unnumbered generations, would persist with greater force than those new and changing characters which seem by comparison like the fashions of a season. The manners and customs which were described by the Arabs in the ninth century the same as they are by the travelers in the nineteenth century would be little affected by the changing forms of the society around them. The new society would assume more the character of its persistent than of its more yielding part. Intense conservatism would check the progress of reform and improvement. That liberty of personal thought and action, the assertion and exercise of which have secured the freedom and independence of governmental or religious control we now enjoy, would receive a severe shock, were our society composed in part of a people whose first and highest duty has always been to obey and depend implicitly upon an authority, and who have no word for liberty in their language.*

If the further development of our civilization is to be desired, it must be guarded from the retarding influence of a different race. If our institutions and governmental principles are worthy of preservation, they must be protected from a people who represent in all the instincts of their nature different feelings and forms. If we ignore the plain teachings of history upon the effect of the mingling of societies composed of different races, or having different civilizations, and, as is commonly the case with individuals, will learn only from our own experience, the experience is likely to come too late for us to profit by it.

The permanence of a civilization and of a nation depends upon their homogeneity. The Chinese present their uniform and unparalleled

* Williams, "The Middle Kingdom," vol. i, p. 321.

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record of centuries as having escaped the influence of great or frequent immigrations, while the short-lived nations of the West have been repeatedly changed or destroyed by the admixture of foreign elements. The laws which have controlled the destinies of nations in the past are still in operation; as the Preacher has said, "That which has been done is that which will be done, and there is no new thing under the sun."

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THE SCHOLASTIC PRELUDE TO MODERN SCIENCE.*

By HENRY DUNCAN MACLEOD, M. A.

IN the latter half of the sixteenth century a wondrous change came over the spirit of the nation which then held the foremost place in culture and civilization.

After twelve centuries of existence, the Niobe of nations had fulfilled her destiny. By the middle of the fifth century her empire, which had extended from the Euphrates to the Tagus, and from the Forth to the cataracts of the Nile, had seen province after province rent away from her, and had shrunk within the limits of Italy. Rome, which had not seen a foreign foe for seven centuries, had been four times sacked by the barbarians. The free yeomen of the bright days of the republic had perished in the civil wars. The land was parceled out among a small number of gigantic proprietors, and cultivated exclusively by slaves. Tillage had nearly ceased, and all the supplies of corn came from the provinces. With the loss of these the supplies failed, and the population was reduced to the lowest depths of misery. War, pestilence, and famine desolated whole provinces. The army was a host of mercenary barbarians. In 476 they peremptorily demanded that one third of the lands of Italy should be divided among them. The youthful Emperor had the spirit to refuse this demand, and took refuge in Pavia, where he was immediately besieged: the town was captured and pillaged: and the Emperor laid down his uneasy crown. The Senate ignominiously surrendered the vacant authority to the Emperor of the East; and Odoacer, the military commander, reigned in Italy. One third of the lands was immediately confiscated and divided among the successful mutineers.

Sixteen years afterward, a new swarm of barbarians under Theodoric conquered the country and effected new confiscations and settlements; and for thirty years the land enjoyed peace and prosperity under the reign of the wise Theodoric. But in 568, Alboin, King of the Lombards, introduced a new host, and founded a dynasty which

* Abstracted from Macleod's "Elements of Economics," Book I, "History of Economics." D. Appleton & Co.

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lasted two centuries, until overthrown by Charlemagne and the Franks; and they again were succeeded by the Germans, in 962, under Otho the Great.

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Thus, during the space of five centuries, Italy was overrun by five successive hosts of invaders: but, with great sagacity, they left the Roman municipal institutions untouched: so that while the forms remained the population was almost entirely renewed. Moreover, the invaders on all occasions favored emancipation, so that by the eleventh century slavery had died out, and the land was once more inhabited by a free people.

Thus, after the gestation of five centuries, the conquering races and the conquered had become amalgamated into one people, and a new nation arose which exhibited such a transformation as had never before been exhibited in the history of the world. The land which had been held by the most prosaic and unimaginative of nations became the mother of all the arts and of all the sciences.

The cities of Italy, enjoying peace and settled government under the Germanic emperors, rapidly progressed in prosperity and wealth, and began to extend their commerce throughout Europe, and became habituated to self-government under the decaying house of Franconia.

But when the Hohenstaufens, a more energetic race, succeeded, Frederick Barbarossa, one of the ablest sovereigns of the middle ages, attempted to reimpose upon them the yoke of the empire. The Lombard cities took up arms in their own defense. Barbarossa was at first successful: he captured Milan and razed it to the ground. But he was finally vanquished in 1176, on the field of Legnano; and Italy became all but nominally independent.

The energies of the people being thus aroused, soon developed themselves in every direction. First architecture, then sculpture, then painting, then poesy, was called into existence; and, during the space of four centuries, Italy produced such a galaxy of illustrious names in the arts as no other country can boast. The powers of Nature seemed to culminate in Michael Angelo, and then decayed.

The day that Michael Angelo died, Galileo was born.

At the same time the study of jurisprudence revived. The great Code of Justinian had been published during a short period while Italy was reunited to the Eastern Empire, and then Justinian caused his code to be adopted throughout the whole empire. But the original Latin soon fell into desuetude in the East, and was superseded by Greek compilations; and was finally set aside by the revised code called the Basilica, published in Greek in the ninth century.

In the troubled state of Italy the study of jurisprudence was naturally much neglected. Each separate race of invaders had its own code of laws—founded, however, on preceding Roman codes; and every nationality was allowed to follow its own laws. Consequently, though the Code of Justinian never ceased to exist, its effects were

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much weakened. At the beginning of the twelfth century a great school of law was founded by Pepo and Irnerius at Bologna, and for two centuries produced an illustrious line of jurists, to which students flocked from all parts of Europe.

But the most remarkable and original product of the middle ages was the Scholastic Philosophy; and, as the Baconian philosophy was the reaction against it, it is necessary to give a brief outline of it.

Socrates was the first to perceive that all systematic reasoning in science and philosophy must be based upon general concepts, ideas, or definitions of terms. The dialogues of Plato are full of discussions on the meanings of terms—the Good, the Beautiful, the Holy, the Just, and numerous others. If any action was said to be holy or just, it was first of all necessary to define the holy, or the just. Thus the Platonic dialogues are full of inductive reasonings as to fundamental concepts. Now, when a certain moral concept is formed in the mind, it does not by any means follow that it should be realized in any actual person, nor that it should be seen in any action. It is quite possible to form a mental concept of the holy or the just, without there being any holy or just person, or any one doing a holy or just action.

From this it followed that general concepts might have an actual and real existence without being embodied in any concrete form. Plato argued by analogy from the moral to the physical world. He held that all nature was framed in accordance with certain ideas, or notions existing in the Divine mind, which were quite independent of any particulars. Thus, there was an idea or notion of a man, horse, etc., before there was any actual man or horse—though he was rather staggered at the notion of there being eternal ideas of mud, hair, dirt, etc. Thus, besides the world of spiritual existences, Plato held that there is also a distinct world of invisible, self-existent, eternal, and unchangeable ideas. These, with some variations, were the doctrines which were called *realism* in the middle ages. Aristotle, the disciple of Plato, combated these doctrines in several of his works. He maintained that these universals, as they were called, could not be separated from their particulars: he denied that universals could have a separate reality from the particulars. Hence the universals were mere names for certain particulars. This, somewhat modified, was termed *nominalism* in the middle ages.

The Greeks were the first to discover that there is an innate power of discerning *truth* in the human mind; and that there is a science of truth, which can be reduced to a systematic form. This science is termed *logic*. Zeno, of Elea, was the first to employ this science, to prove the fallacy of the arguments of his opponents. It was much used by Socrates and Plato in their discussions and dialogues; but Aristotle was the first to reduce it to a systematic form. He first showed that all error can be exposed and all truth set forth in a systematic form.

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Logic or dialectic, therefore, in the hands of Aristotle was a mere method of testing the truth of philosophical systems: he never supposed that syllogism could be applied to the discovery of the truths of physics. Both he and Plato foreshadowed and adopted the inductive method for the discovery of truth; in which, however, he was not very successful.

The scholastic philosophy of the middle ages was the attempt to combine the idealism of Plato with the logic and dialectics of Aristotle: but, unfortunately, it attempted to apply the syllogistic method to the discovery of truth.

When Christianity became known to philosophers, the Platonists perceived that there was much in it in accordance with their system. They were the first of philosophers to adopt it, and they endeavored to combine it with their own philosophy.

As the general intellect decayed in the decadence of the Western Empire, all originality vanished. The highest literature fell into oblivion. Theology was taught from books; and consequently writers confined themselves exclusively to commenting on the usual text-books. St. Augustine and some of the Latin fathers were still read; but the whole course of philosophy consisted of some parts of Aristotle's "Organon," Plato's "Timæus," and a few tracts of Cicero and Seneca. A few lessons in grammar and logic, with just enough mathematics and astronomy to calculate Easter, were the highest instruction. The age of Charlemagne was the nadir of the human intellect. Soon after him appeared the first original genius of the middle ages. Paschasius had asserted the doctrine of transubstantiation. John Scotus Erigena was employed to refute it. He was a realist and a mystic: his work marked the revival of metaphysical speculation.

About the middle of the eleventh century Berengar, Archdeacon of Tours, revived the eucharistic controversy, adopting the same side as Erigena. Berengar's doctrines, founded upon reasoning, and supported by much profane learning, greatly agitated the Church; and he was combated by Lanfranc in the name of authority, and afterward by Anselm, who endeavored to reunite the claims of reason and faith. These metaphysical controversies about the deepest mysteries of faith revived the old contests of Plato and Aristotle.

Realist views were then generally current; but about the same period Roscelin, Canon of Compiègne, strongly adopted the nominalist side. In discussing the mystery of the Trinity he gradually lapsed into tritheism. The Church was shocked and alarmed, and in 1092 he was condemned by the Council of Soissons, and obliged to leave France. The impiety which resulted from nominalism produced a reaction in favor of realism. Anselm and William of Champeaux thundered against him on the realistic side.

But a doughty champion revived the fortunes of nominalism. Abélard pointed out the absurd consequences of realism, and William

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retired from the field. Three thousand disciples carried Abélard's fame and doctrine into every country of Europe. But the rage for definition and dialectics led Abélard into the heresies of Berengar and Roscelin, and he was silenced and consigned to the cloister.

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These controversies had fairly roused the spirit of metaphysics, and several champions appeared on either side: when an unexpected discovery added tenfold fuel to the flame.

Athens had been for centuries the university of the Roman world. The narrow policy of Justinian closed her schools, and the teachers were scattered throughout the world. A learned colony had settled at Edessa on the borders of Syria and Mesopotamia, and founded a flourishing school of Greek science and philosophy. In process of time Edessa fell before the conquering Moslem. The dynasty of the Abassides came from Khorassan, where learning had long been held in honor. Almanzor, and his successor Haroun-al-Raschid, founded schools at Bagdad, and diligently sought out the monuments of Greek learning, and caused them to be translated into Arabic; and its literature was enriched by translations of the Greek works on mathematics, astronomy, mechanics, Euclid, Ptolemy, Hippocrates, Galen, Dioscorides, and especially Aristotle and the neo-Platonists.

Africa and Spain rejected the Abasside dynasty, but equally cultivated the arts and sciences. Colleges and schools were founded in every city of Spain. Magnificent libraries contained translations of all the Greek masterpieces. Thus for three centuries, while Europe was plunged into the lowest depth of barbarism, the arts and the sciences flourished in the Mohammedan world from Khorassan to the Ebro. Then arose a great series of Moslem doctors and philosophers, Alkendi, Alfarabi, Gazali, and especially Ibn-Sina, Ibn-Badja, Ibn-Thofail, and Ibn-Roshd, known to the infidels respectively as Avicenna, Avempace, Abubazer, and Averroes. These men annotated and commented upon the entire works of Aristotle.

The same spirit of inquiry agitated the Jewish world. In the eighth century the Karaites broke away from the Talmud, and asserted the right of reason to judge faith. To combat the growing heresy, the school of Sora was founded near Bagdad, and they were equally obliged to cultivate dialectics. Saadia (892–943) made a strong effort to reconcile reason and revelation.

The Jews in Spain were equally active, and the philosophy of Ibn-Gebirol (Avicebron), rejected by his own nation, convulsed the Christian schools. In the twelfth century an orthodox reaction began. Juda Hallevi denied the power of reason to judge religious mysteries. Jewish philosophy reached its highest point in Moses Maimonides.

Thus, by a curious coincidence the Jewish, the Christian, and the Mohammedan worlds were simultaneously immersed in dialectics, and agitated and convulsed by the perennial conflict between reason and faith.

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While the minds of the three great religious communities were thus distracted, some rays of Mohammedan learning penetrated into the Christian schools. A few travelers had brought back specimens from the East. The Crusades still further stimulated intercourse between the hostile creeds. Arabic versions of Aristotle were imported along with bales of merchandise into Sicily, Italy, and the south of France; and some diligent scholars translated the Arabic works of science into Latin. Raymond, Bishop of Toledo (1130–1150), caused several of the works of Avicenna, Gazali, and Alfarabi to be translated into Latin; and Michael Scot and others translated the Arabic versions of Greek works into Latin. All this mass of new literature gave an immense stimulus to metaphysical controversy. The intoxication of mind produced a flood of discussion which threatened to be fatal to orthodoxy. The first scholastics professed themselves devout sons of the Church, but the inevitable tendency of free inquiry was to lead them further and further away from orthodoxy. The doctrines of Avicenna, Averroes, and Avicebron convulsed the Christian schools; and the teaching of Aristotle seemed to lead to the plainest pantheism and materialism.

The Catholic Church was now thoroughly aroused and alarmed. It was, indeed, shaken to its foundations; and, as Aristotle seemed the original source of all these heresies, he was formally condemned by the Church in 1204, 1209, and 1215. Thus in all the three religious communities the appeal to reason was dangerous to faith; and the Aristotelian philosophy was a terror equally to orthodox Jews, to orthodox Mohammedans, and to orthodox Catholics.

The Catholic Church seemed on the very brink of destruction; the scandalous lives and the venality of the court of Rome shocked all Christendom. Every country swarmed with heretics in revolt against the tyranny of the priesthood. But the Pontiff was equal to the crisis. The Crusades had familiarized the followers of the meek and gentle Jesus with the idea that the slaughter of infidels was grateful to the Creator. And heretics were worse than infidels. Accordingly, Innocent III carried fire and sword into the fairest provinces of Christendom.

A great revolution was at hand, and the Church was saved in the very crisis of her existence. In the same year, 1206, Dominic, a Spaniard, founded an order of mendicant friars at Toulouse, and Francis, at Assisi. They were bound to devote themselves to poverty and preaching. The new orders spread with marvelous rapidity, and in a very few years all Europe was filled with them. They were devoted to the defense of Catholic dogma. Each order cultivated the most profound learning, and studied the pagan philosophers to profit by them and to confute them. The rival fraternities vied with each other in celebrated names. The Franciscans boasted Alexander de Hales; the Dominicans, Albert of Cologne, surnamed the Great.

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These two, with William of Auvergne, Bishop of Paris (1218–1248), consolidated that system called the Scholastic Philosophy, which saved Catholicism from the heretical wisdom of the Arabians.

The greatest of the three was Albert, and twenty folio volumes attest his industry. He commented on all the works of Aristotle. Albert perceived that general concepts are at the base of all philosophies. He held that they existed independently of the mind; but he did not recognize a being called Humanity independent of actual human being; nor of Animality beyond actual animals. He held that the genus is an essence which only exists in particulars, but does not depend upon them. It emanates from the mind of God. Thus humanity and all other essences are the concepts, ideas, or forms existing in the mind of God, realized in individual beings. Hence, to find the origin of the universal, it was necessary to go back to the first cause. Albert was thus a modified realist. All realities were supposed to exist as concepts of the Divine mind; and also all concepts of the Divine mind had corresponding realities.

By this means all knowledge of external nature was to be found in the concepts or ideas of the mind; and these mental abstractions were supposed to be real physical existences.

Now, theology is the creation of the human mind, and consists in abstract concepts; and these were formed into a logical system of dogmatic theology. This being granted, these great master-minds saw the prodigious use of the Aristotelian logic in forming the subject into a great scientific system. In fact, if the freedom of inquiry could be curbed, and opinion restrained to certain orthodox fundamental concepts, there was nothing like the Aristotelian logic for reducing them to systematic form. Hence the Aristotelian logic, instead of being adverse to the Church, was now its greatest defender.

The greatest of all the scholastic doctors was Thomas Aquinas, the pupil of Albert of Cologne; and his works are the very incarnation of the scholastic philosophy.

It was then supposed that theology comprehended every other science; and physics was framed in the same spirit as theology. All physical science was supposed to be founded on certain mental concepts, which were supposed to be real. But all reference to Nature herself was prohibited, as savoring of heresy, and from fear of contradicting some doctrine of theology. Aristotle's theory of matter and form was adopted—the matter being the physical substance and quality of things, and form being that which distinguishes them into different classes.

Thus all physical science was reduced to syllogisms; and it was supposed that by varying these all physical truth might be discovered. The system was therefore entirely *a priori;* it began with the highest abstractions—pure fictions of the mind—and reasoned deductively from causes to effects. By this means the idealism of Plato, together with

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the logic of Aristotle, was utilized in the service of the Church, and the union of the Church and philosophy was irresistible, and enthralled the human mind for three centuries.

Thus the logic of Aristotle, which was never intended as anything but a defense against philosophical error, was turned into a system for the discovery of truth and scientific investigation. Aristotle himself would have been the first to protest against this misuse of it. The labors of the men were prodigious, but they were utterly barren of results—as barren as the labor on the tread-mill.

HOW ANIMALS BREATHE.

By HERMAN L. FAIRCHILD.

II.

SPECIAL ORGANS OF THE FOOD-TRACT.—Another class of respiratory organs may now be distinguished, namely, those developed directly from the alimentary canal. Here belong the more highly specialized organs of the vertebrates.

AQUATIC ORGANS OF THE FOOD-TRACT.—The gills or branchiæ of fishes are analogous in position and structure to those of crabs, but are morphologically different, as they are not developed from the skin directly, but from the lining of the pharynx. A powerful heart impels the blood rapidly through the gills, while these are bathed by water-currents produced by the pumping action of the mouth; so that rapid and constant changes are effected in both the blood and the aërating water. The branchiæ are comb-like fringes of minute blood-vessels,

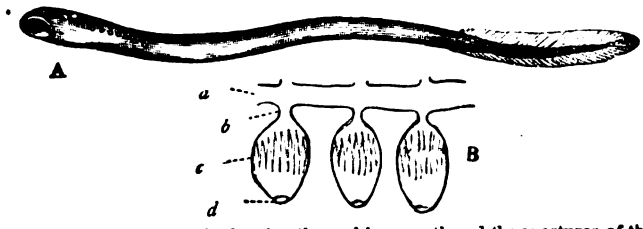


FIG. 1.—A, LAMPREY (*Petromyzon*), showing the sucking-mouth and the apertures of the gill-sacs. B, diagram to illustrate the structure of the gills in the Lamprey: *a*, pharynx; *b*, tube leading from the pharynx into one of the gill-sacs; *c*, one of the gill-sacs, showing the lining membrane thrown into folds; *d*, external opening of the gill-sac. (In reality the gill-sacs do not open directly into the pharynx, but into a common respiratory tube, which is omitted for the sake of clearness.)

placed on bony arches, having a complex structure, and beautifully adapted to their purpose of exposing a great amount of blood in small space and in brief time.

It is impracticable to describe at length the various arrangements

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of gills in the different groups of fishes. Their origin from the food-tract is clearly shown in the lowest fish, the worm-like *Amphioxus*, which has gills formed from a large, barrel-shaped pharynx pierced with transverse slits through which the water is drawn by cilia (Fig. 2, page 645 of the September, 1881, "Monthly"). This creature differs from all other known vertebrates in the possession of cilia as the means of renewing the water.

The lamprey and hag, and the shark family, have the branchiæ in separate pouches developed from and connected with the pharynx; while most common fishes possess the familiar form.

In the embryonic state, the shark has external gills—long, filamentous appendages projecting through the gill-slits. But gills of this nature have a more remarkable and enduring character in the amphibia. In the toads, frogs, and most salamanders, these external gills give place early in life to internal fish-like gills, which are, in turn, replaced by lungs. But in certain species these external organs persist throughout the life of the animal; and the group is consequently known as the *Perennibranchiata*. The *Proteus*, of Austrian caves, has three pairs of scarlet fringes on each side of its neck. In the *axolotl*, of Mexico, the six gills are somewhat arborescent; while in the *Menobranchus*, found in the United States, they are plume-like. The *Siren* of the Carolina rice-swamps is another member of this group.

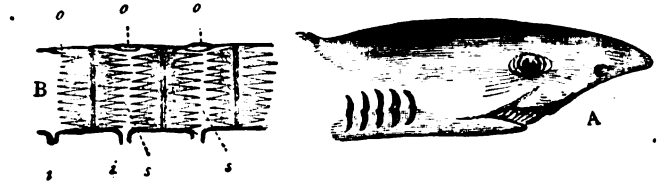


FIG. 2.—A, HEAD OF A PIKED DOG-FISH (*Spinax*), showing the transverse mouth on the under surface of the head, and the apertures of the gill-pouches. B, diagram of the structure of the gill-pouches: *o*, *o*, external apertures; *i*, *i*, apertures leading into the pharynx; *s*, *s*, gill-sacs, containing the fixed gills.

These plumose appendages upon the neck of the perennibranchiates would seem, judging simply by their appearance, to be as truly a part of the outer skin as any gills of the invertebrates. Indeed, such relation is much less apparent in the crabs and in the true snails. But, for reasons lying deeper than mere appearance, the gills of amphibians are classed with food-tract organs. However, this involves a nice distinction, since the food-tract and skin are fundamentally one.

AËRIAL ORGANS OF THE FOOD-TRACT.—Dismissing now the water-respiratory organs of the food-canal, we pass to the consideration of its special air-breathing organs.

The habit among fishes of swallowing air has already been mentioned. It is probable that in many fishes this air, or a portion of it, is simply passed through the gills, or perhaps is held in the oral cavity to aërate more highly the water that bathes the gills. However this

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may be, free air is so essential to many fishes that they die if prevented from obtaining it, especially in hot weather.

There is no organic reason why fishes could not breathe air if the gills could be kept moist and free. Indeed, there are a few fishes which even pass a great part of their lives out of water. "Such are the two genera, both belonging to the *Gobiidæ*, *Periopthalmus* and *Boleopthalmus;* these skip along close to the water-line on the seashore, where they hunt for mollusks and insects. In their branchial



FIG. 8.—EIGHT STAGES OF THE DEVELOPMENT OF THE TADPOLE, FROM THE RECENTLY HATCHED (1) TO THE ADULT FORM (8).

cavity, like all fishes, they have true gills; but these, though not differing widely from those of other fishes living constantly in the water, are far from filling up the cavity, which is rather large; and this seems to contain not merely water but air as well."* It will be seen that this respiration is analogous to that of the land-crabs. And no better illustration is needed to show the identity in principle of the two kinds of respiration, aquatic and aërial.

Another class of air-breathing fishes, of which the *Anabas scandens*, or climbing perch of India, is a famous example, have an upward extension of the branchial cavity containing complicated foldings of the skull-bones covered with mucous membrane, which remains moist either by secretion or by condensation of moisture from the air. The *Anabas* lives in ponds which are liable in times of severe drought to

* Karl Semper's "Animal Life," p. 189.

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become only mud or even entirely dry. It then travels over scorched and dusty ground in quest of water, and has been kept alive without water for six days. Tropical fresh-water fishes are commonly "able to survive droughts, living in semi-fluid mud or lying in a torpid state

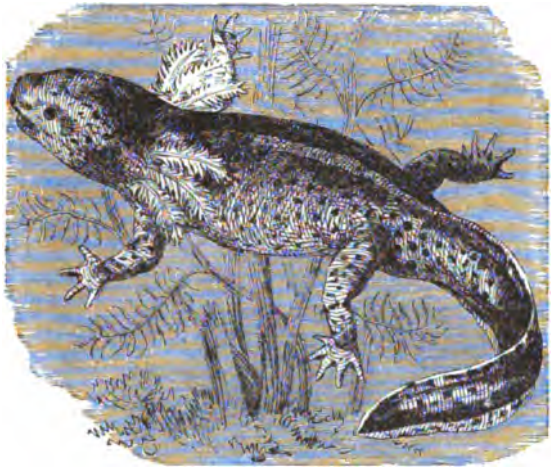


FIG. 4.—*Siredon pisciforme*, THE MEXICAN AXOLOTL.

below the hard-baked crust at the bottom of a tank, from which every drop of water has disappeared."*

The lung of vertebrates is an offset, "diverticulum," of the food-canal, and in some form is possessed by all classes of back-boned animals. In the fishes it is represented by the "swim-bladder," which is mechanical in function, serving to vary the specific gravity of the body. Yet in some species it has also a respiratory function. It is quite wanting in those fishes which, like the skate, grovel on the sea-bottom, and it is relatively large in the flying-fishes. In most adult



FIG. 5.—*Periophthalmus Koelreuteri*, a fish which pursues Onchidium—a land mollusk on the sea-shore. The large ventral fins serve for a forward leap. (After Semper.)

fishes the air-bladder is entirely closed, having no communication with any other organ; and the inclosed gas is obtained from the blood. This is largely nitrogen in fresh-water fishes, and oxygen in salt-

* Gunther's "Introduction to the Study of Fishes," p. 24.

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water fishes; but the proportion of oxygen varies at different times, and is thought to act as a reserve against a time of need. This would be indirectly a respiratory function.

Certain fishes, the pike and eel for example, have the air-bladder communicating with the stomach, while the carp and many others have it in communication with the œsophagus. In the gar-pike, a cellular air-bladder communicates with the mouth by a trachea and glottis; and the mud-fishes have the same, not only resembling thus in structure the lungs of reptiles, but performing the same function. Thus we find in the single class of fishes a progression from a closed sac of mechanical function to a double lung like that of reptiles, and the point of communication rises from the stomach to the mouth.

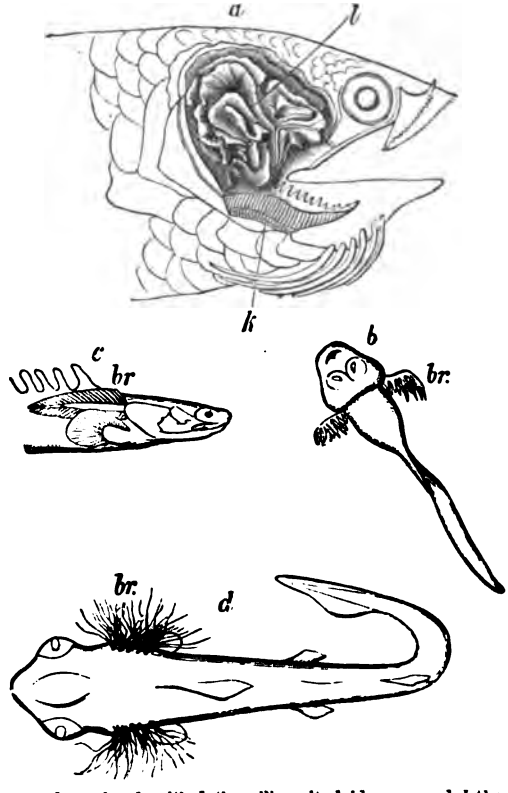


FIG. 6.—*a*, *Anabas scandens*; head, with *k* the gill-cavity laid open, and *l* the contiguous cavity containing the foliated labyrinthine structure. *b*, Tadpole; *c*, young Polypterus from the Nile; *d*, embryo of the shark. All these have external gills, *br*. (After Semper.)

All amphibians possess lungs in the adult state, but with varying degree of usefulness. Those having permanent gills may use the lungs very little, as the *Proteus* and *Menobranchus*, some of them perhaps not at all; while others, as the *Siren*, for instance, use them mainly. Other amphibians without gills may also quite dispense with the lungs,

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using the skin instead. Even the frogs and toads can long survive the removal of their lungs. Many species of this class aid respiration by swallowing air. Frogs and toads force the air into their lungs by a swallowing action, made necessary by the absence of ribs; and they can be suffocated, and turtles also, by holding their mouth open.

In the amphibians, we have a class of animals making use of four distinct means of respiration; three of them—skin, gills, and lungs—in about equal degree. It might, therefore, be supposed that their respiration should be more active and the aëration of their blood more complete than in other vertebrates. Nevertheless, quite the reverse is the truth, for the reason that any function is better performed when localized or "specialized."

This latter fact is illustrated in the reptiles, which have a circulation as incomplete as the frog, with respiration more active, although

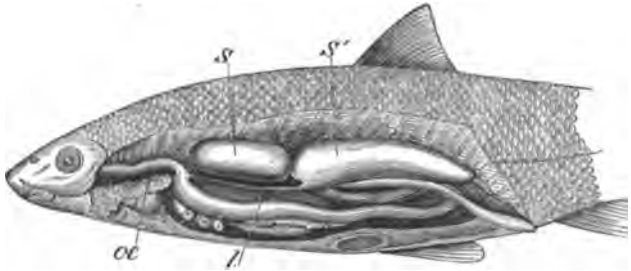


FIG. 7.—LONGITUDINAL SECTION OF A BLEAK. *s*, anterior; *s'*, posterior portion of the air-bladder; *oe*, œsophagus; *l*, air-passage of the air-bladder. (After Semper.)

possessing only lungs. These are, of course, better developed in the reptile, where they are large sacs, having the interior surface increased by foldings, producing *sacculi*. Serpents have the left lung undeveloped, the right one forming a long, cylindrical sac capable of holding a large amount of air. By this means water-snakes are rendered buoyant, and fitted for long submergence. The last fact is also true of turtles.



FIG. 8.—DIPNOI (*Lepidosiren annectens*), ONE OF THE MUD-FISHES, USING THE AIR-BLADDER AS A LUNG.

Lizards and crocodiles have two lungs, usually somewhat divided, and extending through the whole trunk. By their inflation the chameleon can give itself a plump appearance.

Reptiles have only a slight motion of the ribs, and are remarkable as a class for feebleness of respiration, considering that their lungs are

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proportionately the largest among animals. In some species the skin is quite as active as the lungs, and the latter can be removed without causing immediate death.

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The lungs of birds are less developed structurally than those of mammals, but are much larger. Connected with them in various parts of the body are air-sacs, especially in the abdomen and beneath the skin of the neck and wings. Except in water-birds, the hollow bones also contain air, and by their connection with the lungs respiration can be continued through an opening in the arm or thigh-bone, although the windpipe may be tied.

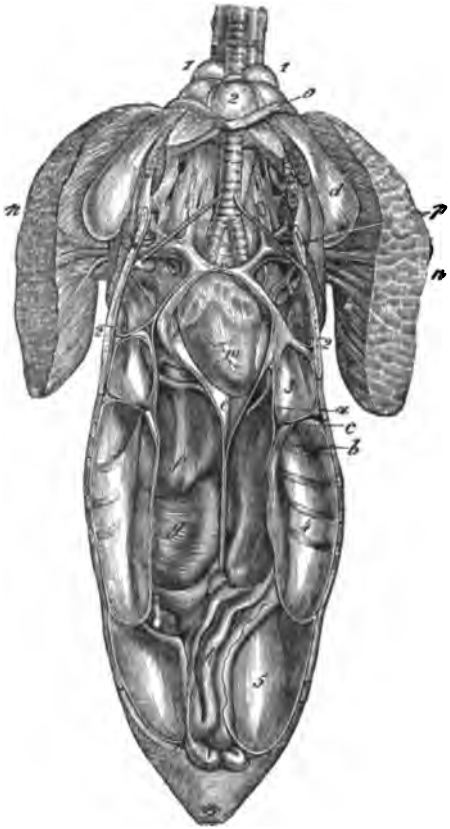


FIG. 9.—GENERAL VIEW OF THE AIR RESERVOIRS OF THE DUCK, OPENED INFERIORLY; ALSO THEIR RELATIONS WITH THE PRINCIPAL VISCERA OF THE TRUNK. 1, 1, anterior extremity of the cervical reservoirs; 2, thoracic reservoir; 3, anterior diaphragmatic reservoir; 4, posterior ditto; 5, abdominal reservoir.—*a*, membrane forming the anterior diaphragmatic reservoir; *b*, membrane forming the posterior ditto.—6, section of the thoraco-abdominal diaphragm.—*d*, subpectoral prolongation of the thoracic reservoir; *e*, pericardium; *f*, *f*, liver; *g*, gizzard; *h*, intestines; *m*, heart; *n*, *n*, section of the great pectoral muscle above its insertion into the humerus; *o*, anterior clavicle; *p*, posterior clavicle of the right side cut and turned outward. (From M. Sappey's work.)

The respiratory system is most developed in birds of powerful flight, and doubtless aids in rendering them buoyant. Perhaps the air-sacs beneath the wings assist in holding the latter outstretched; and it has been suggested that the sacs might serve as a cushion to protect those which suddenly dive into water after prey.

The blood-capillaries in the lungs of reptiles and amphibians are exposed to the air on one side only, while those of birds and mammals are arranged on a different and superior plan, being exposed on two opposite sides. Lungs of birds consist of an aggregation of distinct lobules or "lunglets." As the lungs are attached to the dorsal side of the chest, and the diaphragm is imperfect, expiration is effected by an active effort—by pulling the breast-bone nearer the spine, and so diminishing the cavity.

While reptiles can live in air too impure for mammals, birds will die in an atmosphere which to mammals is quite harmless. Birds bear

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a relation to other vertebrates similar to that of insects among the invertebrates. They lead an insect-like existence; and their rapid respiration is effected not, as in mammals, by minute partitioning and subdivision of the lungs, but, as in insects, by extension and increase in capacity. And the air-cavities in the bones and tissues bring the air, as in insects, into effective contact with the capillaries of the system.

In mammals, respiration is quite restricted to the lungs, the skin performing in man only about one fiftieth part of the work. The lungs are less in proportionate bulk than those of reptiles and birds; but the lack of capacity is compensated by the minute subdivision of the cavity, giving immensely greater surface. The active carnivores possess the largest lungs.

The ultimate cells of the human lungs are from one two-hundredth to one seventieth of an inch in diameter, and in number are about six hundred million. Mammalian lungs are always partially filled with air, and only by great pressure can the air be sufficiently expelled from the lung-tissue to allow it to sink in water. This property has given the lungs the vulgar name of "lights."

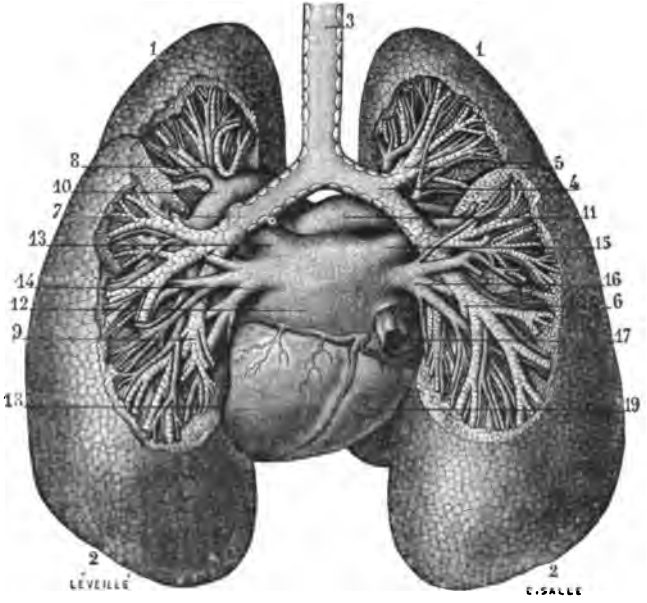


FIG. 10.—BRONCHI AND LUNGS OF MAN. (Sappey.) 1, 1, summit of the lungs; 2, 2, base of the lungs; 3, trachea; 4, right bronchus; 5, division to the upper lobe of the lung; 6, division to the lower lobe; 7, left bronchus; 8, division to the upper lobe; 9, division to the lower lobe; 10, left branch of the pulmonary artery; 11, right branch; 12, left auricle of the heart; 13, left superior pulmonary vein; 14, left inferior pulmonary vein; 15, right superior pulmonary vein; 16, right inferior pulmonary vein; 17, inferior vena cava; 18, left ventricle of the heart; 19, right ventricle.

That portion of the contained air which in life can not be expelled from the lungs is called *residual* air. The amount of air moved in ordinary breathing employs but a small part of the breathing capacity,

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and is termed *tidal* air. Besides the residual air which can not be expelled, the lungs ordinarily contain a large quantity which can be exhaled by a forced expiration. This is known as *reserve* air. And, in addition to these three kinds, a large quantity can be inhaled by a forced inspiration, called *complemental* air.

In this can be seen a fine adaptation to the requirements of varying circumstances; for, if the breathing of mammals were normally at the full capacity, there would remain no provision for varying the rapidity of respiration according to temperature and exercise. Moreover, the residual air gives uniformity and constancy to the respiratory change of the blood, and prevents sudden variations in the kind, amount, and temperature of the air in the lung-cells, which would be injurious to the blood and to the delicate tissues. The change of the residual air is slowly effected by the physical process of diffusion between it and the reserve air. When this purifying change is not sufficiently rapid, we are impelled to take a "deep breath," and so wholly replace the reserve air.

The relative and the absolute amounts of each of the four kinds of respiratory air in the human lungs may be tabulated thus:

Vital Capacity	Complemental air (can be inhaled by effort)...	90–110 cubic inches.
	Tidal air (moved in ordinary breathing).....	20– 30 " "
	Reserve air (can be exhaled by effort).....	90–110 " "
		200–250 cubic inches.
Residual air (can never be exhaled)		100–130 " "
Total capacity of human lungs.....		300–380 cubic inches.

The breathing-pump of mammals may be compared to a conical box with movable sides and base. By contraction of the muscles attached to and connecting the ribs, the sides of the chest are moved upward and outward; while at the same time the diaphragm, forming the arched base of the chest, is depressed or flattened by its muscular contraction. Thus the greater muscular effort in ordinary breathing is used to enlarge the cavity of the thorax or chest, producing inspiration—not, as in birds, to diminish the cavity, producing expiration. In other words, the air is forced into mammalian lungs by atmospheric pressure when, through muscular effort, the chest enlarges; and the air is expelled simply by the elastic reaction of the lungs and chest.

The lungs are freely suspended by the windpipe, and are distended by the atmospheric pressure in opposition to their elasticity. Consequently, an opening in the walls of the thorax is liable to produce suffocation, by giving the air a more direct and easy route to the vacuum of the chest than through the trachea and lungs.

A delicate membrane called the *pleura* closely invests the lungs, and is then reflected to line the cavity of the thorax. By the secretion of a serous fluid, it prevents friction, which would otherwise result from the constant movement.

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A rude apparatus to illustrate the mechanism of breathing in mammals is easily made by suspending the lungs of some small animal in a glass bell-jar closed below by an elastic membrane—a sheet of rubber, for instance—the only access for air to the interior being through the windpipe. Then the forced enlargement of the cavity, by pulling down the membrane, causes the inflation of the lungs. This apparatus is deficient in mobility of the walls.

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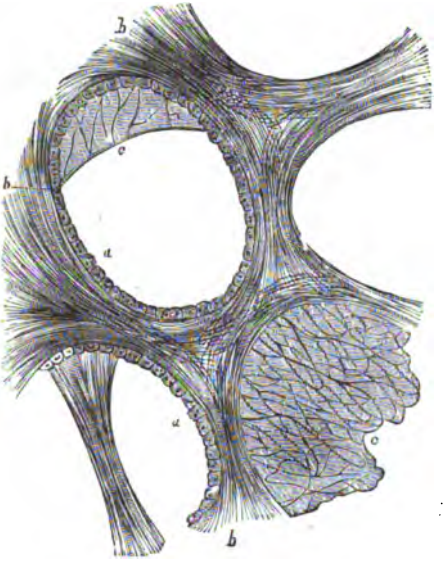


FIG. 11.—AIR-CELLS OF LUNG, WITH INTERVENING TISSUES. *a*, epithelium; *b*, elastic trabeculæ; *c*, membranous wall, with fine elastic fibers.

The rapidity of the respiratory movements in man is about one inspiration to four heart-beats, or fifteen to twenty-five per minute; greatly varying, however, according to age, sex, and circumstances. In animals with high temperature, breathing is much faster, becoming almost a tremor in birds. In the whale, on the contrary, breathing is suspended while the animal is under water; it being provided with reservoirs of pure blood. When the latter is exhausted, the creature comes to the surface and puffs and "blows" to obtain air and refill the reservoirs.

The difference in color of the blood of vertebrates is chiefly due to the varying amount of oxygen in chemical combination with the hæmoglobin of the red corpuscles—the brightness of color being proportionate to the oxygen. An essential part of the hæmoglobin is iron; and it has been supposed that the change in color is due to a chemical change from a ferrous to a ferric salt. But this simple and plausible explanation is now denied by eminent physiologists, who, however, admit that the iron has some essential but unknown influence. A

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minor cause of the darker color of the blood is the swelling of the corpuscles by absorption of carbonic acid.

The corpuscles are the oxygen-carriers, seizing the oxygen in the lungs and conveying it to the tissues, where it unites with the carbon

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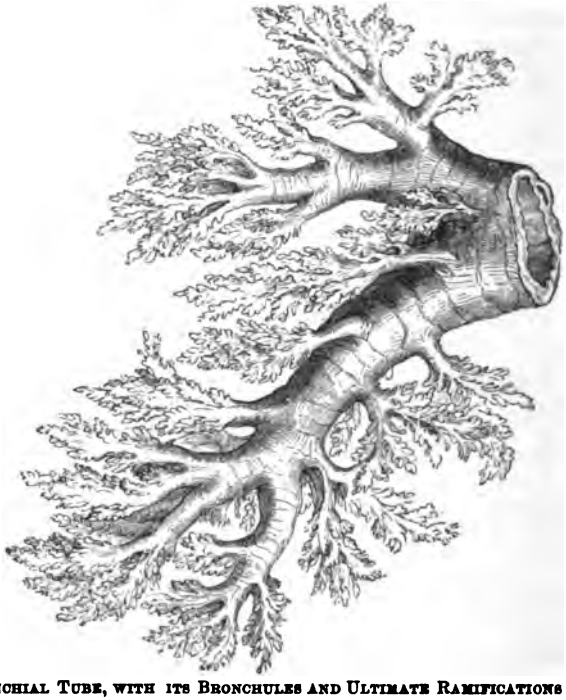


FIG. 12.—BRONCHIAL TUBE, WITH ITS BRONCHULES AND ULTIMATE RAMIFICATIONS (natural size).

and hydrogen. The corpuscles also convey carbonic acid to the lungs, but they divide this labor with the serum.

In large quantity, carbonic acid acts as a narcotic poison; for, on account of its superior attraction for the hæmoglobin, it replaces and excludes the oxygen. Other gases, as nitric oxide, have the same effect. Nitrogen, on the other hand, is entirely negative in its effect on the blood, and consequently serves to dilute the oxygen of the atmosphere, without injury to animal life.

More oxygen is inhaled than is exhaled as a component of carbonic acid. The extra amount doubtless unites with hydrogen to form a portion of the exhaled water, and to produce sulphuric and phosphoric acids.

The human lungs exhale, in twenty-four hours, about two pounds of carbonic acid. This is the product of the burning of nine ounces of carbon. As giving some idea of the forces within the body, it is interesting to know that the combustion of nine ounces of carbon liberates over six million foot-pounds of energy. This is equivalent to

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more than one eighth of a horse-power acting continuously for the twenty-four hours; or it equals one hundred and eighty-two horse-powers working for one minute.

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But the combustion of carbon does not include the total oxidation within the body; for, in less degree, hydrogen, sulphur, phosphorus, and iron, are also burned.

A large part of the energy thus produced is utilized in the unceasing labor of the circulation and the respiration. In a year the number of respirations is, in most persons, over nine million; and one hundred and twenty-five thousand cubic feet of air carried through the lungs purifies at least five thousand tons of blood. Yet, so perfect is the apparatus, that we are almost unconscious of its action, unless warned by disease, or the delicate lining of the air-tubes is irritated by some foreign matter.

HAS SCIENCE YET FOUND A NEW BASIS FOR MORALITY?

By Professor GOLDWIN SMITH.

TO ask whether Science has yet found a new basis for morality, or even to answer that question in the negative, is a widely different thing from saying that morality can not exist without religion. It is still more widely different, if possible, from imputing immoral tendencies to science. No sane being doubts that the tendency of truth of every kind is moral, or that the tendency of falsehood of every kind, if persisted in, is immoral. But we are not bound to accept at once as science everything that is tendered as such by scientific men on subjects with which, perhaps, they have not long been familiar, and at a time when the excitement created by great discoveries is sure to give birth to a certain proportion of chimeras. If we were, we should have to accept the theory of the automaton man, which has been pressed upon us by the very highest scientific authority with a confidence bordering on the despotic, and that of the "citizen atoms," which, according to Haeckel, while diffused through space, concerted among themselves the structure of the world. Nor in any case can we allow ourselves to be hurried headlong by the current of new opinion into negative any more than into positive conclusions; above all, when the abjuration of a belief involves not merely a change in treatises of philosophy, but the greatest practical consequences, such as the abolition of religion. For abolished religion ought to be, and must be, as soon as it is proved to be founded on falsehood; the proposal of freethinkers, like Renan, to keep up the system as the means of restraining the vulgar and protecting the refined enjoyments of the cultivated, being no less shallow and, in an age

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of educated artisans, impracticable than it is repugnant to morality. We may accept with admiration and gratitude Darwin's scientific discoveries without feeling ourselves obliged to draw from them inferences which the discoverer himself has not drawn. We may recognize the breaches made by science, history, and criticism in the evidences not only of Christianity, but of natural religion; we may admit with sadness that the world is at present left without any positive proof, in a producible form, of articles of belief deemed but a few years ago as indisputable as they were fundamental; yet we may decline at once to pronounce that the religious sentiment in man is devoid of meaning, and that the evidences are absolutely incapable of rational reconstruction. Doubt, frankly avowed, and coupled with a resolve under all perplexities to be patient and see what the future of inquiry may have in store, is the attitude, as I am persuaded, of many men of science in whose characters caution and reverence have a place, as well as of many thoughtful and cultivated men of the world.*

* I take this, the first available opportunity, of saying that a paper professing to be a critique of three articles of mine—two in "Macmillan" and one in the "Atlantic Monthly"—on subjects akin to that of the present paper, by Miss Louisa Bevington, which appeared in the "Fortnightly Review" of August last, was as complete a misrepresentation of the purport of those articles, of their spirit, and, above all, of the attitude of their writer toward science and scientific men, as angry prejudice could produce. The most recent of the three articles attacked had appeared in the "Atlantic Monthly" a year and nine months before this sudden outpouring of the vials of philosophic wrath, the immediate motive for which it is difficult to divine. The nature of my offense, however, is apparent enough. In her exordium Miss Bevington discloses her intention of suppressing what she is pleased to term the "noisy literature" of people like me, who accept Darwin's scientific discoveries and yet refuse, as at present advised, to draw inferences which, as has been said in the text, Darwin himself has not drawn, and which he has given us no reason for believing that he is disposed to draw. She hardly displays the spirit of the philosophy of which she is the devotee. The highly evolved ought to have patience while inferior creatures are going through the necessary stages of their evolution. I am charged with "reading evolutionism into the views of persons not commonly credited with paramount scientific authority, for the purpose of taking it out again ethically besmirched and reeking with the blood of the weaker peoples." If the charge were true, it would justify any amount of denunciation and almost any mixture of metaphors. But the passages of my three articles on which Miss Bevington founds it (and which she represents as the main purport and substance of the articles, though in truth they are of the most cursory kind and comprise in all only three or four sentences) do not relate to evolution at all: they relate to the doctrine of the moral inequality of races and their different claims to legal protection, put forth by Professor Tyndall at the time of the Jamaica affair. Professor Tyndall, not Dr. Darwin, is the "eminent man" to whom I allude, as I have thought that anybody who remembered the Jamaica controversy would have known. To the scientific doctrine of evolution I gave the frankest adhesion, acknowledging "that it was unspeakably momentous, and that great was the debt of gratitude due to its illustrious authors." This Miss Bevington does not quote, but she satisfies her sense of justice by alluding to the passage as 'certain ethical admissions favorable rather than not to the evolution hypothesis." I am incapable of such folly as ascribing immoral consequences to any genuine discovery of science. Science, in combination with historical philosophy and literary criticism, is breaking up religious beliefs; and the break-up of religious beliefs is attended, as experience seems to show, with dan-

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He must be a scientific optimist, indeed, who refuses to admit that society has come to a critical juncture. That the rule of human life may ultimately be placed on grounds wholly independent of religion is a possibility which, once more, is not here disputed, though it is reasonable to wait for the demonstration of experience. But the interval may be one of serious disturbance. To use an undignified comparison, the crustacean may be sure to get another shell, but he will be soft in the mean time. It seems impossible to question the fact that the morality of the mass of the people, at all events, has hitherto been greatly bound up with their religious belief. Ecclesiastical dogma may have had no effect on them; perhaps it has had worse than none, inasmuch as it has put forms in place of moral realities—an evil equally great

ger to popular morality. To say this, and to illustrate it historically, as I did in the "Atlantic," is a very different thing from saying that science is immoral. The inroads made, not more by science than by the other agencies and influences enumerated, on the evidences of religion have been recognized by me in the article on "The Prospect of a Moral Interregnum" with a freedom which must, I should think, have shown anybody not blinded by philosophical antipathy that it would be absurdly unjust to identify me with reactionary and obscurantist orthodoxy. My position, frankly avowed in all the articles, is that of doubt. I think I may venture to say that no one who is acquainted with me, and knows what my course has been on university questions, and questions of education generally, will deny my loyalty to genuine science. Instead of disparaging the morality of scientific men I have expressly recognized their moral superiority as a class, only pointing out that we can not reason from their case to that of the multitude. To those of the number who served on the Jamaica Committee I have paid the best tribute in my power by saying that they were "among the foremost champions of humanity on that occasion," as Miss Bevington finds herself compelled with very manifest reluctance to admit. There can be no harm in saying that the passage was inserted in the second "Macmillan" article to satisfy Mr. Herbert Spencer, who, as I learned in a conversation with him, had misconstrued, strangely as it appeared to me, a passage in the first. I assured him that I felt, and had always expressed in public and private, the greatest admiration and gratitude for the noble conduct of Mr. Huxley and others of that school in the Jamaica business, and that, if there was any possibility of misapprehension on the subject, I would take the first opportunity of removing it. In what respect I failed to fulfill my promise I am at a loss to see. I could not say that science was the main support of the movement in the country; the main support of this, as of the anti-slavery movement, Miss Bevington would have found, if she had carried her statistical researches a little further, was the Christianity of the Free Churches. What a political clergy might do from political motives could in no way affect religion. That in the case even of the men of science, a philanthropy, the offspring of the Christianity in which we have all been nurtured, was likely to be the impelling influence rather than anthropology, was an opinion for which I had my reasons, and which at all events was not offensive. In the interest of scientific truth Miss Bevington does not shrink from affecting to believe that I am assailing science when I deprecate the invasion of Afghanistan in quest of "a scientific frontier." Nor does she shrink from making up a quotation out of two passages, one of which is taken from an article in "Macmillan," the other from an article in the "Atlantic Monthly," and which, if they relate to the same controversy, do not relate to the same persons. The tone of the article in the "Fortnightly" was such as could hardly fail to act as a warning against too ready an acceptance of its statements. But anything published in so eminent a journal goes forth with some authority, and the idea that a large circle of readers might be led utterly to misconceive my feelings toward science and men of science gave me, I confess, some pain.

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whether the forms are articles in irrational creeds or outward observances. But can it be maintained that the belief in an All-seeing Eye —in infallible, inflexible, and all-powerful justice—in a sure reward for well-doing and a sure retribution for evil-doing—has been without influence on the conduct of the mass of mankind, or that its departure is likely to be attended by no consequences of importance? There are two miners, say, by themselves, and far from human eye, in the wilds of the far West: one has found a rich nugget, the other has toiled and found nothing. What hinders the man who has found nothing, if he is the stronger or the better armed, from slaying his mate as he would a buffalo, and taking the gold? Surely, in part at least, the feeling, drawn from the Christian society in which his youth was passed, that what is not seen by man is seen by God, and that, though the victim himself may be weak and defenseless, irresistible power is on his side. I say in part only; I say at present only; and, once more, I do not prejudge the question as to the possible appearance of an independent and self-sustaining morality in the future. We dwell too exclusively on the restraining principle. Who can doubt that religion has, as a matter of fact, largely impelled to virtue; that it has formed characters at once of great force and of great beneficence; that it has sustained philanthropy and social progress? Who can doubt that many good and noble works have been, and are still being performed, from love of God and from a love of man which is inspired by belief in our common relations to God? Who can doubt that heroes and reformers have been led to face peril, to risk their lives in the service of their kind, by the conviction that they were doing the Divine will, and that while they were doing it they would be in the Divine keeping? Would it be so easy even to man a life-boat if all the ideas and all the hopes which center in the village church were taken out of the seaman's heart? Go to the beach: tell the men that if they sink there will be an end for ever of them, and of their connections with those whom they love; are you sure that they will not be rather less ready to take an oar?

Hundreds of thousands have suffered death for their religion. Is it conceivable that the belief for which they died can have had no influence on their lives? Is it conceivable that the influence can have been confined to the martyrs? Is not Christendom almost coextensive with moral civilization? And does not the whole face of Christendom —do not its literature, its art, its architecture, show that religion has been its soul? So, at least, thought that eminent agnostic who pronounced the eighteen centuries of Christianity a retrogression from the happy and scientific age of Tiberius, and by that strange burst of antitheistic frenzy showed that we may have to be on our guard against a fanaticism of hostility to religion as well as against a fanaticism of religion.

The opinion of those who are confident that no moral disturbance

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is coming, but, on the contrary, a great and universal improvement in morality, might have more weight with us if we were sure that their eyes were turned in the right direction. But their observation is apt to be limited, or too much directed to the circle of scientific men around them. Scientific men are pretty sure to be above the average in point of morality; they have dedicated themselves to a high calling, they are elevated by its pursuits, they are free from the more violent passions, and removed from the coarser temptations. For the signs of change we must look rather to the scenes on which men struggle for wealth or power, and the social regions in which the common vices prevail. We must look to the multitudes, who, being now told that they have no hope beyond this world, are apparently making up their minds to have as large a share of the goods and pleasures of this world as their force will give them. Communism, intransigentism, and nihilism are not well represented in scientific reunions. They who sat round the dinner-table of Helvetius, and congratulated each other on the coming of an age of reason and happiness, were the destined victims, not the workers, of the guillotine.

Moreover, as has been said before, the intellectual world, at all events, is still in the twilight of religion. That expression is, indeed, too weak in the case of the positivists, who, not only call themselves a church, but make good their claim to the title by sermons which would do the highest honor to any pulpit, and, though they prefer the name of humanity to that of God, must be really worshiping a deity, not an abstract term, which would be as deaf to prayers or praise as a stock or a stone. An abstract term, in truth, would be rather less susceptible of adoration than that which, like a stock or a stone, has at all events a real existence. But even the man of intellect who rejects all churches and all worship has still sentiments, hopes, and a conscience formed under the influence of Christianity. The same thing is indicated by the repudiation of the name atheist, and the adoption of the strange term agnostic. Blank absence of belief or inclination either way is probably an impossible frame of mind; in nine cases out of ten, when a man calls himself an agnostic, he most likely means that he retains his belief in the existence of a God, though without being able to present the proof distinctly to himself. The very term law, which physical science continues to use, though we can physically be cognizant of nothing beyond general facts, has a theistic significance, and carries with it a certain sense of religious elevation and comfort. Small probably, as yet, is the number of those who have fairly looked in the face blind force and annihilation.

But to the present question. An heroic physician—we remember to have come across the case in some Italian history—finding that a new and mysterious plague is ravaging his city, devotes himself to the preservation of his fellow-citizens, shuts himself up with a subject, takes his observations, consigns them to writing, and, feeling the poison

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in his own veins, goes calmly to the hospital to die. On the other hand, a man, between whom and a great fortune there stands a single life, takes that life in such a way as to escape suspicion, gets possession of the fortune, and, instead of a life of drudgery to which he would otherwise have been doomed, passes his days in the healthy development of all his faculties, in the enjoyment of every pleasure, intellectual and social, as well as physical, amid the troops of friends and grateful dependents with which his hospitality and munificence surround him, and, after an existence prolonged by comfort, ease, and immunity from care, dies universally honored and lamented. Why is the first man happy, and the second miserable? Theism, on his own hypothesis, has an answer ready. What is the answer of agnostic science? We must prefix an epithet, because without it a distinction drawn between science and theism begs the question. A rational theist maintains that theism is science.

We are likely to find the answer, if anywhere, in the "Data of Ethics," by Mr. Herbert Spencer—a book belonging to a series which has earned for its author, from Darwin himself, the title of "our great philosopher"; and which every one, whether he accepts its general conclusions or not, will allow to exhibit powers of acute criticism, and to be written in a most lucid and attractive style.

Mr. Spencer commences, as might have been expected, not with humanity, but with the mollusks, and treats men simply as the last (he says the highest, but we have a *caveat* to enter against that phrase) of the evolutionary series. His tests of right and wrong in the actions of the most evolved of animals, as in the case of the least evolved, are pleasure and pain—pleasure denoting that the action is favorable, pain that it is unfavorable, to the vitality of the organism. His "supreme end" is "increased duration," together, if we understand his phraseology rightly, with increased intensity, "of life." An authoritative conscience, duty, virtue, obligation, principle, and rectitude of motive, no more enter into his definitions, or form parts of his system, than does the religious sanction. Of that which constitutes moral beauty, he has no word. Actions of a kind purely pleasant are absolutely right. The highest instance of right conduct is a mother suckling her child, because "there is at once to the mother gratification, and to the child satisfaction of appetite, a satisfaction which accompanies furtherance of life, growth, and increasing enjoyment." That the action is a mere performance of a function of nature, involving the exertion of no high quality, does not lower its place in the scale. Conduct, even the noblest and most heroic, which has any concomitant of pain or any painful consequence, is, to that extent, wrong, and the highest claim to be made for such conduct is that it is the least wrong which under the conditions is possible. We need not shrink from the hypothesis, or even commit ourselves to the rejection of it. Possibly the conclusion ultimately reached may be that man is nothing but the highest

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mammal, and in that case the hypothesis will be true. The present question is, whether it affords a new basis for morality.

Applying the tests, then, to the cases mentioned, we find that the action of the Italian physician is at least partly wrong: it gives him pain, and, instead of prolonging or intensifying, terminates his own life; it is ethically inferior to that of a Caffre woman suckling her child. On the other hand, the action of the murderer is at least partly right: to himself it is unquestionably productive of a great deal of pleasure, and, by releasing him from toil which might have been injurious to his health, it very likely prolongs his life, and certainly intensifies his enjoyment. The benefit extends to his family, and to all those who will profit by his judicious and liberal use of the wealth which comes into his hands. If the murdered man was a fool, a niggard, or a selfish voluptuary, who would have made no use of his riches or have used them ill, it really may be said that all the visible and calculable consequences of the action are good. One human life, indeed, is sacrificed, but from Mr. Spencer's point of view nothing can be said about the indefeasible sacredness of human life. Sacredness in general, and the sacredness of human life in particular, are religious conceptions, and as such have no place in his philosophy. Man may be "the highest of mammals," but is there any assignable reason why you should not put him, as well as any other inconvenient mammal, out of your way? When a stag gores his fellow-stag to death, that he may have exclusive possession of the does, we do not think that he does anything wrong, but, on the contrary, regard his action as a striking instance of the law of natural selection carried into effect through the struggle for existence. Mr. Spencer may say, and does say, that a few æons hence, by the progress of evolution, or, to use his own formula, by "our advance toward heterogeneity," matters will be so adjusted, and men will have become so sensible of altruistic pleasure, that it will be not less disagreeable to you to kill your neighbor than to be killed yourself. But the murderer, if this is pressed upon him, will say: "A few æons hence I shall be out of the way; I will do that which, as it brings me present pleasure, with increased duration and intensity of life, is, as far as I am concerned, right." It is not very apparent what answer could be made. We are in quest, be it observed, at present, not of a moral horoscope of humanity, but of motives which, by making the men of our day—not the Herbert Spencers, but the ordinary men—do good and abstain from evil, shall save the world from a moral interregnum.

Pleasure is relative to the organism. There is no such thing as a type or ideal of perfection. This also Mr. Spencer lays down with the same distinctness with which he lays it down that pleasure and pain are the sole and universal tests of right and wrong in conduct. The master will perhaps be somewhat startled by seeing his twofold doctrine developed under the fearless hands of one of his disciples.

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Dr. Van Buren Denslow, the author of "Modern Thinkers," is one of the Americans who, sometimes with more of mother-wit than of erudition, are grappling vigorously, and in a practical spirit, with the great problems of the age. His work is introduced with a preface by Mr. Robert Ingersoll, the foremost teacher of agnosticism on that continent. The doctor is a profound admirer of Mr. Spencer, whom he depicts, in grandiose language, as assisting in the majesty of science at the birth of worlds. But he wants to push the agnostic principle to its logical conclusion, which, according to him, is, that there is no such thing as a moral law, irrespectively of the will of the strongest:

It is generally believed to be moral to tell the truth, and immoral to lie. And yet it would be difficult to prove that Nature prefers the true to the false. Everywhere she makes the false impression first, and only after years, or thousands of years, do we become able to detect her in her lies. . . . Nature endows almost every animal with the faculty of deceit in order to aid it in escaping from the brute force of its superiors. Why, then, should not man be endowed with the faculty of lying, when it is to his interest to appear wise concerning matters of which he is ignorant? Lying is often a refuge to the weak, a stepping-stone to power, a ground of reverence toward those who live by getting credit for knowing what they do not know. No one doubts that it is right for the maternal partridge to feign lameness, a broken wing or leg, in order to conceal her young in flight, by causing the pursuer to suppose he can more easily catch her than her offspring. From whence, then, in nature, do we derive the fact that a human being may not properly tell an untruth with the same motive? Our early histories, sciences, poetries, and theologies are all false, yet they comprehend by far the major part of human thought. Priesthoods have ruled the world by deceiving our tender souls, and yet they command our most enduring reverence. Where, then, do we discover that any law of universal nature prefers truth to falsehood, any more than oxygen to nitrogen, or alkalies to salts? So habituated have we become to assume that truth-telling is a virtue, that nothing is more difficult than to tell how we came to assume it; nor is it easy of proof that it is a virtue in an unrestricted sense. What would be thought of the military strategist who made no feints, of the advertisement that contained no lie, of the business-man whose polite suavity covered no falsehood?

Inasmuch as all moral rules are in the first instance impressed by the strong, the dominant, the matured, and the successful upon the weak, the crouching, the infantile, and the servile, it would not be strange if a close analysis and a minute historical research should concur in proving that all moral rules are doctrines established by the strong for the government of the weak. It is invariably the strong who require the weak to tell the truth, and always to promote some interest of the strong. . . .

"Thou shalt not steal," is a moral precept invented by the strong, the matured, the successful, and by them impressed upon the weak, the infantile, and the failures in life's struggle, as all criminals are. For nowhere in the world has the sign ever been blazoned on the shop-doors of a successful business-man, "Closed, because the proprietor prefers crime to industry." Universal society might be pictured, for the illustration of this feature of the moral code, as consisting of two sets of swine, one of which is in the clover, and the other is out. The swine that are in the clover grunt, "Thou shalt not steal—put up the bars." The swine that are out of the clover grunt, "Did you make the clover?—let

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down the bars." "Thou shalt not steal," is a maxim impressed by property-holders upon non-property-holders. It is not only conceivable, but it is absolute verity, that a sufficient deprivation of property, and force, and delicacy of temptation, would compel every one who utters it to steal, if he could get an opportunity. In a philosophic sense, therefore, it is not a universal, but a class, law; its prevalence and obedience indicate that the property-holders rule society, which is itself an index of advance toward civilization. No one would say that, if a lion lay gorged with his excessive feast amid the scattered carcass of a deer, and a jaguar or a hyena stealthily bore away a haunch thereof, the act of the hyena was less virtuous than that of the lion. How does the case of two bushmen, between whom the same incident occurs, differ from that of the two quadrupeds? Each is doing that which tends in the highest degree to his own preservation, and it may be assumed that the party against whom the spoliation is committed is not injured at all by it. Among many savage tribes theft is taught as a virtue, and detection is punished as a crime. . . . Having control of the forces of society, the strong can always legislate, or order, or wheedle, or preach, or assume other people's money and land out of their possession into their own, by methods which are not known as stealing, since, instead of violating the law, they inspire and create the law. But, if the under dog in the social fight runs away with a bone in violation of superior force, the top dog runs after him bellowing, "Thou shalt not steal," and all the other top dogs unite in bellowing, "This is divine law, and not dog law"; the verdict of the top dog, so far as law, religion, and other forms of brute force are concerned, settles the question. But philosophy will see in this contest of antagonistic forces a mere play of opposing elements, in which larceny is an incident of social weakness and unfitness to survive, just as debility and leprosy are; and would as soon assume a divine command, "Thou shalt not break out in boils and sores," to the weakling or leper, as one of "Thou shalt not steal," to the failing struggler for subsistence. So far as the irresistible promptings of nature may be said to constitute a divine law, there are really two laws. The law to him who will be injured by stealing is, "Thou shalt not steal," meaning thereby, "Thou shalt not suffer another to steal from you." The law to him who can not survive without stealing is simply, "Thou shalt, in stealing, avoid being detected."

So the laws forbidding unchastity were framed by those who, in the earlier periods of civilization, could afford to own women, for the protection of their property rights in them, against the poor who could not. . . . We do not mean, by this course of reasoning, to imply that the strong in society can, or ought to, be governed by the weak: that is neither possible, nor, if possible, would it be any improvement. We only assert that moral precepts are largely the selfish maxims expressive of the will of the ruling forces in society, those who have health, wealth, knowledge, and power, and are designed wholly for their own protection and the maintenance of their power. They represent the view of the winning side, in the struggle for subsistence, while the true interior law of nature would represent a varying combat in which two laws would appear, viz., that known as the moral or majority law, and that known as the immoral or minority law, which commands a violation of the other.

This is strong doctrine, and the passage seemed worth extracting at length. It is curious, both as a specimen of the practical tendencies of a certain school of thought, and as a reply to the historical skepticism which refuses to believe that the teaching of the sophists really

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was what it is represented to have been by Socrates and Plato. It would also seem to be a pretty conclusive answer to those who deride the apprehension of a moral interregnum, and feel confident that society is going to sail, without interruption or disturbance of its rule of conduct, out of the zone of theistic into that of scientific morality. It appears that between one state and the other there may be an interval in which the question will be not between the moral and the immoral, but between the top and the under dog.

The Marquis of Steyne is an organism, and, like all other organisms, so long as he succeeds in maintaining himself against competing organisms, is able to make good his title to existence under the law of natural selection. He has his pleasures: they are not those of a St. Paul, or a Shakespeare, or a Wilberforce, but they are his. They make him happy, according to the only measure of happiness which he can conceive; and if he is cautious, as a sagacious voluptuary will be, they need not diminish his vitality, they may even increase it both in duration and intensity, though they may play havoc with the welfare of a number of victims and dependents. He may successively seduce a score of women without bad consequences to himself. Why is he doing wrong? In the name of what do you peremptorily summon him to return to the path of virtue? In the name of altruistic pleasure? He happens to be one of those organisms which are not capable of it. In the name of a state of society which is to come into existence long after he has moldered to dust in the family mausoleum of the Gaunts? His reply will furnish the anthropologist with a fine illustration of the faculty of facial expression. Suppose you could induce him to try a course of virtue, or of altruism, if the term is more scientific, what in his case would be the practical result? Would it not be a painful conflict between passion and conscience, or perhaps, in the terms of the evolutionary philosophy, between presented sensations on the one hand, and represented or re-represented sensations on the other? Is it not probable that he would end his days before that conflict had been brought to a close? Its fruits, however imperfect, would, of course, be both happy and precious in the estimation of theism; but in the estimation of the philosophy embodied in the "Data of Ethics," what could they be but pleasure, unquestionable pleasure, lost, and pain, pain of a very distressing kind, incurred? And so with other organisms, which, as Dr. Van Buren Denslow would say, are pursuing their peculiar and congenial though conventionally reprobated walks of life. The assassin, the robber, and the sharper have their status in nature, as well as any other members of the predatory tribes. It is possible that by the gradual triumph of industry over militarism, and the general progress of evolution, those changes which Mr. Spencer confidently predicts may be brought about. The wolf may become as the lamb, and may even in the general competition for altruistic pleasures tenderly conjure the lamb to eat him. At present he is a

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wolf—a wolf with two legs it may be, and with the other physiological attributes of the highest of the mammals—yet as much at liberty as the lowest of the mammals to gratify his appetites so long as he does not eat any one who will disagree with him.

The author of the "Data of Ethics" discusses, in three lively and interesting chapters, altruism and its relations to egoism. But Dr. Van Buren Denslow flouts all this as "theological," and wonders that his sage should have allowed himself to be so much affected by the atmosphere of modern Christianity. The doctor hits the nail hard as usual, and there seems reason to suspect that he hits it on the head. "Thou shalt love thy neighbor as thyself," is commonly cited as the precept of the Gospel. But the full commandment is, "Thou shalt love the Lord thy God with all thy heart, and thy neighbor as thyself." Supposing the theistic hypothesis to be true, and the communion of the Christian Church to represent a reality, to love one's neighbor as one's self is rational; if the two are members of each other, each in loving the other loves himself, and there is no need of any elaborate comparison or arbitration. But on any other hypothesis it seems difficult to press the claims of altrusim on an egoistic organism. You must alter the organism, or wait till it is eliminated by evolution. If a man is selfish, his pleasures will be selfish; and there, so far as we can see, according to the philosophy of the "Data of Ethics," is an end of the question.

Hear once more Dr. Van Buren Denslow:

> The unphilosophical element in Herbert Spencer's scheme is its dogmatical assumption that there is a moral law, philosophically deducible by argument from the facts of nature; that this moral law is unique and single, not dual, though all the forces of nature whose study is to lead up to the knowledge of this law are dual and not single; that while at some points it may not yet be clearly definable, yet all the facts indicate both its existence and its philosophical deducibility from nature. On this point he says, p. 282: "For reasons already pointed out, a code of perfect personal conduct can never be made definite. Many forms of life, diverging from one another in considerable degrees, may be so carried on in society as entirely to fulfill the conditions of harmonious co-operation. And if various types of men, adapted to various types of activities, may thus lead lives that are severally complete after their kinds, no specific statement of the activities universally required for personal well-being is possible. But though the particular requirements to be fulfilled for perfect individual well-being, must vary, along with variations in the material conditions of each society, certain general requirements have to be fulfilled by the individuals of all societies. . . . Perfection of individual life hence implies certain modes of action which are approximately alike in all cases, and which therefore become part of the subject-matter of ethics. That it is possible to reduce even this restricted part to scientific definiteness, can scarcely be said. But ethical requirements can here be to such extent affiliated upon physical necessities as to give them a partially scientific character. . . . That it will ever be practicable to lay down precise rules for private conduct in conformity with such requirements, may be doubted. But the function of absolute ethics in relation to private conduct will have been

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discharged when it has produced the warrant for its requirements as generally expressed [i. e., that the individual should so promote his own pleasure as not to mar the pleasure of others]; when it has shown the imperativeness of obedience to them; and when it has thus taught the need for deliberately considering whether the conduct fulfills them as well as may be."

While Spencer gives away reluctantly nearly his whole position here (for of what value is an ethical system which can shed no light on the path of private duty?), yet the small portion he retains is retained unjustly, and must be surrendered. An ethical system which boils down into an exhortation to all men to promote their own interests has no ethical quality left in it; for, as we have seen, the mere doing of that which is clearly essential to self-preservation pertains to business and not to morals; since, to have a moral quality, an act must raise the question, Is it right? which mere attention to business does not raise any more than the flight of birds, the falling of water, or the explosion of gases.

The nearest thing to an authoritative and universal rule which we get in the "Data of Ethics" is the assertion that "the life of the social organism must, as a rule, rank above the lives of its units." Supposing even that society is in any but a figurative sense an organism with a life of its own distinct from those of its members, this canon, as it stands in Mr. Spencer's pages, appears to be almost as much a dogma and as little supported by demonstration as anything in the Athanasian Creed. Prove to a man, if you can, that to enjoy his own pleasure he must avoid interfering with the pleasure of others, obtain the co-operation of his fellows, and pay a certain tribute to the interests of society. But to tell him that, where there is a question between the life or the pleasure of the social organism and his life or pleasure, the claim of the social organism must rank first, is to tell him what, we venture to think, you will not be able to prove with any arguments supplied by the "Data of Ethics," the reasoning of which, like the promptings of Nature apart from theism, point rather the other way. The chapter on the "Sociological View of Ethics" is not, at least I have not found it, the clearest in a book generally remarkable for perspicuity: but, if I do not mistake, it forecasts a diminution of the claims of society on the allegiance of the individual man, in proportion as militarism gives way to industry, and the need of protection against the violence of other social organisms becomes less.

In one remarkable passage Mr. Spencer seems practically to avow the inability of his principle to settle what have hitherto been deemed the plainest questions of morality:

> In men's wider relations frequently occur circumstances under which a decision one or other way is imperative, and yet under which not even the most sensitive conscience, helped by the clearest judgment, can decide which of the alternatives is relatively right. Two examples will suffice. . . . Here is a merchant who loses by the failure of a man indebted to him. Unless he gets help he himself will fail; and if he fails he will bring disaster not only on his family but on all who have given him credit. Even if by borrowing he is enabled to meet immediate engagements, he is not safe; for the time is one of panic, and

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others of his debtors by going to the wall may put him in further difficulties. Shall he ask a friend for a loan? On the one hand, is it not wrong forthwith to bring on himself, his family, and those who have business relations with him, the evils of his failure? On the other hand, is it not wrong to hypothecate the property of his friend, and lead him too, with his belongings and dependents, into similar risks? The loan would probably tide him over his difficulty; in which case would it not be unjust to his creditors did he refrain from asking it? Contrariwise, the loan would very possibly fail to stave off his bankruptcy; in which case is not his action in trying to obtain it practically fraudulent? Though in extreme cases it may be easy to say which course is the least wrong, how is it possible in all those medium cases where even by the keenest man of business the contingencies can not be calculated? . . . Take, again, the difficulties that not unfrequently arise from antagonism between family duties and social duties. Here is a tenant farmer whose political principles prompt him to vote in opposition to his landlord. If, being a Liberal, he votes for a Conservative, not only does he by his act say that he thinks what he does not think, but he may perhaps assist what he regards as bad legislation: his vote may by chance turn the election, and on a parliamentary division a single member may decide the fate of a measure. Even neglecting, as too improbable, such serious consequences, there is the manifest truth that, if all who hold like views with himself are similarly deterred from electoral expression of them, there must result a different balance of power and a different national policy: making it clear that only by adherence of all to their political principles can the policy he thinks right be maintained. But, now, on the other hand, how can he absolve himself from the responsibility for the evils which those depending on him may suffer if he fulfills what appears to be a peremptory public duty? Is not his duty to his children even more peremptory? Does not the family precede the state? and does not the welfare of the state depend on the welfare of the family? May he, then, take a course which, if the threats uttered are carried out, will eject him from his farm, and so cause inability, perhaps temporary, perhaps prolonged, to feed his children? The contingent evils are infinitely varied in their ratios. In one case the imperativeness of the public duty is great and the evil that may come on dependents small; in another case the political issue is of trivial moment and the possible injury which the family may suffer is great; and between these extremes there are all gradations. Further, the degrees of probability of each result, public and private, range from the nearly certain to the almost impossible. Admitting, then, that it is wrong to act in a way likely to injure the state, and admitting that it is wrong to act in a way likely to injure the family, we have to recognize the fact that in countless cases no one can decide by which of the alternative courses the least wrong is likely to be done.

In the first case nothing, according to common conceptions, could appear more certain than this, that a man has no right to borrow money under any circumstances, or for any purpose whatever, unless he is sure that he can pay, or, at least, has fully apprised the lender of the risk. In the second case, it seems equally clear that in the exercise of a public trust public duty ought to prevail over all private considerations, and that, though a man may be justified in abstaining from voting if the state fails to afford him protection against the tyranny of his landlord, he can not possibly be justified in voting

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wrong. But we can easily see how, in both cases, the philosophy of the "Data of Ethics" breaks down. It finds itself involved in a hopelessly bewildering calculation of the relative amounts of pleasure and pain attending either line of conduct in its bearing on the sensation of the agent and of other people. Whether any other philosophy capable of distinct statement holds good is, of course, a different question, as we bear in mind throughout.

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By the very method of his inquiry the author of the "Data of Ethics" is cut off from any appeal to human morality as essentially distinct from that of other animals. He is committed to the position that the conduct and ethics of man are merely an evolution of those of the mollusks. When he takes a woman suckling her child as his highest type of a right action, it is difficult to see why he might not as well have taken any other mammal. The sentence would run just as well, "Consider the relation of a healthy cow to a healthy calf. Between the two there exists a mutual dependence which is a source of pleasure to both. In yielding its natural food to the calf, the cow receives gratification, and to the calf there comes the satisfaction of appetite—a satisfaction which accompanies furtherance of life, growth, and increasing enjoyment." There is a *caveat*, as was said, to be entered against "higher" and "lower," applied to the earlier and later products of evolution; they carry with them the suggestion of a moral difference which might form a foundation for ethics. But, if the evolutionist were asked why the latter and more complex was higher than the earlier and simpler organism, we apprehend his only answer would be, that it was higher because it was later and more complex. If the pleasures of the other animals are less intense so are their pains, and from a large class of the pains which beset humanity they are altogether free. A sea-gull lives, it is said, longer than a man: it has found a sphere in which it has few enemies; it knows no care for the morrow, no moral effort, no moral conflict, no strivings after an unattainable ideal. At least it gives no sign of anything of the kind. Why is it to be dubbed lower?

Besides the list of pleasures denoting the conduciveness of the action to vitality, there may be said to be in the "Data of Ethics" a set of characteristics derived from perfection of evolution. Such are "adjustment of an action to an end," "definiteness," "exactness," "heterogeneity," "complexity," "multiformity," subordination of immediate to remote objects and of motives connected with presentative to those connected with representative and re-representative sensations, all regarded as placing the highest mammal at the top of the ascending scale; while the mollusks, with whose rudimentary ethics Mr. Spencer sets out, are at the lowest. Such, also, are the criteria stated in the terms of Mr. Spencer's special and, to common minds, mysterious theory of the movement of evolution, his "rhythms," and his perfect state of "moving equilibrium." Mr. Spencer, as he has

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eloquently avowed, thinks the first Napoleon about the greatest enemy of his kind who ever lived. Yet in which of the attributes of perfect evolution did Napoleon fall short? Were not his actions as admirably adjusted as possible to their evil ends? Was he not in the highest degree "punctual," methodical, and exact? Was any man ever more multiform in his activities or heterogeneous in the parts which he enacted? Did any man ever keep his eye more steadily fixed on remote objects or play a longer game? No one can question the vastness of his brain-power, and his historian boasts that his head was the largest and the best-formed ever submitted to the investigation of science. History can not pretend to say anything about his "rhythm," but during a considerable part of his life, at all events, he may be said to have been in moving equilibrium, for he was always on horseback, and had so loose a seat in his saddle that he rode merely by balance, and when the horse stumbled was apt to be canted over its head, though the powers of evil always preserved his neck. He is a figure to be noted by agnostics, for, though he lived before positivism, he was a perfect positivist. He had, as he tells us himself, shut all religious ideas out of his mind as hindrances to action; he had learned to discard metaphysics and philosophy altogether as the dreams of ideologues; he insisted on positive education, and he took his own propensities as the parts of his nature which were to determine his conduct without respect for any moral conventions. There is a curious *jeu d'esprit* (such, no doubt, it is) which connects, across the gulf of centuries, Bonaparte with that other great positivist before positivism, Machiavelli. It is a copy of "The Prince," supposed to have been found in the Emperor's carriage at Waterloo, with a running commentary by his hand, showing the correspondence of his own policy with Machiavellism; and the likeness is very striking.

Are not "punctuality" and whatever it denotes as much shown in keeping a guilty assignation or a rendezvous of crime as in appearing at the hour fixed for a charity meeting? Was "the adjustment of an action to its end" ever more exact, were the qualities which adjust actions to their ends ever more signally displayed, than when Ravaillac, having marked his opportunity and chosen his position well, drove the knife, which he had chosen with care and thoroughly sharpened, at a single stroke into the heart of a king whose life was the hope of the world?

Mr. Spencer, in his present work, wisely forbears touching the question of moral necessity. So far as the "Data of Ethics" is concerned, therefore, he avoids the reef marked by the wreck of the automaton man. The reasonings by which automatism is supported, it may be noted by-the-way, are simply a reproduction of those of Jonathan Edwards, who was not in quest of truth, but of a philosophic basis for his Stygian dogma, and was himself half conscious that he had reduced his own argument to an absurdity when he found himself

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logically compelled to ascribe to the All-Good the personal authorship of crimes; for, of course, it could signify nothing to the question of agency, if no new spring of action was interposed, how long the chain of mere instrumentalities might be. He was right in asserting moral causation, which is given us by consciousness, and without which the moral world would be a chaos. His fallacy lay in the assumption that moral causation was the same as physical. What has been inappropriately called free-will may be roughly defined as the difference given us by consciousness between moral and physical causation. Though it is the most certain, as well as the most momentous, fact of our being, we shall probably never succeed in precisely formulating it by any phrase that we can devise, even supposing it to be fixed, and not to be increasing, with our ascent from a lower to a higher, from a more material to a more spiritual life.

Though not a declared automatist, however, Mr. Spencer is, by virtue of his general philosophy, a necessarian. He holds that evolution, which is the order of the universe, "consists in a change from an indefinite coherent homogeneity to a definite coherent heterogeneity, through continuous differentiations and integrations." The universe may well have heaved a sigh of relief when, through the cerebration of an eminent thinker, it had been delivered of this account of itself. Yet it must be a curious universe if this is its secret. As the Yankee said of the enormously rich church with a very scanty congregation, "it must be doing the smallest business on the largest capital of any concern in this State." Man, the insect, aims at producing things which we feel to be noble, and which, according to the measure of his span, will endure; but the power of the universe does nothing but turn the homogeneous into the heterogeneous and back again through the same tread-mill round of differentiations and integrations, every round ending in the same fatal "equilibration" and total wreck of all the results of the process. The higher the fruits, the more senseless the destruction. What set the homogeneous moving in the first instance and made it become the heterogeneous? This would be the question which we should have to ask if the law were tendered as a physical explanation of the origin of the world. Why, we might also ask, is the coherent to be called the heterogeneous, and the incoherent the homogeneous? Might not the terms as well be reversed?* But it is enough here to say that the theory is mechanical necessarianism, and that as such it is scarcely reconcilable, in a scientific point of view, with the high strain of ordinary morality and the passionate denunci-

* We have always suspected that with regard to the sociological portion of Mr. Spencer's theory of evolution, and perhaps even with regard to the whole theory, a very considerable part had been played by our old friend the division of labor. Adam Smith knew the bounds of his discovery, if discovery it could be called. Though the employments of men diverge and multiply, the unifying influences of civilization generally on the members of a community are greater than the diversifying influences.

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ations of wrong which we find in such passages of Mr. Spencer's work as this:

Such a view (of the progress of altruism) will not be agreeable to those who lament the spreading disbelief in eternal damnation; nor to those who follow the apostle of brute force in thinking that because the rule of the strong hand was once good it is good for all time; nor to those whose reverence for one who told them to put up the sword is shown by using the sword to spread his doctrine among the heathens. The conception set forth would be received with contempt by that Fifeshire regiment of militia, of whom eight hundred, at the time of the Franco-German War, asked to be employed on foreign service, and left the Government to say on which side they should fight. From the ten thousand priests of the religion of love, who are silent when the nation is moved by the religion of hate, will come no sign of assent; nor from their bishops, who, far from urging the extreme precept of the master they pretend to follow, to turn the other cheek when one is smitten, vote for acting on the principle strike, lest ye be struck. Nor will any approval be felt by legislators, who, after praying to be forgiven their trespasses as they forgive the trespasses of others, forthwith decide to attack those who have not trespassed against them, and who, after a Queen's speech has "invoked the blessing of Almighty God" on their counsels, immediately provide means for committing political burglary.

This is enough to show that, whatever the writer's moral system may be, his own moral sentiment is strong. But, surely, it is a splendid inconsistency. The bishop and the Fifeshire militiamen were in certain stages of evolution, or, in other words, of progress from the homogeneous to the heterogeneous, through the necessary differentiations and integrations. The Episcopal organism in its state of comparative homogeneity could no more help being fond of converting Afghans, by killing them and burning their cottages, than a tiger can help wanting to eat the bishop, or the Buddhist sage in Mr. Arnold's "Light of Asia" can help wanting, in the immensity of his benevolence, to be eaten by the tiger. Bishop and militiamen alike will surely give their censor the crushing answer that they could not possibly be more differentiated or nearer the perfection of moving equilibrium than they are, without breaking the Spencerian law.

Another strong point, which any organism indisposed to altruism might make, is the warrant apparently given to purely selfish action by the struggle for existence. "In large measure," says Mr. Spencer, "the adjustment of acts to ends which we have been considering are components of that 'struggle for existence,' carried on both between members of the same species and between members of a different species; and, very generally, a successful adjustment made by one creature involves an unsuccessful adjustment made by another creature, either of the same kind or of a different kind. That the carnivores may live, herbivores must die; and, that its young may be reared, the young of weaker creatures must be orphaned." Why, a Borgia or a Bonaparte will ask, is the law to be confined to the case of carnivores and herbivores? Do not I equally fulfill it by making a prey of the

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herbivores of humanity, or by destroying in any way I can other carnivores who happen to stand in my way? If my acts are well adjusted to these ends, as Machiavelli says they are, why are they not good? The result will be that survival of the fittest which science proclaims to be the decree of Nature. Is it not difficult to find an answer which will not involve what Dr. Van Buren Denslow derides as theistic altruism?

The motive power to which, at bottom, Mr. Spencer's ethic mainly appeals in urging to moral effort or self-restraint, is the hope of a future social state, which in his, as in other agnostic philosophies, fills the void left by the discarded hope of a future life. Here, again, he is confronted by the logical consequences of his mechanical necessity: what must come will; we need not make any effort or forego any gratification to bring it about; the "co-operation" which he speaks of is needless, or, rather, illusory; nor is it in our power to forestall the process of evolution. Apart from this, however, the prospect of a social goal indefinitely distant, and to be attained not by the individual man, but by humanity, influences only highly educated imaginations and refined natures, if it greatly influences even these. What does Bill Sykes, what does a director of the Glasgow Bank, what does William Tweed, what does Fiske, or St. Arnaud, or St. Arnaud's employer, care about the fortunes of humanity a million years after he as an individual being has ceased to exist? What impelling force, to keep that side of the matter in view also, will such visions have with the multitudes of common people, unread in the "Philosophie Positive," on whose conscientious performance of duty society depends, and whose goodness is the salt of the earth? The philosophers of the ultra-evolutionary school put out of sight, in the scientific sweep of their social theories, two commonplace facts—individuality and death. Death some of the philosophers of the last century thought might be abolished: those of the present appear to think that, if we will all be quiet and refrain from ill-omened words, it may be hushed up. They constantly quote Spinoza's saying, that true wisdom concerns itself not with death but with life. Spinoza had inherited the creed of religious secularism, which in his active intellect took the form of pantheism—without, however, losing its essential character as a belief generated at a stage before the wisdom or the folly, as the case may be, which concerns itself with death and the life beyond death, had come into the world. But does any one seriously believe that man can now be put back into that infantine state in which he once passed his days like the other animals, without spiritual aspiration, and, like them, lay down at last to sleep without hope or fear? What a clearance of art, architecture, poetry, philosophy, and history does a return to contented and dreamless secularism imply! Yet the other part of the undertaking is even more arduous. That men should be made to feel themselves members one of another, granting the theistic hypothe-

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sis, is not absolutely impossible; it may even be said that, tremendous as the obstacles were, in a space of time very short compared with the total duration of the race, an appreciable, if not a great, progress has been made. At least, it will hardly be denied that in philanthropy the world at the present day is more advanced than it was in the reign of Tiberius. Of that, Mr. Spencer's own sentiments are proof enough. In no ancient writer is there to be found a protest like his against the oppression of the weaker races. But to get this sensible, warm motion to lose itself in a mere generalization, whether the generalization be humanity, animality—which for all that we can see has just as good a claim as humanity—or simply evolution, and to be content with the prospective welfare of this generalization instead of thinking about its own, does seem to us absolutely impossible, unless it be in the case of a very extraordinary temperament, or during the brief continuance of an artificial mood. Besides, all ends sooner or later in a physical catastrophe—in the catastrophe, according to Mr. Spencer, of equilibration; and how can it be expected that people will be animated to moral effort by the idea that they are "co-operating with evolution in producing the highest form of life," when evolution itself flings all the results of so much differentiation and integration back into homogeneity with the recklessness of a child overturning its castle of sand?

There surely goes a good deal of quasi-religious faith to the making of this evolutionary millennium. We have in effect to assume that all the agencies of progress now at work will continue in full force, notwithstanding the departure of the beliefs with which some of them have been hitherto bound up, and that no new evils will emerge. Unhappily, the last part of the assumption is contradicted by the evidence alike of the sanitary, social, and political spheres. That physical Nature will become kinder to us there seems no reason to believe. The author of the "Data of Ethics" does not promise that she will: he says that flood, fire, and storm will always furnish occasions for the display of heroism—heroism which there will no longer be any very tangible motive for displaying. On the progress of science we may count; and this is so important as to make us feel that humanity altogether has at last struck into the right path. Yet, if we shut our ears for a moment to the pæans which are being sung over telegraphs and telephones, we become conscious that, while science has been making miraculous strides, the masses have not yet made strides equally miraculous, either in character or in happiness.

Mr. Spencer seems to expect unbounded improvement from the final ascendency which he confidently anticipates of industry over war. He is no doubt aware that the distinction between the military and the industrial types of society is familiar, though his use of it as a universal key to history is new. There never can have been a purely military state of society; somebody must have produced, or there would have been nothing for the warriors to pillage; nor is the difference between

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the ancient community, in which there was a warrior caste of masters with an industrial people of slaves, and the modern community, in which there is an industrial people of citizens with a standing army of professional soldiers, though most momentous, quite so radical as Mr. Spencer assumes. The most perfect type of a purely industrial community, perhaps, is China; not a very encouraging example, as the Chinese, besides their servility, their unprogressiveness, and their total lack of political life, are untruthful, vicious in some other respects, mean, and, as their punishments show, abominably cruel. In London and our other great commercial cities the military element is trifling, even taking in the volunteers; yet of vice and unhappiness there is surely enough. Biographers at some future time, seeking in Mr. Spencer's works materials for a life of the great philosopher, will find that he evidently had experience in his own person of some of the special evils of industrialism, such as plumbers who make business for builders, and crockery-breaking servant-girls, to whom he was compelled to apply that article of his ethical code which forbids you, when your crockery is concerned, to allow your line of conduct to be decided by altruism alone. These are but trifling instances of an industrial depravity over which jeremiads innumerable have been chanted, and which in its consequences even to life is hardly less destructive than war. The final transition will also be a most critical affair. A society wholly destitute of military force and without martyr spirit, which can hardly exist apart from religion, will be at the mercy of any surviving six-shooter of the past.

In a recent number of this review there was an article by Mr. Spencer on "The Industrial Type of Society," * to which was appended a note drawing a comparison between the morality of religious communities and that of savages who have no religion. The Christian era was represented as a hideous succession of public and private atrocities, innumerable and unmeasurable, of bloody aggressive wars, ceaseless family vendettas, bandit barons and fighting bishops, massacres—political and religious—torturings and burnings, assassinations, thefts, lying, and all-pervading crimes. Nor was this description confined to the past. We were called upon to read the police reports, the criminal assize proceedings, the accounts of fraudulent bankruptcies, political burglaries, and criminal aggressions at the present day. With this picture we were invited to contrast the honesty, the truthfulness, the amiability, the mild humanity of the Bodo, the Dhimáls, the Lepchas, the Santáls, the Veddahs, the Arafuras, and the Hodas who have no notion of God nor belief in the immortality of the soul. Decisive judgment was given in favor of the savages by the philosopher, whom we can not suppose to have been indulging in mere rhetoric. But it will be allowed that the Christian nations are in general respects, and notably in everything pertaining to science, the most civilized. If in the

* "Contemporary Review," October, 1881.

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most important matter of all they have retrograded to this extent, what becomes of the hope of civilization?

Yet Mr. Spencer himself sees the promised land of evolutionary adjustment and felicity from a very advanced Pisgah. His man is a man in a suburban villa with a good business in the city, who has only to be content with a sufficient income, avoiding the moral gulf of overwork, and that of "snatching a hasty sandwich," instead of taking a regular luncheon every day. Alas! to say nothing of the myriads who in the past have lived and died in slavery and misery of all kinds, how many centuries must elapse before the question between a hasty sandwich and a regular luncheon becomes a practical one for any appreciable portion of mankind! To do too much office-work is bad for health, and therefore, as Mr. Spencer most truly says, bad in every way; but how many are there who must either do too much work or starve! It is not healthful to be on the wintry Atlantic clinging to the frozen shrouds, to pant all day beside the fiery furnace, to be delving in the dark mine, to be sitting as a cab-driver exposed to all weathers, to be toiling as a farm-laborer with overtasked sinews from dawn to dusk. Of the labor which is the lot of most men, and in which their lives are almost entirely spent, very little is, like that of the artist, relieved by any sense of enjoyment; the bulk of it is drudgery and nothing else. Schopenhauer exaggerates, of course. Were it not so, the end, in spite of his super-subtile objection to the exertion of will in self-destruction, would be universal suicide. There is happiness in life; above all, the happiness of affection, though it is in this that we most keenly feel the sting of death. Yet if this life were all, and if enjoyment were the object of being, it would be difficult to deny that the pessimist had a formidable case, or that the world, on the whole and for the majority of mankind, was a failure. It is, at least it may be, otherwise if the theistic hypothesis is true, if the secret of the universe is not mechanical but moral, if the paramount object is the formation of character, and if the results of effort are to endure, in any form whatever, beyond the physical catastrophe of the planet. Trying to be good is within the power of a galley-slave; and it is conceivable that by being ever so little better than himself the most abject of mankind may cast into the moral treasury a mite more precious in the estimation of the Author of our moral being than the effortless virtue of a born seraph. In touching upon such points we feel that the criticism which repels a physical account of morality is not merely destructive, but conserves something on which it is possible that a rational theology may hereafter be partly based.

In short, while we find, as was said before, in the "Data of Ethics" much that is acute, much that is eloquent, much that is interesting, we do not find in it a new basis of morality. We do not find a practical answer to the question which was put at the beginning. We do not find anything that, on the mass of mankind, is likely to act as

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a strong inducement or as a strong deterrent. We do not find anything that can be relied on to save society from the danger of a moral interregnum. An exaggerated interpretation is not to be put upon that phrase. Society will hold together, and the milkman will go his round. For that, daily needs, habit, human nature, the examples of China and Japan, both of which are agnostic, sufficiently answer. Society has held together during former intervals between the fall of one morality and the rise of another; but it has been in rather a sorry way. Things have righted, but before they have righted there have been times to which nobody wishes to return. The continuity of history is indisputable; yet it is not such as to preclude very terrible convulsions; and surely the doings of nihilism, which in its speculative aspect is clearly a product of the present disturbance of religious and, at the same time, of ethical beliefs, are warning enough of the existence of subterranean fires. Once more, it is not from the personal tendencies of the distinguished party which surrounds an intellectual teatable that we can gather with certainty those of the masses inflamed by fierce passions and goaded by animal wants, or even those of genius itself, like that of Napoleon, in pursuit of selfish aims. That all will be well in the end, theists, at any rate, must implicitly believe; yet the day of salvation may be distant.

"It is strange," says Mr. Spencer, "that a notion so abstract as that of perfection, or a certain ideal completeness of nature, should ever have been thought one from which a system of guidance could be evolved." Call the notion abstract, and the remark may be true. But it is certain that a personal type, or supposed type, of perfection, has furnished Christendom with guidance, with a rule of life at all events, up to this time. The sudden disappearance of that type must fill all, except the most serenely scientific minds, with misgivings as to the immediate future, it being admitted by "our great philosopher" that there is nothing to be put in its place.

There are one or two points which, though not strictly pertinent to the present inquiry, it may not be wholly beside the mark to notice. One of these relates to the theistic notion of morality, which we can not help thinking the author of the "Data" misapprehends, so far as rational theists are concerned. "Religious creeds," he says, "established and dissenting, all embody the belief that right and wrong are right and wrong simply in virtue of divine enactment." In another passage he represents the religious world as holding that "moral truths have no other origin than the will of God." There is a fallacy in the term "will." A law is not made by the will of the legislator; it is enforced by his will, but it is made by his nature, moral and intellectual, the goodness or badness of which determines its quality and the salutariness of obedience. Wise advice given by a father to his children is useful in itself, not merely because he gives it. Moreover, what a rational theist may be said to hold is simply that our moral

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nature points true to that of Him in whom we have our being ; that he is with us when we do right, against us when we do wrong ; that our well-doing moves his love, our evil-doing his aversion. There is nothing apparently more absurd in this than in believing the same thing with regard say to a friend, or even with regard to the community of which we form a part, and the good-will of which is a motive and a support of our rectitude. Nor is there any sort of necessity, so far as this belief is concerned, for entangling ourselves in a metaphysical labyrinth by going behind the divine nature and speculating on the possibility of its having been other than it is. Being is an inscrutable and overwhelming mystery : there is no more to be said.

That religion had its origin in primeval worship of the ghosts of ancestors or chiefs, and that, these ancestors or chiefs having been ferocious cannibals, we are hence enabled to account for the belief in propitiation by self-torture and the other diabolical characteristics of modern creeds, is a theory which Mr. Spencer habitually propounds as certain and almost self-evident. Scientific the theory may be, and on questions of science the utmost deference is due to its inventor's authority : that it is historical must be denied. In truth, when it appeared some of us could not help being reminded of Voltaire's prompt explanation of the fossil shells found on mountain-ranges, and adduced by ecclesiastical writers in proof of the Deluge, as cockles dropped by pilgrims from their hats. Euhemerus explained the Greek mythology in some such way, but his explanation has not been applauded. Not in the Hebrew Scriptures, not in the Rig-Veda, not in the Zendavesta, not in any of the monuments of primitive religion which philological science has been placing before us, not in any important mythology, whether Greek or of any other nation, can we find the slightest confirmation of the cannibal chieftain view. Everything seems to show that the earliest religious impressions were those made by the great powers of Nature, especially by the Sun in his glory ; and that this was the real origin of natural religion ; though, be it remembered, there must have been a religious impressibility, however rudimentary, in man, otherwise religious impressions could not have been made. As man advanced, the power seen through his moral nature became, instead of those seen with his eyes, the paramount object of his worship. There would surely be something utterly preposterous in the supposition that evangelical Christianity was a survival of the primitive worship of dead chieftains. Mr. Spencer seems to have swallowed whole Mr. Tylor's theory of animism, and to have given it an application which was not given it by its acute and learned author ; for Mr. Tylor, if I do not misunderstand him, would allow that Nature-worship was the origin of religion. The result, at all events, historians will say, is an unhistoric presentation of the most important subject in the history of opinion. In his volume on "Ceremonial Observances," Mr. Spencer maintains the surprising thesis that ceremony

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was primordial, and that politics and religion (or, to use his exact expression, political and religious control) were developed out of it by divergent evolution. His proof is the similarity of the modes in which reverence is shown to gods and to political rulers, and which, he says, denotes the kinship of the two sets of observances and their community of origin. In tracing this similarity he allows his fancy a pretty free range, as, for example, when he identifies the visit of a worshiper to a temple with a morning call paid to a great man, and the payments made for the support of a Christian clergy with sacrifices to a heathen deity. But it does not occur to him that man, being provided with only one set of organs of expression, is obliged to use them in the case of a ruler as well as in that of a god, and may do so without at all confounding in his mind the different characters and claims of the two. The abject adulation which deified the Roman emperors is a proof of this, not a contradiction; for the adulators were perfectly aware that they were giving to a man that which properly belonged to a god, and in the profanation lay the very point of the sycophancy. So with regard to the names of God, which Mr. Spencer thinks we shall be much startled by finding to have been originally descriptive words, and to have expressed superiority. Man has no celestial vocabulary. However distinct his conception of God might be from his conception of anything else, he would have to use the same words to express his reverence in this case as in that of a father or a chieftain. We do not see that the question as to the origin of religion is in any way affected by this discovery. Men speak now of the majesty of the king and the majesty of God; of the honor due to one as well as of the honor due to the other, without any confusion of ideas as to the respective natures and claims of the two beings. The most startling thing surely would have been to find a name for the Deity, unconnected with anything else in human thought or speech, a linguistic aërolite, as it were, dropped from the sky.

Mr. Spencer's view of the origin of religion is perhaps not unaffected by his extreme notion as to the importance and influence of militarism, of which he sees everywhere the malign traces. According to him, the Home Office, when it crops the head of a convict (and washes him), is unwittingly perpetuating the custom of taking trophies by cutting off the hair. When you give a man a lower seat at table, or in an assembly, the survivalist sees in the act a desire to have the force of gravity on your side in the conflict for which everybody is mentally preparing. There is something rather laughable in the idea that the high table on a dais in a college hall is a military vantage-ground from which the "don" may be able to make an onslaught on the under-graduates with the force of gravity on his side. Between sun-myths and survivals there will soon be no room left for any natural belief or action.

The twist, as many readers will deem it, extends to every subject

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connected with religion, among others to that of asceticism, at which Mr. Spencer tilts ever and anon with a good deal of vehemence, and of its connection with Christianity. Religion is represented as still imbued with the belief, derived from blood-thirsty ancestors, in a diabolical God who is to be propitiated by self-torture. Nothing of the kind is to be found in the Gospel, in the apostolic fathers, or in any form of evangelical Christianity. Jesus was denounced by his enemies for not being an ascetic. Paul lived a life of self-denial and voluntary exposure to suffering and peril; but it was not for the purpose of self-torture, it was, like his celibacy, for the purpose of propagating the Gospel, as a soldier undergoes toils and privations for the sake of victory, or a man of science for the sake of a discovery. Even the Baptist was not a self-torturer—he was a reformer preaching by austerity. Launched into the world, Christianity felt the influence of the various currents of thought and tendency—Hellenic, Roman, Alexandrian, and Oriental—nor did it escape that of the fakirism which had been generated in the mud of the Ganges. The monks of the Thebaid were fakirs, and may be left to Mr. Spencer's mercy. But so was not Benedict, or Bernard, or Anselm. Western asceticism on the whole corresponded to its name, which denotes not self-torture but self-training—the self-training of the spiritual athlete. Its central idea was that of liberating the soul from the shackles of the flesh in order to its complete union with the Deity. Chimerical it was, no doubt, and extravagant in some of its manifestations, but it was not diabolical, nor did it point to anything diabolical in the nature of the ascetic's God; and it is by no means clear that, in such a case as that of Anselm, it would not have stood Mr. Spencer's test of pleasure, though the pleasure would have been of a peculiar and perhaps fantastic kind. It was compatible with immense usefulness, social, educational, and even industrial, for monasticism in its prime was a great agricultural improver. Moreover, as alchemy helped to give birth to chemistry, asceticism may have helped, by conquering the brutish appetites which hold unlimited sway over the barbarian, to give birth to rational temperance. No portions of the "Data of Ethics" are better worth reading than those in which the writer inculcates attention to health, both for our own sakes, and for the sake of the offspring to whom our constitutions are to be transmitted; and preachers, if they wish to be practical, might do a great deal of good by dwelling oftener on the last point. But, waiving the theological form of expression, it is difficult to put the duty of caring properly for the body higher than it was put by the apostle who called the body the temple of the Holy Spirit. And though no one wishes to detract from the dignity of physiological science, or to underrate the benefits which a diffused knowledge of it might confer, it is certain that the temperance, soberness, and chastity which Christianity has labored not without effect to inculcate, are keeping unscientific people in perfect health with the cheerfulness

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which attends it, while even a thorough knowledge of physiology seems often to be of little avail for self-management.

In conclusion, I must say again that I am not here contending that theism or that Christianity is true, nor do I blink the tremendous difficulties with which at this moment the proof of both of them is beset. I stand up for history, and decline either to reject existing beliefs before they are confuted, or to accept new beliefs before they are proved. There is nothing in this inconsistent with the most grateful veneration for science, or the most perfect willingness to embrace any kind of truth. *Vincat veritas, ruat cœlum.* Only, if the catastrophe does happen, it will surely be better, with such spirit as we can summon, to confront the void, and not to try to delude our souls by putting figments in the room of that which has been lost.— *Contemporary Review.*

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FOSSIL SEEDS.*

By STANISLAS MEUNIER.

THE attention of Adolphe Brongniart was for a long time given to the silicified fossil seeds which are inclosed in the beds of Autun and Saint-Étienne. The illustrious naturalist found the study a virgin domain, and an appropriate complement to his great labors on fossil plants. Although our knowledge in this department is still very far from complete, Brongniart was able to lay the foundation of a classification of these interesting remains; and it gives us pleasure, as much in the historical point of view as in its bearing on botany, to give a succinct idea of it here.

The seeds which Brongniart examined are divided into two principal groups:

A. Seeds with a binary symmetry, more or less flattened and bicarinated. This natural group includes the genera *Cardiocarpus* (Fig. 1, 1), *Rhabdocarpus* (Fig. 1, 2), *Diplotesta*, *Sarcotaxus*, *Taxospermum*, and *Leptocaryon*, analogous to genera of the existing family of the *Taxineæ*.

B. Seeds with a symmetrical radiation around an axis, in which the number of the divisions varies from three, as in *Pachytesta*, *Trigonocarpus* (Fig. 1, 3), *Tripterospermum*, to six, as in *Ptychotesta*, *Hexapterospermum*, *Polypterospermum* (Fig. 1, 5), *Polylophospermum* or eight, as in *Eriotesta*, *Codonospermum* (Fig. 1, 6), or the section of which is circular, as in *Stephanospermum* and *Ætheotesta*. These seeds appear to represent the *Sigillariæ* and the calamites, and some genera of the cycads and conifers.

* Translated for "The Popular Science Monthly" from "La Nature."

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Before entering upon the account of his studies, Brongniart describes, in an introductory chapter, the periods of vegetation and the different floras that have succeeded each other on the earth's surface. "We may consider," he says, "as having been deposited during a same epoch of the creation of the vegetable kingdom, and as belonging to

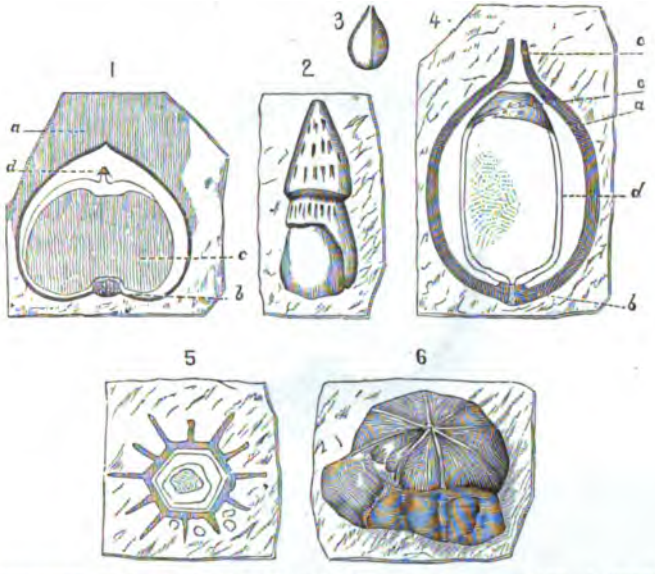


FIG. 1.—SPECIMENS OF FOSSIL SEEDS EXAMINED BY ADOLPHE BRONGNIART.—1, *Cardiocarpus drupaceus*. Section through the plane of the keel. *a*, thick testa; *b*, chalaza; *c*, kernel and albumen; *d*, micropylar extremity of the kernel (natural size). 2, *Rhabdocarpus conicus*, Grand' Eury. General form from a specimen that was broken before preparation (natural size). 3, *Trigonocarpus pusilus* (natural size). 4, longitudinal section passing through the chalaza and the micropyle (magnified five times); *a*, testa; *b*, chalaza; *c*, micropyle; *d*, kernel; *e*, cavity on the summit of the kernel, with grains of pollen. 5, *Polypterospermum Renaultii*, transverse section (natural size). 6. *Codonospermum anomolum*, external view, as it appears in the broken rock.

a same ancient flora, the different beds in which we find the same collection of species, and during the deposition of which some at least of these species have persisted from the beginning to the end of the local phenomena.

"This is what constitutes an epoch in the geological study of vegetable fossils; but several of these epochs often succeed one another, all preserving a considerable number of common characters in the nature and relative proportion of the principal families that belong to them; and this succession of analogous epochs forms a period in the history of the successive development of the vegetable kingdom."

The successive creation of different vegetable forms is thus divided into three long periods, called the reign of the Acrogens, the reign of the Gymnosperms, and the reign of the Angiosperms—"expressions indicating only the successive predominance of one or another of these three grand divisions of the vegetable kingdom, without neces-

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sarily supposing the complete exclusion of the two others." The reign of Acrogens was manifest during the Carboniferous and Permian periods; the reign of the Gymnosperms during the Vosgian and Jurassic; and the reign of the Angiosperms during the Cretaceous and Tertiary periods.

Proceeding to the study of the fossil seeds found silicified in the coal-beds of Saint-Étienne, M. Brongniart makes a comparative review

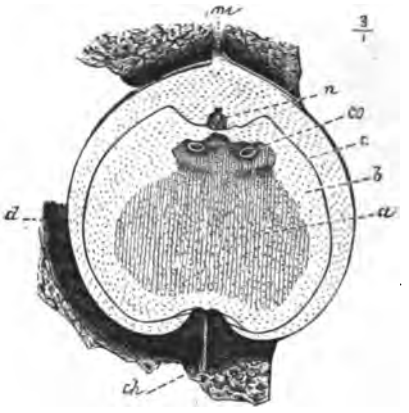


FIG. 2.—CARDIOCARPUS SCLEROTESTA, LONGITUDINAL SECTION PASSING THROUGH THE MICROPYLE, THE CHALAZA, AND THE PRINCIPAL PLANE OF THE SEED (magnified three times). *a*, albumen, well preserved, inclosed in the embryonary sac; *b*, hardly visible remains of the embryonary sac; *c*, envelope of the kernel reduced to its epidermis; *co*, the two corpuscles, placed symmetrically in the plane of the seed, below the pollinical chamber; *m*, the pollinical chamber, but slightly developed in this group of seeds; *d*, endotesta; *mi*, micropylary canal of the testa, leading to the pollinical chamber; *ch*, chalazian region of the seed.

of the structure of the seed and ovule of the cycads, and of different silicified seeds of the coal-beds, and announces one of the most remarkable discoveries in fossil botany, the value of which consists in the light which the study of fossils is made to cast upon the interior anatomy of existing forms. A singular feature was observed in the organization of a considerable number of these seeds, in that there existed, near the summit of the kernel, and in the corresponding part of the micropyle of the testa (or outer integument), a cavity in the cellular tissue, containing nearly always granules or free vesicles, which could only be regarded as grains of pollen; and from the presence of which M. Brongniart was led to designate the cavity as the pollinical chamber. Nothing of the kind is known in existing gymnosperms. The cycads, however, had been previously indicated as presenting analogies with the Palæozoic plants under study; and M. Brongniart's views upon this point have received a striking confirmation from the observations of the gardener of the museum and of M. Renault. The published volume of the "Lectures on Fossil Botany" of the latter gentleman contains a carefully copied plate, showing a similar pollinical chamber in the *Ceratozamia Mexicana*. Figs. 2 and 3 show the grains very plainly in *Cardio carpus sclerotesta*.

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The work, of which we have given a brief summary, "Recherches sur les Graines Fossiles Silicifiées," consists of twenty-one plates, giving accurate and exactly colored representations of the seeds examined, with careful explanations. The completion of the text was interrupted

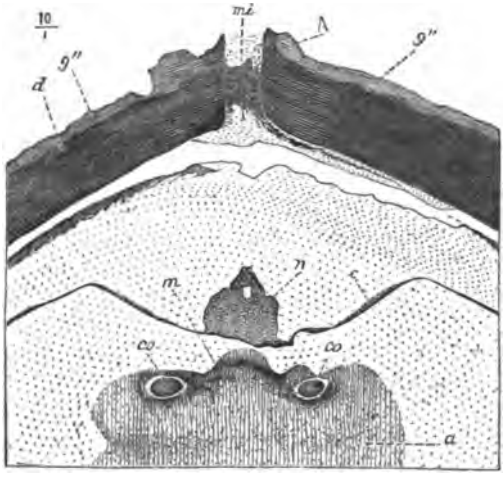


FIG. 3.—PART OF THE PRECEDING FIGURE, MAGNIFIED TEN TIMES.

by the death of the author, but the plates are finished, the details in them that were left lacking having been supplied by M. Renault, after comparison with the identical specimens. The whole work, in its present form, constitutes a real monument erected by pious hands to the memory of the illustrious founder of the science of fossil botany.

THE UNAWEEP CAÑON.

BY HENRY GANNETT.

OF all the physical features of the earth, the courses of rivers are among the most unchangeable. Once outlined, they are adhered to with a wonderful tenacity. Only a general change in the slope of their basins will usually suffice to divert them from their original courses. Mountains and plateaus may rise across their paths, but, like a saw, the river cuts its way through the obstacle. It is very rare to find a case where a river has been diverted from its course by the rising of a mountain-range or other minor elevation across it, while numberless instances of rivers having overcome such obstacles are to be seen in all mountainous regions. The Cordilleran region of the West presents us with many such examples. Many are familiar with the gorge by which Green River passes the Uintah range, in Wyoming

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and Utah, where the river has apparently preserved even its minor sinuosities in a cañon thousands of feet in depth. The Colorado River system is a magnificent example of the persistence of rivers. Established ages ago, when only the great general contour of the region was outlined, it antedated all the ranges of mountains and the plateaus which now diversify the surface. Nearly all these uplifts are at right angles, or nearly so, to the courses of the main streams; yet, in all cases save one, the rivers have preserved their courses, by cutting gorges as the mountains rose. Grand River, which is one of the two largest branches of the Colorado, presents us with a fine succession of these cases. Indeed, it may be said that from its head, in Middle Park, to its mouth, the river is almost continually in trouble; its course is nothing but a succession of gorges and of transverse valleys. In Middle Park it cuts several minor ranges; at its point of exit from the park it encounters the Park ranges, which it cleaves from summit to base, making a cañon two to three thousand feet in depth. Then follow many miles of precipitous cañon, of great depth, which the river has carved in a high plateau. Emerging from this it meets a barrier, in what is known as the Hogback range, through which it levels a passage. Then follows for many miles a deep and narrow valley, between the Book Cliffs on the north and the Battlement Mesa on the south, which looks down on the river from a height of fully four thousand feet. Next, the Little Book Cliffs dispute its passage. These face the west, and toward the east, in which direction the river approaches, have a long and gentle slope downward. The river, holding steadily its course, enters the plateau, and rapidly eats its way below the surface. For many miles its cañon is so deep, narrow, and tortuous, that it can with the utmost difficulty be traced. At the face of the cliffs it emerges suddenly to daylight, in the broad, desert valley of the Gunnison. It holds its normal course across this valley, meeting the Gunnison on the west side. Then, right against the bluffs which border the Uncompahgre Plateau, it turns sharply at right angles, and flows off northwest, then west, then southwest again, and south, hugging closely the northern end of this great plateau, while on the right stretches away the desert expanse of the Grand River Valley to the base of the Book Cliffs.

It may be interesting to trace the behavior of a stream under these trying circumstances, when a mountain-range rises to dispute its path. We are not here concerned with those mountains which have arisen suddenly, by catastrophic action, but only with such as have been slowly evolved. In the former case, rivers, like all other natural features, share in the general overturning and destruction. When an elevation commences gradually across the course of a river, its first effect is to lessen the rapidity of the current above the crest of the elevation and to increase it below that point. The erosive power of a stream is proportional, other things being equal, to the

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rapidity of its current. Erosion is therefore more rapid below the crest. But this erosion not only deepens the bed of the stream below the crest, but also pares away the crest, from down-stream upward, so that the point where the velocity of the stream changes is constantly tending up-stream. This point, then, will always be found above, i. e., up-stream from the crest of the obstacle. The degree of obstruction which this rising mass will afford to the stream depends, not at all on the absolute height to which it may rise, but to the degree of rapidity of its rise as compared with the erosive power of the stream. If the rate of rise be greater than the erosive power at first, it forms a temporary dam, and a lake is produced above the obstacle, which increases in depth until a sufficient fall is given to the stream to enable it to cut at the same rate at which the range rises. Then equilibrium is established, and the cutting goes on at the same rate as the range increases in elevation. When the rise ceases, the lake is gradually drained in whole or in part, as the river gradually cuts away the dam by moving its crest up-stream. A diversion of the stream can only occur by reason of a new channel being made accessible by the rise of water back of the dam.

Such, in brief, is the conduct of a river when its course is in danger from the rise of a mountain-range across it. It may be added that the many examples before us show that in nearly every case the river has had little trouble in sawing its way through them. Dams have seldom risen to very great height, nor have lakes collected to great depths.

One very remarkable case has, however, come under the writer's personal observation, of a river having been diverted from its course, and forced to take a long *dĕtour*, having made an unsuccessful attempt to cut through the obstacle. In the western part of Colorado, near the Utah boundary, is a great plateau, known as the Uncompahgre Plateau. This is an inclined plateau ; its crest-line, starting at the northern base of the San Juan Mountains, runs off northwestward for fifty miles or more. It slopes with the dip of the strata at a low angle to the northeast, breaking off toward the southwest by a series of gigantic steps. Its crest ranges in height from 9,000 to 10,000 feet above sea-level, while the valley of the Gunnison, at its eastern base, has an elevation from 4,500 to 5,000 feet. At its eastern base lies the valley of the Uncompahgre, Gunnison, and Grand, which trends off to the northwest, and is occupied successively by the rivers above named. It is a broad, open valley, ranging in width from ten to twenty miles. In its southeastern and upper part it is traversed, near the middle, by the Uncompahgre River. Below the point where this stream joins the Gunnison, the latter hugs the base of the plateau, and is hidden by cañon-walls a few hundred feet in depth. The Grand, below its junction with the Gunnison, also flows close to the southwest side of the valley, and is, for a part of its course, in a low cañon, fifty to one hun-

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dred feet in height. The last two rivers, entering the valley from the east, cross it immediately and at once take a general northwest course. The Grand flows on toward the northwest until it rounds the end of the Uncompahgre Plateau, when it sweeps slowly around to the southwest, and resumes its normal direction, still hugging closely the left side of the valley.

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Southwest of the Uncompahgre Plateau the eye looks out over a stretch of low, arid plateaus, traversed, in deep cañons, by the Rio Dolores and its tributaries. This stream is an important branch of the Grand, entering it at the foot of the great valley, after that river has passed around the end of the Uncompahgre Plateau, and just as it plunges into the course of cañons by which it passes the Sierra la Sal.

Traveling along the crest-line of the Uncompahgre Plateau, one is interested in observing how sharply the crest-line serves as a water-parting. The drainage toward the west heads in the crest, without cutting it at all. The bluff-wall is everywhere continuous. But in the midst of these observations one is astonished by riding suddenly to the verge of a tremendous gorge, thousands of feet in depth, which apparently comes in from the west, and extends up into the plateau to the northeastward, against the slope and dip of the strata, as far as the eye can reach. Down in the depths he sees a small stream flowing westward. Descending into this cañon, an operation not easily performed at any point, and traversing its bed northeastward, he comes in a few miles to a divide in the cañon, and beyond the divide he finds a small stream flowing northeast into the Gunnison. This is the Unaweep Cañon.

The Unaweep Cañon is cut across the Uncompahgre Plateau, from the great valley of the Gunnison and Grand on the northeast, to the low, desert plateaus on the southwest. Its course is nearly southwest, and almost precisely at right-angles to the crest of the plateau. It joins the Gunnison at a point about six miles above the mouth of the latter stream, at an elevation above the sea of 4,600 feet. Tracing its course southwestward, its bed is seen to rise slowly, but not so rapidly as the level of the plateau, so that the cañon increases gradually in depth. The bottom rises to a divide, 7,000 feet above sea-level, and several miles east of the crest of the plateau. The walls at the divide have a height of 1,200 feet. West of the divide, the slope of the bed of the cañon changes slowly, and its descent to the westward does not become very rapid until the crest of the plateau is passed. At the crest, the height of the cañon-walls is 3,000 feet. At the point of junction with the Rio Dolores, the elevation is 4,618 feet above the sea, or practically the same as at its junction with the Gunnison.

The first few miles from the Gunnison the cañon is very narrow, has no great depth, and is cut in soft, recent, sedimentary rocks. This portion might easily have been cut by the small stream now occupying it—a theory which is supported by the fact that the strata here on

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the margin of the plateau have been very much disturbed, which would easily have obliterated all traces of the original cañon. Entering the body of the plateau, the cañon suddenly assumes a greater breadth. As it increases in depth, it exposes a series of several hundred feet of stratified rocks, below which the granite comes to the surface. At the crest of the plateau the lower two thirds of the walls are of granite, the upper 1,000 feet being sedimentaries. From its northeastern end the cañon gradually widens from a bed-breadth of a hundred yards to one of at least a mile; at the crest, the cañon suddenly narrows to a mere stream-way, with rugged, vertical walls.

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It is purely a cañon of erosion. There is no sign whatever of any local disturbance which could account for its existence. The strata on the two sides are perfectly conformable.

To attribute this cañon to the streams now occupying it is manifestly absurd. Not only are they utterly insignificant in comparison with the amount of erosion which has taken place, but no similar streams, of any magnitude whatever, could have cut the cañon down at the divide; neither could the western one have cut back into the plateau to any such extent. There is no lateral slope toward this cañon to determine the drainage of any considerable area of the plateau in this direction. It is plainly the scene of the defeat of a large stream, in its struggle to maintain its ancient course—of a victory of volcanic over aqueous forces. Another thing is equally apparent—that the stream here diverted came from the eastward and not from the westward, and that it was the Grand River. This is shown by the following considerations: (1) The general slope of the country, disregarding local accidents of topography, is from the northeast toward the southwest; (2) the direction of the course of Grand River above this cañon, which is almost precisely in line with (3) the character of its course, which shows that it antedated all other uplifts, and, as the Uncompahgre Plateau, from its trend and association, must have been coexistent with the rest, it must have antedated this also; (4) the features of the cañon itself afford the strongest possible evidence of a stream flowing southwest through it. The profile, with the summit *east* of the crest of the plateau, the slow descent west of the summit to the crest of the plateau, and the rapid descent beyond the crest, point unmistakably to this conclusion. The plan of the cañon is no less clear in its indications. It is well known that a rapid stream erodes its bed *downward;* a sluggish one, on the other hand, erodes laterally, thus broadening its bed. Here we have precisely these phenomena. Beyond the crest of the plateau, where the slope is great, the cañon is very narrow; while east of the crest, where the velocity of the stream must have been very much lessened, it widens rapidly, and then gradually diminishes in width.

At what stage in the rise of the Uncompahgre Plateau the river abandoned the unequal contest and took its present course around the

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end of the plateau, we have no means of knowing definitely. Present relative elevations can not be relied upon as safe evidence. It is probable, however, that it was not far from the close of the rise, as otherwise the bed of the cañon, under the crest of the plateau, rising more rapidly than at any other point, would be the highest point, and the divide would be there instead of being several miles farther east.

Altogether, this phenomenon affords a very interesting study for the structural geologist and the geographer.

RECENT WONDERS OF ELECTRICITY.*

By W. H. PREECE, F.R.S.

II.

LAST week, when we had the pleasure of meeting, I endeavored to disabuse your minds of any such idea as that electricity was a fluid, or, in fact, any kind of matter. I pointed out to you that every electric phenomenon really was a form of that curious, mysterious agency that exists throughout nature, that produces all the work done on the face of the earth, that probably is at the root of life itself, called energy. Nevertheless, we can speak of electricity as though it were a distinct entity; precisely in the same way that we speak of sound, of light, and of heat. We know that sound and heat are not sensible to the touch, or taste, or sight; so electricity is of the same character, and is invisible and insensible in every shape or form. Moreover, we can not either create or produce energy; there is only a certain fixed quantity of energy in the universe, and all that we can do is simply to transform it into its different shapes, such as I illustrated to you last week. All physical phenomena, without a single exception, may be traced to the mere transformation of this energy. I showed you on the last occasion how, by simply winding a wire round a mass of iron, and sending a current of electricity through the wire, we could produce that form of energy called electro-magnetism. To-night I have to speak of one or two other forms in which this energy does its work—forms in which, when electricity is transferred through matter, it does work in some shape or another. The operation of the electric current, when passed through chemical compounds in solution or liquid, is to tear asunder the constituents of the compound, and to arrange them on different sides. A simple means of illustrating this is a glass jar, like the one before you, containing water and two glass tubes, each fitted with a stop-cock. When an electric current is passed through

* Lecture delivered before the Society of Arts, January 4, 1882, and reprinted from the journal of the society.

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the water, the elements of water—oxygen and hydrogen—are driven asunder, and take refuge, as it were, in the right- or left-hand tube respectively. To prove that these gases have been collected, if a lighted match be placed over the hydrogen-tap, the hydrogen will give evidence of its presence by inflammability; but, if the match be blown out and immediately presented to the tap of the tube containing the oxygen, that gas will make its presence evident by relighting the match. The effect of the passage of electricity through water is something like the effect which would be produced by a storm, or other agency, in this room, which caused all the boys of this audience to go to one side, and all the girls to go to the other—excepting that in water there are always two parts of hydrogen to one part or volume of oxygen. Not only does the current tear asunder the oxygen and hydrogen of water, but it also breaks up the constituents of most of the chemical compounds, and the weight of material decomposed per second is an exact measure of the work done and of the current flowing. For instance, if we take a solution of sulphate of copper and pass electricity through it, the solution is broken up into copper and sulphuric acid, and, if a bunch of keys were put into the solution while the electricity was passing through it, the keys would receive a deposit of copper. If nitrate-of-silver solution were used instead of the sulphate-of-copper solution, silver would be deposited upon the keys or piece of metal inserted. Through the kindness of Mr. Bolas I am able to show you an experiment of this kind, which will enable me to give you a record of this evening's entertainment. I have here a large glass dish containing a liquid, which no doubt appears to you like water, but which is really a solution of the double salt of cyanide of silver and potassium. In this solution I now place a piece of sheet-copper, which you see has the usual appearance of copper all over it. Now, while that plate of copper is inserted to one half its extent in water, we will pass electric currents through the liquid from the hand dynamo-machine on the table [experiment proceeding], which cause the cyanide of silver to break up into cyanogen on one side and silver on the other; and, if I take out the plate of copper, you see there has been deposited upon its immersed surface a coating of silver. Silver spoons and all the various kinds of electro-plate wares receive their silver deposit in the manner I have just shown you. Now, we will set this small dynamo-machine in action by turning its handle, thus converting the energy of the human body into electric energy; and we will immerse a quantity of brass buttons in the liquid, which, when they have received their coating of silver, will be laid aside, ready for distribution as a memento at the close of the lecture. Through the kindness of Messrs. Elkington I am able to show you the handsome specimens of electro-plating which hang on the walls of the room, and which were plated at their works at Birmingham, by a process exactly similar in character to that I have described, except-

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ing that steam-power is substituted for the manual labor you just saw for producing the electric currents.

We next come to the work performed by electricity in passing through solids. The result of that work is simply the production of heat. Before me you will notice two brass stands, and between them I will suspend a piece of fine platinum wire. I now join up one of my battery wires to one of the brass stands, and touch the other brass stand with the other battery wire; the effect appears as a red glow in the platinum wire. If I bring one of my battery wires from the bottom of the brass stand to the end of the platinum wire, the color of the glow becomes brighter; and, as I move my battery wire along the platinum wire, the glow or light produced by the high temperature in the platinum becomes more and more intense, until finally, when it reaches a certain temperature (about 3,000° Fahr.), the wire is ruptured, and falls to the ground. That is evidence that the passage of electricity, through solid conductors, produces heat, and the amount of heat produced is proportioned to the work done in the battery. Energy expended in one part of a circuit must be given out at another. If zinc is consumed in a battery, it generates a certain amount of energy; that energy must be evident in some other part of the circuit, and the heat you saw in the platinum was really the heat that would have appeared in the battery itself if we had not caused the current to flow through a solid conductor which offered a considerable amount of resistance to its progress, as compared with the resistance in the battery itself. This power of producing heat has been utilized in various ways, such as for firing fuses. [An Abel fuse was exploded.] At many places throughout the country, time-guns are fired by such an electric fuse to announce the Greenwich time current at a certain hour. Mines and torpedoes are exploded in a similar manner; quarries are blasted, and many other results are brought about by passing electricity through platinum wire placed in explosive substances, or by special fuses. I do not intend to frighten or alarm you, but for your amusement, and through the kindness of Professor Abel, I have had fuses fixed out of harm's way at various points round the room, and, when a small current is passed through them, you will hear the explosion produced. Those fuses might have been fixed miles away, and the same effect would have been produced, and from it you will understand how a number of charges can be fired, or a number of guns can be discharged simultaneously on board our large men-of-war.

The next branch of the subject is the work done by electricity in its passage through air and gases. I have shown you that, in its passage through liquids, it tears the constituents of the solution asunder; in its passage through solids heat is produced; and in its passage through air, it not only produces heat, but violent projection of material particles as well, which it renders incandescent, producing sparks, heat, and other disruptive effects. To illustrate this, I have provided

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an Apps's induction coil, to which can be joined up vacuum tubes of various kinds, and through which the currents produced by the hand dynamo-machine will be passed. [A beautiful collection of vacuum tubes, fitted with various rarefied gases, was then shown, while the lights were turned down.] In those effects we have the result of electricity passing through air, and gases of extreme tenuity, and also an indication of the way in which electricity produces heat—and, therefore, light—in gaseous matter. All instances of artificial lighting or heating are simply due to the fact that we are able to produce heat, and heat of a very high temperature. It is a curious fact that all matter, whether metal or porcelain, carbon or lime, begins to emit light at precisely the same temperature, which closely approaches 1,000° Fahr., or, to be accurate, I believe it is 980° Fahr., so that, whenever it is possible by any means to raise any material to that temperature, light is emitted, and the intensity of light increases, until, in the case of carbon, when about 4,000° Fahr. is reached, the material is destroyed. In platinum, a lower figure (3,082°) represents the point of fusion. To obtain this very high temperature by electric currents, we must utilize higher means of producing the electricity than I have hitherto shown you. In the battery I have just used, the electric current was produced by the combustion of zinc; but now I want to explain to you how, as I said, muscular power was converted into electric energy. The reason is simply due to the fact discovered by Faraday, that whenever a wire or conductor moved through the sphere or field of a magnet, it became electrified. I take up the brass rod before me and move it rapidly, and by doing so have, to a certain extent, electrified it by causing it to pass through the magnetic field of the earth. The earth is an enormous magnet—a fact which we know, because our compasses guide the mariners across the deep. The air in this room is under the influence of the earth's magnetism; and if I move a wire or rod within that influence, at right angles to the lines of magnetic force, I cause it to be electrified, but only to an excessively small extent. The strength of the current produced depends upon the strength of the magnetic field, and upon the velocity with which the conductor moves across the field. Instead of having only one rod, or one wire, we have in this hand-machine an arrangement of a thousand turns of wire; instead of having the weak magnetism of the earth, we have the powerful field of permanent magnet; and, instead of causing it to move through the air by the velocity of my arm, we apply multiplying gear, which, as you see, imparts velocity to it of great rapidity. Thus motion, through a magnetic field, produces an electro-motive force. There never can be a continuous electro-motive force without some source of energy. Here we have mechanical energy expended, and all the conditions for the production and maintenance of a current. Energy expended in one point must be found in some form in another point. If it is not utilized, it is wasted.

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Some of it must always be wasted, and the true economist will try and waste the least possible quantity. If I place a piece of platinum wire between the two wires connected with the hand dynamo-machine, you see that the muscular energy of my assistant, by turning the handle, generates currents of electricity, which give a red heat to the platinum wire. The energy of the body is thrown into the machine, the machine converts it into electricity, the electricity passes through the wire, which, by having work done upon it, is rendered incandescent, and, in consequence, becomes luminous. I have here a lamp containing a piece of platinum wire, and, if I connect it to the wires of the dynamo-machine [this was done], the platinum glows and gives us light. It is a machine precisely similar in principle to the one now before you, fixed under the arches on the Thames embankment, and worked by a steam-engine (lent for the purpose by Messrs. Robey) that is supplying currents of electricity to the lamps now lighting this room. There is an occasional throb in the light; this is produced by the unsteadiness of the engine, which was not specially prepared for the purpose, but was the best available. It is, in fact, an agricultural machine. There are two kinds of electric machines of this class. One is called the magneto-machine, like the one before you, because the magnetic field is produced by the presence of a powerful permanent magnet, which, I think, is visible to most of you, and which consists of several pieces of steel that have been magnetized. The other kind of machine is called the dynamo-machine, in which the magnetic field is produced by an electro-magnet, which is itself excited by the currents it generates, so that there is a kind of accumulative action; one current piles up the agony on the other current, and all of them together, acting on the electro-magnet, increase the total effects, until the iron is saturated with magnetism. So much as regards the production of currents for electric-lighting purposes. The motion of the conductor through the magnetic field may be caused by the energy of coal, which is consumed to generate heat and steam for working a steam-engine; or, as at Godalming, by the energy of water on a water-wheel; and it is very probable that, where water is available, it will be the most economical source of energy for electric-lighting purposes. Sir William Armstrong, at his seat at Craigside, near Newcastle-on-Tyne, has illuminated his house for some time by currents of electricity, produced by a water-fall in his grounds, so that, he says, his library and his drawing-room are lit by the river flowing through his grounds. As regards the light itself, there are two kinds of lamps. I have already explained and illustrated to you the fact that electricity in its passage through air produces sparks. I have here what is called an arc-lamp; in it two rods of carbon are held by two brass clips (not in metallic connection with each other), and the ends of the carbon are, when in action, a short distance apart. On joining up the wires to the brass clips the current flows, a bright light is instantly set

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up in the air between the carbon points, and the arc is formed. This light is due to the passage of an infinitely rapid succession of particles of carbon which are projected across the air-space, which, in their high state of incandescence, produce light, and which in brilliancy would not compare unfavorably with that of the sun. The light from a larger arc-lamp would be far more brilliant than this, but I do not want to damage your eyes or my own. I have experimented on the electric light so much, that I have suffered great tortures from the irritating and exciting influence of its bright rays upon the retina of the eyes, and I advise all people who have an opportunity of examining the arc-light, not to look at it too much, or the eye-sight may be unfavorably affected. The arc-light is used principally for lighting large areas : for instance, Charing Cross station is lit by one form of arc-light, called the Brush ; Cannon Street station is lit by what is known as the Brockie lamp ; the space in front of the Royal Exchange is lit up by the Siemens arc-lamp ; King's Cross station is lit up by the Crompton plan ; and so on. A very brilliant arc-lamp at Paris, which attracted a great deal of attention, was called the Jasper light. But all arc-lamps play upon one string, similar to the plan I have just shown, viz., that when two pieces of carbon are maintained at a certain distance from each other, and electricity passed between them, great heat and brilliant light are the result. There are certain difficulties in arc-lamps which militate against their employment for domestic and internal use generally. The light is very intense ; the effect is irritating ; the ladies do not like it (and they are a powerful influence in this country), because it does not suit their complexion, nor their style of costume for evening wear : they have set their faces against it for internal illumination, and, that being so, it is all up with it. Now, the light that is going to supplant the arc light for domestic purposes is the incandescent light. The principle of the incandescent lamp is exactly the same as that I showed you in Mr. Becker's lamp, viz., that a suitable substance is inclosed in a glass bulb, from which the air has been extracted, and is brought to a high state of temperature by the passage through it of currents of electricity. The lamps illuminating this room are Mr. Edison's incandescent lamps, whose representative, Mr. Johnson, has been most indefatigable in his assistance for these lectures. The Edison lamp consists of a single curl, or loop, of a fine carbon filament (instead of platinum wire) placed in an exhausted glass bulb. The carbon is extremely thin—as thin as a human hair—but, in spite of its extreme tenuity, you see [knocking a lamp on the table] that concussion or shaking does not cause it to break, but it possesses great resilience, and vibrates like a steel spring ; and it is so refractory that it will stand electric currents of enormous strength. As I have said, the lamps before you are worked by electric currents generated by an Edison dynamo-machine on the Thames embankment, but each lamp is self-regulating and can be turned on and off by turning

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a tap very like those used on gas-brackets. The stronger the current supplied to the lamp, the greater its heat and brilliancy; and when, by turning a handle in the instrument I have for the purpose, the strength of the current is increased, it forms a brilliant light in the glass tube, until the amount of current is greater than the carbon can stand, when it radiates a beautiful blue haze, which indicates that its end is near, and then it is broken (as you see), and the lamp goes out. I can easily replace the broken lamp by unscrewing it out of its socket, and placing a fresh one in its place, when at once all is in good order, and the light resumed. These lamps are water-tight as well as air-tight, and to prove this I will insert a lighted lamp into the little aquarium on the table, when you see that the globe is brilliantly lit up, and that the fish it contains show rather a sign of curiosity than discomfiture, and seem rather proud of their colors which are so distinctly brought out by the brilliancy of the light. Here I have a globe of colored water to show what brilliant effects can be produced. A good deal has been said about the dangers of electric lighting, and how careful we ought to be in its use, and there is no doubt that electricity is a very dangerous agent if you do not know how to use it. We have heard of the danger from fire through its use in theatres and houses, but I want to show you that, when I place a cambric pocket-handkerchief round a lamp, which I then break while electricity is going through it, no spark or fire of any kind occurs, but the lamp instantly goes out. There is also danger from wires coming in contact with each other, and in that case they short circuit the machine; they cause an increased strength of current to flow, producing heat, and in that manner setting fire to houses. To obviate this danger, "safety-catches" have been introduced by Mr. Edison. These safety-catches consist in the insertion of a very small piece of lead wire in the circuit, which is readily fusible, so that if the current becomes unnecessarily powerful, it passes through the lead wire, heats it to fusing-point, and so breaks down the section on which the "safety-catch" is placed, eliminating at once all danger. It does not affect any other lamps, as you see. When the fused safety-catch is replaced by a good one, the lamps which were broken down by its rupture become lighted up again. We have the means of regulating the lights now burning in the room. Here is an apparatus in connection with the machine at the engine-station, and, by moving the handle and inserting in the circuit a certain amount of resistance, I am able so to reduce the current flowing from the machine that a considerable lowering of the light takes place. On turning the handle back again, the former brilliancy returns. That shows the electric light in the latest stage of its perfection. We have a bright light now in this room, but no impure gases are given off by the electric light, and the air is not vitiated by it. The room is warm, but that warmth is due to the number of people present, and not to the heat produced by the elec-

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tric light; though the electric light does, as I have said, generate heat to produce its effulgence. Many people talk of the electric light as being "cold" and cheerless. The light produced by the arc-lamp does look cold and cheerless; but the soft, delicious, incandescent lamp before you has just as soothing an effect upon the eye as the prettiest lamps or the pleasantest candle; and it has certainly removed all the objections that were previously raised to the electric light for internal illuminating purposes.

The next and last branch of my subject is the transmission of motive-power to a distance. I have shown you how currents of electricity are produced; also how they do work; how they produce electromagnetism; how they generate heat; how they produce light; and now I want to show you that the whole thing is reversible. If, by the exertion of mechanical power, currents of electricity can be produced, those very same currents of electricity can in their turn produce mechanical power. If, instead of receiving currents of electricity from the dynamo-machine on the Thames embankment, we transmitted currents of electricity to it, we should cause it to rotate, but in the reverse direction. I have here a small machine for the purpose of illustrating this to you; it is the invention of Mr. Griscom, who has supplied it to a large extent in America for turning sewing-machines. The wires from the hand dynamo-machine are now attached to the Griscom motor, and, when currents of electricity are generated by turning the handle of the dynamo, they are conveyed to the motor, and cause it to revolve with the high rapidity you see. It is surprising that such a tremendous momentum should be produced by so small a strength of electric current. The wires connecting the two machines in this instance are short, but the effect would have been practically the same had the machines been miles apart. By changing the wires, the direction in which the motor rotates is reversed, so that I not only get power transmitted, but can reverse its direction. In this case, as the electricity is generated by hand, its power is small; and, therefore, with my strength (which is only about one twelfth of a horse-power), I can stop the rotation of the motor; but, if steam-power were employed to generate the electricity, the power transmitted would be beyond my control in that sense. This motive-power was illustrated, in many different forms, at the Paris Exhibition; for instance, from the commencement of the Champs-Elysées to the exhibition building, a tram-car was propelled (sometimes at the rate of twenty-five miles an hour) upon rails laid down for the purpose, and, during the time that the exhibition was open, that car carried seventy-five to eighty thousand people, who were conveyed to or from the building by motive-power generated by steam in the exhibition and conveyed by wires to the farther extremity of the track. An electric railway will form part of the Electric Exhibition at the Crystal Palace, and among the proposals to be laid before Parliament next session is a project for

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constructing an electric railway between Northumberland Avenue and Waterloo Station. Again, at the Paris Exhibition, an enterprising firm of agriculturists showed land-plowing by electricity, and, in fact, the application of electricity to innumerable useful purposes was illustrated—rock-boring, newspaper-printing, driving of sewing-machines, embroidery, leather-work, glass-cutting, wood-carving, lifts raised, ventilation assisted, etc. I am looking forward to the Crystal Palace Exhibition with great interest, to see how far these exhibits will be repeated. The exhibition will be well worth a visit; in fact, all exhibitions are worth visiting, for they excite interest, they induce every one, more or less, by generating curiosity, to add to his knowledge, they honestly stimulate national as well as individual competition, and they always result in the enlargement of the useful application of a power like that of electricity, because a man of one trade who sees electricity used in another trade can not resist thinking out whether it can not also be usefully applied to his own purposes. We sometimes hear electricity spoken of as a mysterious agency, and sometimes as a wild, untamed beast. It is only mysterious to the ignorant, and it is only untamed to the unskilled. I hope that the promise I made to you at first starting, that you would leave this room with a fair knowledge of how the electric light is produced, has been fulfilled, and I can only add that electricity will always prove an obedient slave to those who take the trouble to understand it; but it may prove, and it has proved, a very dangerous ally to the ignorant and the unskilled.

MODERN EXPLOSIVES.

By BENJAMIN VAUGHAN ABBOTT.

IS any one noting the loss of life and property by explosions? Can not some improved measures of protection be suggested? There is great increase in the number, variety, and potential energy of explosives, and they are causing a startling number of disasters; and these involve not only the proprietors who have the control, and the hands who do the work of the magazine, mine, quarry, factory, steamship, locomotive, in which the explosion occurs, but also the general public—by-standers, persons walking, riding, or lodging near, passengers by train or steamboat, carriers or purchasers of dangerous goods improperly packed, and many others. Recall a score of the more novel and peculiar cases of the season of 1881, those which represent the advance in this peril, and see if they do not indicate that more stringent regulation of the subject is demanded for public safety.

There was wide-spread excitement in August when British custom-

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house officers discovered clock-work machines loaded with dynamite concealed in barrels of cement just imported from this country, and Irish revolutionary patriots in America avowed that they had sent them to be used against England, and that they hoped by similar devices to render English vessels unsafe and unprofitable. Many remembered the project of Thomassen, years ago, for blowing up in mid-ocean a vessel on which he had goods heavily insured, and wondered whether such plans could indeed be extended to the shipping of a whole nation. There were like alarms later. The officers of the Bothnia were naturally disturbed when two strangers prowled through her passage-ways and, a few moments afterward, the carpets over which they had passed burst into flames from some novel combustible smeared upon them. In Liverpool a second discovery was reported of dynamite cartridges concealed in bales of cotton received from America, and believed to be destined to destroy mills at Oldham. All these were merely alarms. More lately an explosion of dynamite on board the Glasgow steamer Severn is reported to have killed nine persons and injured forty-three, four of these fatally. These things have brought to public notice the want of any distinct, efficient law to punish the sending of explosives on board ship with the purpose of destroying her on her voyage. If an explosion occurs, if life or property is destroyed, the general laws against murder, piracy, or defrauding insurers, would probably apply. But suppose the infernal machine is detected before injury is done, so that the offender can be charged only with having sent it aboard. Is there any sufficient law against this? No doubt the practical danger is small. Aside from the hope that villains capable of forming such a plot are very few in number, it is well known that most of the cargo of ocean-bound steamers is received direct from responsible exporting houses, and a stranger could scarcely obtain access to their packing-rooms in order to conceal cartridges in their merchandise. Still there must always be some tons of miscellaneous parcels, and the ship-owners can know little or nothing of the senders of these. It must always be possible for a schemer, under pretense of taking passage, to send a trunk aboard containing an infernal machine. How could this be discovered? But difficulty of detection is no reason why the public should not have the protection of a severe law for cases which may be detected. Such laws as exist are designed rather to forbid concealing the character of explosives in order to avoid the ship-owner's objection to take them, or his demand of a higher freight on the score of the danger, than to prevent the heinous offense of plotting the destruction of the vessel. For example, in New York city the authorities discovered that hands on board the Havana steamship Saratoga were concealing gunpowder packed in fourteen fifty-pound cans (seven hundred pounds in all), underneath berths in state-rooms. On a canal-boat were found forty boxes, each marked "I. R. P.," believed to mean "Irish Revolutionary Par-

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ty," and holding twenty-five tin cans, each containing a pound of gunpowder. Probably there was no intent in either case to injure vessel or passengers—the offender only desired to get his powder safely landed at the vessel's destination without paying duties or high freight charges. Present laws cover this species of fraud much better than they do the worse crime of plotting to destroy ship, crew, and passengers.

When explosions are mentioned, one naturally thinks first of gunpowder. Explosions in powder-factories in Maine and Missouri destroyed the entire building and killed, in one case one workman, in the other eleven. A similar disaster in Mexico destroyed a whole square, burying many families under the ruins, and about sixty bodies were recovered. Some mishap in firing the fog-gun at Bird Rocks Light-house, on the St. Lawrence, ignited a barrel of gunpowder near by, killing three persons. A Louisiana merchant, in his store, struck a match to light a cigarette, and a scintilla of the burning sulphur flew into a can containing twenty-five pounds of powder. The explosion demolished the building and stock of goods, killed the careless proprietor and injured two blameless by-standers. Now, gunpowder has been so long in use and is so familiarly known, that there ought to be an end of such carelessness as accounts like these indicate. Very rarely, a disaster by gunpowder occurs which may be called pure accident. In a room where drugs were ground in quantities, dust of sulphur, also of saltpeter, gradually settled on the beams, in corners and crevices, and in the various places where dust in such a work-room is wont to gather, and it was intermingled naturally with dust such as every breeze brings, supplying a modicum of carbon. The mixture was equivalent to gunpowder, and, when a workman dropped a lighted candle, the roof flew off in fragments. He was scarcely to blame. There is a "white gunpowder" about which a prudent person might make a mistake. But the majority of powder explosions are attributable to sheer carelessness. The trouble is that "familiarity breeds contempt"; yet how to induce greater care is a perplexing question.

Nitro-glycerine and dynamite have done their share of mischief. In Colorado, four out of five men, who were preparing a charge of nitro-glycerine for a mining blast, were killed by a premature discharge; and in Pennsylvania a magazine containing three hundred pounds of this substance exploded, doing immense damage. At Council Bluffs, just as the Garfield memorial exercises were closing, there was a fearful explosion of a car-load of blasting-powder, probably dynamite, which demolished the railroad company's buildings and nearly fifty of their cars, dug a hole in the ground forty-five feet across and fifteen feet deep, shattered buildings throughout the city and glass windows even in Omaha across the river, and made itself felt as far as Missouri Valley, twenty miles away. One can not judge from the brief

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accounts given what are the precise causes of such disasters, but there is reason to believe that ignorance is prolific; that many persons have only a vague knowledge of the qualities of nitro-glycerine, can not recognize it when they see it, and are not acquainted with the various forms in which it is compounded or with the peculiar dangers of handling it carelessly. Nitro-glycerine itself is a dense, yellowish liquid, but, in order to diminish the danger attending its use, fine earth, ground mica, sawdust, or some similar powder, is saturated with it, and thus the various blasting-powders known as dynamite, mica-powder, dualin, rend-rock, etc., are formed. These compounds can be transported with comparative safety. But the nitro-glycerine easily drains off from the powder and oozes from any crevice in the vessel in which the compound is kept. Drops of it thus bedewing the edges of a box may very easily be mistaken for oil escaping, and if workmen ignorantly endeavor to nail the box tighter or to open it for examination there will be a disastrous explosion. Several have occurred in past years in this way. The victims knew, no doubt, that nitro-glycerine (or the compounds) may be exploded by a blow (contact with fire is not needful), but they did not suspect that the innocent-looking oil was nitro-glycerine. Why should not youth be taught in the schools somewhat of the practical dangers of these substances which are coming into such common use? They would pursue the study with interest, especially if there were judicious experiments. A Missouri story is that a teacher confiscated a small metal box which a pupil was playing with in school hours, and, thinking it contained chewing-gum, tried to break it open with a hammer. It was a dynamite torpedo of the kind used on the railroad-track as a danger-signal, and large bits of it had to be cut out of the lady's cheek. Would it not have been well if she had known somewhat of the aspect of torpedoes? Was it not more important to the journeyman plumber who threw the lighted match into the pan of camphene, mistaking it for water, by which the great printing establishment of Franklin Square was burned some twenty-eight years ago, to know camphene by sight than to have memorized many of the matters prominent in a public-school course? Surely workmen, especially "raw hands" in establishments where these things are used, should be systematically instructed in advance, and the courts are now enforcing this principle. Two lawsuits were heard during 1880, where managers of mining companies introduced blasting-powder as a substitute for gunpowder, without specially instructing the workmen as to the change and the new precautions they ought to take. The workmen used the powder improperly, and some of them were badly hurt. The victims brought suit for damages, and the companies retorted that the disasters were due to carelessness of the men. Both courts said that the proprietors of mines have a right to introduce a more effective powder, but they are bound to give their men judicious instructions and cautions, and to furnish them with any implements or apparatus appro-

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priate to diminish as much as possible the danger of using the new agent; and, for neglect of the superintendents to give these instructions, the proprietors were required in both cases to pay damages.

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The importance of some education of the working classes on these matters is increased by the frequency with which new explosives are introduced. One, called "explosive jelly," was brought to notice early last summer. It is made by dissolving nitro-glycerine and gun-cotton in ether, and then evaporating the ether; and it is said to be the most powerful of the nitro-glycerine compounds, though it can be exploded only by a detonator, which fact diminishes danger. A novelty called "dynamoge" is mentioned in late European papers.

Folly of workmen solves many of this class of disasters. In Sawyer City, Pennsylvania, a gang of men digging a well were about to set a torpedo for blasting. The foreman, said to have been an intemperate man, hastily poured two quarts of nitro-glycerine into the shell, and then attempted to fit the cap to its place. It was tight, he gave it an angry blow with his fist, the charge exploded, and five men were killed, three others being badly hurt. Criminal use of dynamite has been detected in several cases. A Brooklyn man found a dynamite bomb-shell under the stoop of his house, apparently put there in the night by some enemy, and the fuse lighted; but a friendly rain-storm had extinguished the fuse. In Ohio a workman found a yellowish roll lying lengthwise on one of the rails of the Baltimore and Ohio road. He did not know what it was, but it was tested by the superintendent, and found to be dynamite in sufficient quantity to have blown any train to atoms. It was evidently placed to wreck an express train then nearly due. On the Great Northern Railway in Ireland the guard detected nine pounds of dynamite which a passenger was carrying for some unlawful purpose, and took it from him. In Central America, a merchant was murdered by a new and ingenious use of dynamite. The charge was placed in the large lock of his store-door, with the exploder arranged to be set off by the door-key. He was instantly killed on attempting to unlock the door. When such an attempt is successful, the laws are efficient to punish it. But in most of the States the laws are defective in regard to mere attempts or plots. The statute-books punish shooting at a person or administering poison, although he be not killed or even hurt; but, perhaps, say nothing about schemes fully as dangerous for destroying life or property by these explosives. Apparently the means are so novel that Legislatures have not had time to think of them. The advice to give instruction on these subjects to school-pupils and workmen should probably be extended to embrace the law-makers of the land.

There are curious infelicities in the laws as to carrying explosive powders about the country. Cities and towns very generally have ordinances which restrict carting them through the crowded streets, but

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these do not apply to long journeys. Before railroad days it was well understood that Congress controlled carriage of dangerous articles by water, for to regulate navigation was early understood to be a duty of the Federal Government. But in those days nitro-glycerine was unknown, and the fulminates were little used. Hence both were ignored in the early laws of Congress regulating water-carriage of dangerous articles, which mentioned only gunpowder and acids, and the like. Recently it has been thought that the authority of Congress extends to railroad-trains running from State to State, for this is a branch of "commerce among the States." When Congress came, in 1866, to legislate as to carrying nitro-glycerine and its compounds, the law was made to apply equally to vessels, and to railroads extending from one State to another. But no one has noticed that the old laws as to gunpowder ought equally to be extended to through railroad-trains. Apparently there is no Federal law prescribing precautions for railroad-carriage of gunpowder across the country, and yet, according to the most advanced views, the States have not power to pass laws on the subject. Each State has, however, power to say how explosives shall be carried within her own boundaries; and this leads to another infelicity, which is, that the law of the Union and of a State may clash. For example, United States law requires the blasting-powders made from nitro-glycerine, and the oil itself, to be packed and labeled in a peculiar way, when they are to be sent by rail from one State to another. The law of Colorado imposes restriction on nitro-glycerine, but, as amended last summer, for the convenience of the miners, it exempts dynamite and other powders. Now, if a train in Colorado should be wrecked by explosion of dynamite in the loading, the victims will not derive much comfort from being told that the offending keg did not come from the eastward States, and so was not subject to the United States rule, but was put aboard at Denver. Whatever restriction is needful ought to be imposed by Federal and State laws alike, and for short journeys as well as upon long.

The subject of dynamite is "a cloud with a silver lining"—the topic has its lighter aspects. One journal narrates that workmen, employed in blasting, left about a hundred pounds of dynamite exposed in an open box. Two cows of a neighboring farmer drew near, looked, smelled, tasted, and, finding that the compound had a saltish flavor, began to regale themselves heartily: in a moment those cows were staggering without heads. At a certain military post there was a mule who had "outlived his usefulness," also a commanding general who desired to experiment in instantaneous photography. The animal was placed in position before a camera, his forehead bearing a cotton bag containing six ounces of dynamite; the slide of the camera was supported by a fuse, and this fuse and the dynamite were connected in the same electrical circuit, by wires leading to a battery

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placed at a safe distance. On pressing the key so as to send the electricity through the wires, both fuse and dynamite were fired simultaneously, and the camera slide fell so quickly after the mule's head vanished, that a good photograph was taken of the creature, standing headless, before its body had had time to fall. Shocking to the mule; but entertaining and instructive to the class of military students which assembled to witness the experiment. More shocking, perhaps, is a device reported from the Southwest, called "the torpedo-chicken." It looks like a chicken, and sits like one on the roost among live fowl. But when, at about midnight, the hand of the chicken-thief of the region grasps it, a catch is thrown out of place, a powerful spring moves, a hammer strikes a percussion cap, there is an explosion, and about four ounces of bird-shot are thrown in every direction. The finale is said to be that a dusky figure is seen running or limping down the alley, and a husky voice is heard: "Fo' de Lawd! but what has de white folks got hold of now?" The scientific accuracy of this description will be appreciated, when the reader learns that it is from the "Detroit Free Press." Evidently, here is a hint to inventors: what a variety of burglar-alarms, thief-catchers, and other detective devices may be developed! The account circulated a year or two ago, of the newly invented trunk, fitted with pockets of nitro-glycerine at the corners, which might operate by way of reward of merit for any super-active baggage-smasher, is but a forerunner.

One would suppose that the various forms of ordnance would be managed with peculiar skill and care, yet they give rise to many disasters. A workman intrusted with packing seventy-five thousand percussion-caps in boxes handled them roughly; they exploded, and he was killed. Another, who was charging a rocket in the ordnance fulminate-room at a navy-yard, was killed, his companions severely hurt, and the inner walls of the building demolished by a premature discharge. Several men were badly hurt by a like disaster, in the course of loading cartridges with fulminate, at the factory of the Winchester Repeating Arms Company, in New Haven. A bomb-shell was sent among a quantity of old iron to a foundry in Brooklyn to be melted; but it was loaded, and within a few minutes after it was thrown into the furnace there was a disastrous explosion. The saddest case of the kind narrated during the summer is that in which Lieutenants Edes and Spalding lost their lives at Newport. They were sent to plant a torpedo, and full instructions were given them as to the precautions needful; but, through some error or neglect on their part, the electrical circuit was prematurely closed, and the torpedo fired while they were yet in their boat above it.

Not half of the casualties reported during the season have been mentioned, nor has anything been said of the numerous fatalities from bursting of kerosene lamps and cans, of leaky gas-pipes, steam-boilers, revolving stones, inflammable dust, and other things not intended as ex-

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plosives. Yet, surely ground has been shown for the suggestion that increased attention should be bestowed upon the improvement of the laws, and the instruction of the common people, relative to the modern explosives.

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THE GERM THEORY.*

By Professor LOUIS PASTEUR.

GENTLEMEN: I had no intention of addressing this admirable Congress, which brings together the most eminent medical men in the world, and the great success of which does so much credit to its principal organizer, Mr. MacCormac. The good-will of your esteemed president has decided otherwise. How could one, in fact, resist the sympathetic words of that eminent man, whose goodness of heart is associated in no small degree with great oratorical ability? Two motives have brought me to London. The first was to gain instruction, to profit by your learned discussions; and the second was to ascertain the place now occupied in medicine and surgery by the germ theory. Certainly I shall return to Paris well satisfied. During the past week I have learned much. I carry away with me the conviction that the English people are a great people; and, as for the influence of the new doctrine, I have been not only struck by the progress it has made, but by its triumph. I should be guilty of ingratitude and of false modesty, if I did not accept the welcome I have received among you, and in English society, as a mark of homage paid to my labors during the past five-and-twenty years upon the nature of ferments—their life and their nutrition, their preparation in a pure state by the introduction of organisms (*ensemencement*) under natural and artificial conditions—labors which have established the principles and the methods of *microbie* (microbism), if the expression is allowable. Your cordial welcome has revived within me the lively feeling of satisfaction I experienced when your great surgeon, Lister, declared that my publication in 1857, on milk-fermentation, had inspired him with his first ideas on his valuable surgical method. You have reawakened the pleasure I felt when our eminent physician, Dr. Davaine, declared that his labors upon charbon (splenic fever or malignant pustule) had been suggested by my studies on butyric fermentation and the vibrion which is characteristic of it. Gentlemen, I am happy to be able to thank you by bringing to your notice a new advance in the study of microbie as applied to the prevention of transmissible diseases—diseases which, for the most part, are fraught with terrible consequences, both for man and domestic animals. The subject of my com-

* London "Lancet's" translation of an address delivered at the International Medical Congress in London, August 8, 1881.

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munication is vaccination in relation to chicken-cholera and splenic fever, and a statement of the method by which we have arrived at these results—a method the fruitfulness of which inspires me with boundless anticipations. Before discussing the question of splenic-fever vaccine, which is the most important, permit me to recall the results of my investigations of chicken-cholera. It is through this inquiry that new and highly-important principles have been introduced into science concerning the virus or contagious quality of transmissible diseases. More than once, in what I am about to say, I shall employ the expression virus-culture, as formerly, in my investigations on fermentation, I used the expressions, the culture of milk-ferment, the culture of the butyric vibrion, etc. Let us take, then, a fowl which is about to die of chicken-cholera, and let us dip the end of a delicate glass rod in the blood of the fowl with the usual precautions, upon which I need not here dwell. Let us then touch, with this charged point, some *bouillon de poule*, very clear, but first of all rendered sterile under a temperature of about 115° Centigrade, and under conditions in which neither the outer air nor the vases employed can introduce exterior germs—those germs which are in the air, or on the surface of all objects. In a short time, if the little culture-vase is placed in a temperature of 25° to 35°, you will see the liquid become turbid, and full of tiny microbes, shaped like the figure 8, but often so small that, under a high magnifying power, they appear like points. Take from this vase a drop as small as you please—no more than can be carried on the point of a glass rod as sharp as a needle—and touch with this point a fresh quantity of sterilized *bouillon de poule* placed in a second vase, and the same phenomenon is produced. You deal in the same way with a third culture-vase, with a fourth, and so on to a hundred, or even a thousand, and invariably, within a few hours, the culture-liquid becomes turbid and filled with the same minute organisms. At the end of two or three days' exposure to a temperature of about 30° Cent., the thickness of the liquid disappears, and a sediment is formed at the bottom of the vase. This signifies that the development of the minute organism has ceased—in other words, all the little points which caused the turbid appearance of the liquid have fallen to the bottom of the vase, and things will remain in this condition for a longer or shorter time, for months even, without either the liquid or the deposit undergoing any visible modification, inasmuch as we have taken care to exclude the germs of the atmosphere. A little stopper of cotton sifts the air which enters or issues from the vase through changes of temperature. Let us take one of our series of culture preparations—the hundredth or the thousandth, for instance—and compare it, in respect to its virulence, with the blood of a fowl which has died of cholera; in other words, let us inoculate under the skin ten fowls, for instance, each separately with a tiny drop of infectious blood, and ten others with a similar quantity of the liquid in which

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the deposit has first been shaken up. Strange to say, the latter ten fowls will die as quickly, and with the same symptoms, as the former ten; the blood of all will be found to contain after death the same minute infectious organisms. This equality, so to speak, in the virulence both of the culture preparation and of the blood is due to an apparently futile circumstance. I have made a hundred culture preparations—at least, I have understood that this was done—without leaving any considerable interval between the impregnations. Well, here we have the cause of the equality in the virulence. Let us now repeat exactly our successive cultures, with this single difference, that we pass from one culture to that which follows it—from the hundredth to, say, the hundred and first, at intervals of a fortnight, a month, two months, three months, or ten months. If, now, we compare the virulence of the successive cultures, a great change will be observed. It will be readily seen, from an inoculation of a series of ten fowls, that the virulence of one culture differs from that of the blood, and from that of a preceding culture, when a sufficiently long interval elapses between the impregnation of one culture with the microbe of the preceding. More than that, we may recognize, by this mode of observation, that it is possible to prepare cultures of varying degrees of virulence. One preparation will kill eight fowls out of ten, another five out of ten, another one out of ten, another none at all, although the microbe may still be cultivated. In fact, what is no less strange, if you take each of these cultures of attenuated virulence as a point of departure, in the preparation of successive cultures, and without appreciable interval in the impregnation, the whole series of these cultures will reproduce the attenuated virulence of that which has served as the starting-point. Similarly, where the virulence is null, it produces no effect. How, then, it may be asked, are the effects of these attenuating virulences revealed in the fowls? They are revealed by a local disorder, by a morbid modification more or less profound in a muscle, if it is a muscle which has been inoculated with the virus. The muscle is filled with microbes which are easily recognized, because the attenuated microbes have almost the bulk, the form, and the appearance of the most virulent microbes. But why is not the local disorder followed by death? For the moment let us answer by a statement of facts. They are these: the local disorder ceases of itself more or less speedily, the microbe is absorbed and digested, if one may say so, and, little by little, the muscle regains its normal condition. Then the disease has disappeared. When we inoculate with the microbe, the virulence of which is null, there is not even local disorder, the *naturæ medicatrix* carries it off at once; and here, indeed, we see the influence of the resistance of life, since this microbe, the virulence of which is null, multiplies itself. A little further, and we touch the principle of vaccination. When the fowls have been rendered sufficiently ill by the attenuated virus which the vital resistance has arrested in its de-

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velopment, they will, when inoculated with virulent virus, suffer no evil effects, or only effects of a passing character. In fact, they no longer die from the mortal virus, and, for a time sufficiently long, which in some cases may exceed a year, chicken-cholera can not touch them, especially under the ordinary conditions of contagion which exist in fowl-houses. At this critical point of our manipulation—that is to say, in this interval of time which we have placed between two cultures, and which causes the attenuation—what occurs? I shall show you that, in this interval, the agent which intervenes is the oxygen of the air. Nothing more easily admits of proof. Let us produce a culture in a tube containing very little air, and close this tube with an enameler's lamp. The microbe, in developing itself, will speedily take all the oxygen of the tube and of the liquid, after which it will be quite free from contact with oxygen. In this case, it does not appear that the microbe becomes appreciably attenuated, even after a great lapse of time. The oxygen of the air, then, would seem to be a possible modifying agent of the virulence of the microbe of chicken-cholera—that is to say, it may modify more or less the facility of its development in the body of animals. May we not be here in presence of a general law applicable to all kinds of virus? What benefits may not be the result? We may hope to discover in this way the vaccine of all virulent diseases; and what is more natural than to begin our investigation of the vaccine of what we, in French, call charbon; what you, in England, call splenic fever; and what, in Russia, is known as the Siberian pest; and, in Germany, as the Milzbrand? In this new investigation I have had the assistance of two devoted young *savants*—MM. Chamberland and Roux. At the outset we were met by a difficulty. Among the inferior organisms, all do not resolve themselves into those corpuscle-germs which I was the first to point out as one of the forms of their possible development. Many infectious microbes do not resolve themselves, in their cultures, into corpuscle-germs. Such is equally the case with beer-yeast, which we do not see develop itself usually in breweries, for instance, except by a sort of scissiparity. One cell makes two or more, which form themselves in wreaths; the cells become detached, and the process recommences. In these cells real germs are not usually seen. The microbe of chicken-cholera and many others behave in this way, so much so that the cultures of this microbe, although they may last for months without losing their power of fresh cultivation, perish finally like beer-yeast which has exhausted all its aliments. The anthracoid microbe in artificial cultures behaves very differently. In the blood of animals, as in cultures, it is found in translucid filaments more or less segmented. This blood or these cultures freely exposed to air, instead of continuing according to the first mode of generation, show, at the end of forty-eight hours, corpuscle-germs distributed in series more or less regular along the filaments. All around these corpuscles matter is absorbed, as I have

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represented it formerly in one of the plates of my work on the diseases of silk-worms. Little by little all connection between them disappears, and presently they are reduced to nothing more than germ-dust. If you make these corpuscles germinate, the new culture reproduces the virulence peculiar to the thready form which has produced these corpuscles, and this result is seen even after a long exposure of these germs to contact with air. Recently we discovered them in pits in which animals, dead of splenic fever, had been buried for twelve years, and their culture was as virulent as that from the blood of an animal recently dead. Here I regret extremely to be obliged to shorten my remarks. I should have had much pleasure in demonstrating that the anthracoid germs in the earth of pits in which animals had been buried are brought to the surface by earth-worms; and that, in this fact, we may find the whole etiology of disease, inasmuch as the animals swallow these germs with their food. A great difficulty presents itself when we attempt to apply our method of attenuation by the oxygen of the air to the anthracoid microbes. The virulence establishing itself very quickly, often after twenty-four hours, in an anthracoid germ which escapes the action of the air, it was impossible to think of discovering the vaccine of splenic fever in the conditions which had yielded that of chicken-cholera. But was there, after all, reason to be discouraged? Certainly not; in fact, if you observe closely, you will find that there is no real difference between the mode of the generation of the anthracoid germ by scission and that of chicken-cholera. We had, therefore, reason to hope that we might overcome the difficulty which stopped us by endeavoring to prevent the anthracoid microbe from producing corpuscle-germs, and to keep it in this condition in contact with oxygen for days, and weeks, and months. The experiment fortunately succeeded. In the ineffective (*neutre*) *bouillon de poule* the anthracoid microbe is no longer cultivable at 45° Cent. Its culture, however, is easy at 42° or 43°, but in these conditions the microbe yields no spores. Consequently it is possible to maintain in contact with the pure air, at 42° or 43°, a *mycélienne* culture of bacteria entirely free of germs. Then appear the very remarkable results which follow: In a month or six weeks the culture dies—that is to say, if one impregnates with it fresh *bouillon*, the latter is completely sterile. Up to that time life exists in the vase exposed to air and heat. If we examine the virulence of the culture at the end of two days, four days, six days, eight days, etc., it will be found that long before the death of the culture the microbe has lost all virulence, although still cultivable. Before this period it is found that the culture presents a series of attenuated virulences. Everything is similar to what happens in respect to the microbe in chicken-cholera. Besides, each of these conditions of attenuated virulence may be reproduced by culture; in fact, since the charbon does not operate a second time (*ne récidive pas*), each of our attenuated anthracoid microbes constitutes

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for the superior microbe a vaccine—that is to say, a virus capable of producing a milder disease. Here, then, we have a method of preparing the vaccine of splenic fever. You will see presently the practical importance of this result, but what interests us more particularly is to observe that we have here a proof that we are in possession of a general method of preparing virus vaccine based upon the action of the oxygen and the air—that is to say, of a cosmic force existing everywhere on the surface of the globe. I regret to be unable, from want of time, to show you that all these attenuated forms of virus may very easily, by a physiological artifice, be made to recover their original maximum virulence. The method I have just explained of obtaining the vaccine of splenic fever was no sooner made known, than it was very extensively employed to prevent the splenic affection. In France we lose every year by splenic fever animals of the value of 20,000,000 francs. I was asked to give a public demonstration of the results already mentioned. This experiment I may relate in a few words. Fifty sheep were placed at my disposition, of which twenty-five were vaccinated. A fortnight afterward the fifty sheep were inoculated with the most virulent anthracoid microbe. The twenty-five vaccinated sheep resisted the infection; the twenty-five unvaccinated died of splenic fever within fifty hours. Since that time my energies have been taxed to meet the demands of farmers for supplies of this vaccine. In the space of fifteen days we have vaccinated, in the departments surrounding Paris, more than 20,000 sheep, and a large number of cattle and horses. If I were not pressed for time, I should bring to your notice two other kinds of virus attenuated by similar means. These experiments will be communicated by-and-by to the public. I can not conclude, gentlemen, without expressing the great pleasure I feel at the thought that it is as a member of an international medical congress, assembled in England, that I make known the most recent results of vaccination upon a disease more terrible, perhaps, for domestic animals than small-pox is for man. I have given to vaccination an extension which science, I hope, will accept as a homage paid to the merit and to the immense services rendered by one of the greatest men of England, Jenner. What a pleasure for me to do honor to this immortal name in this noble and hospitable city of London!

DEAN SWIFT'S DISEASE.

By Dr. BUCKNILL, F. R. S.

DURING the past autumn I received a letter from a gentleman engaged in literary work, requesting my opinion on the "mysterious disease" of the great author and wit whose name distinguishes this paper. My interlocutor particularly wished to know whether the

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sane part of Swift's life was likely to have been in any way affected by the latent presence of insanity; whether a correct diagnosis was possible; whether parallel cases were on record; and, finally, whether a surfeit of green fruit, at the age of twenty-three years, was capable of resulting in the absolute fatuity from which the patient suffered at seventy-five.

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This questioning has stimulated me to an investigation which I had thought was already threadbare, but which I found full of interest; and when I say that, upon weighing the evidence, it will probably be acknowledged that Jonathan Swift's mysterious disease was an instance of that curious form of disease, labyrinthine vertigo, or le maladie de Ménière, the knowledge of which is one of the most recent triumphs of pathological research directed by physiological experiment, it will scarcely be thought that it was needless to reopen a controversy in which already everything had been said which ought to have been said, and not a little which ought not to have been said.

When Dr. Beddoes suggested that Swift's ailments and his conduct toward women were due to dissolute habits in youth, Sir Walter Scott replied that, "until medical authors can clearly account for and radically cure the diseases of their contemporary patients, they may readily be excused from assigning dishonorable causes for the disorders of the illustrious dead." But, if Dr. Beddoes were unquestionably wrong in making such a suggestion without evidence, Sir Walter was scarcely right in making his retort too general; for, if medical opinions respecting the states of mind of persons who have departed this life must be forbidden until medical men can insure the radical cure of diseases, not only will much valuable evidence respecting the validity of wills be excluded, but the science of pathology itself, depending upon the history of diseases and verified by observations made after death, must be interrupted until an event which seems impossible has taken place.

Whether the causes of disease are or are not dishonorable, and whether the subjects of them are or are not illustrious, has nothing to do with the scientific question; and the often-quoted sneer of Swift's greatest biographer at the medical profession seems, when examined, as silly as general sarcasm usually is. Undeterred by such sarcasm, an eminent medical man did investigate the causes for the disorders of the illustrious dead in a work which he modestly called an essay, published in 1849, and entitled "The Closing Years of Dean Swift's Life," etc., by W. R. Wilde, M. R. I. A., F. R. C. S. This little work, marked by the excellences of careful research, sound reasoning, moderate opinions and fair conclusions, would have rendered further discussion needless if medical science had stood still since its publication; but the advances made in medical psychology during the last thirty-two years might give us some excuse for reconsideration even if Ménière

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had never made his discovery of a definite form of disease previously unrecognized, which appears to conform in all important points with the life-long disease of the illustrious dean.

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Even in Swift's latest biography, or rather that fragment of one which so strongly makes us feel that touch of the vanished hand of the most appreciative critic of men of letters, the late John Forster's charming volume, the author speaks of Swift's giddiness and deafness, not as symptoms of one disorder, but as "two life-long enemies," and it is a curious enough fact that Swift himself attributed the origin of these two enemies to different causes, operating at different periods. In a letter to Mrs. Howard in 1727 he writes: "About two hours before you were born I got my *giddiness* by eating a hundred golden pippins at a time at Richmond; and when you were four years and a quarter old, bating two days, having made a fine seat further in Surrey, where I used to read, there I got my *deafness*, and these two friends, one or other, have visited me one or other every year since; and, being old acquaintances, have now thought fit to come together." Mrs. Howard having been born in 1690, the date of the deafness given in this letter would be 1694, when Swift was twenty-seven years old. But in a passage quoted by Forster, page 48, Swift wrote: "In England before I was twenty I got a cold, which gave me a deafness that I could never clear myself of . . . my left ear has never been well since."—April 30, 1737.

One can not but concur in Johnson's remark on the above, that "the original of diseases is commonly obscure, and almost every school-boy eats as much fruit as he can get, without inconvenience." But it may also be remarked that if Swift had been "a contemporary patient," although we might not have effected a radical cure of his disease, we should at least have understood enough of its origin and nature to have saved him from tormenting himself by a life-long abstinence from fruit, of which he was passionately fond, under the belief that it had caused and continued to excite his disease by inducing that "coldness of stomach to which he attributed his vertigo and its accompanying sickness."

In a letter of 1708 he says that, "I was through a long time pursued by a cruel illness that seized me at fits and hindered me from pursuing any business." It is possible that this illness was but a return of the dangerous colic from which he suffered in 1696; and it is not until 1710 to 1713, and while residing in London, that he describes in some detail the symptoms of his life-long complaint in his "Journal to Stella." The most descriptive passage is perhaps the one dated October 31, 1710:

"This morning, sitting in my bed, I had a fit of *giddiness;* the room turned round for about a minute, and then it went off, leaving me *sickish*, but not very. I saw Dr. Cockburn to-day, and he promises to send me the pills that did me good last year; and likewise has

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promised me an oil for my *ears*, that he has been making for that ailment for somebody else."

A fit of giddiness, with sickness and ear-disease, is not this labyrinthine vertigo?

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On different days in *January*, 1711, he writes:

"I had an ugly fit in my chamber last night. . . . My head is not in order, and yet is not absolutely ill; but giddyish, and makes me listless. . . . One fit shakes me a long time."

February 1st.—"I walked into the City to dine, but I walked plaguy carefully, for fear of sliding against my will."

April 18th.—"I did not go to the House of Commons about the yarn: my head was not well enough. I know not what is the matter. It has never been thus before; two days together giddy from morning till night, and I totter a little, but can make a shift to walk."

In *May:* "I do not totter as I did, but walk firm as a rock, only once or twice for a minute."

September 1st, he notes an important peculiarity, distinguishing cerebral from stomachic vertigo: "My head is pretty well; only a sudden turn at any time makes me feel giddy for a moment, and sometimes it feels very stuffed."

The journals of October show that he distinguished ordinary from vertiginous headache: "My head has ached a little in the evening, but it is not of the true giddy sort, so I do not much value it. . . . I had a little turn in my head this morning, which, though it did not last above a minute, yet being of the true sort, has made me as weak as a dog all this day."

During the years of residence in London which embrace the period of the "Journal to Stella," his other enemy, deafness, is only referred to incidentally, as when he compares it to that of the Lord Treasurer; but, after his return to Ireland, his deafness becomes sufficiently severe to make him complain.

In 1720 he writes, "What if I should add that once in five or six weeks I am deaf for three or four days?"

In 1724 he writes, "I have been this month past so pestered with a return of the *noise and deafness* in my ears that I had not the spirit to perform the common offices of life." Subsequently, in the same year, "My deafness has left me above three weeks, and therefore I expect a visit from it soon." It was evidently periodic and paroxysmal, like the giddiness.

He complains in another letter of an old vexatious disorder of a deafness and *noise* in the ears. In 1727, in a letter to Sheridan, he says that his deafness is worse than it ever before had been, and that it is accompanied by giddiness and tottering. "I believe," says he, "that this giddiness is the disorder which will at last get the better of me." And again, "I walk like a drunken man, and am deafer than ever you knew me."

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In 1728, in "about eight months," says Wilde, "he had half a dozen attacks of the giddiness and sickness, each of which lasted about three weeks." But in 1731 he wrote to Mr. Gay, "The giddiness I was subject to, instead of coming seldom and violent, now constantly attends me more or less, though in a more peaceable manner, yet such as will not qualify me to live among the young and healthy." In 1736, writing to Pope, "years and infirmities have quite broke me. I mean that *continual* disorder in my head." In 1737, to Alderman Barker, "I am forced to tell you my health is much decayed; my deafness and giddiness more frequent; spirits I have none left; my memory is almost gone."

Long before, however, these symptoms had commenced. Impairment of memory he complained of as early as 1713, after the attack of shingles; and later on in the same year he speaks of his horrible melancholy changing into dullness, and from thenceforth increasing irritability of temper and mental depression are traceable throughout his history and correspondence. Not that he was at any time really of unsound mind or incapable; for, when in 1737, in the Bettesworth affair, a gratifying address was presented to him, it is recorded that "when this paper was delivered Swift was in bed, giddy and deaf, having been some time before seized with one of his fits; but he dictated an answer in which there is all the dignity of habitual pre-eminence and all the resignation of humble piety."

The above quotations are but a selection from a far greater number of references which might be made to Swift's letters and journals, affording conclusive evidence, as I venture to think, that he suffered from twenty years of age from the disease, whose characteristic symptoms are, "that the patient is suddenly seized with vertigo and a feeling of nausea or positive sickness, with great constitutional depression and faintness. Usually the giddiness comes on simultaneously with ringing or buzzing in one or, it may be, both ears."—*Ferrier.*

It has this year been pointed out by Féré, in the "Revue de Médecine," that there are two forms of the disease to be recognized, "une forme grave avec état vertigineux à peu près permanent interrompu par les paroxysmes, et une forme moins fâcheuse, constituée par des accès séparés par des périodes de santé parfaite. . . . Dans la forme bénigne [of which Swift's was an example] les accès ne se produisent quelquefois qu'à des distances très éloignées. E. Ménière cite une malade qui eut une rémission de onze mois. Pendant ces périodes d'accalmie, la surdité persiste avec une intensité variable, et elle s'accompagne souvent des sensations subjectives intermittentes de l'ouïe. La maladie elle-même dure tant que la surdité n'est pas absolue."

Up to the date to which we have traced the progress of the disease, it appears to have been purely a physical malady, with no mental symptoms, unless some degree of loss of memory can be so called.

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Swift, indeed, complains bitterly of the impairment, as if memory were gone, and in his declining years of age and sickness it may have been a dull function compared with the brilliant faculty he once possessed. But clearly the memory was still serviceable which enabled him to compose, with wonderful vivacity, even such poetry as that outburst against political and social corruption—"The Legion Club"—which Jeffrey thinks "deserving of attention as the most thoroughly animated, fierce, and energetic of all Swift's metrical compositions; and though the animation be altogether of a ferocious character, and seems occasionally to verge upon absolute insanity, there is still a force and a terror about it which redeems it from ridicule, and makes us shudder at the sort of demoniacal inspiration with which the malison is vented." This poem, written in 1736, was his last work; its appreciation by his most hostile critic will show how little he suffered from loss of any mental faculty when he wrote it. That disease and grief had made him irritable and passionate, and often desponding, is clear enough from his correspondence and the accounts of him which have come down to us; but that there was any failure of mind this "Legion Club" fully disproves; and, if fiercely expressed hatred is any evidence that an author is on the verge of insanity, Jeffrey must have been curiously insensible to the testimony he was bearing against his own soundness of mind in his criticism of the greater master of his own art.

Between 1736, when Swift wrote "The Legion Club," and 1741, when the outbreak of insanity really took place, there can be no doubt that he passed through a period of great wretchedness and depression—he was "miserably ill." He had lost to a great extent two of his senses, for he was deaf and his eye-sight failed; his dearest friends had died before him, and his public sympathies were constantly outraged.

In 1738 he wrote to Alderman Barker: "I have for almost three years past been only the shadow of my former self, with years of sickness and rage against all public proceedings, especially in this miserably oppressed country. I have entirely lost my memory, except when it is aroused by perpetual subjects of vexation."

Two years later he wrote the following pathetic letter to his old friend Mrs. Whiteway:

"I have been very miserable all night, and to-day extremely deaf and full of pain. I am so stupid and confounded that I can not express the mortification I am under, both of body and mind. All I can say is that I am not in torture, but I daily and hourly expect it. Pray let me know how your health is, and your family. I hardly understand one word I write. I am sure my days will be very few; few and miserable they must be. I am for these few days yours entirely,

J. SWIFT.

"If I do not blunder it is Saturday."

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A very pitiful state this period of becoming insane, and yet not having become so. But even at this late date one can not recognize the invasion of mental disease. Misery and despondency there was, more than enough, but not madness, unless Job was mad. But Swift was rapidly tending toward madness, and he knew it, for strong forebodings of insanity, which are not common, existed in him in a remarkable degree. Sir Walter Scott says that "his first state was that of violent and furious lunacy"; but Sir William Wilde points out that all the biographers have had no other sources of information as to the outbreak and history of his insanity than two letters; one from Mrs. Whiteway, and one from his cousin, Mr. Deane Swift.

Mrs. Whiteway wrote November 22, 1742, as follows, omitting some expressions of feeling:

"I was the last person whom he knew, and when that part of his memory failed he was so outrageous at seeing anybody that I was forced to leave him, nor could he rest for a night or two after seeing any person. He walked ten hours a day, would not eat or drink if his servant staid in the room. His meal was served ready cut, and sometimes it would be an hour on the table before he would touch it, and then eat it walking. About six weeks ago, in one night's time his left eye swelled as large as an egg, and the lid, Mr. Nicholls [his surgeon] thought would mortify, and many large boils appeared on his arms and body. The torture he was in is not to be described. Five persons could scarce hold him, for a week, from tearing out his own eyes; and for near a month he did not sleep two hours in twenty-four. Yet a moderate appetite continued; and, what is more to be wondered at, the last day of his illness he knew me perfectly well, took me by the hand, called me by my name, and showed the same pleasure as usual in seeing me. I asked him if he would give me a dinner? He said, 'To be sure, my old friend.' Thus he continued that day, and knew the doctor and surgeon and all his family, so well that Mr. Nicholls thought it possible he might return to a share of understanding, so as to be able to call for what he wanted, and to bear some of his old friends to amuse him. But alas! this pleasure to me was but of short duration; for the next day or two it was all over, and proved to be only pain that had roused him. He is now free from torture, his eye almost well, very quiet, and begins to sleep, but can not without great difficulty be prevailed upon to walk a turn about his room; and yet in this way, the physicians think, he may hold out for some time."

The only other authentic account from personal knowledge is contained in the letter of Mr. Deane Swift to Lord Orrery, dated April 4, 1744. After stating that a thousand stories of the illness had been invented and imposed upon the world, he proceeds to state some facts witnessed by himself:

"On Sunday the 17th of March, as he sat in his chair, upon the

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housekeeper removing a knife from him as he was going to catch at it, he shrugged his shoulders, and rocking himself, he said, 'I am what I am. I am what I am'; and about six minutes afterward repeated the same words two or three times over. Sometimes he will not utter a syllable, at other times he will speak incoherent words; but he never yet, as far as I could hear, talked nonsense, or said a foolish thing. About four months ago he gave me great trouble. He seemed to have a mind to talk to me. In order to try what he would say, I told him I came to dine with him, and immediately his housekeeper, Mrs. Ridgeway, said, 'Won't you give Mr. Swift a glass of wine, sir?' he shrugged his shoulders, just as he used to do when he had a mind that a friend should not spend the evening with him. Shrugging his shoulders, your lordship may remember, was as much as to say, 'You'll ruin me in wine.' I own I was scarce able to bear the sight. Soon after he again endeavored, with a good deal of pain, to find words to speak to me; at last, not being able, after many efforts, he gave a heavy sigh, and I think was afterward silent. This puts me in mind of what he said about five days ago. He endeavored several times to speak to his servant [now and then he calls him by his name]; at last, not finding words to express what he would be at, he said, 'I am a fool.' Not long ago the servant took up his watch that lay upon the table, to see what o'clock it was; he said, 'Bring it here,' and when it was brought, he looked very attentively at it. Some time ago the servant was breaking a large, stubborn coal, he said, 'That's a stone, you blockhead.' In a few days, or some very short time after guardians had been appointed for him, I went into his dining-room, where he was walking; I said something to him very insignificant, I know not what, but, instead of making any kind of answer to it, he said, 'Go, go,' pointing with his hand to the door, and immediately afterward, raising his hand to his head, he said, 'My best understanding,' and so broke off abruptly, and walked away."

These two letters are stated by Sir William Wilde to be the only account of the last three years of Swift's life that has come down to us. He died October 19, 1745, in the seventy-eighth year of his age. His death, according to Lord Orrery, being easy, without the least pang or convulsion; but according to Faulkner, being one of "great agony, with strong convulsive fits" for thirty-six hours before. The only record of the autopsy which was made is that Mr. Whiteway "opened the skull, and found much water in the brain." A more interesting record, however, remains in the plaster cast of Swift's head. Of this Sir Walter Scott says that "the expression is most unequivocally maniacal, and one side of the mouth horribly contorted downward as if in pain." But Sir William Wilde, whose observation we greatly prefer in such a matter, says: "The expression is remarkably placid, but there is an evident drag on the left side of the mouth, exhibiting a paralysis of the facial muscles to the right side. Upon the

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back of the cast are two lines of writing, greatly defaced, of which this much can still be read: 'Dean Swift, taken off his * * * * the night of his burial, and the f * * * * one side larger than the other in nature * * Opened before * * * The mould is in pieces.'" A deep indentation, says Wilde, shows where the calvarium had been sawn; and accurately corresponds with the division of the skull found in Swift's coffin in 1835. On the same excellent authority we know that the cast of the interior of Swift's skull is remarkable as showing the enormous development of the vessels within the cranium, the very small anterior lobes, the great size of the glandulæ Pacchioniæ, the exceedingly small cerebellum, a natural formation as may be seen by the very low position of the tentorium, the immense size of the posterior and middle lobes, particularly the former, and the absence of any appearance of disease in the anterior lobes, as far at least as this cast of the interior of the skull is capable of demonstrating.

Swift of course was not exempt from intercurrent diseases, the most important of which appear to have been a severe colic in 1696, which brought him to extremity, "so that all despaired of my life, and the newspapers reported me dead"; an attack of herpes zoster of the left neck and shoulder, with its atrocious after-pains, in 1712; and a severe attack of ague in 1720, which lasted a whole year. But these maladies appear to have passed away without permanent injury, and it is to the cold which, before he was twenty, gave him a deafness and an ear "which has never been well since," to which we must look as the origin of his physical and ultimately of his mental miseries, and which made him often describe himself as

"Vertiginosus, inops, surdus, male gratus amicis."

He does not appear ever to have guessed that his vertigo was due to the state of the auditory organ, nor indeed did any physician ever suspect that such was the case in any one suffering from ear-giddiness, until, led to reflect on the subject by Fleurens's experiments on the semicircular canals of pigeons and rabbits, Ménière recognized the causal connection in 1861. The paroxysmal nature of the affection, with long intervals of immunity, is well marked in Swift's case, although it would appear from a quotation made by Forster, p. 253, from one of his note-books, that the fits were pretty frequent, the reference to fits in his journal and correspondence only applying to the more serious occasions. The quotation is as follows:

"1708. *Nov.*—From 6th to 16, often giddy. G[d] help me. So to 25 less. 16, Brandy for giddiness 2*s*. Br[dy] 3[d]. *Dec.* 5.—Horribly sick. 12*th*.—Much better, thank God and M. D.'s prayers. 16*th*.—Bad fit at Mrs. Barton's. 24. Better; but dread a fit. Better still to the end. 1709, *Jan.* 21*st*.—An ill fit but not to excess. 29. Out of order. 31. Not well at times. *Feb.* 7.—Small fit abroad. Pretty well to the end. *March*.—Headache frequent. *April* 2*nd*.—Small

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giddy fit and swimming in the head. M. D. and God help me. *August.*—Sick with giddiness much. 1710. *Jan.*—Giddy. *March.*—Sadly for a day. *4th.* Giddy from 4th. *14th.*—Very ill. *July.*—Terrible fit. G[d] knows what may be the event. Better towards the end."

It is true that the paroxysms were not so numerous as those of most other cases of the disease which are on record, and also that the deafness never became absolute, and therefore that the disease never ceased. It increased in intensity as life advanced, until it confined him to his chamber for weeks at a time. It is also to be remarked that a slight degree of vertigo caused great constitutional disturbance. "I had a little turn in my head this morning, which, though it did not last above a moment, yet, being of the true sort, has made me as weak as a dog all this day."—*Journal*, October 23, 1711. "This morning I felt a little twitch of giddiness, which has disordered and weakened me with its ugly remains all this day."—*Journal*, January 25, 1812. Another characteristic of the vertigo, noted in a quotation already given, is that at one time any slight movement of the head brought it on.

It is certain that this fearful disease, aggravated with the increase of years, had an influence in the causation of Swift's insanity; but that its influence was direct—that is to say, by the extension of the local disease to the brain—is by no means so sure as its indirect effect as one source of the profound depression which marked the latter years of his sane life. We have no authentic account of the first outbreak of insanity, and Sir Walter's statement that, after his understanding failed, "his first state was that of violent and furious lunacy," would seem to have been applicable only to that later period when he suffered indescribable torture from some unknown local disease, producing exophthalmos of the left eye. It is clear there was emotional depression amounting to melancholia, and "much water in the brain," which was probably sub-arachnoid effusion, is sufficient evidence of dementia. But there was also that form of aphasia in which scraps of reasonable language come automatically, though intentional effort can produce no words, and very curiously, in connection with this fact, comes the evidence of the plaster-cast, "brought to light a hundred years after death," that there was right-sided hemiplegia. The knowledge of the importance of this fact also has been acquired since Sir William Wilde wrote his work, and it is not, therefore, surprising that while he so carefully and skillfully marshals the data upon which our diagnosis is now made, he does not connect the right-sided hemiplegia with the very peculiar affection of speech recorded by one of the two authentic witnesses above quoted. Sir William Wilde expresses the opinion that the hemiplegia had existed for several years before death, "for we find the same appearance much glossed over by the artist, together with a greater fullness or plumpness of the right

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cheek shown in a very admirable bust, probably the last ever taken." But as Wilde admits, the "six well-known busts of Swift, undoubtedly taken about the same time, exhibit six different forms of head bearing but little resemblance to each other," the much-glossed-over appearance can, therefore, scarcely be admitted as evidence. Probably the stroke of palsy recorded in the plaster-cast had taken place unobserved at or about the time of the actual outbreak of the mental disorder, which might have masked the physical symptoms from observation.

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When "the Vandal desecration of monuments" in 1835 exposed Swift's skull to the phrenologists, the great Dublin aurist might possibly have found in the bones of the ear traces of the cause of his giddiness. When Mr. Whiteway examined the brain he might have found the cause of Swift's right-sided hemiplegia and his aphasia. It is enough now that we can diagnose his life-long disease as labyrinthine vertigo, and his insanity as dementia with aphasia; the dementia arising from general decay of the brain from age and disease, the paralysis and aphasia from disease of one particular part of the brain.

With all the tortures of the life-long disease from which he suffered and its obvious effect upon his temper in his later years, it is wonderful that Swift did retain his reason until, in the seventy-fourth year of his age, he was in all probability struck down by a new disease in the form of a localized left-side apoplexy or cerebral softening, which determined the symptoms of his insanity.

That Swift's works contain no indications of insanity appears to me certain. As well say that Shakespeare was mad because he wrote a good deal which we think nasty. In the fashion of the day, Swift was too prone to make what may be called excrementitious jokes and gibes. But that perfect gentleman Antonio voided his rheum upon Shylock's beard; and the same kind of thing runs through our literature, no one objecting, until we rather recently began to become less natural and more nice. Some of our smaller humorists and men of letters have criticised this great king of humor as if he were both bad and mad, not perceiving that if he were really insane he must be pitied and not cursed. But it is the weakest of arguments to say, with Festus, for want of argument, "Much learning doth make thee mad." There is always weakness in madness, but there is little sign of this in Swift's works. There is always some inconsequentness or incoherency in madness, but there is none of this in Swift. Down to that last letter to Mrs. Whiteway he is most wretched, but he is still collected and wholly himself.

One final consideration is that the oppressive and disabling nature of Swift's life-long disease has been greatly underrated in the more severe of the criticisms which have been made with regard to his conduct to Esther Johnstone. I do not know that labyrinthine vertigo would necessarily incapacitate a man for the performance of marital

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duties, but it certainly might be a barrier to them more formidable than unprofessional critics are likely to suppose possible. Dr. Beddoes suggested that Swift was impotent from youthful dissipation, of which there is not a tittle of evidence. May not the great and grave disease of which I have adduced such copious evidence have been the real reason why Swift did not live with the woman whom it is certain that he loved with the most tender and persistent devotion?—*Brain.*

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HYACINTH-BULBS.

By Professor GRANT ALLEN.

IF we were not so familiar with the fact, we would think there were few queerer things in nature than the mode of growth followed by this sprouting hyacinth-bulb on my mantel-piece here. It is simply stuck in a glass stand filled with water, and there, with little aid from light or sunshine, it goes through its whole development like a piece of organic clock-work, as it is, running down slowly in its own appointed course. For a bulb does not grow as an ordinary plant grows, solely by means of carbon derived from the air under the influence of sunlight. What we call its growth we ought rather to call its unfolding. It contains within itself everything that is necessary for its own vital processes. Even if I were to cover it up entirely, or put it in a warm, dark room, it would sprout and unfold itself in exactly the same way as it does here in the diffused light of my study. The leaves, it is true, would be blanched and almost colorless, but the flowers would be just as brilliantly blue as these which are now scenting the whole room with their delicious fragrance. The question is, then, how can the hyacinth thus live and grow without the apparent aid of sunlight, on which all vegetation is ultimately based?

Of course, an ordinary plant, as everybody knows, derives all its energy or motive-power from the sun. The green leaf is the organ upon which the rays act. In its cells the waves of light propagated from the sun fall upon the carbonic acid which the leaves drink in from the air, and, by their disintegrating power, liberate the oxygen while setting free the carbon, to form the fuel and food-stuff of the plant. Side by side with this operation the plant performs another, by building up the carbon thus obtained into new combinations with the hydrogen obtained from its watery sap. From these two elements the chief constituents of the vegetable tissues are made up. Now, the fact that they have been freed from the oxygen with which they are generally combined gives them energy, as the physicists call it, and, when they recombine with oxygen, this energy is again given out as heat, or motion. In burning a piece of wood or a lump of coal, we

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are simply causing the oxygen to recombine with these energetic vegetable substances, and the result is, that we get once more the carbonic acid and water with which we started. But we all know that such burning yields not only heat, but also visible motion. This motion is clearly seen even in the draught of an ordinary chimney, and may be much more distinctly recognized in such a machine as the steam-engine.

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At first sight, all this seems to have very little connection with hyacinth-bulbs. Yet, if we look a little deeper into the question, we shall see that a bulb and an engine have really a great many points in common. Let us glance first at a somewhat simpler case, that of a seed, such as a pea or a grain of wheat. Here we have a little sack of starches and albumen laid up as nutriment for a sprouting plantlet. These rich food-stuffs were elaborated in the leaves of the parent pea, or in the tall haulms of the growing corn. They were carried by the sap into the ripening fruit, and there, through one of those bits of vital mechanism which we do not yet completely understand, they were selected and laid by in the young seed. When the pea or the grain of wheat begins to germinate, under the influence of warmth and moisture, a very slow combustion really takes place. Oxygen from the air combines gradually with the food-stuffs or fuels—call them which you will—contained in the seed. Thus heat is evolved, which in some cases can be easily measured with a thermometer, and felt by the naked hand—as, for example, in the malting of barley. At the same time motion is produced; and this motion, taking place in certain regular directions, results in what we call the growth of a young plant. In different seeds this growth takes different forms, but in all alike the central mechanical principle is the same: certain cells are raised visibly above the surface of the earth, and the motive power which so raised them is the energy set free by the combination of oxygen with their starches and albumens. Of course, here, too, carbonic acid and water are the final products of the slow combustion. The whole process is closely akin to the hatching of an egg into a living chicken. But, as soon as the young plant has used up all the material laid by for it by its mother, it is compelled to feed itself just as much as the chicken when it emerges from the shell. The plant does this by unfolding its leaves to the sunlight, and so begins to assimilate fresh compounds of hydrogen and carbon on its own account.

Now, it makes a great deal of difference to a sprouting seed whether it is well or ill provided with such stored-up food-stuffs. Some very small seeds have hardly any provisions to go on upon; and the seedlings of these, of course, must wither up and die if they do not catch the sunlight as soon as they have first unfolded their tiny leaflets; but other wiser plants have learned by experience to lay by plenty of starches, oils, or other useful materials in their seeds; and, wherever such a tendency has once faintly appeared, it has given such an advan-

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tage to the species where it occurred that it has been increased and developed from generation to generation through natural selection. Now, what such plants do for their offspring, the hyacinth and many others like it do for themselves. The lily family, at least in the temperate regions, seldom grows into a tree-like form; but many of them have acquired a habit which enables them to live on almost as well as trees from season to season, though their leaves die down completely with each recurring winter. If you cut open a hyacinth-bulb, or, what is simpler to experiment upon, an onion, you will find that it consists of several short abortive leaves, or thick fleshy scales. In these subterranean leaves the plant stores up the food-stuffs elaborated by its green portions during the summer; and there they lie the whole winter through, ready to send up a flowering stem early in the succeeding spring. The material in the old bulb is used in thus producing leaves and blossoms at the beginning of the second or third season; but fresh bulbs grow out anew from its side, and in these the plant once more stores up fresh material for the succeeding year's growth.

The hyacinths which we keep in glasses on our mantel-pieces represent such a reserve of three or four years' accumulation. They have purposely been prevented from flowering, in order to make them produce finer trusses of bloom when they are at length permitted to follow their own free-will. Thus the bulb contains material enough to send up leaves and blossoms from its own resources; and it will do so even if grown entirely in the dark. In that case the leaves will be pale yellow or faintly greenish, because the true green pigment, which is the active agent of digestion, can only be produced under the influence of light; whereas, the flowers will retain their proper color, because their pigment is always due to oxidation alone, and is but little dependent upon the rays of sunshine. Even if grown in an ordinary room, away from the window, the leaves seldom assume their proper deep tone of full green; they are mainly dependent on the food-stuffs laid by in the bulb, and do but little active work on their own account. After the hyacinth has flowered, the bulb is reduced to an empty and flaccid mass of watery brown scales.

Among all the lily kind, such devices for storing up useful material, either in bulbs or in the very similar organs known as corms, are extremely common. As a consequence, many of them produce unusually large and showy flowers. Even among our native English lilies we can boast of such beautiful blossoms as the fritillary, the wild hyacinth, the meadow-saffron, and the two pretty squills; while in our gardens the tiger-lilies, tulips, tuberoses, and many others belong to the same handsome bulbous group. Closely-allied families give us the bulb-bearing narcissus, daffodil, snow-drop, amaryllis, and Guernsey lily; the crocus, gladiolus, iris, and corn-flag; while the neighboring tribe of orchids, most of which have tubers, probably produce more

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ornamental flowers than any other family of plants in the whole world. Among a widely-different group we get other herbs which lay by rich stores of starch, or similar nutritious substances, in thickened underground branches, known as tubers; such, for example, are the potato and the Jerusalem artichoke. Sometimes the root itself is the storehouse for the accumulated food-stuffs, as in the dahlia, the carrot, the radish, and the turnip. In all these cases, the plant obviously derives benefit from the habit which it has acquired of hiding away its reserve fund beneath the ground, where it is much less likely to be discovered and eaten by its animal foes. For it is obvious that these special reservoirs of energetic material, which the plant intends as food for its own flower or for its future offspring, are exactly those parts which animals will be likely unfairly to appropriate to their personal use. What feeds a plant will feed a squirrel, a mouse, a pig, or a man, just as well. Each requires just the same free elements, whose combination with oxygen may yield it heat and movement. Thus it happens that the parts of plants which we human beings mainly use as food-stuffs are just the organs where starch has been laid by for the plant's own domestic economy—seeds, as in the pea, bean, wheat, maize, barley, rice, or millet; tubers, as in the potato and Jerusalem artichoke; corns, as in the yam or tare; and roots, as in arrow-root, turnip, parsnip and carrot. In all these, and in many other cases, the habit first set up by Nature has been sedulously encouraged and increased by man's deliberate selection. What man thus consciously effects in a few generations, the survival of the fittest has unconsciously effected through many long previous ages of native development.—*Knowledge.*

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THE JAVANESE CALENDAR.*

By J. A. C. OUDEMANS.

THE Egyptians, Greeks, and Romans regulated their most important field-labors, the sowing and gathering of their crops, etc., by their observations of the movements of the heavenly bodies, as the rising and setting of the stars. It is obvious that this system gives only an approximation to the true time; for not only the time of the rising and setting of the stars, but also the relative situation of the stars to each other, is changed by the precession of the equinoxes. Notwithstanding this, this system is still used by some of the less civilized peoples of the East Indies; and, although the Dutch Government employs the Gregorian calendar exclusively in its colonies, the Javan-

* J. A. C. Oudemans, Mededeeling betreffende de sterrebeelden, wier hoogte boven den Horizen, op een bepaald oogenblick van den nacht, door de Javanen ten behoeve van de lanbouw geraadpleegd wordt. Amsterdam, 1881.

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ese agriculturist goes to this day by his own calendar, which is based upon the position of Orion and the Pleiades, and the length of the shadow at noon. The geographical situation of Java is such (mean latitude 7° south), that the sun stands at 30½° north of the zenith on the 21st of June, and at 16½° south of it on the 21st of December. The shadow, on the 21st of June, falling in a southerly direction, is nearly double the length of the shadow on the 31st of December, which falls in a northerly direction. The shadow requires six months to pass from its greatest length toward the south to its greatest length toward the north, and a year to return to the same position.

If the length of the shadow on the 21st of June is divided into four equal parts, and the length on the 21st of December into two equal parts, we shall have six equal measures of length corresponding with six unequal intervals of time; these intervals may then be distinguished according to the length of the shadow. The Javanese avail themselves of this peculiarity of shadows in their country to adjust the division of their solar year, the first day of which corresponds with the 21st of June of the Gregorian reckoning. They divide the year into twelve unequal months (*mangsa*), which are respectively 41, 23, 24, 25, 27, 43, 43, 26, 25, 24, 23, and 24 days long. Independently of this division, the farmer plants his rice and other crops according to the height of Orion and the Pleiades above the horizon. This height is taken either at night-fall, half an hour after sunset, or in the morning, half an hour before sunrise. The following are the names of the calendar months, and the most important observations and farmers' rules that are connected with them:

First month (*Kasa*), forty-one days, from the 21st of June to the 31st of July inclusive. Orion and the Pleiades are visible in the east, respectively 25° and 45° above the horizon. The sun turns back toward the south; a man's shadow at noon reaches four feet south. The fresh-water fish *iwak bettik* has one spot on its head. It is time to plant the second crop of rice.

Second month (*Kara*), twenty-three days long, from the 1st to the 23d of August. The Pleiades are in the zenith, Orion 70° above the eastern horizon. The *iwak bettik* has two spots. The sun goes farther toward the south. A man's shadow at noon measures two feet south.

Third month (*Ketiga*), twenty-four days, from the 24th of August to the 16th of September. Before sunrise the Pleiades are 70° above the western horizon, Orion in the zenith. The leaves begin to fall from the trees. The *iwak bettik* has three spots. The course of the sun continues to be in the north, and the noonday shadow measures one foot south. The second crop of rice begins to ripen.

Fourth month (*Kapat*), twenty-five days, from the 17th of September to the 11th of October. Before sunrise the Pleiades are 50° and Orion 70° above the western horizon. The *glattiks*, or rice-birds, fall upon the fields in multitudes in search of food. The fruit-trees

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have new buds and fresh leaves. The *randoe* fruits are ripe, the cotton appears and begins to fall. The sun rises in the east and casts no shadow at noon. Harvest begins.

Fifth month (*Kelima*), twenty-seven days, from the 12th of October till the 7th of November. The medical plants called *lempoeygang* begin to put out new roots. The swallows called *maog terrik* collect on the slopes of the mountains to feed upon the winged ants that fly out at that time. The chirping birds called *tjekithoets* sing more than usual. The *iwak bettik* has five spots. A man's shadow measures a foot north. Plant maize.

Sixth month (*Kanem*), forty-three days, from the 8th of November till the 20th of December. Heavy rains begin. Plant rice. Orion is visible in the eastern horizon immediatcly after sunset. Woodcocks appear and resort to the ponds for food. The beetles (*kowangaus*), which were not visible before the rainy season, come down from the mountains to lay their eggs on the green herbage which is half covered with water. The spiders called *kemlandingaus*, which before this time of the year spun their webs horizontally, spin them now vertically. The fruits begin to ripen. The *iwak bettik* has six spots. The sun advances toward the south, and a man's shadow measures two feet north.

Seventh month (*Kepitoe*), forty-three days, from the 21st of December till the 2d of February. Orion and the Pleiades are respectively 25° and 45° above the eastern horizon. Rice-planting is continued. The distillable herb, wood-ivy (*ouvi*), is ripe. The eggs of the beetles open. The *iwak bettik* has seven spots. The sun turns back toward the north, and the shadow measures nearly three feet north.

Eighth month (*Kerraloe*), twenty-six days, from the 3d to the 28th of February. Orion is in the zenith, the Pleiades are 70° above the west. Rice-planting is completed. The *iwak bettik* has eight spots. The *glagahs* begin to bloom. The sun rises in the east.

Ninth month (*Kesauga*), twenty-five days, from the 1st till the 25th of March. Orion is in the zenith at six o'clock in the evening, the Pleiades 70° up in the west. The *iwak bettik* has nine spots. The flowers of the *glagah* fall. The sun crosses the equator.

Tenth month (*Sepoeloch*), twenty-four days, from the 25th of March till the 17th of April. The Pleiades are 45°, Orion 65° up in the west. The spots of the *iwak bettik* have disappeared. The rice is ripe and the harvest begins. The sun is in the north, and the shadow measures from one to two feet south.

Eleventh month (*Destha*), twenty-three days, from the 18th of April till the 10th of May. The rice-harvest everywhere. The nights are cold and the days are the shortest in the year. Orion is visible 16° up in the west at half past six in the evening. The Pleiades are invisible. The *randoe*-trees begin to bloom. The sun goes toward the north and the shadow measures three feet south.

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Twelfth month (*Sada*), forty-one days, from the 11th of May till the 20th of June. The Pleiades may be seen at half past five in the morning, a little later Orion. The rice-harvest is finished, cotton and indigo are planted, and the ground is prepared for maize. The shadow measures three feet south, and the sun goes to its northernmost point.

Such, according to our Dutch author, is the calendar of the Javanese. It furnishes a series of careful observations such as we meet only among a primitive people. It also affords numerous examples of the peculiarities not only of the starry skies of the tropics, but also of the meteorological conditions and the properties of tropical vegetation. —*Die Natur.*

SKETCH OF M. LOUIS PASTEUR.

LOUIS PASTEUR, the distinguished French chemist and author of researches in fermentation and the germs of disease which have been fruitful in valuable discoveries, was born at Dôle, in the Jura, December 27, 1822. He entered the university in 1840, became a supernumerary Master of Studies at the College of Besançon, was received as a pupil in the École Normale in 1843, took the degree of Doctor in 1847, and was appointed Professor of Physics in the Faculty of Sciences at Dijon in 1848, and of Chemistry at Strasburg, in 1849. In 1854 he was appointed Dean of the newly created Faculty of Sciences at Lille, and was intrusted with the duty of organizing it. In 1857 he returned to Paris, and became Scientific Director of the École Normale. In December, 1863, he was appointed Professor of Geology, Physics, and Chemistry at the École des Beaux-Arts, and was elected a member of the Institute. He has written numerous works relating to chemistry, and has contributed much to the "Recueil des Savants Étrangers" and the "Annales de Chimie et de Physique"; and for his researches relative to the polarization of light he received, in 1856, the Rumford medal from the Royal Society of London. His work in pure chemistry, however meritorious, and brilliant enough though it was, has been eclipsed by his vastly more important and more fruitful reseaches in fermentation; into the causes of certain diseases of plants, animals, and man; and into the modes of reproduction of the lower organisms (or the theory of spontaneous generation), and the parts which those lower organisms play in the production of chemical changes, and in the origination and spread of disease—in which field he may almost be said to have constituted a new science, and has certainly performed a work of incalculable benefit to mankind. These investigations have been pursued under the light of the theory, to which their results in turn have given additional force, that all fermentations are processes connected with life, and that this life—and any life—is not of spontaneous pro-

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duction, but proceeds from some previously existing life or parent. Hence, he has held, and has aimed to show, that fermentation can never take place if all access of germs to a fermentable substance is prevented. From fermentation he has extended his theory of the agency of microscopic organisms in working changes, to the explanation of the origin and multiplication of various infectious diseases, each of which, as well as each kind of fermentation and putrefaction, is caused by its own specific organism.

M. Pasteur took a prominent and most active part in the controversy respecting spontaneous generation, which raged quite bitterly a few years ago. He performed the most decisive experiments that were made, and has contributed more than any other person to turn the current of scientific thought against that theory, and to bring the weight of opinion in favor of his own theory of panspermy. The controversy on this subject, which had been resting for many years after the researches of Siebold, Leuckart, and others, into the mode of development of sexless parasites, was reopened as to the infusoria in 1858 by Pouchet, who affirmed that previous experiments in regard to boiled infusions were inexact, and that boiling did not prevent the appearance of infusorial life, as it would necessarily do if such appearance was dependent on the existence of living organisms or germs in the liquids previous to boiling. M. Pasteur, having become interested in this subject through his studies in fermentation, came forward with his test experiments. The question seemed a very difficult one, and incapable of a definite solution, so that Pasteur's friends, Biot and Dumas, were impelled to counsel him against wasting too much time upon it. They had, however, good reason afterward to revise their opinions. M. Pasteur boiled a suitable organic infusion in glass flasks, which he sealed hermetically while the boiling was going on, so as to exclude the air that might bring in new germs to take the place of those which the boiling had killed. The flasks were then taken to different localities, where, after a time, the necks were broken and air was admitted to the boiled infusion. Pasteur reasoned that if the organisms, which were produced in the liquid on exposure to the atmosphere, were spontaneous growths excited to life by the action of the atmosphere alone, the products would be the same wherever the bottles were broken; but if the manifestation of life depended upon the introduction of new organisms or their germs from the air—since the air of different places would probably contain different organisms and be charged in different proportions with them—there would be different results in different places. The experiments showed manifest differences, in accordance with Pasteur's anticipations, and were considered to demonstrate the existence in the atmosphere of extraneous particles, the introduction of which into an infusion was the necessary condition of life appearing there. Professor Tyndall says of them that they, "carried out with a severity perfectly obvious to the instructed scientific

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reader, and accompanied by a logic equally severe, restored the conviction that, even in these lower reaches of the scale of being, life does not appear without the operation of antecedent life. The main position of Pasteur, though often assailed, has never yet been shaken. It has, on the contrary, been strengthened by practical researches of the most momentous kind. He has applied the knowledge won from his inquiries to the preservation of wine and beer, to the manufacture of vinegar, to the staying of the plague which threatened utter destruction to the silk-husbandry of France, and to the examination of other formidable diseases which assail the higher animals, including man. His relation to the improvements which Professor Lister has introduced into surgery is shown by a letter quoted in his 'Études sur la Bière.' Professor Lister there expressly thanks Pasteur for having given him the only principle which could have conducted the antiseptic system to a successful issue."

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The most highly appreciated of Pasteur's earlier researches—because they most closely touched the economical interests of his country, and had a direct bearing on the prosperity of one of its great industries—were those which he made upon the disease of the silk-worm. A plague had raged among the silk-worms of France for fifteen years. The revenue from silk-culture had doubled itself during the twenty years before 1853, and appeared at that time likely to continue to increase. Then disaster suddenly fell on the business, and the production of cocoons fell from twenty-six million kilogrammes in 1853, in the course of twelve years, to four million kilogrammes, the fall entailing, in the single year last mentioned, a loss of one hundred million francs, or twenty million dollars. Dumas, the chemist, whose home lay in the district that was most afflicted by the scourge, asked Pasteur, with almost a personal interest in the matter, to undertake the investigation of the malady. Pasteur, says Professor Tyndall, at this time had never seen a silk-worm, and he urged his inexperience in reply to his friend. But Dumas knew too well the qualities needed for such an inquiry to accept Pasteur's reason for declining it. "I put," he said, "an extreme value on seeing your attention fixed on the question that interests my poor country; the misery surpasses all that you can imagine." The disease had been called *pébrine* by M. de Quatrefages, a name which Pasteur adopted; it was outwardly manifested by black spots on the bodies of the caterpillars, and also declared itself in their stunted and unequal growth, the languor of their movements, their fastidiousness toward food, and their premature death. It had already been discovered that the unhealthy worms were afflicted with peculiar corpuscles in enormous numbers, which were also sometimes found in the eggs, and which were connected with the disease. Pasteur directed his attention to these corpuscles, and proved that they might be incipient in the egg, and escape detection, and that they might also be germinal in the worm, and still

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baffle the microscope; but that, as the worm grew, they grew also, and appeared, if they existed, large enough to be detected without difficulty in the moth.

Pasteur's first communication on the facts he had discovered, made to the French Academy of Sciences, in September, 1865, called out some rather sharp criticism on the presumption of the chemist who had ventured to instruct physicians and biologists on a subject that belonged to them. "They found it strange," he says, "that I was so little in the current on the question. They set against me works which had been appearing for a considerable time in Italy, the conclusions of which demonstrated the inutility of my efforts, and the impossibility of arriving at a practical result in the direction in which I was engaged; and that my ignorance was great on a subject on which studies without number had appeared during the last fifteen years." If the scientific men were thus disposed to reject his new truths, it was hardly to be expected that the cultivators would accept his guidance in a direction contrary to that in which they were going. To strike their imagination, and, if possible, determine their practice, he hit upon the expedient of prophecy. Having inspected fourteen parcels of eggs, and examined the condition of the moths which produced them, in 1866, he wrote out predictions of what would be the fate of the lot in 1867, and placed it as a sealed letter in the hands of the Mayor of St. Hippolyte. When the reports of the cultivators were compared with the forecasts in the letter, in the next year, his prediction was found to have been exactly fulfilled in twelve out of the fourteen cases. Two additional parcels of eggs, pronounced by him healthy, produced an excellent crop.

M. Pasteur's researches in fermentation have been practically applied by him in his process for preserving wines by the application of heat, and his process for manufacturing beer by fermentation sheltered from all contact with air.

In 1874 the Copley medal of the Royal Society was awarded to M. Pasteur "for his researches on fermentation and pébrine." Mr. Spottiswoode, in making the presentation, observed that Professor Pasteur's researches on fermentation consisted essentially of two parts, the first part embracing the examination of the products, and the second the causes of fermentation. Previous observers had noticed the production, in solutions of sugar which had been fermented, of substances other than the two commonly recognized, alcohol and carbonic acid; but it remained for M. Pasteur to show which were essential and which were occasional products. In regard to the cause of fermentation, "it had been found that certain solutions, when exposed to the air, soon became full of living organisms; and Pasteur's experiments led him to support the view that these organisms originated from the presence of germs floating in the air. He found that no living organisms were developed if care were taken to destroy all those which might be pres-

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ent in the solution, and if the solutions were then carefully sealed up free from air. Nor was it necessary to exclude the air, provided that pure air, free from germs, were admitted. By passing the air through red-hot tubes or through gun-cotton before reaching the solutions, he found that the development of organisms, in such boiled solutions, did not take place. [A single exception was noticed in the case of milk, which required a higher temperature to destroy the organisms.]

Professor Pasteur also examined the gun-cotton through which the air had been passed, and he found, among other things, certain cells to which he attributed the power of causing the growth of organisms in solutions. By sowing some of these cells in solutions which had previously remained clear, and finding that such solutions speedily became turbid from the growth of living organisms, it was proved that the air which had passed through the gun-cotton had lost its property of causing the development of life in solutions, because the germs which the air contained had been stopped by the gun-cotton." The results on this point might be summed up: "1. No organisms are developed in solutions if care be taken to prevent the possibility of the presence of germs; 2. This negative result does not depend upon the exclusion of oxygen; 3. The matter separated from ordinary air is competent to develop organisms in solutions which previously had remained unchanged. Not less important were the results of Pasteur's experiments respecting the chemical functions of the ferment. . . . He proved that those conditions which are most favorable to the healthy growth and development of the yeast-cell are most conducive to the progress of fermentation, and that fermentation is impeded or arrested by those influences which check the growth or destroy the vitality of the cell. . . . To the biologist, two of Pasteur's researches are of very great importance. He has shown that fungi find all the materials needed for their nutrition and growth in water containing an ammonia salt and certain mineral constituents, and devoid of any nitrogenized organic matter; and he has proved that all the phenomena presented by the destructive silk-worm epidemic, the pébrine (even the singular fact that it is hereditarily transmitted through the female and not through the male), are to be explained by the presence of a parasitic organism in the diseased caterpillars."

M. Pasteur's later researches have been continued in the same direction as those which we have already mentioned, and have resulted in a great expansion of the germ theory and its application to useful purposes. Those which have so far been most fruitful in practical consequences are the investigations which he has made into the cause of the cholera in fowls and of carbuncular diseases in cattle and sheep, and into the means of preventing them by the cultivation of the infectious germs in diluting fluids and inoculation with them—investigations the results of which have already been heralded over the whole earth, and the inestimable value and importance of which have

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been almost universally recognized. The processes by which he has arrived at his discoveries and the success which has attended his application of them are best told in his own language, and are thus told in his address before the recent International Medical Congress, which is published in the present number of "The Popular Science Monthly." This address, the "Westminster Review" says, "was as fascinating in the unerring sequency of experiments as in the unbounded prospects of preventive medicine foreshadowed, and the masterly unraveling of some of Nature's most occult secrets."

M. Pasteur in 1880 proposed the application of the method which he used in seeking the cause of the silk-worm disease, to the detection of a parasite destructive to the phylloxera, and its cultivation as an antidote to that pest of the grape-vine. He said in a "programme for researches," which he communicated to the Academy of Sciences, on this subject, suggesting an inversion of the problem studied in the case of the silk-worm: "Let us seek a parasite for the phylloxera species, and, far from combating it, let us cause it to multiply and fasten upon the phylloxera till it destroys it, as the pébrine parasitic corpuscle so easily destroyed the silk-worms. . . . The rapid multiplication of the phylloxera is only a trifle beside the vital and propagative power of certain parasites. . . . The hall of the Academy of Sciences is very large; it has a capacity of hundreds of cubic metres. I am sure I could fill it with a liquid of such a nature that, on planting in it a parasitic microscopic organism of the fowl, the whole immense mass would, in the course of a few hours, be troubled by the presence of the organism in such abundance that all the phylloxeras in the world would be, in number, only as a drop of water to the sea compared with the numbers of the parasite of which I speak."

Notwithstanding this, he is so confident of the efficiency of the methods of treatment which his researches indicate, that he has been able to say, in his work on the silk-worm disease, that "it is in the power of man to make parasitic maladies disappear from the surface of the globe, if, as is my conviction, the doctrine of spontaneous generations is a chimera."

Another field of investigation, in which M. Pasteur has made a few preliminary steps, is that of the transmission of human diseases by microscopic organisms. He has now numerous co-laborers in these fields, in England, France, Germany, and other nations, many of whom have become famous through their researches, and who are extending the range of investigation every day; but he was the first to direct attention to this branch, and is still the leader of the company.

M. H. Bouley, speaking in the name of the Academy of Sciences, before the annual meeting of the "Five Academies," said, in special reference to M. Pasteur's work: "See how, at once, Nature has suffered one of her most impenetrable secrets to be snatched from her—the mystery of contagions is unveiled; and Science, enlightened by the knowl-

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edge of their cause, is resolving that marvelous problem of transforming the agent that causes death into an agent preservative against its assaults! . . . Justice," he continued, "is often tardy for inventors; its pace is frequently so halting that their life is not long enough for them to have time to see it come. M. Pasteur, whom I name at last, has had the privilege of seeing it hasten its pace for him. He is also one of those whose virtue does not rest when it has made their opinion good. Master of what he knew to be the truth, he has desired and has known how to give it force by the evident clearness of his experimental demonstrations, and to force the majority of those who were at first refractory to confess it with him." A writer in the "Westminster Review" gives eloquent utterance to a similar sentiment, when he speaks of M. Pasteur as one "whose researches have yielded so much material profit that one thinks of him as of the orange-tree standing in all the glory of blossom and fruit at the same time."

M. Pasteur was received with enthusiastic acclamations by the International Medical Congress when he arose to make the address which we publish; and the address was distributed by the Government through all parts of the United Kingdom. The "Graphic," publishing his portrait, published also a remark of Sir James Paget, that, by his discoveries relative to carbuncular diseases he had done for cattle what Jenner had done for the human race. And Professor Huxley has said that he considered the discoveries so important that they were worth all the five milliards of francs which France paid to Germany after the war of 1870–'71.

In 1868 M. Pasteur was awarded a prize of 10,000 florins by the Agricultural Minister of Austria for the discovery of the best means of contending with the silk-worm disease. A decree was signed by Napoleon III and M. Ollivier in July, 1870, but never promulgated, making him Senator. The French Government granted him, in 1874, a pension of 12,000 francs, "in consideration of his services to science and industry," and in the next year increased the pension by the addition of 6,000 francs. The *Société d'Encouragement*, in 1873, awarded him a prize of 12,000 francs for his studies relative to the silk-worm, wine, vinegar, and beer, collectively.

M. Pasteur was elected a member of the French Academy of Sciences in 1862, to take the place of Senarmont in the section of Mineralogy. In 1869 he was elected one of the fifty foreign members of the Royal Society of London. His principal works, besides his communications to the "Recueils des Savants Étrangers" and the "Annales de Chimie et de Physique," are: "Nouvel Exemple de Fermentation déterminé par des Animalcules infusoires pouvant vivre sans Oxygène libre" (Paris, 1863); "Études sur le Vin, ses Maladies, etc." (1866); "Étude sur le Vinaigre, etc." (1868); "Études sur les Vers à Soie" (2 vols., 1870); "Quelques Réflexions sur la Science en France" (1871); and "Études sur la Bière."

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ENTERTAINING VARIETIES.

THE MOUNTAINS OF THE MOON;*

OR,

TRAVELS AND ADVENTURES OF HAKIM BEN SHEYTAN.

TRANSLATED BY F. L. O.

CHAPTER II.

THE grace of Allah be with all who walk in his ways, and with all those who read my words and ponder in their hearts the wonders by him to me revealed! And the peace.

There is a mountain in Monghistan which forms the boundary between the hunting-grounds and the cultivated lands, and, two hours after we had left the rock-tombs, we passed the last brook at the foot of that mountain and entered an open hill-country, with a few inclosed fields here and there, but without a drop of drinking-water. The sun went down before we had reached a human habitation, and, as the sky was almost cloudless, we decided to camp under a hedge of mulberry-trees, whose boughs would shelter us from the night-dew. There was no house in sight, but, walking along the hedge in hopes of assuaging my thirst with a few berries, I saw a light that seemed to flicker in a grove on the opposite bank of a ravine. The Karman had seen it, too, for I saw him climb down the rocks with our water-skin under his arm. But he soon returned. "It was no house," said he. "It was the camp-fire of a traveler, a vagrant, who had made his bivouac in that grove."

"Is he a Monakee?" I asked.

"Yes, sir," said my guide. "You can smell him without crossing this ravine. He is burning pest-weed,† to befuddle himself, after the vile fashion of these people."

I instantly put on my sandals and clambered down the cliffs. The presage had been fulfilled. I had dreamed that I should see the first Monakee in the night. The grove consisted of a copse of tamarinds, with an undergrowth of thorn-trees; and I had already made my way to the upper line of bushes, when I stopped and stood spell-bound at the sight that met my eyes. The fire rose from a pile of brush-wood, under a large tamarind, on the top of the hillock, and at the foot of the tree sat a creature with the form of a human being, but with the face of a hog-baboon.‡ His eyes were small and furtive, his beard a mere fringe of bristles, and his nose, which was bluish-red, had the shape of a cucumber.* He wore neither a turban nor a sword-belt,

* Copyright by D. Appleton & Company, 1882.

† Yerba-pesta, pest-plant, or stink-weed.

‡ Schweins-Pavian, the *Papio Anubis*.

* "En forma de un pepino."

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but his shoulders were covered with a mantle of hairy or bristly leather, and his feet with a sort of leathern boxes, apparently of considerable weight. The vessels and implements of his camp were equally curious. He was roasting a fowl by means of a fork-spit, and at his side lay a large goat-skin that seemed to contain a combustible fluid, for whenever he placed it to his lips a rill of drops trickled down his face into the fire, where it flared up like camphor-powder.* But the strangest thing was a small iron pot, at the foot of the tree. It was stuffed with smoldering weeds, emitting a sort of yellowish smoke, and this vapor—which almost overpowered me with nausea—he seemed to inhale with a peculiar relish, for every now and then he would bend his head over the pot and utter a complacent grunt as the reek entered his nostrils. I do not think that he suspected my presence, though his eyes peered around furtively; but he appeared to be uneasy for some reason or other, and, as he listened to the rustling of the night-wind, he had a curious way of inclining his head sidewise, after the manner of a wary hog. I had watched him nearly half an hour, when I heard behind me the cracking of a dry twig, and, at the same time, the baboon-man suddenly snatched his fowl from the spit and hid it behind the tree. I, too, now heard the sound of approaching footsteps, and, turning round, I recognized the Karman, who had become uneasy at my long absence, and seemed surprised to find me here behind the trees. The man-ape had not seen us yet, for he glared about in every direction; but, when we stepped from behind the bushes, he rose to his feet—a fat, stout fellow, more than five feet to the top of his unturbaned head—and, in an almost human voice, uttered something that sounded like a question, though I did not understand him.

"What does he say?" I asked the Karman; but I had hardly spoken those words when the baboon-man again lifted his voice, and—who shall describe my astonishment to hear that brute address me in fluent speech, in the language of the Khundi-Arabs! "Have pity on me, Aboo-Kunts," said he, joining his hands in a deprecatory way; "do not drive me from this grove. I am a virtuous pauper, performing a pilgrimage for the benefit of my soul, and hope to meet friends at Beth-Raka."

"Peace be with thee, brother," I replied, as one would answer the appeal of a human being. "Salem Kehamad! We, too, are strangers and travelers. Eat thy meal in peace; but, if thou canst spare a cup of drinking-water, I beseech thee to exchange it for our abundant thanks, for we are famished with thirst."

He glared at us in silence. "Strangers? Then Yesha is merciful," said he, at last, and resumed his seat at the fire. I thought he had not understood me, and asked the Karman to repeat my question.

"Water! What water?" said he, looking up with an expression of great surprise. "Yesha Ben Allah! Are you blind, O brother of

* Yed-el-Káfoor, camphor-dust, a sort of fumigating powder.

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my father? Have I four legs, that I should drink water like a beast? My name is Ben Khelpus, and the poorest of my tribe have never drunk anything weaker than brand-acid.* Yet the All-Knowing is the most compassionate. Come here," he muttered, and conducted us to the head of a ravine on the other side of the hill. "There is a kraal at the foot of this gully," said he, "and you will find the good-man in a rock-cell, in the side of the hill, where you see that tall tree, down there."

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I thanked him for his kindness, and, as the smoke of his weeds had almost suffocated me, I took this opportunity to bid him a good-night. Since he was going to Beth-Raka, I expected to have his company the next day.

"But do not tell them where you have seen me," he called after us, as we were walking away. "Allah may have hardened their hearts, and I want to eat my supper in peace."

The moon was risen, and we had no difficulty in finding our way to the foot of the hill, and, by groping about the rocks near the tall tree, we discovered what we supposed to be the door of the grotto-house. The occupants, however, seemed to be deaf or fast asleep; we knocked and knocked, but nobody answered.

"Listen, sir," said the guide. "Do you not hear something?"

I put my ear to the door and heard, now plainly, a moaning and groaning sound, that seemed to come from the interior of the cave.

"They are sick, and perhaps in need of help," I whispered. "Shall we open the door?"

I listened again, and once more I distinguished the same sound. It resembled the groan of a dying man, and I hesitated no longer. Forcing my cutlass into the crack of the door, I put my shoulder to the wooden lock, and, at the second wrench, the board yielded with a grating sound. By good luck I had braced my knee against the edge of the rock, and could steady myself by a swift grip, or I should certainly have fallen senseless to the ground, for the effluvium of the cave completely stunned me for a second or two.

"For Allah's sake, what is this?" I cried, as I staggered backward, and, like an answer to my words, I heard an uproar of sudden howls, and a hoarse shout that sounded like the voice of an old man. "Woe! woe!" he bellowed. "Cover your heads—cover your heads! The door is open! Who has done that?"

"Here, my father; friends and men of peace!" I cried, for I thought that they had taken us for robbers. But again the wailing broke out with renewed violence. "Night-prowlers! Madmen! Where are they?" cried the old man, as he stepped forth with his head muffled up in a cloak or blanket. "Where are they?"

"Here!" said I. "Not robbers, my father, nor are we madmen, but travelers, perishing with thirst and craving a drink of water. Be-

* "Brand-Essig" (W.).—A sort of pyroligneous acid.

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lieve me, we do not want to rob you," I repeated, for the clamor still continued.

"Not rob us!" cried the old man. "You have already done us a greater harm! If we had not waked up in time, the night-air would have done us an injury which no medicine could undo!"

"Not so, Aboo Mungha," said I, "we heard you groan as in a sore disease, and some of your children are certainly sick; but, if you will let them sleep in the open air, the benediction* of Nature will help them more than all the balm of Feringistan."

"What words are these? You must be a bold unbeliever!" rejoined the old man; "how can Nature or anything natural be possibly good? Who are you?" and putting his hand to my shoulder he pushed me out into the bright moonlight. But my dress and face soon told him that I was a stranger, and his heart then seemed to relent. "My name is Er-Masood; be welcome if you come in peace," said he, and taking my hand he led me to a deep spring at the foot of the hill. "If the men of your tribe drink water, the Holy Ones have guided you well," said he; "this spring is the best in the valley; cattle, and even deer, resort to it from a great distance." He then offered us the shelter of his rock-den, but, seeing that we preferred the open air, he advised us to cover our heads very carefully, and, bidding us good-night, he retired to his cave.

We had left our wander-sacks under the mulberry-hedge, and, as the distance was only short, the Karman offered to fetch them down, while I gathered an armful of grass for our camping-ground. The adventures of this night, however, were not yet ended, for, looking about among the brambles of the hill-side, I discovered a child, a young Monakee, who had hidden himself behind a leafy bush.

"My little brother! what is he doing here?" I asked, when he instantly covered my mouth with his hand, and implored me not to betray him.

"My head ached so that I thought my soul would leave me," he whispered; "pray, let me get a little fresh air before you drive me back!"

He had made himself a couch with his coat and an armful of leaves. To these I added some of the grass I had gathered, and bade him lie down and keep quiet. "I shall not betray him; may Allah be his helper!" I thought, for, on passing the cave, I had again heard the moans of his unfortunate brethren.

When the Karman returned, the moon was shining from a cloudless sky; in the trees and bushes the cicadas chirped their serenades, and on the slopes of the grassy hill-side we saw a swarm of rabbits chasing each other to and fro. They played and gamboled, enjoying the sweet night-air, while the Monakees lay groaning in their noisome cave.

* Eyn-daljah—literally, "the shining face."

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The morning dawned in a streak of spear-shaped clouds,* presaging a warm day, so we commended the child to the care of Allah, and ascended the hill before Er-Masood had opened his den. Our red-nosed friend had left his camp, but, when we reached the main road, we met several Monakees driving their working-steers to the field. They eyed us with surprise, and some of them quickened their steps to keep up with us, thus giving me an opportunity to observe them well. Whatever might be their sins, I soon saw that the hand of Allah weighed heavily upon their race. They wheezed and coughed; their children looked pale-cheeked, and, among the three or four score of adults we met on that day, I did not see half a dozen purely human countenances. Some had fish-eyes, and some pig-noses, and nearly all the old males were disfigured by the bloated appearance of their faces. They all marched on their hind-legs, but their gait was remarkably awkward; they can not walk with dignity, and in the cities, where I afterward saw large assemblies of their people, only the younger boys seemed to have anything like a natural grace of deportment. Whenever the road led up-hill, their knees weakened, and they had to pause, panting for breath, while the small dogs that accompanied them went boldly ahead. Their feet were shod with leather boxes, and, though the morning was rather sultry, most of them were muffled up to their chins in blankets or heavy cloaks. These garments, however, were well woven, and, like their agricultural implements, evinced the skill of their artificers. Their conversation, too (whenever they ceased to discuss their various bodily ailments), seemed to turn upon mechanical topics; in matters pertaining to natural science and the wonders of natural history they are strangely incurious; their country-people have no names for the splendid butterflies of their fields, and few of them can identify a single constellation of the starry firmament.† In these border districts a corrupt dialect of the Khundi-Arabs is the prevailing idiom; farther west the vernacular of ancient Monghistan is more generally spoken, though nearly all their educated men have some knowledge of the Arabic language.

On the next steep hill we had left all the villages behind, when we reached a cross-road where we saw a Monakee standing on all-fours, with his head between his hands, and moving his hind-feet up and down like the stampers of a water-wheel. The Karman turned back to me smiling, but I beckoned him to follow me behind a hedge, where we could watch the strange creature unobserved.

"Do you not know him?" whispered my guide; "it is the traveler, the same man we met in the woods last night: that is the way they say their prayers."

* *Nubes rayadas* (R.).

† "The poorest Bedouins," says Professor W., "are as familiar with practical astronomy as a German *Förster* with the slang and mystery of woodcraft. They have names, and even nicknames, for every constellation and every conspicuous star."

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I peeped through the bushes and saw that he was right: it was Ben Khelpus, the man with the goat-skin and pest-pot. His performance had lasted about five minutes, when he stopped and turned his head sidewise, and, following the direction of his gaze, we saw a little girl walking across the fields with a sort of basket in her hand. Ben Khelpus crouched down, drew a short club from his bundle, and, rising suddenly on his hind-legs, he made for the field in a kind of a bear-trot. The girl saw him come and ran away, shrieking, but the pilgrim, too, then broke into a gallop, and chased her through a canebrake, where we lost sight of them. In the next minute, however, we heard a loud scream, and a second later Ben Khelpus reappeared, carrying in his hand the girl's basket, which he flung away after devouring its contents. He then returned to the cross-road, where he took a deep draught from his goat-skin, and finished his devotion by performing a number of hand-springs. While he repacked his bundle we left our hiding-place, and approached him from the other side of the road.

"How fares my brother?" I asked, when he turned his head.

"Well! thanks to Allah, whose perfection be extolled," he replied; "a man feels so much better after prayers!"

"Are you, too, going to Kápeebad?" I inquired, as he prepared to accompany us.

"Nearly," said he, "but after a day's journey beyond Beth-Raka, I shall ascend the mountain of Sidi-Máyas, for the promotion of my spiritual welfare— Hold this bundle a moment," said he, when we passed an inclosed orchard; and, after pushing down some of the upper stones, he succeeded in climbing the wall, and soon returned with a cloutful of apricots.

"Are you not afraid the owner might see you?" I asked.

"Not I," said he; "no heretic would dare to lay his hands upon a pilgrim: they fear the vengeance of my fellow-believers."

"Who are those heretics?" I asked.

"Vile misbelievers," replied he; "they waste all their prayers on the nephew of Allah."

"I told you so," said the Karman, who had repeatedly mentioned that shocking superstition.

"Yes, the Horn-Ghost* will roast them severely," added the pilgrim; "they confine their worship to that nephew, and pay no respect to the rest of the family, nor to the three hundred servants of his household. They even despise the gate-keeper of the heavenly mosque."

"And do you hope to enter that gate?" I asked.

"Yesha is merciful," said he; "I constantly make the sign of the

* *El Cornado*, "Old Horny." The horns of Eblis, are not confined to the cacodæmons of the Semitic religions; in the language of the Siberian Yakoots, Atkinson tells us, the local Beelzebub is called "the Old Horn Man," and the national Jehovah "the Gentleman with the Russian Uniform."

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holy triangle, and acquit myself of the prescribed prayers; and, moreover, I am going to worship at the shrine of Sidi-Máyas, where I shall perform the three hand-springs, the three somersaults, and the three holy groans, and thus cleanse my soul from sins past and future for three times three solar years."

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We passed several well-cultivated fields, and stopped at a camp of field-laborers, where my guide purchased some manioc-roots for our dinner, and informed our companion that he could supply his wants for a single copper coin.*

"Pilgrims carry neither copper nor silver," said Ben Khelpus, "for Yesha supplies all their wants. No, I have no money," he added; "I wish, though, I had; my dram-skin is nearly empty, and these Caffres † will not fill it for me. I shall have to use my club if Allah does not soften their hearts."

The day was oppressively hot, and the sun had passed the meridian, when we at last reached a brook at the foot of a wooded hill. Here we decided to cook our dinner, and, while my companions gathered a supply of fire-wood, I drove away two hogs that offended us by their smell and their greedy grunts. My guide assured me that the Monakees not only tolerate, but fatten and eat these unclean animals—an assertion which seemed hardly credible till it was confirmed by some very suspicious circumstances.

After chasing the brutes out of sight, I ascended to the top of the hill, which afforded a good lookout over the surrounding country. Nearly all the uplands are covered with plantations of poison-berries, and the valleys with pest-weeds, so that the useful products are almost confined to the fruits of a few orchards and manioc-fields. In the rear of the cliffs several acres of ground were inclosed with curious wire-fences, and at the end of the first field I found an open shed containing two plows of excellent workmanship. No plowman or horses were in sight, but higher up I met an old man carrying a heavy tub with a sort of black mold, which he scattered here and there to fertilize his fields. The weight of the tub seemed to bear heavily upon him, for I saw him stagger under his load and clutch at the trees to support himself.

"This labor, father, has overtaxed your strength," said I, when I met him.

The old man put down his tub and had to pant for breath before he could reply. "Yes, it is very hard," said he; "nor is this the worst part of my work: I have to fetch the mold from my garden and carry it up this steep hill."

"Do you live far from here?" I inquired.

* *Jedeed*, a small coin, the tenth part of an Arabian denar.

† Unbelievers. Caffre, as well as Giaour, is derived from *Gebir*—the Gebers, or Fire-worshipers of Western Persia, who so obstinately resisted the inroads of El Islam, that their name became a synonym of "infidel."

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"There is my house," said he, pointing to the valley, "over yonder, where you see that large orchard at the foot of the hill."

"And is the produce of that orchard not sufficient to support you?" I asked him.

"My wants, sir, are but small," said he, "but I have a wife and a daughter who are in need of wakkad* trailing-gowns with double tails, and red-squirrel skins are very expensive."

"Have they, then, no other garments?" I inquired.

"Many, sir," he replied, "but they are gray and single-tailed."

"Father," said I, "I am a physician, and it is my duty to warn you," for I had noticed that he breathed with difficulty, like a person exhausted by a grievous cough. Such labor, I told him, would surely aggravate his disease, and if he hoped to recover he must have more rest and better food.

"Alas! we have sold our milch-cow," said the old man, "and I have to furnish those gowns before the end of this season."

"Then repurchase your cow," I replied, "and let your women wear their usual garments."

He sighed and shook his head. "The women of this country have to follow the customs of Moropolis," said he, "a city of great wealth and refinement. The Moropolitans have ordained that trailing-gowns shall be red and double-tailed, and Monghistan has to obey. All the women would be against me: I might defy them, but I dread the consequences."

By much persuasion I at last encouraged his heart, and agreed to follow him to his home. The orchard was not far from our camping-ground; so I hoped to return before my companions had prepared our meal. The old man conducted me through a flourishing tree-garden, and ushered me into his cottage, where we found two women, both unveiled, but of very decorous deportment. "My name is Mak-el-Frit," said the old man, "and this is Pitha, my wife, and my daughter Pitheka."

They received me with politeness and offered me the hospitality of their table; but, seeing a skewered pig upon their hearth, I asked them to excuse me, adding that I would soon be obliged to rejoin my companions.

"How comes it, my husband," said the *kabira*,† at last, "that your labor has ended so long before sunset?"

"It has ended for ever," said Mak-el-Frit, "I can endure it no more"; and, after explaining the nature of his disease, he told them that he intended to repurchase his milch-cow, and that they must content themselves with gowns of gray-squirrel skin.

At these words the two women started up and glared at each

* Aboo-l-wakkad, literally "father of a great tail," a squirrel. The name is applied both to the gray palm-squirrel and the civet-cat of Northern Africa.

† Kabira, the "head-woman," the mistress of a house.

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other with bewildered looks; but, when Mak-el-Frit attempted to state his reasons, they saw that he was in earnest, and Pitheka threw herself sobbing upon a bench, while her mother uttered a piercing shriek, and, after clutching at the empty air, sank to the ground as in a swoon. Seeing her fall, I ran out to get a cup of water, but when I returned the two women had recovered and were sitting like monuments on the floor of the room. "Wakkad-russ, wakkad-russ —gray-squirrel skins," the kabira repeated, with a vacant stare, and in a hollow voice, after which they both shrieked louder and longer than before, while a tame monkey leaped down from the window and joined in the clamor. "Mak-el-Frit, are you bereft of your reason?" asked the kabira, after a pause.

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The husband seized the monkey and flung it out of the window, but made no other reply. The kabira then turned to her daughter. "I see how it is," said she; "he wants to drive us forth, to beg our bread in a foreign land, where no one knows that I am the daughter of honorable parents. O my child! O my sugar-eating parrot! we shall taste the bread of affliction; we shall wander homeless till our souls return to the peace of Ghinnistan." Then rising to her feet — "And thou, hard-hearted one, who preferrest a cow to thy wife," said she, "go and tell the neighbors that thou hast driven me forth to seek a grave in a stranger's land; for thou shalt behold my face no more.—Come, my daughter," said she, and strode toward the door, when the old man stopped her, and adjured her for Heaven's sake not to darken his countenance.*

"I will do what I can," said he, "and you shall have that gown before long, but may be it will be single-tailed."

"No, double-tailed, by Allah!" said the kabira, "and if you want me to stay I have to impose a strict condition: Never again insult your wife or your daughter by such propositions. Even the beggar-women of Moropolis would despise a gray-squirrel gown, and the daughter of my father shall not become a by-word in the land of her birth. Heed my words, for my father has friends who will not suffer his daughter to be oppressed, nor will they fail to invoke the severity of the law against cruelty insupportable. Will you promise me those gowns, and shall they be duly double-tailed?"

The old man sighed, but made no reply.

"Will you promise?"

Mak-el-Frit hesitated.

"Come, my daughter," said the kabira, "we must leave this house."

"No, no, I will work, I will work!" cried the old man, and seizing his tub he rushed through the open door. When I left the cottage, I saw him hasten toward the hill at the top of his speed. He was an old man, well stricken with age, and the failure of my plan grieved me.

* "Sein Angesicht schwärzen" (W.)—i. e., disgrace him.

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Yet this was to be a day of disappointments, for when I returned to our camp the Karman met me at the foot of the grove and informed me that our dinner had disappeared. He had gone down to the creek to fill our water-bottle, and when he returned our maniocs were gone, as well as the contents of our oil-flask, and six pounds of dates which had been taken from our traveling-bag. "The man who did it must be the father of a wolf," * said he, with a mistrustful look at the pilgrim.

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But Ben Khelpus protested his innocence. "It is a perfect mystery to me, O fathers of Khundistan," said he, "though it now occurs to me that it may have been one of those swine we saw at the creek. Swine, O brothers of my father, are gifted with an excessive appetite, especially for maniocs. Dates, likewise, they eat with an exceeding great relish."

The Karman looked at me, pointing to the hilt of his cutlass. I understood him, but I shook my head. Determined to get rid of this man, I yet thought it better to let him depart in peace.

"Is there nothing left?" I asked.

"Only a handful of parched durra † and a piece of goat-cheese," replied the guide.

"Cheese? then let us eat it now," said Ben Khelpus—"right now, before it becomes too dry. For to-morrow is the weekly mourning-day, when all true children of Yesha must abstain from cheese. As the Good Book hath it:

> "'Salvation is to him who observes the prescribed fasts,
> And the foot ‡ is safe which avoids transgression.'

What says my father?"

I made no reply, and not a word was spoken till we heard the sound of approaching footsteps. It was Mak-el-Frit, returning to his garden to refill his tub. His heart was heavy, and he tried to pass by in silence, but the pilgrim stopped him. "O my father," said he, "have you any rakee at your house, or any brand-acid? For, by Allah (whose perfection be extolled!), my goat-skin is nearly empty."

Mak-el-Frit sighed and shook his head, but the pilgrim repeated his question. "Is there no pity in your heart?" he added; "have you forgotten the behest of Yesha?"

Mak-el-Frit passed on, and the pilgrim then stepped behind a tree, took a club from his sack, and, after readjusting his bundle, followed the old man with rapid steps. Before he returned we forded the brook and resumed our journey. The heat of the day had moderated, and we hoped to reach Beth-Raka before night.

About three miles west of the ford we overtook a man whom I had seen at the laborers' camp, and who seemed to have passed us while

* Aboo-l-kalb, *padre de un lobo*, R. † *Sorghum vulgare*, a kind of millet.

‡ "Foundation," in the original. In the second hemistich of this verse *eddém* (foot) should be substituted for *ed-demneh* (footing, or foundation), for the sake both of the sense and the metre.

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we were cooking our dinner. He wore a black cloak with a high collar which somewhat concealed the absence of a beard, for his face resembled that of a sick old woman. He seemed, however, to be a person of considerable information, for he inquired after the state of affairs in Fan-Khundistan, mentioning the name of the sheik and his chief counselor. "Where have you left your companion?"* he asked, after I had answered his first questions.

I understood that he referred to Ben Khelpus, and told him under what circumstances we had parted from that pious pilgrim.

The stranger smiled. "That fellow," said he, "belóngs to the sect of the *Tripilates*, so called from the triple hat of their chief imam. You have acted wisely; your appearance is that of a learned stranger, and I marveled to see you in the company of that man."

"You do not belong to his sect, then?" I inquired.

"Yesha forbid!" said he; "there are many kinds of superstitious people in this country, but the Tripilates are the worst. They pay divine honors to countless unworthy servants of Allah, while we confine our worship to his nearest relatives. As for myself, I profess the creed of the *Thumpers*,† who were the first to secede from the community of the Tripilates. Our dervishes derive their authority from the first chief imam, whose sacred slap of approval encouraged his successor to continue the work of the Lord. If you come to Kápeebad you will find that nearly all the respectable people belong to our sect. The superstition of the Tripilates," he added, "prevails only in the southern valleys; theirs is a grossly corrupt form of the Yeshanee faith, while ours is a pure and refined doctrine." He stopped and put his hand to his breast—to attest the superior sanctity of his creed, as I supposed, till I saw that he was rubbing his stomach. "I do not feel well this evening," said he, "I have eaten three pounds of fat hog-flesh, and I fear that it was not properly fried."

My amazement at these words increased when we soon after reached the top of a hill where the ground was thickly covered with chestnuts and beechnuts, which, as the Karman informed me, are despised by the Monakees, and serve only to fatten the animals whose mention has already thrice defiled these pages, and whose flesh, as a means of sustenance, a proper person would hardly prefer to the pangs of actual starvation.

While we rested a few minutes, a swarm of wild pigeons alighted in the trees, and almost in the same moment an arrow whizzed from a thicket of brambles, and one of the birds fell fluttering to the ground. The hunter was a bottle-nosed old man, with a perceptible smell of rakee about him, but the workmanship of his cross-bow once more convinced me that it has pleased Allah to endow these people with a won-

* "Prophet," W. By the omission of a letter and the misplacing of a diacritical point, *nedeem* (boon companion) in the Tunisian edition may have been converted into *nedyeh*, prophet or embassador. † *Tocadores* (R.), Klopfer (W.)—Slappers or Thumpers.

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derful degree of mechanical skill. The bow-iron was as thick as my arm, but could be bent by means of an ingenious lever; the cord was made of a curious kind of vegetable fiber, stout, but twisted as evenly as a lute-string, and retaining that appearance under a tension that would have snapped the strongest sinew. The arrows were altogether unlike ours—unfeathered, short and thick, and terminating in a dagger-like point of hardened steel. With a shower of these darts the Monakees have often repulsed the charge of the best warriors of Darfoor and Khundistan.

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We had now reached the ridge of this hill-country; to the west the view was bounded only by an airy-blue mountain-range; at a distance of now less than twelve leagues we recognized the hill with the towering mosques of Kápeebad, and at our feet lay the town of Beth-Raka, embowered in trees and shrouded in a cloud of murky smoke. At the next cross-road our companion left us, after giving me the names of several learned friends of his in the city of Kápeebad, for I had not mentioned the object of my journey, and, judging from my questions, he probably took me for one of those traveling scholars* who visit foreign countries for the love of learning.

My guide had never been in Beth-Raka before, as Kápeebad can be reached by a road through the northern highlands, which is preferable in the rainy season; but the suburbs of the city were already in sight, and, as the sun was still more than an hour high, we were in no danger of losing our way. Our road led now steadily down-hill, and we quickened our pace in order to reach the town before dark, for I was curious to ascertain the cause of the black smoke that rose incessantly from the bottom of the valley.

—— *The Summit of the Earth.*—Adolphus Schlagintweit, the immortal though unpronounceable explorer of Central Asia, calls the highland of Pamir "die Welt-Zinne"—the roof of the world. On the road from the Punjaub to Yarkand four passes have to be crossed that are higher than 17,500 feet, and for a distance of 280 miles the halting-ground is not below the height of Pike's Peak. On the eastern plateau of the Beloor-Dagh there is a shelter-house near a cliff from whose summit the main chain of the Himalayas with all its giant peaks and immeasurable ice-fields is in full view from the highlands of Lassa to the sources of the Indus, while in the west the head-waters of the Oxus and Jaxartes can be traced to the borders of Ḉabool, where the peaks of the Hindoo-Koosh lift their crests of everlasting snow. In spring the echo of the avalanches resembles the boom of continuous thunder; and in midwinter, when the storm-wind sweeps the table-land, whirling pillars of snow scud along the ridges, and often seem to dance together like specters in their fluttering winding-sheets. Our "Land of the Sky" in the Southern Alleghanies must be a mere piazza compared with that top-roof of the earth.

* The scholars of the Arabs, like those of ancient Greece, were mostly peripatetic philosophers. Tabari, Ibn-Koteiba, and Ibn-Baitar traveled on foot through all the provinces of the Saracenic empire.

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CORRESPONDENCE.

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ANTEDILUVIAN LONGEVITY.

Messrs. Editors.

A LETTER in your February number, from Mr. C. S. Bryant, propounds a new view respecting the age of antediluvian patriarchs, and expresses a hope that the revisers of the Old Testament will give heed to what he regards as cases of apparent errors in the reading of Hebrew numbers. Being one of those revisers, I may, perhaps, properly ask for a little space in which to comment on his suggestions. While I have no doubt of his sincere desire to solve a serious difficulty, I must say that his theory is utterly untenable. This can be easily shown.

Mr. Bryant says, "In reading *concrete numbers*, the Hebrews gave the larger number first." This is true in some cases, in others not. Thus in Genesis xiv, 14, the Hebrew gives the number of Abram's servants as "eighteen and three hundred," the larger number last. Even in Genesis v, 3, adduced by Mr. Bryant, the Hebrew reads, "thirty and a hundred years"—the larger number last. In like manner also in verse 5, Adam's age is said to have been "nine hundred years and thirty years." I do not see, therefore, the bearing of this inaccurate observation. Mr. Bryant's point really is (though he does not state it) that, though the Hebrew inserts no conjunction "and" between "nine" and "hundred," we may read it "nine *and* a hundred and thirty." When he speaks of an inverted rule in the case of verse 5 (authorized version), and says that verse 3 translated in the same way would read "thirty hundred years," he overlooks the fact that in verse 3 the Hebrew has a conjunction between the two numerals, reading "thirty *and* a hundred," so that the most literal translation would still give us one hundred and thirty. In short, the authorized version renders with perfect exactness.

The real question, then, is whether Mr. Bryant's method of putting in a conjunction where there is none in the Hebrew is justifiable. In the case in question the word "hundred" is in the *plural*, so that, exactly rendered, it would be "nine hundreds year, and thirty year" ("year" being singular, as we often say, colloquially, "a hundred foot"). Mr. Bryant overlooks this fact, which is very inconvenient for his theory. Even, therefore, though we might imagine that "nine hundred and thirty" really should be read "nine, one hundred, and thirty," the plural form "hundreds" is unexplained.

Mr. Bryant says, "At the date of this writing the Hebrews had no means of writing 'nine hundred,' or any number of hundreds above one, without repetition or circumlocution." This is an assertion without proof, and needs no answer. That it borders on the absurd is obvious to almost any one.

But more conclusive proof of the error of Mr. Bryant's hypothesis is yet to come. It prepares any one to expect it when, e. g., Seth's age, according to him, is stated (verse 8) as "twelve years, and nine [and] a hundred years," and so is equal to one hundred and twenty-one! Circumlocution indeed! Could not the poor Hebrews express even 21 better than by adding 12 to 9? So Enos's age is got by adding 5, 9, and 100!

But the absolutely knock-down argument is this: Mr. Bryant says (without telling us how he learned it) that "Seth was born when Adam was one hundred and thirty years old, and was his last child." But he forgets to quote verse 4, which says (according to his own method of translating), "And the days of Adam after he had begotten Seth were eight [and] a hundred years." Thus, adding 130 to 108 we get necessarily 238 as Adam's age at his death. And yet, absolutely overlooking this, Mr. Bryant makes Adam's whole age to have been only 139! Precisely the same absurdity results in the following cases: Seth at the birth of his son was one hundred and five years old. But *after* the birth of Enos he lived (verse 7), according to Mr. Bryant's own way of translating, "seven years, and eight [and] a hundred years." So, then, at his death, Seth must have been 105 + 115 = 220 years old. But Mr. Bryant, translating verse 8 in his peculiar way, makes the age to be one hundred and twenty-one! We have, in the mention of the age before and that after the birth of the son, an absolute test of the correctness of Mr. Bryant's theory as compared with the ordinary one. According to the ordinary one, the two numbers added together make exactly the number given as the whole age. According to Mr. Bryant's theory, the narrator can not add together any of the two numbers correctly. He contradicts himself, so that the merest child can see the blunders.

If Mr. Bryant thinks that this method of reducing the ages of the patriarchs is going to relieve the biblical narrative of difficulty, he is obviously mistaken. I repeat that, he may be very sincere; but, in view of what has been presented, his sincerity can be

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vindicated only at the expense of his good sense and intelligence.

Yours truly, C. M. MEAD.

ANDOVER, MASSACHUSETTS, *January* 31, 1883.

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Messrs. Editors.

A NOTE in your department of correspondence, February number, page 553, on "The Duration of Human Life," by Charles S. Bryant, of St. Paul, Minnesota, calls for an answer. I do not undertake or need to reply to it in full. It would be enough to follow the saying, *Ex uno disce omnes.*

Says Mr. Bryant, "Seth was born when Adam was one hundred and thirty years old, *and was his last child.*" He says this which I have italicized, although, in the Scripture account, the very next words to those concerning the birth of Seth (Gen. v, 3) are, "And the days of Adam after he had begotten Seth were eight hundred years, and he begat sons and daughters" (Gen. v, 4).

Here I might drop the matter, simply saying that this is a specimen of Mr. Bryant's statements throughout the letter. But I will follow them a little further. Mr. Bryant does not pretend to question the record that "Adam lived a hundred and thirty years and begat . . . Seth"; but, where the account adds, as quoted above, that "after this he lived eight hundred years," he gives him nine years! Now, even his own so-called "rule" about the Hebrew reading of "concrete" (*sic!*) numbers—*the largest, first*—could not twist eight hundred (800) into nine (9). This "rule" itself applied to eight hundred would give a hundred and eight, which added to one hundred and thirty, would be two hundred and thirty-eight, instead of Mr. Bryant's one hundred and thirty-nine, for Adam's lifetime.

Carry out this process of examination (and any bright school-boy can do it), and Mr. Bryant's amazingly shrunken "table" of the ages of the antediluvian patriarchs at death (page 554) is, according to his own (and I know not whose it is, if it is not his own) "rule," elaborately wrong in *every instance.*

But, now, whence comes this "rule"? The Hebrew grammar (see Conant's "Gesenius," for instance) teaches that "when *units and tens* are written together, the *early* writers commonly place the units first, as 'two and twenty'; the *later* writers almost invariably reversing them, as 'twenty and two.'" But what has this to do with writing hundreds, thousands, etc.? Nothing at all. The "rule" is—mythic—to say the least of it.

Again, that "at the date of this writing, the Hebrews had no means of writing nine hundred or any number of hundreds above one, without repetition or circumlocution," is as untrue as it is to say that we now have no such means. Mā-âh was *one hundred;* mâthăyim (a *dual* form) was *two hundred;* sh'lōth mā-ōth (the last a "construct form" of mā-âh, one hundred) was *three hundred;* and so on throughout. There was just as much "circumlocution" in this as there is in our language, and no more.

The fact is, that in Gen. v, 3, the Hebrew says, "Adam lived thirty *and* a hundred years (sh'lōshīm *u* m'ăth shânâh)," i. e., one hundred *and* thirty years; while in the fourth verse it says, "And all the days of Adam after he had begotten Seth were eight hundred years (sh'mōnĕh mā-ōth shânâh)," with no *and* (*u* or *v*) between eight and a hundred; and no "rule," let us remember, but Mr. Bryant's fictitious one, for putting the "larger" number one hundred before the "smaller" eight. In the fifth verse, in exactly the same unmistakable way, the Hebrew says, "And all the days that Adam lived were" (not "a hundred years and thirty years and nine years," as Mr. Bryant expressly and untruly states it, but) "nine hundred years and thirty years," just that and nothing else.

I am prompted to take the trouble to write this, and ask you to publish it, because the positive and yet positively false and misleading article in hand not only might do, but is doing, violence to truth between the covers of a scientific journal. In the Teachers' Institute of our city, a company numbering some two or three hundred, I had, not long ago, given a summary of general history, when this very article was referred to by a teacher, in remarking upon the exercise as perhaps affording an explanation of, and a way to remove, the "difficulty" (?) in the Bible account of the longevity of the antediluvians. Even though there were any real difficulty here (I am glad to see that M. de Solaville does not feel obliged to get rid of a difficulty at this point, but only mentions some offered explanations of a remarkable fact), the cool fabrications of the letter I criticise are not the means that would remove it.

ALBERT BIGELOW.

BUFFALO, NEW YORK, *February* 15, 1883.

AN ELECTRICAL NUISANCE.

Messrs. Editors.

THE scientists will confer a boon on one of our mechanical trades if they will suggest some practical solution to the following difficulty: Every one conversant with the machinery of the press-room of a large printing establishment has heard of the great annoyance caused by the generation of electricity while the sheets are passing through a cylinder press. The action of the fluid causes the sheets on issuing from the press to adhere closely, and at all angles, to the

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"fly" or rack which takes the sheet and inverts it upon the receiving-table. After leaving the fly, the sheets, as they are piled a hundred or two deep, are attracted to each other, so much so that more than ordinary force is necessary to remove one sheet from another. The pile of printed matter, as placed by the fly on the receiving-table, should be evenly and neatly placed, but because of this difficulty it is left at all sorts of angles. The result is, that not more than one half the work can be accomplished that might otherwise be done. My own observation of the matter leads me to the following conclusions: 1. That the electricity is generated by some paper in greater force than by others, sized and calendered book-paper proving the most troublesome. 2. That the paper, if wet, causes an instant solution of the trouble. 3. That experiments tried, such as connecting the wooden fly with gas or water mains, by means of a good conductor, covering the receiving-table with a metal surface and wiring this to conductors, or connecting different parts of the press when in motion by wire connections, with the hope of neutralizing the positive and negative currents, have all failed, and in the language of the foreman of one of our largest printing establishments, "We must keep our temper, and endure the annoyance till science comes to our aid," by a practical solution of the problem, we mean a solution subject to the following conditions: We can't afford to hire a boy to make adjustments for the escape of the nuisance. We can't *wet* a book paper without ruining it. We can't have the "fly" of *iron* rather than of wood, as that would make it too heavy. With these conditions, can you, Mr. Editor, give us help, and do the printers a service?

A. W. Bacheler.

Manchester, New Hampshire, *Feb.* 20, 1882.

EDITOR'S TABLE.

GOLDWIN SMITH ON SCIENTIFIC MORALITY.

AMONG all subjects now undergoing investigation there is, perhaps, none so important as that of the relation of science to morality; and hence every real contribution to it, however apparently slight, should be cordially welcomed. But it is not the easiest of subjects to deal with. The number of those qualified for the original elucidation of scientific ethics is not great; traditional opinions resist revision, and there is a wide-spread jealousy of science which resents its entrance into this sphere of thought as a needless and a dangerous intrusion. This often gives rise to a one-sidedness and an unfairness in controversy that are greatly to be regretted. The argument of Professor Goldwin Smith, which we republish, notwithstanding the ability with which it is written, is open to this objection. We give it in full as a first-rate representation of the "other side" (which we have been accused of neglecting), but it can not be suffered to pass without some emphatic protest.

In the first place, there seems a misleading element in Professor Smith's question-title. It would naturally be inferred that the paper is an inquiry into the validity and adequacy of a code of morals scientifically based; but this is not so. The writer does not ask, "Is science competent to elucidate the grounds and determine the principles of morality?" nor, "Is there such a thing as a valid science of ethics?" nor, even, "What is the relation of science to morality?" but he asks, "Has science *yet* found a *new basis* for morality?" The implication here is, that science has been hunting after something of questionable existence, and now claims to have found it, and offers it as a new foundation of morals. This conveys a wholly wrong impression of the nature of ethical science. Professor Smith might as well have asked, "Has science yet found a new basis for combustion?" The answer will, of course, depend upon what is meant by a "new basis"; but any answer only raises the further question, "What has science really done in regard to the phenomena of combustion?" To this we

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should have to say that combustion is a natural process of which men knew a great deal that was true and indispensable long before science appeared. What science did was simply to develop, step by step, the pre-existing common knowledge upon the subject into a more complete, accurate, and methodical form. So also with morality, or the phenomena of human conduct, in respect to its quality of right and wrong. Much was known about it that was true, practical, and essential to human society before science was ever dreamed of. But the early knowledge was imperfect, and required to be improved and made more clear and systematic by the establishment of principles, as has been the case with other forms of knowledge that have gradually grown into science. There was never any "new basis" in this process of growth. Practical morality has always been grounded in nature and in common experience—has always, to some extent, recognized the right and wrong of human conduct as determined by the known consequences of human actions. Scientific morality was never something to be "found" or done without; it was an inevitable stage in the development of thought and a part of the great modern movement of the study of the order of nature. The problem has not been to find a new thing to replace an old one, but to make the old one better. The problem of our time has come to be to determine the bearing of the later and more highly developed sciences upon the improvement or progress of ethics.

Professor Smith believes that owing to the great advances of modern thought there is a loosening of old bonds and a great peril to morality. He says: "Science, in combination with historical philosophy and literary criticism, is breaking up religious beliefs; and the break-up of religious beliefs is attended, as experience seems to show, with danger to popular morality." Twenty-five years ago Herbert Spencer foresaw the emergency that Professor Smith declares has now arisen, and, adopting what Professor Smith considers to be the "unspeakably momentous" principle of evolution for his guide, gave himself entirely to the mastering and reconstruction of those divisions of knowledge which lead up to ethical science, or "the establishment of rules of right conduct on a scientific basis." Having reached the subject with this profound and systematic preparation, he has given us a preliminary outline of his views of scientific morality in the small volume of the "Data of Ethics." Professor Smith's article is an attack—and, we regret to say, a most unscrupulous attack—upon this book.

Throughout his article Professor Smith represents Mr. Spencer as asserting, in his ethical volume, that the individual is to decide the right and wrong of an action by a direct balancing of the pleasures and pains involved, not to the community in general, but simply to himself. This is not so. Even had Mr. Spencer made no disavowal of this doctrine, the most cursory examination of his work would have shown that he takes no such position. But, when he dwells specifically upon the point, shows the fallacy of the idea, and explicitly repudiates it, the charge made against him is, to say the least, without excuse.

Spencer says, "It is quite possible to assert that happiness is the ultimate aim of action and at the same time to deny that it can be reached by making it the immediate aim." And, again: "The view for which I contend is, that morality, properly so called, the science of right conduct, has for its object to determine how and why certain modes of conduct are detrimental and certain other modes beneficial. These good and bad results can not be accidental but must be necessary consequences of the constitution of things; and I conceive it to be the business of moral

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science to deduce from the laws of life and the conditions of existence what kinds of action necessarily tend to produce happiness, and what kinds to produce unhappiness. Having done this, its deductions are to be recognized as laws of conduct, *and are to be conformed to irrespective of a direct estimation of happiness or misery.*" The italics are our own, but they broadly and positively define Mr. Spencer's position to be the reverse of that charged upon him in this article. Yet, notwithstanding this unequivocal statement, it pleases Professor Smith to represent Spencer's moral doctrines as absolving men from all moral obligation, and as giving a virtual license to crime by making immediate pleasure and pain the test of right and wrong; and, that his accusation might be sufficiently offensive, he draws pictures of a voluptuary and of a murderer excusing their actions by the principles of the "Data of Ethics."

But Professor Smith goes still further, and labors to show that Mr. Spencer has laid down principles which he has not himself the courage to pursue to their applications, and which cut up, root and branch, all pretext of any morality whatever. He quotes largely and repeatedly, from a late book of Dr. Van Buren Denslow, certain brutal passages in which the idea of any morality, except the will of the strongest, is sneered at as ridiculous. It is denied in these quotations that there is any such thing as a moral law which is broken by lying or stealing, and it is declared that the rules which have arisen against these practices are only expressions of a predominant brute force in society, which maintains them as a means of imposing upon and plundering the weak and the defenseless.

And how does Professor Smith make out that this is the outcome of Spencer's doctrines? By representing that Dr. Van Buren Denslow is a "profound admirer" and a "disciple" of Herbert Spencer who is only more "fearless" than his "master," and carries out his doctrines to their legitimate conclusions. The "Saturday Review" reproduces the substance of Professor Smith's article, and gives special distinctness to this feature of it. It says: "The case will become clearer if we turn from Mr. Spencer himself to his American admirer and disciple, Dr. Van Buren Denslow, who, as sometimes happens with disciples, has carried out his master's principles more consistently to their logical results. In a work entitled 'Modern Thinkers,' and commended to the public by a preface of Mr. Robert Ingersoll's, the chief apostle of agnosticism in America, he argues that on scientific principles there is no such thing as a moral law irrespective of the will of the strongest."

Now, the whole force of this case depends upon the assertion of Goldwin Smith that Dr. Van Buren Denslow is a "disciple" of Herbert Spencer. But the assertion is not true in any sense or in any degree. On the contrary, Dr. Denslow is an open antagonist of Mr. Spencer. His essay on Spencer's philosophy, first published in the Chicago "Times," while speaking of the man in the usual terms of perfunctory compliment, as have also Goldwin Smith and the "Saturday Review," is adverse, carping, and depreciatory on every point that he considers. The criticism was regarded as so damaging that Spencer's friends were told they must reply to it or for ever hold their peace; and we were confidently assured that the last we should ever hear of Spencer's system was the thud of the clods that Denslow had thrown upon its coffin. When the revised essay appeared in "Modern Thinkers," there was added a sharp attack upon the "Data of Ethics," in which the whole argument was scouted. And yet this man is paraded as Spencer's "disciple" for the unworthy purpose of fastening upon him the odium of opinions in total contradiction to all that he has ever written.

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Mr. Spencer is accused of relaxing the restraints of morality; but he has simply sought to make its reasons clearer, its foundations deeper, and to give to its principles the authority of science. Is morality weakened by being better understood, or are its obligations loosened by changing blind rules into rational principles? It is the peculiarity, and we may add that it is the difficulty, of scientific ethics that it is the most stringent of all systems. Where else are we taught so emphatically that the penalties of misdoing follow necessarily in the very nature of things and can not be escaped? Scientific ethics teaches that moral laws can not be broken with impunity, because of the inexorable causal relation between actions and results. This is, indeed, its great power as a controlling system, and it needs but to be thoroughly realized to exert its full influence. That it can not be so realized is largely because the community is educated in a different system. While it is recognized in common experience that immorality has its natural retributions, and while society embodies this principle in its laws by annexing inexorable penalties to criminal actions, yet the moral system which claims the highest sanction is of quite another order. A morality is taught by religious authority in which sins are forgiven in the sense of a remission of the penalties of immoral actions. In the current moral code the relation of cause and effect in conduct, as an inevitable law, finds no place; nay, the doctrine that the consequences of evil-doing may be escaped is a permanent ground of appeal to the evil-doer.

Professor Smith says: "Can it be maintained that the belief in an All-seeing Eye—in infallible, inflexible, and all-powerful justice, in a sure reward for well-doing and a sure retribution for evil-doing—has been without influence on the conduct of the mass of mankind?" But has the belief in an All-seeing Eye been associated in the past, or is it now associated, with "infallible, inflexible justice"? Are we not rather taught that the All-beholding has a plan by which the "vilest sinner" may be saved from the consequences of immoral conduct? Do our ten thousand churches teach this view, or do they not? In what system is righteousness accounted as but "filthy rags"? Is it agnostics, or theists, who for centuries have trafficked in absolution? Who furnishes the weekly passports of murderers from the gallows to glory? Stupendous and immortal penalties have been threatened against wrong actions, and then the evasion of these penalties has been conveniently provided for. Is not this easy system of morals, which arranges for the defeat of justice, more open to the charge of laxity than a scientific system in which penalties are both proportioned to transgressions and follow them with a salutary certainty?

INDEX TO "THE POPULAR SCIENCE MONTHLY."

THE present number closes the twentieth volume of "The Popular Science Monthly." The contents of these volumes are esteemed so valuable for reference that there have been many applications for a full index. This is now in preparation, and will shortly be issued in a separate form.

LITERARY NOTICES.

INTERNATIONAL SCIENTIFIC SERIES, No. XXXIX.

THE BRAIN AND ITS FUNCTIONS. By Dr. J. LUYS, Physician to the Hospice de la Salpêtrière. D. Appleton & Co. Pp. 327. Price, $1.50.

WE have here one of those striking cases, unfortunately too rare, in which the very ablest man makes the most thoroughly popular book. Dr. Luys, at the head of the great French Insane Asylum, is also one of the most eminent and successful investigators of cerebral science now living; and he

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has given, unquestionably, the clearest and most interesting brief account yet made of the structure and operations of the brain. The books of Drs. Luys and Bastian are to a great degree supplementary to each other. Dr. Luys, in treating "The Brain and its Functions," confines himself to the human brain, and makes his work an exclusively human study. Dr. Bastian, in his "Brain as an Organ of Mind," deals comprehensively with the supreme nerve-centers of the whole animal series. His work is profusely illustrated with diagrams of the figure and anatomical structure of the brains of all grades of animals; while Dr. Luys, passing by the whole scheme of inferior life, has but six illustrations in his book, and these are designed simply to make clear the offices and relations of fundamental parts, so as to explain the corporeal conditions of psychical processes.

We have been fascinated by this volume more than by any other treatise we have yet seen on the machinery of sensibility and thought; and we have been instructed not only by much that is new, but by many sagacious practical hints such as it is well for everybody to understand. Lest we be thought to speak too strongly in commendation of the sterling character of this work, and in order to give some idea of the author's method, we quote the following excellent statement concerning it from the columns of the "St. James Gazette":

No living physiologist is better entitled to speak with authority upon the structure and functions of the brain than Dr. Luys. His studies on the anatomy of the nervous system are acknowledged to be the fullest and most systematic ever undertaken. He begins by treating the soft and delicate material of the brain-tissues with chromic acid, which hardens it so as to fix it sufficiently for the purposes of laboratory work, without altering or distorting its essential constitution. He then cuts off very thin slices of the tissue one after another, and, by employing different chemical reagents for which the various minute elements of the brain have varying susceptibilities, he obtains transparent colored sections of the nervous matter, which throw into strong relief the distinction between cells and fibers, besides exhibiting clearly the nature and direction of their intricate ramifications. In this manner he has systematically made many thousand delicate sections of brains, horizontally, vertically, and laterally, at distances of a millimetre from one another, each of which he photographs, till at last he has succeeded in producing a series of maps of its entire structure which place the relations of its organs in strikingly novel lights. The first division of his present volume is devoted to summing up briefly the main results of these important researches. The late Professor Clifford has already popularized them in part for the English reader; but we believe this is the first time that they have been definitely set forth in any fullness before the general public on this side of the Channel.

Confining his attention to the cerebral hemispheres alone, without entering into any particulars as to the cerebellum and other minor appendages, Dr. Luys begins by pointing out the fundamental distinction between the nerve-cell or real central organ and the nerve-fiber or connecting thread. The first answers to the telegraph-office, the second to the wire uniting one office with another. The gray matter which forms the outer covering of the convolutions consists of closely packed cells, and is thus really the essential brain; the white matter in the center consists of fibers aggregated into bundles, and is thus really a mass of large nerves. Of the single cells themselves, with their numerous converging fibers, as well as of their arrangement in superimposed layers, Dr. Luys gives very graphic and instructive diagrams. The business of the cells individually and of the gray matter as a whole is to receive sensory messages from the external organs of the senses and to transform or to co-ordinate their impulses into the proper movements—as, for example, when we see a fruit or flower, and stretch out our hands to pick it. The white substance is shown to consist of numerous interlacing fibers, having for their function the conveyance of such information from without inward, or the carrying down of such motor impulses from within outward. Their definite arrangement in regular lines between the two hemispheres, as well as between the surface of the convolutions and the optic thalami and corpus striatum, is admirably shown by diagrammatic figures. This is the most important result of all Dr. Luys's work. He has made it clear that sense-impressions traveling from the eyes, ears, or skin, arrive first at the bodies known as the optic thalami; that they are there re-enforced and worked up, as it were, in special ganglia; and that they are thence reflected to the surface of the hemispheres, where they are finally converted into appropriate movements. He has also fairly settled the fact that certain minor bodies within the optic thalami are closely connected with the main nerves of sight, smell, taste, and hearing respectively, and that they must be considered as subordinate or intermediate centers where the data supplied by those senses are put into shape for consideration on the surface of the brain. The normal course of an excitation in the sense-organs seems to be this: it first proceeds along the fibers to its own subordinate center in the thalami; it then passes up to the corresponding portion of the convolutions; it there for the

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first time affects consciousness; and it is finally reflected back to the corpus striatum, whence it goes down the motor fibers to perform whatever actions have been decided upon for it by the conscious cells.

ADOLPH STRECKER'S SHORT TEXT-BOOK OF ORGANIC CHEMISTRY. By Dr. JOHANNES WISLICENUS, Professor of Chemistry in the University of Würzburg. Translated and edited, with Extensive Additions, by W. H. Hodgkinson, Ph. D., and A. J. Greenaway, F. I. C. New York: D. Appleton & Co. Pp. 789. Price, $5.

LET no one suppose that in this "short text-book" we have to deal with a primer. Everything is comparative, and the term "short" here has relation to the enormous development and extent of recent organic chemistry. This solid and comprehensive volume is intended to represent the present condition of the science in its main facts and leading principles, as demanded by the systematic chemical student.

We have here, probably, the best extant text-book of organic chemistry. Not only is it full and comprehensive and remarkably clear and methodical, but it is up to the very latest moment, and it has been, moreover, prepared in a way to secure the greatest excellences in such a treatise. The original "Text-Book of Organic Chemistry," by Adolph Strecker, was a work of great merit, which stood high in Germany, and passed through several editions. The author was vigilant in keeping it up to the time, and was about to enter upon the preparation of the sixth edition, making important changes required by chemical progress, when his labors were cut short by death in 1871. Professor Wislicenus, the accomplished chemist of Würzburg, was then induced after considerable reluctance, owing to the pressure of his official duties, to undertake the task which the author was prevented from accomplishing. This was done in so thorough a manner that, while much of Strecker's best work remained, it received a new cast and a more perfect adaptation, both to the state of the science and to the requirements of those for whom it was primarily intended. So largely was the treatise impressed by the originality of Professor Wislicenus that it became generally recognized as his work; and, when it was proposed to reproduce the book in English, Professor Wislicenus only consented on the condition that the very latest results of research in organic chemistry should be embodied in it. He stipulated that "regard shall be had to the largely increased material and essentially nearer insight into the relations and nature of organic compounds already known, that have been obtained since the publication of the book." Drs. Hodgkinson and Greenaway seem to have faithfully carried out this conscientious purpose of the author.

It is not necessary to attempt here any statement of the method or classification of the book, as it would take more room than we can give, and, after all, would concern chiefly the special students of organic chemistry. The names upon the title-page are the best guarantee of the character of the volume, and an examination of its pages shows that it has been executed with remarkable clearness and accuracy. In regard to the formulæ based upon the atomic theory which now play so prominent a part in organic chemistry, Professor Wislicenus admonishes students that they must be taken with great reserve. On this point he says: "In the present state of our science we can not neglect the frequent use of structural formulæ based on the valency of the chemical elements. Their partial uncertainty and, in many points, tangible short-comings, need not prevent their use to some extent in a text-book, although their use requires care. With regard to the manner of writing the constitutional formulæ, no dogmatic adherence to any single method will be adopted, so that the formula of one and the same substance may be found varyingly written in different places. With every one of these systems of formulæ there is the danger of substituting a concrete image in place of an idea. These images we certainly can not do without, but we must keep the idea lying behind such an image as far as possible pure, and also mobile, seeing that in comparison with older views we have in it only relative not absolute truth."

SENSATION AND PAIN. By CHARLES FAYETTE TAYLOR, M. D. A Lecture delivered before the New York Academy of Sciences, March 21, 1881. New York: G. P. Putnam's Sons. Pp. 77. Price, 75 cents.

THIS interesting monograph is an important practical contribution to what may be called the science of illusions. It is a curi-

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ous study in medical psychology, in which the author draws upon an extensive practice for illustrations of the phenomena of self-deception in the processes of sensation and the experience of pain. The first portion of Dr. Taylor's lecture is devoted to a brief account of the action of the nervous system, not only as a receptive apparatus for the production of sensibility, but as a reacting mechanism in which sensations are stored and accumulated to give rise to centrally-initiated feelings and impulses. "Up to a certain point," says Dr. Taylor, "and in a certain degree and manner, we are unquestionably automata. If it were otherwise, life would be simply impossible. The sensations which we receive through the five senses set a-going certain machinery, the result of which is sensory life, as certainly as the open valve lets in the steam which makes the ponderous engine throb with motion and power. But steam, having once been used, flows out lifeless, a simple waste. Not so the sensations. Once received, they are never wholly spent, but in various forms remain as a portion of our vital selves so long as we live. And, once received, we may use and control their accumulated substance much as we will."

But if illusions arise in the action of the peripheral senses, so definite in their action and so open to observation, they are far more liable to arise in regard to the feelings which come from centrally-initiated impulses, and prominent among these deceptions are the false location of pain and the false interpretation of centrally-initiated impressions. On this point Dr. Taylor remarks: "If the direct evidence of our special senses can not be depended on, as previously shown, how much greater must be the liability to error, when conclusions are drawn from feelings depending on those pulses of nerve-force which have been set up in the cerebral end of the nervous system! And yet, large numbers of people take the evidence of their feelings, having nothing but an emotional origin, as evidence of bodily conditions. An emotional temperament is simply one in which the pulse of action in the nerve-centers rises higher than the occasion requires. There is a throb or explosion of energy, under a stimulus which would produce only a pulse in ordinary persons. Æsthetic education, particularly when not accompanied by special discipline, tends to increase inherited habits, until the existence of some persons consists of successions of nerve-center explosions, with all the prodigal waste of energy which accompanies that state. Such a person is thrown into ecstasies of pleasure or pain by causes by which a balanced temperament would not be affected. If a lady, she has a large variety of feelings, many of them disagreeable; and, if for any reason her attention becomes engaged with them, it is apt to become absorbed in their contemplation. If she has feelings along the back, she concludes she has spinal disease. If it is the head which disturbs her—and why should it not, with regular batteries of nerve-center explosions, touched off by her own untrained and rampant emotions?—she thinks there must be brain-disease or something horrible there; the more horrible in name the better it will suit the particular ebullition which names the disease."

Many interesting cases are given illustrating the illusions that thus arise; we quote a single one: "A young lady of seventeen came to me about ten years ago for what she and her friends supposed was disease of the hip-joint. After examination, I told her that there was no disease of the joint whatever. I tried to explain to her comprehension that, for some reason, she had become anxious about the hip-joint, and that her attention was so fixed on it that all sensations transmitted from that vicinity caused such throbs of the nerve-centers that an ordinary sensation was converted into an extraordinary one, and the anxious attention which she directed to that part made her painfully conscious of what would otherwise be normal sensations and thus unnoticed. But I failed to impress her sufficiently to divert her attention from the part, and she continued to walk on crutches, in all, during eight years. At last she suddenly found that she was not lame. I had the pleasure of examining her about six months after she had ascertained that she was not lame, and I found a wholly unaffected joint, precisely as it was seven years previously when I first saw her."

Sufficient has been said to illustrate the principal points of Dr. Taylor's discourse.

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The subject is clearly presented, and his views and conclusions are not only practical, but so important that they can not receive too much popular attention.

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ANTISEPTIC SURGERY: THE PRINCIPLES, MODES OF APPLICATION, AND RESULTS OF THE LISTER DRESSING. By Dr. JUST LUCAS-CHAMPIONNIÈRE, Surgeon to the Hôpital Tenon. Translated and edited by FREDERIC HENRY GERRISH, A. M., M. D., Professor of Materia Medica and Therapeutics in Bowdoin College. Portland: Loring, Short & Hannon. 1881. Pp. 240. Price, $2.25.

THE editor's object in introducing this work is to enable his fellow-practitioners in America, in the absence of any low-priced treatise on the subject in the English language, to gain such a knowledge of Lister's method as will enable them to apply it with essential accuracy. The method has become thoroughly established in medical science, and is being rapidly adopted by intelligent practitioners in all countries. It is recognized in England, "reigns supreme" in Denmark, "has its enthusiasts" in Germany, "has gained a firm foothold" in France, and is represented among the surgeons in Austria, Switzerland, Holland, Russia, Italy, and America. "Nélaton," says the author, "was accustomed to say that the man who should discover the means of suppressing purulent infection deserved a statue of gold. If this view of Nélaton's was generally entertained, the statue would be raised to Professor Lister, for purulent infection has disappeared from the list of wound complications in the services in which his method is followed."

THE ORIGIN OF PRIMITIVE SUPERSTITIONS, AND THEIR DEVELOPMENT INTO THE WORSHIP OF SPIRITS, AND THE DOCTRINE OF SPIRITUAL AGENCY AMONG THE ABORIGINES OF AMERICA. By RUSHTON M. DORMAN. Twenty-six Illustrations. Philadelphia: J. B. Lippincott & Co. 1881. Pp. 393. Price, $3.

MYTHOLOGY, as considered by the author, includes in its broadest definition all pagan religious beliefs, commonly called superstitions, and can not be confined to collections of fables and traditions, which are the folk-lore of peoples. In this, its larger sense, it is a very important branch of archæological science, and its study reflects much light into a past which written history has not penetrated. The author is struck with the universality of mythology, and with the evidence it presents of the homogeneity of man's religious beliefs, and his purpose is to collate the facts that show this homogeneity, to reduce to a system of religious beliefs the multitude of superstitions that have germinated among uncultured peoples, and to trace all superstitions to a common origin. The general prevalence of the same superstitions and folk-stories among primitive peoples has led to exaggerated efforts to trace a derivation of one system of mythological belief from another by contact or migration of myths. Mr. Dorman believes that these efforts have been wrongly directed; that the mythologies in question are all of natural development among each people; and that their similarities among all peoples in the same successive stages are explained by the fact that their growth has always and everywhere taken place according to the laws of man's spiritual being. Hence we have no need to assume communications between the negroes and the American Indians and other uncultured peoples, of the existence of which we have no evidence, to account for the coincidence of such myths as the "Uncle Remus" stories of the plantation negroes with similar stories among tribes strange to them. Mr. Dorman takes issue with those who believe that the higher phases of belief and worship have been the most ancient, and have become debased in the ruder forms. According to his view, "all primitive religious belief is polytheistic. All savage tribes are full of the terror of invisible spirits which have been liberated by death," which fill all nature, animate and inanimate, are in the air, the wind, the storm, the rock, the vale, the river, the water-fall, and which "transmigrate into human beings, animals, plants, and even into inanimate stones, idols, and heavenly bodies, which are supposed to be animate thereafter. Hence originates the worship of ancestors, and also of animals, plants, stones, idols, and the heavenly bodies." He is also convinced that those writers are wrong who have affirmed of any people that they are destitute of religious feeling, and as-

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serts that many such authors have contradicted themselves unwittingly by giving lists of the superstitions of the people against whom they made the charge. In all his own studies on the subject he has not found a people, "no matter how savage, who have no religion, if the word is used in its broadest sense, to embrace all superstitions." He also denies that any of our Indians were primarily monotheists, or that the belief in a Supreme Being has existed among them for any considerable time, and asserts that no approach to monotheism had been made before the discovery of America by Europeans, and that the idea of the Great Spirit mentioned in books on the aboriginal tribes of America is an introduction by Christianity. The body of the work consists of citations from a host of authors illustrative of the condition of Indian thought and development in respect to religion, and especially in regard to the doctrine of spirits, fetichistic superstitions, rites, and ceremonies connected with the dead, animal-worship, the worship of trees and plants, of remarkable natural objects, and of the heavenly bodies, the animistic theory of meteorology, and priestcraft. The whole is as interesting as it is instructive, and as instructive as it is interesting, and is believed by Mr. Dorman to show that a gradual development from the rudest superstition, rather than a degeneracy from monotheism, has taken place; and that "the religion of the aboriginal tribes of America was a system of superstitions, all of which are explicable by the doctrine of the agency of multitudes of spirits, and in no other way."

TOKIO DAIGAKU (UNIVERSITY OF TOKIO). THE CALENDAR OF THE DEPARTMENTS OF LAW, SCIENCE, AND LITERATURE. 2540 TO 2541 (1880 TO 1881). Tokio, Japan: Published by the University. Pp. (in English) 199.

ATTENTION is first drawn to the historical summary which immediately follows the list of officers and professors, and relates the different steps in the organization and development of the university in detail. It shows that the introduction of Western learning into Japan dates from between 1703 and 1711; that an observatory was established in 1744; that a translation-office was instituted in 1811 to translate Dutch books; that the Dutch language was taught in 1858, and the English, French, German, and Russian languages were introduced, and courses in mathematics, botany, and chemistry were established in and after 1858; and that instruction was given mainly in the English language in 1867. The subsequent course of the university has been in the direction of expansive development, and need not be reviewed minutely. Instruction is given in the departments of law, science, and literature, which names cover nearly all that is included in similar departments in Western institutions, and some other matters peculiarly Japanese and Chinese, by American and European and Japanese professors. The law department includes English and French law, and ancient and present Japanese law; the scientific department is comprehensive; the literary department includes English literature, philosophy, political philosophy and economy, history, Buddhism, and Japanese and Chinese literature. More than fifty professors, assistants, and teachers are employed, two hundred and five students and ninety-two graduates are registered, and fifteen students are entered as sent abroad to England, France, and Germany.

ENGLISH PHILOSOPHERS: BACON. By THOMAS FOWLER, M. A., F. S. A., Professor of Logic in the University of Oxford. New York: G. P. Putnam's Sons. 1881. Pp. 202. Price, $1.25.

PROFESSOR FOWLER'S object is, to present the character of the revolution which Bacon endeavored to effect in scientific method, as well as the nature of his philosophical opinions generally, in a form intelligible and interesting to readers who have no technical acquaintance with logic or philosophy. The several chapters include the life of Bacon, an account of his works, reviews of his "Survey of the Sciences," and his "Reform of Scientific Method," an examination of his philosophical and religious opinions, and an estimation of his influence on philosophy and science. On the last point, Professor Fowler believes that the influence and direction given by Bacon to science were of "the very highest importance." He called men to study the ways and imitate the processes of nature,

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insisted on the importance of experiment as well as of observation, recalled men to the study of facts, promoted their emancipation from the bonds of authority and the enchantments of imagination, insisted on the subordination of scientific inquiries to practical aims, promoted hopefulness, and clothed his thoughts in marvelous language.

ELEMENTS OF GEOMETRY. By SIMON NEWCOMB, Professor of Mathematics, U. S. Navy. New York: Henry Holt & Co. 1881. Pp. 399. Price, $1.75.

PROFESSOR NEWCOMB does not, like many who have written on this subject, consider Euclid's system perfect, but believes that it fails in several points to meet modern requirements, and needs remodeling. This he attempts in a few features, most noticeably in the recognition of angles of a larger measurement than 180°. He accordingly treats the sum of two right angles as itself an angle, to which he gives the name of a "straight angle," and explicitly defines it. He also uses language more in accordance with modern ideas in speaking of planes. In an introductory book, besides the usual fundamental axioms and definitions, practical exercises are given in the practice of the analysis of geometric relations by means of the eye. Some of the first principles of conic sections have been developed, as a preliminary study of that subject, or to give some knowledge of those curves to those who do not intend to study analytical geometry. In proportion, a middle course has been adopted between the rigorous and prolix treatment of Euclid and the easier and simpler, but ungeometrical, method of American works.

DOCUMENTS RELATING TO THE HISTORY AND SETTLEMENTS OF THE TOWNS ALONG THE HUDSON AND MOHAWK RIVERS (WITH THE EXCEPTION OF ALBANY), FROM 1630 TO 1684. By B. FERNOW, Keeper of the "Historical Records." Albany, New York: Weed, Parsons & Co. Pp. 617.

THIS is the thirteenth volume of the series of documents relating to the colonial history of the State of New York, published officially under the direction of the Secretary of State. It embraces deeds, bargains, transactions of councils, memoirs, and correspondence, the general bearing of which illustrates the relations of the early settlers with the Indians. An important lesson drawn from these relations and their workings is that of the practical value of fair dealing with the Indians. It was the rule of the settlement of New Netherland, invariably enforced from the beginning, that no man could settle upon Indian land unless the Indian title was first extinguished in a manner satisfactory to the Indian proprietors. The consequence of the observance of the rule was that "the Dutch, living at the door of the powerful Five Nations, could always count upon the friendship of their Indian neighbors." This friendship had a momentous bearing upon the future of the continent, for it kept the Hudson River, the only natural route to the North and West, always open and safe for the white man, and thus greatly facilitated settlement.

HOUSES AND HOUSE-LIFE OF THE AMERICAN ABORIGINES. By LEWIS H. MORGAN. Washington: Government Printing-Office. Pp. 281, with numerous Plates.

THIS, the last work of the lamented author, was completed by him during the later days of his failing strength for publication in Major Powell's reports of the Geographical and Geological Survey of the Rocky Mountain region. It formed substantially the fifth part of the original manuscript of the author's "Ancient Society," but was omitted from that work on account of the size which it had reached. Parts of it have appeared in detached articles; a summary of the whole as a cyclopædia article; the substance of two of the chapters, as "Montezuma's Dinner" and the "Houses of the Mound-Builders," in the "North American Review"; and other parts, as "A Study of the Houses and House-Life of the Indian Tribes," with a scheme for exploring the ruins in New Mexico, Arizona, the San Juan region, Yucatan, and Central America, in the "Transactions of the Archæological Institute of America." The facts and views embodied in these articles being placed now in their proper connection, with others bearing upon the same point, the full force and clearness which they are capable of furnishing are given to the author's theory. That theory is that the

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communal houses of the Indians at the time of the first white settlements in our country, the pueblos of New Mexico and Arizona, the structures whose ruins abound in Mexico and Central America, and the mounds of the mound-builders, illustrate a common type of house-construction and a communistic mode of living by the *gens* or tribe, which are not peculiar to the American aborigines, but have appeared as elements in primitive life at a stage between savagery and barbarism, among many other nations. The illustrations, drawn from and applied to all the classes of structures under review, and the historical citations, afford strong re-enforcements to the author's presentation.

GEOLOGY OF THE ENVIRONS OF TOKIO. By DAVID BRAUNS, Ph. D., M. D., Professor of Geology in Tokio Daigaku. Tokio, Japan: Tokio Daigaku. 1881. Pp. 85, with Eight Plates.

THIS is Number IV of the "Memoirs" of the Science Department of the University of Tokio, and contains accounts of the examinations of the alluvial, diluvial, and tertiary deposits of the neighborhood of Tokio, Yokohama, and other parts of Japan, some of which present difficult problems, and descriptions of the fossils (mollusks). The conclusion is reached that the Japanese shell-layers which were examined have the greatest resemblance with the Crag, and next to it with the younger sub-Apennine deposits, while the rocks resemble very closely the European Faluns. The plates, besides a sketch-map of the environs of Tokio, give representations of earth-sections and of some thirty typical fossils.

REPORT ON THE GEOLOGY AND RESOURCES OF THE BLACK HILLS OF DAKOTA. By HENRY NEWTON, E. M., and WALTER P. JENNEY, E. M. Washington: Government Printing-Office. Pp. 566, with Atlas.

PROFESSOR NEWTON'S part of this work includes the general introduction, observations on the routes to and from the Black Hills, and the account of the geological formations of the region, as observed in his survey during the summer of 1875. The author died in 1877, before completing his report, and the work of finishing it fell to Mr. C. K. Gilbert, who has performed it with fidelity to the author's intention, bearing in mind what has been learned concerning the gold of the Black Hills since the survey was made. Mr. Jenney's part of the report is his own exclusively, and includes a detailed review of the mineral resources, and the climate and general resources, of the Black Hills. Additional chapters, with plates of illustrations, are furnished: On "Paleontology," by R. P. Whitfield; "Microscopic Petrography," by John H. Caswell; "Botany," by Asa Gray; and "Astronomy" and "Barometric Hypsometry," by Horace F. Tuttle.

MEASUREMENTS OF THE FORCE OF GRAVITY AT TOKIO AND ON THE SUMMIT OF FUJINOYAMA. By T. C. MENDENHALL, Ph. D., Professor of Experimental Physics in Tokio Daigaku. Tokio, Japan: Published by Tokio Daigaku. 1881. Pp. 17.

THIS is Number V of the "Memoirs" of the Science Department of the University of Tokio. The experiments were conducted with a pendulum, in 1880, and produced results that seemed to show that the mountain is deficient in attraction.

PUBLICATIONS RECEIVED.

Chemical and Physical Analysis of Condensed Milk and Infants' Milk-Foods. By Dr. Nicholas Gerber. Translated and edited by Dr. H. Endemann. New York. 1882. Pp. 101. Nineteen Plates.

The Establishment of an International Tribunal. By A. H. Stoiber. New York. 1882. Pp. 24.

Catalogue of Southwick & Jenck's Natural History Goods. Providence, Rhode Island. 1881. Pp. 23.

Quarterly Report of the Chief of the Bureau of Statistics for the Three Months ended September 30, 1881. Washington: Government Printing-Office. 1882. Pp. 180.

Circulars of Information of the Bureau of Education. No. 5. 1881. Washington: Government Printing-Office. 1881. Pp. 47.

Pulpit Talks on Topics of the Time. By the Rev. J. H. Rylance, D. D. New York: I. K. Funk & Co. 1882. Pp. 46.

Question-Book of Natural Philosophy. With Notes, etc. By Albert P. Southwick. Ansonia, Ohio. 1881. Pp. 16. 10 cents.

Transactions of the New York Academy of Sciences, 1881–1882. Vol. I, No. 2. November, 1881. Published for the Academy. Pp. 29.

Contributions to the History of the Vertebrata of the Lower Eocene of Wyoming and New Mexico. Made during 1881. By E. D. Cope. Philadelphia, 1881. Pp. 98.

Report of the Proceedings of the Ensilage Congress. Published by the New York Plow Company. 1882. Illustrated. Pp. 66. 30 cents.

The Development History of the Flowers of the Gunnera Chilensis. By William A. Keller-

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mann. Oshkosh, Wisconsin. 1881. Illustrated. Pp. 23.

The Chemical Cause of Life Theoretically and Experimentally Demonstrated. By Oscar Loew and Thomas Bokorny. Munich. 1881. Illustrated. Pp. 60.

Proceedings of the Boston Society of Natural History. Vol xx, Part IV, January to April, 1880; and vol. xxi. Part I, May to December, 1880. Boston. 1880.

Scientific Proceedings of the Ohio Mechanics' Institute. Vol. i, No. 1. Cincinnati, January, 1882. Pp. 48. Quarterly, $1 a year.

Gold-bearing Drift of Indiana. By George Sutton, M. D. Reprinted from the "Proceedings of the A. A. A. S." Salem, Massachusetts. 1882.

Publications of the Cincinnati Observatory. Micrometrical Measurements of Four Hundred and Fifty-five Double Stars observed with the Eleven-inch Refractor during the Year ending September 1, 1880, under the Direction of Ormond Stone, A. M., Astronomer. Cincinnati. 1882. Pp. 69.

Ninety-sixth Annual Report of the Society of Mechanics and Tradesmen of the City of New York. Prepared by the Finance Committee. New York: Henry Bessey, printer. 1882.

On the Effect of Prolonged Stress upon the Strength and Elasticity of Pine Timber. By R. H. Thurston. Reprint from the "Proceedings of the Cincinnati Meeting of the A. A. A. S." Pp. 8.

Boston Society of Natural History. Guides for Science Teaching. No. I. About Pebbles. By Alpheus Hyatt. 1879. Pp. 26. No. II. Concerning a Few Common Plants. By George L. Goodale. 1881. Pp. 61. No. III. Commercial and other Sponges. By Alpheus Hyatt. Illustrated. 1879. Pp. 43. No IV. A First Lesson in Natural History. By Mrs. Agassiz. Illustrated. 1879. Pp. 64. No. V. Common Hydroids, Corals, and Echinoderms. By Alpheus Hyatt. Illustrated. 1881. Pp. 32. No VI. The Oyster, Clam, and other Common Molluska. By Alpheus Hyatt. Illustrated. 1881. Pp. 65. No. XII. Common Minerals and Rocks. By William C. Crosby. 1881. Pp. 130. Boston: Ginn, Heath & Co.

Annual Reports of the Boston Society of Natural History, 1879-1880; 1880-1881. Boston. 1882. Pp. 35.

Fifth Annual Report of the Superintendent of the Yellowstone National Park. By P. W. Norris. Washington: Government Printing-Office. 1882. Pp. 81. With Map.

Soluble Compressed Pellets. A New Form of Remedies for Hypodermic Use. By H. Augustus Wilson, M. D. Reprint from "Transactions of the American Medical Association," 1881. Philadelphia. 1881. Pp. 4.

Science in Public Schools. By George Davidson. Reprint from "Mining and Scientific Press." Pp. 5.

The Distribution of Plant Life. By Dr. B. W. Barton. Address before the Maryland Horticultural Society, April, 1881. Pp. 8.

Report on Diphtheria. By Franklin Staples, M. D. Winona, Minnesota. Pp. 44.

The Oyster Industry, by Ernest Engersoll, illustrated, 1881, pp. 250, and A Monograph on the Seal Islands of Alaska, by Henry W. Elliott, illustrated, 1882, pp. 178. Washington: Government Printing-Office.

Trance and Muscle Reading. By G. M. Beard, M. D. New York. 1882. Pp. 40.

Incandescent Electric Lights. New York: D. Van Nostrand. 1882. Pp. 176. 50 cents.

A Year of Miracle. A Poem in Four Sermons. By W. C. Gannett. Boston: George H. Ellis. 1882. Pp. 106. 50 cents.

Paine Genealogy, Ipswich Branch. By Albert W. Paine. Bangor, Maine. 1881. Pp. 184.

The Burgomaster's Wife. A Romance. By Georg Ebers. New York: William S. Gottsberger. 1882.

The Art of Voice Production. By A. A. Patton. New York: G. P. Putnam's Sons. 1882. Pp. 106. $1.

The Use of Tobacco. By J. L. D. Hinds, Ph. D. Cumberland Presbyterian Publishing House. 1882. 75 cents.

Marriage and Parentage. By a Physician and Sanitarian. New York: M. L. Holbrook & Co. 1882. Pp. 185.

The Temple Rebuilt. A Poem. By Frederick R. Abbe. Boston: D. Lothrop & Co. 1882. $1.25.

Beliefs about Man. By M. J. Savage. Boston: George H. Ellis. 1882. Pp. 130. $1.50.

The Gospel in the Stars, or Primeval Astronomy. By Joseph A. Seiss, D. D. Philadelphia: E. Clayton & Co. 1881. Pp. 452.

A Practical Treatise on Hernia. By Joseph H. Warren, M. D. Boston: J. R. Osgood & Co. 1882. Illustrated. Pp. 428. $5.

The Voyage of the Vega round Asia and Europe. By A. E. Nordenskiold. Translated by Alexander Leslie. New York: Macmillan & Co. 1882. Pp. 756. Illustrated. $6.

POPULAR MISCELLANY.

About Eggs.—All eggs of birds are good for food, and all are palatable enough to be eaten by a hungry man; but the most and the best food-eggs are furnished by the gallinaceous birds. The number of eggs consumed in the more populous countries is immense. Great Britain imports 785,000,000 from the Continent, they representing a value of more than £2,500,000; while Ireland furnishes nearly 500,000,000; and the home production is probably nearly equal to the amount of the importation from the Continent. The consumption, already so large, is increasing at a rate which shows that the value of this kind of food is steadily and rapidly growing in appreciation. The United States is supposed to produce 9,000,000,000 eggs annually, of which 25,500,000 dozen are sent to the New-York market. More than 800 dozen eggs are consumed in a single English hospital in the course of a year. The use of eggs as a standard article of diet has been limited by reason of their perishable nature; but this difficulty is now, in a measure, obviated by the desiccating and condensing process practiced in St. Louis and New York, and the canning process of Herr von Effner in Germany. Eggs are preserved in some parts of England by boiling them, removing the shells, and pickling them; in the United

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States, by the common liming process, which keeps them fit for every purpose except that of boiling; and in China, by covering them with a paste of lime, salt, and ashes, from which they come out, however, rather the worse in appearance and smell. All eggs brought to Paris must be examined before being offered for sale; and sorted, by being passed through rings of three centimetres eight millimetres in diameter for the small, and four centimetres for the average size. An ordinary fowl's egg weighs from one and a half to two ounces; the egg of the duck from two to three ounces; those of the sea-gull and turkey from three to four ounces; that of the goose from four to six ounces. Eggs of wild birds are esteemed on account of the flavor that is given them by the food of the birds, and on account of the larger proportion of the more nutritious yellow that they contain. The ostrich is beginning to take rank as a valuable egg-producing domestic fowl. Each female bird will lay from twelve to sixteen, even, according to some, from twenty-five to thirty eggs, in August and September; and, as several couples will sometimes unite to hatch together, it often happens that as many as sixty eggs may be found in and around a single nest. Each of these eggs is considered equivalent to twenty-four eggs of the domestic hen; so that, as single domesticated birds have been said to lay eighty-two eggs in a season, we have the possible product of one ostrich represented by 2,624 hens' eggs. The eggs of the Australian emu, which are nearly as large as those of the ostrich, and green, are eaten by the settlers with much relish, although they are somewhat strong in flavor. The eggs of the Rhea ostrich of the South American pampas, of which forty, fifty, or seventy may be found in a nest, form a staple article of food during the spring months. The eggs of sea-fowl are largely consumed in many places, and those of the gull give rise to a considerable trade. A business of this kind is actively carried on off the coast of Northumberland, where prodigious quantities of eggs are collected; at the Pedro Keys, near Jamaica, where several kinds of sea and land birds resort; the coasts of Norway and Labrador; Funk Island, near Newfoundland; parts of the African coast, and islands generally. Eggs of water-fowl form an important part of the food of the Faroe Islands; the eggs of the dusky petrel are sent, in immense quantities, from Bass's Strait to Tasmania and Australia; incredible numbers of auks' eggs are collected on the coast of Labrador; the eggs of the malee-bird of Celebes are esteemed a great delicacy, and will each fill an ordinary tin cup, and form, with bread or rice, a very good meal.

The Yellows in the Peach-Tree.—Mr. W. K. Higley has given in the "American Naturalist" an account of the observations he has made to learn the cause of the yellows in the peach-tree and the manner in which it is disseminated. He is satisfied that the disease is due to a fungoid growth, but not to a *noemaspora*, as Mr. Taylor, of the Agricultural Department at Washington, believes, for that form occurs on other trees that receive no harm from its presence; nor to a fungus in the tissues of the roots, for no fungus has been recorded as occurring there. He worked, in his examinations, upon the theory that the fungus must be natural to the tree, enjoying the same conditions of development as are favorable to the growth of the tree. Hence, he took no pains to cultivate the plant, but examined specimens as they were gathered from diseased trees. Nothing was found in the roots. Mycelia were found in sections of the trunk, on the under side of the inner bark next to the cambium layer, with many of the filaments penetrating and ramifying through that layer, and, in some specimens, mycelia between the layers of wood. In some of the smaller branches and the growing ends of the larger branches, the tissues seemed to be completely filled with mycelia, and in one case the bark appeared to be split. Filaments of fungus were found in the leaves of the abnormal branches characteristic of trees affected with the yellows, and the chlorophyl in all such leaves was completely disorganized. The most satisfactory results were obtained from the examination of the fruits, in which mycelia were abundantly found just beneath the skin, extending for a short distance into the fleshy parenchyma. The form was the same as that which was found in other parts

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of the tree; this form, Mr. Higley believes, as the final result of his investigations so far, to be at least a part of and probably the whole cause of the disease. The affection is, of course, transmitted by whatever will convey the fungus or its spores. Mr. Higley has no faith in any of the cures that have been proposed for the yellows, and believes that where they have seemed to be successful, not yellows, but some other cause of trouble was present. The only remedy he can propose is to root out the tree and burn every part.

The Approaching Transit of Venus.—An international conference respecting the observations of the transit of Venus, which will take place next December, was held in Paris last October, under the presidency of M. J. B. Dumas. Most of the European countries, Brazil, Chili, and the Argentine Republic, were represented, and reported upon the observing stations which would be cared for by their respective countries. France will establish eight stations, Brazil five, Germany four, Denmark and the Netherlands, Austria, Hungary, Chili, and Mexico one each, Spain and the Argentine Republic two each, forming a line of stations from the southern part of the United States through Central America, the West Indies, and the east and west coasts of South America to the Strait of Magellan. Besides these, Great Britain will have sixteen stations arranged in groups of two, with principal centers of observation at the Cape of Good Hope, in Australia, New Zealand, and the Antilles; and Portugal will have two stations within its proper limits, and one at Benguela or Lorenço Marquez. No reports were made from Italy and the United States. A committee to which the subject was referred made a report concerning the best arrangements for details of observation; and a resolution was adopted in favor of calling, after the return of the observing expeditions, an "International Commission on the Transits of Venus," in which each state should be represented by a plenipotentiary, to form a provisional organization for collecting all the data of the observations, and deducing from them in common a general determination of the parallax of the sun.

Sewage in Oysters.—The oysters of Dublin Bay are threatened with extinction in consequence of the turning of the sewage of the city into the water. Edible fish were numerous a generation ago in the river Liffey, which is the chief carrier of sewage to the bay, but now they are rarely seen there. Oysters were taken for examination, by Dr. Charles A. Cameron, from a spot which is covered by about ten feet of water at high tide, but is nearly dry at low water. The brine of a large proportion of them emitted a slight but distinctly fetid odor, and when examined microscopically was found to swarm with micrococci and other low organisms of sewage. Of samples of sea-water taken at the beds at high tide and from little pools containing oysters at low water, the latter contained ten times as much albuminoid ammonia and thirty times as much saline ammonia as the former, proving that it was in great part composed of sewage. It is impossible for the oysters to keep from imbibing much of this water; and if we sometimes acquire the germs of fever from drinking water and milk, why may we not also from the juice of oysters raised in sewage-polluted waters?

Malarial Organisms.—M. A. Laveran has found, in the blood of patients suffering from malarial poisoning, parasitic organisms, very definite in form and most remarkable in character; motionless, cylindrical curved bodies, transparent and of delicate outlines, curved at the extremities; transparent spherical forms provided with fine filaments in rapid movement, which he believes to be animalcules; and spherical or irregular bodies, which appeared to be the "cadaveric" stage of these, all marked with pigment-granules. He has also detected peculiar conditions in the blood itself. During the year that has passed since he first discovered these elements, M. Laveran has examined the blood in one hundred and ninety-two patients affected with various symptoms of malarial disease, and has found the organisms in one hundred and eighty of them, and he has convinced himself by numerous and repeated observations that they are not found in the blood of persons suffering from diseases that are not of malarial origin. In general, the

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parasitic bodies were found in the blood only at certain times, a little before and at the moment of the accession of the fever; and they rapidly disappeared under the influence of a quinine treatment. The addition of a minute quantity of a dilute solution of sulphate of quinine to a drop of blood sufficed to destroy the organisms. Mr. Laveran believes that the absence of the organisms in most of the cases (only twelve in the whole one hundred and ninety-two) in which he failed to find them was due to the patients having undergone a course of treatment with quinine.

The Freezing of a Salt Lake.—Dr. Woeikoff has published the results of some observations which were made at his suggestion into the conditions of freezing and thawing of a salt lake near Orenburg, Russia. The lake has a surface of 473 square metres and is about five feet deep. Its water contains sixteen per cent of salt, and the mud of its bottom is rich in sulphuretted hydrogen. During January, 1879, except for one day, when the temperature was barely above the freezing-point, the thermometer in the air ranged from —6·3° to —28·2° centigrade, while the temperature of the water at the surface was from —3·4° to —13° C., and at the bottom from —3·8° to —12·8° C. On the 27th of December, when the temperature of the air was as low as —21° C., the lake was covered with a viscous ice, which soon began to thaw, however, when the temperature of the air rose to —6° C., and the temperature of the water was as low as —7·8° C. By the 3d of January all the ice had disappeared, but the temperature of the water was still 7·2° C. below the freezing-point, or about 19° Fahr. On January 11th, the temperature of the air being —22° C., and that of the water being —9·8° C. at the surface and —5·6° at the bottom, the lake began again to be covered with viscous ice, and soon froze, the ice reaching a thickness of about six inches in ten days. But the remainder of the water was still unfrozen, notwithstanding that its temperature decreased to —10° C. on January 17th, and even to —12·8° C. on January 30th. Never before, says Dr. Woeikoff, were temperatures below —4° C. or 24·8° Fahr. observed in saline solutions outside of laboratories, while here were temperatures of —13° C., or 8·6° Fahr., observed in a salt lake. However, former experiments, especially those of M. Zöppritz, have proved that there is no diffusion of salt before congelation; it seems that in this lake (Kupalnoze) there is such a diffusion of salt toward the lower stratum of water, even before the freezing begins, otherwise it would be difficult to explain how colder water might remain on the surface, were it not for the greater amount of salt in the lower strata. It has always been difficult to explain how ice is formed on the surface of oceans while the temperature of maximum density is lower than that of congelation, and the observations on this lake were instituted in the hope that they might throw light upon the subject. The lake, however, contains too much salt to afford a sure standard of comparison with oceanic water.

A Collection of Quaint Scientific Instruments.—The Royal Mathematical and Physical Museum, in Dresden, Saxony, was founded by Prince Augustus I in the sixteenth century, and has grown into an extensive collection of articles illustrating the condition of science at particular periods, and its progress. "According to Adam Ries," a German expression to denote that any fact is mathematically exact, refers to the mathematician, Adam Ries, who in 1550 published a little book on reckoning with counters and with the Arabic numerals. His counters, and the hand-circles, staffs, and various devices with which people made their calculations before the Arabic numerals came into general use, are shown here. Another curious instrument, of the eighteenth century, is a proportion staff "for the mechanical extraction of the square and cube roots, and the proportioning and calculation of geometrical figures." Among the optical instruments is the famous burning mirror of Walter von Tschirnhausen, of which the "Acta Erudita" from 1687 to 1697 says, "He has with this glass set fire to wet wood in an instant, boiled water in a small vessel, melted lead, bored through iron plates, changed brick and stone to glass." Tschirnhausen performed the first experiments on solubility of the earths with this instrument.

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The collection of clocks comprises nearly every conceivable variety of time-pieces, from sand-clocks to the Dresden Universal Clock which gave the time at three hundred and sixty places, and automatons driven by clock-work. The collection of telescopes covers nearly the whole history of the instrument, beginning with a Galileo's telescope and including a Kepler's, a Rheita's, the Huygens's, Dolland's, and Frauenhofer's refractors, and several kinds of reflectors. One of the most precious articles in the collection is a very elaborate globe, with all the principal constellations and astronomical lines, and the magnitudes of the stars carefully indicated, which bears an inscription stating that it was made by Mohammed Ben Muwajed-el-Ardhi, without date or place of making. Beigel, of Dresden, calculated in 1808, from the positions of some of the stars on the globe, that it must have been made in the ninth century. Dr. Adolph Drechsler believes that the maker was a son of the famous astronomer Muwajed, who was called by Hulagu, the third emperor of the Mogul dynasty, from Damascus to superintend the observatory at Maragha, and that the date of the instrument was about A. D. 1279. The chief value of the collection is in the opportunities it affords for the study of the development of instruments in the several branches of science.

Evolution of Deer-Horns. — Mr. W. Boyd Dawkins has called attention to the confirmation of the doctrine of evolution afforded by the development of the antlers of animals of the deer-kind. In the middle stage of the Miocene, the cervine antler consists merely of a forked crown. This increases in size in the Upper Miocene, though it still remains small and erect, being not quite eleven and a half inches long, with four small tines in *Cervus Matheri*. The antlers of the succeeding (Pliocene) deer, in the Auvergne, were longer and larger and more branching than those of any earlier deer, and had three or more well-developed tines. The *Cervus dicranios* of the Upper Pliocene of the Val d'Arno had antlers so complicated as almost to defy description, though they were still smaller than those of the Irish elk. That animal survived into the succeeding age, and has been described in England as Sedgwick's deer. The Irish elk, moose, stag, reindeer, and fallow deer, appeared in Europe in the Pleistocene age, all with highly complicated antlers in the adult, the first having the largest antlers as yet known. "From this survey," says Mr. Dawkins, "it is obvious that the cervine antlers have increased in size and complexity from the mid-Miocene to the Pleistocene age, and that their successive changes have been analogous to those that are observed in the antlers of the living deer, which begin with a simple point and increase in number of tines till their limit of growth is reached. In other words, the development of antlers indicated at successive and widely separated pages of the geological record is the same as that observed in the history of a single living species."

Tests for Color-Blindness.—Dr. William Thomson, of Jefferson Medical College, has devised a test for color-blindness, for use on the Pennsylvania Railroad, which is in a measure self-working, and may be applied with precision by any agent at any station on the line. It is based on Holmgren's system of many-colored yarns, but the number of skeins is reduced from the one hundred and fifty used by Holmgren to forty. The forty skeins, each bearing its serial number, are hung by buttons, that can be easily unhooked, upon a stick about two feet long, in such a way that the numbers are hid. The first half of the series of yarns, numbered from one to twenty, are devoted to the green test. The odd-numbered skeins are of shades of green, and the even-numbered ones of "confusion colors"—grays, tans, light browns, etc. The other half is similarly occupied with skeins of red, and the "confusion colors" for red-browns, sages, and dark olive, arranged alternately. A man placed before the instrument is told to select ten skeins to match the green test-skein, which is shown him. If his eyes are normal, he will readily select the ten green skeins, and the clerk simply finds the numbers of the skeins thus selected and puts them down. If the man's eyes are defective, he will hesitate in selecting the skeins; if color-blind, he will throw out skeins at

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random of the green and confusion colors. In either case the clerk has only to set down the numbers, which tell the story, and furnish the medical man all the facts he needs for making up his judgment. The test is applied in precisely the same way by means of the other half of the stick for red-blindness. The reports of the examinations have almost uniformly shown that 4·2 per cent of the men are color-blind.

New Conditions affecting Life in France.—M. A. Legoyt has continued his reviews of the movement of population in France, with a study of the vital statistics of the nation for 1879. The population of the country continues to increase, but at a constantly diminishing rate. The hygienic condition of the people has been improved by the prevalence of greater ease in living, the spread of vaccination, and increased scientific exactness in the healing art; but new causes of mortality, incontestably grave, have been introduced. The chief of these is the excessive use of alcoholic drinks, signalized by the more general consumption of liquors distilled from grain and the beet-root, taking the place of wine, which is likely to increase if the ravages of the phylloxera continue. It is also marked by an increase of arrests for intoxication, of persons found dead, and of suicides, traceable to this cause. The number of suicides has almost quadrupled since 1827, while the population has increased only one-fifth. The growth of mental diseases is also detrimental to public health and longevity. A new cause of mortality worthy of attention is the continued increase in the prices of the necessaries of life, accompanied by a decrease in the rate of interest on invested funds. The population decreased in 1879 in twenty-six departments, most of which were in Southern France, where distress was occasioned by the ravages of the phylloxera. In details, the vital reports for 1879 show a slight increase of marriages, a few less births, a few more deaths, than were returned in 1878, and a decrease in the excess of births over deaths, which was already small enough. No direct regular relation is discoverable, either in France or in twelve other countries which are compared with it for this view, between the proportion, to the thousand, of marriages, births, and deaths. Generally, but not always, a greater number of marriages was followed by a greater number of births.

Theories of Comets' Tails.—M. Camille Flammarion suggested an inquiry at a recent session of the French Academy of Sciences, whether the perfect transparency of the tails of comets should not authorize us to believe that they are not material, but an electrical or other excitation of the ether produced by the mysterious star in a direction opposite to that of the sun. M. Faye at a subsequent sitting answered this suggestion with a material theory, to the effect that the sun appears to be endowed at the same time with two forms of action, one attractive, the other repulsive. The repulsive force is not proportional to the masses, like attraction, but to the surfaces, and therefore produces effects which are more marked as the matters on which it acts are less dense. It is not exercised through every kind of matter, like attraction, but may be enfeebled or arrested by the interposition of the slightest screen. It is not propagated instantaneously, as attraction is, but successively, like light and heat; hence its action upon a point in motion is not exercised in the same direction as attraction, although both forces emanate from the same star. Finally, this force varies inversely as the square of the distance, the same as light and heat. The repulsive force operates on the planets and their satellites as well as upon comets, but has escaped attention as to them, in consequence of their compactness. It operates also upon our globe, upon the limits of our atmosphere, but its meteorological effects are masked by the more evident effects of solar radiation which are at work during exactly the same period. Multiple tails to comets are not exceptional, as was till lately believed; that quality has been found to be more general as comets have been observed with more powerful instruments. The recent comet (*b*, 1881), it is true, seems to have but one tail; but that is because we are not far removed from the plane of its orbit, within which all the tails are included, so that they appear to us projected upon one another. For the same reason the tail of this comet appears straight.

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If we looked at it from the front instead of in section, its natural curvature would strike every eye. M. Flammarion upheld his electrical theory at the succeeding meeting of the Academy, maintaining that no solution of continuity had ever been remarked upon any comet. The tail has always appeared homogeneous, plane, still, like a beam of electric light. He acknowledged that his interpretation was hypothetical, but claimed that his hypothesis was very probable. Might not the electrical illumination, he said, very intense in the nucleus, more feeble in the immediate surrounding, be prolonged into space, impelled by the contrary electrization of the sun? The phenomena of those long, imponderable, and transparent tails, hitherto unexplained, would then be a simple luminous excitation of the ether.

New Carboniferous Fossils.—A considerable addition to the fauna of the Lower Carboniferous period has been made by the recent discovery in the shales of Eskdale and Liddesdale on the river Esk, in Scotland, of the fossils of a larger number of new organisms than have been obtained from the entire Carboniferous system of Scotland for years past. The remains are in an excel lent state of preservation, and in some instances are so admirably wrapped up in thin matrices as to retain structures which have never before been recognized in a fossil state. Among them are twenty new species, adding to science five new genera, of ganoid fishes. One of the genera, *Tarrasius*, is so peculiar that no place can be found for it in any known famliy. Two specimens have been found in such conditions as to leave in doubt some important parts of their structure. Associated with the skeletons of the fishes are some new phyllopod and decapod crustaceans, one of them having its intestinal canal distended with food. Several new macrurous decapods occur that differ in no essential respect from their living representatives. Numerous and often admirably preserved specimens of scorpions have been found, of forms that do not differ essentially, so far as regards external organs, from the living scorpion. Mr. Peach, who describes them, has recognized in them every structure of the recent form, down even to hairs and hooks on the feet. The sting alone has not been observed, but the poison-gland has been found. The chief difference lies in the larger proportion of their mesial eyes to the lateral ones, and to the whole animal, than in the living form. These fossils afford no more help in tracing the pedigree of the scorpion than is furnished by the living form, for they make it obvious that the animal has remained with hardly any change since Carboniferous times. It appears to be the most ancient type of arachnid. Some species must have included individuals eight or ten inches in length.

Animal Retribution.—The Boston papers tell a curious story of the retribution which recently came upon a buck, which, by virtue of his superior strength and sagacity, had exercised a tyrannous lordship over the herd of deer on the Common, and had thereby excited the hatred of the younger bucks. The time came when he had to shed his horns. The other bucks gained knowledge of the fact with a marvelous quickness, gathered around him, made a concerted attack upon him and speedily disabled him, despite the gallant resistance he tried to make. He was knocked down, butted and kicked till his head and sides streamed with blood, shoved this way and that, with all the fury accompanying each action that the pent-up spite of years could render itself capable of, and, finally, was reluctantly compelled to give up the ghost. Several of the men employed on the Common and public grounds witnessed the affray, and attempts were made to drive off the old fellow's assailants, but it was of no use. Each attempt was resented by the infuriated deer, and every man who entered the inclosure with pacific intentions was obliged to flee for his life. The murder having been consummated, the fury of the animals became appeased, and the dead carcass was removed from the arena.

Permanence of Vegetable Structures.—Dr. Karl Müller has recently observed a very noteworthy instance of the permanence of vegetable tissues in the case of specimens of mosses that were taken from the ancient viking ship which we described in our May number as having been found last year on the coast of Norway. The mosses had

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been buried with the vessel for about a thousand years, yet they retained their structure unimpaired, only they had become browned, or turned to brown-coal, and were easily identified as belonging to *Hypnum squarrosum*, *Climacium dendroides*, and other common species. No difficulty was met in making a satisfactory microscopical examination of them, and the cell-structure was brought out as plainly as if they had been freshly gathered. These, however, were only some of the more recent among several ancient specimens of peat-mosses that Dr. Müller reports that he has examined with similar results. The mosses of a tuft supposed to be from the lake-dwellings retained the individuality of their parts; and in a tuft taken from the turf under the drift in the Baltic provinces of Prussia, the plants, older by hundreds of thousands of years than the other specimens, were so well preserved that they were easily recognized by their form and cell-structure as belonging to a Scandinavian species of almost exclusively Arctic growth, which must have come down in the glacial period. We are often surprised at the good condition in which the unfossilized bones of prehistoric men and animals are sometimes found; but the beautifully preserved condition in which these mosses occur is a far more wonderful phenomenon, because those organisms are among the plants of the slightest structure, and are not subject to fossilization. Still more wonderful is the perfection with which the minute structure of the diatoms is preserved.

Soldering by Pressure.—It is known that Faraday, in 1850, observed that two pieces of ice brought in contact and subjected to pressure would be soldered together, and unite into a homogeneous mass. This soldering, which took place the more readily in proportion as the pieces of ice were nearer their melting-point, was regarded by Faraday as due to a special property of ice. Mr. W. Spring has recently undertaken a methodical series of experiments in the compression of a variety of bodies. That their condition of division might be well established, he reduced the substances experimented upon to powder, and subjected them in a mold of steel to a pressure of between two thousand and seven thousand atmospheres. Filings of lead were converted at two thousand atmospheres into a solid block, showing no granulation under the microscope, with a density slightly above that of ordinary lead. At five thousand atmospheres the lead became like a liquid, and ran into all the interstices of the apparatus. Powders of zinc and bismuth at five to six thousand atmospheres gave solid blocks, with a crystalline fracture. Approaching six thousand atmospheres, zinc and tin seemed to liquefy. Powder of prismatic sulphur was converted into a solid block of octahedric sulphur. Slack sulphur and octahedric sulphur passed into the same condition. Red phosphorus passed into the denser state of black phosphorus. Thus, simple bodies undergo chemical transformations under the simple action of pressure. The transformation of amorphous powders, like that of zinc, into crystalline masses, is a kind of auto-combination. Some of the hard metals never lose their pulverulent structure under any pressure. Powders of the bioxide of manganese and the sulphurets of zinc and lead solder under pressure, and present the aspect of natural crystalline pyrolusite, blende, and galena; while silica and the oxides and sulphurets of arsenic do not suffer any agglomeration. Some pulverized salts are solidified by pressure, and become transparent. Hydrated salts—as, for example, sulphate of soda—may be completely liquefied at a high pressure. Certain organic substances—the fatty acids, moist cotton, and starch—change their appearance, lose their texture, and undergo a very evident molecular packing.

NOTES.

THE city of Charleston, South Carolina, according to the annual review of Mayor Courtenay, is paying a much higher relative rate for school purposes than Northern cities which have secured for themselves greater educational advantages. Compared with Boston, it gives, in proportion, nearly one half as much again for its primary public schools alone as that city for all its schools, and gives, besides, annual appropriations to the High School and Charleston College. The grievous burden has been thrown upon the city by the extraordinary needs of the colored population, and gives it, the city officers believe, a right to call upon the Government for help.

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THE largest trees known are probably a *Eucalyptus amygdalina*, or "peppermint-tree," growing in the Dandenong district of Victoria, Australia, which is said to measure 370 feet to the starting-point of the crown, and 417 feet to the top, and a specimen of the same species, mentioned by Baron Ferdinand von Müller as having reached the incredible height of 480 feet. A tree was cut near Ballarat in 1869 which was 96 feet in circumference at the ground, 34 feet at 12 feet above the ground, 8 feet at the height of 144 feet, and at 210 feet was still five feet in circumference. Another tree measured three feet in circumference at the extreme point of its height, 335 feet, while its real top seemed to be missing.

THE death is announced of Theodor Schwann, the distinguished physiologist, whose name is inseparably connected with the history of the "cell theory." He was born in 1810 near Düsseldorf, but spent most of his active life as Professor of Anatomy in the Catholic Universities of Louvain and Liége, Belgium. Three important pieces of work, each of which has been the starting-point of endless researches, are due to him. The first consists in his observations and reflections relative to the cell-structure of organisms; the second, his discovery of the organic nature of yeast, of the yeast-plant as the cause of alcoholic fermentation, and of organisms as the cause of putrefaction in general; and the third, his investigation of the laws of muscular contraction.

DR. W. J. HOFFMAN observes, in his "Annotated List of the Birds of Nevada," that the absence of birds in large areas in that State, and their abundance in certain localities, "can mainly be attributed to the peculiar distribution of the vegetation. With the birds, as with insects, particularly the *Coleopteræ*, if an area of vegetation, composed of a certain class, be found, we generally know what may be expected as typical of that area. The greater altitudes attained in the Rocky Mountains have furnished additional facts regarding the breeding of certain species, which may truly be considered sub-Alpine when compared with their northward range."

THE statements in reference to the education estimates for England, made by Mr. Mundella, in the House of Commons, indicate that it is the intention of those having the matter in hand to make elementary education more efficient and better adapted to convey to the pupils a knowledge of those things that will be really useful to them in after-life. Among the amended provisions of the code laid before the House was one for giving in infant schools a systematic course of simple lessons on objects and on the phenomena of nature and common life. Among the "class-subjects" in boys' and girls' schools are physical geography and elementary science, and among the specific subjects are mechanics, animal physiology, botany, the principles of agriculture, and domestic economy.

DR. EDWARD T. CARSWELL, in his address as president before the American Academy of Medicine, takes strong grounds in favor of requiring evidence of graduation from a college as a condition of admission to the medical school, and of the abolition of the fee system, as essential elements of reform in medical education.

THE recent International Medical Congress in London recommended as tests for sight, to be enforced on signal-men and look-out men at sea, that in all ocean-going vessels there should always be in actual control of the helm a person possessing with both eyes, without glasses, normal sight both as to acuity and colors, and that in addition one of the persons on the look-out should be similarly qualified; that in vessels engaged in the coasting-trade, every person liable to take charge of the helm should possess sight under similar conditions, equal to at least two thirds of the normal; that all persons engaged in marine signaling and all pilots should have normal sight; and that hypermetropic (over-sighted) persons should not be admitted. The congress also advised the constitution of an international commission to consider the means of improving the system of signals, and to fix upon the standard colors and upon the sizes of the signals to be employed.

THE death of Dr. Christian Gottfried Andreas Giebel, Professor of Zoölogy in the University of Halle, was recently announced. He was born in 1820, and had occupied his professorate at Halle since 1860. He was the author of numerous works in his branch of science, among which were the "Fauna of the Primitive World" (1856), "The Mammalia in their Zoölogical, Anatomical, and Paleontological Relations" (1855), "A Natural History of the Animal Kingdom" (1864), "Agricultural Zoölogy" (1869), a "Thesaurus Ornithologiæ" (1877), and a work on "Parasitic Insects," besides numerous smaller works.

DR. J. BOUILLAUD, a French physician distinguished for his researches in heart disease, died in Paris last October, in the eighty-sixth year of his age. He discovered the relations between organic affections of the heart and acute articular rheumatism, and recognized and partially defined the anatomical lesion which produces aphasia. He published his first work, a "Treatise on Diseases of the Heart," in 1824.

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DR. D. W. PRENTISS, of Washington, D. C., has described a remarkable change in the color of the hair which followed the use of pilocarpine in the case of a young woman treated by him. The hair, which was at first light blonde, with a yellow tinge, became chestnut brown in the course of a month and almost a pure black in six months, and acquired a more vigorous and thicker growth. A microscopic examination showed that the change in color was due to an increase of the normal pigment, and not to a dye. The eyes also became darker. The hair of an infant, treated for croup, showed a distinct change to a darker color after ten days' use of pilocarpine.

THE death is announced of M. Bussy, the eminent French chemist. He was the first person that succeeded in obtaining metallic magnesium.

MR. M. E. WADSWORTH has called attention to a confusion in which the term Laurentian as the name of a geological formation has become involved by its having been appropriated to two different sets of rocks. Mr. Edward Desor first used the name in 1850, and applied it to some marine deposits in Maine, on the St. Lawrence River, and on Lakes Champlain and Ontario. He employed it afterward in several papers published in scientific journals and transactions, and it seems to have passed into current use among geologists between 1850 and 1857. Sir William Logan in 1854 applied the same name to the Canadian rocks, which he had heretofore called the "metamorphic series," and which are the equivalents of the Azoic rocks of Foster and Whitney. Mr. Wadsworth maintains that the later appropriation should give way to the earlier application.

PROFESSOR E. D. COPE describes the remains of a large mosasauroid reptile, to which he gives the name of *Clidastes conodon*, of which a part of a skeleton has been discovered by Professor Samuel Lockwood near Freehold, New Jersey. The parts found include numerous vertebræ; the greater part of the lower jaw, with some teeth; a humerus and ulna nearly perfect; a nearly entire coracoid, and parts of both scapulæ; and indicate an animal larger than any *Clidastes* hitherto known.

HERMANN VON SCHLAGINTWEIT, the eldest of the three brothers who became distinguished by their explorations of the highlands and mountain-regions of India, died in Munich on the 19th of January. He was born in 1826, published works on the physical geography of the Alps in 1850 and 1854, and in the three years following 1844 traveled with his brothers Adolph and Robert through the East Himalaya region and Assam, Cashmere, Ladakh, and Balti, and over the Karakorum and Kuen-Lun Mountains to Chinese Turkistan. The results of their explorations have been embodied in two works of high scientific value, which, unfortunately, are not yet completed.

THE crayon-pencils now much used by children have been found to be colored with poisonous dyes. The Dublin "Journal of Medicine" has an account of a child who was taken with all the symptoms of poisoning, for which he was treated with emetics and purgatives. The vomited matter was marked by particles of a green substance containing copper, and the discharges from the bowels bright-green fragments. The child was sick for a month. It was found, on examination, that he had eaten a part of a green crayon, colored with arsenite of copper.

THE deaths of Dr. Karl Peters, Professor of Mineralogy and Geology at Grätz University, and author of numerous papers, and of Dr. Karl Fortlage, Professor of Philosophy at the University of Jena, are announced. Dr. Peters was fifty-seven and Dr. Fortlage seventy-five years of age.

A REPORT has been published by the Legislative Assembly of New South Wales on museums for technology, science, and art, and upon scientific, professional, and technical instruction in the colony, which is full of information in connection with the extension of scientific instruction in its relations to technology.

DR. PELLEGRINO MANTEUCCI, who died in London on the 8th of August last, in the thirty-first year of his age, had just accomplished the hitherto unachieved task of crossing Africa from the Red Sea to the Gulf of Guinea. He left Suakim on the Red Sea, with two companions, in March, 1880, with the intention of crossing the continent. Prince Borghese left him at Darfoor, and he and Lieutenant Massari went on alone. Reaching the Niger, they embarked on that river and arrived at Egga, where they found the agent of a European company on the 8th of June, and set sail for Europe on the 1st of July. The two travelers entered the Mersey on the 5th of August, only three days before Manteucci's death.

THE first discovery of fossil human remains in the caverns of Brazil has been made by Dr. Lund near Agua Santa, province of Minas Geraes, where an osseous *breccia* has been found, containing human *débris*, closely associated with the remains of extinct species.

DR. JAVAL has recently declared, in a communication to the Société de Médecine Publique et d'Hygiène Professionelle, that the electric light, in the degree of division to which it has been brought, is absolutely harmless, and without danger to the sight.

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