THE

AMERICAN GEOLOGIST

A MONTHLY JOURNAL OF GEOLOGY

AND

ALLIED SCIENCES

VOLUME XII.

JULY TO DECEMBER, 1893.

MINNEAPOLIS, MINN.
THE GEOLOGICAL PUBLISHING COMPANY.
1893.

ALFRED ROPER, Printer.

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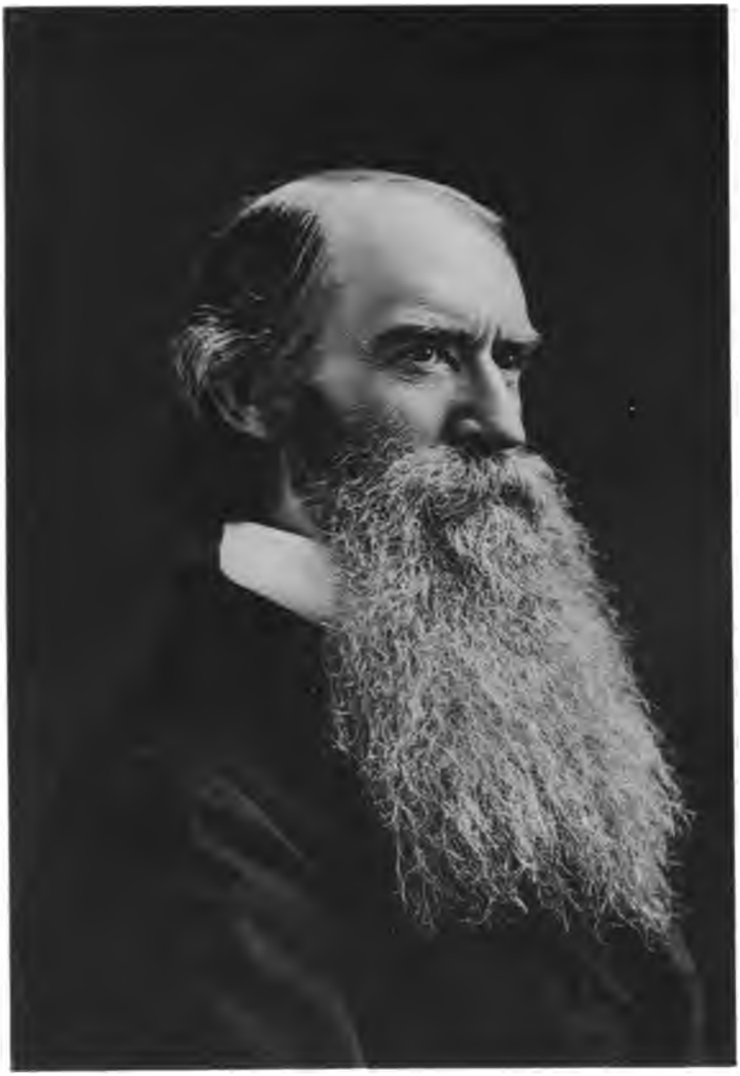
JULY NUMBER.

AUGUST NUMBER.

DECEMBER NUMBER.



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J. S. Newberry

THE

AMERICAN GEOLOGIST

VOL. XII. JULY, 1893. No. 1.

JOHN STRONG NEWBERRY.

By JOHN J. STEVENSON, New York.

John Strong Newberry, M. D., LL. D., was born at Windsor, Conn., on December 22d, 1822. He was a descendant of Thomas Newberry, who settled at Dorchester, Mass., about 1630, and whose widow with her sons removed to Windsor, Conn., in 1636. The family resided in Windsor for nearly two centuries and held a prominent place in the affairs of the colony, several of them having held commissions and done good service in the French and Indian war, in the expedition against Carthagena and in the Revolution. His grandfather, General Roger Newberry, held the rank of brigadier general in 1781, and became a member of the Connecticut Land company which bought from the state of Connecticut the northern counties of Ohio, known as the "Western Reserve."

Soon after Dr. Newberry's birth, his father, Henry Newberry, moved to Ohio, taking up his father's land at the falls of the Cuyahoga, where he founded the town of Cuyahoga Falls. Four years later, in 1828, he opened coal mines near Tallmadge, and was the first to make systematic efforts to introduce coal as a fuel along the Lake Shore region. The rich flora shown in the roof shales of these mines early attracted the son's attention so that, prior to 1841, he had made an admirable collection of Coal Measure plants. In that year Prof. James Hall, while on his way from Cleveland southwestward, remained for a few days at the Newberry home and studied the region of Cuyahoga Falls with "John Newberry" as his guide. His paper presented to the Association of American Geologists, in 1842, makes reference to the fact. Prof. Hall did much during that journey to secure a right understanding of the relations between the rocks of New York and those of the Mississippi valley; but he did nothing more important during that trip than that which he did at Cuyahoga Falls, in giving a positive impetus to the studies of the boy, whose curiosity had been awakened by the ferns in the coal shales, but who now saw equal importance in the molluscan remains of the Waverly. More than once Dr. Newberry told the writer what Prof. Hall had done for him during that brief visit; how he had removed many of his difficulties and had enlarged his field of view. From that time the determination to be a naturalist was fixed.

After the usual preparation, he went to Western Reserve college at Hudson, Ohio, where Prof. Samuel St. John held the chair of natural history. No happier lot than this ever befell a young man; for preceptor and pupil were well mated. Indeed the attraction of pupil for preceptor was thought to be too great and some members of the faculty took offense, going so far as to expostulate with Prof. St. John for encouraging a tendency to one-sided development of the boy's intellect. The conscientious professor endeavored to bring the pupil to a sense of his duty; but the twig had received the final bending and expostulation was of no avail. The years at college were spent well; the curriculum as a whole was not neglected, but the main object was always prominent and all studies were pursued with it in full view.

Graduating as Bachelor of Arts, in 1846, he studied medicine in the Cleveland Medical school, receiving the degree of Doctor in Medicine in 1848; after which he visited Paris to complete his medical studies. But, as he stated it, while he did some work as a medical student he did a great deal of work as a botanical student under Brongniart. The stay in Paris was cut short and he returned in 1851 to Cleveland, where he began to practice medicine. As the city at that time had attained only to modest dignity, his practice necessarily reached out into the country and afforded him many an experience, which was the source of much amusement to him in later years.

Though practicing his profession faithfully, Dr. Newberry found time to continue his study of science; for in 1851 he published four papers, two of which dealt with problems of no mean order. In 1853 he published four papers in the Annals of Science, discussing the Carboniferous plants of Ohio. Unfortunately, few descriptions accompanied the names given to new species, so that fellow students were unable to determine them; and many of the names given in the lists became synonyms for species named and described at a later date. Even at that time his enthusiasm proved to be as contagious as it was in later years. F. V. Hayden was studying medicine under him; but soon became so thoroughly a student in geology that the study of medicine was continued only that he might have opportunity to do geological work in the far west; there being no other way than that of securing an appointment as surgeon to some exploring party.

The agitation for a railroad to the Pacific coast crystallized in the early fifties, and Congress ordered the dispatch of expeditions by the war department to make reconnaissance of several lines. Dr. Newberry was chosen as surgeon and naturalist to Lieut. Williamson's party, working in California and Oregon during 1855. The multiplicity of duties laid upon him left little opportunity for detailed geological work, but the sixty-eight pages devoted to geology in his report showed the keenness and quickness of observation which always characterized him. His botanical report of ninety-four pages is no mere catalogue of species, but the great body of the report consists of notes upon the forest trees of the Pacific coast, making it one of the most interesting as well as one of the most useful of all the botanical publications issued from our government offices. The notes upon the mammals in the zoological portion of the report are marked by the same keenness of observation and are expressed in a singularly informal style which renders them very attractive to the general reader.

This report bears date of 1857. During its preparation the author was in Washington laboring at the Smithsonian Institution and acting as professor of geology at the Columbian University.

At this time, the exploration of the Colorado river of the west became a military necessity and, in 1857, Lieut. Ives was directed to organize an expedition for the work. Dr. Newberry was appointed surgeon to the expedition and placed in charge of the natural history with an assistant. His report, published in 1861, was unquestionably the most important contribution to western geology offered up to that time. He had had the advantage of his California work and of close association at Washington with Meek and Hayden, who had already made their first studies in the upper Missouri region and had brought back the collections, on which was based the grouping offered by Hall and Meek for the Upper Missouri Cretaceous.

Upon completion of the report on the Colorado expedition, Dr. Newberry set out in the summer of 1859 with Capt. J. N. Macomb to explore an area of about 12,000 square miles, extending westward nearly 350 miles from the meridian of Santa Fé, New Mexico. The report upon this work was prepared in 1860, but, owing to the outbreak of the civil war, its publication was deferred and it did not appear until 1876. The war brought exploring work to an end and Dr. Newberry abandoned geology for a time. In September, 1861, he resigned from the army and became secretary of the western department of the United States Sanitary Commission, embracing the whole of the Mississippi valley. He was practically the executive officer of this immense organization, with his headquarters at Louisville, Kentucky. This position he retained until the close of the war and the final settlement of the affairs of the commission. While there were many who shared in this great work, by which a full million of soldiers were relieved and the hospitals maintained in efficiency, yet it must be conceded that the details of the original plan as well as of the methods for its execution were determined by Dr. Newberry more than by any other. The final report was published in 1871.* Having completed this work, he came to New York in the autumn of 1866 to take the chair of geology and palæontology in the school of mines of Columbia college, which he retained until his last illness.

*Report of the United States Sanitary Commission in the Valley of the Mississippi. Cleveland, O., 1871.

A great part of Dr. Newberry's energies had been devoted to the study of the geology of Ohio and, in numerous papers he had discussed the Carboniferous and surface geology of that state. When the second geological survey was ordered, in 1869, Gov. Hayes, as was eminently proper, placed the work in his charge. This appointment afforded opportunity for the completion of some studies which had been begun long before, and the reports were a channel through which to present valuable material which otherwise might not have been published for many years. But some of his experiences on the survey did him an injury from which he never fully recovered. He gained a knowledge of human nature, of certain types of human nature, of whose existence he had heard, but of which before he had no personal knowledge. His confidence in the integrity of men received a terrible shock, which, for a time, seemed likely to make him cynical, but his own honesty of purpose was such that he could not believe long that many others were unlike himself.

The experiment of managing the geological survey of one state while living in another had been made by geologists more than once, but always with uncertain success; and Dr. Newberry's experiment, as he sometimes said, did not break the record. Yet he remained at the head of the organization from 1869 to 1884 and secured the publication of four volumes on the geology and two volumes on the palæontology of the state, which were noteworthy contributions to American science. The remaining two volumes of the second survey reports were published by his faithful friend, Edward Orton, who had succeeded him as director of the survey. From the date of his resignation as state geologist of Ohio until he was stricken down in 1890, he was incessant in labors, his publications increasing in number and importance each year.

Dr. Newberry's work as a palæontologist constitutes by far the most enduring part of his contributions to knowledge, but his work in stratigraphical geology is of great importance. In many senses he was a pioneer, a fact not always remembered by critics, who forget that revision is easy in comparison with the original labor of construction. That so much of his stratigraphic work in Ohio and in the far west has stood the severe tests of review by others and has remained an accepted part of the science, bears tribute to the keenness of his observation and to the good judgment with which his comparisons were made.

His first extended publication upon stratigraphical geology was the report upon work done in California and Oregon during 1855, forming part of Pacific R. R. Reports, vol. VI. This contains descriptive notes of the region traversed; a discussion of the character and age of the coals found on Vancouver and the coast of Oregon; the coals of Bellingham bay and Coose bay in Oregon are referred to the Miocene, owing to the close resemblance of their flora to that of the Upper Missouri lignitic series, whereas those of the Vancouver group are placed in the Cretaceous because of the fauna, despite the Tertiary facies of the flora. The glacial geology receives a fair share of attention and suggestions are offered to explain the disappearance of glaciers from that region.

The Colorado river report* was much more important, as the author had very little to distract attention from his proper work. The expedition began its work near the mouth of the Colorado and followed that stream by boat, and afterwards by meander on shore for nearly five hundred miles, after which the river was left behind and the party marched eastward across Arizona and New Mexico to Fort Defiance, where the expedition was disbanded; but Dr. Newberry was enabled to continue his studies eastward to Fort Leavenworth, Kansas, then almost the outlying post of civilization. Among the noteworthy features of this report are the sections of the Colorado cañon; the correlation of the Lower Cretaceous of Arizona and New Mexico with that of the Upper Missouri region; the impartial revision of work done during previous explorations in portions of the region crossed; and the recognition at Las Vegas, New Mexico, of the upper members of the Upper Missouri Cretaceous. The report contains a careful discussion of the causes producing the plateau region topography and cañon system, all the salient features being regarded as due to the action of running water. The extent of the continental area at various periods is considered and the conclusion

*Report upon the Colorado river of the West. Explored in 1857 and 1858, by Lieut. Joseph C. Ives. Washington, 1861. Part III. Geological Report by Dr. J. S. Newberry, geologist to the expedition; 4to, pp. 154, 6 plates.

reached that the area of land in the western regions must have been greater than supposed by most writers, for otherwise one can not account for the accumulation of such vast thicknesses of sediment as are shown in the region crossed by his party. Here too is presented the ingenious theory respecting the occurrence of gypsum with red shale, that it is due to the action of decomposing pyrite on calcium carbonate and shale. This report contains a recognition of Triassic, Jurassic and Cretaceous in the Mesozoic and of the Coal Measures in the Palæozoic.

The report of the expedition with Capt. Macomb* was published in 1876 as prepared in 1860, and its author had good reason for self-congratulation upon the success with which it stood the test of later studies by others. It was at once an amplification and a revision of his previous work. The route was from Independence, Mo., to Santa Fé, the line being different from that followed on the return from the Colorado river expedition. Thence the course led to the junction of the Grand and Green rivers "of the Great Colorado of the west." An especial feature of this report is the full identification of the Upper Missouri Cretaceous section in New Mexico and Arizona, though the subdivisions recognized by Meek and Hayden at the north could not be made out in full detail at the south. Dr. Newberry's grouping is:—

Lower Cretaceous, equivalent to No. 1 of the Upper Missouri.

Middle Cretaceous, equivalent to Nos. 2, 3 and 4 of the Upper Missouri.

Upper Cretaceous, equivalent to No. 5 of the Upper Missouri.

But the enormous thickness of the Upper Cretaceous led him to surmise that part of it might be Tertiary. Detailed descriptions of Cretaceous make up much of the volume. Jurassic was recognized with some hesitation at several localities, but the gypsum-bearing formation of New Mexico was placed in the Trias without hesitation because of the plants discovered in the old copper mines of Abiquiu. The Cretaceous sandstones, both Upper and Lower, were found to contain leaves of angiospermous plants, not merely in eastern New

*Report of the Exploring Expedition from Santa Fé, New Mexico, to the junction of the Grand and Green rivers of the Great Colorado of the West, in 1859, under the command of Capt. J. N. Macomb; with Geological Report by Prof. J. S. Newberry, geologist of the expedition. Washington, 1876. 4to, pp. 148, map and 19 plates.

Mexico, where they had been collected on the return from the Colorado river expedition, but also at many localities westward beyond Santa Fé. A discovery of curious interest in view of the discussions had between 1875 and 1881, was that of the tuberculate *Halymenites* in the Lower Cretaceous (Dakota) sandstone, a form which in eastern Colorado is diagnostic of the Fox Hills group.

Four volumes upon the geology of Ohio were published during the period in which Dr. Newberry was director of the second geological survey of that state; his contributions to these were of great importance. Prior to the organization of the survey, he had worked out the section of the Lower Coal Measures, had discussed the petroleum of the eastern portion and had presented a synoptical view of the surface geology, besides publishing a sketch of the geology and a geological map of the state in Walling's Atlas of Ohio. After the organization of the survey, his studies were confined to the Coal Measures and to the surface geology, each of which received careful attention even in the preliminary or annual reports. Volume II of the final reports contains a chapter of eighty pages on surface geology, which, beyond all doubt, was the most careful and detailed presentation of that subject offered in this country up to that time. The basins of the great lakes are regarded as due to enlargement of pre-glacial valleys by glacial erosion, a doctrine presented long before by the author, but here enforced; the causes of the climate of the ice-period are sought for and the various explanations and theories are tested; the nature and the relations of the lake ridges, discovered long before by the New York geologists but studied more carefully by Gilbert and N. H. Winchell, are examined, especially in the light of the studies by those geologists and of Dr. Newberry himself; the known facts respecting preglacial drainage are grouped; and the drift deposits of Ohio are described in detail.

The same volume contains a long chapter upon the Carboniferous, in which are discussed some matters which could not be determined finally at that time. The coal beds are grouped and correlations made between different portions of the state, as well as of adjoining states. Very largely the grouping, in so far as it refers to the state of Ohio, remains good. The close revision of the work within the state has necessitated some changes, but they are fewer than might have been expected. Some of the errors in Dr. Newberry's references were due to erroneous identifications made by, at least, one of the aids or younger assistants, and others appear to have been due to similarly erroneous identification on the part of other aids. There is no room for surprise that some of Dr. Newberry's correlations with Pennsylvania coal beds proved wrong; they were merely suggestive—they could be no more; for the geology of western Pennsylvania had not been made perfectly clear by the geologists of the first survey of that state, who had made their investigations when the country was but little developed.

Dr. Newberry's labors in palæobotany began evidently at once after his return from France, for in 1853 he published the studies of Carboniferous plants already referred to. No further publications respecting Carboniferous plants appeared until 1873, when vol. I of the final reports of the Ohio survey was issued. This contained descriptions of only a few new species, the rest of his material being retained to make part of a third volume on palæontology, which, unfortunately, was not ordered by the legislature. This seems to have been his last publication upon Palæozoic plants.

The first discussion of Mesozoic and Cenozoic plants appeared in the report on California and Oregon in connection with the discussions of the coals of Vancouver and Oregon; but the studies of plants belonging to those eras began in earnest after his return from the Colorado river expedition, when the specimens collected by Hayden in the Upper Missouri region and those collected by himself in the eastern part of New Mexico were compared. His recognition of the Cretaceous age of those plants involved him in a somewhat acrimonious controversy with other palæobotanists of this country and Europe, which, however, to the credit of all concerned in it ended without leaving any personal bitterness behind it. During the war he published the results of a study of collections brought in by George Gibbs of the Northwestern Boundary survey, in which he reiterated his statement that the Vancouver coals are Cretaceous, while those of the mainland are of later date, probably Miocene.

Soon after coming to New York, he presented to the Lyceum of Natural History an elaborate review of the later extinct floras of North America with descriptions of new species from both the Cretaceous and the Tertiary. This memoir contains a discussion of the Dakota plants in their relations to European forms of later date, together with an extended comparison of the Tertiary floras found in different portions of our continent, the whole forming the first synoptical study of the later floras which had appeared in our country. The figures of the new species were published without the text in 1878, as a special volume by the United States Geological Survey of the Territories. The descriptions of the Triassic flora discovered by him at the old copper mines of Abiquiu were published with the Macomb report in 1876.

From this time until his last illness Dr. Newberry devoted much labor to study of Mesozoic plants. His last publication appeared in 1888 as an appendix to his monograph of the Triassic fishes; but his monograph on the plants of the Amboy clays would have been ready for the press had he been able to work for a few weeks longer. His especial grief, when his labors were cut off so abruptly, was that the work on the Laramie plants, his *opus magnum*, was incomplete. He had spent years of labor on this; it had been revised again and again, yet in its author's estimation it needed still further revision.

In 1853, Dr. Newberry published some notes on "The Fossil Fishes of the Cliff Limestone" of Ohio; and thenceforward the study of fossil fishes proved equally alluring with that of fossil plants. His next publications were short papers in the Proceedings of the Philadelphia Academy of Sciences and the Bulletin of the National Institute; but his first extended work appeared in the second and fourth volumes of the Illinois survey reports, in 1866 and 1870, in which, with Mr. Worthen as associate, he described and figured thirteen new genera and one hundred and forty-six new species of fishes from the Carboniferous. Meanwhile the Ohio survey had been organized and he was enabled to publish in detail much of the material which he had prepared upon the Devonian and Carboniferous fishes of that state.

The volumes on palæontology contain descriptions of seventeen species of Devonian and fifty-four species of Carboniferous fishes. The second volume, which appeared in 1875, includes his detailed study of *Dinichthys* and the discussion of its relations to modern forms, a discussion which, whether it be accepted in all its conclusions or not, is a credit to science and a model in respect of the judicial method employed. Much additional matter upon the fishes of Ohio remained to be published in the third volume of palæontology, which was not authorized by the Legislature. From this time, frequent brief announcements were made in the Transactions of the New York Academy of Sciences and elsewhere, until 1888, when his monograph of the Triassic fishes appeared, which contained descriptions and figures of twenty-eight species, fifteen of them being new. This was followed quickly by a monograph of the Palæozoic fishes of North America, also published by the United States geological survey; it contains descriptions of fifty new species, numerous new genera and careful revision of the studies upon *Dinichthys* and some other important forms, of which many new and much better specimens had been obtained. This was his last important publication.

The one distinguishing characteristic of Dr. Newberry's method was conscientious study, which became more and more intensely characteristic as the years went by. This led to increasing caution, to careful comparison with the labors of fellow students everywhere and to frequent revision of his papers prior to public announcement of his results. No fear of losing priority could induce him to publish in haste; he never described a form as new until diligent search through all material within his reach had convinced him; his descriptions of field-work were prepared with equal care. This abundant caution made him exceedingly tenacious of his opinions when once formed and strong evidence was required to convince him of error. But when evidence was presented, it was weighed carefully and judiciously; no matter how unwelcome the verdict might be, it was accepted frankly and the error acknowledged unhesitatingly. The clearness and directness of his style were due to this painstaking study; his statements were never open to the charge of obscurity. His method led him into broad investigation and his reading extended into many fields, so that he became a man with singularly well furnished intellect.

Dr. Newberry's work received recognition from fellow laborers in many lands. He was a charter member of the National Academy of Sciences; foreign correspondent of the London Geological Society, from which he received the Murchison medal in 1888; he was president of the American Association for the Advancement of Science in 1867; he was president of the New York Academy of Sciences for twenty-five years; he had been vice-president of the Geological Society of America, and he was made president of the last International Congress of Geologists, though it was known that he was too ill to attend any of the meetings.

Dr. Newberry's personality inspired confidence so that he made others do work for which he was unfitted. While possessing comparatively little of what is termed executive ability, yet he had the power of inducing others, who had that ability, to use it in directions designated by him. An organization into which he threw himself was certain soon to have within it not a few as deeply concerned in its welfare as was he himself. He shunned active leadership, preferring the less irksome but equally important position of adviser; so that the extent to which his influence was exerted for good in New York is not likely to be estimated properly.

He was never selfish; he thirsted for fame, yet he made no effort to secure recognition. His sense of justice was keen, that of an honorable man; with assistants on the Ohio survey, in his museum, attached to his professorship, most of them earnest students and many of them following the same lines of study with himself, he had every opportunity to enrich himself by seizing suggestions coming from inquiring minds, or by utilizing results obtained during studies which he had directed. But during twenty-five years of intimate acquaintance with him, the writer never knew of an instance where the fruit of another man's labors was taken. It was his proud assertion that in all his life he had never used without full acknowledgment, anything belonging to another. So careful was he, that, in more than one instance, he credited another with a suggestion, which was but a clearer statement of what he himself had said only a few moments before.

He was unreserved in dealing with his fellow workers; no fear of loss restrained him. Whatever he had learned from others, whatever he had gained from his own investigations, was placed freely at the disposal of any who sought for information or assistance in prosecuting a research. His time and his efforts were freely given to encourage anyone who showed an honest desire to gain knowledge. His time was wasted by visitors of all sorts, some of them earnest inquirers, but most of them not such; yet only under the most exasperating circumstances did any intruder have reason to suppose that he had not been a more than welcome visitor.

Dr. Newberry was a man like other men; his shortcomings were known to his friends as well as were his excellencies; he was impetuous and sometimes he was severe, possibly unjust in judging men or in dealing with them. But of bitterness he knew little; of forgiveness he knew much. His defects were those of a strong man; in many they would have been sources of weakness, but somehow they seemed to make his friends stand more firmly by him.

From his youth he was a pleasant companion; in his later years his conversation was filled with quiet humor and delightful reminiscence. His cheerful disposition stood him in good stead amid the trying days of his middle life. To the last he was cheerful and resolute. Even when stricken by a disease from which he could not recover, which he, as a physician, knew must cause a lingering death, with gradual and gloomy fading away of his powers, he carried himself with a manly dignity, which challenged the respect while it aroused the sympathy of all who saw him. Man that he was, strong man that he was, he endured the bitterest of sorrow as he saw his powers lost just as he was about to complete the work of his life. But when the first suffering had passed, he yielded himself with fortitude and carried the burden without repining.

On December 3d, 1890, while engaged at his work, he was stricken by paralysis of the right side. Partial recovery followed and he was able to complete some studies during the autumn of 1891; but the advance of the disease continued and his work ended early in 1892. He passed away on December 7th, 1892, leaving to his family a priceless heritage, the memory of a life unstained by selfishness, spent in advancing the good of his fellows.

Dr. Newberry married, in 1848, Miss Sarah Brownell Gaylord, daughter of Erastus F. and Lucetta C. Gaylord, belonging to a family which settled at Windsor at about the same time with the Newberry family. She, with five children, four sons and one daughter, survives him.

After the preceding memoir had been completed the writer received a letter from Prof. James Hall referring to his early acquaintance with Dr. Newberry. It is given here entire:

ALBANY, N. Y., March 24, 1893.

My Dear Prof. Stevenson:—I had intended to reply more fully to your letter of inquiry respecting my acquaintance with Dr. Newberry.

In the early part of April, 1841, I left Albany for Buffalo, and thence by steamer, the first one out of the harbor for the season, landing at Cleveland; having it in view to take up the study of the rocks at this point, which I then supposed to be a continuation of the Chemung group, and to follow them, in the first place to the Coal Measures and thence across the state. From Cleveland I made my way to Cuyahoga Falls, and there met Dr. Newberry, who was spending a short vacation at his father's house. I found him a most amiable and intelligent young man, deeply interested in natural history and conversant with the geology of his neighborhood, having acquired a great deal of knowledge from the study of the rocks in his father's coal mines, and otherwise well acquainted with the interesting localities within the state. He visited with me the localities at Cuyahoga Falls and vicinity, and gave me much information in regard to other localities in different geological formations, which enabled me to arrange my itinerary much more satisfactorily than I could otherwise have done. He has often said to me that my coming to Cuyahoga Falls, fresh from the fields of New York geology, opened his eyes to things which had not before attracted his attention, and decided him to devote himself to geological science. While I was imparting this knowledge which we had acquired in New York, he was giving me knowledge of the geology of Ohio, which enabled me to make the journey across the state much more interesting and profitable in a scientific way than it possibly could have been under other circumstances.

Dr. Newberry was at that time a young man about nineteen years old, while I was in my thirtieth year. Our intercourse was of that kind which can be readily understood between persons of that age, both earnestly devoted to science; and before we parted we had become fast friends, initiating a friendship which continued uninterruptedly for more than fifty years, and only ended with his death.

Dr. Newberry was in every sense the soul of honor, and no one could learn to know him without loving him. In later years, when his home was in Cleveland, and my journeys to the west frequent, I never passed through the place without remaining a day or longer to have some intercourse with my friend. After his removal to New York it was a source of great satisfaction to me to have frequent interviews and consultations with him.

Living the isolated life which, in late years, I have been compelled to do, the friends made in earlier years become very dear to me, and the loss of Dr. Newberry leaves a sad void in my heart; and as my friends, one after the other, leave me, I feel that I have already lingered too long.

Very truly yours,
JAMES HALL.

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*This list in an incomplete form was first printed in the School of Mines Quarterly, Jan., 1893. Two pages of additions were distributed with the reprints, but are incorporated here. The papers are classified by subjects in the Transactions of the N. Y. Acad. of Sciences for March, 1893, Vol. XII. Acknowledgements are due Messrs. C. A. Hollick, L. F. Ward and H. L. Fairchild for assistance.

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Dr. Newberry was also one of the editors of Johnson's Encyclopædia, having charge of Geology and Palæontology. He wrote many articles on these subjects for its pages.

Biographical sketches of Dr. Newberry have been published in all the current biographical dictionaries and cyclopædias. Portraits of him appear accompanying such sketches in "Men of Progress," 1870-71, p. 317, and "Contemporary Biography of New York," Vol. V, 1887, p. 255. The Popular Science Monthly, Vol. IX, p. 491 (1876), contains a sketch with portrait, and in Fairchild's History of the New York Academy of Sciences, there is an excellent artotype. Since his death memorials have already appeared with portraits in the Engineering and Mining Journal, Dec. 17, 1892, p. 581, the Scientific American, Dec. 31, 1892, p. 423, and the School of Mines Quarterly, Jan., 1893, with two steel portraits; while others have been read before our principal scientific societies, or are in preparation for them. The most complete and elaborate memorial is to be found in the Trans. N. Y. Acad. Sci., March, 1893, and is from the pen of H. L. Fairchild.

NOTES ON SOME OF THE IRON-BEARING ROCKS OF THE ADIRONDACK MOUNTAINS.

By Frank L. Nason, Jefferson City, Mo.

The magnetite-bearing rocks of New Jersey and the extension of the same belt through Orange and Rockland counties, New York, to the Hudson river was the especial field of work of the writer during his connection with the New Jersey geological survey. Among the more tangible results of this work was, 1st, the identifying of persistent types of rock; 2d, the actual tracing of them through the states above named in practically continuous belts; and, 3d, tracing the relations of at least one of these types to the magnetite ores of the Highland range of New Jersey and New York.

The magnetite ores of this belt are highly crystalline, they exert a powerful effect on a compass needle, and many of them possess a distinct polarity, being often rather strong magnets or lodestones. They very rarely possess a distinct crystalline form. In fact, the writer knows of no crystals of magnetite being found. There are no associated finely crystallized minerals with the exception of molybdenite. This latter mineral is found in quantities as high as 2% in the ores of the Hude mine at Stanhope, N. J., but here it occurs as finely disseminated scales or small bunches, more abundantly in the lower hornblende ores. Large crystals have rarely been met with at the Hibernia mines. At the Ogden mines, however, these crystals are found of great beauty and of remarkable size. One crystal in the cabinet of Mr. Thomas Lang, of Ogdensburg, N. J., is about two inches in diameter and three-fourths of an inch thick. Four of the prism faces are perfect, while the crystal is attached to a piece of feldspar by the remaining two. A cluster of crystals, six inches in its largest diameter, four inches in its shortest, and one-half of an inch thick, was also found there.

Graphite has never been observed in these ores by the writer, even with special search.

Apatite is constantly associated with them. At Terro Mont is a mine known as the "Canfield phosphate mine," which carries over 30% by weight, of this mineral. The Dickerson mine, near by, is also a phosphate-bearing one, though in such small quantities that it is not objectionable for foundry iron. The same is true of the great deposit at Hibernia, Hurdtown, Port Oram and Ringwood mines, as well as at Sterlington and Forest of Dean mines, in New York state. At many of these mines there are great lenses of pure phosphate of lime, but these are so related to the ore bodies that no difficulty is experienced in cobbing the mineral from the ore. The fact remains, though, that apatite is widely distributed through all of the ores, rendering them unfit for making Bessemer pig iron. Abundant as this mineral is, it is never found in good crystals, it occurs either as grains of various sizes from the size of a pea down, or in large crystalline lumps.

Hornblende, quartz, and red and white orthoclase feldspar make the usual mine rock. Black mica or biotite is rarely found.

Titanic acid in the form of rutile is occasionally met with, but never in injurious quantities.

Isopyre is found at the Dickinson mine. At the Ringwood mines, stilbite is found in the crushed mine rock in small but perfect crystals. At the same mines small but beautiful crystals of calcite sparingly occur in "vugs" in the crushed rock.

Garnet occurs in the Hope mine at Ringwood, principally in the mine rock, and this is the only instance of this kind known to the writer.

Sulphide of iron is constantly associated with these ores, but only in three instances abundantly enough to necessitate the roasting of the ores before smelting.

To the country rock of these mines the writer has given the name Mt. Hope type,* from a locality where it can be easily studied in relation to the bodies of magnetic ore.

This rock is massively bedded, with only slight traces of foliation. It is usually fine-grained, about the same general texture as the Westerly R. I. granite.

Its mineral constituents are quartz, orthoclase and plagioclase feldspars, and magnetite. This latter mineral usually occurs in rough grains of small size, but it is occasionally observed in perfect octahedral crystals. The percentage of this mineral varies greatly but probably never exceeds 2 to 5%. Hornblende and black mica occur. It is noticeable, though, that these minerals vary in proportion to the amount of magnetite present. A rock of the above type having a noticeable quantity of these minerals, while preserving all of its other characteristics, is almost wanting in magnetite, while if magnetite is present in its usual proportion these minerals are never present.

Zircon is sometimes present in minute crystals. It is rarely visible to the naked eye, but thin sections show it to exist quite abundantly.

The color of the rock is very light gray. It strongly resists weathering.

Intimately associated with this rock is a graphite gneiss. This rock is characterized by the presence of from 1 to 15% of graphite. Magnetite is a very rare mineral. Hornblende and black mica are the more prominent non-feldspathic minerals. Contact of this graphite gneiss either with the above rock (Mt. Hope) or with the following described rock has not been observed.

*See Annual Report, State Geologist of N. J., 1889, p. 30.

The third noticeable type of rock has been termed the Oxford type. It is named from a prominent locality at the Oxford tunnel on the Delaware, Lackawana and Western R. R.

This rock is much coarser-grained, generally, than the Mt. Hope rock, and, in fresh fractures, has more of a bluish cast. The feldspathic constituents of the rock are about the same as the Mt. Hope type. There is hardly a trace of magnetite present. This with the characteristic presence of hornblende, makes it easily distinguished from the Mt. Hope rock. In addition to this the rock is beautifully and strikingly banded or foliated, which serves as a still further distinguishing characteristic.*

The above review is necessary in order to bring out the writer's point, viz., the striking resemblance of the magnetite-bearing rocks of the Adirondack mountains to those of New Jersey and southern New York.

The writer visited the prominent iron mines of the Adirondack mountains while connected with the New Jersey Survey, and the following notes were made.

From Carthage, N. Y., along the line of the Carthage and Adirondack R. R. to the Benson mines, there are frequent outcrops of the typical labradorite rocks of the Adirondack Mts. At Little river, the terminus of the road, is a remarkably large deposit of magnetite iron ore. The ore body is lean, carrying from 15 to 25 or 40% of metallic iron. On account of the size of the deposit, though, a great concentrating plant has been erected. The outcrop is reported to be three miles long and is about two thousand feet wide. This latter point was verified by the writer.

The country rock in immediate contact with the ore body could not be found, if it showed on the surface, in the limited time for examination. The rock of the ore body, however, in its lower parts, had all of the lithological features of the Mt. Hope rock in New Jersey. The ore itself had the characteristics of the New Jersey magnetite. Molybdenite was sparingly found. Grains of phosphate of lime were also distinguished. Garnet in small crystalline grains was observed.

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* For a fuller description of the relations of these rocks to each other the reader is referred to Ann. Rep., State Geologist of N. J., 1889, p. 34, et seq.

Near Natural Bridge, east of the white limestone, there are also outcrops of lean magnetic ore having the same general resemblance to the Little River deposits but of much more limited extent. What was not distinctly observed at the Little River mines was noticed here, extensive outcrops of a rock of the Mt. Hope type. Near by, but with contacts, if such existed, covered with soil, was the peculiar graphite gneiss found so abundantly in New Jersey.

At St. Regis Falls on the Northern Adirondack R. R. a rock cut in the railroad was made through a rock lithologically identical with the Mt. Hope rock. At this point the rock was interbedded with a dark hornblende-feldspar rock so often noted in New Jersey.*

No graphite rock was found near by. This may exist, however, as no extended search for it was made. Beyond this point to Paul Smith station rocks when exposed were principally of the labradorite type.

At the Mt. Lyon magnetite mines on the Chateaugay R. R. the country rock was also lithologically identical with the Mt. Hope type. Neither the Oxford rock nor graphite gneiss was observed here, though search was as limited as at the other localities. Careful examination was made of the ores and mine rock, however. These in all the important details agreed very closely with the magnetic ores and mine rock of New Jersey.

At the Mineville iron deposits, however, the most striking resemblances were found. In many of the mines phosphate of lime or apatite was observed in grains included in the ore. Crystals were rarely observed. In the Port Henry ore bed this mineral occurs in layers in which the iron is in a less quantity than the apatite. Many of the ores are Bessemer, and in this respect they differ from the New Jersey deposits, though in New Jersey some Bessemer ores are found in parts of a vein while the greater part of the vein is non-Bessemer. Like the New Jersey ores, these of the Mineville region are remarkably free from titanic acid. Molybdenite was not observed by the writer, though it is reported to be sparingly found.

The ore of these deposits is somewhat unlike the magnetites

* For a description of a similar rock in the Mt. Hope type see Ann Rep., State Geologist of N. J., 1890, p. 76.

of N. J. in two respects. In the first place a great bulk of these ores are what is known as "shot ore." This is too well known to need special description. The N. J. ores are usually hard and compact though thoroughly crystalline. In the second place, while the N. J. deposits have never yielded any good crystals, the Barton Hill or "Lover's Hole" mine is principally made up of perfect crystals of magnetite, often of great size and of remarkable purity. The form is of the unmodified and modified octahedron. In the mine great crystalline masses of ore two and three feet in diameter break up into cleavage pieces, and often perfect octahedrons are cleaved from the mass.

Shot ores are not common in the New Jersey mines in great quantities. Yet at the Dickerson, Hurdtown and Richards mine they form no inconsiderable proportion of the ore mined. These ores occur in many other mines, but not in such quantities.

In the Adirondack region the larger number of magnetite deposits are not especially remarkable for their size, certainly not averaging greater than the New Jersey mines. The deposits at Mineville, however, eclipse all. They are among the largest of worked deposits so far as known. The country rock of these mines is not to be distinguished lithologically from the Mt. Hope rock described by the writer. The extent of this rock was not traced beyond the immediate vicinity of the mines where it showed abundantly and unmistakably. A rock which corresponded closely to the Oxford type was also found and in the same relative position. No graphite gneiss was observed.

As to the identity in age of the Mt. Hope and Oxford types of rock found from the Durham Furnace in Pennsylvania to the Hudson river at West Point, there can be but little doubt. These rocks can be traced almost continuously between these two points and in their distinct ridges, presenting practically a continuous outcrop. At least these rocks have been traced from the Delaware river into New York near the point mentioned.

If the above inference is correct it naturally follows that the ore bodies enclosed in these rocks are of the same age. At least the weight of opinion is in favor of their being cotemporaneously bedded deposits.

Although the fringing gneisses of the Adirondack mountains are too far from our assumed base line to make any conclusions which will cover these latter rocks and ores, it can be safely assumed that the magnetites of the localities above described bear the same relation to each other as do the analogous deposits in New Jersey, that is, the Adirondack gneissic ores are of the same age. The attempt to correlate the two localities, New Jersey and the Adirondack region, is quite another matter. The most we can say is that the rocks and ores from the two localities are practically indistinguishable by any criterion which we are now able to establish, and that they are probably of the same age.

In speaking of the Adirondack region, it must be remembered that in the labradorite rocks (norites of Dr. Hunt) there are magnetites which in physical and chemical characteristics are wholly distinct from the gneissic ores described. The broad differences are as follows: 1st. The labradorite ores are titaniferous, often as high as 45%, and are, as a rule, non-phosphatic. 2d. The gneissic ores are non-titaniferous as a rule, and are highly phosphatic in places and are never wholly free from phosphate. 3d. The norites are massive, only showing an occasional banded structure; the enclosing rocks of the gneissic ores are bedded and foliated, often approaching a schistose structure.

Geological Survey of Missouri, Feb. 15, 1893.

ON SOME DIKES OCCURRING NEAR LYON MT., CLINTON CO., N. Y.

By Arthur S. Eakle, Cornell University.

Within the last three years many of the numerous dikes, which occur in the region of lake Champlain and in the neighboring Adirondack mountains, have been studied by professors Kemp and Marsters, and their results have lately been published in abstract*. The writer, who accompanied them upon their second trip to the region, during the

*Kemp, J. F., and Marsters, V. F. The Trap Dikes in the Lake Champlain Valley and the neighboring Adirondacks. Trans. N. Y. Acad. Sci., vol. xi, p. 13, 1891. Abstract. This paper describes the different types of dikes occurring in the region, and also cites many references to dike literature.

 past summer collected specimens of several dikes from the vicinity of Lyon mountain, and a microscopic examination of the rocks shows them to vary somewhat from the types they describe.

Red Laurentian gneiss forms the country rock, although gray is also common; a few miles south, light and dark green norite appears almost as abundant.

The dikes occur on the west side of Upper Chateaugay lake. Three of them intrude through the gneisses along the lake front, and the rest occur within 200 rods of the shore, in Franklin county. Their positions are shown in the accompanying sketch of the lake. The contours in the sketch were not accurately run, but are introduced simply to show the hilly nature of the region. For some distance north of Indian point, the high knobs reach and form the water front, and dikes 2 and 3 cut through the rocky face of the bluff. The rest of the shore is low, and at its southern or upper end, is quite marshy.

The country is heavily wooded and few outcrops of rock occur, but the presence of dike boulders scattered here and there on the surface, seems to indicate that the country is as abundantly seamed with these igneous intrusions as the region of lake Champlain.

The dikes are all narrow, from 1 to 3 feet, and have a general strike east and west; a direction that is characteristic of the dikes of this whole region. The three dikes on the shore of the lake will be described more in detail as the rest do not deviate from them in character.

Two of the kinds of dikes described by Kemp and Marsters, occur; namely, the porphyry or trachyte, or so-called bostonite, and the olivine diabase, but notable differences in character exist.

The rocks of these dikes are, chemically and structurally, of two greatly contrasted kinds. Dike 1, intruding through the gneiss at Indian point, is porphyritic and highly acidic. It is a dark colored porphyry of fine matrix and phenocrysts, 3 to 8 mm. in size, of red orthoclase feldspar.

Under the microscope the trachytic structure is well seen. The ground mass is holocrystalline and made up of small idiomorphic crystals of feldspar. The large phenocrysts of orthoclase are commonly twinned and more or less kaolinized. A very small amount of plagioclase appears in the usual lath-shaped rods. As is seen by the analysis of this dike, the amount of soda is quite high and suggests anorthoclase as part of the groundmass, owing to the plagioclase being insufficient in quantity to account for it. Irregular grains of quartz occur as an interstitial filling. Chlorite, as an alteration product of augite, is common. In a few crystals the core remains sufficiently unaltered to permit of its identification as augite. Magnetite does not appear in the slide but hematite is common as a stain.

The name "bostonite"* has been applied to certain porphyries and trachytes, occurring especially with elæolite syenites, and professors Kemp and Marsters have adopted the name for the porphyries of lake Champlain. These porphyries are much lighter in color and more porphyritic than dike 1; their color in general is quite similar to that of the keratophyr described by Sears†. The main difference, however, lies in the presence of much chloritized augite in dike 1, while in the bostonites of lake Champlain no dark silicates occur. In the two cases, the widths of the dikes and the nature of the enclosing rock are quite different. From the writer's knowledge of the lake Champlain porphyries, they are generally wide masses intruding through the shales of the Utica and Hudson River stages, while dike 1 is only one foot wide and enclosed by solid walls of gneiss. Possibly the different conditions of environment may have modified the character of the rock constituents.

The amount of silica in dike 1 is higher than in either the bostonite or keratophyr. The amount of magnesia is smaller than one would naturally suppose, from the amount of green chlorite in the slide. In its composition the dyke is closely allied to the keratophyr, but in appearance it is quite different.

Dikes 2 and 3, and those inland, are of the basic type and do not differ greatly from the common olivine diabases of the region. They are dark, almost black, and very compact.

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*Hunter, M., and Rosenbusch, H. Tschermak's Min. u. Petr. Mitth., xi, p. 445, 1890.

†Sears, J. H. On Keratophyr from Marblehead Neck. Bull. Mus. Comp. Zool., xvi, 9-170.

The writer's analysis of dike 1 is shown in column I. For comparison, analyses of a bostonite by Kemp* and the keratophyr described by Sears are shown in columns II and III respectively.

	I.	II.	III.
SiO_2	67.16	62.22	65.66
Al_2O_3	14.53	19.17	20.05
FeO	——	——	trace
Fe_2O_3	4.17	3.39	trace
MnO_2	——	——	0.13
CaO	1.26	1.44	0.67
MgO	0.41	trace	0.18
K_2O	6.10	5.926	6.98
Na_2O	5.55	5.374	6.56
Loss	1.10	2.33	0.41
	100.28	99.85	100.64

Plagioclase and augite with varying amounts of olivine make up the essential part of the rock. Magnetite is an abundant accessory from the alteration of the dark silicates and often assumes beautiful arborescent forms. The plagioclase is of the usual lathe shape and shows frequent twinning. Augite occurs both idiomorphic and in irregular grains. The common forms of the idiomorphic crystals are $\infty P(110)$, $\infty P\acute{\infty}(010)$, and $\infty P\bar{\infty}(100)$. In some of the dikes the augite predominates as the dark silicate, and the rock approaches more the augite-porphyrite type of dikes. It is of the usual rose tint, and the deeply colored crystals show a slight pleochroism. The large well formed crystals exhibit a beautiful zonal structure and the zonal walls surround a granular core of slightly decomposed material. Twinning is rare, but in a few cases occurs parallel to the clinopinacoid $\infty P\acute{\infty}$ (010). Extinction angle is about 43°.

Dikes 2 and 3 are notably different in respect to the kind of green silicate present. The two dikes present the same ophitic structure, but in the former the green mineral is mainly epidote, with minor amounts of chlorite and little, if any, olivine. The epidote possesses a marked pleochroism from green to yellow in incident light, and shows strong double refraction and brilliant colors in polarized light. It appears to be a final alteration product of original augite.

*Kemp, J. F. & Marsters, V. F. Trans. N. Y. Acad. Sci., xi, 1891, p. 13.

Chlorite appears as the first stage in the decomposition and from thence has passed into epidote. In many crystals the original crystallographic form is preserved and the sections are broken up into rods of epidote, often in parallel arrangement. The amount of epidote is exceptional to the diabases of this region, as very little has been noted in the other dikes.*

Analyses of diabases are placed below. Those in columns I and IV are of dikes 2 and 3, respectively. Columns II and V contain analyses by Kemp, and column III by Leeds.

	Eakle. I.	Kemp.* II.	Leeds.† III.	Eakle. IV.	Kemp.‡ V.
SiO_2	44.51	45.46	43.41	50.89	51.93
Al_2O_3	19.99	19.94	19.42	15.39	18.13
Fe_2O_3	7.22	15.36	5.72	5.77	8.92
FeO	——	——	6.69	——	——
CaO	8.15	8.32	9.11	8.75	9.82
MgO	8.11	2.95	5.98	7.60	5.30
K_2O	2.60	3.21	0.47	2.72	1.42
Na_2O	5.24	2.12	4.39	5.67	4.34
TiO_2	——	——	0.35	——	——
CO_2	——	——	2.00	——	——
Loss	2.93	2.30	3.00	2.46	1.42
	98.75	99.66	100.54	99.25	101.28

No epidote is found in dike 3, the green mineral being entirely olivine. Most of it is serpentinized to some extent, but a few idiomorphic crystals remain comparatively fresh and show forms similar to those cited on the augite crystals. The several oxides of iron, magnetite, hematite, and limonite, are abundant from its alteration. The index of refraction is high and the double refraction strong.

The dikes occurring inland do not differ essentially from dike 3 and may be cited as typical diabases. Some of them have their crystals prevailingly idiomorphic, with augite in excess. Such rocks have been called augite-camptonites by Kemp.§ There is a very striking similarity, in structure and mineral constituents, existing between these diabases and

*Kemp, J. F., and Marsters, V. F. Trans. N. Y. Acad. Sci., xi, p. 13, 1891

†Leeds, A. R. Notes on the Lithology of the Adirondacks. 30th Ann. Rep. N. Y. State Mus., p. 102.

‡Kemp, J. F. On Dikes near Kennebunkport, Me. AM. GEOLOGIST, Mch., 1890, p. 129.

§Ibid.

those of Kennebunkport, Me. They have the same rose-colored augite, and the relative amounts and arrangement of the several constituents are also about equal.

The high percentage of silica in dike 3 is exceptional for the diabases; it corresponds very closely to the analysis, in column V, of the augite porphyrite from Kennebunkport. No hypersthene was found in any of the slides.

The writer is indebted to professors Kemp and Tarr for suggestions, and especially to the former for the use of his large collection of slides of the lake Champlain and other dikes, which he kindly loaned for study and comparison.

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ENGLACIAL DRIFT.

By WARREN UPHAM, Somerville, Mass.

Application of the term Englacial Drift.—This term was proposed ten years ago by Prof. T. C. Chamberlin for the portion of the unstratified glacial drift which was enclosed within the ice-sheet at the time of its final recession from any area, being named "*Englacial or Superglacial Till* (since the material embraced in the ice must have become superficial by ablation before it was deposited)."* Previous to that time, however, the doctrine that much drift was incorporated in the lower part of the ice-sheet, being thence deposited partly as unstratified drift, or till, and partly as stratified beds of gravel, sand, and clay or fine silt, borne away and laid down by the streams which flowed from the melting ice-border, had been definitely worked out and published from many observations and studies by J. D. Dana,† N. S. Shaler,‡ N. H. Winchell,§ G. F. Wright,‖ C. H. Hitchcock,** the present

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*U. S. Geol. Survey, Third An. Rep., for 1881-'82 (pub. 1883), p. 297.

†Trans., Conn. Acad. of Arts and Sciences, vol. ii, 1870, pp. 66-86. Am. Jour. Sci., III, vol. v, pp. 198-211, March, 1873, and numerous papers in vols. x, xii, xxiii, xxiv, xxvi, and xxvii, 1875-1884. Manual of Geology, first ed., 1862, p. 547; second (1874) and third (1880) eds., p. 543.

‡Proc., Boston Society of Natural History, vol. xiii, 1870, pp. 196 204. U. S. Geol. Survey, Seventh An. Rep., for 1885-'86 (pub. 1888), pp. 322, 323.

§Geol. and Nat. Hist. Survey of Minn., First An. Rep., for 1872, p. 62. Pop. Sci. Monthly, vol. iii, pp. 293, 294, July, 1873.

‖Proc., Boston Soc. Nat. Hist., vol xix, pp. 47-63, Dec., 1876; vol. xx, pp. 210-220, April, 1879.

Geology of New Hampshire, vol. iii, 1878, chapter ii, p. 282, etc writer,* and doubtless others in this country, and by Otto Torell† and N. O. Holst‡ in Sweden, besides perhaps other European writers. Among these Prof. Dana and Dr. Torell have given this subject very thorough attention; and the writings of the former in the American Journal of Science, with the work of Prof. James Geikie on the Great Ice Age, were the chief sources of my first interest in the problems of the glacial and modified drift. This doctrine, so well stated by Dana in the papers cited, I have found applicable and an indispensable key for the discovery of the origin of the drift in New Hampshire and other parts of New England, also in New York, and in Minnesota and other parts of the Northwest, as also in Manitoba. The term englacial in distinction from subglacial drift is much needed in the theoretic consideration of the methods of formation of the various drift deposits, and at present attracts special notice from the difference of opinion among glacialists as to the probable proportion of the drift which was englacial when the ice melted away. Professors Chamberlin§ and James Geikie‖ think that this englacial drift was of small amount; but the other authors before mentioned think that its amount was large, yielding usually an observable superficial stratum of the till and nearly all of the modified drift. Prof. R. D. Salisbury would restrict the term englacial to the drift, chiefly boulders, enclosed at considerable hights in the ice-sheet and borne along without intermingling with the more plentiful drift held in its basal part; but since both these portions of the drift were englacial and finally superglacial by ablation of the ice, it seems preferable to speak of them respectively as the upper and lower portions of the englacial drift.

*Proc., A. A. A. S., vol. xxv, for 1876, pp. 216-225. Geol. of N. H., vol. iii, pp. 3-19, 176, 285-309.

†Am. Jour. Sci., III, vol. xiii, pp. 76-79, Jan., 1877.

‡Paper on the Origin of Eskers, published in Sweden in 1876, reviewed with notices of Holst's observations of englacial drift in Greenland, by Dr. Josua Lindahl in Am. Naturalist, vol. xxii, July and Aug., 1888.

§Bulletin, Geol. Soc. of America, vol. i, 1890, pp. 27-31. Journal of Geology, vol. i, pp. 47-60, Jan.-Feb., 1893.

‖Great Ice Age, sec. ed., 1877, pp. 415, 416, etc.

**Geol. Survey of New Jersey. An. Rep. for 1891, pp. 65-83. AM. GEOLOGIST, vol. x, p. 219; vol. xi, p. 243.

Definite Division between the Subglacial Till and the Ice carrying its enclosed Drift.—Observations of widely different glacial striation on adjoining parts of the same rock exposure, the two sets of striæ being on surfaces of slightly different inclination which join each other with a bevelled edge or angle, convince me that a very definite plane divided the bottom of the moving ice-sheet with its enclosed drift, boulders, pebbles, and sand grains, which acted as graving tools, from underlying stationary drift accumulations, not less than from the immovable bed-rock. There was, at least in the places of these crucial observations, no pushing or dragging forward of the drift beneath the ice. Several of these localities of adjacent differently striated bevelled rock surfaces I have noted in southwestern Minnesota,* and others in Somerville, Mass. In all these places the contrasted directions of glaciation are apparently referable to deflections of a continuous ice-current, rather than to any withdrawal and subsequent new advance of the ice. During some considerable interval between the times of different courses of the glacial current, a very thin layer of stationary drift covering a part of the rock surface protected it from striation while the later ice erosion engraved its striæ on the closely contiguous part of the same ledge. Here, and I think likewise generally, the only transportation of drift took place within the moving ice-sheet, not by any sliding or rolling under it.

Glacial Currents carry Drift only into the lower part of the Ice-sheet.—The conditions of the flowing ice which seem to me to have been efficacious to carry drift upward into it from tracts of plane or only moderately undulating contour, were the more rapid onflow of the ice-sheet in its upper and central parts and even in the portion near the ground but not in contact with it, than upon the bed of the ice-sheet where its movement was much retarded by friction. A very good analogy with the slowly rising currents which I believe to have existed in many portions of the base of the ice-sheet is afforded by the edges of alpine glaciers, where the crevasses extending diagonally upstream into the glacier testify that

*Geology of Minn., vol. i, 1884, pp. 504-5, and 549-50. Compare with Prof. Chamberlin's memoir, "The Rock-Scorings of the great Ice Invasions," U. S. Geol. Survey, Seventh An. Rep., for 1885-'86, pp. 147-248, especially pp. 175, 176, 200-207.

the movement of its friction-hindered border is from the side of the valley into the ice mass. But the arched surface of the glacier and the great supply of its central current prevent the drift so worn off and borne away from being carried into the axial portion of the ice stream. Similarly the steady accession to the mass of the ice-sheet over any place by onflow from its thicker central part and by the accumulating snowfall forbade the drift of the upwardly moving basal current from being carried far into the ice in comparison with its total thickness. The evidence of the esker called Bird's hill near Winnipeg, Manitoba, shows that much englacial drift had there been uplifted from a nearly level country to a hight of more than 500 feet in the ice-sheet.* Probably some of the englacial drift there was as high as 1,000 feet or more in the ice, but doubtless a larger part was below than above the altitude of 500 feet; and this was on an area where the ice-sheet had attained probably a thickness of 5,000 or 6,000 feet, its lower fifth or sixth part bearing considerable enclosed drift. In like manner the outer portions of the ice-sheet, where its thickness was less, had probably at its time of culmination no englacial drift above its lower sixth or fourth or third part. Whatever boulders and other drift became incorporated in the higher portion of the zone reached by the currents flowing upward would be thence carried forward in some regions, as from the Huronian and Laurentian areas north of lake Huron to the boulder belts in Illinois, Indiana, and Ohio, described by Chamberlin,† without intermixture with other englacial drift brought into the ice by less powerful currents on all the intervening extent, which in the case mentioned is about five hundred miles.

Although the englacial drift is here spoken of as existing in large amount in the basal fifth or sixth part of the ice-sheet, its proportion to the containing ice would yet be small, so that usually if a section could be inspected it would be

*Geol. and Nat. Hist. Survey of Canada, Annual Report, new series, vol. iv, for 1888-'89, pages 36-42E.

†"Boulder Belts distinguished from Boulder Trains—their Origin and Significance," Bulletin, G. S. A., vol. i, pp. 27-31. "The Nature of the Englacial Drift of the Mississippi Basin," Journal of Geology, vol. i, pp. 47-60.

pronounced nearly free from drift. Even in the exceptional locality of Bird's hill, where I think we have evidence that the volume of the ice-held drift was much larger than the average, being at least equal to a thickness of forty feet, it was distributed through probably 1,000 feet of ice, and perhaps no more than ten feet of drift was in the zone from 500 up to 1,000 feet, so that the proportion of ice there to its drift would be as fifty to one. This consideration will mainly account for the impression received by observers of living glaciers and ice-sheets, that they contain very little englacial matter, which indeed is true as compared with the ice itself, though sufficient to produce an important part of its resulting drift formations. Again, it has often been remarked that icebergs show very scanty and rare enclosures of drift, but this is largely attributable to the submerged position of those parts, especially in the case of the tabular antarctic icebergs, which are melted away without overturning.

While favored districts, as near conspicuous marginal moraines and along belts of confluent ice currents, received sometimes not less than a thickness of forty feet of englacial drift, its usual amount on most other areas was probably no more than a few feet, perhaps seldom so much as ten feet and occasionally diminishing to almost nothing.* In many sections the englacial may be readily distinguished from the subglacial drift, and this is eminently true for the upper part of the englacial drift when it consists mostly of boulders transported long distances; but very frequently it is quite difficult or impossible to draw any line between the lower part of the englacial matter, which was principally of local derivation, and the accumulations of similar drift formed beneath the ice-sheet.†

Englacial Drift becomes Superglacial only by Ablation.—Professor Chamberlin, in his recent very valuable paper on the englacial drift of the Mississippi basin, several times speaks of the opinions of writers who believe in the considerable volume of the englacial drift, as if they suppose the

*"Inequality of Distribution of the Englacial Drift," Bulletin, G. S. A., vol. iii, 1892, pp. 134-148.

†"Criteria of Englacial and Subglacial Drift," AM. GEOLOGIST, vol. viii, pp. 376-385, Dec., 1891.

glacial currents to move gradually upward from the ground to the ice surface. Such a supposition, however, seems to me quite untenable. Instead, in my own writings and those of most if not all of these authors, the exposure of the drift on the surface of the ice-sheet near its border, whence much of it was washed away to form the eskers, kames, and valley drift, is ascribed wholly to the superficial melting of the ice-sheet, which is called ablation. Twenty years ago Prof. N. H. Winchell, with almost prophetic vision, as if seeing the drift-covered and forest-clad borders of the Malaspina glacier or ice-sheet, between Mt. St. Elias and the ocean, which was explored by Russell* in 1891 and 1892, wrote as follows of the North American ice-sheet:

In regions far to the north, the eye probably would not be able to discern any object except that of the universal ice. The surface of the ground would be thousands of feet below the traveller, if we may be permitted to presume so hardy a human being. Like Dr. Kane exploring the great Humboldt Glacier of Greenland, he would meet with countless obstacles and dangers. But those obstacles would consist of hummocky ice, or crevassed ice, or perpendicular ice-walls. He would see no soil, no rocks, no vegetation, no animal life. The winds would whistle, storms would rage, snow would be drifted about, and the ineffectual sun would rarely venture to smile on the dreary waste. Farther to the south, the explorer would find isolated spots of bare ground. He would see about them the accumulated *débris* of bowlders, gravel and dust, from constant winds, spread more or less over the ice-field, staining its painful whiteness, and showing the more grateful aspect of earth and stones. Another hundred miles farther south, and he finds the evidence of the dissolution of the ice-sheet multiplying. Occasional streams of water run on the surface of the ice, or plunge into some of its openings. Deep gorges reveal multitudes of fragments of rock frozen into the ice, and occasional bands of dirt and gravel embraced in the solid ice. The surface is everywhere dirty, or perhaps muddy, from the wasting away of the surface of the glacier. He meets frequent openings, in which generally water may be seen or heard. Into these gorges the *débris* slides down the sloping sides, increasing the insecurity of his footsteps. Still farther south, the general surface is covered with a pulpy earth, mingled with stones and bowlders. The ice is evidently much attenuated. The areas of firm, uncovered *terra firma* are wonderfully increased in size and frequency. The ice itself is crowded into the valleys, or, if it be in a broad, level tract, like the State of Minnesota, the surface is covered with the *débris* of the con-

*National Geographic Magazine, vol. iii, 1891, pp. 53-203, with 19 plates and maps. Am. Jour. Sci., III, vol. xliii, pp. 169-182, with map, March, 1892. Am. Geologist, vol. viii, p. 384, Dec., 1891.

flict of ice with earth, the ice itself being visible only in those places where crevasses reveal it, or where deep gorges are worn by running streams. Travelling still farther south, the explorer would come upon large areas in which he would not be able to know whether the glacier underlay the superficial drift or not. If he were to stop on one of those wide areas, and make his latitude and longitude certain, by a series of astronomical observations, he might find to his surprise, after a few years' residence, that his observatory and apparatus had been bodily carried, by an imperceptible motion, some rods to the south. If he were to penetrate the earth on which his foothold seems so steadfast, he might find, equally to his surprise, that he was still riding on the surface of a vast ice-sheet, the earth and soil of which may have furnished him annual crops of potatoes and barley. In other places in the same latitude he would find the ice laid bare over considerable areas, washed clean by the drainage incident to the dissolution of the glacier. The turbid streams would be vastly larger than those which occupy the same beds to-day. They would run with tenfold more violence. The drift-materials would be freed from the clayey portions, and be spread along their channels in curious and varying assortment. In some places the thickness of the whole sheet of drift would be brought under this washing and stratifying process. In others, the ice gently dies out, and lets it down on the rocky surface without any change from the condition in which it lay on the glacier.*

Besides regarding the area of predominant ablation as much wider than seems to me probable, even during the glacial retreat, this view, like that of Dana, attributes nearly all the drift deposition to the Champlain epoch or time of departure of the ice-sheet, in which the drift had been enclosed. On the contrary, it seems to me certain that much deposition of drift took place under the ice, probably even in larger aggregate amount than the portion which was englacial when the ice-sheet finally disappeared. But the latter, as I have elsewhere endeavored to show in the papers before cited, appears, according to my studies, to have been the source of a considerable part of the till, and of nearly all the material forming the eskers, kames, and other modified drift: while the terminal moraines, if I understand the method of their formation, were chiefly amassed from previously englacial drift, and the drumlins, though subglacial accumulations, were made of material which had been englacial until peculiar conditions attending the departure of the ice caused it to be deposited in these remarkable subglacial hills.†

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*Popular Science Monthly, vol. iii, pp. 293, 294.

†"Conditions of Accumulation of Drumlins," AM. GEOLOGIST, vol. x, pp. 339-362, Dec., 1892.

The ice-sheet was not only a rasp or plow for the erosion of the materials of the drift from the old preglacial land surface, but was also, as I believe, a mill in whose lower part these materials were mostly very thoroughly commingled. Thence the resulting grist was in large part deposited under the ice, but also an important amount was still enclosed within it, becoming at last superglacial before its deposition, when the returning warm climate again uncovered the land.

THE TERMS OF AUXOLOGY.*

"Zoologischen Anzeiger," pp. 420 and 429, Nov. 14 and 28, 1892.

By S. S. Buckman, F. G. S. and F. A. Bather, M. A., F. G. S., London.

Ontogenetic Stages.

In a paper entitled "Values in Classification of the Stages of Growth and Decline, etc,"† Prof. Alpheus Hyatt divided the life of the individual into some five or six stages, which he designated by certain definite terms. These stages can, he believes, be recognised throughout the animal kingdom; indeed their value has already been proved for *Cephalopoda* by his own important papers, notably the "Genesis of the Arietidæ,"‡ for *Pelecypoda* by Dr. R. T. Jackson,§ and for *Brachiopoda* by Dr. C. E. Beecher.‖ Few modern workers will deny the existence of some such stages, or the necessity for naming them. It is therefore unfortunate that the designations proposed by Prof. Hyatt are open to serious objection on etymological grounds: this, no doubt, is largely the reason why they do not seem to have found favor with European laborers in similar fields. Since, however, Hyatt's terms are gradually coming into general use in America, and since they have lately been brought forward in Britain by Prof. J. F. Blake,** some protest should now be raised. They who un-

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* *Αὔξη*, growth, and *λόγος*, science.

†Proc. Boston Soc. Nat. Hist. Vol. XXIII, p. 396, March, 1888.

‡Smithsonian Contributions to Knowledge. No. 673, Washington, 1889.

§"The development of the Oyster, with remarks on allied genera." Proc. Boston Soc. Nat. Hist. Vol. XXIII, p. 531, March, 1888; and "Phylogeny of the Pelecypoda. The Aviculidæ and their Allies." Mem. Boston Soc. Nat. Hist. Vol. IV, No. VIII, pp. 277-400, July, 1890.

‖"Development of the Brachiopoda." Amer. Journ. Sci. Vol. XLI, p. 342. April, 1891, and Vol. XLIV, p. 133, Aug. 1892.

**"The Evolution and Classification of the Cephalopoda, etc." Proc. Geol. Assoc. Vol. XII, p. 275, London, April, 1892.

dertake this ungrateful task are bound to set up something in place of what they destroy; a fresh series of terms is therefore proposed, but in its construction the original has been altered no more than seemed absolutely necessary.

The following table gives, in the first column, the terms now applied by Hyatt to the successive ontogenetic stages: in the second column, those which it is here proposed to substitute; in the third column the words that may be used in ordinary literature, when technical strictness is not considered necessary. Some may think that the better known words of the third column, or their equivalents in the various European languages, should suffice for the purpose; but scientific precision demands terms that do not already possess some more general meaning, that can be transferred with ease into other tongues, and that lend themselves to the formation of suitable compounds.

Hyatt	Here proposed	Literary equivalents
1. Embryologic	Embryonic	Embryonic
2. Naepionic	Brephic	Infantine or Larval
3. Nealogic	Neanic	Adolescent
4. Ephebolic	Ephebic	Adult or Mature
5. Geratologic	Gerontic	Senile
a Clinologic	Catabatic	Declining
b Nostologic	Hypostrophic	Atavic

ETYMOLOGICAL REMARKS ON THE ABOVE TABLE.

1 Embryonic. The term "Embryologic" means "connected with the study of the embryo." Hyatt, however, did not wish to say "A stage connected with the study of the embryo," but "A stage connected with the embryo;" otherwise "Embryonic stage," a phrase well understood and in ordinary use.

2 Brephic. The first term used by Hyatt for this stage, was "Silphologic," which, besides being open to the same objection as "Embryologic," was apparently derived from a word that meant either a cockroach or a bookworm, neither of which have any obvious connection with the subject. It was in a footnote to Mr. Jackson's paper of 1888, quoted above, that Hyatt substituted the term "Nepionic." Were this a Greek word we should be glad to retain it; it is, however, only an impossible corruption of *νήπιος*, made still worse by the spelling "næpionic" which Hyatt and Beecher now affect. As there is no other word connected with *νήπιος* that can be readily anglicised, we have adopted the word

βρεφικός, derived from βρέφος, the unborn or new-born young of men or other animals.

3 Neanic. Hyatt's term "nealogic" is said to be derived from νεαλής and λόγος. If such a compound were possible it would be "nealologic;" but, as before, the latter half is superfluous. *Νεανικός* springs from the same root, and, being congruous with the other terms, is the obvious word to employ.

4 Ephebic. The word "Ephebolic" has greatly puzzled us. We can only explain it as a corruption of "Ephebologic," but the "logic" is unnecessary, while the word ἐφηβικός, the adjective of ἔφηβος, gives the exact term required.

5 Gerontic. The word "Geratologic" is stated by its author to be derived from γέρας; this, however, instead of denoting "old age," means "a gift of honour." There is a word γῆρας, with a genitive γήρατος used by very late authors, it is true; but even so there remains the unnecessary "-logic." The proper word to use is clearly γεροντικός.

5a Catabatic. "Clinology" can only mean the science of bed-making, so "clinologic" cannot be used in the sense attributed to it by Hyatt. *Καταβατικός* which we have chosen to replace it, means literally "affording an easy descent," and is the best word not already occupied that we can find. It should at least be readily understood.

5b Hypostrophic. "Nostologic" is open to the same objection as "Embryologic." The word we suggest, derived from ὑποστροφή, a recurrence or relapse, seems to convey the exact meaning with greater clearness.

Definitions of the Terms.

It is only possible to define these stages in a very general way, for their characteristics vary greatly in the different classes of animals. It is moreover impossible to draw any hard and fast line between the successive stages, except in rare instances. The following definitions are generalized from the evidence of those groups to which the principles of auxology have already been applied.

1 Embryonic. This stage includes all individual history from the ovum up to the time when the organism can be referred definitely to its class. This stage has been sub-divided by the American authors into protembryo, mesembryo, metembryo, neoembryo, typembryo and phylembryo.

2 Brephic stage immediately succeeds the embryonic, and during it no specific characters can be distinguished.

3 Neanic. During this stage specific characters and all other morphological features present in the adult, appear and undergo development.

4 Ephebic stage denotes the period of full development of the individual, when all specific characters are clearly recognisable.

5 Gerontic. During this stage changes take place which are due to gradual failure of powers. The stage may be sub-divided into:

a Catabatic stage, in which the individual loses its ephebic characters.

b Hypostrophic stage, in which the continued loss of characters causes pronounced reversion.

Examples and Remarks.

It may be noted that in an individual of a progressive series gerontic changes are truly reversionary, the decline due to diminishing vitality in the catabatic stage causing a certain degree of reversion to the characters of the neanic stage. In an individual of a retrogressive series, however, in which the characters of the ephebic stage are less elaborate in development than those of the neanic, or even brephic stages, the gerontic stages shew simply characters of a still further decline. In some extreme cases, however, the hypostrophic stage of an individual of a retrogressive series may possess characters of, apparently, a renewed progressive development; from which it would seem that when reversion has completed the cycle of changes, further reversion may produce characters belonging to a recommencement of the cycle.

In applying the definitions of the brephic and neanic stages, it should be remembered that specific characters sometimes make their appearance in ontogeny before generic. The period at which any character appears depends largely on the length of time for which it has been a character of the race. In many cases, characters that are regarded as specific have a higher antiquity than those that are regarded as generic.

It may also be pointed out that the physiological episodes of birth and puberty have no definite relation to particular stages in the above scheme, though they may accelerate or retard purely morphological characters.

As a simple example of the ontogenetic stages, we may take the ammonite now known as Deroceras ziphus, of which some good figures were given by Wright under the name of Aegoceras dudressieri. Confining our attention to the surface characters, we see, following on the embryonic protoconch, these stages:

{ Brephic, Neanic, Ephebic, Gerontic }
{ Smooth, Costate, Spinous, Costate } . This gerontic stage is clearly catabatic with reversion to neanic characters. It does not happen, in this species, to be succeeded by a hypostrophic stage; but it is shown by closely allied species that the costate surface would be succeeded by a smooth one, that is to say, a reversion to the brephic stage so far as this character is concerned.

On the other hand, in Coroniceras trigonatum *Hyatt*,* which is an individual of a retrogressive evolutionary series, the following auxologic changes may be noted:

{ Brephic, Neanic, Ephebic, Gerontic }
{ Spinous, Costate, Costate, Smooth } . Here also the gerontic stage is catabatic; but it is a reversion to a stage of phylogenetic development omitted from the ontogeny on account of earlier inheritance. The same applies to the ornamentation of both the neanic and ephebic stages.

PHYLOGENETIC STAGES.

It must be kept in mind that the terms hitherto considered denote stages in the growth of an individual. They or their predecessors have, however, often been applied, even by Hyatt himself, to stages in the history of a race. Beecher, though he points out the difference in clear enough language (op. cit. II, p. 148), nevertheless speaks of Gwynia and Cistella as nostologic (=hypostrophic) types of terebratuloids; by which he means that in their ephebic stage they resemble the earlier stages in the history of the group, or the brephic stages in the ontogeny of such a form as Terebratulina. This use of the same words for two very distinct ideas leads either to confusion of thought, or to the employment of

*Genesis of Arietidæ. Pl. VI, fig. 3; pl. VII, fig. 1, p. 182.

cumbrous qualifying phrases. We therefore suggest that, when it is desired to express stages of phylogeny, the syllable phyl- should be prefixed to the above terms, as shown in the annexed table. In this table we also give, in the first column, the physiological terms employed by Hæckel for growth, perfection and decline in ontogeny; and, in the last column, the terms used by the same writer to denote corresponding periods in phylogeny. It should be noted that these latter terms are not morphological, but have reference chiefly to number of species and individuals, and partly also to size and predominance. They have of late been used, it seems to us, wrongly, in a morphological sense, especially by American writers, probably for want of the very terms we now propose. Beecher, for instance, in his most interesting essay on the development of Bilobites (= Orthis biloba and allies), speaks of certain forms as epacmic and others as paracmic, when it would probably be more in accordance with his meaning to call them phylobrephic and phylogerontic. Thus also we should say that the Productidæ attained their paracme in the Permian, when they were represented by the phylogerontic Strophalosia and Aulosteges; that the characters of the neanic and ephebic stages of Coroniceras trigonatum are phylocatabatic; or, to give one more instance, that the ephebic Cistella and Baculites are phylhypostrophic.

	Ontogeny.	Phylogeny.	
Anaplasis	Embryonic	Phylembryonic	Epacme
	Brephic	Phylobrephic	
	Neanic	Phyloneanic	
Metaplasis	Ephebic	Phylephebic	Acme
Cataplasis	Gerontic	Phylogerontic	Paracme
	Catabatic	Phylocatabatic	
	Hypostrophic	Phylhypostrophic	

The use of the term phylembryonic does not really clash with Jackson's term phylembryo; for the phylembryo of the individual represents the phylembryonic stage of the race: the essential morphological features of the two are the same.

Stages of Individual Morphogenesis.

Yet another caution as to the use of the above terms seems required. As already pointed out, the various characters that go to the formation of an individual or a race, at any one period of its development, may themselves differ greatly from one another in the degree of their own development. It is possible to trace the evolution of one character from its first appearance to its final loss, right through the history of a long line of individuals. For the designation of the successive stages in the history of a character, the ontogenetic terms might be used, with the addition of the prefix morpho- , *e. g.*, morphobrephic, morphophebic.

AUXOLOGY.

It does not seem to us that any apology is needed for the title of our paper. Growth and change do not stop when the embryonic stage has been passed, nor is the study of later stages of less importance than that of the earlier. It is indeed possible that the application of these principles to some of the problems of anthropology and sociology might prove of practical utility. To predict the future, as the study of gerontic characters enables one to do, is neither less fascinating nor less valuable than the embryologist's decipherment of the past. And yet, while a part of this science has its special name, its text-books and its professors, the whole science, through being unchristened, is in danger of also being unrecognized. In proposing for it the name of "auxology," we fulfil a want that may not indeed have long been felt, but that would otherwise have been felt more and more with the progress of years and knowledge. We hope that, in discussing the terms of this science, we have said nothing to offend those who have been most active in laying its foundations.

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RANGE OF CHOUTEAU FOSSILS.

By R. R. ROWLEY, Fort Smith, Ark.

Below, we give the range of the most common species of Chouteau fossils in Missouri as facts gathered by ourselves in years of collecting from that horizon. The strata pass upward in regular order from left to right, the Kinderhook or Waverly being introduced not as a separate division, but to receive certain species so referred in neighboring states, but known to occur in the Lower Burlington beds at Louisiana, Hannibal, and elsewhere in eastern Missouri. The star (*) to the right of the name of the species shows the presence of that fossil in the division whose name and thickness is indicated above:

	Dark-blue Shales, 2 feet thick.	Yellow sandy Shales, 1 to 4 inches thick.	Lithographic Limestone 30 to 50 feet thick.	Green Shales, 25 to 30 feet thick.	Vermicular Sandstone, 4 or more feet.	Chouteau Limestone, from a few to 50 feet.	Kinderhook or Waverly.	Lower Burlington, L. S., 30 to 50 feet thick.	Upper Burlington, L. S.
Goniatites sp?			*		*?			*?	
Porcellia nodosa							*	*	
Allorisma hannibalensis	*	*			*				
Spirifera marionensis	*	*	*	*	*	*		*?	
" striatiformis							*	*	
† " peculiaris			*			*		*?	
Spiriferina clarksvillensis		*	*	*				*?	
" solidirostris							*	*	
Syringothyris hannibalensis		*	*		*			*?	
Cyrtina acutirostris		*	*					*?	
Ambocœlia minuta		*	*					*	
Athyris hannibalensis	*	*	*	*	*			*	
Nucleospira barrisi		*	*						
Terebratula burlingtonensis							*	*	
" sp?		*	*	*?	*				
Rhynchonella missouriensis	*	*							
Orthothetes lens	*	*	*		*?				
Orthis missouriensis	*	*	*	*					
Productella pyxidata	*	*	*	*	*	*			
Chonetes ornata		*	*						
" geniculata		*	*						
Strophalosia scintilla		*	*						
†Strophomena rhomboidalis			*			*		*	
Crania rowleyi		*	*			*?			
" sp?		*	*						
†Platycrinus allophylus			*			*			
" insolens						*			
†Blairocrinus (2 or more spe.)			*			*			
†Granatocrinus rœmeri			*			*?			
" sp?						*			
Zaphrentis ida	*	*	*						
" elliptica							*	*	
† " calceola			*			*		*	*
Chonophyllum sedaliense					*?	*		*?	
Michelinia expansa						*			
Leptopora placenta			*?			*			
Lithostrotion microstylum						*			
Palaracis enorme	*	*	*						
Chonopterium effusum		*	*						
Ptychostylus subtumidus	*								

April 17, 1893.

†Species found in the Lithographic Limestone horizon of southern and southwestern, but not eastern, Missouri.

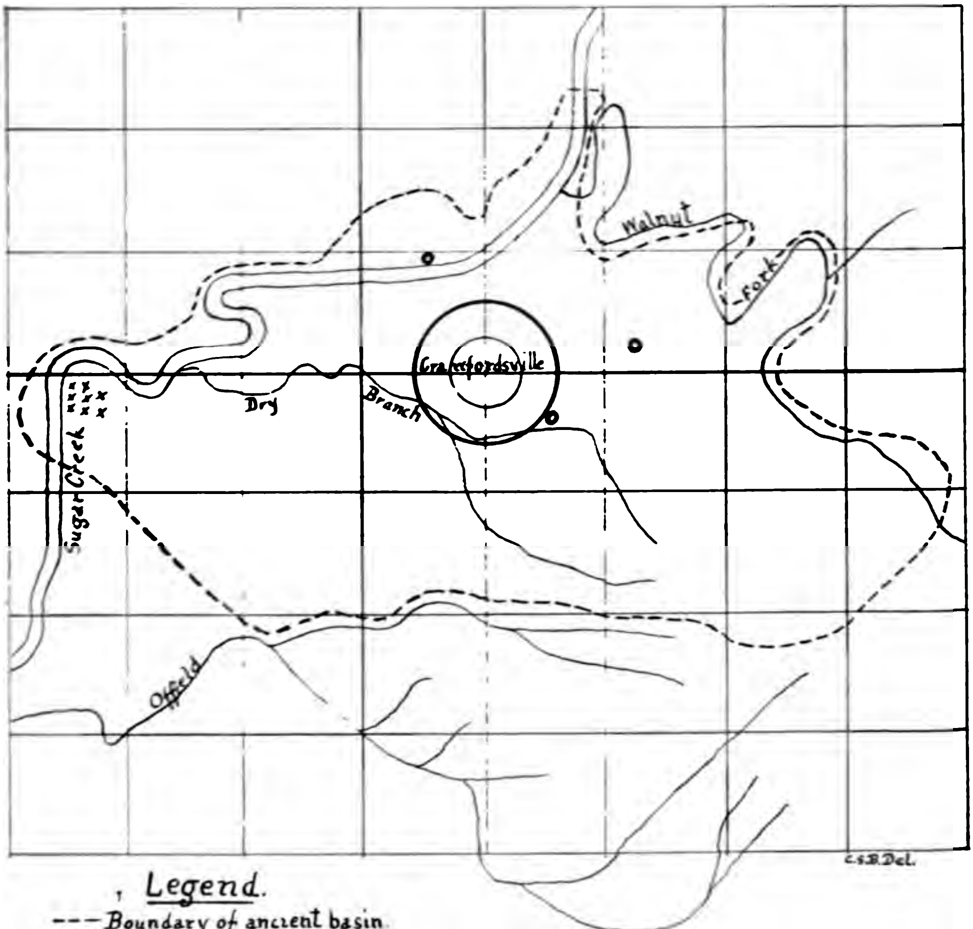
EROSION OF SMALL BASINS IN NORTHWESTERN INDIANA DURING THE TIME PRECEDING THE PLEISTOCENE PERIOD.

By CHARLES S. BEACHLER, Crawfordsville, Indiana.

During the past five years in my study of the Keokuk rocks of northwestern Indiana, my attention has been repeatedly given to a high and well defined line of rock bluffs and hills in the central part of Montgomery county enclosing a deep basin filled with drift, with an area of twenty square miles.

The surface rocks of the county consist of Keokuk sandstone underlaid by shales of the same group; the water eroding away these rocks in the center of the county left the deep basin which is surrounded by this high and abrupt line of bluffs and hills; in many places where the drift has been deposited against the rocks of these old bluffs so as to hide them, the recent streams have cut away the drift and sought the low, rocky bed, again exposing the old rock wall on the outside and forming a high bank of exposed glacial drift on the inside of the stream. The rock forming the edge of the basin between the sources of the two small streams, South branch of Walnut Fork and Offield creek, is entirely hidden, as the drift has not been eroded.

The material filling the basin is stratified, the lower part being boulder clay, which after being deposited was eroded and modified before it was covered with gravel and sand; at one place west of Crawfordsville are seen in the bottom of a deep gravel-pit, resting on the boulder clay, two square blocks of Devonian rock, probably from the vicinity of Logansport, which were picked up, transported and deposited by the ice after the boulder clay had been deposited; the overlying gravels and sands in their stratified position were then by the action of the water spread out, covering over these blocks of transported rocks as well as the whole of the boulder clay itself; then judging from the number of foreign boulders, some from the lake Superior region and others from the northeast, scattered over the surface of the material filling the basin, there must have been the melting of another glacier or of floating ice.



Legend.
--- Boundary of ancient basin.
o Gas well borings.
x Terminal moraine.

The drift, as shown by gas-well sections, has an average depth of one hundred and fifty feet; the deepest part of the basin is at the north edge of the city of Crawfordsville where a gas well was drilled; the mouth of the well is in an alluvial deposit about one hundred feet lower than the glacial deposit upon which the city is built; the drill penetrated one hundred and fifty feet of drift, making the depth of the basin at this point two hundred and fifty feet. At the gas well east of the city the drill struck a boulder at one hundred and fifty feet and at the well drilled southeast of the city one hundred and forty feet of drift were penetrated.

At the extreme western edge of the basin a terminal moraine is seen; large boulders of foreign rock were originally scattered over the fields, but have been piled up for fences and a great number have been hauled away.

At the most northern point of the basin, Sugar creek having channeled its way through the surrounding rock, enters and follows the north and western rocky wall and upon leaving the basin has cut its deep channel through the solid rock for many miles.

The only glacial markings on the bed rock are seen at the most western edge having the direction of 10 degrees E. of N.

The origin of these basins in the glacial region of Indiana is evidently due to the erosive power of water before the Pleistocene period.

I. It is known by the study of living glaciers that glaciers abrade but do not erode hard rocks, and both modern and extinct glaciers are known to have flowed over even loose moraines and gravels.*

II. So deep a basin with such a small area could not have been eroded by ice leaving the faces of the enclosing walls vertical.

III. The striæ observed on the bed rock at the western edge of the basin are not parallel with the walls at this point.

IV. There are basins, similar to these of the state of Indiana, to be seen in the Sub-carboniferous rocks of the south beyond the limit of the glaciers.

ON THE STRUCTURE AND PROBABLE AFFINITIES OF CERIONITES DACTYLIOIDES OWEN.

By S. Calvin, Iowa City.

In his *Report of a Geological Exploration of a part of Iowa, Wisconsin and Illinois*, made under instructions from the Secretary of the Treasury of the United States in the autumn of the year 1839, Dr. David Dale Owen describes and figures

*Dr. J. W. Spencer, Proceedings American Association for the Advancement of Science. Vol. XXXVII, page 198.

a small fossil from the "Coralline beds of the Upper Magnesian Cliff Limestone of Iowa and Wisconsin," under the name of *Lunulites? dactioloides.* The report was printed in June, 1840, and was reprinted with some additions and emendations in 1844. The fossil in question, *Lunulites? dactioloides*, is described briefly, as follows, on page 68: Truncated spherical, with five or six sided cellular depressions in rows around the circumference, like those on a thimble, one inch and a quarter in circumference." The illustration of the species, figure 4, plate xiii, exhibits a fossil with a spherical surface marked by rounded pits arranged quincuncially. The pits are relatively large and separated from each other by thick walls. Owen's figure is indeed a very imperfect illustration of the fossil as we now know it; and were it not for the text which describes the cellular depressions as five or six sided, and the fact that no other spheroidal fossils having the surface marked by polygonal depressions are known from the horizon of the Niagara limestone, the forms we have studied might never have been identified with Owen's species. The identification was first made by Meek and Worthen who, in the Geology of Illinois, vol. iii, page 345, give the results of their study of this species under the name of *Pasceolus? dactylioides* Owen. They recognize the difference between the form they describe and Billings' genus *Pasceolus*, but without deciding the zoological relationship of the form under consideration, and even without settling the question of whether it was an external or internal cast, they propose for it the new generic name of *Cerionites.*

In the fourth volume of the Geology of Wisconsin, page 267, Prof. R. P. Whitfield effects another change in the spelling of the specific name, and discusses the characters of the species in question under the head of *Cerionites dactyloides* Owen, although in the description of plate xiii, Whitfield allows the name to stand as *Cerionites dactiloides.*

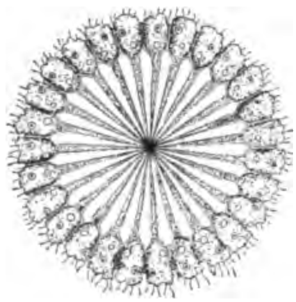
Concerning the specific name I think it must be evident that Owen intended to use a term implying, not that the fossil described was *like a finger*, but that it was *like a thimble*—something to put on the finger. The word that comes nearest to standing for thimble may be spelled with our Roman letters *dactulios* from which we may derive dactilioides, the form in which Owen probably intended to write it, or *dactylioides*, the more correct spelling employed by Meek and Worthen.

Cerionites is found in Iowa about the middle of the Niagara limestone, being most plentiful at the horizon represented by the exposures near Maquoketa, in Jackson county. The matrix is a buff or yellowish dolomite, and the fossil itself as usually found, and as it was seen by Owen and Messrs. Meek and Worthen, is a more or less compressed sphere, from three-fourths of an inch to an inch and a half in diameter, composed of the same material as the matrix, and marked on the surface by shallow pits that are usually six sided, though the number of sides may vary from four to seven. The pits vary also in size; although the relations are not absolutely constant, still in general the larger pits belong to the larger individuals. A small tubular opening descends from the bottom of each pit to the center of the sphere. For a good illustration of the usual appearance of the fossil the reader is referred to the Geology of Illinois, volume iii, plate 5, figure 2c.

The appearance of the fossil varies with the conditions under which it was preserved. There are also differences of appearance due to variations in modes of growth. Meek and Worthen recognize an upper and a lower side differing in respect to size and character of the pits. Whitfield speaks of a point of attachment. From a study of a large series of individuals we may now demonstrate that the normal colonies of *Cerionites*, when alive, were spherical, unattached bodies, in which the structures now indicated by the pits were similar in size and other characteristics over the entire surface. On the surface of a number of our specimens we have a series of prisms, about a tenth of an inch in length, with their inner rounded ends resting in the concave pits. These prisms, which correspond in number and size with the pits of the surface, as we usually see it, are very loosely attached to the body of the fossil and to each other; indeed, it is evident that between the individual prisms, and between the ends of the prisms and the bottoms of the pits, thin laminæ of some sort have been dissolved out. Moreover, the prisms are of the same material as the matrix, and also of the same material as the fossil itself.

Now, in all our dolomites the fossils are usually in the form of casts. Chitinous and calcareous structures are dissolved away, and the places these structures occupied are, in a majority of instances, vacant; what was hollow in the original fossil has been filled with the material of which the embedding rock is constituted, and what was solid is simply an unoccupied space. Bearing these facts in mind we can easily restore the original solid parts of *Cerionites.* All the solid parts of our present fossils of this genus from Iowa were hollow. The vacant spaces between the prisms referred to, and between the rounded ends of the prisms and the bottom of the shallow pits were occupied by thin laminæ of chitinous or calcareous matter. The small opening leading from the bottom of each pit toward the center of the sphere was occupied by a slender cone that was probably hollow, especially at its larger outer end. The spaces now occupied by the prisms were hollow and bounded by thin walls, constituting the laminæ already mentioned; so that we would get, as a result of our efforts to restore the solid parts of the original organism, a number of shallow, polygonal coherent cups, with thin chitinous walls, so arranged as to enclose a spherical space, each cup sending toward the center of the sphere a slender radial tube or rod of the same chitinous material. The tubes or rods were certainly very delicate at the center of the sphere, at which point they were probably all more or less intimately united and from which they diverged as radii, one to the bottom of each cup.

Cerionites, therefore, was a colony of individualized units of some sort. Each separate individual was surrounded by a thin chitinous or calcareous theca that took the form of a shallow polygonal calyx. Each was united to the center of the sphere, the point at which growth began, and from which it proceeded outward along radial lines, by a slender thread of protoplasm which was also inclosed in a delicate chitinous sheath. The colony was free and doubtless moved through the water with the graceful rolling motion that characterized colonies of *Uvella* and *Synura.* The movements of the still more beautiful and much more familiar *Volvox globator* will convey to users of the microscope a correct idea of a mode of locomotion I fancy they might have witnessed, without the aid of the "tube," in all the sheltered coves of the Upper Silurian period where Cerionites congregated. It is probable



IDEAL SECTION OF CERIONTES (original).

that the skeleton was chitinous rather than calcareous. It was flexible enough to undergo extensive deformation without breaking, and exposed parts were frequently decomposed before the entire structure was embedded.

The zoological position of *Cerionites* is less clear than the structure of its skeletal parts. It is scarcely probable, however, that the zooids that inhabited the delicate chitinous thecæ, attained the rank of *Hydrozoa*. It seems more probable that they were rather gigantic *Protozoa*. At all events I know of nothing to render such a view improbable. Some of our modern protozoa are about as large as the smaller individuals of *Cerionites*. Individuals of the genus *Noctiluca* are often a twentieth of an inch in diameter, and the gigantic *Actinosphæria* to which I called attention in the *American Naturalist* for 1890 (Vol. 25, page 964) are even larger. Many of the *Protozoa* secrete a chitinous case or lorica. Many, as *Urella* and *Synura*, live in spheroidal colonies in which the individuals are attached, by bands of more or less modified protoplasm, to the center of the sphere, and in *Synura*, each zooid is contained in a separate membranous sheath, which takes the form of the calices here conceived to have been present in *Cerionites*. Figures 12 and 13, plate 1, of Kent's *Manual of the Infusoria*, representing *Megosphæra planula*, approximate very closely the figures that must be made to express my conception of a living colony of *Cerionites*. The figure accompanying this paper is simply an attempt to represent diagramatically an ideal section of such a colony.

REVIEW OF RECENT GEOLOGICAL LITERATURE.

On the Alleged Proofs of Submergence in Scotland during the Glacial Epoch. I. Chapelhall, near Airdrie. By DUGALD BELL, F. G. S. Trans., Geol. Soc. of Glasgow, vol. ix, pp. 321-344, with map, and view of the village of Chapelhall. Since the researches and observations of Belt, Goodchild, Clement Reid, Carvill Lewis* and others have shown that the shell-bearing morainic deposits and associated kames at hights from 1,100 to 1,350 feet above the sea, on Moel Tryfaen in northern Wales, at various localities in northwestern England, and on Three Rock mountain, near Dublin, are doubtless referable to glacial transportation from the bed of the Irish sea, and therefore cannot be longer accepted as proofs of a great marine submergence of these parts of the British Isles, attention is naturally directed, as in this paper, to the lower occurrences of marine shells in the British drift deposits, among which the highest, aside from the instances before mentioned, is at Chapelhall in Lanarkshire, Scotland. In this village, a well dug about fifty years ago by Mr. James Russell, passed through 14 feet of till, then through 2 feet of clay enclosing numerous shells of *Tellina proxima*, under which a deposit of lower till has a thickness of about 24 feet and rests on the Carboniferous strata of the district. The well is at a hight of 524 (or 526) feet above the sea, and is on the rounded top of a long drumlin-like ridge of till, such as abound in that district, trending nearly from northwest to southeast. No other well of the village nor of any land at similar hight in all the surrounding region reveals any marine shells; nor are any shore lines, deltas or other evidences of sea action found above the late glacial marine beds of the lower part of the basin of the Clyde, a few miles distant on the west and extending up to 100 or 125 feet above the sea, in which this arctic species of *Tellina* is very abundant.

The site of Mr. Russell's well was first visited and its fossils brought to the knowledge of geologists by Mr. James Smith in 1850, since which date it has been often quoted as evidence of a marine submergence of that part of Scotland to the extent of 510 feet or more, during an interglacial epoch. About a dozen years later it was visited by Archibald Geikie, who wrote of it: "From a number of additional wells, sunk on purpose, Mr. Russell ascertained that the clay lay in a hollow of the undermost till, and that this hollow measured about 19 feet long by about 5 feet broad. Pits which were dug beyond the boundary of this little trough showed a great depth of the usual till, but without a trace of brick clay. The shells consisted, entirely, I believe, of *Tellina proxima*. Usually the specimens were broken, but a good many were taken out entire, with both valves together." The very interesting discussion which is here given by Mr. Bell concerning the geologic and topographic conditions of this locality and its relationship to the glaciation of Scot-

*AMERICAN GEOLOGIST, vol. ii, pp. 375, 376, Dec., 1888.

land, which he thinks to have been quite probably continuous but with fluctuations in the extent and thickness of the ice, makes it wellnigh sure that the Chapelhall shells are like those observed in drift sections near Flamborough head by Mr. G. W. Lamplugh, occurring in fragments and shreds of marine beds eroded from a sea bottom over which the ice-sheet advanced upon the land. Sir Archibald Geikie also now regards the Chapelhall locality as insufficient to prove former marine submergence there.

The Anorthosytes of the Minnesota Shore of Lake Superior. By ANDREW C. LAWSON. Bulletin No. 8, Geol. and Nat. Hist. Survey of Minnesota, 1893, pp. 1-23 (part I), with eight plates. The gabbro formation, whose outcrops on the lake Superior coast are the subject of this paper, reaches from Duluth north and east in a belt probably averaging 20 miles wide to the vicinity of the Pigeon river on the international boundary. It is mostly separated from lake Superior by a similar width of the overlying Keweenawan series, beneath which its eroded surface has in some sections rounded, dome-shaped outlines, and occasionally rises boldly, as in Carlton peak, hundreds of feet above the adjacent only slightly tilted Keweenawan beds. This gabbro consists almost entirely of plagioclase feldspar, ranging in composition from labradarite to anorthite, for which class of rocks the name anorthosytes is used by Prof. Frank D. Adams in a memoir, very recently published, describing their occurrence in Canada.* The anorthosytes north of lake Superior were regarded by Irving as the lower part of his Keweenawan series, but Dr. Lawson shows that their pre-Keweenawan erosion and their contribution of boulders at many places to those overlying beds relegate the anorthosytes to an earlier period. Their coarsely crystalline structure, furthermore, in connection with their well established igneous origin, points to the cooling and crystallization of this magma at a considerable depth, from which its overlying portions or higher beds of other rocks were removed by denudation as a land surface before the deposition of the Keweenawan. For this great formation of deep-seated igneous rock, which belongs to the class called batholites by Suess in analogy with the smaller intrusive laccolites of Gilbert, Dr. Lawson proposes the name Carltonian and tentatively correlates it with the Norian of the province of Quebec. Its age is regarded as Archean, and the time of its exposure by erosion is believed to be the great interval which everywhere appears to widely divide the Archean and Paleozoic eras. With this reference of the gabbro to so early time, the Keweenawan series north of lake Superior has probably a maximum thickness of no more than 2,000 feet, instead of the very much larger thickness which Irving claimed for it.

The Laccolitic Sills of the Northwest Coast of Lake Superior. By ANDREW C. LAWSON. In pages 24 to 48, which form the second part of the foregoing bulletin, Dr. Lawson discusses the character and origin of the trap sheets interbedded with the Animikie and Nipigon sed-

*Ueber das Norian oder Ober-Laurentian von Canada. Stuttgart, 1893. (Reviewed by Dr. A. C. Lawson in Science, May 26. 1893.)

imentary strata from Pigeon river and the northeastern border of Minnesota to Port Arthur and Thunder, Black and Nipigon bays. Previous observers have considered these extensive trap sheets as overflows; but from many observations Dr. Lawson maintains that none of them associated with the Animikie formation are of that character, but that they are all intrusive in their origin and are of the nature of laccolitic sills. Some of these sheets reach beyond the Animikie and cap mesa-like hills and cliffs of the later Nipigon or Keweenawan series. There, likewise, they were evidently intrusive sheets, so that their date was later than both the Animikie and Nipigon periods. The author names these intrusive trap beds the Logan sills in honor of Sir William E. Logan.

The Norian of the Northwest. By N. H. WINCHELL. The preface of the bulletin containing Dr. Lawson's papers consists of 32 pages by Prof. Winchell, reviewing the history of investigations of the gabbro north of lake Superior and comparing it with the gabbros at the base of the Keweenawan in the typical region of Keweenaw point and in parts of northern Wisconsin. Their correlation with the similar anorthosyte formations in eastern Canada, where they were studied by Logan and Hunt and named by the latter geologist Norian from their fine development at Esmark, Norway, and in New Hampshire where Prof. C. H. Hitchcock recognizes them in the district of the White mountains, is regarded as so highly probable that the application of the name Norian is advocated for their occurrence in the Northwest. Professor Winchell further discusses the relationship of the gabbro and anorthosyte rocks of northeastern Minnesota with certain red metamorphic sedimentary rocks of the Animikie series, which in extensive belts appear to have been the result of fusion by the igneous agencies producing the gabbro. This view would place the age of the gabbro later than the time suggested by Lawson, so that perhaps, in the opinion of Prof. Winchell, the gabbro may have been the deep molten magma from which the the diabase outflows in the Keweenawan series were derived, as suggested by Irving. If this be true, the unconformity of the latter in some places upon the former and derivation of boulders from it imply that the Keweenawan period comprised stages of land oscillation and considerable subaerial erosion. But Prof. Winchell notes the occasional occurrence of detached masses of the anorthosyte rocks having as large dimension as 200 feet enclosed within a matrix of the Keweenawan diabase; and he inclines to the belief that usually or perhaps always where the anorthosytes occur in place they are separated from the Keweenawan by intervening Animikie beds, which often are much metamorphosed.

Republication of Conrad's Fossil Shells of the Tertiary Formations of North America. By GILBERT DENNISON HARRIS. Washington, 1893. 121 pp., 20 pls.

It is a curious fact that a work so indispensable to students of American Tertiary paleontology as Conrad's "Tertiary Fossils" should be so rare that few even among specialists in that field are fully aware of the degree of incompleteness of the copies they may be able to consult. It is, indeed, surprising to learn that among the fourteen copies which Mr. Harris has located in the principal libraries and private collections of our country, not one complete edition has been found, a remarkable circumstance, which, while it has long made desirable the republication of Conrad's work, constitutes at the same time an unfortunate reminder of a painfully bitter scientific controversy between two able and distinguished co-workers. Besides an important table of contents and the introduction which includes several pages of very valuable bibliographic information gathered during a long and painstaking search of the extant copies and among library records, this "republication" contains the entire work as published by Conrad, consisting of the following parts: No. 1, probably published at about the date given, Oct. 1, 1832, with both the original and revised forms of dedication and preface; No. 2; No. 3, dated August, 1833 on the front cover, and Aug. 24 on the back cover, probably distributed about the first of September, and republished by Capt. Vogdes in 1879; No. 4, dated Oct. 1833, on the front cover, Nov. 1 on the back, probably distributed about the 26th of November, and reprinted by Capt. Vogdes in 1879; and the much enlarged and illustrated republication of No. 3, dated March 1, 1835, with both the original and revised forms of the "Observations on the Eocene deposits of the United States," the original (the more common form) having been published about March 1, 1835, while the revised form, from data obtained by Mr. Harris, is believed by him to have been published in 1836 or 1837. In preparing the present edition Mr. Harris has reproduced the various parts and editions with original pagination, lining, italicising, punctuation, orthography, capitalization, and with covers of the original color, bound in place, together with excellent lithographic reproductions of the eighteen original plates, so that this "republication" is essentially a fac-simile edition of all the parts in all the different forms that Conrad ever published under the above title. For convenience of reference the whole volume is supplied with a running pagination bracketed at the bottom of the pages. Properly speaking, the original work of Conrad ends with page 56 of the revised third part and plate 18, but Mr. Harris has further increased the value of the volume by including an index and two additional plates found in a so-called appendix to the copy in the Museum of Comparative Zoology at Cambridge, Mass. Plate 20 is numbered very faintly on the original, and all the figures but one, which is evidently *Cytherea nuttalii* Con., are named in lead pencil on the plates. Mr. Harris regards these plates as possibly "proofs for a contemplated number that should embrace a revision of the Claiborne bivalves similar to that of the univalves (Republication of No. 3.)" It is wholly unnecessary to remark on the value of or interest in this complete republication. Paleontologists and geologists are greatly indebted to the painstaking and ability as well as the enterprise, coupled with considerable financial risk in a work of this nature, with which Mr. Harris has prepared this excellent presentation.

RECENT PUBLICATIONS.

I. State and Government Reports.

U. S. Geol. Survey. Mineral Resources of the United States, D. T. Day. 1891.

U. S. Geol. Survey. Bulletin 85, Correlation papers. The Newark System, I. C. Russell. 1892.

II. Proceedings of Scientific Societies.

Proc. Ala. Indus. and Sci. Soc. Vol. II, 1892, contains: The Ultimate Composition of Some Alabama Cokesley, Wm. B. Phillips; Alabama Bauxite, H. McCalley; The Clays of Alabama, E. A. Smith; Surveying and Opening Mines, G. H. Montgomery.

Proc. Acad. Nat. Sci. Philadelphia, Pt. I, 1893, contains: Metamorphism of Sedimentary Rocks, J. Wilcox; Notes on some Minerals and Rocks, E. Goldsmith; Notes on the occurrence of Quartz and other Minerals in the Chemung measures near the line of Lycoming and Tioga Counties, Pa.

Philosophical Soc. of Washington. Bulletin Vol. XII, pp. 241-292, contains: The Moon's Face, a Study of the Origin of its Features, by G. K. Gilbert.

III. Papers in Scientific Journals.

State School of Mines Scientific Quarterly, Golden, Colo., Sept., 1892, contains: Ore Deposits of Newman Hill, Rico, Colo., J. P. Farish. Dec., 1892, contains: Notes on the Treadwell Mine, H. P. Cushing; Vein and Mine Sampling, H. R. Wood.

School of Mines Quarterly, April, 1893, contains: Description of the Topographic Work of the U. S. Geological Survey, G. F. Sherman.

Can. Rec. of Sci. Vol. V, No. 6, contains: Trematobolus (an articulate Brachiopod of the Inarticulate order), G. F. Matthew; A Visit to Lake Superior Mines, W. A. Carlyle.

Amer. Naturalist, May, 1893, contains: New Discoveries of Fossil Mammalia of Southern Patagonia, Florentine Ameghino.

Jour. of Geol. Feb.-Mch., 1893, contains: An Historical Sketch of the Lake Superior region to Cambrian Time, C. R. Van Hise; The Glacial Succession in Ohio, F. Leverett; Traces of Glacial Man in Ohio, W. H. Holmes; The Volcanic Rocks of the Andes, J. P. Iddings; On the use of the terms Poikilitic and Micropoikilitic in Petrography, Geo. H. Williams.

IV. Excerpts and Individual Publications.

Trematobolus. An articulate Brachiopod of the Inarticulate Order, G. F. Matthew. Can. Rec. of Sci., Jan., 1893.

A Geological Reconnoissance in the vicinity of Gouverneur, N. Y., By C. H. Smyth, Jr. Trans. N. Y. Acad. of Sci. Vol. XII. Apr., 1893.

Geology and Mineral Resources of Kansas, Robt. Hay. From 8th Biennial Report of State Board of Agriculture. '91-92.

On the Evolution of the Earth and Heavenly Bodies, Joseph Wilcox. Read before Deleware Co. Inst. Sci. Dec., 1892.

Review extraordinary of "Man and the Glacial Period," by a member of the U. S. Geol. Survey, with annotations and remarks thereon by Judge C. C. Baldwin.

The Interpretation of certain verses of the first chapter of Genesis in the light of Paleontology. H. C. Chapman. Proc. Acad. Nat. Sci. of Philadelphia. Feb., 1893.

On a series of Peculiar Schists near Salida, Colo. Read before the Colo. Sci. Soc. Jan., 1893. By Whitman Cross.

The overturn of the Lower Siberian Strata in Rensselaer Co., N. Y. Dr. A. S. Tiffany.

A Sodalite-Syenite and other Rocks from Montana, by W. Lindgren and analyses by W. H. Melville. From Amer. Journal of Science, Vol. XLV. Apr., 1893.

Cretaceous and early Tertiary of Northern California and Oregon, by J. S. Diller. Bull. Geol. Soc. of Amer., Vol. 4, pp. 205-224.

Acmite Trachyte from the Crazy Mountains, Montana, J. E. Wolff and R. S. Tarr. Bull. Mus. Comp. Zool. at Harvard College, Vol. XVI, No. 12.

On Phosphate Nodules from the Cambrian of southern New Brunswick, W. D. Matthew. Contr. from the Geol. Dept. of Columbia College, No. IX.

Notes on the Gasteropoda of the Trenton Limestone of Manitoba, with a description of one new species, J. F. Whiteaves. Can. Rec. of Sci.. Apr., 1893.

Notes on some Minerals and Rocks, E. Goldsmith. Proc. Acad. Nat. Sci. of Philadelphia. 1893.

Geological and solar Climates. A Thesis. M. Manson.

The Production of Iron Ores in 1892, J. Birkinbine. Extract from "Mineral Resources of the U. S. for 1892." D. T. Day, Chief of the Division of Mining Statistics and Technology.

V. Foreign Publications.

The Water Supply of the Metropolis, G. F. Harris, Proc. Soc. of Amateur Geologists, Vol. I, No. 3.

Catalogue Illustré des Coquilles Fossiles de l' Eocene environs de Paris, par M. Cossman, Annales de la Societe Royale Malacologique de Belgique, Bruxelles, 1886-1892, by G. F. Harris, Geol. Magazine, III, Vol. X, No. 344, p. 75, Feb., 1893.

A Revision of the British Fossil Cainozoic Echinoidea, J. W. Gregory, Proc. Geol. Assoc., Vol. XII., Nos. 1 and 2, July, 1891.

Elements de Paleontologie, par F. Bernard, Asst. au Mus. d' Histoirie Naturelle, Premiere partie (p. 1-528).

Contributions to Canadian Palæontology, Vol. 1, Pt. 4, by J. F. Whiteaves; The fossils of the Devonian Rocks of the Islands, Shores, or immediate vicinity of Lakes Manitoba and Winnipegosis.

Verhandlungen der Gesellschaft fur Erdkunde contains: Herr Dr. Theodor Wolf; Ueber das Westliche Tiefeand, Ecudors, Band XIX, Nos. 9 and 10, 1892.

Zeitsch. d. Gesell. fur Erdkunde, zu Berlin, Band XXVII, No. 4, 1892, contains: Die Kordillerenpasse zwischen der Argentinischen Republic und Chile vom 22° bis 35°, S. B., von Prof. Dr. Ludwig Brackebusch. Band XXVII, No. 5, 1892, contains: Die Gebirgsformen im subwestlichen Karnten und ihre Entstehung, von Dr. Fritz Frech.

Zeits. fur praktische Geologie for April contains: Bildung von Erzlagerstatten durch Differentiations processe in basischen Eruptivmagmata, by J. H. L. Vogt; Betrachtungen und Beobachtungen über die entstehung von Goldlagerstätten, W. Moricke; Die Mineralkohlen in Russisch-Asien (schluss), by R. Helmacker; Die Tropfsteinhohlen bei Rubeland im Harz und ihre entstehung durch unterirdlische Wasserwirkung, by J. H. Kloos.

Measurement of Geological time. T. M. Reade, Geol. Magazine, Decade III, Vol. X, No. 345, March, 1893.

Folds and Faults in the Devonian Rocks. H. Hicks, Geol. Magazine, Decade III, Vol. X, No. 343, Jan., 1893.

The Mineral Waters of Canada. H. P. H. Brumell, Ottawa Naturalist, Feb. and Mch., 1893.

VI. Proceedings of Scientific Laboratories, etc.

Bulletin of the Amer. Mus. of Nat. History, Vol. IV, 1892, contains: Osborn and Wortman on Fossil Mammals.

PERSONAL AND SCIENTIFIC NEWS.

Cope on Palæolithic Man.—In an article on the genealogy of man in the April number of the American Naturalist Prof. Cope concludes thus: "The flints which were discovered in the stratum of cave-deposit containing the human remains (at Spy, in Belgium) are of the palæolithic type known as Mousterien in France, which are of later origin that the Chelléen or older palæolithic. It is interesting to observe that these flints are of the same form as the obsidian implements which I collected at Fossil lake in Oregon, with the bones of extinct llamas, horses, elephants, sloths, etc. The animals which accompanied the man of Spy are:

Cœlodonta antiquitatis,	Woolly Rhinoceros,
Equus caballus,	Horse,
Cervus elaphus,	Red Deer,
Cervus tarandus,	Reindeer,
Elephas primigenius	Mammoth,
Ursus spelæus,	Cave-Bear,
Meles taxus,	Badger,
Hyæna spelæa,	Cave Hyæna.

Five of these are extinct and four still exist.

As the evidence now stands the most primitive and simian of human races inhabited Europe. No trace of the Neanderthal race has been found in any other region. As, however, palæolithic implements are found in all continents we may anticipate that this or some similar species of man will be discovered there also."

MR HAROLD W. FAIRBANKS, of Berkeley, California, has been appointed again on the staff of the Mining Bureau.

MISS FLORENCE BASCOM HAS RECENTLY RECEIVED the degree of Ph. D., at Johns Hopkins University after a course of study in inorganic geology and paleontology. Her thesis on the volcanic rocks of South Mountain was prepared last summer during a stay at Monterey Springs. It involved a careful examination of a mountainous area five miles square, during which Miss Bascom was the object of much curiosity on the part of the natives, who dubbed her "the stone woman." The results of her work have attracted much attention, and will soon be published in full.—*Baltimore Sun.*

While Miss Mary E. Holmes, whose work was reviewed in the GEOLOGIST, Vol. I, p. 60, seems to have been the first lady to receive the degree of Ph. D. in this country for a course of study entirely geological, the same having been given by the University of Michigan, Miss Bascom has certainly not had many other predecessors.

THE TEXAS GEOLOGICAL SURVEY received an appropriation of $20,000 per year for two years, but the governor vetoed that for the second year. The work, therefore, is likely to stop after March 1, 1894. We regret that politics sometimes operates disastrously on such public measures. Such an enterprise has to be kept above the political intrigues of party, but for that very reason it is considered legitimate prey for any shortsighted "economist" to try his hand on. The Texas survey has blossomed like a rose in a desert, amid sands and cyclones, and it ought to be fostered by every true friend of progress in that great state.

AN IMMENSE GALENA NUGGET has lately been discovered in the Slocan district, West Kootenay, British Columbia. It is on a mountain side 4,150 feet above the sea. When the moss, stones and earth were removed its dimensions were found to be 10 ft. 9 in. by 7 ft. 9 in. by 8 ft. 6 in., 30 feet in circumference. Its weight is about 175 tons, and its actual value, when smelted, largely because of the silver it contains, will be about $35,000. It had fallen from a large vein seen higher in the mountain.

THE AUSTRALIAN INSTITUTE OF MINING ENGINEERS has recently been organized, and its first meeting was held at Adelaide. It promises to become in Australia as successful and influential as the American Institute of Mining Engineers is in America. Its rules and general scheme of organization resemble those of its American prototype. The officers are:

SIR HENRY AYERS, *President.*

JOHN HOWELL, H. H. SCHLAPP, PROF. TATE, *Vice-presidents.*

URIAH DUDLEY, *Secretary.*

E. D. CLELAND, *Treasurer.*

THE PROCES-VERBAL OF THE INTERNATIONAL COMMISSION of the geological map of Europe, issued by the secretary, Prof. E. Renevier, gives the essential results of the meetings held at Lausanne, September 27th and 28th, 1892. These meetings were attended by MM. Beyrich and Hauchecorne from Berlin, Karpinsky from St. Petersburg, Michel-Levy of Paris, Torell of Stockholm, Capellini of Bologne and Renevier of Lausanne. Considerable progress has been made on the great map. M. Hauchecorne presented a general chart showing the condition of the work. M. Capellini promised the immediate delivery of three of the Italian sheets. On motion of Michel-Levy the word "protogine" was removed from association with gneiss in the legend. M. Karpinsky presented a geological chart of Russia prepared by the Geological Committee, on a scale of 2,500,000 which is about to be published, and read a paper explanatory of the terms of the legend. He also exhibited an unpublished geological map of the southwestern part of Russian Poland, on a scale of 100,000. M. Torell exhibited the geological map of Sweden, colored upon the topographical base of the international map. It requires yet to decide several questions of detail, and particularly to distinguish the true granites from the general ensemble of the other crystalline rocks. It was decided that there ought to be an understanding between MM. Reusch of Norway, Torell of Sweden, Moberg of Finland and Karpinsky of Russia, so that these countries may be shown in the same style, especially in whatever pertains to the crystalline rocks and the glacial deposits. The Russian map, presented by Karpinsky does not show the southern limits of the western glaciation, but the commission determined that it would be necessary to indicate this on the international map, to continue it into western Europe, and likewise to express the extreme limits of the moraines about the Alps, and of other mountain ranges that have had glaciers.

The Commission, at the instance of Hauchecorne, determined to urge forward the printing of the map as fast as possible, and pledged itself to publish the first five sheets by the date of the Congress of 1894. The next session of the Commission will be held in Berlin in September, 1893.

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VOL. XII. AUGUST, 1893. No. 2.

THE RECENTLY FOUND CASTOROIDES IN RANDOLPH COUNTY, INDIANA.

BY JOSEPH MOORE, Richmond, Ind.

PLATE III.

I. *Introductory Notice.*

In the Journal of the Cincinnati Society of Natural History, Nov., 1890, appeared an article concerning a skeleton of the "Great Fossil Beaver," *Castoroides ohioensis*. The main part of said article was devoted to anatomical description. As the structural details have already been given, it is hardly desirable to repeat them here, but rather to give some items that may be of more general interest to the reader.

Since the contribution to the Cincinnati Journal was made there has been further opportunity for study and comparison and the missing parts have been restored and mounted by Prof. Ward, of Rochester, N. Y. The entire specimen as represented in the accompanying photograph is in the museum of Earlham College, Richmond, Indiana.

II. *Locality and Character of Ground.*

Randolph is in the eastern tier of the counties of Indiana about midway north and south.

About six miles nearly east of Winchester, the county seat, and about the same distance southwest of Union City, is the farm of Jno. M. Turner, on which the remains were found. The farmers of the neighborhood were opening a large ditch to drain a swampy tract, locally known as "the dismal." The ditch is over seven miles long, six to ten feet deep, ten feet wide at top and five or six at the bottom.

In the region of the find, the first three to four feet consist of dark loose mould abounding in fragments of shrubby stems and vines in various stages of decay. Below this is a layer two or three feet deep, of fine-grained, gray marly silt, about half the weight of which, when dry, is soluble in hydrochloric acid. This layer, in which the bones were bedded, contains, more or less perfectly preserved, various species of small gasteropods and bivalves common to our fresh water marshes. Underneath this light colored sediment are coarser and finer drift gravels which form the bottom of the ditch. The tract drained is near the divide between the head waters of White River, Ind., and the western tributaries of the Miami in Ohio.

III. What was Found.

(1) Of the head—

(*a*) Upper maxillaries, complete, with all the teeth except the right posterior molar.

(*b*) The vomer.

(*c*) The right nasal.

(*d*) The right malar process.

(*e*) The palatines.

(*f*) Enough of the basi-sphenoid to show the anterior portions of the pterygoid fossæ.

(*g*) The lower jaw perfect with all the teeth.

(2) Of the cervical vertebræ there are three, viz: Atlas, axis, and No. 3, completely co-ossified with the axis.

(3.) Dorsal and lumbar vertebræ, nineteen, the full number.

(4) The sacral vertebræ, four, the full number, and well consolidated.

(5) Caudal vertebræ, fourteen, as follows: 1, 2, 3, 4, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17. (Whole number about 25.)

(6) Sternum, two pieces, the pre-sternum and the xiphisternum.

(7) Ribs, twenty-four.

(8) Scapulæ, both present but broken. They each show, however, the glenoid cavity, the spine and the processes.

(9) Clavicles, both perfect.

(10) Humeri, both perfect.

(11) Radii and ulnæ present, right and left.

(12) Femora, both perfect.

(13) Tibiæ, both perfect.

(14) Fibulæ, both present but broken loose from the tibiæ and each lacks the upper epiphysis by which it attached to the larger bone. (The tibia and fibula are fused together along their lower third, the same as in the leg of the musk-rat.)

15) Right hind foot—

  (*a*) Astragalus.
  (*b*) The five metatarsals.
  (*c*) The first phalanx of the third digit.

(16) Left hind foot—

  (*a*) Astragalus and calcaneum.
  (*b*) The I, III, IV and V metatarsals.
  (*c*) The first phalanx of the third digit and the first and second of the fourth digit.

Some of the parts now lacking would doubtless have been found had there been some one to oversee the digging who had experience and a sense of their value.

IV. Of the Missing and Broken Parts.

These, in the main, are indicated by the parts not already herein named. The gaps most to be regretted are made by the absence of the brain cavity and of the fore feet. As to the cranial region it is fortunate for science that there are at least two pretty well preserved skulls known, viz: the Clyde skull of Wayne county, New York, and another larger one, now in the Smithsonian collection, from Lenawee county, Michigan, presented by Dr. Kost. Of the fore feet no fragment appears ever to have been reported. In the restoration they are modeled after the forefeet of Castor.

Any one who notes in detail the points of correspondence between the known parts of the hind feet of Castoroides and the homologous parts of Castor, can hardly conclude that the fore feet of the former could be other than very similar to the same members of the latter.

Numbers 4, 5, 6 and 7 of the cervical vertebræ were not found.

Of the caudal vertebræ numbers 5, 6 and 8 of the larger pieces and all the smaller pieces beyond number 17 are wanting. Of these smaller terminal pieces there were almost certainly as many as eight, making twenty-five in all.

Of the hind feet neither of the cuboids and none of the cuneiforms or other smaller tarsals were found, but from the articular surfaces of the calcaneum, the astragalus and the proximal ends of the metatarsals, their size and nature are reliably determined. The other absent portions of the hind feet are indicated by the omissions in the parts already named. Enough are in hand to show all the characters of these skeleton feet except that none of the distal phalanges were found. There is sufficient basis however for a very reliable inference as to their form and size.

There are indications that the larger and medium sized tail vertebræ bore on their under sides the chevron bones characteristic of a number of species of vertebrates, but of these none were preserved.

V. *Some Special Points of Structure.*

The double posterior nares may well be noted by all who write the cranial anatomy of Castoroides, since, in all the domain of the mammalia through their whole range in time we find no other species presenting the same structural feature. Look at the basal region of a skull of the ground hog (Arctomys monax) and you will note that the internal pterygoid blades *approach* each other *slightly* near their middle. Imagine them to be plastic so that you can press them together in the middle making them weld but leaving them separate fore and aft, and you will have essentially the double posterior nares of Castoroides; the one antero-inferior, the other postero-superior.

The compound character of the molars, though by no means peculiar to the species, may still be worthy of note here. These teeth are severally made up of three to four flattened cylinders of enamel enclosing dentine and surrounded by cement by which they are held together. They are quite similar in this respect to the grinders of the Mammoth except that in the latter the numerous plates, in addition to being cemented together are united to a common basement near the fangs.

In Castoroides the plates are nowhere so joined but that by the weathering of the cement they may fall entirely apart.

There is no semblance of fangs to these grinders, but each tooth is set as a simple tenon in a mortise.

I have no means at present of making a general comparison but I know of no other rodent with upper incisors so nearly surrounded with enamel. Instead of simply a plain enamel plate in front, as in the beaver and many other species of this order, we here have the grooved, striated and cross-wrinkled enamel, not only in front but over the outer, and part of the back surfaces. From this structure the crowns, instead of being beveled like a chisel tend to wear irregularly cup shaped with the proximal border lowest.

The third cervical vertebra is so completely fused to the axis as to have no neural spine of its own. So close and so unsuspected was the union that the fact was for some time overlooked. Is it an exceptional case, or is it a mark of the species? It does not appear like an ordinary instance of ankylosis such as we occasionally see in the dorsal or lumbar vertebræ of old horses, but to have more of the connate character of the cervical vertebræ in most cetaceans.

The hind feet are very large, and from the divergence of the metatarsals and their well-rounded distal extremities, the long toes admitted of a great spread and were almost certainly webbed. The forelegs are not only so constructed as to admit of being very closely flexed at the elbow joint, but afford evidence that they were much of the time in that position.

VI. A few Measurements.

The entire length of the spinal column, as restored, including the head, is six feet two and a half inches. The length with the curves, as it stands mounted is five feet four inches. Length of head eleven and a half inches. The tail is two feet, nine inches, which is three inches longer than the cervical, dorsal, lumbar and sacral series taken together. The hind foot measures eleven and a quarter inches. Entire length of upper incisors, following the anterior curve, is nine and one-half inches and their projection from the sockets, in front, is full 3½ inches. The lower incisors are 10¾ inches long and project 5¼ inches.

This skeleton, though probably that of a well-matured individual, does not represent the largest size which the species attained.

Its head is not so large as one already spoken of, in the United States museum at Washington. A fragment of the right half of a lower jaw found many years since at Memphis, Tenn., and described by Dr. J. Wyman, shows a decidedly more massive series of grinders.

VII. Fragments from the Same and Other Localities.

The nearly complete skeleton thus far considered we will call No. 1.

No. 2. The distal end of a right lower incisor. This fragment is near four inches in length and has the crown badly hacked, scarred and striated by its antagonist. The enamel is flaked off anteriorly for near two inches backward from the cutting edge, showing the glossy grooved surface of the dentine. This fragment indicates an animal much smaller than No. 1, and was picked up quite remote from it.

No. 3. Five scraps of enamel with adhering dentine, sizes from half-inch square to one by one and a half inches, found near locality of No. 1. These clearly indicate, by the coarseness of the striæ and the width of one of the pieces, a very large upper incisor.

No. 4. A right humerus, well-preserved, except that the proximal epiphysis is wanting. This indicates a creature for size about equal to No. 1.

No. 5. The distal $\frac{3}{4}$ of another right humerus indicating an animal larger than No. 1.

No. 6. A left calcaneum, perfectly preserved and having a clean, fresh look. This also indicates a larger specimen than No. 1 and may or may not belong with No. 5.

No. 7. The proximal extremities of radius and ulna, each about two inches long, showing articular surfaces perfectly, and indicating a full sized animal.

No. 8. The proximal $\frac{1}{3}$ of a right fourth metatarsal.

No. 9. The proximal end, three inches long of the right third metatarsal. This bone is larger than its homologue in No. 1.

No. 10. A fragment of an atlas showing perfectly the articular surfaces on one side.

No. 11. The third caudal vertebra in good state of preservation and indicating a much smaller specimen than No. 1.

No. 12. Four inches of a right illium including the acetabulum nearly complete, and bearing two inches and more of the pubic arch. This shows the trihedral form of the illium and bears the rough, articulating surface by which it joined the sacrum.

(Nos. 1 to 8 were all found either in the ditch or along the banks where the diggings were spread over the ground on either side, and all, with probably one exception, within a range of 80 rods along the banks. As a number of them were picked up by boys who worked the adjoining fields we cannot rely on the exact localities. I believe them to represent at least nine individuals, which may be suggestive of a colony.)

No. 13. I have in trust a left lower incisor, 11½ inches long almost perfect. This belongs to Dr. J. W. Joy, of Richmond, Ind. It was found some years since near Greenville, Darke county, Ohio, in company with Mastodon remains. A description of this tooth by Dr. F. W. Langdon, of Cincinnati, was published in the Journal of the Cincinnati Society of Natural History, Vol. 6, page 238.

No. 14. A fragment of an upper incisor which I picked up in Wayne county, Ind., two miles east of Richmond, where a farmer was scooping out the wet earth for a fish pond. This was found along with sound teeth and decayed bones of the Mastodon.

No. 15. A fragment of an upper incisor from near Sonora, Preble county, Ohio, said to have been found with remains of Mastodon.

No. 16. Two to three inches of an upper incisor in the state cabinet at Indianapolis. Locality not given in the Indiana Report.

No. 17. Remains found near Greenfield, Indiana, Hancock county. These belong to a Dr. Adams, who had sent them to a specialist for examination so that I failed to see them.

I copy the following from "Monograph of North American Rodentia." Coues and Allen, United States Geological Survey of Territories. Hayden, 1877, Vol. XI, page 424.

"The remains of Castoroides ohioensis thus far reported, (1876), consist of the right ramus of the lower jaw and an upper incisor from Nashport, Licking county, Ohio, (from which the animal was originally made known) first described by Foster; the skull and the right ramus of the lower jaw from Clyde, Wayne county, New York, described (and the skull figured) by Wyman, the ramus of a lower jaw from Memphis, Tennessee, also described and figured by Wyman; two molars, an upper incisor and two petrous bones from near Shawneetown, Illinois, and fragments of teeth from the Ashley river, South Carolina, described by Leidy. A skull from near Charleston, Coles county, Illinois, is also mentioned by Leidy. Hall and Wyman both refer to the discovery of its remains near Natchez, Miss., and in Louisiana. Winchell mentions the discovery of remains in Michigan of which no description has yet appeared. In the Museum of Comparative Zoology, Cambridge, Mass., are portions of several lower incisors and parts of several molar teeth, from Dallas, Dallas county, Texas, collected by Mr. J. Ball, from 'alluvial' deposits on the Trinity river, associated with the remains of an extinct horse and the Mastodon. There is also in the Museum of Comparative Zoology an excellent cast of a very large skull from an unknown locality, but probably from either Illinois or Michigan."

(May not this be the skull now in the National Museum at Washington, from Lenawee county, Michigan?)

In the eighth report of the Minnesota Survey is an account of a large specimen of a lower jaw found at Minneapolis. The same is figured and described by N. H. Winchell, with some comparisons with former discoveries.

As to geographical range, the remains of Castoroides are found from South Carolina and Texas to Minnesota, Michigan and New York.

As to time, these largest of rodents living or fossil, were among the latest extinct mammals of the Quaternary.

A CRITICAL NOTICE OF THE STRATIGRAPHY OF THE MISSOURI PALÆOZOIC.

By G. C. Broadhead, State University, Columbia, Mo.

The Archæan includes the granites and porphyries of southeastern Missouri. They are intersected by dykes of diabase and dolerite, but in no instance have trap dykes been observed penetrating more recent formations.

Beds of coarse pebbly sandstone and of magnesian limestone are found reposing upon the Archæan without any alteration of the contact layers. We therefore conclude that there is unconformity between them, and there is a lost interval between the Archæan and the superincumbent terrane. One mile northwest from Fredericktown a section of strata shows as follows:

1—21 feet of dark ash colored magnesian limestone.
2—18 feet of white siliceous limestone.
3—23 feet of gritty dolomite.
4—40 feet of sandstone in thick beds.
5—2 feet of red shaly sandstone.
6—Reddish gray granite.

On Twelve-mile creek, in Madison county, the equivalent of No. 3 of the above section is seen resting upon two feet of variegated marble, which latter is separated from the porphyry below by five feet of shale. The unaltered strata dip eastwardly 15°.

On the west side of St. François river, near the mouth of Leatherwood creek, we find:

1—5 feet of magnesian limestone.

2—13 feet of gray dolomite.

3—11 feet of dolomite.

4—20 feet of marble beds. Strata dip 22°. Course, S., 65° W. The marble is of variegated red, buff, drab and gray.

On the St. François river, in Sec. 33, T. 34, R. 5 E., we find 65 feet of sandstone and conglomerate, containing rounded porphyry pebbles and resting on porphyritic granite. On the Mine La Motte tract sandstone is found below the magnesian limestones. At the head of Black river, in Iron county, two feet of limestone was observed resting on porphyry, with 40 feet of sandstone and conglomerate overlying it. Similar occurrences may be seen at Iron Mountain. On Marble creek, Iron county, a bed of 20 feet of reddish porphyry appears at the edge of the water with nearly 300 feet of unaltered magnesian limestone overlying it. Summing up, we find that the section of the older series in southeast Missouri is about this:

1—Magnesian limestone.
2—20 to 40 feet of gritty dolomite.
3—20 feet of Ozark marble and calcareous conglomerate.
4—40 to 90 feet of sandstone.
5—2 to 30 feet of red shales.
6—porphyry.
7—granite.

It is in the limestones of this series that the lead, nickel, cobalt and copper of Mine La Motte and the St. Joe mines are found. A few fossils are also found as *Lingulella lamborni* Mk., in shales at Mine La Motte, and *Lingula* and *Scolithus*, near Fredericktown, and *Obolella polita* near Polks. In Madison county and elsewhere in southeast Missouri other fossils were obtained from chert beds on the highest hills, whose position is probably either in the Second sandstone or just below. Other fossils were also found in residual masses of chert occupying a topographical position near the foot of the hills, but which are probably of the same geologic age as the other chert fossils. Among those fossils were observed *Orthis*, *Orthoceras*, *Murchisonia*, *Maclurea*, *Capulus*, *Straparollus*, *Lituites*, *Cyrtoceras*, *Ophileta*.

These lower limestones with the basal sandstone of Madison county may include over 300 feet, and seem evidently to be lower than the Third Magnesian limestone of central Missouri. The limestones may be the equivalent of Prof. Swallow's Fourth Magnesian. As. Prof. Swallow's Third sandstone has not been recognized in southeast Missouri it would be difficult to say where the Third ended and the Fourth begun. We may say Lower Magnesian or Third Magnesian. They are cavernous and many fire springs of water issue from them. They are the basal members of the Ozark series.

THE THIRD MAGNESIAN limestone is easily recognized by its peculiar subvitreous appearance. It is generally coarse grained, light colored and slightly bluish gray or flesh-colored, often cavernous, sometimes forming natural bridges. Most of the caves of southern Missouri occur in this formation and some of them are very handsome with numerous stalactites and onyx deposits. In Washington county it incloses numerous mammillary crystallizations of quartz, which seem to be secondary deposits in small cavities in the limestone. It is lead-bearing in southeast and central Missouri, the ore-bearing beds being chiefly within the Ozarks, and generally 30 to 40 miles from their margin. The limestone at the mines is often found decomposed. The lower Magnesian limestones, including the Third and Fourth, often occur in thick beds, as on the Niangua, Osage and St. François and their tributaries.

The third Magnesian limestone is well exposed on Little Piney and the Gasconade creeks at Clifty, Dry Creek, Paydown and the Narrows, and as far north on the Gasconade as Mount Sterling; and it is easily recognized. Friede's cave is in this limestone as also the "Natural Bridge" on Clifty creek. Below the mouth of Little Piney it is over 180 feet thick with the Second sandstone lying above it. The Second sandstone which overlies the Third Magnesian limestone, although rarely containing fossils is easily recognized by its position above the Third Magnesian and below the Second Magnesian, and cannot be confounded with the First sandstone (St. Peter's). The Second sandstone is coarser-grained than the First, is not so white and is more coherent. It is also sometimes quite useful for building purposes.

The Second sandstone occurs at many places in the Gasconade bluffs overlying the Third Magnesian limestone, being about 50 feet thick, near the hilltop at the mouth of Little Piney. Following down the Gasconade it descends lower in the hills as we approach Mount Sterling, where it soon dips beneath the horizon. Thence to the mouth of the Gasconade the prevailing rock is the Second Magnesian limestone and as we approach the Missouri, the First sandstone is seen high in the bluffs. The Second sandstone is often overlain by a few feet of siliceous cellular rock, as seen in Cole county and also in Webster. Referring to page 10 of Geol. Report of Missouri, 1855-71, we find several notices of the occurrence of the First sandstone on high ridges east of the Gasconade. The elevation of these ridges is between 1000 and 1200 feet above the sea. The Second sandstone is seen at Arlington at about 880 feet above the sea, or 200 to 300 feet lower, which would be about the thickness of the intervening Second Magnesian limestone, and the beds of Second sandstone on the Gasconade opposite these outliers is as low or lower. The two sandstones although apparently not far off horizontally, differ too much in their vertical position to be confounded.

The First sandstone is found near the hilltop at several places between the Gasconade and Washington. It is in the railroad cut at Gray's Summit and occupies the base of the hill at Pacific, at Horine and at Crystal City. At all of these places it is overlain by the well known First Magnesian limestone. The Second Magnesian limestone on which it rests is the rock seen all along the railroad from Washington to Jefferson city, and at Jefferson it reaches from the base to the summit of the hill. The lower beds are thick and densely crystalline and often cellular. Higher up are argillo-magnesian limestones, locally termed Cotton rock, and often separated by buff shales inclosing chert concretions, with sometimes a thin bed of white sandstone. Thin layers of Oolitic chert are occasionally found. *Lingula*, *Orthis Pleurotomaria*, *Straparollus*, *Ophileta*, *Murchisonia* and a trilobite have been found, and the limestones often seem to be made up of fucoids. Many of the limestones also emit a fetid odor when struck.

The section at Pacific shows:

1—Trenton limestone with Black river beds at the lower part.
2—First Magnesian limestone with *Cythere*.
3—100 feet of exposed First sandstone.

Just east of Pacific the sandstone dips beneath the horizon. In St. Charles county, just below Augusta, we have:

1—Trenton and Black river limestone.
2—First Magnesian limestone.
3—133 feet of Saccharoidal sandstone.

A little to the east the sandstone dips beneath the horizon. One mile west of Augusta the First sandstone rests upon the Second Magnesian limestone, and it is found in that position westwardly in Warren, Montgomery and Callaway, but becomes gradually thinner to the west, and in Callaway it often occurs as a pocket overlying older rocks. At West Point, Ill., the succession is the same as that observed at Pacific and at Augusta. At Westpoint the sandstone occupies the base of the bluffs for one mile, and shows 75 feet thickness. It is also here soft and white and it has been referred by Prof. Worthen to the age of the St. Peter sandstone. It is overlain here by 75 feet of First Magnesian limestone with Trenton limestone above, containing well known Lower Silurian fossils.

At Jones Siding, Ralls county, the sandstone is barely exposed at the foot of the hill, but the overlying limestones exactly resemble those seen at Westpoint, Illinois, nearly 100 miles distant. In the insane asylum well, St. Louis, the First sandstone (St. Peter) was reached at about 1,400 feet, and its measured thickness found to be the same as that observed at Augusta, over 30 miles distant. On L'outre river, near the line of Callaway and Montgomery, the succession is: (1) Trenton, (2) First Magnesian, (3) the First sandstone. About three feet of the upper portion is found here to be vertically columnar, seemingly as if worn by water, or as ice appears on the edge of a melting block. West of central Missouri the St. Peter sandstone and the first Magnesian limestone become thinner, and at some places are entirely wanting.

Partial List of Fossils of the Ozark Series.

	Lower Magnesian Limestone.	Third Magnesian Limestone.	Second Sandstone.	Second Magnesian Limestone.	First Sandstone.	First Magnesian Limestone.
Scolithus	x	x				
Trilobite, sp		x		x		
" sp		x				
Cythere						x
Lingula	x	x		x		
Lingulella lamborni	x					
Orthis		x	x			
Obolella polita	x					
Murchisonia caranifera		x		x		
" ozarkensis		x		x		
Loxonema				x		
Straparollus valvato formis		x		x		
Raphistoma subplana		x				
Ophileta		x	x	x		
Metoptoma	x	x				
Turbo	x			x		
Maclinea	x					
Pleurotomaria				x		
Endoceras		x				
Phragmoceras		x				
Orthoceras		x	x			
Lituites	x	x		x		

The annexed section of the well at the Insane Asylum, St. Louis, indicates four sandstones below the Second sandstone. The outcrops at the surface in southeast Missouri show three sandstones, the First, Second and the "Potsdam," at the base of the Ozark series. Prof. Swallow's general section includes three sandstones, from the First to the Third, inclusive, without counting their intercalated beds.

VERTICAL SECTION OF THE BORINGS OF THE ST. LOUIS, MISSOURI, INSANE ASYLUM WELL.

System.	Series.	Formation.	Description.	Thickness in feet.	Total from surface
Quaternary.		Loess............	Marly clay...........	40	40
			Clay and limestone, 21 ft......		
			Coal, clay and lime-stone, 25 ft.........		
	Mississippian Series.		Shales, limestone, coal and clay, 34 feet.....	80	120
		Lower Carbonifr's	Limestone with chert	670	790
		Chouteau Group..	Limestone with chert	93	883
Lower Silurian		Trent., Black Riv. and Birdseye.?	Limestones..........	......	......
			Limestones..........	421	1304
UPPER CAMBRIAN.	Ozark Series.	First Magn. lime.	....	148	1452
		First Sandstone...	Saccharoidal	133	1585
		Sec'nd Magn. lime.	....	517	2102
		Third Sandstone..	....	82	2184
		....	Limestone and chert	487	2671
		Third Magnesian limestone and its extension downward.	Limestone and sand stone (?)...........	172	2843
			Sandstone...........	37	2880
			Limestone...........	142	3022
			Sandstone	98	3120
			Magnesian slate......	13	3133
			Magnesian limestone. Some sandy beds at lower part.	371	3504
			Sandstone...........	41	3545
			Limestone...........	13	3558
			Sandstone with granite and feldspar pebbles (?).............	285	3843

LOWER SILURIAN. This may include Hudson River, Trenton and Black River beds.

No. 1. The Hudson River occurs as flagstones and shales in Lincoln and Pike and may be the source of the sulphur springs of those counties.

No. 2. The Trenton includes about 30 feet in the upper part of whitish limestone, the lower beds somewhat brown. These beds are often cavernous and are the equivalent of the Galena limestone of Illinois and Iowa, but in Missouri they are not lead-bearing. The chief fossils are *Chætites Lycoperdon*, *Receptaculites* and *Orthis Testudinaria*. I have not found the *Receptaculites* either above or below. On account of its presence Dr. Shumard applied the name Receptaculite to the limestone. It is found in Ralls, Pike, Lincoln, St. Charles, Warren, Montgomery, Jefferson, St. Louis and Cape Girardeau, and is extensively burned for lime.

No. 3. Includes about 100 feet of Trenton limestone, embracing many thin fucoidal beds. This is also somewhat cavernous. In the upper beds are many fossils, including *Murchisonia gracilis*, *M. bellicincta*, *Pleurotomaria lenticularis*, *Tellinomya*, *Edmondia*, *Modiolopsis*, *Endoceras proteiforme*, *Orthoceras*, *Strophomena*, *Orthis subæquata*, *Asaphus*, *Ceraurus*, *etc.*

No. 4. Includes about fifty feet of thickly bedded flesh colored and drab limestone with many calcspar specks. Black river beds.

THE UPPER SILURIAN is not an important factor in Missouri geology. Dr. Shumard reported a considerable thickness in Cape Girardeau and St. Genevieve. In Montgomery county we find on the streams flowing towards the Missouri about 20 feet of a coarse gray crinoidal limestone, very cavernous and containing but few fossils. At Paynesville, Pike county, upper Silurian corals are found and a *Tentaculites* in gray limestone. On Sugar creek, Pike county, are thick bedded buff magnesian limestones, resembling the well-known "Grafton rock."

THE DEVONIAN is found in Perry, St. Genevieve, Lincoln, Pike, Montgomery and Callaway. In the southern and eastern parts of Callaway are found numerous corals and well marked brachiapods. In Pike county at the base of the Devonian are found a few feet of a white oolite which Prof. Swallow has referred to the Onondaga, a division of the Corniferous. He mentions the occurrence of *Acervularia davidsoni* (See pp. 107 and 178 of Swallow's Geological Report, 1855). From his description of other rocks containing this fossil I have no doubt of its being the fossil that I have identified as *Acervularia davidsoni* in the Devonian of Warren and Callaway. Prof. Swallow mentions also having found other Devonian fossils in the oolite. Near Clarksville are found a few large rugose corals which appear to be Corniferous. Overlying the oolite at Louisiana are 5 feet of brown shales, and above them are a few feet of black shales. In eastern Missouri this slate has only been found in Pike and Ralls. It is supposed to lie at the top of the Devonian and to be equivalent to similar slates in Arkansas, Tennessee, Kentucky and Ohio. Numerous fossils have been found in the Devonian of the eastern and southern parts of Callaway county. About 19 feet of limestone containing *Favosites alpinensis*, appear at the water's edge at Providence, Boone county. Further up the river no Devonian is found. Near Otterville, in Cooper, similar fossils have been also found. This is the farthest limit west and southwest of the Devonian in Missouri.

LOWER CARBONIFEROUS OR MISSISSIPPIAN SERIES OF WINCHELL.

Mississippian series.	Genevieve Group...	Chester. St. Louis, Warsaw.
	Osage Group.......	Keokuk, Burlington.
	Chouteau Group....	Chouteau limestone, Vermicular sandstone, Lithographic limestone.

The *Chouteau* includes Chouteau limestone 100 feet, Vermicular sandstone and shales 75, and Lithographic limestone 55 feet. Some of the early geologists assigned what we have designated as the Chouteau to the Chemung of the New York geologists, basing their conclusions upon the presence of certain fossils which seemed to be Devonian. But further examination developing many Carboniferous forms, this group is now considered as belonging at the base of the Lower Carboniferous. Its representative or near ally is the Kinderhook of Illinois, and probably the Knobstone of Indiana and Kentucky, the Marshall group of Michigan, the Waverly of Ohio and probably part of the Vespertine of West Virginia.

We do sometimes observe a slight mingling of fossils near the junction of the Burlington and Chouteau, as in Green and Christian and elsewhere, but the lithological appearances will have to be more particularly considered. The lower Burlington beds are gray and brown, the upper Chouteau shaly blue and drab, and do not contain so many fragments of Crinoidea as does the Burlington. The beds of the latter are more often made up of crinoidal remains with intermingled shells of Brachiopoda. The Burlington beds are also generally traversed by stylolite bands.

The lithographic limestone is 55 feet thick at Louisiana and consists chiefly of thin layers of dove-colored, compact limestone, with a conchoidal fracture. The outcrops in the Mississippi bluffs include strata which are also exactly like the famous lithographic beds of Solenhofen, Bavaria. Fossils are of rare occurrence, but there are included a few species also found in the Chouteau limestone. On the Osage and Sac rivers is a bluff of Magnesian limestone which has been referred to the age of the Lithographic. At Taberville it contains *Pentremites rœmeri*, and other *Pentremites*. Prof. Swallow reports finding in it *Spirifer marionensis*, *Sp. Cuspidatus*, *Productus murchisonianus* (*P. shumardanus*), *Proetus missouriensis*, *Plumulites gracilis* and *Taonurus cauda-galli.* About one-half of the fossils found in the Lithographic beds are also found in the Devonian.

The *Vermicular* sandstones and shales contain nearly all typical Chouteau fossils. This formation reaches to 100 feet thickness in Pike county.

The term Vermicular was applied by Prof. Swallow on account of its being generally traversed in various directions by small worm-like windings. I have observed it presenting this appearance in Ralls, Cedar and Green and other counties. At Cedar Gap and Dunnigan's Mill, in Cedar county, it contains typical Chouteau fossils, including *Allorisma hannibalensis*, *Phillipsia* and *Entolium cooperensis.* The Chouteau limestone is generally of a dull drab or dove color. At Sedalia the course brownish-gray Burlington is separated by a few feet of fossil shales from the underlying Chouteau limestone. The Chouteau in this neighborhood contains numerous vermiform chert concretions. In some places it also contains small geodes having a rugose appearance. At Sedalia the top shales often abound in corals as *Mitchellinia placenta*, *M. convexa*, *Lithostrotion*, *Chonoplyllum sedaliense* and *Zaphreutis calceola*. Other fossils found in Pettis are* *Syringapora*, *Zaphrentis*, *Fenestella delicata*, *Phillipsia*, *Rhynchonella missouriensis*, *R. cooperensis*, *R. gregaria*, *Spirifer marionensis*, *Sp. lineatus*, *Sp. vernonensis*, *Sp. missouriensis*, *Retzia*, *Phillipsia merimacensis*, *Phœthonides*, *Chemnitzia*, *Euomphalus latus*, *Schizodus*, *Sphenotis contractus*, *Edmondia*, *Macrodon chemungensis*, *Cardiopsis radiata*, *Crenipecten ovata*, *Pernopecten sedaliensis*, *Grammysia ventricosa*, *Chonetes ornata*, *Cypricardinia consimilis*, *Mytilarca fibristriata*, *Pholadella newberriens*,

*Mr. R. A. Blair, of Sedalia, has kindly donated to me many of these fossils.

Palæoneilo bedfordensis, *Nucula houghtoni* and *Pernopecten circulus*, also several species of Productus and probably *Productella*.

A red limestone occurs in the Chouteau on the Merrimac, in St. Louis county. The Chouteau is rarely present in St. Charles, Warren, Montgomery and Callaway. It is better exposed in the Missouri bluffs in Boone county. The other members of the Chouteau have not been seen in these counties. The Chouteau limestone is also found on Cuivre River in Lincoln county.

The *Burlington* beds are easily recognized in northeast Missouri. The lower white beds are prominent in the bluffs at Hannibal and Louisiana. Where the upper beds are seen we find at top 10 to 17 feet of chert and red clay, as in the Missouri bluffs, St. Charles county. At Peruque on the Wabash road it is 17 feet thick. Prof. Swallow defined about 8 distinct groups and most of them are well exposed in the river bluffs in St. Charles county east of Femme Osage. At Columbia the upper 50 feet consists of gray limestone, then below are thick beds of coarse gray and brown limestone. The limestones are generally stylolitic and also contain many chert concretions. Fossils found at Columbia are: *Spirifer plenus*, *Sp. grimesi*, *Sp. striatus*, *Athyris lamellosa*, *Prod. punctatus*, *P. flemingii*. The lower beds contain *Euomphalus latus*, *Chonetes shumardana*, *Orthis swallovi*, *Or. mitchellini* and *Athyris incrassatus*; crinoidea are found throughout.

The Burlington beds are often cavernous and from the caves there flow many excellent springs.

In southwest Missouri the beds are not so easily separated from the Keokuk above, therefore Prof. H. S. Williams has offered the name of Osage to include the Keokuk and Burlington. Both are found on the Osage hills, hence the name seems appropriate.

In northeast Missouri the Keokuk contains shale beds inclosing large geodes as they do also in Illinois and Iowa. The Keokuk in southwest Missouri is largely made up of chert beds with some layers over 10 feet in thickness. Prof. Swallow thought that there was 100 feet of chert on Shoal Creek, Newton county.

The lead and zinc of southwest Missouri is mined in the Keokuk and there is often associated a good deal of chert.

The limestones at the mines are also often much broken and sometimes changed to dolomite. Very fine crystals of calcite occur at the mines. The Keokuk may be distinguished from the Burlington by a few characteristic fossils, as *Hemipronites crenistria* (*O. keokuk*), *Spirifer keokuk* and sometimes *Archimides*. The latter fossil is rarely found in southwest Missouri. Other fossils found in the Keokuk of Jasper county are *Orthis dubia*, *Productus cora*, *Prod. alternatus*, *P. altonensis*, *P. flemingii*, *P. setigerus*, *P. magnus*, *P. mesialis*, *P. wortheni*, *Sp. pseudolineatus*, *Sp. subcuspidatus*, *Sp. lateralis*, *Sp. incrassatus*, *Sp. logani*, *Sp. increbescens*, *Sp. tennicostatus*, *Rhynchonella mutata*, *Rh. subcuneata*, *Athyris roysii*, *Terebratula parva*, *Ter. trinuclea*, *Camoraphoria subtrigona*, *Zaphentis centralis*, *Amplexus*, *Phillipsia*.

The lower 20 feet of limestone at Boonville may be considered to be Keokuk, the shaly beds above with thin layers of limestone and abounding in fossils, including *Archimedes*, *Pentremites* and *crinoidea* may be of the Warsaw age. Similar beds are found on Salt river, Monroe county, northwest of Paris. At Moscow Mills, Lincoln county, are similar beds abounding in Archimedes and corals.

Genevieve Series. This name has been applied by Prof. H. S. Williams to the group of Lower Carboniferous rocks above the Keokuk, and includes the St. Louis and Chester or Kaskaskia groups. On the hills of Jasper and Newton, and at other places in northeast and southwest Missouri we often find quantities of loose chert, some of it seeming of Keokuk age, while other pieces indicate a more recent age. This chert contains many fossils, some of them in an excellent state of preservation. The chief fossils are *Amplexus*, *Pentremites conoideus*, *Actinocrinus*, *Batocrinus*, *Spirifer pseudolineatus*, *Spirifer increbescens*, *Athyris plano-sulcata*, *Rhynchonella subcuneata*, *Terebratula fusiformis*, *Productus cora*, *Athyris ambigua*.

The *St. Louis group* is better developed in St. Louis and St. Charles counties. It is generally thinly bedded, of pure limestone, close grained, drab or dove color, durable and affording a good foundation stone. Makes good lime, and some beds afford a cement stone. Other beds have been used for lithographic purposes.

This formation is sometimes cavernous and sink holes are often characteristic. A few fossils have been obtained here which have not been found in other formations as *Productus marginicinctus*, *Lithostrotion canadense*, *L. proliferum*, *Melonites multipora* *Poteriocrinus longidactylus*.

Certain quarries in St. Louis have afforded fine crystals of millerite, calcite, fluorite and dolomite. The Chester group may be only found in St. Genevieve county. At the top of the Missouri Lower Carboniferous are found certain sandstone beds, of a buff or drab color, in St. Genevieve, where it affords an excellent building material. Of a similar character it is seen in the Missouri bluffs on the north side opposite Boonville, also near the road from Boonville to Marshall near the west line of Cooper county and south of LaMonte. On Oliver's prairie in Newton county, it affords an excellent flagstone and also contains Lower Carboniferous brachiopoda. It is over 80 feet thick in the northeast part of Lawrence county and occurs in outlying beds near Joplin. In Callaway near Fulton its equivalent is a massive cherty conglomerate. In the northeast part of Callaway the sandstone is ferruginous. On Turkey creek, Cedar county, are castellated cliffs of well marked Ferruginous sandstone and in the southern part of Cedar it carries considerable iron ore, as it also does in the southwest part of Green. On Shoal creek in Lawrence county it is quite ferruginous. In the southeast part of Dade county it carries copper sulphide.

THE COAL MEASURES occupy the northern and western part of the state and underlie an area of 23,100 square miles with a total aggregate thickness of about 2,000 feet, including about 170 feet in Atchison county and part of Holt which may be lower Permian.

Most geologists have divided the Upper Carboniferous of Missouri and Iowa into the Upper, Middle and Lower Measures. A micaceous sandstone was considered by Prof. Swallow to form the upper part of the Lower Coal Measures. But as that sandstone does not seem to be continuous, and is difficult to trace, I think it best to speak only of Upper and Lower coal measures, including the Lower and so-called Middle in one series. The Lower Coal Measures have an average thickness of 664 feet, all lying below No. 74 of the section of the

Upper Coal Measures described in the Missouri Geological Report of 1872. "Iron Ores and Coal Fields." A soft sandstone, often shaley and varying from 100 to 160 feet thickness, I would therefore consider to be the upper part of the Lower Coal Measures. It is the first rock struck in the shafts and borings at Randolph near Kansas City, and at Kansas City it is less than 50 feet below the base of the bluff. The rock at the base of the Upper Coal Measures is about 6 feet of limestone, some beds brown, some gray, the lower beds very even bedded and of an ash gray color and often very straight-jointed. Two feet beneath this limestone we find a seam of coal 3 to 9 inches thick. This coal is found at Pleasant Hill, Lone Jack, Missouri City, in the east part of Harrison county and 5 miles south of Princeton, Mercer county. The Middle and Lower Measures underlie an area of about 12,000 square miles and include fifteen seams of coal aggregating 20 feet. The Upper Measures include nine seams aggregating 4 feet thickness, in a total of 1100 feet of vertical thickness. Summing up we find Lower Measures—664 feet; Upper Coal series above—1100 feet, and above these 50 feet no rocks seen; still higher we have 180 feet of Permo-Carboniferous. Total, 2,000 feet.

The Upper Measures include a greater thickness of limestones than do the Lower Measures; but shales and beds of sandstones occur at intervals from the base to the summit of the series. The Lower Measures in northern Missouri includes some beds of limestone, but in the southwestern the strata are chiefly of sandstones with some shale layers, with rarely a limestone. Many of the rocks as well as the coal of the southwest are very bituminous, as shown both in appearance and odor. Fire clays are abundant as under-clays of the Coal Measures, and are more rarely found in the Upper Measures. Beds of clay-ironstone are interstratified in the Lower Measures. Selenite, calcite, arragonite, baryte and pyrite are also found in the Coal Measures. Small particles of zinc blende are sometimes found, and in Adair county I have obtained beautiful gœthite crystals. At a few places fine specimens of fossil plants have been obtained from shales, as at several places in Henry county and at Moberly. At White Rock quarry, Carroll county, fine calamites have been obtained.

In the bluffs near Hall's station, Buchanan county, and on Niagara creek, Andrew county, are found a number of plants in thin clay shale laminæ interstratified with a coal seam.

At one place on Big Drywood, Vernon county, five miles south of Deerfield, *Conostychus* has been found. *Fusulinæ* abound in some of the Lower limestones, but at long intervals are rare until we reach the upper one-half of the Upper Coal Measures. In the shales near the hilltop at Kansas City are many fine forms of *Crinoidea* showing all their parts. *Chætetes milleporaceus* abounds in large masses in the Lower Measures. *Conularia crustula* has only been found in Kansas City. *Syntrilasma hemiplicata* is found in the Upper Coal Measures only.

Above the highest observed strata in Nodaway and the southern part of Holt county there is a calculated gap of 50 feet, covered by loess, but which may consist of sandy shales as observed on the Missouri river bluffs in Nebraska between White Cloud and the Big Nemaha.

Beginning in the bluffs in the northwest part of Holt county and extending to the northwest part of Atchinson county, are a series of limestones, sandstones and shales which may be Permian. A condensed section of these beds is as follows, counting from the top:

1—53 feet of sandstone and shales, the latter green and red.
2—5½ feet of limestone.
3—2 inches of clay.
4—2 inches of coal.
5—22 feet of sandy shales.
6—3 feet of green and red shales with nodular layers of limestone.
7—4 feet of brown Fusulina limestone.
8—28 feet of shales.
9—3 feet of limestone and shales with fossils.
10—12 feet of sandstone and shales with fossil Lamellabranchs.
11—3 feet of limestone and shales-fossils. The limestone is jointed and contains *Productus semireticulatus* var. *Calhounianus* Sw.
12—34 feet shales, olive and red, with ironstone.
13—Shelly limestone, containing Sp. (Martynia) *plano-convexus.*

Fossils obtained from the Atchison beds were *Productus calhounianus*, *P. concinnus*, *P. splendens*, *P.* var. *wabashensis*, *P. prattenianus*, *Spirifer cameratus*, *Sp. planoconvexus*, *Chonetis flemingii*, *Ch. smithii*, *Athyris subtilita*, *Rhynchonella Uta*, *Syntrilasma hemiplicata*, *Euomphalus rugosus*, *Nautilus* *nodosodosatus*, *Aviculopecten carboniferus*, *Fusulina robusta*, *Archæocidaris aculeatus*.

Fossils similar to the above have been obtained from near the mouth of the Big Nemaha and at Hillsdale, Nebraska. The character of the beds and certain Brachiapoda, including *Productus semireticulatus* var. *calhounianus* with *Meekella striatocostata*, resemble very much the lower Permian of Elk, Cowley and Greenwood counties, Kansas. But at Kansas City, within less than 100 feet of the base of Upper Coal Measures, we *do* find certain fossils which are very much like some Permian fossils, as *Aviculopecten* and *Eumicrotis*. But the limestones are very different in other respects.

THE THREE GREAT FOSSIL PLACODERMS OF OHIO.

By E. W. Claypole.

The discoveries of the past few years have brought to our knowledge a large fish-fauna whose existence was previously unsuspected. The great shale-mass of Ohio has yielded little of interest to the early research of the palæontologist. It was consequently regarded as very barren ground. So barren, indeed, had it been in almost all its exposures that evidence was lacking to determine its precise age and position, and it has, therefore, been divided at various levels between the Devonian and the Carboniferous systems. This great Ohio Shale, the marginal, or rather, the off-shore deposit of all but the earliest ages of the Devonian era in Ohio, crops out from north to south through the middle of the state, from the lake to the river. At its southwestern outcrop it is only from 300 to 400 feet in thickness, but it gradually thickens southward and eastward until near lake Erie it reaches about 1,000 feet, at Cleveland 1,300, in the Tuscarawas valley 1,800, and on the river its bottom has not been reached at 2,500 feet. So great a mass of one material indicates a long continuance of almost unchanging conditions of deposit and, indeed, this shale is the equivalent of all the sediments in Pennsylvania from the top of the Corniferous Limestone to the top of the Catskill Sandstone, a distance, sometimes, of 7,000 or 8,000 feet.

The great scarcity of fossils above alluded to which was for many years supposed to characterize the shale still holds in regard to all but a few forms. Lamellibranchs and Brachiopods are conspicuous by their absence. Crustaceans are unknown. No Crinoid has yet come to light. Corals, Polyzoa, Cephalopods and Gasteropods alike fail us in this wide expanse of ancient mud through which the auger descends in drilling at the rate of 100 to 150 feet a day, revealing only a monotonous variation of hue—"black shale"—"sandy shale"—"light shale"—"dark shale"—in beds so uncertain in thickness and interval that the exact comparison of records, even in adjacent boreholes, seems not yet possible.

At two horizons, however, this almost utter sterility is pleasingly broken by richly fossiliferous strata. The so-called "Huron Shale" of Newberry is well exhibited near Delaware, O., and to the perseverence and the hammer of the Rev. H. Hertzer it yielded a magnificent series of the remains of fossil fishes which were described by Prof. Newberry in the Palæontology of Ohio, (Vol. I) where he thus speaks of the skill and patience of their discoverer:—

"Our first knowledge we owe to the industry and acuteness of observation of the Rev. H. Hertzer, a clergyman stationed for two years at Delaware, Ohio, and who, while performing his ministerial duties and receiving a very small salary, found time to make many important collections and observations in geology. The Corniferous at Delaware abounds in fossils and Mr. Hertzer collected a splendid suite of the ichthyolites which characterize this formation, but the Huron Shale had up to this time been regarded by all geologists as barren ground. Near its base it contains a great number of concretions of impure limestone sometimes ten or more feet in diameter. In examining some of these Mr. Hertzer discovered that they not infrequently contained masses of silicified wood or fragments of bones. Several of these were taken to the meeting of the A. A. A. S., at Buffalo, in 1866. They were submitted to me and I recognized them as the bones of huge ganoid fishes, altogether new to science. With enthusiasm fired anew by the interest which these specimens excited, Mr. Hertzer devoted all the time possible to further examinations. The rock is one of the most untractable known and Mr.

Hertzer deserves great credit for the care and skill with which hundreds of fragments were carefully gathered and each cemented into its proper place. A head and mandible of *Dinichthys* restored nearly to their former integrity now constitute the pride of the collection of the School of Mines of Columbia College."—p. 320.

Following this remarkable outburst of ichthyic life comes the great mass of the shale, a greenish layer of several hundred feet in thickness and almost devoid of life saving here and there a few lonely brachiopods representing very few species. Its poverty is most remarkable in contrast with the preceding, and not less so when we regard the period that followed it after this long interruption. The story of the fishes is again taken up in the black Cleveland Shale at a higher level, and new genera and species of closely related but different forms are found in its concretions.

What became of the great fishes during the long interval that elapsed between these dates is unknown. Similar deposits were going on in the seas and so far as we know similar conditions generally prevailed around them, but the huge placoderms of the early stratum disappeared and not a bone or a fragment has yet come to light in Ohio that indicates their continued existence. A very few detached plates and pieces of plates have been described from other states, sufficient to remove all doubt of their survival were such doubt in the present day at all possible. But these are all.

Several hundred feet of shale—the Erie Shale of Newberry—contributed to fill this ancient sea or rather gulf, whose bottom subsided as deposition progressed (perhaps its cause) and yet no sign of ichthyic life appears. It is not probable that the muddy shores of the Appalachian Gulf were forsaken by the descendents of the finny tribe that had frequented them in previous ages and whose progeny returned in later times. It is more likely that all the relics were destroyed after their death owing to unfavorable conditions. For it is always to be recollected in this connection that it forms no part of Nature's proceedings to preserve the relics of her dead. "Dust to dust and ashes to ashes" is her motto. She sets her agents of destruction at work as soon as the life has left the body and they quickly reduce it in most cases to an unrecognizable mass to be used over again in the manufacture of other animals and other plants. She keeps no sepulchral urns for the ashes of her dead but scatters them broadcast over the earth and the waters wherever chance may drop them. Only, as it were, when some accident has eluded her watchfulness do we find the fossil form. Out of the millions of beings that have lived and died one has here and there escaped oblivion and remains "a monument more lasting than bronze or the towering pyramids" of Egypt. Many a fossil species is represented by a solitary specimen in some one museum, and though others will doubtless some day be discovered, yet there is no doubt in the mind of every paleontologist that the number of the finally saved will bear no proportion whatever to that of the utterly lost.

This second discovery was due to the industry and patience of another volunteer in the field, Mr. Jay Terrell, of Oberlin, O. Picking up one day on the lake shore a small pebble he recognized in it the well known structure of bone, and being thereby stimulated to search farther he ended by the discovery, in the Cleveland Shale, of a fauna surpassing in extent that already found by Hertzer in the Huron. For some years, owing to a mistaken conception regarding the stratigraphy, this shale was regarded as lying on the same horizon and being the same as the Delaware beds. But this is known to be an error and that the beds at Avon Point are in truth in the Cleveland Shale is now admitted by all.

Most of Mr. Terrell's specimens were obtained from the cliff on the shore of lake Erie, where the action of the waves constantly breaks down and exposes new surfaces. His work was prosecuted, sometimes amid water and ice in the early spring, with an energy and enthusiasm deserving of the lasting gratitude of palaeontologists. Not a single species from the lower horizon has been found here, but Mr. Terrell's researches have confirmed the results of Mr. Hertzer regarding the structure of these gigantic placoderms and added largely to their number. Dr. Newberry gives in his volume on the palaeozoic fishes of N. A., 28 species from the Cleveland Shale.*

*In addition to the 28 species of Dr. N.'s work there is another which has apparently by some oversight been placed in the wrong position. On p. 70 *Callognathus serratus* is placed among the fishes of the Huron though credited to and belonging to the Cleveland Shale.

One of these Titanichthys is the largest placoderm known from Ohio and probably from the continent. Most of them were found originally by Mr. Terrell, though other and better specimens have since rewarded the labors of later palaeontologists. Unfortunately most of his specimens, including all the finest, were destroyed in the great fire at Elyria and had he not had the foresight to make and distribute photographs of them we should have no monument of his labors.

This great fish-fauna brought to light about 1870 was followed in a few years by the discovery of a third locality. In the valley of the Cuyahoga and of Rocky river Dr. W. Clark, of Berea, found, about the year 1885, the first of a series which proved only the earnest of a truly magnificent collection. While many of his specimens were, as might have been anticipated, identical with those of Mr. Terrell, yet not a few are new and greatly enlarge our ideas of the fauna of the Cleveland Shale.

The monarch of these muddy shores—the gigantic Titanichthys—of whose remains detached plates have been found at Avon Point, is only known in size and detail (thus far) by the more nearly complete specimens exhumed from the valley of Rocky river. His rival, more formidably armed and armour-clad, though of rather smaller size—Dinichthys—is also now better understood in consequence of Dr. Clark's discoveries. Still another species, the contemporaries of these, though not placoderms, and therefore outside of our present field, yet await examination and study.*

Several other laborers have worked in the same field, such as Kepler, Gould, Wagner, Park, Terrell and Wheat, and success has, in a greater or less degree, attended all their efforts. But to the three above named and Dr. J. S. Newberry, who has skillfully interpreted the fossils, is the world especially indebted for its present knowledge of the ancient fish-fauna of central Ohio.

The future has vastly more in store than the past has revealed. "The harvest is plenteous but the laborers are few." Time and patience, such as these men have shown, are rare.

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*NOTE.—Since this passage was written some of these have been described by the writer. See "The Cladodont Sharks of the Cleveland Shale," in the May number of this Magazine.

Love of the work is rarer still and without this no one, whatever may be his gifts, can possibly succeed. The reward, in this money-making age, does not attract many votaries. Pure science is, like virtue, her own and her only reward. But the world is the better and men are the wiser for the labors of such men in fields of great difficulty and intricacy. Let us hope that ere long others will come out and join those who now are at the task and share with them "the burden and the heat of the day."

Returning from this brief digression, we desire here to dwell for a time, for the benefit of the many readers of the GEOLOGIST who do not pretend to special knowledge and whose pleasure and profit the Magazine is, in part at least, intended to serve, on the characters of those species which, so far as we yet know, must have been the rulers—the tyrants if the reader so please—of the muddy waters wherein the Cleveland Shale was deposited. So little is yet known of them that it is impossible to write of more than the foreparts of their bodies as their latter ends have never been discovered. So to make the comparison equal for all, we will consider only the jaws and principally the lower jaw, or the mandible, as it is usually called.

The earliest known was a species of *Dinichthys* different from *D. Hertzeri* of the Huron Shale. Of this creature the lower jaws are the parts commonly found and the best preserved. They have been so well studied, described and figured by Newberry that little remains to be known about them and the specimens now reconstructed in the museum of Columbia college, New York, "the pride of that collection," are the admiration and, if it were possible, the envy of ichthyologists the world over.

The jaw of Dinichthys is a deep but not thick blade, thinning out behind where it was inserted into a mass of muscle or ended in cartilage. Anteriorly it grew thicker and terminated in a strong and nearly vertical, pointed tooth with very massive base, whose point fitted, as shown by the wear, on the inner and anterior face of its antagonist above.

Behind this tooth is a short depression in the jaw followed by a long, sharp-edged cutting blade without teeth and always worn on the outer face from continual shearing contact with a corresponding upper bone, as one blade of a pair of scissors slides over and past the other. When to this we add the fact that this jaw, so formidably armed and fitted out with weapons of destruction and defense, was two feet in length and evidently worked by a powerful set of muscles, we can in some degree realize the dominating position which its owner could and doubtless did assume among his contemporaries. I say "doubtless did," for at least one specimen is known which shows upon its surface the prints of the terrible fangs of *Dinichthys.*

Such a structure is almost or altogether unparalleled, not only among fishes, but in the whole animal kingdom. Indeed, it is not even a character of the genus, for the predecessor of *D. Terrelli* of the Cleveland Shale, the equally formidable *D. Hertzeri* of the Huron, did not possess this terrible pair of shears. Its lateral teeth were of no extraordinary shape or size. So far, therefore, as we yet know, *D. Terrelli* is unique upon earth. Nature here attempted a new type of dentition which she never afterwards repeated. Did it fail in effectiveness as do many of the patents of man? Possibly so. At all events the pattern was abandoned, laid on the shelf and no more castings made. All later teeth were moulded on the pattern previously adopted.

The second member of this trio is the still more gigantic *Titanichthys* of Terrell, found in 1883. Surpassing Dinichthys in length of jaw, at least as three to two, its defensive plates form the largest armour known. But it was inferior in massiveness. Its head-plates are thin and light when compared with those of its rival. It measured four feet and four inches in breadth, but with the exception of a few separate bones we know little of the body of the animal. Some of the jaws already found, though three feet in length, are slender by the side of the massive bone of the former fish. The jaw or tooth in front slopes forward at an obtuse angle, and is therefore ill adapted for the purpose of closing with a snap, as did the tremendous "steel trap" of Dinichthys. We may, therefore, infer that its owner was less formidable than his more heavily armour-clad companion.

The jaw, behind the front tooth, is hollowed out in a groove or furrow (alveolus) which Newberry suggested may have been covered or filled with a horny sheath like that of a turtle. But the discovery of conical, blunt teeth in connection with these jaws leaves scarcely room to doubt that they were set in the alveolus above mentioned. This is unusual in fishes, but is at the same time a character frequently seen in reptiles and may indicate the intermediate nature and position of these creatures.

What then was the probable food of *Titanichthys?* Some day perhaps his fossil stomach may be found to tell the tale, as has happened with more than one of our extinct predecessors on earth. But we may in the meantime hazard a few suppositions. The waters of the Cleveland shale abounded in sharks. To a creature with the armour of *Titanichthys* the teeth of even the most formidable of these would be harmless and many of them may have fallen victims to his huge jaws. But it may be replied, and with at least a show of reason, that so ponderous a brute could never catch the nimble but unarmed elasmobranch. Possibly the objection is fatal to the supposition. But we do not know the locomotive organs of *Titanichthys.* The huge iron-clads of to-day are not among the slowest of ships. And sometimes the nimble may be taken by the craft of the slow. The race is not always to the swift.

Furthermore the sharks above alluded to must have preyed on some other of the finny tribes. We have the stomach of one in which lies a half digested ganoid fish of unknown genus and species, indicating to us the existence at that day of other fishes whose relics we have not seen, and reminding us of our deep, deep ignorance of the life of the Devonian seas. To this ignorance we may safely appeal for the solution of these enigmas, and we must yet grope for many a day through the mist and darkness before we can repeople these seas with their ancient population or call before our mind's eye all the fishes that then lorded it over the rest of creation.

The third and last number of this remarkable trio surpasses even the first in the formibable nature and strength of its offensive weapons. It was but recently discovered and the specimen is not yet cleared from the matrix. The jaws, however, are quite enough to prove its character and differentiate it at once from both Dinichthys and Titanichthys. Rivaling the former in size (the jaws found being 24 inches long) it surpassed it in bulk and weight. The description given of Dinichthys will suffice for the front teeth of this species so far as yet known, but there are no shear-blades behind them to cut and slice the prey. On the lower jaw is a blunt projecting point on which fits a powerful two-pointed tooth corresponding to the round-edged cutting plate in the upper jaw of Dinichthys, though in neither case has it yet been found exactly in life position. The tooth measures 9 inches horizontally and 7 inches vertically, and as an instrument of offence it must have surpassed in power and destructiveness the cutting shears of *Dinichthys terrelli.*

To this monster of the ancient sea, considering that Dr. N. has had already the pick of the classic nomenclature, has been applied the generic name "Gorgonichthys," and in appreciation of the amount of time and labor that its discoverer has spent upon its extrication it is only just that the specific term should memorialize his patience and skill. The fish, then, of which I lately gave a preliminary notice, is known as *Gorgonichthys Clarki.* It was found in 1891.

Our readers are now prepared to understand in part, at least, the significance of such discoveries as these. The existence of predaceous fishes implies the existence of others on which they could prey, and so again of other creatures and plants to support these. In imagination, then, we can see the waters of this Appalachian gulf swarming with life that has passed away, and whose remains, if not totally destroyed, will one day be found. Their existence, however, is not one whit less certain though their forms should never become known.

The creation of this numerous fleet of armour-clad beings from the scattered fossil remains of the Devonian strata of Ohio is in keeping with similar discoveries elsewhere especially in Scotland where the work of H. Miller in the Old Red Sandstone has made the subject and the ground alike classic. It was a singular stage in the evolution of fishes. Nature apparently loaded these small brained creatures with all the protective armour that they could carry, and it would seem as if she had reached at last a limit beyond which it was impossible to increase it without destroying the buoyancy of the fish. Just as now the navies of the world are loaded down with iron to such a degree that though well nigh impenetrable they are in danger from that which should be their protection, so Dinichthys and his fellows were so thickly encased in bone that it is not easy to see how they can have possessed proportionate activity. The next step in naval architecture will probably be to follow the example set by nature in post-Devonian days and strip off or reduce the ponderous armour-plates, as she has stripped off or thinned down the bony shields of her mail-clad fishes. With increase of brain and nerve there has come a diminution of plate and scale so that the swift Teleosts of the recent seas have steadily superseded the huge Ganoids and Placoderms of old.

Nature, though slow, learned her lesson millions of years ago; man has his yet to learn. About the close of the Devonian age she began to discontinue the building of the enormous placoderms which we have been describing, and adopted a lighter form—the Ganoids—of which the American Gars may be considered a surviving pattern, and being apparently pleased with the result of her experiment she took a further step at the commencement of the Cretaceous era and covered her fleets with thin scales of horn, transferring the bones to their inner parts and thus introducing her bony fishes—the Teleosts—her latest type of fish-construction. These trust to activity and watchfulness rather than to armour for safety.

It is singular, or at least unexpected, that the armour of these fishes was "all forward." Their hinder parts were certainly in many, and probably in all cases, naked or scaly. Had they no dangers astern from which they needed protection? Or were the only creatures that they could fear so slow that a stern-chase was always a losing race? We cannot tell. It says little for the speed of the pursuer when the pursued leaves his back undefended.

Monsters such as these can scarcely have been mud-fishes, buried in the bottom with merely head and jaws exposed. Teeth like theirs can not have been evolved except in creatures that employed them in open struggle with their prey or their foes. They are scarcely the weapon of cunning or concealment.

One of the two views seems necessary: Either they had no foes to fear behind or they kept their soft back parts out of danger, and perhaps one reason for their supercession by the later and lighter ganoid and teleosts may be that the greater activity of the latter enabled them to attack in the only vulnerable place. Be this as it may, the fact remains that these ponderous creatures died out. Their load of bony plates sank to the bottom and there lay sometimes almost undisturbed in the muddy shale only to be resurrected by man after millions of years had passed away.

THE UNCONFORMITY OF THE COAL MEASURES AND THE ST. LOUIS LIMESTONE IN IOWA.

By Charles Rollin Keyes.

At Keokuk, in the extreme southeastern corner of Iowa, outliers of Coal Measure deposits are found in a number of places near the summits of the bluffs bordering the Mississippi and Des Moines rivers. The bluffs rise to a hight of 150 to 200 feet above the river level. They are made up almost entirely of massive limestones of Lower Carboniferous age. The uppermost member of the calcareous series is the St. Louis Limestone. As represented in this locality it is partly a compact, coarse-grained limerock, regularly bedded, partly a brecciated limestone. The St. Louis in Iowa is of particular interest as it is the great floor upon which were deposited unconformably the Coal Measures of the region. The unconformity is quite marked at numerous places. The line of contact is displayed distinctly in a ravine north of Rand park, Keokuk, as shown in the accompanying plate taken from photograph (plate IV). The lower light portion is the brecciated St. Louis limestone; the upper dark part is the basal sandstone of the Coal Measures. The latter is a rather soft, friable rock, light buff or brownish in color and fills the uneven, channeled surface of the St. Louis limestone.

As early as 1857, in a paper published in the American Journal of Science, James Hall wrote: "I have ascertained in the most satisfactory manner that the coal fields of Iowa, Missouri and Illinois rest uncomformably upon the strata beneath, whether these strata be Carboniferous limestones, Devonian, Upper Silurian or Lower Silurian Rocks."* Although

*Am. Jour. Sci., (2), vol. xxvii, pp. 197, New Haven, 1857.

no details were given nor any references made to the evidence this appears to be the first notice calling attention to the existence of a physical break in the Carboniferous rocks of the Mississippi basin.

A decade later, White,* calling attention to the same fact, stated that another unconformity existed between the St. Louis limestone and the underlying rocks of the Lower Carboniferous. These remarks also appeared subsequently in the Iowa Report,† but were very general in their character. Yet there is added to Hall's observation the important fact that the St. Louis limestone also overlaps in the state of Iowa.

In Iowa, at least, it appears that the extension of the Coal Measures beyond the boundaries of the St. Louis limestone was much more than an overlap in the ordinary sense of the word, such as might have taken place off shore in gradually deepening waters. It was a sinking of an ancient land surface which had been more or less profoundly carved into hills and vales, affording protected nooks favorable to swamp formation and the rapid accumulation of vegetable materials.

Since the observations recorded by Hall and White were originally published little work bearing upon the subject in hand has been done until quite recently. In Missouri, Iowa and western Illinois much valuable information has accumulated within the past few years so that now the principal changes of the coastal contour which took place during the Carboniferous over the region mentioned are tolerably well understood. The exact character of the unconformities referred to by the writers named have been made out with considerable detail; while numerous minor physical breaks have also been recognized.

The problem therefore centers around the oscillation of the Old Carboniferous shore-line in the upper Mississippi basin. The changes are graphically shown in the accompanying diagram, (Figure 1), representing the movements of the land margins in the probable direction of greatest shifting. The Devonian rocks doubtless extended northward beyond the present limits of Iowa. Toward the close of the Devonian period the seas over this region gradually contracted. This

*Am. Jour. Sci., (2), vol. xlv, pp. 331-334, New Haven, 1868.

†Geology Iowa, vol. I, pp. 225-229. Des Moines, 1870.

recession continued more rapidly as the Lower Carboniferous period was ushered in, until the water-line reached nearly to the present southern boundary of Iowa. The St. Louis epoch

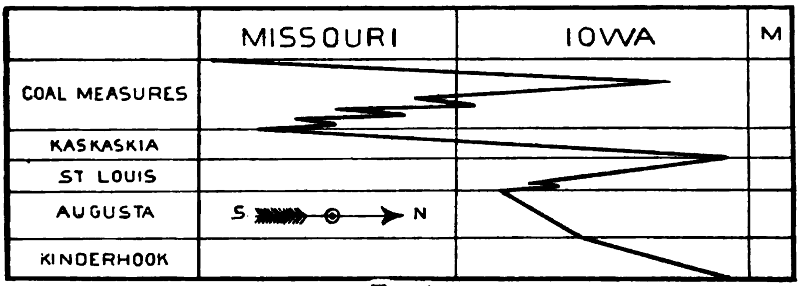

FIG. 1.

represented a period during which there was a general depression of the land, allowing an overlap of the St. Louis rocks of more than 200 miles.

At the beginning of the Kaskaskia epoch or the last stage of the Lower Carboniferous, another cycle of the great continental change set in, pushing the shore-line rapidly some 500 miles southward to the vicinity of the present city of St. Louis. Shore deposits were laid down along the line of the Mississippi river in southeastern Missouri and western Illinois, with open sea depositions farther southward, and probably also west of the Missouri river. While the Kaskaskia beds were being deposited south of the mouth of the Missouri river agencies of degradation were actively at work over all Iowa and northern Missouri. The St. Louis limestone was deeply eroded, as is plainly shown in numerous places. The depressions, channels and gorges were soon filled with clays and sands while here and there thick beds of Carbonaceous matter were buried.

For the most part the Coal Measures represent a period of general though not uninterrupted subsidence. During the latter part of the period the waters receded rapidly far beyond the boundaries of both Missouri and Iowa. A long time intervened before the seas again occupied the Iowa territory. This incursion was recorded in the Cretaceous deposits of the northwestern part of the state.

This is in brief, then, a statement of the shore-line changes during the Carboniferous in the upper Mississippi valley.

In considering now the character of the physical break at the base of the Coal Measures in Iowa and Missouri, attention must be directed briefly to a few of the leading sections showing the line of contact between the two formations.

One of the most important exposures bearing upon the question under consideration has been fully described in connection with the cross-section of the Lower Coal Measures of the central part of the state.* It was shown that in Marion county between Harvey and Redrock, a distance of ten miles, not less than 75 feet of shales were represented between the two different horizons of the Coal Measures reposing against the St. Louis limestone. The great part of the vertical distance just referred to appeared to be due to irregularities in the limerock, which were carved through erosion prior to the laying down of the Coal Measures.

Near Fairfield, in Jefferson county, the Coal Measure clays with their seams of carbonaceous matter rest directly upon the uneven surface of the St. Louis marls which cap the limestone of the same age, and which contain fossils in abundance.

At various places in Keokuk and Mahaska counties borings, as well as exposures, indicate that the irregularities in the surface of the St. Louis limestone are even greater than they are in Marion county, as already explained. The borings just referred to are quite numerous and special care has been taken for the reason that search was in progress for a "second" vein of coal —a seam supposed to be much lower than the one at present being worked. In one place where the St. Louis limestone was exposed at the surface, operations with a diamond drill had begun in hopes of reaching the "lower" coal bed. The reason given for carrying on the work in this manner is that a mile away the coal at present worked was many feet lower down than the limestone outcrop and therefore the coal bed must lie beneath.

Relations similar to those above described have also been observed in connection with the St. Louis limestone and Lower Coal Measures at Ft. Dodge and elsewhere in Webster county. Similar cases might be cited again and again, if it were necessary, in the present connection.

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*Bul. Geol. Soc. America, vol. III, pp. 283-310. 1892.

CERRO TUCUMCARI.

By JULES MARCOU, Cambridge, Mass.

Mr. W. F. Cummins, of the Texas Geological Survey, has published in *The American Geologist*, June, 1893, pp. 375-383, an article entitled *Tucumcari Mountain*, in which he says, that "Prof. Marcou was wrong in his designation * * * that he did not follow what others had done before him. * * * It is evident to me for the reasons assigned that the Big Tucumcari of Marcou is not the same as the Cerro of Tucumcari of Simpson, and that the one now known as Big Tucumcari by the inhabitants of the country and so marked on my map is the one described by Lieut. Simpson." Mr. Cummins' knowledge of Lieut. Simpson's *Report of Exploration and Survey of Route from Fort Smith to Santa Fé, made in 1849*, is very deficient and incomplete; the most important part and the one I referred to in *The American Geologist*, Dec., 1892, p. 372, —the Simpson map—being passed over entirely, as if it did not exist.

In transmitting the report of Lieut. Simpson, to the U. S. Senate, Washington, January 4, 1850, Colonel J. J. Abert, chief of Corps Topographical Engineers, states distinctly: "the report and *map*;" and in my paper of *American Geologist*, I go so far as to say: "a small sketch map, marked No. 4, in Lieut. J. H. Simpson's report of 1849, Washington, which gives also the *exact position of the Little and Big Tucumcari*."

If Mr. Cummins had given a copy of Lieut. Simpson's map, as he did of my map of 1853-57, for comparison, all his remarks and perfectly useless long dissertation would have fallen to the ground. For it is a question of plain fact, recorded very distinctly on Simpson's map and accessible to everybody.

The cut—Fig. 2 upon next page—is an exact copy of a part of Lieut. Simpson's map.

The excuse of Mr. Cummins, is probably, that he never saw it. Then why did he raise a question of correcting the geography of my map and accusing me of not following my predecessors, when he does not know himself, what others have done before me.

Here is the true history of the Cerro Tucumcari. The Spaniards of New Mexico, called *Commancheros* because they traded with the Commanches Indians, used to go every year to meet the Commanches on the plains, somewhere between the Tucumcari, the Llano Estacado, and the great gypsum and salt basin near the great bend of the Canadian river, called by

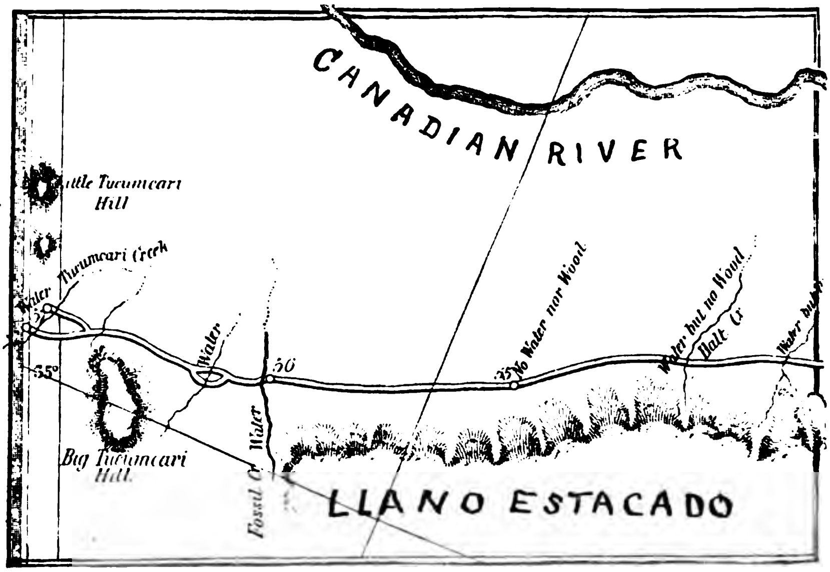


FIG. 2.

the Commanches Goo-al-pah. They used to go with their rather primitive two-wheel carts, drawn by oxen, and made wholly of woods, with plain wheels, without any iron whatever, not even nails. The road made by these carts started from Arto-Chico, or the Pelos-Pueblo, and passed through Laguna Colorada, Plaza larga, Cerro Tucumcari and Llano Estacado. That road existed during the whole of the eighteenth century and probably even before. All the names of localities along that road are Spanish, except Tucumcari, a Commanche name, meaning a very high isolated mound or mountain.

1839-45.—The first man who put the name Tucumcari in print, is Josiah Gregg, in his excellent work: *Commerce of the Prairies*, 1845, Vol. II, Chapter III—*a new route revealed*, in order to evade the difficult pass of the *Angosturas* or Narrows of the Canadian river. Gregg calling some isolated mountains west of the Angosturas, *Cerro de Tucumcari;* and he spoke also of the *Tucumcari route;* but he does not give any drawing or description which can be used to identify the Cerro. It was in 1839, that Gregg explored this very old Mexican road.

1841-46.—The celebrated *Texan Santa Fé Expedition*, from Austin, May, 1841, so vividly described in two volumes by the humorous writer, Geo. Wilkins Kendall, New York, 1846, passed through the Angosturas, without signalizing in any way the Tucumcari, in the text or on the map.

1845-46.—*Report of an expedition led by Lieut. J. W. Abert, on the Upper Arkansas and through the country of the Commanche Indians, in the fall of the year 1845.* Washington, 29th Congress, 1st Session, Senate, June, 1846. In the text nothing is said about Tucumcari. The expedition followed down the left side of the Canadian river, and did not come near the Cerro Tucumcari, distant 25 or 30 miles far away south. But on the map accompanying the report, Lieut. Abert and his associate, Lieut. V. G. Peck, U. S. Topographical Engineers, have written *Cerro Tucumcari*, on a place entirely isolated, merely as a guess, and from what they had learned from the New-Mexican traders and the Commanches and Kioways Indians. It was the first time that the name had been inscribed on a map.

1849-50.—*Route from Fort Smith to Santa Fé. A Report and Map of Lieut. J. H. Simpson, of the route from Fort Smith to Santa Fé; also a report on the same subject from Capt. R. B. Marcy, 5th Infantry.* Washington, 31st Congress, 1st Session, House of Representatives, Ex. Doc. No 45.

In the text Lieut. Simpson speaks of the *Cerro des Tucumcari* or Tucumcari hill and Tucumcari creek, at pp. 13, 14 and 17, and gives a description of one of the hills, seven miles north of Camp 57, 18th June, 1849. Farther on, at p. 44, Capt. Marcy, June 18th, says: "Our encampment is upon a small creek directly between two mountains, called by the Commanches the *Big and Little Tucumcari.* The *larger one* is about *three* miles to the *south* of our road, and some eight miles in diameter at the base. The *smaller one* is about *eight* miles *north* of the road, two miles in diameter and 750 feet high."

Two maps accompany this book, one by Lieut. Simpson, in four sheets, entitled: *Map of route pursued by the U. S. troops from Fort Smith, Arkansas, to Santa Fe, New Mexico, via south side of Canadian river, in the year 1849*; marked

Nos. 1, 2, 3 and 4. Scale 10 miles to 1 inch. The second map is only on one sheet, by Capt. Marcy, entitled, *Topographical Maps of the road from Fort Smith, Arkansas to Santa Fe', N. M., and from Dona Ana, N. M. to Fort Smith.*

These two maps, are the first made on the spots by scientific explorers, and are most important for the exact geography of the Tucumcari area. Lieut. Simpson's map being on a large scale, gives all the details, as well executed as can be expected from an exploring party, under military march, escorting a large band of California emigrants. The Tucumcari area is given on map No. 3, and is repeated on Map No. 4 in order to show the "continuation of details" as it is noticed by Lieut. Simpson. On both sheets, we see, as described by Capt. Marcy in his diary, the Camp No. 57, on the Tucumcari creek, situated between the Little Tucumcari hill and the Big Tucumcari hill. Both Simpson and Marcy in their diaries, say that when in Camp No. 57, they received a visit from a party of Commanches Indians, among them several chiefs. They came, while Simpson was engaged, under the protection of an escort of dragoons, in exploring the hill north of the camp, which he calls neither *Little*, nor *Big* Tucumcari, but only *Cerro Tucumcari.* Capt. Marcy received the Indians, and during the friendly entertainment and calumet smokes, he learned from them, that the hill north of the camp was called *Little Tucumcari*, when the one south of the camp was called *Big Tucumcari.* Simpson after his return from the northern hill, was made acquainted by Marcy with this; and he took it on his memorandum book—not in his diary—and when at Santa Fé, in constructing the map of the road, on the 28th of July following, he took care to separate the Cerro Tucumcari in two, as the Commanches Indians had indicated on the spot, locating with care and exactness the Little and the Big Tucumcari.

The map of Capt. Marcy, on account of the small scale, does not give many details, but locates however the two hills, giving only one name, badly spelled by the engraver, of *Cerro Tu-cu-car-ri.*

1851.—*Map of the Territory of New Mexico, compiled by Lieut. John G. Parke*, U. S. Top. Engrs., Santa Fé. A large sheet, published by the War Department, Washington. On it we have the Big Tucumcari hill, south of the road, the Little

Tucumcari hill, north of the road, and the Tucumcari creek between. Lieut. Parke compiled that part of his map from Simpson's map.

1853-57.—The 21st September, 1853, Lieut. A. W. Whipple's exploring party for a Railway route near the thirty-fifth parallel, from the Mississippi river to the Pacific Ocean, reached and encamped on the same spot where Simpson and Marcy had camped four years previously. We had in our hands several copies of Simpson's map and both the reports of Marcy and Simpson, and we had no difficulty in recognizing the Little and Great Tucumcaris. During our short stay of only two days, the 21st and 22d of September, Lieut. Whipple, assisted by the topographer A. H. Campbell, the surveyor John P. Sherburne, and myself, made a rapid survey, adding considerably to the topography of the area, as it will be easy to see, in comparing our map, published first in the atlas accompanying the octavo edition of *Report of the Secretary of War on the several Pacific Railroad Explorations*, Washington, 1855,House Doc. 129; and second in vol. xi, *Reports of Explorations and Surveys*, etc., 1861, quarto edition, with the Map of Lieut. Simpson. My part in the survey, was to make a geological sketch map, which I did, and published in my *Geology of North America*, 4to, Zurich, Switzerland, 1857.

All of us followed carefully Simpson's map, who has the priority, and ought to have the credit. My part in the topography of the area, was to name one very prominent hill, *Pyramid Mount* and also *Monte Revuelto*, the corner mountain of the Llano Estacado.

Conclusion.—The first three original maps of the Tucumcari area, are: first the map of Simpson of 1850, then the map of Whipple (two editions, 1855-60), and my Geological Map of 1857. These maps have the priority in regard to names and localities, and if priority exists in geography, as in all other sciences, then the map of Mr. Cummins, entitled: *Geological Map of the staked plains and adjacent area*, published in the *Third Annual Report of the Geological Survey of Texas*, Austin, 1892, is wrong and cannot be used for the geographical names and topographical positions of the Tucumcari area, as I have said previously in my paper published in THE AMERICAN GEOLOGIST of December, 1892.

NOTES ON SOME OF THE FOSSIL CORALS DESCRIBED BY DAVID DALE OWEN IN HIS REPORT OF WORK DONE IN THE AUTUMN OF 1859,* WITH OBSERVATIONS ON THE DEVONIAN SPECIES, PHILLIPSASTREA GIGAS OF LATER AUTHORS.

By SAMUEL CALVIN, Iowa City.

The geologist who has occasion to work over the ground covered by the investigations of Dr. D. D. Owen in the years from 1839 to 1852, must experience perpetual surprise that, considering the circumstances under which Dr. Owen carried on his observations, so much geological work could have been done, and done so well. Another surprise awaits the investigator who sets about to determine the extent to which the fossil species described by Owen have been recognized by subsequent writers on paleontology. It is to be admitted that Owen's figures are sometimes very imperfect, and his descriptions are sometimes distractingly brief and pointless; but, in the manner of descriptions at least, he followed the custom of his time, and was, in this respect, no greater sinner than many another whose specific names have been honored by the widest acceptance. In the work cited, which is essentially a reprint of the report published in 1840, we have figures and descriptions of a number of corals from what Owen calls "The Coralline Beds of the Upper Magnesian Cliff Limestone of Iowa and Wisconsin." The formation from which the corals under consideration were derived is now known throughout Iowa and Wisconsin as the Niagara Limestone. The figures given in illustration of the species described are, for their time, exceptionally good, and the descriptions are not more defective than the average descriptions of the fourth or fifth decades of the present century.

Collections from the horizons that furnished Owen's types will contain a number of species that may positively be identified with the forms which he figures and describes. For example, *Anthophyllum expansum* Fig. 3, Plate XIII, *Cyatho-*

*Report of a Geological Exploration of part of Iowa, Wisconsin and Illinois, made under instructions from the Secretary of the Treasury of the United States, in the autumn of the year 1839, with charts and illustrations. By David Dale Owen, M. D. Ordered to be printed by the Senate of the United States, June 11, 1844.

phyllum corinthium Fig. 6, and *Cyathophyllum undulatum et multiplicatum*, Fig. 10, are different phases of the same species, and are identical with a species that is not uncommon at Coffin's Grove, four miles west of Manchester, in Delaware county, Iowa. This species, in some of its varying phases, is illustrated in figures 1, 2, 3, and 4 of plate v, accompanying this paper. Dr. Rominger, in his work on the fossil corals of Michigan, p. 120, recognizes the identity of our Iowa species with Owen's fig. 10, plate XIII, and this, so far as I am able to discover, is the only reference to this species that has been made by our more modern writers. The species which Owen illustrates and describes under the three figures and the three names cited, belongs to the genus *Ptychophyllum*, and, giving priority to the first name used, the species should stand hereafter as *Ptychophyllum expansum* Owen.

Porites ? astraformis, plate XIII, fig. 8 is clearly identical with *Plasmopora follis* Ed. and S. H., and not with *Pachyphyllum woodmani*, as suggested by Miller in *North American Geology and Paleontology*, 1889, page 201. On the same plate, figure 11, *Sarcinula (porites?) glabra* is a good figure of *Lyellia americana* Ed. and H. On plate XIV, fig. 12, another individual of the same species is illustrated under the name of *Sarcinula costata* Goldfuss. *Lyellia americana* Ed. and H., is one of the most common species found in association with the corals figured on plates XIII and XIV of the work cited; and all the species there illustrated are more or less common in the coral bearing beds of the Niagara Limestone in Delaware county, Iowa.

Astrea mammillaris Owen, plate XIV, fig. 3, has been correctly identified by Rominger in *Fossil Corals of Michigan*, p. 133, with the form now recognized by paleontologists as *Strombodes mammillatus;* but *Astrea ? gigas* Owen, plate XIV, fig. 7, has not been so fortunate as the preceding. Billings, in the *Canadian Journal of Industry Science and Arts* new series, number XX, March, 1859, page 128, has identified Owen's *Astrea ? gigas* from the Niagara Limestone, with a Devonian species which exhibits an entirely different structure, and belongs not only to a different genus from the individual figured by Owen, but belongs to a totally different section of the sub-order *Rugosa*. The specimen collected and studied by Owen is a *Strombodes*. The species is a good one, the differences between it and all other described species of the genus being very marked. Moreover, the species may still be collected in the same locality and at the same horizon whence Owen's specimen was obtained. Figure 5, plate v, illustrating this paper, is reproduced from a photograph of an individual which exhibits the exact characters shown in Owen's excellent figure.

The species considered by Billings in the *Canadian Journal* for 1859, page 128, is that which has come to be recognized as *Phillipsastrea gigas*. Its affinities are with *Heliophyllum* and *Acervularia*, and it is not known outside the Corniferous and Hamilton divisions of the Devonian. On the other hand, *Strombodes gigas*, the species described by Owen as *Astrea ? gigas*, has its affinities with *Chonophyllum* and *Ptychophyllum*, and its range is in the lower part of the Niagara Limestone, as the assemblage of strata bearing this designation is developed in Iowa.

The form that we have recently been calling *Phillipsastrea gigas* Owen, on the authority of Billings,* Rominger,† Nicholson‡ and Davis§, is a well marked and easily recognized species, but owing to the error in identifying it with Owen's Niagara species, *Strombodes gigas*, it remains without proper specific designation. The form is somewhat common a few feet above the horizon characterized by *Spirifera pennata* Owen, in Johnson and Linn counties and the southern half of Buchanan, in Iowa. For this magnificent species I propose the name *Phillipsastrea billingsi*. Figures 1 and 2, plate vi, will show the general features of the species so far as relates to details of structure.

The species discussed in this paper should stand as follows:

Ptychophyllum expansum Owen.

Plate v, Figs. 1-4.

Anthophyllum expansum Owen. Report on Mineral Lands, 1844, p. 69. Plate xiii, Fig 3.

Cyathophyllum corintheum Owen. Report on Mineral Lands, 1844, p. 69. Plate xiii, Fig. 6.

**Canadian Journal* for 1859, p. 128.

†*Michigan Fossil Corals*, p. 129.

‡*Pal. of Ohio*, vol. ii, p. 241.

§*Kentucky Fossil Corals*, plate 118.

Cyathophyllum undulatum et multiplicatum Owen. Report on Mineral Lands, 1844, p. 69. Plate XIII, Fig. 10.

Plasmopora astraformis Owen.

Porites ? astraformis Owen. Report on Mineral Lands, 1844, plate XIII, Fig. 8.

Plasmopora follis Edwards and Haime. Foss. de Terr. Pal., p. 220.

Plasmopora follis Rominger. Mich. Foss. Corals, p. 14. Plate III, Fig. 2.

Plasmopora follis Davis. Kentucky Foss. Corals, Plate I, Figs. 9, 10.

Lyellia glabra Owen.

Sarcinula (porites?) glabra Owen, Report on Mineral Lands, 1844, Plate XIII, Fig. 11.

Sarcinula costata Goldfuss Owen, Report on Mineral Lands, 1844, Plate XIV, Fig. 12.

Lyellia americana Edwards and Haime, Mon. Pol. Foss. Terr. Pal., p. 226.

Lyellia americana Rominger, Mich. Foss. Corals, p. 15, Plate II, Figs. 1, 2.

Lyellia americana Davis, Kentucky Foss. Corals, Plate III, Fig. 2.

Strombodes gigas Owen.

PLATE V, FIG. 5.

Astrea ? gigas Owen, Report on Mineral Lands, 1844, p. 70, Plate XIV, Fig. 7. Not *Phillipsastrea gigas* Owen, of Billings and subsequent authors.

Phillipsastrea billingsi Calvin.

PLATE VI, FIGS. 1, 2.

Phillipsastrea gigas Owen, Billings, *Canadian Journal*, 1859, p. 128. Incorrectly identified with *Strombodes gigas* Owen, (*Astrea? gigas* Owen.)

Phillipsastrea gigas (?) Owen, Rominger, *Mich. Foss. Corals*, p, 129, Plate XXXVII.

Phillipsastrea gigas Nicholson, *Pal. Ontario*, 1875, p. 77.

Phillipsastrea gigas Nicholson, *Pal. of Ohio*, Vol. II, p. 241.

Phillipsastrea gigas Davis, *Kentucky Foss. Corals*, Plate 118, Figs 1, 2.

This species may be thus described:

Coralla growing in irregular, hemispherical or lenticular masses varying from a few inches to more than two feet in diameter and covered on lower side with a wrinkled epitheca. *Corallites* irregularly polyglonal, the larger two inches or even more in diameter, intimately united throughout their entire length, not bounded by definite outer wall. *Calyces* shallow with well defined central pit. *Septa* in each corallite from forty-five to sixty in number, thin, more or less confluent with septa of adjacent corallites at their outer margins, bearing numerous, thin, lamella-like carinæ on their sides in the region outside the central pit, very finely denticulated on their free margins, divided into two orders that occur alternately, those of the first order extending into the central area where they are non-carinated and are usually twisted together to form a pseudo columella; the septa of the second order end abruptly at the margin of the central area. *Diaphragms* limited to a very narrow central area. *Dissepiments* feebly developed in the interlocular spaces.

Near the outer margin of the corallites the septa and carinæ become somewhat confused, the septa are often sinuous or zigzag, and the carinæ complicated by the presence of additional elements, to the simple ridge of which a carina is usually constituted. The extreme of confusion and complication occurs where adjacent corallites blend into each other. In polished specimens the central area seems to be quite definitely set off from the outer. This appearance is due to the absence of carinæ within the central area, the suppression of each alternate septina at its margin, and the crowded condition of the carinæ and dissepiments just outside the central pit.

The species in question is in no way related to *Strombodes* and cannot ever be compared with *Astrea ? gigas* (Strombodes gigas)of Owen.

THE PROTOCONCH OF ORTHOCERAS.

By J. M. Clarke.

Divergent views in regard to the nature of the protoconch in the nautiloid genus, *Orthoceras*, have been expressed by Professor Hyatt and Dr. Branco, the principal investigators of the developmental phases of this genus. The facts recorded by both these eminent observers are, in the main, the same.

Branco has considered as the embryonal shell or protoconch ("Anfangskammer"), the conical or cup-shaped termination of the tube as usually found, and which generally bears upon its outer and distal surface a "*Narbe*," or cicatrix. This chamber is separated from the second in order by a siphonated septum, the suture of which is not deeply impressed, or its place indicated on the exterior of the tube by a groove or constriction, or otherwise distinguished from the other septa of the shell.

This "Anfangskammer" of Branco is considered by Hyatt as likewise the first chamber, but of a secondary condition of growth, and not as the embryonal shell; while the "*Narbe*" or cicatrix is regarded as the remnant of the protoconch. In Professor Hyatt's earlier papers this interpretation of the cicatrix was largely a matter of deduction, for no specimens of *Orthoceras* had then been observed which retained much further trace of this feature than a shriveled obsolescent lump or scar on the end of the first chamber, but in the progress of his investigation material has been brought to light which places beyond a doubt the correctness of his interpretation. He has confirmed the point in his recent masterly essay on the "Genesis of the Arietidæ," and illustrated it with original figures of *Orthoceras politum*, Klipstein, and *O. elegans*, Muenster, from the St. Cassian beds.*

The protoconch of these species, though conspicuous in comparison to its usual condition of retention, is still but a shrunken,wart-like appendix, its size being in strong contrast to that of the first chamber.

Hyatt explains the wrinkled aspect of this lump by "assuming it to have been composed of conchiolin. This accounts for its almost invariable absence, since such an organ must have been easily lost or destroyed. The lumps must consequently be regarded as the remnants of conchiolinous protoconchs having elongated and narrow apertures; but probably they were, when in a living condition, much larger and more oval and more similar to the protoconch of the Ammonoids."†

The purpose of this note is to describe and illustrate a protoconch evidently of a species of *Orthoceras*, found in the *Styliola limestone* of the Genesee shales, on Canandaigua Lake, N. Y., in an asssociation of species which represents the earliest appearance in this country of the fauna of *Goniatites intumescens*, Beyrich.‡

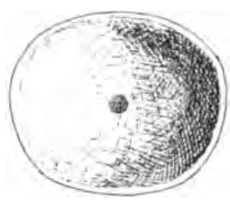
**Op. cit.*, page 10.

†*Op. cit.*, page 9.

‡For a preliminary list of the species of this fauna, both in its first appearance in the *Styliola limestone* and in its reappearance and more abundant development in the *Naples beds*, see Neues Jahrbuch für Mineralogie, etc., vol. I, p. 161, 1891, and AMERICAN GEOLOGIST, p. 86, 1891.

The specimen is briefly described. It consists of the first or apical chamber of the shell, to which the protoconch is attached. The upper end of the specimen shows the first septum (not counting the "apical plate" separating the protoconch from the first chamber) to be circular and with a central sipho. The lateral walls of the first chamber taper rapidly to the plane of conjunction with the protoconch and its depth is about one-half that of the latter.

The protoconch itself is semiovoid in shape, and when compared with those of *Orthoceras* previously described or figured, is of very large size. It shows no indication of shrinking or other irregularity and its distal extremity is perfectly smooth.



The length of the entire specimen is .85mm.; that of the protoconch, .60 mm., and the diameter of the first septum, 1 mm.

As this specimen was found by itself in no immediate association with *Orthoceras*, the great size of the protoconch led at first to some doubt as to its correct generic relations.

Although specimens of *Orthoceras* are not uncommon at this horizon, *Bactrites* is equally plentiful,* and the examples of both in my possession, in condition of preservation, leave little to be desired for the study of developmental phases. The critical distinction between the protoconch in question and that of *Bactrites* is one of some delicacy and is, namely, the position of the sipho upon the first septum. Branco has

*The usual species of *Bactrites* occurring in the *Styliola layer* and, more abundantly, with the recurrence of the Intumescens-fauna in the "lower Portage," is probably the same fossil to which was originally given the name *Orthoceras aciculum*, later called *Coleolus aciculum*. The usual mode of retention of this, as well as of the associated fossils distributed through the shales, does not often permit satisfactory determination of generic characters.

shown that the protoconch in a single specimen referred to *Bactrites*, is ovoid,* but in the examples from the Naples beds it is much shorter, subspherical and its resemblance to that of this *Orthoceras* very close. As far as I am aware the course of lateral (dorsal) sipho across the first chamber of the shell has not before been ascertained in *Bactrites*, but it is here clearly evident that the siphonal passage on the first septum is distinctly lateral and does not change to a central position in traversing the first chamber.

With this point determined there seems no reason to quession that this protoconch is one of the *Orthoceras* which has undergone no atrophy or resorption. Perhaps some explanation of its fullness and comparatively great size may be found in the following consideration. The associated individuals of *Bactrites* bearing protoconchs are, to a very large degree, actual young shells retaining the chamber of habitation, and not fragments of partially grown or mature individuals. Similar young and nearly entire shells of *Orthoceras* have also been found, but without the protoconch. It is probable that this protoconch has been derived from a shell so young that atrophy and wrinkling have not manifested themselves as they may have done with the more mature development of the shell. This, I believe, is the only recorded observation of the protoconch in palæozoic forms of *Orthoceras* and its shrunken condition in the post-palæozoic forms may have a phyletic significance. Attention may be directed to the remarkable similarity in form between this protoconch and that of *Belemnites*, as given by Branco.† The difference in the two lies wholly in the position of the sipho which is lateral at the first septum of *Belemnites* and hence the protoconch of the latter is a notable reproduction of that of *Bactrites.*

EDITORIAL COMMENT.

In the August number of the "Popular Science Monthly" Major Powell, the director of the U. S. Geological Survey, has published an article apparently in reply to one that appeared

*Zeitschrift der deutsch. geolog. Gesellschaft, vol. 37, p. 3, 1885.
†*Op. cit.* vol. 32, p. 608, 1880.

in the April number from the pen of one of the editors of the AMERICAN GEOLOGIST. The distinguished writer, though perfectly courteous, fails to meet the point of the previous article and does not, consequently, answer any of its criticisms. So far from being an attack upon the U. S. Geological Survey is was aimed solely at certain writers (of whom Major Powell says that only one is a permanent member of that body) who had trespassed beyond the due limits of scientific criticism in their reviews of Prof. Wright's recent book, and far beyond the bounds of courtesy in their attacks on Prof. Wright himself. All that the director has written in defense of the survey is, therefore, beside the mark, while the discourtesy and bad logic of the assailants pass unnoticed and therefore unrebuked.

Of course, we acquit the Director of all part in the original controversy. He was, he says, away from home and an invalid. But a word from him even implying disapprobation of so unusual and unbecoming a mode of conducting a scientific controversy would have been of great weight and significance.

This is not the place to enter into any argument concerning the evidence for the existence of glacial man in North America. It is one of those geological problems whose solution is not yet fully attained or attainable. It is to be regretted that on a topic where the most scrupulous accuracy of statement is eminently desirable, a writer of Major Powell's distinction should have allowed himself to use language so lax or so capable of being misunderstood. As an illustration, when writing of the quartzites found on Piny Branch, he says: "Objects of the same character have been found all over the United States. Within the last twenty years the writer has seen them made by Indians in the Rocky Mountain region, and they are scattered far and wide over nearly all the gravel hills of the United States." No doubt there is much truth in these words, but they are too sweeping in their significance.

Again, the circumstances of the finding of the Nampa image, as given by Prof. Wright in the Proceedings of the Boston Society of Natural History, are quoted incorrectly and apparently at second or third hand. Indeed, the language of Major Powell is almost a burlesque of the original and suggests a more erroneous notion of the facts than it actually asserts.

The Director has given the facts regarding his connection with the image and it is now easy to see the utter inaccuracy of the story as related by at least one of the critics in the American Anthropologist and in the Literary Northwest. Nothing more is needed to destroy the value of that attack.

One word should be added with regard to this image. It is not quite fair to speak of it in connection with so-called palæoliths as if it were classed with them. No one has put forward such a claim. Both it and the Californian relics, if all genuine, are manifestly of different type from any palæolithic implements or utensils, and Prof. Wright, in his book, has given due prominence to this fact, dwelling at length on the recency of the lava flow and its erosion. The error lies in the assumption that the glaciation in California was contemporaneous with that of the eastern states, a point on which Major Powell's language is not sufficiently guarded.

We observe that the case on which Prof. Wright lays the most stress as having come under his own observation—the flint from the Newcomerstown gravel—is not so much as referred to in the article. Possibly the writer felt in regard to it as one of his fellow disputants now feels. The following lines which recently appeared in Science are exceedingly significant:

"The critical scrutiny of the evidence of palæolithic man in North America, which has lately occupied considerable attention, has perhaps been pushed too far. When, as in the Ohio field, discoveries have been made which cannot be gainsaid, it is scarcely fair to prefer every conceivable explanation of them to the simplest one—that the articles were originally deposited where found." (Science, 23-6-93, p. 341.)

Contrasting this with the language of the same writer, a few months ago, we note an important change of opinion. We quote his own words:

"Dr. Wright's next examples are the finds of rough implements in the glacial gravels of Ohio by Dr. Metz, Dr. Cresson and Mr. Mills. The first two are eminent archæologists, but neither is a geologist. Not one of the finds, therefore, is conclusive." (Science, 28-10-92, p. 249.)

Yet not a tittle of additional evidence has been published in the interval.

Omitting other misquotations and misstatements, we will refer to only one more. Major Powell, in speaking of Prof. Wright's book, says it was widely advertised and circulated "as the greatest contribution that had ever been made to glacial geology." We do not recollect having ever seen any such advertisement or anything even remotely approaching to a similar description of the work. Nor do we believe that any such claim has been put forward on its behalf by any one, least of all by its author. Had any pretentious assertion of this kind been made, it would assuredly deserve severe condemnation from Major Powell or anyone else.

Into the vexed question of Prof. Wright's connection with the U. S. Geological Survey we will not enter. It seems to us that the sensitiveness manifested on this point by some of the disputants is quite superfluous; that the dates which have been published effectually dispose of all ground for objection and that it is scarcely consistent to profess a desire to disown a worker while making so free a use of the results of his work.

REVIEW OF RECENT GEOLOGICAL LITERATURE.

Continental Problems: Annual Address by the President, G. K. Gilbert. Bulletin of the Geological Society of America, vol. iv, p. 179-190, with five figures in the text; February 27, 1893. This paper states the principal problems relating to the origin and history of the earth's continental plateaus which are expected to have a prominent place among the themes of discussion by the International Congress of Geologists in its session as one of the auxiliaries of the World's Fair, during the closing part of this month. About two-fifths of the surface of our globe are depressed between 11,000 and 16,000 feet below the sea level, forming the deep, somewhat uniform ocean beds; and one-fourth lies between the contour 5,000 feet above the sea level and the contour 1,000 feet below it, having a mean altitude of about 1,000 feet and forming the continental plateaus. Two answers are given to the question: How are the continents held up? The first regards the earth's mass as so rigid that it is strong enough to sustain the vast weight of the continents above the low ocean basins; while the second, which Mr. Gilbert thinks more probable, supposes the density and therefore weight of the continents and of underlying portions of the earth's crust to some undetermined depth to be less than of the portions beneath the oceans, so that at some level horizon far below the surface the weight of the overlying matter is everywhere the same. The first is called the doctrine of terrestrial rigidity, and the second the doctrine of isostasy. If we accept isostasy, the second problem is expressed in the question whether the difference between the continents and ocean floors in their density is due to a difference in their temperature or arises from differences in composition. Proceeding next to the question of the origin of the continents, the only or chief hypothesis which has been propounded, namely, that of Dana, is regarded as perhaps accordant with the theory of isostasy, but in need of more full comparison with the increasing data of recent years. The author's studies of the moon led him to suspect that the continents may have begun to exist on account of accessions to the matter of the earth's equatorial tract; but this hypothesis is set aside because the great circle most coincident with the continental areas passes through the poles. Differential elevation and subsidence of the continental plateaus are believed by Mr. Gilbert to depend on causes which are yet unknown and have probably not yet been suggested. Again, the general permanence of the continents, though highly probable, is not yet fully demonstrated; and the doctrine of the growth of continents, although generally accepted, is shown to be still open for profitable discussion.

Comparison of Pleistocene and Present Ice-sheets. By WARREN UPHAM. Bulletin G. S. A., vol. iv, pp. 191–204; March 24, 1893. From the ascertained slopes of the surface of the Greenland ice-sheet, the author infers that the glaciated areas of North America and Europe were much uplifted, so that the borders of their Pleistocene ice-sheets had similarly steep slopes, the amount of uplift for the central portion of Canada being thought to be not less that 5,000 feet. From the rate of erosion of the Muir glacier, found by Wright and Reed to average about three-fourths of an inch yearly, it appears that a period of perhaps 10,000 or 20,000 years would suffice for the observed volume of the Pleistocene glacial erosion and resulting drift. The recent exploration of the Malaspina glacier or ice-sheet in Alaska by Russell is thought to sustain the view that the ice-sheets of the Glacial period had much englacial drift; that during their departure the annual amount of ablation may have been twenty-five feet or more, so that near the glacial boundary a thickness of 2.000 to 4,000 feet of ice would be melted in one or two centuries; that large portions of the englacial drift were carried away by streams to form eskers, kames and valley drift; and that forest beds enclosed between deposits of till probably in most or all cases were formed by only moderate re-advances of the ice-sheets. The chief evidence which has been supposed to prove interglacial epochs appears therefore consistent instead with the view that the Ice age was continuous and geologically brief.

Cretaceous and Early Tertiary of northern California and Oregon. By J. S. DILLER. Bulletin G. S. A.; vol. iv, pp. 205–224, with maps; April 14, 1893. The Wallala formation of Becker and White is shown, through Dr. Dall's observations, to be a phase of the Chico beds, which, though formerly supposed to be separated by a long interval from the beds at Horsetown, are now found to be with these and the Knoxville beds an essentially conformable and continuous series of sediments, deposited without distinct interruption. During that time, beginning with the Shasta or Knoxville and Horsetown beds and extending onward to the Chico, the region of the Klamath mountains was sinking, and the subsidence continued until the sea reached the western base of the Sierra Nevada and all or nearly all that part of California northwest of the present site of Lassen Peak, and almost the whole of Oregon, were beneath its waters. The Chico and Tejon beds, however, which in middle California appear as a continuous series, are found by Mr. Diller to be separated in Oregon by unconformability, and the paleontologic evidence, so far as it goes, indicates a faunal break in that region between the Chico and Tejon formations, the latter of which is regarded as the earliest Tertiary of California and Oregon. Between the times of deposition of these formations the area of the Klamath mountains was again raised above the sea, and its Shasta-Chico beds were subjected to mountain-folding.

The Faunas of the Shasta and Chico Formations. By T. W. STANTON. Bulletin, G. S. A., vol. iv, pp. 245–256; June 8, 1893. Comparative study of all the collections of fossils from these formations, which were described in the foregoing paper, shows that they are united and have no faunal break. Certain portions of the series are characterized by the abundance of particular species or genera, as *Aucella* in the lower beds and several genera of ammonites in the Horsetown division; but these sub-faunas are so bound together by connecting species that they cannot be regarded as really distinct. The whole is therefore named the Shaska-Chico fauna, and its age at least in the Horsetown beds, is regarded as not more recent than the Cenomanian.

On the Geology of Natural Gas and Petroleum in southwestern Ontario. By H. P. H. BRUMELL. Bulletin G. S. A., vol. iv, pp. 225–240; May 20, 1893. At Petrolea, in Lamberton county, Ontario, where rock oil has been produced during the past thirty years, it is found in the Corniferous limestone at the depth of about 475 feet. In that district some 3,000 wells are stated to be now producing, their yearly supply being about 800,000 barrels. The oil cannot be easily refined, on account of the considerable proportion of sulphur which it contains in a form as yet undetermined. Though the Corniferous formation yields merchantable quantities of oil only in this county, it is known to be somewhat petroliferous over a wide extent of adjoining country. Gas has been found in this region in large quantities at two geologic horizons, one being in or near the Clinton in Essex county, and the other being the Medina in Welland county. A detailed report on these wells, with maps and sections, is soon to be issued by the Canadian Geological Survey.

Notes on the Occurrence of Petroleum in Gaspé, Quebec. By. H. P. H. BRUMELL. Bulletin, G. S. A., vol. iv, pp. 241–244; May 20, 1893. Prospecting for petroleum has been carried on in a desultory manner for about thirty years in the vicinity of Gaspé basin, on the eastern part of the Gaspé peninsula, Quebec. The oil-bearing formation consists of a great thickness of sandstones and underlying limestones, the whole being of lower Devonian and perhaps partly Upper Silurian age. Recently a well bored here by an English company is said to have reached a depth of 3,000 feet, passing through 2,150 feet of yellow and white sandstone, and then through 850 feet of bluish shaly limestone, in which, at a depth of about 2,600 feet, a small quantity of high-grade oil was found. The further exploration of this oil district, in view of the probable exhaustion of the Petrolea field in Ontario, will be watched with interest.

Two Neocene Rivers of California. By WALDEMAR LINDGREN. Bulletin, G. S. A., vol. iv, pp. 257–298, with five plates of maps, sections, and grades; June 19, 1893. This paper embodies a part of the results of the author's work under the direction of Dr. G. F. Becker, for the U. S. Geological Survey in the Gold belt of the Sierra Nevada. In connection with the detailed mapping of the country on the scale of about two miles to the inch, much accurate information has been obtained concerning the Neocene or late Tertiary river channels, now largely covered by deep volcanic flows or removed by erosion. The auriferous gravels of the remaining portions of these channels give to them a great practical importance. It seems to be proved that the Sierra Nevada in Neocene times, in the watersheds of the Yuba and American rivers, formed a mountain range as distinct as that of to-day, and that its first summit in general coincided with the corresponding present divide. But the grades of the remaining Neocene gravel channels indicate that the western slope of the Sierra has been made considerably steeper since the ante-volcanic rivers flowed on its surface, through uplifting of the middle part of the range and relative subsidence of its western border. The process of this deformation is shown to have probably taken place, as Dr. Becker first pointed out, by a multitude of distributed faults of slight throw, rather than by tilting as a single rigid block in the manner advocated by LeConte. With the latter hypothesis, the maximum amount of tilting would appear to be 60 to 70 feet per mile, giving to the range a maximum increase of elevation of between 3,600 and 4,200 feet; but the hypothesis of Becker and Lindgren, which seems to accord better with the often apparently local and irregular deformation, may allow greater increase of hight. The author thinks that the Sierra Nevada, before the accumulation of the Neocene gravels began, was a mountain range greatly worn down by erosion, but not reduced to a baselevel.

Malaspina Glacier. By ISRAEL C. RUSSELL. Journal of Geology, vol. i, pp. 219–245, with map; April-May, 1893. Among the characters of this glacier or ice-sheet which are brought out here for the first time or are presented more prominently than in the author's previous papers on this subject, perhaps the most noteworthy is the supply of much, probably the greater part, of its ice by outflow from the extensive high névé field which lies north of the Augusta and St. Elias ranges. This vast névé expanse has a general elevation of 8,000 or 9,000 feet, and is pierced by hundreds of short ranges and isolated peaks which rise by estimate some 5,000 to 6,000 feet above the ice-filled valleys. The Seward glacier, which is the principal feeder of the Malaspina ice-sheet, flows from the high névé tract. In examining the map it will be seen that the drift which covers the entire outer border of this ice-sheet cannot be all or mainly supplied by the lateral and medial moraines of its confluent tributaries from the mountain valleys, but that on the inter-morainic portions of the border it must have been brought by englacial transportation in the lower part of the ice, being exposed on the surface by ablation. Drainage in many places by englacial streams, washing away portions of the englacial and superglacial drift has formed esker ridges and broad deposits of sand and gravel spread out over the thinned margin of the ice, these features being best observed on the eastern edge of the ice-sheet adjacent to Yakutat bay. On this side, in one locality, the ice has recently advanced into the dense forest and cut down scores of large spruce trees, piling them in confused heaps. In its advance the ice here plowed up a ridge of blue clay in front of it, revealing thus the character of the strata on which it rests. This clay is thickly charged with sea-shells of living species, proving that the glacier in its former great advance extended into the ocean, and that a rise of the land has subsequently occurred. Similar shells, likewise all of a living species, had been previously found in the strata forming the crest of a fault scarp at Pinnacle pass, 5,000 feet above the sea.

The Osar Gravels of the Coast of Maine. By George H. Stone. Journal of Geology, vol. i, pp. 246–254; April-May, 1893. In this summary of a report to be published by the U. S. Geological Survey, the author ascribes the osars or eskers of the coastal region of Maine to deposition by streams flowing in sub-glacial tunnels, supposed to pass in some places upward and over transverse hills and to continue beneath the sea-level to the ocean-bordered ice-front. To account for the termination of the osars at a nearly uniform altitude above the present sea-level, which is some 200 feet below the late glacial coast line, and for the discontinuous condition of the seaward ends of the osars, with gaps of varying lengths, it is supposed that beneath the sea level the subglacial streams were unable to enlarge their tunnels by melting and that the rush of water through the constricted portions swept them clear of all drift, bearing it onward to the debouchures of these streams in the open sea. If this were the case, however, we should expect large submarine deposits of gravel and sand like the material of the osars to have been amassed at these places. The absence of such deposits seems to render this view very doubtful; and we may therefore ask whether it is not more accordant with the observed facts to attribute these osars to deposition in the cañon-like lower reaches of superglacial streams close to their debouchure from the ice-front into the ocean.

The Horizon of Drumlin, Osar and Kame formation. By T. C. Chamberlin. Journal of Geology, vol. i, pp. 255–267; April-May, 1893. This paper presents arguments for the view that the drumlins, osars, and kames were formed chiefly or wholly from drift borne along beneath the ice, and in the case of the sand and gravel osar and kame deposits further transported and heaped up in their present forms by subglacial streams. Among the materials of kame hillocks, incorporated masses or tongues of typical till of the ground-moraine type have been observed, with gradations from them to partially modified masses and layers, half of till and half of gravel, and to completely assorted and stratified gravel and sand, thus showing every stage of derivation from the underlying and surrounding till. The view assumes that the amount of englacial drift was too scanty to yield these deposits, and that all or nearly all the drainage of the departing ice-sheet found its way through crevasses and moulins to the ground. It seems very difficult, however, under these conditions to account for high osar or esker ridges, like that of the Pinnacle hills near Rochester, N. Y., 100 to 200 feet above the surrounding nearly plane surface, yet containing throughout all their mass, quite to their top, plentiful large and small boulders and gravel which in that instance were derived from ledges within a distance of no more than three or four miles northward. These hills and other eskers and kames presenting similar characters must apparently have been formed by streams flowing down from the melting ice-surface and gathering its englacial and finally superglacial drift in open ice-walled channels. The drumlin observed in Wisconsin and mentioned as resting on and enveloping a knob of peculiar quartzite may have been deposited in the manner supposed by Upham in his paper in the last December GEOLOGIST, in which case its accumulation would necessarily be attended with much abrasion of the knob and incorporation of its fragments in the drumlin mass. This essay and many others which have lately appeared seek for explanations of the manner of drift transportation and deposition, that is, of the genesis of our drift formations; and two diverse working hypotheses, one believing the englacial drift to have been plentiful, the other that it was of small amount, lead to somewhat unlike interpretations for these and for nearly all our other drift deposits. Meanwhile, to this and all questions concerning the history of the Ice age, much light is being brought by the explorations of the Malaspina glacier and the Greenland ice-sheet; but the conditions attending the closing stages of the Pleistocene glaciation were doubtless in some respects widely different from those of the now existing ice-sheets of arctic and antarctic lands.

The Finger Lakes of New York. By ALBERT P. BRIGHAM. pp. 21. Reprint from Bulletin of the American Geographical Society, vol. xxv, 1893. The region of the Finger lakes in the south central part of New York is regarded as a plateau extending from the Catskill mountains to the Genessee river, with its summits about 2,000 feet above the sea and much of its general surface above 1,000 feet. The main watershed of this plateau extends from east to west with slopes descending from it, one northward to lake Ontario and the Mohawk, the other southward, bearing the head streams of the Susquehanna. Upon both faces of this east and west ridge or plateau and extending across the divide, is found the remarkable series of deeply cut valleys which hold the Finger lakes. The altitudes of these lakes above the sea ranges from Cayuga and Seneca, which are the two lowest and largest, respectively at 378 and 441 feet, to Canadice, the highest, at 1,099 feet. Cayuga and Seneca lakes each exceed thirty miles in length and have maximum widths of three miles, with maximum depths respectively 435 and 618 feet, in each case reaching below the level of the ocean.

The main outlines of the contour of this region are believed to have been produced in pre-glacial times by subaërial erosion; and the channels cut in the plateau by its streams flowing southward and northward appear to have become continuous by backward cutting at their head-waters, with only low cols separating them in the present Finger lake valleys. The narrowing of these valleys toward the southern ends of the lakes and at the present moraine-covered water parting leads to the conclusion that the streams then flowing where the Finger lakes now lie were tributary to the preglacial river whose valley now is occupied by lake Ontario. During the Glacial period ice erosion moulded the highlands in smoothly flowing slopes, crowned with long, gentle, drumloidal swells, thinly enveloped by drift; but at the northern ends of the lakes a considerable depth of drift was deposited in the northward continuation of their valleys, sufficient, probably, in the case of Cayuga lake to account for at least half of its depth, and for about two-fifths of the depth of Seneca lake. The residue of the depths of these lakes, besides the unknown but probably small thickness of their bottom sediments, is attributed to glacial excavation, aided to some degree by crust oscillation. Within recent time the erosion of small tributary streams has formed the beautiful Watkins and Havana glens and the Glen Ora and Hector falls on the borders of Seneca lake, the Eagle Cliff and Taghannock falls in and near Ithaca on Cayuga lake, and many other very picturesque ravines and waterfalls.

The Origin of Igneous Rocks. By Joseph Paxton Iddings. Philosophical Society of Washington, Bull. vol. xii, pp. 89-214, June, 1892.

Mr. Iddings has had ample opportunity in carefully studying several volcanic regions to collect much valuable data concerning the "consanguinity" of igneous rocks, and in this paper he presents in detail his "reasons for concluding that all the volcanic and other igneous rocks of any region are so intimately connected together by mineralogical and chemical relations that they must have originated from some single magma, whose composition may be different in different regions; and, further, that it is the chemical differentiation of this primary magma which gives rise to the various kinds of igneous rocks."

The first part of the paper is devoted to a historical review of the ideas held by different geologists as to the nature and origin of igneous rocks. Beginning with Scrope, to whom we are indebted for the first modern treatise on volcanoes, the contributions of the more important authors are mentioned, chief among whom are Darwin, Dana, Bunsen, Von Walterhausen, Von Richtofen, King, Dutton, Rosenbusch and Brögger. In the next part of the paper the mineralogical, chemical and geological evidences of the *consanguinity* of igneous rocks are fully discussed. This term is used to express the idea that all the igneous rocks of any volcanic district have been derived from a single stock-- i. e., from a common but gradually varying magma. The localities from which most of the illustrations are drawn are two regions with which the author is very familiar,—Electric peak and Sepulchre mountain, and Crandall basin. Following this is a consideration of the differentiation of molten magmas, the cause, processes and results of differentation and the localization of volcanic phenomena. Arguments are presented to show that the compounds of a magma do not exist as definite mineral molecules, nor even as fixed silicate molecules, but as simple oxide molecules, which arrange themselves in different associations according to physical circumstances; and that differentiation does not go on in accordance with definite stoichiometric proportions. The conclusion is that the character of the differentiation of molten magmas is "that of a chemical separation affecting the elementary oxides of the constituent elements," and that the magma is a solution of these oxides. In this the author differs from the ideas of Bunsen and Lagorio and those usually accepted,— i. e., that a molten magma consists of a solution, or perhaps an alloy, of the different fixed mineral compounds, the solvent being an acid silicate of potash and soda. He also differs from the recently published views of Rosenbusch, one of the recognized leaders in the study of igneous rocks, and concludes that Rosenbusch's idea of the existence of certain definite, stoichiometrically proportioned molecules, termed "kerns," which are capable of dissolving any of the oxides or metals in rocks to varying extents, is without foundation. Differentiation in a molten magma must have gone on when the magma was still fluid and is not due to the crystallization of certain minerals and their subsequent accumulation by gravity or other means in certain areas, as has been suggested by Brögger and Vogt. The cause of differentiation is thought to be differences in physical condition in different parts of the magma, and the means, as first suggested by Lagorio, is the application of the principle of Soret, who found that if two parts of a solution of any salt be kept at different temperatures there will be a concentration of the salt in the cooler part of the solution.

In the views as to the consanguinity of the igneous rocks of any area and the idea that a molten magma is not composed of solutions of fixed mineral compounds, Mr. Iddings has taken a step in advance of the thinkers in this realm, and too much cannot be said in praise of his excellent article. A valuable part of the paper is the selected tables of accurate rock analysis and also the diagrams of molecular variations in certain groups of igneous rocks.

CORRESPONDENCE.

The Formation of a Terrace.—On the southeast shore of a lake lying in the S. E. ¼ of Sec. 3 in the township of Aastad, Otter Tail county, Minnesota, is a remarkably well developed beach ridge for a lake of so small size. It rises about six feet above the level of the lake, extends across an inlet which has thus been lagooned, and throughout its length of about thirty rods has the form of a circular arc of 45°. The lagoon outside the beach is at least four feet higher than the lake, and has an area of about two acres, with a level bottom excepting a narrow belt around the shore, and at present contains one and a half feet of water, it being a wet season. In spring, or during heavy rains, a stream flows into this lagoon from the southeast, which drains a small pond and about 50 or 60 acres of the adjoining hillsides.

A section of the ridge from its summit to a depth of four feet reveals stratified sand and gravel, containing many pebbles from one to two inches in diameter, but mingled with mud throughout, which forms probably 25 per cent. of the entire deposit. The pebbles seem to be little waterworn, being like those found in summits of hills interpreted as glacial moraines. Here and there through the beach formation could be found a barely distinguishable stratum of pure sand, sloping toward the lake, with very uncertain continuation. The stratification of the material of this ridge could better be recognized at a distance of a few feet than by nearer examination. The general contour of the ridge corresponds, however, so accurately to the type of beach ridges that there can be no question as to its origin.

Passing along the ridge from its western end, one finds the summit there to form a nearly level plateau, about three rods wide, and a slight depression exists between the verge of the plateau toward the lake and its verge toward the lagoon. The whole formation bears the appearance of being two ridges thrown up at successive times, the last being two or three rods nearer the lake, fully as high as the first, and at some points higher. The first beach thus formed, or the side of it now apparent, terminates abruptly about midway between the two extremities of the ridge; but it rises again from the water four or five rods on, leaving in this break a kind of bay nearly two rods deep, indenting the beach deposit as far as to the second ridge. The break lies nearly opposite the mouth of the watercourse which enters the lagoon. It appears that the ridge in its earlier history had this break through which the stream current and the waters of the lagoon issued into the lake. The second beach formation dammed this channel, probably at a time when the lagoon was dry or when its bottom had been raised by sediment so as to discharge its water into the lake, leaving no current to maintain the channel.

It is a question of only a short time when the sediment carried in by the rills from snow and rain, and the mud deposited by snow drifted hither and melted, will raise the bottom of the lagoon to a level with the beach ridge which has dammed it up. Then people will see here a terrace with no conclusive indication of its origin. The writer has in mind two such terraces which he once endeavored to explain as delta plains, until characteristics in their formation clearly disproved this theory. In each case the face of the terrace sloping toward the lake consisted of stratified sand and gravel, while farther back the ground was marshy, consisisting of mud which was not penetrated by digging to a depth of four feet.

Perhaps it should be added that the remarkable hight of the beach deposit described as adjoining this lake in Aastad is explained by the fact that the shores to the right and left of the beach approach each other toward the original inlet till the distance between them is only about twenty rods at the place where the beach was formed. This undoubtedly caused a concentration of the force of the waves as they rolled in from the northwest, a distance of a little more than half a mile.

Fergus Falls, Minn. N. P. NELSON.

THE DRIFT MOUNDS OF OLYMPIA AND OF LONG ISLAND.—I was much interested in reading the paper on the "Drift Mounds of Olympia" in the June number of the GEOLOGIST, as I had just paid a second visit to the so-called sand-dunes at Easthampton, Long Island, and I am inclined to think that they have a common origin.

In 1891, September number of the AMERICAN GEOLOGIST, I spoke of these peculiar ridges as being formed by streams of water flowing from the front of the ice-sheet, and this view has been confirmed by subsequent investigation; but I am inclined to think now, that said streams were in a sense *subglacial;* that is, the upper part of the glacier seems to have advanced some distance south of the so-called terminal moraine. As early as 1885,* I had partly conjectured this, but misled by the common idea that the backbone of the island marked the southern limit of the ice-sheet, I was unable to account for certain phenomena connected with the drift ridges and clay deposits that make up the south side. The study of the englacial till however, has led me to see that this upper drift extended further southward than the subglacial till, as the bottom drift is called, and yet, the absence of large boulders on the south side of the island is difficult to account for, as they seem to end at least, with the marginal kames. The clay, however, covering the stratified deposits is continuous from the central ridge to the ocean, but thins out from about two feet to a few inches.

Most writers have imagined that this frontal plain, with its ridges on deltas, was formed underneath the waters of the ocean when the sea stood over this part of the island, and that it was subsequently elevated. I do not know how many ups and downs our poor island has had in the hands of theoretical geologists, but there is no appearance of oscillation at least, since the age of ice.

In regard to the drift mounds of Olympia, G. O. Rogers rejects Professor Le Conte's theory of their origin, and formulates one similar to my own, with this difference, that the streams that assisted in forming the mounds were superglacial instead of subglacial. Mr. Rogers may be correct, but if the Olympian mounds are in any way related to the hummocky ridges on the south side of Long Island, I would question his theory very much, They were doubtless formed similar to kettle hole depressions with their interlacing ridges, but were not the depressions, as well as the mound ridges, formed beneath the ice? These are no

*See my pamphlet on "The Geological Formation of Long Island, 1885," p. 8.

chance formations, but they belong to a beautiful and wonderful system of drainage. I have followed these old river channels through the terminal moraine, from depressions in the north, and they begin to ramify in the same way as they enter the plain on the south, and the hummocky ridges are more or less prominent, and complicated according to the size and sweep of the ancient currents. The so-called sand-dunes of Easthampton, have no counterpart on the island as far as their peculiar contour is concerned, yet, when Mr. Howell of Southhampton called my attention to them in 1886, I at once conjectured their origin, although they had always been a puzzle to him. He wrote: "These are veritable sand-dunes of white sand, covered with a growth of ordinary beach grass, and a geological puzzle. If we could say they were deposited by a cyclone it would shorten matters, but we can't, and there is a difficulty in holding that they are signs of an old beach line. It is with me a standing puzzle." A study of like phenomena on the west end of the island gave me the key to unlock the mystery, and I explained their origin to him although the locality had never been visited by me. A brief visit to Easthampton in 1891 fully confirmed my conjectures. I went over them carefully in my second visit, only a few weeks ago, and now I am more confident than ever that subglacial streams played an important part in their formation. The sand in the hills is finely laminated, but the surface of the narrow wall-like top ridges are covered with till containing small fragments of rock, not so much water-worn as the pebbles found between the ridges. In a bank by the side of the road, underneath what appeared to be englacial till, was a deposit of clay several feet in thickness, containing some boulders of the cobble stone order, mostly quartz and fragments of Archean rock. One I found of hard sandstone with a brown crust something like a loaf of bread baked hard in a slow oven. It was similar to one found by me at Phœnix Hill, Louisville, Ky., in the clay covering the limestone rock. It was a singular coincidence and it impressed me very much.

The spaces between the ridges which are amphitheater-like in form, contain some of the best farming lands of the Hamptons, and during my last visit the air was sweetly scented by the fields of clover, while the ridges enclosing them were scantily covered with coarse grass, with here and there a shrub or dwarfish cedar. They are certainly singular formations like the drift mounds of Olympia, yet any one familiar with such phenomena can see they are not "*veritable sand-dunes*," but are due to streams of water which flowed at one time from the main ridge some two or three miles distant. Their submarine origin, as held by some, I think, is out of the question.

If the drift mounds of Olympia and the Easthampton ridges are in any way related then Mr. Rogers and the present writer are not very wide apart, after all, in the conclusions arrived at as regards their origin. I hold however, that the streams that formed them were in a sense subglacial, that is, the upper part of the glacier must have extended over the regions in question, and that the mounds, or ridges, were formed beneath the ice-sheet, the final liquefaction of which left the slight clayey deposit on the surface so much like englacial till, already referred to, as occurring at Easthampton; and this may be the finer top soil mentioned by professor Le Conte as being left in spots on the Olympian mounds.

From the description of the latter, by Mr. Rogers, I am almost certain that they are the same in origin as the drift hills of Easthampton, and if the true explanation is found for one, it will solve the problem of the other. There is little doubt but that the same phenomena exist along the whole southern front of the ice-sheet, although there may be sections seemingly altogether different in character. I know it is so on Long Island. The Shinnecock hills, for instance, are really marginal kames without any terminal moraine proper, such as we find on the west end of the island, while across the Hempstead plains there is nothing but a fringe of boulders to mark the southern limit of the ice-sheet.

Therefore, the *terminal moraine* has been represented as passing near Roslyn while in fact, it is, or *should be*, several miles in advance of this point. All this diversified condition of things is due to the action of the old subglacial streams, and the quality of the drift. These phenomena, no matter how diversified, are all subject to the same law and there is nothing like chance or confusion about them when properly understood. Mr. Rogers says that the Olympian mounds are without order; Chamberlain and Salisbury also speak of the drift ridges as defying all laws of symmetry and orderly arrangement,* but I cannot think so, if they are in any way related to the drift formations of Long Island.

JOHN BRYSON.

Eastport, L. I., June 20, 1893.

PERSONAL AND SCIENTIFIC NEWS.

MR. E. H. LONSDALE, LATELY OF THE MISSOURI GEOLOGICAL SURVEY, has transferred his field of operations to Iowa, where he is now assisting in the work of the geological survey of that state.

MR. H. F. BAIN, FOR TWO YEARS PAST student at the Johns Hopkins university, is now assisting in the work on Iowa coals, in connection with the state geological survey.

IN THE EARLY AUTUMN, THE MISSOURI GEOLOGICAL SURVEY will issue its first volume on the Palæontology of the state. It is by Dr. Charles R. Keyes. There are six hundred pages of text, about sixty plates, including several hundred figures, and a large colored geological map of the state, besides other illustrations.

THE REPORT OF THE LEAD AND ZINC DEPOSITS of Missouri, by Mr. Arthur Winslow, state geologist, and James D. Robert-

* *The Driftless Area*, Chap. 3. p. 261, Sixth Annual Report, U. S. Geol. Survey.

son, assistant geologist, will appear shortly as volume IV of the Missouri geological survey.

THE FIRST ANNUAL REPORT OF THE IOWA GEOLOGICAL SURVEY is now ready for distribution. It is a royal octavo volume of four hundred pages, printed on heavy paper with wide margins. It is illustrated by a dozen full-page plates and numerous figures. It also contains a colored geological map of the state. The papers accompanying the administrative reports of Prof. Samuel Calvin, state geologist, and Dr. Charles R. Keyes, assistant state geologist, are as follows:

Geological Formations of Iowa, by C. R. Keyes -	135	pages
Cretaceous deposits of Woodbury and Plymouth Counties, with Observations on their Economic Uses, by Samuel Calvin - - - -	17	"
Ancient Lava Flows in the Strata of Iowa, by Samuel W. Beyer - - - - - - -	8	"
Distribution and Relations of the St. Louis Limestone in Mahaska county, Iowa, by Harry Foster Bain - - - - - - - - - - -	10	"
Annotated Catalogue of Minerals, by Charles R. Keyes - - - - - - - - - - -	15	"
Some Niagara Lime-burning Dolomites and Dolomitic Building Stones of Iowa, by Gilbert L. Houser - - - - - - - - - - -	12	"
Bibliography of Iowa Geology, by Charles R. Keyes - - - - - - - - - - -	225	"

THE GEOLOGICAL SOCIETY OF AMERICA, with Sir William Dawson as president, will hold its fifth summer meeting in Madison, Wisconsin, on Tuesday and Wednesday, August 15th and 16th. Foreign geologists attending the World's Fair and Congress of Geologists, are invited to attend this meeting and to present papers. A session of exceptional interest is anticipated. In connection with this meeting an excursion will be taken, during the preceding week, to the iron-mining district of the northern peninsula of Michigan, under the guidance of Profs. C. R. Van Hise and M. E. Wadsworth; and during the week of the meeting there will be excursions to Devil's Lake, to the Dells of the Wisconsin river, and to the border of the Driftless Area, in the vicinity of Madison, under the guidance of Profs. Chamberlin, Salisbury and Van Hise.

IMMEDIATELY FOLLOWING THIS MEETING, THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, with Prof. William Harkness presiding, will hold its forty-second meeting in Madison, Wisconsin, August 17th to 23d. The meetings of the several sections will be in the buildings of the State University. Section E (Geology and Geography) will meet in the Geological lecture room, with Mr. C. D. Walcott, presiding, and Prof. R. T. Hill, Secretary. Mr. Walcott's vice-presidential address, to be given on Thursday afternoon, August 17th, is entitled "Geologic Time as indicated by the Sedimentary Rocks of North America." In the evening of the same day the address of the retiring President of the Association, Prof. Joseph LeConte, will be given in the Assembly Chamber of the State Capitol. Friday, Monday, Tuesday and Wednesday will be devoted to meetings of the sections for the reading and discussion of papers. On Saturday free excursions are planned to visit Devil's Lake, the Dells of the Wisconsin, the Driftless Area, and one of the State Fish Hatcheries.

THE WORLD'S CONGRESS OF GEOLOGISTS, AUXILIARY TO THE COLUMBIAN FAIR, will convenc in Chicago on Thursday, August 24th. Themes and questions of world-wide and international interest are expected to be presented and discussed, rather than papers giving only details of local observations. Prof. T. C. Chamberlin of the University of Chicago, is Chairman of the Committee.

MR. A. P. LOW, OF THE CANADIAN GEOLOGICAL SURVEY, left Quebec in June with a party equipped for an absence of two summers and the intervening winter in the interior of the Labrador peninsula, expecting to extend their exploration northward to Ungava bay.

AMONG THE RECENT LOSSES TO SCIENCE, not altogether geological, must be enumerated Karl Semper, late professor of zoology in the University of Wurtzburg, at the age of 61. In 1877 Prof. Semper was invited to give a course of Lowell lectures, and on the material of these was based his work "On the Natural Conditions of Existence as they affect Animal Life." The name of Edwin Vivian, of Torquay is also on the list. Mr. Vivian was one of the prominent associates of W. Pengelly in stimulating the examination of Kent's Cave at Torquay, in Devonshire, the results of which have afforded sure ground for the belief in the antiquity of the human race. The past month also records the death of the veteran professor of geology, Ferdinand Senft.

THE UNIVERSITY OF DORPAT, NOW JURJEFF, is beginning to issue its publications, according to the imperial decree, in the Russian language. We have just received what appears to be an importnnt thesis on the development of the carpus and tarsus in mammals illustrated by three beautiful plates, but the work is not accompanied even by an abstract in French or German and it will thus be of little service to the majority of anatomists interested in the subject.—*From Natural Science.*

THE SO-CALLED PRIMÆVAL FOSSIL *Eozoon Canadense* has been subjected to so much destructive criticism that there are now few believers in its organic nature, but until this month no analogous structure had been recorded as found under conditions that could explain the origin of so curious an arrangement of different minerals. At the meeting of the Geological Society of London, on June 7th, however, Dr. Johnson Lavis exhibited some ejected blocks of metamorphosed limestone from Monte Somma, displaying a perfect eozoonal structure. They have been studied most carefully by Dr. J. W. Gregory and himself and their microscopal characters correspond in all details with those of the original Canadian specimens. In many cases, on account of their freshness the Monte Somma blocks exhibit some of the pseudo-organic structure details, such as the stolon-tubes, in far greater perfection than does the true so-called Eozoon Canadense.—*From Natural Science for July.*

Henry F. Blanford, late of the Geological Survey of India, died on Jan. 3, 1893. He was appointed with his brother M. W. T. Blanford, still living, on the staff of that survey in 1855, and served on it for seven years. In his investigation of the Talchir coal-field he observed and called attention to the remarkable boulder-bed which has been often adduced in evidence of the occurrence of a glacial era in Carboniferous time. Later he surveyed the Cretaceous beds near Trichinopoly and Pondicherry, his work being mainly palæontological. An account of the Nautilidæ and the Belemnitidæ was published in 1862, and with it a sketch of the geology of the Neilgherry Hills.

In later years and after his retirement from the survey Mr. Blanford chiefly occupied himself with Meteorology, especially that of India, and when the Department of Meteorology was established at Calcutta he was placed at its head. He finally retired in 1888 and lived thereafter in the south of England, at Folkestone.

Mr. Blanford became a Fellow of the Geological Society of London in 1862, and of the Royal Society in 1880. He was president of the Asiatic Society of Bengal in 1884 and 1885.

Dr. I. C. White, of Morgantown, W. Va., is in Chicago serving as one of the Judges of Awards in the Mines and Mining department of the Columbian Exposition. He was unanimously chosen President of the Mines and Mining Judges at their meeting for organization, July 15th, and presided that day, and also on the following Monday, but Tuesday morning he found himself suffering from an acute attack of malaria, and unable to leave his room. As his condition did not seem to improve, he resigned the presidency of the Committee on Thursday morning, and Dr. Howe, of Boston, was elected his successor. Dr. White is now (24th) convalescent, however, and expects to resume his duties as one of the judges in a day or two.

THE

AMERICAN GEOLOGIST

Vol. XII. SEPTEMBER, 1893. No. 3.

AN EXAMINATION OF GLYPTODENDRON, Claypole, AND OF OTHER SO-CALLED SILURIAN LAND PLANTS FROM OHIO.

By Aug. F. Foerste, Dayton, Ohio.

Did land plants of the class of *Lycopodiaceæ* live in the region of the Cincinnati anticlinal during the Clinton age? When in the December number, 1878, of the Geological Magazine, Prof. E. W. Claypole published his paper entitled, "On the occurrence of a fossil tree (Glyptodendron) in the Clinton limestone (base of Upper Silurian), of Eaton, Ohio, U. S.," this question seemed answered affirmatively in the most direct manner. Again, in 1886, when Prof. Edward Orton found a peculiar fossil in the Clinton at Brown's quarry, two miles west of New Carlisle, Ohio, Leo Lesquereux wrote to him the following communication, which, although a private letter and not having the force of a published note, will be of interest in this connection:

Columbus, Ohio, Oct. 27, 1886.

Prof. Edward Orton, Columbus, O.

Dear Sir: Evidently a *Lepidodendron-knorria*, that is *Lepidodendron decorticated?* passing to *Knorria*; but not the *Glyptodendron* of Claypole, which has the bolsters rounded at apex, not pointed like yours, which is of the type of *L. veltheimianum*, and perhaps the species. Specimen too obscure for specific determination, but valuable and interesting to a high degree. *Glyptodendron* is a *Lepidodendron* of the *L. turbinatum* type of the Chester group. I have in the past week received fine specimens of an *Asterophyllites* from the Trenton limestone, base of the formation at St. Paul, Minnesota.

Leo Lesquereux.

Being at that time engaged in a study of the Clinton fossils of the state, Prof. Orton sent the above communication with the specimen to the writer, who perceived at once its identity with much more perfect specimens discovered the preceding year at the same quarry. One of these, while presenting similar exterior markings, showed by its interior structure that these fossils belong to some curved or coiled type of nautilòid cephalopods, like *Cyrtoceras* or *Gyroceras*. The exterior markings, however, being indistinct in all the specimens, they were supposed to be due to a concretionary layer of lime surrounding the original fossil. When, in Vol. 7, 1888, of the Paleontology of New York, C. E. Beecher published *Cyrtoceras subcompressum* from the same quarry, the identity of all of these Brown's quarry specimens was recognized; and in a paper read before the Boston Society of Natural History, May 1, 1889, and published in its proceedings, the writer gave a figure showing the interior structure of one of his specimens, a too distinct figure of some of its surface markings, and a conjectural figure showing the supposed degree of coiling. This last is now believed to be entirely incorrect.

The writer suspected that the *Glyptodendron eatonense* of Claypole might eventually prove to belong to the same species, and in 1890 he made a trip to Akron, Ohio, to see the type specimen. The surface markings of the latter were much larger and to a certain degree different in form from those of the Brown's quarry specimens. In 1892 the writer discovered at Huffman's quarry, southeast of the asylum at Dayton, a specimen which threw new light upon the matter, and a second trip was taken to Akron to secure a better knowledge of the Eaton *Glyptodendron*, and it then became evident that the various fossils here discussed were at least of the same type.

The Eaton *Glyptodendron* and the Brown's quarry *Cyrtoceras* have been sufficiently described in the publications above cited. The Huffman's quarry specimens will be described in the forthcoming volume of the Ohio Geological Survey. It remains therefore only in this place to institute a comparison between the various specimens and to note the conclusions.

The Brown specimens show the septa and the siphuncle;

the Huffman specimen having surface markings shows only the septa, although a second much larger fragment of an interior cast indicates both the septa and the siphuncle; the Eaton specimen shows neither, being only a cast of the exterior surface.

The Brown specimens in the writer's possession show a marked dorsal flattening of the shell, the sides being gently and the ventral surface strongly convex (See Fig. 7c, Pl. vii, Proc. Boston Soc. Nat. Hist., Vol. xxiv). The Huffman specimen at first sight seems to be quite different, since it does not show a very marked dorsal flattening or a marked though rounded angulation at the junction of the dorsal with the lateral surfaces. Indeed, the present curvatures would seem to indicate that the longer diameter was lateral and the shorter dorso-ventral. This is believed to be due to pressure modifying the original form of this fragment of the shell. Judging by the shape of the *scars*, as further explained in the next paragraph, the real form of the shell is found to be such as to warrant direct comparisons with the Brown specimens. The siphuncle, as in the latter, is apparently nearly central, a little nearer the dorsal side. The dorsal convexity is greater than the lateral, there being no marked angulation along the dorsolateral region; instead of that, this is the region of the greatest convexity of the shell, though the curvature here is regular and not angulated. The lateral faces round into the ventral ones, as in the Brown specimens. The Eaton specimen gives no ideas on the general form of the shell.

The "*scars*" of the Brown specimens have an average width of 4 mm. on the dorsal surface, about 50 mm. above (toward the aperture) the point where the lateral diameter is about 54 mm. and the dorso-ventral diameter 68 mm. The average width is 3.5 mm. on the ventral surface, where the lateral diameter of the shell is estimated to be 45 mm. and the dorso-ventral diameter is 56 mm. On the dorsal surface the *scars* have a greater length than on the lateral surface, owing to the greater arching of the lower crescentic boundaries, and to the fact that the upper extremities of these boundaries approach each other as a rule more closely anteriorly at the boundary of the next upper scars. The cause of this change of form is much better seen in the Huffman specimen. The crescentic striæ ornamenting the interior of these scars can be detected only under favorable light in the smaller Brown specimen, and not at all on the larger one. The smaller Huffman specimen has at its smaller extremity a lateral diameter of 51 mm. and a dorso-ventral diameter of 62 mm. The names for the various sides are given by way of analogy with the Brown specimen, where the longer diameter is dorso-ventral. The scars of the Huffman specimen are also larger and longer on the dorsal surface, which establishes another analogy with the Brown specimen, and to the latter point is given great weight in determining the position of the diameters of the shell above discussed. Accepting this interpretation, the dorsal scars have an average width of 7 to 8 mm. and the lateral scars one of 4.5 to 5.5 or sometimes 6 mm. towards the smaller end mentioned above. From this it will be seen that at corresponding diameters of the shell the Huffman specimen has much larger scars. On the dorsal surface the lower crescentic border of the *scars* is more strongly curved; as a result the relative length of the scars of this area as compared with their width is greater than in the case of the scars on the lateral sides. Their average length on the dorsal side is 5.5 to 6.5 mm., ranging as low as 5 and as high as 7 mm. Their average length on the lateral faces is 3 to 3.5 mm., varying occasionally to 4 or 4.5, rarely 5 mm. The result is a more rhombic appearance of the scars on the dorsal surface; a feature to which especial attention is called, since reference will be made to it again in relation to the true interpretation of the Eaton *Glyptodendron*.

The surface ornamentation of the Huffman specimen is very distinct. The interior area of the *scars* is always depressed beneath the level of the defining crescentic ridges. These ridges are always most distinctly defined along their upper side. Their definition along the lower side is also usually good, except towards the middle where they meet the crescentic ridges of the next lower laterally applied scars. Here the depressed area of the scars of the vertically lower (second lower) series is often sufficiently elevated above towards the aperture to weaken the definition of the bounding ridges near the middle of their lower sides. The depressed interior area of the scars is traversed by rather coarse striæ of which 7 to

9 occupy a length of 4 mm. The striæ near the lower side of each scar follow the crescentic outline of the bounding ridges, becoming less curved above. On careful examination it will be found that in some cases the bounding ridge is not distinctly defined. The striæ of one scar will run over into and be continuous with those of the next lateral one. At the point where the defining ridge ought to occur laterally, these striæ curve strongly forward, and are massed closer together, forming an elevation, the extreme form of which is the usually strong elevated bounding ridge. Even where this crescentic ridge is sharp and distinct, the striæ can be traced across the same; in this case the flexure of the striæ is often less where crossing the ridge, and it is not so evident that the ridge is not an autogenous product, perfectly distinct from any more marked curving and massing together of the striæ. It is believed, however, that these fossils are nearest related to those species of *Cyrtoceras* ornamented by horizontal striæ and are a variety of that type, due to peculiar irregularities of growth at the aperture which caused frequent and regular concave emarginations of the edge, successively and more or less gradually, alternating in position, some disappearing, others arising in intermediate places, thus giving rise to the peculiar imbricated scar-like areas so characteristic of these shells.

There is no doubt of the congeneric relations of the Brown and the Huffman specimens. The case of the Eaton *Glyptodendron* is much less certain, owing to the small size of the cast and the absence of all indication of the interior structure. It is a cast of a fragment of the exterior surface and does not present the more detailed structure of the area of the scar. Attention is called to the following details: The crescentic ridges bounding the lower side of the scar areas are strongly curved, in fact they are practically semi-circular. The ridges are much more strongly defined above; or the scar there meets the ridge at the base of a rather abrupt declivity, while the areas below meet on a more inclined slope. The area of the immediately (vertically) lower scar rises anteriorly, at times ascending regularly as far as the middle of the defining ridge of the succeeding scar, thus lessening the definition of the ridge at that point. Owing to the greater rise of the middle ridge above the general level of the area of the scar above it, it is best defined there, while the elevation of the ridge becomes in many cases less defined towards either end. At the junction of the horns of these crescents (as ends of these ridges may be called) with the succeeding ridges, they are sometimes indistinct, especially exteriorly. The scar areas are too poorly preserved to show the surface marking. With this exception, the above description also gives the characteristics of the scars of the Huffman specimen.

The average width of the scars is 8.5 to 9.5, sometimes 10 mm.; their average length is 11.5 to 12.5 mm. from ridge to ridge. The length of the scars is therefore relatively greater than in the Huffman specimens, where the length and width are more nearly equal. The great length of the scar, combined with the great curvature of the defining ridges, makes it probable that the Eaton *Glyptodendron*, if congeneric, represents a fragment of the dorsal side of these shells. The scars are arranged in diagonally intersecting series. The Huffman specimen, as a rule, does not show the same faultless regularity in the arrangement of the scars, except indeed on the dorsal surface, as far as the preservation of the scars there extends in our specimen; this being another reason why we suppose the Eaton specimen to represent part of the dorsal side. The curvature of the Eaton fragment, as shown by the cast, is that of an arc having a radius of 65 mm. If the fragment be part of the dorsal side, it must therefore belong to a point of the shell having considerably greater diameters than the Huffman specimen, a fact already indicated by the larger scars of the Eaton specimen.

Finally, the condition of the cast itself seems to suggest its connection with that of a shell rather than with that of a piece of wood, since the upper boundary of the fragment is that of a regular and even though curved line, such as is not very infrequent in the case of the fracture of a shell, but one that would hardly occur in a branch or trunk of a tree of equal diameter broken transversely. It would be more likely to splinter, and to fracture irregularly. Of course there will always be an element of uncertainty about *Glyptodendron*, owing to the fact that it shows neither the interior structure, the general form of the fossil, nor the detailed surface characters of the scars, the only clear features being the boundaries of the scars. But from the present standpoint of paleontological investigation, based upon the material so far collected, *Glyptodendron* is a cephalopod and not a plant. Its surface features are closely those of a known cephalopod and do not bear the same close resemblance to any known plant.

The result of these comparisons has been the conclusion that all of these specimens are congeneric. Are they of the same species? This the writer would not like to answer definitely. He has no doubt that the Brown specimens so far indicate but one species. The Huffman specimen seems to have decidedly larger scars, and this and the absence of marked dorsal flattening and a more rapid increase in the diameter of the shell towards the aperture may constitute the distinguishing characteristics of a second species. The Eaton specimen scars are not sufficiently larger to warrant the creation of a third species. In that case the already published name for the Eaton specimen will have to serve also for the much better preserved Huffman specimen. The name *Glyptodendron* may be retained as a subgeneric term under *Cyrtoceras*.*

The general curvature of the shell is now believed to be much nearer that of the general forms of *Cyrtoceras* than of *Gyroceras*.

The classification of these shells will then be as follows:

Genus CYRTOCERAS.

Sub-genus GLYPTODENDRON, Claypole.

C. (*G.*) *eatonense* (Claypole) Foerste.

Localities: Near Eaton, Ohio; also at Huffman's quarry, in white, very fine-grained limestone, coming from the bottom of the quarry. Clinton group. The Huffman specimen should be taken for the present as the new type of the species, since it alone furnishes an idea of the interior structure, general form, and the minuter surface details.

C. (*G.*) *subcompressum* Beecher.

Locality: Brown's quarry, two miles west of New Carlisle

*If the author of *Glyptodendron* may be allowed, as one of the Editors of the AMERICAN GEOLOGIST, to intrude with a short foot note, he would like to suggest that, if his genus of 1877 prove to be really a cephalopod, its name should be entirely dropped. Etymological reasons alone would dictate this course, if no others existed. The subscriber has followed Mr. Foerste's investigation with interest for some time past, and cannot but feel convinced that he has made out a good case against the existence of land plants in Ohio in the Clinton age, though the superficial markings are unusual or even unexampled in a cephalopod.—E. W. C.

and about ten miles west of Springfield, Ohio. Near the upper part of the Clinton group.

The so-called land plants described by Lesquereux from the Cincinnati group of the anticlinal region, namely: *Protostigma sigillarioides*, *Psilophyton gracillimum*, and *Sphenophyllum primævum*, have had their claims as land plants denied by every competent observer whose botanical knowledge would warrant an opinion. The first species may be a fucoid; the second is probably a *Dendrograptus* or graptolite; and the last species is not even a plant, its organic character being totally unproved.

The answer to the question proposed at the very beginning of this paper would be, that at present there is no *evidence* of the existence of land plants in the region of the Cincinnati anticlinal during the Clinton age. The writer does not care to deny that such plants may have existed in this area, though he is of the opinion, for geological reasons, that they did not. Certainly from a theoretical point of view, it is more than probable that at as late a time in the world's history as the Clinton age certain sea plants had already taken up the habit of growing in fresh water, and of the latter some had probably begun to grow on land, wherever this land was. Theoretically, also, the original sea water should have been much less salty than to-day. The writer is hardly, however, of the opinion that plants of as high a degree of organization as the Lycopodiaceæ were already in existence during Clinton times, though negative evidence must never be considered conclusive.

DESCRIPTION OF PLATE.

Fig. 1. *Cyrtoceras* (*Glyptodendron*) *eatonense* (Claypole) Foerste. *a.* View of one of the lateral faces. *b.* View of the dorso-lateral angle with the dorsal side on the right and the lateral face on the left. Neither of these figures attempts to give more than the general form and arrangement of the "scars;" the more minute surface characters of the latter are shown in *c*, slightly enlarged. *d.* The dorsal side, with the "scars" omitted, showing the accidental lateral bending of the shell, which makes the detection of the true dorsal side so difficult, as further explained in the text. Huffman's quarry, one mile south of Dayton, Ohio.

Fig. 2. *Cyrtoceras* (*Glyptodendron*) *eatonense* Claypole. The original type specimen. An illustration prepared partly from a reverse drawing of the original cast, and partly from a gutta-percha cast made from the specimen by Prof. Claypole. Near Eaton, Ohio.

Fig. 8. *Cyrtoceras (Glyptodendron) subcompressum* Beecher. Lateral view, showing on the right the dorso-lateral angle, and on the left a part of the original surface, preserving the "scars" in places. This is a drawing of the exterior of the specimen whose section is shown by Fig. 7*b*, of Plate VII, in vol. xxiv of the Proc. Boston Soc. Nat. Hist., 1889. The figure 7*d*, of the same plate, is more regular than in nature, though on the dorsal side of other specimens greater regularity is shown. Brown's quarry, two miles west of New Carlisle, and ten miles west of Springfield, Ohio.

All the figures, except 1*d*, are reversed, the aperture of the shells being directed downward. This is done to secure a light favorable for the ready demarcation of the "scars."

"THE CORRECT SUCCESSION OF THE OZARK SERIES:" A REVIEW REVIEWED.*

By Frank L. Nason, Jefferson City, Mo.

In the April number of the American Geologist for 1893, Prof. Broadhead criticises my conclusions in regard to the sandstones and limestones of the Ozark series, as published in "The Iron Ores of Missouri."

On the face of it there would seem to be no necessity for interfering, in a special report on iron ores, with the geological correlation of other geologists, either antecedent or contemporary. In the beginning of my work I had no intention of doing this, but proposed to accept my geological facts from others. As my studies of the "Specular Ores of the Sandstone Region" progressed, I felt myself compelled to understand thoroughly the relation between the so-called "Second sandstone" and the so-called "First sandstone." Work in this direction had not progressed far before the suggestion came that the two were in reality but one, and after the study of the river sections this suggestion became a settled conclusion, at least so far as the Ozark region is concerned. It will not be necessary to go into detailed reasons for the necessity of this. The main fact of general interest is this: The writer concludes that in the Ozark region there is but one sandstone; Prof. Broadhead defends the idea of three sandstones. In the same candid spirit with which Prof. Broadhead attacks my work, I wish to defend it.

*The Correct Succession of the Ozark Series. By Prof. G. C. Broadhead, State University, Columbia, Mo.

In this paper only the more important points of Prof. Broadhead's criticism will be considered.

I. Prof. Broadhead says: "Mr. Nason informs us that the reasons of the early geologists for separating the formations are insufficient. This seems gratuitous, as he does not give those reasons nor has he sufficiently studied the field to be able to give an opinion."

Prof. Broadhead could not have read carefully the chapter to which he objects or he would have seen that the seven pages (pp. 96 to 103, Iron Ores of Missouri) were made up almost entirely of quotations from Broadhead, Shumard and Meek. These quotations are supposed to be the reasons upon which they based the division of the Ozark series. If these are not the reasons, they gave none in their written works in the survey reports.

If anyone will carefully read either the original reports from which I carefully quoted, or the quotations already referred to (pp. 96 to 103, Iron Ores of Missouri), he will find that the data there given, upon which are based the divisions of the Ozark series, are purely lithological. Data of this nature are always unreliable and to-day are almost, if not quite, discarded by geologists. They are never regarded as independent bases, but only as concurrent evidence. In the reports quoted, moreover, not only are the data altogether lithological, but the characteristics are so loose and rambling as not to give the shadow of a basis upon which to found even an unimportant geological division.

The first quotation made seems to support the writer rather than Prof. Broadhead. Mr. Meek says in his report on Moniteau county:

> The rock I have supposed to be identical with the above, i. e., First or Saccharoidal sandstone, is everywhere in Moniteau, excepting in a very few instances where it is very thin, a heavy bedded friable sandstone. It is usually indistinctly stratified, and varies in color, from nearly a pure white, through various shades of yellow, to a dusky brown.
>
> Sometimes it contains enough calcareous matter to cause feeble effervescence when acids are dropped upon it.

It seems that Mr. Meek only *supposed* this rock to be identical; if he is sure of it he does not say so, and I leave it to any fair-minded reader to say whether the characteristics which he gives would serve either to identify or differentiate this sandstone from dozens of others which might occur. Much less are they sufficient data upon which to base an important geological division.

Farther, every report which was obtainable was carefully searched by the writer for a full description of not only the First sandstone, but of the Second and Third sandstones. The search was fruitless, except for the following. Mr. Shumard in describing the saccharoidal First sandstone in St. Genevieve county, says:

This important formation consists of white and ferruginous sandstone, occurring usually in massive beds. Its lithological and chemical characters in this county have been fully described by Dr. Litton, in the Second Annual Report (Part II, page 85).

For the benefit of those who may not have access to the above report, I quote *verbatim* the "lithological and chemical characters" so "fully described" by Dr. Litton:

I mention now as existing in the greatest abundance, and sufficient to supply the wants of the Union, a remarkably pure sandstone, found in the neighborhood of St. Genevieve, Plattin Rock and other places. This constitutes what is denominated saccharoidal sandstone, and is, in many places, almost snow-white, in beds easily approached and of variable thickness. This sandstone separates the upper from the second magnesian limestone, and about eight miles from St. Genevieve there is an exposure of it, from twenty to twenty-five feet high. It is unusually white, crumbles easily upon a slight pressure, is made up of rounded grains, and has little, if any, cementing substance to unite the particles. It does not color in the least by heating; and, so far as I could discover, does not contain any material that, by oxidation, would color the glass made from it. It is, and has been, extensively quarried, and packed in barrels, is shipped from St. Genevieve and Plattin Rock to various points. Two analyses of this—number one by fusion with carbonate of soda, and number two by treating with hydrofluoric acid, gave:

	1.	2.
Silica............	98.81	99.02
Lime............	0.92	0.98

The above has been quoted in full from the description referred to by Mr. Shumard, in order that perchance the reader may discover some subtle but distinguishing characteristic which has escaped the writer, but by which the authors referred to were able to recognize unmistakably the First sandstone when they saw it. One, at least, of the above mentioned observers seems to have had difficulty in this respect, for instead of saying the sandstone observed in Moniteau county *is* the First sandstone, he says, "the rock I have *supposed* to be identical," etc. He is evidently in doubt about some of the characteristics described by Dr. Litton, but whether these doubts refer to "easy approach," the hight of the deposits, or to the fact of its being "packed in barrels," he does not say.

The above quotations are fair samples of the full "lithological and chemical characteristics" of these rocks as defined by the authors quoted. What would be thought to-day of a man who should attempt to found an important geological division upon such data?

Prof. Broadhead is wrong when he states that the writer has not visited the counties of Franklin, Jefferson, and St. Genevieve. No detailed work was done in these counties, but they were visited.

II. Prof. Broadhead's criticism in regard to fossils can be fairly explained. It is true that in the plates of sections in the "Report on Iron Ores" the writer omits "fossils" in all the sections after section 26, while in a paper in the AMERICAN GEOLOGIST he reports fossils all along the Gasconade river. These statements are not so contradictory as they appear. On page 110, "Iron Ores of Missouri," this statement will be found: "Comparatively few of the fossil localities have, however, been located; only the better ones are shown on the maps, for they may be found in nearly every bluff."

In making the sections along the Big Piney, Gasconade and Current rivers, fossils were found in the following manner. The talus at the foot of the bluff was first searched. If fossils were found, the mother stratum was sought for and in every case the search was successful. In many cases, however, from lack of time, or from the fact that the junction point of the sandstone and limestone was obscured, the fossils found in the talus were not traced to the parent ledge. The sixteen localities given in the plates of sections are so easily observed that one can find them with little trouble. In many more sections the ledge is not marked on account of obscure outcrop. There are hardly a half dozen sections in which fossils were not found in the talus. Putting these two facts together, first, that no attempt to locate in the parent stratum the fossils found in the talus was a failure, and, second, that fossils were found in nearly every section observed, is it too great a generalization to say that a fossil stratum reached from Cabool to Gasconade city ?

III. Again, Prof. Broadhead makes a mistake, quite excusable under the circumstances, of supposing that the writer omits, in the report on iron ores, mention of the locality at Mt. Sterling. This place is not mentioned by name, but on page 107 of the above mentioned report, sections 27, 28 and 29 were taken at this place. The writer's conclusion was that the sandstone there observed was a large lens or bed, entirely independent of the stratum of sandstone on the bluff. However this may be, the sandstone on the bluff never showed any signs of leaving the summit and descending beneath the river level. On the other hand, the sandstone on the bluff was traced nearly continuously from Cabool to this point. If then the sandstone in the river at Mt. Sterling is the Second sandstone, that on top of the bluff must be the First, which leads to obvious contradictions.

The facts as observed are as follows. About two miles above Mt. Sterling, just below a bend in the Gasconade river, there are great blocks of sandstone in the river. These blocks come from a bed of sandstone which extends under the limestone in the bluff. The bluff itself is two hundred feet high, and is principally limestone, with the exception of the sandstone at the river level and fragments of sandstone on top of the bluff. At the ferry no rocks are well exposed. About one-fourth of a mile below the ferry, the conditions are as noted in section 27. At the river level a bed of sandstone is exposed at least thirty feet in thickness. Following along this outcrop the talus hides the point of contact between the sandstone and the overlying limestone. The bluff at this point is over two hundred feet high, and is capped with great fragments of sandstone. The sandstone at the point of disappearance is growing calcareous, and is interbedded with stringers of calcareo-argillaceous gritty slate. One-fourth of a mile below, no sandstone appears at the river level, but the first twenty feet is obscured by limestone talus and there are no signs of sandstone fragments. The top of the bluff is capped by sandstone blocks. Less than one mile below Mt. Sterling, a bluff two hundred feet high, capped with broken sandstone, shows limestone from river level to summit.

Now these facts can be explained in two ways. First, looking at them from Prof. Broadhead's standpoint, by supposing that at this exact point the Second sandstone dips and disappears under the Second Magnesian limestone; or, second, we can say that this is but an example of a large lens of sandstone which disappears by thinning out, and by limestone taking its place. Now which of these two explanations is the more plausible?

If Prof. Broadhead's assertion is true there are some very difficult points to explain. His explanation given in the AMERICAN GEOLOGIST is plausible, but the facts do not seem to warrant his conclusion.

Cabool, at the head of the Big Piney river, is 1,150 feet above tide, the mouth of the Gasconade 550 feet. These datum points are from the levels of the K. C., Ft. S. & M. R. R. and the Mo. P. R. R. This gives a difference in level of the two places as 600 feet. The air line distance is ninety-two miles. The average fall per mile then is less than 6½ feet. Prof. Broadhead admits that above Mt. Sterling the Second sandstone appears, and if so it must be at the summit of bluffs over 200 feet high. This, then, is what happens according to Prof. Broadhead. A sandstone which follows along the rivers at an altitude of from 200 to 400 feet for seventy-four miles, suddenly drops from the top of a bluff 200 feet high and disappears. Allowing the distance to be one mile (which is too much), we have instead of an average fall of 6½ feet per mile, a sudden drop of 200 feet. Moreover, there is no gradual fall of this sandstone. With no previous sign of dipping downwards, at the bend above mentioned the sandstone at once appears in the bed of the river, and with the sandstone which has been followed so long still on the summit of the bluff. Further, the sandstone which appears above Mt. Sterling continues, sometimes in heavy beds, sometimes in brown blocks of huge size, and in one place above Fredericksburg in massive beds one hundred feet thick. This cannot be the Second sandstone, because that has, according to Prof. Broadhead, disappeared at Mt. Sterling; nor can it be the First sandstone, for that has not yet appeared. What is to be done with this sandstone? Prof. Broadhead not only leaves this question unanswered, but he fails to show by what means he recognizes the first sandstone at Fredericksburg. It is extremely important that this should be definitely recognized. In reality he not only fails to do this, but he seizes upon an extremely doubtful case and affirms that what may be, and probably is, only a lenticular bed of sandstone of uncertain dimensions, is the disappearing second sandstone.

These are, as the writer understands them, the three principal points taken up by Prof. Broadhead in the paper mentioned: First, the insufficient reasons given by the older geologists for separating the sandstones; second, the apparent discrepancy of the writer's statements in regard to the occurrence of fossils; and third, the occurrence of sandstone at the river level at Mt. Sterling. This fact still remains clear to the writer's mind, that neither Prof. Broadhead nor the older geologists have given sufficient data upon which to base their divisions into the First, Second, and Third sandstones, and the First, Second, and Third limestones.

GLACIAL EROSION.

By Ralph S. Tarr, Ithaca, N. Y.

Mr. Warren Upham, in a valuable paper,* has arrived at the conclusion that "from the volume of the drift and the topographic features of the country a geologically brief period, at the longest perhaps 10,000 or 20,000 years, would suffice for the observed volume of the Pleistocene glacial erosion and resulting drift." It has for some time seemed to me that upon the basis of the character of glacial erosion and drift accumulations, one must conclude that some such brief period of time as the above must be assigned to the last glacial period in place of the commonly stated great lapse of time. Without entering into the consideration of the disputed question of the complexity of the glacial period, I shall state the line of argument upon which this conclusion is based.

Ice cannot destroy the rocks over which it passes without the aid of cutting tools. Leaving out of consideration valley glaciers, where a supply of debris comes from the bordering cliffs, and the rare peaks which may project above the surface of a continental ice-sheet, there are but three ways in which a

*Bull. Geol. Soc. Am., vol. iv, pp. 191-204.

glacier can be supplied with material for erosive work. It may carry or drag along the loose material which it finds in its path; or it may rend rocks asunder wherever a place of entry is found; or it may obtain material from the rock itself by scouring it with the cutting tools already supplied. When the two first sources fail the third must fail also, for the ice of itself can have no appreciable effect upon solid rock.

The supply of loose materials ceases when the zone of disintegration is passed, and the second source must fail soon after this. The erosive action of ice is not to roughen the surface over which it moves, but to round, smooth and polish it, and consequently to lessen the possibility of obtaining a supply of cutting tools. As the period of ice occupancy of a land continues, the power of erosion must diminish and finally amount to almost nothing. The ice will then slide over rounded surfaces practically without any destructive effect and the streams will then issue from its front with a very slight load of sediment.

These statements should, perhaps, be qualified somewhat, since unconsolidated strata will continue to furnish detritus as long as they are exposed to the scouring action of ice; but even this supply will be limited, and, given time, its effects will disappear. For New England, where the facts were observed upon which these deductions are based, this disturbing factor is of very little importance and may, therefore, be neglected.

Using these facts as a basis, we have a means of determining the topographic age of a glaciated country by a study of its topographic form and glacial deposit. A young glaciated region, one subjected to glacial erosion for a brief period, should be littered with glacial drift, probably composed to a greater or less degree, of the products of disintegration. In a later stage, that of maturity, these deposits would be in greater measure, perhaps entirely, composed of fresher rock fragments distributed in greatest abundance near the periphery of the ice-sheet. During old age the country would be nearly free from deposits, and the topography would consist of a series of rounded, polished hills of glacial erosion. The first stage would be brief, the second much longer, and the passage to extreme old age one of very slow development.

Upon this basis our glaciated region is topographically young, or at most not far advanced into maturity.

The length of time required to reach any one of these stages is a function of several variable factors, chiefly the amount of material to be removed, the rate of motion of the ice, and the thickness of the ice-sheet. The first of these factors is determined by the pre-existing condition; the second is dependent upon the supply of snow and the underlying topography; and the third also varies with the ice supply, the topography of the land, and perhaps also with the rate of motion. Hence, in point of time, the rate of development is quite indefinite, but the ultimate result is uniform.

The erosive action of a great ice-sheet is unevenly distributed. Local erosion is most intense in the great valleys down which the ice moved with but little obstruction, since here, in addition to rapid motion, there is a greater thickness of ice. Perhaps, next to these places, hilltops are most powerfully eroded, because here friction is less and consequently motion more rapid. Small valleys, transverse to the direction of ice flow, and to a less extent small valleys parallel to this direction, brought about a condition of slack ice. Here detritus has very often been dragged and allowed to remain, while in some cases even loose fragments have not been removed from cliff faces.* In a more advanced stage of development these places might be made to give up their drift accumulations for erosive work.

Just when the most intense general erosion exists in a great continental glacier is not determined, Mr. Upham, in the paper above quoted, considers the zone of most intense erosion to be not far from the periphery of the ice-sheet in a belt from fifty to two hundred miles within the ice boundary, but I should be more inclined to place it near the periphery of the center of ice distribution. Here the glacier remained longest, it was thicker here, and it seems also that the motion must have been at this place most rapid since the ice-sheet spread out from this center or feeding ground. In a valley glacier the reverse is true because the snow of a large area is concentrated in a relatively small valley; but in a continental

*This may be seen in a number of places in central western Connecticut.

glacier a large area is fed from a relatively small center. It is true that this areal expansion is the result in part of a diminution in thickness; but this in itself would be hardly sufficient to account for the broadening of the ice-sheet away from the center.

From these centers of dispersion the material is dragged and carried out toward the margin of the ice, where that part of it remains which does not come within the grasp of the streams. It accumulates here in greater abundance than elsewhere for the reason that the source of supply is the entire area from center to margin, and because the ice can carry it no farther. Leaving out of consideration the extreme terminal deposits,this drift can be carried no farther than the peripheral parts of the ice-sheet because the glacial motion is too slow, and the thickness of the ice too slight, but chiefly because time enough is not allowed for its slow removal. Like the flood plain of a river, drift is here laid aside temporarily, to be removed when a smaller burden of work is given the ice to do.

This vast accumulation of detritus about the margin of our drift-covered area early led to the belief that the glacier had cut deeply into the region over which it had passed; but that this is not so is well proved by the drainage system and the perfection of development of preglacial topography. Upon the basis of the above argument it seems to signify, rather, a brief occupancy of the land by the ice-sheet.

How long, in years, this may have been, seems hardly capable of approximate estimation in the present state of our knowledge of the rate of glacial erosion. There are too many uncertain factors. The ice is retarded by friction on the bottom and its motion here must be slower than above. Then, too, the ice is less resistant than the rock over which it passes, and the passage of an ice-sheet over a given distance would not necessarily mean that an included rock fragment moved at the same rate, for in all probability it lagged behind, scoring not only the bed rock bnt also the ice. The time of passage of material from center to periphery may therefore be long and the work of erosion slow. Moreover, if there is considerable material being thus dragged along beneath the ice, much of the energy of erosion is exerted in grinding this material, particle against particle, along the numerous slipping planes. Here also the upper portions move along more rapidly than those below, and it is conceivable that, in certain areas where the drift was thick, the bed rock may have been scarcely eroded, being protected by the mantle of drift.

For this reason it is questionable whether the rate of motion observed in the Greenland glacier at its margin can be used as a basis for comparison since this is the motion of the upper part and may not even approximately represent the rate of motion of the lower portion where erosion is in progress. Movements measured along the margin of a continental glacier are of hardly greater value since they may represent the exagerated rate of flow of an ice mass crowded into a limited area, hence giving a more rapid rate than is normal for the main ice sheet. If the measurements are made upon an elevation the rate may be too slow. It may in reality require an entirely different amount of time for a rock fragment held in the base of an ice-sheet to move over a certain distance than one would be led to infer from a study of the Muir glacier or the Greenland glaciers.

These various complex factors make a time estimate of little value; yet, although I find myself unable to acccept his line of argument and conclusions, I believe Mr. Upham's estimate is much nearer the truth than those which call for a long period of time. When the time for the departure of the ice-sheet arrived, it had not removed the material from the region of greatest activity, and had accumulated a mass of drift in the peripheral region, having arrived at no greater topographical age than that of youth or early maturity, or what we may call the stage of adolescence, to use another of the terms employed by Prof. Davis in his classification of rivers. Much work was still to be done when the glacier departed. So far as there are indications of value, it seems to the writer that they point to a slower rate of erosion than that assumed by Mr. Upham in his estimate quoted above and to a smaller total. Accepting the rate of erosion to be that of the Muir glacier, about three-fourths of an inch yearly, in 10,000 years the continental ice-sheet would have removed, on an average, four hundred feet of rock in the zone of greatest activity which he assumes to be near the ice margin. But the perfection of preglacial topography, even in minor details, is such that this amount seems scarcely allowable. Even half this amount appears excessive. On this basis, assuming a rate of erosion one quarter as great as that of the Muir glacier, that is, less than a quarter of an inch a year, the duration of the last glacial epoch would still be within his estimate. While the object of this article is not to make an estimate of the age of the glacial period in years, but rather to show that its age is not great, this general conclusion is stated to show the agreement without insisting upon its value even as an approximate estimate.

Since in the early youth of glacial action the ice is chiefly engaged in the removal of such disintegrated material as may have covered the country at the time of the appearance of the ice-sheet, it would be expected that at the margin of this sheet, if anywhere, the relics of this stage would be found to exist. If this stage has been passed through, and it seems certain that it must have been, somewhere near the margin of the drift we ought to expect to find material thus derived. If, perchance, the glacier was at first more extensive than it was in later stages, it would not be unnatural to expect to find these deposits outside of the limits of the more northern moraine which marked the most long continued stand of the ice.

Disintegrated deposits do exist south of the terminal moraine of the last glacial epoch and these are ascribed by many to a much earlier and distinct epoch, although by some this conclusion is controverted. The author has no personal knowledge of these deposits and does not therefore feel competent to pass judgement upon them, although arguments which seem unanswerable, particularly when taken in connection with outside evidence of diversity of the glacial period, have caused him to accept the evidence which has been presented in proof of two glacial epochs. Nevertheless, in view of the fact that there are a number of glacialists who find evidence of the opposite character, this possible explanation of the disintegrated nature of the extra-morainic drift should be considered as a working hypothesis. There appears to be no escape from the conclusion that disintegrated drift was carried to the ice margin, unless it is assumed that the interglacial epoch was exceedingly brief; and if such drift has been carried there, one may well ask the question, where is it at present?

A CLASSIFICATION OF TOPOGRAPHIC FORMS.*

By Stuart H. Perry, Pontiac, Mich.

The study of topographic forms in their relations to the geological processes by which they are produced and modified has only in recent years risen to the importance of a distinct branch of geology. This new science, which may, perhaps, be most fitly termed Geomorphy, is distinctively American. I do not mean that it is exclusively American, but its development is due largely to the labors of geologists of this country. It is natural that it should have attained such prominence here because Nature has furnished us unexampled opportunities for its study, and it has received the attention of many able scientists. But while much has been written more or less indirectly, the information is widely scattered and the subject has generally been treated only in part and in its more intimate relations with certain phases of geology proper. It is only quite recently that certain writers, such as McGee and Davis, have taken up the subject in its more general and independent relations. Professor Davis has already given in a number of excellent papers a general view of the science in its present state, and has shown the great importance of geological methods in the consideration of this neutral ground between geology and geography. I need not, then, dwell on the subject in its broader relations, but will take up at once the problem which this paper endeavors to solve.

The problem of the classification of topographic forms is one of the most important in Physical Geology, and few attempts have yet been made at its solution. No entirely satisfactory classification has yet been proposed. The great number and diversity of topographic forms, and the many causes and combinations of causes to which they are due, render it nearly impossible to devise a system that will be at once scientific and practical. The requirements of such a system are the same as those of any other classification; namely, that it shall be inclusive, that its divisions shall be natural and not arbitrary, and that it shall be concise and

*This paper was originally written, in a somewhat different form, as a thesis forming a part of the course in Physical Geology in the University of Michigan. The author is indebted to professor Russell, under whom the work was done, for many suggestions, and has made use chiefly of the works of Davis, McGee, Gilbert, Russell, Powell, Dutton, Chamberlin, Upham, Hitchcock and De LaNoë and Margerie.

convenient so as to be of practical utility. These conditions are rarely if ever absolutely fulfilled, for in every branch of science there is a more or less complete gradation so that some features refuse to connect themselves naturally with any division, and must be classified arbitrarily. This is especially true of geomorphy, which abounds in transitional and problematical forms, so that any classification is at best only approximate.

The system that first suggests itself is one based upon external form. For ordinary purposes it is of practical utility, but from its superficial character is of little scientific value, for it places together features of widely different origin while separating others that are closely related genetically. It is impossible, moreover, to make the divisions of such a system exact, since it is impossible to draw sharp lines between different forms which merge into each other through transitional forms. There is also lack of a complete and accurate terminology. The term "mountain" for instance is vague and almost impossible accurately to define, for there is no sharp line separating a mountain from a plateau, mesa or hill.

It is desirable, then, to devise some system that avoids the consideration of external form as a basis. The least objectionable plan is a genetic classification. It accords best with the spirit of modern science, which is concerned more with natural processes than with their products. Any classification by genesis has the disadvantage of grouping together dissimilar forms, but even the most dissimilar products of any given process have some common characteristics that distinguish them from similar products of any other process. Thus all features due to glacial action are naturally connected, and it is natural to group together all volcanic products even if they are as different as a cinder cone and a lava plain.

All natural agencies tend either to build or to destroy, and so all topographic forms may be classed as the result either of constructive or destructive action. They may be again divided according to the particular agencies which have given them their chief characteristics.

It is necessary, however, first to place outside our system one great agency, that of general deformation, which alone has rendered possible the action of all other geological processes. In general it may be said that all the geographic features of the earth are due to elevation and depression. All land masses had first to be raised above the ocean level before other processes could give them their final characters and shape them into plains and mountains. In this way continents and mountains were primarily formed. But the topographic features treated in this paper are not such general features as continents. They are the special forms which the surface of the earth has locally assumed, and in their production the forces of deformation have played directly but an insignificant part. A portion of the earth is raised above the ocean by displacement, but its final character as a mountain range or mesa or prairie is given it by the constructive or destructive action of particular agencies. That process which gave the final character is the one to which the form properly belongs, no matter what other causes may have affected it more remotely. For instance, a mesa produced by a lava flow protecting from erosion the softer strata beneath is properly a product of erosion and not of volcanic action, for the result would be the same if the lava flow had been replaced by a stratum of any other durable rock. The same is true of laccolites, dikes, and necks, exposed by the removal of surrounding strata, and which are here classed as products of degradation. Deformation may be considered an underlying cause of all surface modifications, but it will not be classed as an immediate agency except where its local action has produced forms that have not been materially altered by other processes.*

Constructive action may be classified under five divisions.

The first is volcanic deposition, including all forms built up from ejected materials. This may be called the most important constructive agency, for the chief products of its action, volcanic cones, are among the most prominent features of the earth's surface. To this division belong all volcanic mountains, craters, cinder and tuff cones and fields, and lava plains.

*McGee, in his paper entitled "A Classification of Geographic Forms by Genesis" (National Geog. Mag., Vol. I, No. 1), takes the opposite ground with respect to orogenic and epeirogenic deformation, and classes mesas among volcanic products. He does not make construction and destruction the basis of his classification, but subdivides each of his main divisions, Vulcanism, Glaciation, etc., into constructive and destructive action.

The second division is aqueous deposition, which includes all deposition by standing and running water. I do not, however, place in this division certain features resulting from the temporary action of glacial waters and which are too closely associated with glacial action to be conveniently separated. The most important products of aqueous deposition are alluvial plains and deltas. To this class also belong lake beds which, when left dry from any cause, make plains, as the valley of the Red river of the North and the Quaternary lake beds in the Great Basin. Other minor features of deposition due to the action of littoral currents are found associated with them, such as bars, spits, built terraces and alluvial cones deposited by tributary streams. Along the sea coast tide plains made dry by the elevation of the shore may foım plains or marshes of considerable extent, and with them may be found other features resulting from littoral action such as beaches and terraces.

Chemical deposition may be considered a special case of aqueous deposition and so may be placed in this division. Examples of its action are the various forms of silicious sinter deposited by the springs and geysers in the Yellowstone Park and the great masses of calcareous tufa in the basin of Lake Lahontan.

The third division is glacial deposition. This is a most important agency in giving to certain regions their final topographic characters, though none of its products are of very great magnitude. This division includes the deposition of transported materials by the ice itself and the constructive action of glacial water. Both processes are inseparably connected and many forms are the result of their common action. Moraines, kames, drumlins, osars, and drift plains, belong to this division.

The fourth division, eolian deposition, is of less importance and gives rise only to minor local forms, such as dunes, ridges and sand plains.

The fifth division is local or special deformation. It is often associated with earthquake action, producing local elevations or depressions, but its most important product is fault scarps resulting from gradual and more extended displacements. Of course a line of cliffs resulting from a fault may be so altered by erosion that it naturally falls among erosion products and can not be placed in this division.

The destructive processes are more important than those of construction, for they have produced all the greater features of the earth except volcanic mountains, and all forms, of whatever origin, are subject to modifications by their action. As soon as the land emerges from the water the various destructive processes begin their work and tend to reduce it once more to the ocean level, We find marking the stages of this action an infinite gradation of forms, from the rugged mountain system to the featureless plain that marks the approximate base level of erosion.

Destructive action may be classified under four divisions.

The first is erosion by rivers and streams. This action tends to form cañons and gorges which subsequently broaden into valleys through the action of subaerial degradation. Its effects are most marked in a country that is topographically young, for there it works with the greatest energy and subaerial degradation has not obliterated the evidences of its action. Landslides resulting directly or indirectly from stream erosion may produce local forms of considerable importance. They may also result from subaerial degradation.

Subaërial degradation forms the second division. It comprises the action chiefly of the rain and frost. With the help of streams to carry away the detritus, it broadens cañons into valleys, carves mountain masses into peaks and bad-lands, and finally reduces the whole surface to a flat or gently undulating peneplain. All mountains and mountain systems not of volcanic origin are due to such action; also isolated mountains and hills, outliers, buttes, plateaus, mesas, escarpments and cliffs of recession, and plains not formed directly by constructive processes. The work of subaerial degradation is inseparably connected with stream erosion and so there is no sharp line separating this division from the preceding. The action of the smallest rill differs from that of a river only in extent. For convenience, however,we class the action of rills with subaerial degradation and restrict stream erosion or corrasion to to the action of streams of some magnitude.

The third division comprises the action of waves. The only resulting forms of importance are sea cliffs and beaches, and cut terraces feft by the recession of the water.

The fourth division is glacial erosion. To this class belong valleys made or modified by ice, rock basins, *roches moutonnées*, hills rounded by glacial action, and plains leveled by the same means.

I have placed all special deformation under the head of constructive action, and the objection may be raised that this is an arbitrary classification. Strictly speaking, elevation is constructive and depression is destructive, but I am not aware that any actual forms of importance result from depression alone. If such forms exist, they would naturally constitute a fifth division under constructive action. Apparent depressions may really be due to elevations such as the synclinal depression between two anticlinal folds. Depression sometimes takes place along one side of a fault, but it is usually, if not always, accompanied by an elevation of the other side, and, as far as I know, all fault scarps are due chiefly to the latter action and so may be placed among constructive forms.

The preceding categories include all terrestrial topographic forms of importance resulting from inorganic agencies. The action of vegetable life might be classed as a distinct constructive process but the forms resulting are not of great prominence.

In polar regions, such as Greenland, ice covers the surface to the depth of several thousand feet and makes all the topographic forms which the country possesses. In such cases the ice is to be regarded as a permanent stratum of the earth's crust, subject to the same processes of deformation and erosion that affect other rock masses and yielding forms referable to the same divisions.

The following table gives concisely the different processes with the resulting forms, and constitutes a summary of the plan of classification proposed in this paper:

CAUSES.	RESULTING FORMS.
	CONSTRUCTION.
VOLCANIC DEPOSITION.	Eruptive mountains, craters, cinder and tuff cones and fields, lava flows and plains.

AQUEOUS DEPOSITION.	Alluvial plains, deltas, lake beds, tide plains, bars, spits, alluvial cones, beaches, built terraces, forms resulting from chemical deposition.
GLACIAL DEPOSITION.	Moraines, kames, drumlins, osars, drift plains.
EOLIAN DEPOSITION.	Dunes, ridges, sand plains.
SPECIAL DEFORMATION.	Fault scarps, some local elevations and depressions.

DESTRUCTION.

STREAM EROSION.	Cañons, gorges, valleys, wind and water gaps, cut terraces, some escarpments and landslides.
SUBAERIAL DEGRADATION.	All mountain systems not volcanic, isolated mountains and hills, outliers, buttes, bad lands, plateaus, mesas, dikes, necks, plains, escarpments and cliffs of recession, landslides.
WAVE ACTION.	Sea cliffs, cut terraces, shelves, islands, stacks.
GLACIAL EROSION.	Some valleys, rock basins, *roches moutonnées*, rounded hills, plains.

ON A COLLECTION OF TERTIARY MAMMALS FROM SOUTHERN FRANCE AND ITALY; WITH BRIEF DESCRIPTIONS THEREOF.

By JOHN EYERMAN, F. Z. S., F. G. S. A., Easton, Pa.

For the pleasure of securing this beautiful collection, I am indebted to Dr. C. J. Forsyth-Major, of Florence, Italy, than whom there is no better authority upon the Pliocene mammalian fauna. Dr. Major has collected most of the specimens *in situ*. The collection consists chiefly of insectivores and rodents, although there are a number of ungulates, from the Val d' Arno horizon.

The localities represented are (*a*)Grive St. Alban, (Isère) France, a secondary division of the Middle Miocene; (*b*) Mont St. Giovanni, near Iglesias, Sardinia, an ossiferous breccia of the Pleistocene; (*c*) Toga, near Bastia, Corsica, also an ossiferous breccia; (*d*) Grotta Pietro Tamboni, Tavolara; and (*e*) Olivola, Province of Massa, Italy, the Val d'Arno horizon of Upper Pliocene.

INSECTIVORA.

TALPIDÆ.

Talpa minuta Blain.*

Represented by two humeri having the characteristic great relative breadth. Grive St. Alban, and confined to the Middle Miocene.

T. telluris Pomel.

Considerably larger than *minuta*, and represented by the humerus, radius, ulna, femur and mandible with incomplete dentition $\frac{}{M\ 2\ \&\ 3}$. Grive St. Alban.

T. tyrrhenaica Major.

About twice the size of *minuta* and represented by the mandible $\frac{}{Pm\ 2\ M\ 3}$, humerus, radius, ulna, femur, and tibia. Very characteristic of the ossiferous breccia of Mont St. Giovanni, Sardinia.

SORICIDÆ.

Sorex pusillus v. Meyer.†

Represented by several specimens of maxilla, mandible $\frac{}{C\ 1\ Pm\ 1\ M\ 3}$, and humerus. As a rule, the superior incisors and pre-molars are of variable number. Grive St. Alban. The species extends into the Lower Miocene in Germany.

S. similis Hensel.

This species is somewhat larger than *pusillus*, and is represented by the humerus, femur, maxilla, and mandible $\frac{C.\ 1\ Pm.\ 2\ M.\ 3}{I.\ 1\ C.\ 1\ Pm.\ 1\ M.\ 3}$. Mt. St. Giovanni, Sardinia.

TUPAIIDÆ.

Plesiosorex soricinoides Blain.‡

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*Ostéographie, Insect. p. 97, pl. xi.

†Neues Jahr. 1846, p. 473.

‡Ostéographie, etc. Insect. p. 100, pl. xi.

Represented by maxilla and mandible with incomplete dentition $\frac{\text{Pm. 1 M. 3}}{\text{C. 1 Pm. 4 M. 3}}$. Grive St. Alban. Schlosser* thinks this genus should be placed in the Macroscelididæ. *Parasorex socialis* v. Meyer,† which is perhaps identical with the above, is quite widely distributed throughout the Lower and Middle Miocene.

DIMYLIDARUM, Fam. et gen. nov. Major.

Represented by fairly well preserved portions of the maxilla and mandible. Grive St. Alban. This apparently new family of insectivora, together with a new genus of rodentia, will receive attention in a future and more extended paper.

CARNIVORA.

FELIDÆ.

Felis sp.

Represented by a portion of the mandible with teeth. Val d'Arno horizon, Olivola.

URSIDÆ.

Canis etruscus Major.

Represented by a much crushed skull, with mandibulæ, and by the radius, ulna and tibia. Olivola.

Ursus etruscus Cuvier.‡

Skull with mandible and the greater portion of the dentition. Olivola.

RODENTIA.

There are four families of this order represented in the collection.

SCIURIDÆ.

Sciurus spermophilinus Dep.§

The first superior premolar is frequently absent. Maxilla and mandible with $\frac{\text{M. 2 \& 3}}{\text{I. 1 Pm. 1 M. 3}}$. Grive St. Alban.

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*Die Affen, Lemuren, etc., pp. 118–120.

†Neues Jahr., 1865, p. 844.

‡Tab. Elem. Hist. Nat., 1798.

§C. Depéret, Arch. Mus. Lyon, vol. iv.

S. xerinus sp. n. Major.

Represented by the mandible $\frac{\quad}{M.\ 2\ \&\ 3}$. Grive St. Alban.

There appears to be very little difference between this species and the preceding one.

MYOXIDÆ.

Myoxus sansaniensis Lartet.*

Folding quite complex, and teeth rooted. A badly preserved mandible with $\frac{\quad}{I.\ 1\ \ M.\ 1\ \&\ 3}$. Grive St. Alban.

MURIDÆ.

This family comprises the largest rodents.

Mus orthodon Hensel.†

Represented by maxilla and mandible with nearly complete dentition, the molars having transverse ridges. Mont St. Giovanni, Sardinia.

Cricetodon minor Lartet.*

Represented by maxilla and mandible with nearly complete dentition, the first tooth having two pairs of tubercles. Grive St. Alban.

C. medium Lart.*

Slightly larger than *minor*. Represented by beautifully preserved specimens of maxilla and mandible. Grive St. Alban.

C. rhodanicum Dep.‡

Somewhat larger than *C. medium*. Beautifully preserved maxilla and mandible. Grive St. Alban.

Arvicola ambiguus Pomel.§

This species is somewhat larger than the existing species, *A. amphibius*. Represented by maxilla and mandible $\frac{I.\ 1\ M.\ 3}{I.\ 1\ M.\ 3}$ and cranium with dentition $\frac{I.\ 1\ M.\ 3}{\quad}$. Molars rootless. Mont St. Giovanni, Sardinia.

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*Notice sur la Colline de Sansan, 1851, p. 20 *et seq.*

†Zeits. deutsch. geol. Ges., 1856, p. 660.

‡Arch. Mus. Lyon, vol. iv.

§Cat. Méthodique, 1853, p. 27.

LAGOMYIDÆ.

The genus Lagomys has by far the best representation in the collection, numbering no less than several hundred specimens, representing three distinct species. The genus was named by Cuvier* as early as 1798, although Pallas† described *Lepus* (Lagomys) *pusillus* twenty years earlier. Various names have been given to a number of specialized types based principally upon the size or the presence or absence of the penultimate premolar.

Lagomys sardus Hensel.‡

Somewhat larger than the existing species *pusillus*. As is the case with most of the other species, the entire collection of this species is in a most beautiful state of preservation. *L. sardus* is from the ossiferous breccia of Mont. St. Giovanni, near Iglesias, Sardinia. The following are represented: Maxilla, mandible, cranium, scapula, humerus, radius, ulna, metacarpals, phalanges, femur, tibia, metatarsals, vertebræ, astragalus, calcaneum, navicular, cuboid.

L. sardus corsicanus.

This is *L. corsicanus* of Giebel, but is apparently so near *sardus* that it cannot stand alone as a distinct species. Represented by the humerus, scapula, tibia, and metatarsals, from the superior stratum of the upper chamber of Grotto Pietro Tamboni, Tavolara. This variety also occurs in the ossiferous breccia of Toga, near Bastia, Corsica, and is represented by the mandible with complete dentition, cranium, scapula, humerus, ulna, femur, tibia, meta-tarsals, osilium.

L. meyeri Tschudi.§

Represented by maxilla, mandible, humerus, femur, metacarpals, astragalus, calcaneum, tibia, phlanges, metatarsals, deciduous-molars. Grive St. Alban.

L. œningensis v. Meyer.‖

This is the largest species of the genus in the collection and

*Tab. Elem. d'Hist. Nat., p. 132.

†Nov. Com. Pet., vol. xiii, p. 531.

‡Zeits. deutsch. geol. Ges., 1856, vol. viii, p. 689.

§H. von. Meyer, Foss. Säugth. etc., von Œningen, 1845, p. 7.

‖Neues Jahr., 1836, p. 58.

is perhaps the same as *L. versus* Hensel.* Maxilla and mandible with incomplete dentition. Grive St. Alban.

Titanomys (Lagomys) fontanesi Dep.†

Maxilla and mandible with poor dentition. Grive St. Alban.

MURIDARUM, gen. nov., Major.

This genus is closely related to the American *Paciculus* of Cope. The individual species is somewhat smaller than *Paciculus insolitus* Cope,‡ from the John Day horizon. Maxilla and mandible with $\frac{\text{I. 1 M. 3}}{\text{M. 2 \& 3}}$. Grive St. Alban. A study of this interesting genus will be given in a paper now in preparation.

UNGULATA.

With one exception the following ungulates are from the Val d'Arno horizon, Olivola, Province of Massa, Italy. This horizon is Upper Pliocene, and consists of sands and "sansino" (conglomerate), which, according to Dr. C. J. Forsyth-Major§ contain, as so far discovered, no less than forty species of mammals. The locality is in a lateral valley. All the limb bones and the greater part of the various dentitions are in an excellent state of preservation.

BOVIDÆ.

Leptobos elastus (Croiz sp.) Maj.

In some of the specimens the horn cones are absent; in others the cones are widely separated and sub-cylindrical. Represented by a number of incomplete skulls (one of which is that of a young individual with deciduous dentition), and by several mandibulæ.

CERVIDÆ.

Cervus sp.

Skull, maxilla $\frac{\text{Pm. 3 M. 3,}}{\quad}$, and antlers.

Palæomeryx florensianus Lart.||

*Zeits. deutsch. geol. Ges., viii, 1856, p. 688.

†Arch. Mus. Lyon, vol. iv.

‡Tertiary Vertebrata. vol. iii, Book 1, 1884, p. 854.

§Quart. J. Geol. Soc., vol. xli, *et seq.*

||Notice sur la Colline de Sansan, 1851, p. 36.

Perhaps the smallest of the genus. Molárs have brachydont structure. Represented by superior canine, and by mandible with incomplete dentition. Grive St. Alban.

SUIDÆ.

Sus sp.

Maxilla and mandible with dentition, and mandible of a young individual with deciduous dentition.

EQUIDÆ.

Equus stenonis Cocchi.*

According to Dr. Major† this species is identical with *E. sivaliensis* F. & C.‡ Mandible, phalanges, astragalus and calcaneum.

RHINOCEROTIDÆ.

Rhinoceros etruscus Falc.§

Has very deep grinding surfaces, the true molars having a largely developed buttress. Portion of skull, maxilla, mandible, humerus, femur and tibia.

PLEISTOCENE PAPERS AT THE MADISON MEETINGS.

A large proportion of the papers presented before both the Geological Society of America, in its meeting at Madison, Wis., August 15th and 16th, and Section E (Geology and Geography) of the American Association for the Advancement of Science, which held its annual sessions in the same city August 17th to 22d, related to Pleistocene geology, as the glacial and modified drift, the characters, methods of action, and effects of ancient and of now existing glaciers, and the probable causes of accumulation and departure of the Pleistocene ice-sheets. Notes of these papers, and of the accompanying discussions, are here given in the order in which the papers were read.

*Mem. Soc. Ital. Sci. Nat., vol. ii, 1867, p. 14.
†Quart. J. Geol. Soc., vol. xli, 1885, p. 2.
‡Fauna Antiqua Sivaliensis, pt. 9, 1849.
§Quart. J. Geol. Soc., vol. xv, 1859, p. 602.

GEOLOGICAL SOCIETY OF AMERICA.

On the Limits of the Glaciated Area in New Jersey. By Prof. ALBERT A. WRIGHT, Oberlin, O. Southward from the so-called terminal moraine traced and mapped fifteen years ago by Cook and Smock, of the New Jersey Geological Survey, from Staten Island northwest and west through northern New Jersey, the glacial drift or till is found to extend to an extreme limit of the ice-sheet 15 to 20 miles in front of the moraine. The extra-morainic drift, which has been termed a "fringe" of the great drift sheet, is nearly continuous, though thin, upon this belt from the Watchung mountains and country north of Somerville westward to the Delaware river and onward in Pennsylvania; but eastward from the Watchung trap ridges it is very scanty or wanting. Its material is mostly of local derivation, and such portions as have been carried several or many miles are yet nearly all referable to rock outcrops less distant than the north line of the state. Angles in both the extreme boundary of the drift and in the moraine show that the ice-sheet was lobate, reaching farther in the Hudson and Delaware basins than on the intervening highlands. The general parallelism of the drift border with the moraine, and the features of the early outermost drift and of the somewhat later drift on the north, were regarded by the author as evidence that the glaciation of this area was continuous and geologically brief.

South Mountain Glaciation. By Prof. EDWARD H. WILLIAMS, Jr., Bethlehem, Pa. Oriskany pebbles and boulders, identified by their fossils, were selected as the criterion of the extent of glacial transportation in the region of the Saucon valley and South Mountain, near Bethlehem, Pennsylvania, where the extent of the till as a fringe south of the so-called terminal moraine is found to be 22 miles. At West Bethlehem the till is 12 feet thick, underlain by 22 feet of gravel and sand which have the "flow and plunge" stratification of torrential and varying currents.

Extra-morainic drift in New Jersey. By Prof. G. FREDERICK WRIGHT, Oberlin, O. The fringe of attenuated drift reaching beyond the moraine in Pennsylvania, as described by Prof. H. C. Lewis and the author, is now found to be well defined across the greater part of northern New Jersey and includes the Pattenburg and High Bridge till deposits, which the author a year ago thought more probably referable to landslides. Though most of this drift is from the local formations, some of the rock fragments came considerable distances from the north. The moraine and drift farther north denote more powerful ice action than on the area of the drift fringe. The divisions of the Glacial period shown by the diverse drift deposits seem to be properly called episodes in a single epoch, which was short in contrast with former geologic epochs, though its duration in thousands of years cannot yet be approximately estimated.

In discussion of the foregoing papers, Prof. T. C. CHAMBERLIN differed from the authors in his belief that the extra-morainic drift should be referred to a far earlier time than the moraine and more northern drift, as indicated by their contrasts in extent of oxidation and erosion. The early high terraces, and the late low terraces, of the Delaware valley also are held to be decisive evidence of a very long interval between the times of deposition of the drift on opposite sides of the moraine.

Mr. WARREN UPHAM spoke of his observations of eskers extending three to six miles south of the outermost moraine on Long Island, showing that the ice-sheet extended, probably during only a short time, considerably south of the moraine. He advocated the use of the terms marginal and retreatal moraines, although at their times of formation each was at the receding termination of the ice. The fully oxidized condition of the extra-morainic drift was referred to its derivation chiefly from preglacial residual clays and alluvium and from weathering rock cliffs and knobs, like those of the Wisconsin driftless area and of the country south of the drift; while the very uneven topography and fresh character of the moraines and drift farther north were ascribed to steeper frontal slope and more vigorous currents of the ice-sheet during its recession.

Mr. FRANK LEVERETT stated that in the Mississippi basin much stream erosion took place between the times of the older and newer drift, requiring that interval to be several times longer than the postglacial epoch.

Terrestrial Subsidence southeast of the North American Continent. By Prof. J. W. SPENCER, Atlanta, Ga. The contours of the submarine continental slopes east, south, and west of Florida, in the region of the Gulf of Mexico, the West Indies and the Caribbean sea, as made known by U. S. Coast Survey and other soundings, reveal submerged valleys of rivers, once land surfaces but now covered by 2,000 to 12,000 feet of the ocean. The steep submarine escarpments of the continental plateau and of the Antillean island plateaus are found to be cut to these profound depths by stream courses, often at right angles with the adjacent or intersected mountain belts. The author believes, therefore, that this part of the earth's crust has experienced, at least for large areas, twice as great uplift and ensuing subsidence as the 5,000 to 6,000 feet lately estimated by Jukes-Browne and Harrison from their studies of the geology of Barbados. The time of these great epeirogenic movements is regarded as late Tertiary and Quaternary. But the extreme depths of the West Indian seas, as the Bartlett Deep, southeast of the Grand Cayman island, sinking more than 20,000 feet beneath the sea level, are to be attributed to synclinal folds or troughs of deformation of the ocean bed. The author supposes that North and South America were united by way of the West Indies during the Pliocene period, and that probably up to the Pleistocene the Carribbean sea and Gulf of Mexico opened into the Pacific ocean.

Mr. W J MCGEE, in discussion, granted the probability of such former elevation and subsidence, but would refer them to an earlier time, for accordance with his studies of the much smaller Tertiary and Cretaceous oscillations of the Atlantic coast extending thence north.

Mr. UPHAM noticed the similarity of the West Indian submerged valleys and those of the Delaware and Hudson rivers, respectively about 2,400 and 2,800 feet beneath the sea. These valleys both at the south and north are cut in the gently descending plain of Tertiary and underlying Cretaceous strata, showing their age to be late Tertiary or Quaternary. In high latitudes such epeirogenic uplifts, approximately contemporaneous with these in tropical areas, or alternating with them, are thought to have been the causes of the accumulation of the Pleistocene ice-sheets.

Mr. C. D. Walcott remarked that while the North American continent may have been uplifted as a whole or in large part to great hights, it has not been in any considerable portion profoundly submerged; nor is there geologic evidence of any lately lost Atlantis continent, but instead the Atlantic ocean basin and its bordering continental plateaus seem to be very ancient as grand geographic features.

Evidences of the Derivation of the Kames, Eskers, and Moraines of the North American Ice-sheet chiefly from its Englacial Drift. By Warren Upham, Somerville, Mass. The massive kame hills forming the marginal moraine called the backbone of Long Island eastward from Roslyn were shown to have been accumulated at the mouths of superglacial or englacial rivers, not by subglacial drainage, since any streams under the ice bringing these deposits would have traversed the low area of Long Island sound, being there under 400 to 500 feet of hydraulic pressure. An esker called the Pinnacle hills at Rochester, N. Y., rising 100 to 200 feet from a plain area and extending about four miles, contains from base to top pebbles, cobbles, and even large boulders of Niagara limestone which must have been derived from outcrops of that formation within three or four miles on the north. Their upward transportation seems impossible for a subglacial stream, and it is ascribed to basal ice currents ascending from the ground perhaps one or two degrees, that is, 90 or 180 feet per mile. Again, the Devil's Heart hill, which is a very high kame south of Devil's lake, North Dakota, Bird's hill, an esker seven miles northeast of Winnipeg, Manitoba, and the great retreatal moraines at each side of the glacial lake Agassiz, are indicated by their physical characters and relationship to the ice retreat to be accumulations of englacial drift. These examples appear to be types of the general manner of transportation and deposition of the materials of kames, eskers, and moraines. Besides, the author held that much of the ground moraine or subglacial till had been englacial, contained in the lower part of the ice-sheet, until the time of general recession of the ice produced the conditions of its subglacial deposition.

Prof. Chamberlin, in discussion, stated that little or no englacial drift is observable in the glaciers of the Alps. The local origin of the drift seems to indicate that much of it, and even, as he believes, the greater part, was transported beneath the ice.

Mr. LEVERETT spoke of the thickness of the drift near its boundary in Illinois. In general the drift border is attenuated, but in some places its thickness in the outermost five miles attains a maximum of 50 feet; and several times as much drift is found on that belt as in the adjacent drift-bearing belt 5 to 20 miles back from the boundary.

Prof. H. F. REID, referring to his observations of the Muir glacier, doubted that basal ice currents could ascend and bear drift into the ice-sheet.

The Succession of Pleistocene formations in the Mississippi and Nelson river basins. By WARREN UPHAM. The Lafayette formation of loam, sand, and gravel in the southern states, extending in bluffs on each side of the low Mississippi valley plain to Cairo, is regarded as a fresh-water deposit laid down by rivers when the continent was being raised above its present hight during the epeirogenic uplift ending the Tertiary and beginning the Quaternary era, whose culmination was attended by the accumulation of the continental ice-sheet. Preglacial residual clay and alluvium are supposed to have been swept by the rivers from the mountain and highland regions down to the lower and less rapidly descending broad valleys and coastal plains, forming the Lafayette beds. But as the uplift increased the rivers afterward deeply eroded this formation and the underlying strata. The Lafayette formation is correlated with the Saskatchewan gravels described by McConnell in the valleys of the Saskatchewan and Mackenzie rivers, interbedded in their upper part with the lowest and earliest deposits of the till or glacial drift. Stages of the maximum ice advance and of halts or re-advances interrupting its retreat are shown by the till and moraines, and during this part of the Glacial period the land was depressed under its ice load. The loess and other modified drift were deposited when the ice-sheet was rapidly melting and receding, being derived from its englacial drift, as were likewise the deltas of the glacial lake Agassiz for their greater part. Subsidence of the land beneath the ice, and its re-elevation while the ice-sheet was melting away, are known by the loess, the northward ascent of the lake Agassiz beaches, and the marine beds about Hudson and James bays.

Mr. McGee, in discussion, stated that erosion by the Mississippi river near its mouth was 1,000 feet in vertical depth after the deposition of the Lafayette beds, which he thinks to be a marine or estuarine formation, succeeded by considerable uplift of the continent. The forest beds of Iowa seem to him to prove a long interglacial time, with at least two distinct epochs of glaciation; and the best evidence of such division of the Ice age appears to be the different depths of stream cutting in the earlier and later drift.

Prof. Spencer regarded the correlation of the Lafayette and Saskatchewan formations as doubtful, the former being estuarine.

Prof. R. D. Salisbury also considered the Lafayette formation as marine, and thought it far older than the glacial drift, as shown by its great erosion previous to the loess and other drift deposits.

Prof. Chamberlin thinks the earth movements of elevation and depression were of less duration and less geographic extent than would suffice for the accumulation of the ice-sheet; and all the drift formations in the Mississippi valley imply attitudes of the land either lower or not much higher than now.

The Cenozoic history of eastern Virginia and Maryland. By N. H. Darton, Washington, D. C. In this paper, illustrated by a map and sections, the Lafayette formation and the two divisions of the Columbia formation in the neighborhood of Washington and Baltimore are referred to three stages of marine submergence on the coastal plain and estuarine conditions in the river valleys, with intervening emergence and much erosion, greatest after the Lafayette epoch.

Mr. McGee, in commenting on Mr. Darton's paper, estimated the post-Lafayette erosion to average 250 feet over all that region of the coastal plain, while the post-Columbia erosion is comparatively very slight. The two stages of Columbia deposition are correlated with two glacial epochs in New Jersey, and the intervening emergence and erosion with an interglacial epoch at the north.

Prof. J. A. Holmes and Prof. Salisbury also spoke of their work, respectively in North Carolina and New Jersey, as fully harmonious with Mr. Darton's sequence of oscillations attended by alternate deposition and erosion.

Glaciation of the White Mountains, N. H. By Prof. C. H. HITCHCOCK, Hanover, N. H. In the absence of the author this paper was read by title.

The Gravels of Glacier Bay, Alaska. By Prof. H. F. REID, Cleveland, O. This was an illustrated lecture given in the assembly chamber of the state capitol. Very beautiful and instructive lantern views of the Muir and other glaciers of the district were exhibited, with description of the valley drift, chiefly gravel, under and in which a forest, with many trees yet standing, was buried and is now being brought again to light by the retreat of the glaciers and the resulting stream erosion of the gravels.

AMERICAN ASSOCIATION, SECTION E.

At the first session of Section E for the reading of papers, the local geology of Madison and its vicinity was briefly described by Profs. SALISBURY and VAN HISE, the former speaking of the drift deposits and the latter of the underlying Cambrian formations. Some of the drumlins of the district, and especially those in the city of Madison, were stated by Prof. Salisbury to consist in their central and larger part of stratified sand and gravel, overlain by till, which forms the surface of these oval hills. The plentiful boulders of this till and its smaller rock fragments and gravel are thought to be englacial and finally superglacial drift deposited upon hill masses of sand and gravel formed by subglacial streams. The unusually large proportion of very fine silt or loam in the till here may be due, as Prof. Salisbury thinks, to wind transportation from the neighboring driftless area on the west. A remarkable esker or osar between lakes Monona and Wingra, in the southwestern suburbs of Madison, seems to have been accumulated by a glacial stream flowing transverse to the general ice movement, which here was from northeast to southwest. An area of very abundant drumlins extends eastward from Madison, where their mapping by Mr. I. M. Buell shows an average of about seventy-five for each township six miles square.

By special request of members of this section, Prof. REID repeated his lecture, "The Gravels of Glacier Bay, Alaska," with exhibition of views. He was not able to decide whether in some cases the valley gravels originally filled the entire width of the valley or were limited to their sides by adjoining glaciers.

Mr. LEVERETT, in discussion, spoke of terraces observed by him in Ohio that were probably deposited only on the valley sides. Such terraces are also found in other parts of the northern United States, though less frequent than those produced by the erosion of valley flood-plains.

Prof. SALISBURY mentioned criteria for discriminating terraces left by erosion from those confined originally by ice. The latter would have short esker or kame branches where the ice was crevassed, and kettle holes where its receding border left isolated ice hillocks.

On motion of Prof. G. F. WRIGHT, the section voted to name the northwestern arm of Glacier bay as Reid inlet, in commemoration of the explorations of the bay and its tributary glaciers by Prof. Reid and his parties in 1890 and 1892.

During a part of Monday, Aug. 21st, Section E was adjourned to attend sessions of Section H (Anthropology) occupied with the following papers and discussions on the relationship of man and the Glacial period.

The Evidence of Glacial Man in America. By Prof. G. F. WRIGHT, Oberlin, O. Man's existence in France and Great Britain during the Glacial period has been fully proved and is now accepted by all archæologists and geologists, though at first it was received with extreme incredulity. In this country, likewise, the author thinks that fully reliable proofs of the presence of Glacial man have been found in numerous localities, although recently those evidences have been criticised as delusive. Prof. Wright's own observations, and discoveries by others, as Abbott, Putnam, Carr, Shaler, and Volk, in the glacial gravels of Trenton, N. J., Mills and Metz in Ohio, Kurtz at Nampa, Idaho, and Whitney, King and Becker in the lava-covered gravels of California, were recounted and claimed to be satisfactorily established by their testimony. The origin of the human race was probably in southwestern Asia, whence man migrated northwesterly into Europe and northeasterly to this continent across a land area in the present place of Bering sea.

The Antiquity of Man in America. By W J McGee, Washington, D. C. Although the author several times has found arrow or spear points or other objects of human manufacture so apparently or possibly enclosed in undisturbed deposits of Glacial age that some might have accepted them as proof of the existence of Glacial man, they have seemed to him in each instance more probably or quite surely to belong to later times. Decay of the roots of trees, burrows of animals, and the falling down of talus slopes, may have permitted stone implements of modern age or fragments from their manufacture to become imbedded where they have been erroneously supposed to be relics of men contemporaneous with the Ice age. The recent observations of Mr. W. H. Holmes in New Jersey, Ohio and Minnesota bring grave doubt against the most important localities which before were believed to afford decisive evidences of Glacial man. For the determination of this question the author thinks that much better and more ample testimony is needed, and that for the present its decision must be held in suspense.

An animated discussion followed the presentation of these papers. Prof. Van Hise inquired, Do the earliest stone fragments which are supposed to be artificially flaked show that they were designed for use? Do such flaked stones possess characters by which their relative antiquity can be known? Are there any means of determining the age of a stone implement or flaked fragment, excepting by the geologic position of its occurrence? and can any other testimony than that of an expert glacial geologist be relied upon?

Mr. H. C. Mercer stated that most of the palæolithic implements of the Somme valley gravels and of other European localities had been obtained by unskilled workmen, no larger proportion probably than in America having been found by specialists of archæology and geology.

Dr. H. C. Hovey remarked that much credit is due to Prof. Wright and others for their careful investigations of this subject, upon which we must continue to seek additional light. In Luray cave, far from the entrance, he found an arrow head which seemed surely very ancient, but this is an isolated discovery, for American caves, unlike those of Great Britain and Europe, are almost or wholly destitute of traces of their habitation by early man.

Prof. CHAMBERLIN regards the greater part, or perhaps all, of the evidence for Glacial man in America as untrustworthy. Only very rare implements or artificially flaked fragments of stone have been found at considerable depths in glacial deposits, and these may be best explained by their falling through the hollows left by tree roots, which go down to reach permanent moisture ten or twenty feet below the surface. Instead of deserving to be called implements, most of the flaked stones found at Trenton, N. J., and elsewhere in the river gravels, are to be classed, according to Mr. Holmes' researches, as "quarry rejects." The conditions attending the deposition of these gravels in the Glacial period would be unfavorable for man's abode and loss of implements in his rude hunting and fishing; but during comparatively recent times these gravels have been worked and flaked for the manufacture of implements which were used and lost throughout the adjoining country.

Prof. E. W. CLAYPOLE compared the attitude of many American scientists concerning this question with the reluctance of European geologists to accept the discoveries of early man in the Somme valley. Men now live close to the borders of glaciers and ice-sheets. In Europe the Neolithic stage of culture, or partial use of polished stone implements, was reached before the ice of the Glacial period was melted away.

Mr. UPHAM spoke of evidences of man's existence on the shores of the glacial lakes Iroquois and Agassiz, as published by Gilbert and Tyrrell. The gravel and sand beaches of lake Agassiz enclose no boulders which would be brought by floating ice, and their absence indicates a mild climate during the recession of the ice-sheet. If the accumulation of the ice was caused by a high uplift of the land and its departure was due to a depression, the climatic conditions attending the close of the Glacial period may have been nearly as temperate along the boundary of the retreating ice as they now are on the same latitude. In Alaska an abundant boreal temperate flora, including forest trees, grows on the margin of the waning Malaspina ice-sheet.

Prof. F. W. PUTNAM directed attention to the occurrence of both argillite and jasper implements on the surface about Trenton, N. J., while the only flaked stones found there in the glacial gravels are argillite. The working of the jasper quarries, as shown by Mercer and Volk, belongs to a postglacial and comparatively late epoch. If the specimens obtained in the gravel deposits were introduced by tree roots, burrows, and falling talus slopes, there could be no discrimination selecting the argillite. He had examined the freshly undermined bluffs of a stream at Trenton and discovered a flaked stone of unquestionably artificial origin beneath a large boulder where no root or burrow could account for it. During his long experience in the excavation of aboriginal earthworks, he has observed no holes due to decaying roots at greater depths than two or three feet below the surface. Although trees send roots much deeper, their slow decay is attended with the sifting of fine sand or clay into the place of the root so as to fill it as fast as the decay takes place. Numerous well authenticated discoveries of stone implements and even human bones in formations of glacial origin seem to afford adequate and convincing proof of man's presence here in the Ice age.

After this discussion Section E resumed its separate sessions, in which the following Pleistocene papers were presented:

Some questions respecting glacial phenomena about Madison. By Prof. T. C. CHAMBERLIN, Chicago, Ill. Madison, Wis., the city of this meeting, was described as situated within the area of the later drift near the end of the Green Bay lobe of the continental ice-sheet. The direction of glaciation at Madison was southwestward, with which the longer axes of the drumlins are parallel. About 2,500 drumlins have been mapped, mostly by Mr. Buell, in southeastern Wisconsin, and probably as many more remain to be mapped throughout the eastern part of the state. The sand and gravel cores of the Madison drumlins appear to have been subglacial deposits; and the overlying till, enclosing more and larger boulders than the till of the surrounding lowlands, seems to have been englacial, excepting perhaps that a large part of its loam, according to the hypothesis of Salisbury in a subsequent paper, may have been brought by winds. The osars, kames, and moraines of the region were also briefly noticed.

Ice-sheet on Newtonville sand plain. By F. P. Gulliver, Norwich, Conn. Two models were exhibited in illustration of this paper, one showing the topography of a glacial sand plain or low plateau, with associated esker ridges, near Newtonville, Mass., and the other showing the relationship of the ice-sheet to this area at the stage of its retreat when the sand plain was deposited. The author agrees with Prof. W. M. Davis in regarding these eskers as subglacial; and the plain, which has the characteristic outlines of a delta, is thought to have been accumulated when the sea stood at its hight, nearly 150 feet above the present sea level.

Mr. McGee, in discussion, spoke of the lobation of the waning ice-sheet in Iowa, determining the situation of glacial streams and lakes.

Mr. Upham would ascribe the eskers to ice-walled streams open to the sky, since no boulders or till fell from an ice roof upon them; and the body of water receiving the delta seems to him more probably to have been lacustrine, dammed by the receding ice-sheet, since no shore lines of wave erosion are found on the slopes of drumlins in Boston harbor and its vicinity, some ten miles northeast of Newtonville.

Prof. G. F. Wright spoke of an esker at Lawrence, Mass., running from north to south with descent into the Merrimack valley and ascent from it, where it appears to have been formed by a superglacial river. When the ice beneath the gravel ridge was melted, it settled down to its present undulating course, which cannot so well be referred to a siphon-like subglacial stream.

Amount of glacial erosion in the Finger Lake region of New York. By D. F. Lincoln, Geneva, N. Y. Considerable tracts of the uplands between the Finger lakes have very scanty drift, averaging probably no more than one or two feet; but the valleys south and north of the lakes have deep drift. Apparently the uplands have been glacially planed and their detritus largely deposited in the valleys and in the terminal moraine on the south. In preglacial time the high lands between the lakes were higher, and the valleys may have been deeper, than at the present time. But along with the planation of the ridges the valleys appear to have been much deepened, to the amount of hundreds of feet, by glacial erosion, as is suggested by the tributary water courses on each side, which open into the lake valleys high up their sides. Cayuga and Seneca, the largest two of the Finger lakes, are respectively 378 and 441 feet above the sea level, and their beds sink to 57 and 177 feet below that level.

Prof. W. H. BREWER spoke of his observations of that region during his boyhood and youth, which were spent a few miles west of Ithaca and the south end of Cayuga lake. He would like to have the granite and other crystalline boulders of the district compared with the areas of their parent ledges in Canada.

Prof. H. S. WILLIAMS remarked that near Ithaca glacial striæ are found on the side of vertical or overhanging rock cliffs. Soundings of Keuka lake show that the bed of its eastern branch has a descent of about 100 feet where it joins the western branch and main valley of the lake, indicating that the preglacial drainage there passed to the south.

Prof. CHAMBERLIN noted four east to west belts in the region comprising the Finger lakes, namely, first at the north, the belt of abundant and large drumlins between lake Ontario and these lakes; second, the Finger lake belt; third, the terminal moraine; and, last, the unglaciated area. Preglacial erosion had cut deep notches southward from the Finger lake valleys to the drainage basin of the Susquehanna river. This region presents a most interesting field for further study by glacialists.

Additional facts bearing on the question of the Unity of the Glacial period. By Prof. G. FREDERICK WRIGHT. The valleys of the upper Ohio and its tributaries, below their highest terraces, have been supposed by glacialists who accept two epochs of glaciation and a long interglacial epoch, to have been cut down in the rock strata by stream erosion during interglacial time. The author, who regards the glaciation of the entire Ice age as continuous, thinks that these valleys were eroded during a preglacial time of high uplift of the land; that they were filled with valley drift to the levels of the highest terraces; that stream erosion during the closing stages of the glaciation removed this drift, excepting its scanty remnants as terraces, probably cutting as deep as to the present river beds; and that the later and lower terraces, contemporaneous with adjacent moraines on the north, were then formed by the filling of the valleys again to their hight and by subsequent stream channelling. The valley drift on the Beaver river in Pennsylvania and on Clark's creek, a tributary of that river from the west about nine miles above its mouth, was described as supporting this view of the preglacial erosion of the whole depth of the rock valleys. In the Delaware valley the same history is thought to be recognizable, the great length of time needed for the rock erosion having been preglacial.

Changes of Drainage in Rock River Basin in Illinois. By FRANK LEVERETT, Chicago, Ill. The Rock river, in its course as the chief line of drainage in northwestern Illinois, lies wholly on the area of the earlier drift. Being turned out of its preglacial course by the drift deposits, it has in numerous places along its new route cut 50 to 125 feet into the rock formations. A computation of the volume of rock so eroded shows it to be equal approximately to a mass one mile square and 1,095 feet high; and this erosion was accomplished before the time of the Kettle moraine of Wisconsin, whose overwash gravels run along the bottom of the valley and form terraces 50 feet above the river. Since the deposition of these gravels contemporaneous with the later drift, the river, which has a width of about 500 feet and descends about ten inches per mile, has removed a portion of them equal approximately to a mile square and 657 feet high. The large amount of cutting in the hard rock, and the smaller erosion of the soft gravel and sand, are considered as measures of the relative duration of the time subsequent to the deposition respectively of the earlier and the later drift.

In discussion of the two foregoing papers, Prof. CHAMBERLIN spoke of loops, called ox-bows, at the side of the Ohio valley, where a part of the ancient winding course of the valley has been cut down and shows the highest drift gravels lying on the rock of the old river bed high above the present channel.

Prof. SALISBURY considered the relations of the upper early terrace gravels in the Delaware valley, referred to the Columbia formation, and the lower and late Trenton gravels to be demonstrative of a long interglacial epoch between their times of deposition.

Mr. McGee mentioned the great contrast of the old topographic erosion forms of the early drift and the very uneven surface, with slight erosion or none, shown by the newer drift north of the moraines.

Graphic Comparison of post-Columbia and post-Lafayette Erosion. By W J McGee. On a large area of the Atlantic coastal plain which has been very carefully studied about Washington, D. C., as illustrated by maps and sections, the average amount of erosion from the whole country is shown to have been 200 to 300 feet since the deposition of the Lafayette formation; but since the Columbia epoch the average erosion is perhaps no more than one foot from the same area. The difference in age of these formations is very great, and they are separated by an unconformity, due to this erosion, which is more important than any other similar horizon in the sequence of the Neocene and Pleistocene formations of this coastal belt. After the marine submergence to which the author attributes the Lafayette beds, the land is thought to have risen some 500 feet higher than now during its post-Lafayette denudation.

An Illustration of the Effects of Stagnant Ice in Sussex County, N. J. By Prof. R. D. Salisbury, Chicago, Ill.

A Phase of Superficial Drift. By R. D. Salisbury. These two papers, owing to a temporary absence of the author, were read by title.

Tertiary and Quaternary Stream Erosion of North America. By Warren Upham. If the accumulation of the Pleistocene continental ice-sheet was caused by a great epeirogenic uplift and high plateau climate, as the author believes, exceptional erosion by rivers during the late Tertiary and early Quaternary time should be found throughout the United States and Canada. The very remarkable erosion of the Colorado cañon and its tributaries, the extensive denudation of the Lafayette and older beds along the lower Mississippi and on the eastern coastal lowlands, the formation of the broad, flat valley of the Red river of the North, the channelling of the now submarine extension of the valleys of the Hudson and St. Lawrence rivers, of similar deeply submerged valleys on the coast of California, and of the fjords of our continental borders thence northward to the Arctic archipelago and

Greenland, all appear to be referable to this time of high preglacial uplift, whose culmination was attended with the envelopment of the northern half of the continent beneath an ice-sheet.

In discussion, Prof. G. F. WRIGHT noted the rapidity with which the post-Lafayette erosion would take place if the coastal plain rose 2,000 or 3,000 feet higher than now.

Mr. C. D. WALCOTT spoke of the wonderfully vast erosion in the Colorado region, and showed that it began probably after the middle of the Tertiary era.

Mr. LEVERETT doubted that high uplifts and plateau climate could cause glaciation; to which Mr. UPHAM replied that the present ice-sheets of Greenland, of the district north of Mt. St. Elias, which feeds the Malaspina glacier, and of Norway, are on very high areas, and that probably even the Antarctic ice-sheet, though circumpolar, could not have been formed if that region had been ocean without large tracts of land, a part of which is known to comprise high mountains.

EDITORIAL COMMENT.

THE GLACIAL NIGHTMARE AND THE FLOOD.*

This is a rather singular book. Its author, Sir Henry H. Howorth, has shown great skill in marshalling his facts and in presenting them to his readers. He evidences great research into the subjects of which the work treats. But we hardly think that he will succeed in convincing his fellow geologists of the correctness of his conclusions in regard to the Ice age. His title is enough to indicate the tendency of his argument, but a few sentences from his preface will more justly show his position.

"I hold that the Glacial theory, as ordinarily taught, is based not upon induction but upon hypotheses some of which are incapable of verification while others can be shown to be false. This is why I have called it a 'Glacial Nightmare.' I utterly deny the possibility of ice having moved over hun-

*The Glacial Nightmare and the Flood, by Sir Henry H. Howorth, M. P. Sampson, Low, Marston & Co., London, 1893.

dreds of miles of level country, its capacity to mount long slopes and the excavating and denuding power that has been attributed to it. In the following pages I claim to have shown that a wide-spread flood is a necessary postulate if the geological facts are to be duly explained."

The first three chapters of the work are devoted to a full examination of the theories of the "Champions of Water" as the author calls those early geologists who between 1719 and 1840 maintained that the Drift with its erratic blocks was scattered over the northern lands by a mighty flood of water. In the infancy of the science the enormous difficulties that lay in the way of the maintenance of this theory were unknown or undervalued or explained away by the interpolation of miracles.

The fourth chapter takes up the theory of iceberg-action as the transporting agent and sketches briefly the work of various writers from 1704 to 1843. The abandonment of the former view and the adoption of this was brought about by the numerous observations of striated and polished rock-surfaces and the study of the distribution of erratic blocks.

In chapter V the "Champions of the Glaciers" receive attention, beginning with Playfair in 1802 and ending with Max Braun in 1843. A striking extract from the "Illustrations" of the former writer is given as the earliest published attribution of the dispersal of erratics to glacial transportation. It is as follows: "For the removal of large masses of rock the most powerful agent which Nature employs is without doubt the Glacier." The gradual advance of this theory and the retreat and disappearance of the two others are well sketched, and the conversion of the leading glacialists of the time from the iceberg to the glacier school of geology is told in an interesting manner. The author vividly describes the memorable 18th of November, 1840, when Dean Buckland, himself the author of the "Reliquiæ Diluvianæ" read his recantation and adopted the views of Agassiz and his comrades and when Murchison in reply sneeringly asked if he would make Highgate Hill the seat of a glacier and if Hyde Park and Belgrave square would be within the scope of its action.

The sixth chapter is entitled "The Growth and Culmination of the Glacial Nightmare." With much interesting matter concerning the early glacialists are mixed the beginnings of the Glacial theory as we have seen it in these latter days, portentous in size and duration, filling the valleys of Brazil with Andean ice and capping both poles with alternate lunoids of massive névé.

Sir H. H. H. agrees with Dr. Volger in tracing the first idea of the glacial theory to a little poem published by the botanist, Schimper, on the 11th of February, 1837. It was entitled "Die Eiszeit, für Freunde gedruckt am Geburtstag Galilei."

To Agassiz, however, he attributes the original idea or vision of this prodigious glacier—the glacial nightmare—and with justice, for no one since has dared to picture "die Eiszeit" in the bold and picturesque, we may say hyperbolical language of the great Neuchatelese which is quoted by our author. "The polar ice which at the present day covers the miserable regions of Spitzbergen, Greenland and Siberia extended far into the temperate zones of both hemispheres, leaving probably but a broader or narrower belt around the equator. Nay, if Tchudi's observations in the Cordilleras and Newbold's at Seringapatam shall be confirmed, the whole surface of the earth was according to all probability for a time one uninterrupted surface of ice from which projected only the highest mountain ridges covered with eternal snow. During the glacial period there was no motion, not a brook nor a rill furrowed the surface of the snowy covering."

Such a frigid, frozen condition of our globe may well be described as a glacial nightmare the awakening from which would be cheering and invigorating. Compared with even the widest and wildest views now maintained this was indeed the reign of "omnipotent ice."

In the seventh chapter "the thrilling regions of thick-ribbed ice" in the western world come under examination and the great ice-sheet formed by the confluent Laurentide, New England and Rocky Mountain glaciers is described. This is familiar to most of our readers. Passing on to the glaciation of South America, Agassiz's emphatic language regarding the South Polar ice-cap is quoted, showing that he went to the full length of his theory and even perhaps beyond it. "Is it improbable," asks this glacialist, "that when a sheet of ice 6,000 feet thick moved over New England, the valley of the Amazons had also its glacier poured into it from the Cordilleras? This must have ploughed the valley bottom over and over again, and accumulated at its lower end a moraine of proportions as gigantic as its own. I have found no trace of the glacial inscriptions so characteristic of the ground over which glaciers have travelled, for the simple reason that there is not a natural rock surface to be found in the whole Amazonian valley."

It is not a little amusing to read how these over-zealous and almost rabid glacialists were put to it to solve the zoological puzzles which their excessive "crystallomania" compelled them to face. But on this we cannot here enlarge. Well may our author say that in view of generalizations like these our breath is taken away.

We need not linger over the chapter on supposed glacial beds in earlier geologic ages nor on the review of the various cosmic theories of glaciation, all of which are regarded with more or less of suspicion or skepticism by geologists.

The eleventh chapter possesses special interest just now because it presents a summary of the views regarding interglacial eras. Space forbids our entering into detail, but it is evident that many of the sections that have been relied on to prove the occurrence of these relentings of climate are less demonstrative than has been believed. Thus of the Dürnten beds in Switzerland, M. C. Grad says: "Je n' y ai pas remarqué de stries glaciaires." And Favre says of the beds near Geneva: "Nous n' avons pu découvrir dans les environs de Genève aucune preuve de l'existence de deux époques glaciaires." Falsan also writes: "Nous repoussons, comme peu vraisemblable, la théorie des recurrences de périodes glaciaires distinctes."

In England, Lamplugh says of some Yorkshire sections at Sewerly and Speeton, that "they underlie the basement clay and are, therefore, preglacial, and not interglacial as has been argued. There is no clear evidence here for a mild interglacial period."

The author then discusses the evidence of glacial action in the southern hemisphere and quotes from numerous writers to prove that no general ice-sheet ever prevailed there, but that all the phenomena observed are due to local glaciers. He also maintains that the greatest extension of these glaciers was contemporaneous with the Ice age of the northern hemisphere.

Passing over the ensuing chapters which treat of the movements of a glacier and of the abrading power of ice, we come to the chief assault upon the glacial theory of Agassiz as now accepted. All the arguments that have been urged against the existence and action of a continental ice-sheet are marshalled in order and make a formidable showing. The co-existence of till and striation, the nature of glacial erratics, etc., etc., are brought forward to disprove the occurrence of any continental ice-mass. The following chapter is a contention that the action of land-ice in the so-called glacial period, as in our own time, was limited to ice in the form of glaciers. The chapter may fairly be called a very strong presentation of the arguments on his side of the question. There is no denying or disputing the fact that in the ordinary discussion of the subject much of the opposing evidence is left out, glossed over, or explained away in a more or less unsatisfactory manner. A vast amount of work yet remains to be done before just views can prevail on this topic—views less icy than those of Agassiz, on the one side, and less watery than those of the diluvial geologists, on the other.

The author's expressions thus far have been marked by candor and fairness. He is a rebel against the strictly uniformitarian school of geology, and his book is a really valuable repertory of facts for reference. It may be considered an element in the reaction which has apparently set in against extreme views on the glacial catastrophe. It is marked by industry, perseverence and modesty, and may well lead some of the extreme glacialists to reflect upon the unremoved difficulties that yet encumber their path.

Up to this point we have followed our author with much interest and no little pleasure, and we think our readers would do the same. But when, in his last chapter, he leaves the reviewing of geological literature and the summing up and presentation of evidence, and goes on to develop his special theory, to support which is his great aim and effort, we are unable tó use the same favorable language. Supplemental to the local but extensive glaciers, which he allows, he invokes the operation of a great diluvial catastrophe—a mighty flood of water which was alone capable of shifting and laying down the drift-beds. We cannot go at length into the arguments used in support of this opinion. It must suffice to say that in our opinion they will have but little weight with geologists, especially in America where the evidence on the other side is perhaps much stronger than in Europe. The attempt to apply the investigations of Scott, Russell, Hopkins, and Whewell, etc., on the form of waves is scarcely allowable. Nor is the testimony of geologists always quoted in the sense which the authors intended. Dana's "Connecticut River Flood," for instance, cannot be logically pressed to imply the transport of the drift of the midland states by water. Allowing full scope for floods of terrible force and duration during the Ice age, we do not think the writer has made out a sufficient case for invoking the aid of so portentous a "Deus ex machina" as the well-nigh universal deluge which his interpretation of the drift would require. He says that geologists have found no adequate cause for their ice, but they can readily retort on him with "*Tu quoque*." We fancy they will be inclined to turn the tables and parody his title into the "Diluvial Nightmare and the Ice," for so tremendous a catastrophe as he implies equally well deserves that name.

In conclusion, we may be permitted to remark that our author closes rather summarily without giving his readers any clue to the cause to which he assigns the immense and sudden waves that he says distributed the drift. We can, however, infer from some recent articles of his which have appeared in the Geological Magazine, and from a few hints in his preface, that he intends to appeal to mighty convulsions the like of which in past days appalled the imagination of the early geologists.

"Presently," he writes "came a tremendous catastrophe the cause of which, as I have tried to show in the Geological Magazine, was the rapid and perhaps sudden upheaval of some of the largest mountain chains in the world, accompanied probably by great subsidences of land elsewhere."

Sir Henry will allow us to remind him that it is too late in the day for the most earnest and conscientious opponent of uniformitarianism to advocate the old and lost cause of extreme catastrophic geology or to summon from the vasty deep in which they are forever laid, the spectres of general cataclysm, wreck and ruin that oppressed the bygone ages. Admitting catastrophe even on a large scale at times, we yet think that he has followed an *ignis fatuus*, though honestly, and in this we believe almost all geologists here and elsewhere will agree. His theory is less credible, less reasonable than that which it is intended to supplant, and we fancy some such sentiment as this must have given origin to the unpleasantness at the recent election of new Fellows to the Royal Society.

Glacial Man in America.

The discussion between the advocates and the opponents of glacial man in America was renewed at the recent meeting of the Anthropological Section of the A. A. A. S. at Madison and some contributions of value were made by more than one of the speakers. Mr. E. Volk narrated the results of some work which he had done under the direction of Prof. F. W. Putnam in the valley of the Delaware river, where about thirty miles above Trenton he had exposed a number of ancient pits and taken from them relics of various kinds, whose position indicated an occupation of the valley by successive peoples. In the shallow pits and in the surface peat he found abundance of jasper implements, but lower down, beneath the old soil and in the gravel these were entirely wanting, and only argillites of rude type occurred. No mixture was found on this lower level, but the argillites continued up to the surface, thus apparently indicating, as Mr. Volk contended, that the earliest inhabitants did not use or work the jasper and flint but that this was a later art introduced by a later race. Referring to the "reject" theory, Mr. Volk said that he had found seventeen of these rough tools in a cache all put carefully together, a fact scarcely compatible with the belief that they were merely the waste refuse of the manufacture.

The failure of most visitors to find anything on the ground was alluded to by various speakers and chiefly by Dr. Mercer, who said that he had himself visited the classic quarries at Amiens, St. Acheul and Chelles but had found nothing, and this he said was the almost regular experience of geologists who had gone there during the last forty years, one or two only having been fortunate enough to obtain a flint tool in its original place.

The efforts of the opponents to meet the arguments brought forward were less convincing to the Section, though urged for the most part with ingenuity and propriety. Only one of the disputants lost self-control and allowed himself to employ unparliamentary language in denying that any discrepancy existed between the story of the Nampa image as told by himself and by major Powell. However, as the two versions were read before the Section next morning without note or comment, the assertion under consideration was at once annulled by its obvious inaccuracy.

On the whole the advocates of glacial man in America appear to have gained strength from the discussion, perhaps as much in consequence of the ingenuity of the arguments to which their opponents resorted and the unfortunate and prejudicial manifestation of temper above referred to as in consequence of any great accession of valuable evidence brought forward by themselves. The question is still *sub judice.*

REVIEW OF RECENT GEOLOGICAL LITERATURE.

Revision of the Families of Loop-bearing Brachiopoda: The Development of Terebratalia obsoleta Dall. By CHAS. E. BEECHER. (Trans. Connecticut Academy, vol. ix, 1893, pp. 376-399, plates i, ii, iii.)

Dr. Beecher continues his important systematic studies of the Brachiopoda. In the first paper is given a new arrangement of the genera of the suborder Ancylobrachia, basing it upon the entire history of the individuals, or ontogeny, and not as heretofore alone on mature characters.

The old families *Terebratulidæ* and *Terebratellidæ* are retained, but not in the sense that the former embraced all the short-looped genera and the latter the long-looped ones. The family *Terebratulidœ* is characterized by having, in all stages of growth, a free loop, which may be long or short, with the cirri directed outwards in larval stages. In the *Terebratellidœ* the loop "undergoes a series of metamorphoses while attached to a dorsal septum during the larval and immature stages of the animal, and in the higher forms results in a loop of secondary growth, much like the primary loop of some of the early genera of the *Terebratulidæ*. Cirri directed inwardly in larval stages."

The family *Terebratulidæ* comprises the sub-families *Centronellinæ*, *Stringocephalinæ*, *Terebratulinæ*, and *Dyscollinæ* (Fischer and Oehlert) emend. Beecher.

The greatest change is in the family *Terebratellidæ*. The author shows that mature species of this family may approach each other so closely as to be generically similar and yet belong to distinct genera of two sub-families; in other words, *that nearly the same mature structures may be attained along separate phylogenetic lines.*

In recent years much has been added by Oehlert and Fischer to our knowledge of the recent species of the family *Terebratellidæ*. The author shows more clearly than has heretofore been shown that the species occurring in southern seas pass through a different series of metamorphoses from those in northern seas, and that each *phylum* has a distinct series of growth stages. These stages are compared with well known but heretofore not clearly understood genera, and it is conclusively shown that they are abbreviations of the highest and most complex genus of either the austral or boreal stocks. *Waldheimia* (*Magellania*) *venosa* and *Terebratella dorsata* are two generic terminals of the austral stock, while *W. septigera* (type of *Dallina* n. gen.) and *T. transversa* (type of *Terebratalia*, n. gen.) are the terminals of the boreal phylum.

The author says:

"By observing the stages of development in the austral and boreal terebratellids, it is seen that both start from a common larval stage, and divergence into two lines begins in the first adolescent stages, so that the series of metamorphoses in each is quite distinct nearly to the end. This in itself might not require that the austral and boreal species should be referred to different genera and placed in different sub-families; but when it is found that all the other southern genera of the *Terebratellidæ* represent arrested and degraded stages in the development of a southern *Terebratella* or *Magellania*, and that the northern genera represent similar stages in the development of a northern high type, such a separation necessarily follows. Moreover, these stages have a more profound significance, as several of them in both regions represent established genera now extinct." (p. 380.)

"The genera of the *Terebratellidæ* begin their larval development in a form like *Gwynia*, having no calcified brachial supports, and with a simple circle of centripetally directed tentacles. Then by the growth of a septum in the middle of the dorsal valve, a *cistelliform* stage is reached. From this point divergence begins, and there is one series of transformations resulting in *Macandrevia*, and another terminating in *Magellania*, the mature loops in both groups being practically alike. *Macandrevia* and *Dallina* are morphically equivalent to *Magellania*, and *Terebratalia* is also in exact parallelism with *Terebratella*." (p.383.)

"In each line of progression, the acceleration of the period of reproduction, by the influence of environment, threw off genera which did not go through the complete series of metamorphoses, but are otherwise fully adult, and even may show reversional tendencies due to old age; so that nearly every stage passed through by the higher genera has a fixed representative in a lower genus. Moreover, the lower genera are not merely equivalent to or in exact parallelism with the early stages of the higher, but they express a permanent type of structure, as far as these genera are concerned, and after reaching maturity do not show a tendency to attain higher phases of development, but thicken the shell and cardinal process, absorb the deltidial plates, and exhibit all the evidences of senility and reversion presented during the old age of the higher genera." (p. 388.)

"Progressively through each series, the adult structure of any genus forms the last immature stage of the next higher, until the highest member in its ontogeny represents serially, in its stages of growth, all the adult structures, with the larval and immature stages of the simpler genera." (p. 386.)

The genera of the family *Terebratellidæ* are arranged by the author as follows:

DALLININÆ, n. sub-fam.: *Macandrevia*, *Dallina*, n. gen., *Eudesia*, *Terebratalia*, n. gen., *Trigonosemus*, *Lyra*, *Lacqueus*, *Muhlfeldtia*, *Kingena*, *Imenia*, and *Platidia*.

MAGELLANIINÆ, n. sub-fam.: *Magellania*, *Terebratella*, *Magasella*, *Magas*, *Megerlina*, *Bouchardia*, and *Kraussina*.

MEGATHYRINÆ: *Megathyris*, *Cistella*, *Zellania*, and *Gwynia*.

The second paper is supplementary to the first and treats of the shell development of *Terebratella* (=*Terebratalia*) *occidentalis*, var. *obsoleta*, Dall. The specimens were dredged by the U. S. Steamer *Albatross* off Cerros island, Lower California. The ontogeny of this species is in harmony with other northern forms and is distinct from the true *Terebratella* of austral seas. C. S.

The Fishing Banks between Cape Cod and Newfoundland. By WARREN UPHAM. (Proc. Bos. Soc. Nat. Hist., vol. XXVI, pp. 42-48.) It appears from the descriptions and statements of this paper that in the thousand miles east-northeastward from Cape Cod the submarine border of the American continent differs remarkably from that portion which extends southwardly from the same place. It is of irregular contour, consisting of numerous submerged hills and broad plateaus which rise from 100 to 1,000 feet above the intervening valleys. The depth of water ranges mostly from 10 to 50 fathoms. The general contour resembles that of New England in general, or of eastern Canada. It appears to have been a land area at some time previous to the Quaternary and to have been eroded by rains and rivers. Mr. Upham shows that this elevation must have been since or cotemporary with the close of the Tertiary era, introducing the Quaternary, and amounted to about 2,000 feet above the present land level. Numerous pieces of a peculiar calcareous sandstone have been brought from the bottom of the ocean on these banks by the nets of the fishermen and they contain, according to Prof. A. E. Verrill (Am. Jour. Sci. (3), v. 16, p. 323-324), abundant fossil shells and fragments of lignite of late Tertiary age, and of northern forms now living on the New England coast, indicating an extensive submerged Tertiary formation several hundreds of miles in length, constituting, very likely, the solid foundation of the banks. The banks, therefore, with their complex of valleys, can be classed with the extended submerged Hudson channel and other submarine valleys off the California coast, and with the fiords of all our northern coasts, as evidences of a great epeirogenic uplift of the northern part of the North American continent, preceding and producing the Ice age.

The Conditions of Erosion beneath deep glaciers, based upon a study of the Boulder Train from Iron Hill, Cumberland, R. I. By N. S. Shaler. Bulletin of the Museum of Comparative Zoology at Harvard College, vol. xvi, pp. 185–225, with a map and four plates; Jan., 1893. The rock of Iron hill is a peridotite, a phase of olivine gabbro, yielding 25 to 45 per cent. of metallic iron. Its peculiar and conspicuous appearance, unlike that of any other rock in New England or even in the United States, makes it possible to observe very accurately the extent of its glacial transportation. The outcrop, which is believed to be a volcanic neck or dike, measures about 1,200 by 500 feet, and rises 60 feet above the adjoining somewhat level, drift-covered country. At this source the width of the boulder train is about 700 feet, but in its extent thence to the south it gradually widens to four miles in the vicinity of Providence, about fifteen miles from Iron hill; and in the next twenty-five miles to Newport and the mouth of Narragansett bay it expands to a width of nearly eight miles. Onward it fans out more rapidly, so that its east side touches the west end of Martha's Vineyard. Close to Iron hill the largest boulders are four to five feet in diameter, but thence they diminish in size to only one foot near Providence, and to five inches on Martha's Vineyard, where only three fragments have been found. The boulders are embedded in the till, being there intermingled with others from the various rock formations both north and south of Iron hill. The widening or fanning out of the boulder train Prof. Shaler ascribes to currents of subglacial water, working the drift over perhaps several times before it was finally deposited by the ice-sheet as till. From the volume of its contribution to the drift, and from studies of the glaciated rock surface, Iron hill appears to have been glacially eroded at the surprisingly rapid rate of six inches, or perhaps even a foot or more, for each mile of the ice advance; but about four-fifths of the eroded rock was borne away as sand and fine flour, only one-fifth being boulders, whose scars on the surface of the outcrop show where they were plucked away. A very short time, geologically speaking, would suffice for the glaciation of New England at this rate, which seems to imply the removal of at least an inch of this very hard rock yearly. Since the preservation of the grand features of the preglacial contour upon the drift-bearing region of the United States and Canada is usually very evident, probably the average glacial erosion is rarely so much as 100 feet, which would require only 1,200 years. Such brevity of the ice wear, however, seems to Prof. Shaler consistent with a much longer duration of the Glacial period, according to his most extraordinary and ingenious hypothesis that the pressure of the ice weight, supplemented in some degree by its friction and by the slowly escaping internal heat of the earth, caused the base of the ice-sheet under its thick central part to be melted, so that the ice there rested on a cushion of water, in which no erosion of the underlying rock or drift was possible. Upon the area near the ice border, where it was too thin to be basally melted by its own pressure, glacial wearing and mingling of the drift took place; and in the critical area dividing this tract from the water-cushioned ice the drumlins, "most puzzling of all glacial deposits," are supposed to have been accumulated. During the growth of the ice-sheet and again during its decline, all portions of its area would be for some time subjected to its erosion, mixing, transportation and deposition of drift. Though few glacialists and physicists will probably agree with the hypothesis of pressure melting, all will find much of profitable suggestion in this elaborate and interesting investigation.

The Wanderings of the North Pole. By ROBERT S. BALL. Fortnightly Review, new series, vol. liv, pp. 171-183; Aug., 1893. The investigations of Dr. S. C. Chandler are accepted as an adequate explanation of the small observed variations of latitude, referring them to a revolution of the earth's pole during a period of 427 days, the maximum circle which it describes in its "wanderings" having a radius of about 30 feet. No appreciable secular variation is discovered, and the place of the pole since the Glacial period and from even earlier geologic times is believed to have been without greater changes than would lie inside the area of a block or square enclosed by the intersecting streets of a city.

The Improvement of Geographical Teaching. By WILLIAM MORRIS DAVIS. National Geographic Magazine, vol. v, pp. 68-75; July 10, 1893. The purpose of the teacher and text-book of geography, as professor Davis urges, should be not simply to describe the forms of the land but to recognize their dependence on geologic structure and erosion. An illustrative example is the gently inclined plateau of southern New England, which is shown to have been formerly a peneplain, worn down by subaerial denudation to a surface of moderate relief and subsequently tilted so that its southeastern part now sinks below the sea level, while northward and westward it rises to a hight about 1,500 feet above the sea. This plateau, much eroded and incised by streams, forms the Berkshire hills in western Massachusetts and the prominently hilly southwestern part of New Hampshire. Above its expanse, which is seen to have nearly uniform and apparently continuous crest lines when examined in a broad distant view, isolated mountains, as Wachusett and Monadnock, rise here and there 1,000 to 1,500 feet higher, being remnants of the ancient land whose base-levelling produced the peneplain. For this class of mountain forms Davis suggests that the term "monadnock" may be advantageously used as a generic name. Many other examples of the geologic development of geographic forms are cited, and state geologists are requested to aid the school teacher by devoting portions of their field work, study and reports to this subject.

Illustrations of the Fauna of the St. John Group. No. VII. By G.

F. MATTHEW, M. A., F. R. S. C., (Trans. Roy. Society of Canada, 1893, pp. 95–109 and Plate VII, figs. 1 to 16.)

This paper, as the writer himself states, contains descriptions of the fauna of the Arenig horizon (Div. 3d) in the Bretonian division, and also of certain graptolites and brachiopods of Bands *a* and *b* of the same division. The species are arranged according to their zoological standing and not their stratigraphical position, though the great majority are from Band *d* (Arenig horizon) of the Bretonian. The graptolites are described conjointly by Mr. Matthew and Dr. Henry M. Ami, of the Geological Survey of Canada. The following species are therein recorded:

1. Protospongia ?
2. Bryograptus patens, n. sp.
3. Dictyonema delicatulum *Dawson*.
4. " quadrangulare *Hall*.
5. Clonograptus ? spinosus, n. sp.
6. " flexilis *Hall*, var.
7. Dichograptus logani *Hall*.
8. Tetragraptus quadribrachiatus *Hall*.
9. Didymagraptus patulus *Hall*.
10. " nitidus *Hall*, var.
11. " indentus *Hall*.
12. Retrograptus tentaculatus *Hall ?*
13. Orthis electra *Billings*, var. major, n. var.
14. " " " " lævis, n. var.
15. " orthambonites *Pander*.
16. " euryone *Billings ?* var.
17. " menapiæ *Hicks ?* var.
18. " carausii *Salter ?*
19. Strophomena atava, n. sp.
20. Camerella parva *Billings ?*
21. Styliola primæva, n. sp.
22. Creseis minuta, n. sp.
23. " corrugata, n. sp.
24. Orthoceras—cf. O. priamus *Billings*.
25. " " O. catulus *Billings*.
26. Parabolinella posthuma, n. sp.
27. " (?) sp.
28. Cyclognathus rotundiformis *Matthew*.
29. Euloma, sp. ?

As may be clearly seen, many of the above species have equivalents in the Levis formation of Sir Wm. Logan, and are referable to his Quebec group. In the use of the title St. John group, the term cannot be called a geological one—inasmuch as these forms belong to the second fauna of Barrande.

On Antennæ and Other Appendages of Triarthrus Beckii. By W. D. MATTHEW. Am. Jour. of Science, III, vol. xlvi, pp. 121-125, with a plate; Aug., 1893. In Hudson or Utica shales near Rome, N. Y., many specimens of this trilobite have been collected which show antennæ coming out close together under the center of the front border of the head-shield and generally diverging at an angle of 30° or 40°, composed of many joints, each about half as long as wide and smallest at the base. Both in position and structure they are like the antennae of modern crustaceans. Several of the specimens also show legs for walking or swimming and perhaps branchial appendages. Comparison with Walcott's previous studies of the genera Ceraurus and Calymene shows im portant points of contrast. "The homology with Limulus seems not to be as close in Triarthrus as in the forms studied by Mr. Walcott; but the characters seem to be of a more comprehensive type, approaching the general structure of the other Crustacea rather than that of any special form."

Carte géologique de la Russie d' Europe (échelle 1:520,000) par A. KARPINSKY, S. NIKITIN, TH. TSCHERNYSCHEV, N. SOKOLOV, A. MIKHALSKY, etc. Edition du Comité Géologique, St. Petersburg, 1893; with a "Note explicative." Price 7 roubles.

The Geological Committee of Russia was established eleven years ago. At the close of the first decennial of their work it was decided by them to prepare and publish as nearly a complete map of the area of "Russia in Europe" as their information would warrant. This map is the result. While the great geological map of Russia which will contain 150 sheets on a scale 1:420,000 is steadily progressing, based on the most exact topographical map of Russia which is in existence, this new map is designed to express, in compact form, the state of progress of geological exploration in Russia, derived from all sources. It answers at the same time the urgent needs of men of science as well as the practical necessities of various economical enterprises, and will be very useful until the completion of the large map. While it is more exact and detailed than any preceding map of Russia, it cannot take the place of the beautiful detailed sheets which are issued by the Geological Committee. These will go together to constitute the final result of that great undertaking. The characters indicate principally the geological formations below the drift, but the drift characters of the country are given whenever the drift is so abundant as to conceal entirely the underlying older rocks. These drift formations are: the lacustrine and cotemporary fluviatile deposits, the glacial deposits, and the loess. The map also shows the conventional limit of the extension of erratic blocks, but this does not express the limit of moraines nor the extreme extension of the glacial sheets. The post-tertiary marine submergences are also indicated, but in a general conventional way, since the marine deposits merge gradually into deposits with a fresh water fauna, making it difficult to say where one begins or the other ends.

The Tertiary is designated by four characters expressing different horizons, and the Cretaceous by two (upper and lower). Between the distinctive Lower Cretaceous and the Jura are the beds denominated *Volgian* (upper and lower) extending from the horizon of *Olcostephanus virgatus* to that of *O. nodiger*. The Jura is divided into three parts—superior, middle, and lower, or Lias. There is an indefinite series also between the Trias and the Permian. The Trias and the Permian each has one color, but a Permo-Carboniferous system is also represented. The Carboniferous system is designated in two parts, upper and lower, in general agreement with the subdivisions adopted for the international map of Europe. The Carboniferous and the Devonian of the trans-Caucasus are represented by one color. Other doubtful Carboniferous dolomytes and limestones, and some schists which appear amongst the massive crystallines, are separately indicated. The Devonian is divided, in general, into three parts, and some of these are again divided. A special designation is employed for the paleozoic rocks of the principal chain of the Caucasus, their age not yet being sufficiently determined. The Silurian is likewise divided into two parts, and the Cambrian is represented entire. An attempt is made to separate the crystalline schists from the massive rocks, such as the granites, syenites, gneisses and porphyries, but it is admitted by the authors that the scale of the map is too small to warrant a claim of exactness, and especially if it be recognized that there are numerous intergradations through the intermediary of the gneisses. The basic eruptives and the tuffs, breccias, and green schists have special petrographical symbols on the face of the map. The distribution of the recent volcanoes is also shown.

The principal authors of the map promise, in addition to the "note explicative," to prepare special articles, giving the principles according to which such or such geological facts are expressed by them on the map, also an account of the extension of the different geological formations in the territory of Russia.

RECENT PUBLICATIONS.

I. Government and State Reports.

Monographs of the U. S. Geol. Survey: Vol. XVII, The Flora of the Dakota Group, a posthumous work, by Leo Lesquereux, edited by F. H. Knowlton. 1891, 400 pp., 66 pl.—Vol. XVIII, Gasteropoda and Cephalopoda of the Raritan clays and Greensand Marls of New Jersey, by R. P. Whitfield. 1892; 402 pp., 50 pl.—Vol. XX, Geology of the Eureka District, Nevada; with an atlas, by Arnold Hague. 1892; 419 pp., 8 pl., 9 fig., and 13 atlas sheets.

Bulletins of the U. S. Geol. Survey: No. 82, Correlation Papers—Cretaceous, by Charles A. White. 1891; 273 pp., 3 pl., 7 fig. No. 83, Correlation Papers—Eocene, by W. B. Clark. 1891; 173 pp., 2 pl. No. 84, Correlation Papers—Neocene, by W. H. Dall and G. D. Harris. 1892; 349 pp., 3 pl., 43 fig. No. 85, Correlation Papers—The Newark System, by I. C. Russell. 1892; 344 pp., 13 pl., 4 fig. No. 86 Correlation Papers—Archean and Algonkian, by C. R. Van Hise. 1892; 549 pp., 12 pl. No. 90, Report of the Work Done in the Division of Chemistry and Physics, mainly during the fiscal year, 1890-'91, by F. W. Clarke. 1892; 77 pp., 8 fig. No. 91, Record of North American Geology for 1890, by N. H. Darton. 1891, 88 pp. No. 92, The Compressibility of Liquids, by Carl Barus. 1892; 96 pp., 59 tables, 29 pl. No. 93, Some Insects of Special Interest from Florissant, Colorado, and other points in the Tertiaries of Colorado and Utah, by S. H. Scudder. 1892; 35 pp., 3 pl. No. 94, The Mechanism of Solid Viscosity, by Carl Barus. 1892; 138 pp., 24 fig., 59 tables. No. 95, Earthquakes in California in 1890 and 1891, by E. S. Holden. 1892; 31 pp. No. 96, The Volume Thermo-dynamics of Liquids, by Carl Barus. 1892; 100 pp., 8 pl., 13 fig. No. 100, Bibliography and

Index of the Publications of the United States Geological Survey, with the Laws Governing their Printing and Distribution, by P. C. Warman, 1893; 495 pp.

Report of the Geol. Sur. of Ala., 1893, contains: Report on the Geological Structure of Murphree's Valley, and its Minerals and other Materials of Economic Value, A. M. Gibson.

Geol. Report of the Sur. of Ga., 1893, contains: The Paleozoic Group; The Geology of Ten Counties of Northwestern Georgia, and Resources, J. W. Spencer.

Geol. Sur. of New Jersey, Vol. II, 1892, contains: Gasteropoda and Cephalopoda of the Raritan Clays and Greensand Marls of New Jersey, R. P. Whitfield.

The following chapters of Vol. III of the final report of the Minnesota Survey have been issued: I, Cretaceous Fossil Plants from Minnesota, by Leo Lesquereux; II, The Microscopical Fauna of the Cretaceous in Minnesota, with additions from Nebr. and Ill., by A. Woodward and B. W. Thomas; III, Sponges, Graptolites and Corals from the Lower Silurian of Minn., by N. H. Winchell and Chas. Schuchert; IV, On the Lower Silurian Bryozoa of Minnesota, by E. O. Ulrich; V, The Lower Silurian Brachiopoda of Minnesota, by N. H. Winchell and Chas. Schuchert.

II. *Proceedings of Scientific Societies.*

Jour. Elisha Mitchell Scient. Soc. for 1892, Part 2, contains: Statistics of the Mineral products of North Carolina for 1892., H. B. C. Nitze.

Meriden Scientific Association: Annual Address, A Review of the year 1892, by the President, Rev. J. T. Pettee.

Amer. Geog. Soc. Bulletin, Vol. XXV, No. 2, June, 1893, contains: The Finger Lakes of New York, A. P. Brigham.

Proc. Rochester Academy of Science, Vol. II, Brochure 2, 1893, contains: The Brachial Apparatus of Hinged Brachiopoda and their Phylogeny, H. S. Williams; Preliminary Note of a New Meteorite from Kenton Co., Kentucky, H. L. Preston; Preliminary Note of a New Meteorite from Japan, H. A. Ward; Eskers near Rochester, N. Y., Warren Upham.

III. *Papers in Scientific Journals.*

State School of Mines Quar., Golden, Colo., June, 1893, contains: Fossil Palmettos.

The American Naturalist, Vol. XXVII, No. 318, June, 1893, contains: Recent Researches upon the Succession of the Teeth in Mammals, H. F. Osborn. July, 1893, contains: Some Correlations of Ontogeny and Phylogeny in the Brachiopoda, C. E. Beecher; Certain Shell Heaps of the St. John's River, Florida, hitherto Unexplored, C. B. Moore.

The Jour. of Geol., Apr.-May, 1893, contains: Malaspina Glacier, I. C. Russell; The Osar Gravels of the Coast of Maine, Geo. H. Stone; The Horizon of Drumlin, Osar and Kame Formation, T. C. Chamberlin; A Contact between the Lower Huronian and the Underlying Granite in the Republic Trough, near Republic, Mich., H. L. Smyth; A Pleistocene Manganese Deposit, near Golconda, Nevada, R. A. F. Penrose.

The May-June No. contains: On the Typical Laurentian Area of Canada, F. D. Adams; Melilite-Nepheline-Basalt and Nepheline-Basanite from Southern Texas, A. Osann; Some Dynamic Phenomena shown by the Baraboo Quartzite ranges of Central Wisconsin, C. R. Van Hise; The Chemical Relation of Iron and Manganese in Sedimentary Rocks, R. A. F. Penrose; Some Rivers of Connecticut, H. B. Kummel.

The Geological Magazine for July, 1893, contains: The Volcanoes of Barren Island and Narcondam, V. Ball; on the British Earthquakes of 1892, C. Davison; On the Arctic Lands, Sir H. H. Howorth; The Growth of the Indian Peninsula, P. Lake; The Relative Age of Flints, A. J. Jukes-Browne; New Classification of Brachiopoda, Miss A. Crane; The Cause of Crateriform Sand-Dunes and Cwms, Wm. Shone.

National Geographic Magazine, Vol. V, July, 1893, contains: The Natural Bridge of Virginia, C. D. Walcott; The Geologist at Blue Mountain, Md., C. D. Walcott; Our Youngest Volcano, J. S. Diller.

Amer. Jour. Science, Vol. XLV, March, 1893, contains: Diversity of the Glacial Period, T. C. Chamberlin; Stratigraphic Relations of the Oneonta and Chemung Formations in Eastern Central New York, N. H. Darton; Estimates of Geologic Time, Warren Upham.

The April No. contains: A Basic Rock near Hamburg, Sussex Co., N. J., which has been thought to contain Leucite, J. F. Kemp; The Cretaceous formations of Mexico and their relations to North American Geographical Development, R. T. Hill.

The May number contains: Note on some Volcanic Rocks from Gough's Island, South Atlantic, L. V. Pirsson; Champlain (?) Deposits of Diatomaceæ belonging to the Littoral Plain, A. M. Edwards; The Magothy Formation of Northeastern Maryland, N. H. Darton; Lime and Alumina-bearing Talc, W. H. Hobbs.

The June No. contains: Nikitin on the Quaternary Deposits of Russia and their relations to Prehistoric man, A. A. Wright; Rigidity not to be relied upon in estimating the Earth's Age, O. Fisher; Validity of so-called Wallala Beds as a division of the California Cretaceous, H. W. Fairbanks; Notes on the Geology of Florida: Two of the lesser but typical Phosphate Fields, L. C. Johnson.

Amer. Jour. Science, Vol. XLVI, July, 1893, contains: The Galveston Deep Well, E. T. Dumble and G. D. Harris; Piedmontite and Sheelite from the Ancient Rhyolite of South Mountain, Pa., G. H. Williams; Cambrian and Ozark Series, G. C. Broadhead; Cross Roads Meteorite, E. E. Howell.

The August No. contains: On Mackintoshite, a new thorium and uranium mineral, Wm. E. Hidden; Canfieldite, a new Germanium Mineral, and on the Chemical Composition of Argyrodite, S. L. Penfield; Epeirogenic Movements associated with Glaciation, W. Upham; Antennæ and other Appendages of Triathrus Beckii, W. D. Matthew; Larval Forms of Trilobites from the Lower Helderberg Group, C. E. Beecher.

IV. Excerpts and Individual Publications.

Note on the Nufenstock (Lepontine Alps), Prof. T. G. Bonney. Quar. Jour. of the Geol. Soc. for Feb., 1893, Vol. XLIX.

On the so-called "Gneiss" of Carboniferous age, Guttnannen, Prof. T. G. Bonney. Quar. Jour. of the Geol. Soc. for Aug., 1892, Vol. XLVIII.

Paleontology of the Cretaceous Formations of Texas—The Invertebrate Paleontology of the Trinity Division, Robt. T. Hill, Proc. Biol. Soc. of Washington, Vol. VIII, pp. 9-40, June 3, 1893.

Catalogue of the Official Geol. Surveys of the State of California, A. W. Vogdes. Extr. from Proc. Calif. Acad. Sci., 2d Series, Vol. III, 1893.

The Paleontological Horizon of the Limestone at Nahant, Mass.; Notes on Clinton Group Fossils, with special reference to Collections from Indiana, Tennessee, and Georgia, Aug. F. Foerste, Proc. Boston Soc. of Nat. Hist., Vol. XXIV, 1889.

Clay Materials of the United States, by R. T. Hill. Abstr. from Min. Resources of the U. S. for 1891.

Revision of the Families of Loop-bearing Brachiopoda; The Development of *Terebratalia obsoleta* Dall, Chas. E. Beecher. Trans. Conn. Acad., Vol. IX, March, 1893.

Memoir of Amos Henry Worthen, 1813-1888, Chas. A. White. Read before the National Academy, Nov. 1892.

Description of some of the Fossil Plants from the Great Falls Coal Field of Montana, Wm. M. Fontaine. Proc. U. S. Nat. Mus., Vol. XV, 1892.

Preliminary Contribution to Our Knowledge of the Cretaceous Formation on Long Island and eastward, A. Hollick. Contributions from the Geol. Dept. of Columbia College, No. XII.

Plant Distribution as a Factor in the Interpretation of Geological Phenomena, with special reference to Long Island and Vicinity, A. Hollick. Contributions from the Geol. Dept. of Columbia College.

Notes on a Few Fossil Plants from the Fort Union Group of Montana, with a description of one New Species, F. H. Knowlton. Proc. U. S. Nat. Mus., Vol. XVI, 1893.

Two Neocene Rivers of California, W. Lindgren. Bull. Geol. Soc. of Amer., Vol. IV, 1893.

The Geology and Mineral Products of Missouri, A. Winslow. From "Missouri at the World's Fair."

The Faunas of the Shasta and Chico Formations, T. W. Stanton. Bull. Geol. Soc. of Amer., Vol. IV, 1893.

Notes on Erian (Devonian) Plants from New York and Pa. and (2) Notes on Nematophyton crassum, D. P. Penhallow. Proc. U. S. Nat. Mus., Vol. XVI, 1893.

A Contribution to the Invertebrate Paleontology of the Texas Cretaceous, F. W. Cragin. Geol. Sur. of Texas, 4th Annual Report, 1892.

Preliminary Reports on the Artesian Wells of the Gulf Coastal Slope, by J. A. Singley, and On the Organic Remains from the Deep Well at Galveston, by G. D. Harris. From 4th Annual Report, Texas Geol. Sur., 1892.

Report on Grimes, Brazos, and Robertson Counties, W. Kennedy. 4th Annual Report of Texas Geol. Sur., 1892.

Report on the Rocks of Trans-Pecos Texas, A. Osann, and Trans-Pecos

Texas, W. H. Streeruwitz. 4th Annual Report of the Texas Geol. Sur., 1892.

The Development of the Scales of Lepidosteus, W. S. Nickerson. Bull. of the Mus. Comp. Zool. at Harvard College, Vol. XXIV, No. 5.

The Newly Discovered Moraines in Illinois, Ossian Guthrie.

Development of the Brachial Supports in Dielasma and Zygospira, C. E. Beecher and Chas. Schuchert; On the Development of the Shell of Zygospira recurvirostra, Chas. Schuchert. Proc. Biol. Soc. of Washington, Vol. VIII, 1893.

The Cause of the Great Earthquake in Central Japan, 1891, B. Koto. Jour. of the College of Sci., Imp.Univ., Japan, Vol. V, Pt. 4, 1893.

V. Foreign Publications.

Ueber Urnenfunde in Uebigan bei Dresden. Dr. J. V. Deichmüller, Sep.-Abdr. aus den Abhandl. der Naturh. Ges., "Isis" in Dresden, Heft II, 1884.

Petrefactenfunde im Rothliegenden. Dr. H. B. Geinitz, Sep.-Abdruck aus dem Neuen Jahrbuch für Mineralogie, etc., 1889, Bd. II.

Ueber die rothen und Bunden Mergel der oberen Dyas bei Manchester, von Dr. H. B. Geinitz.

Ueber Nautilus Alabamensis Morton, Nautilus ziczac Sow. und Nautilus lingulatus v. Buch., Dr. H. B. Geinitz, Sepr.-Abdr. aus dem Neuem Jahr. für Mineral., etc., Bd. II, 1887.

Die Versteinerungen des Herzogthums Sachsen-Altenburg, Dr. H. B. Geinitz, Mitth. aus dem Osterlande. Neue Folge, Band 5.

Souvenirs d'un Géologue sur Panama et le Canal de Panama, Jules Marcou.

Bulletin de la Societé des Sciences Naturelles de L'ouest de la France, Tome 2, No. 3, 1892, contains: Note pour servir à la Minéralogie de la Loire-Inférieure, Ch. Baret. Tome 2, No. 4, 1892 contains: Notes pour servir à la minéralogie de Maine-et-Loire, l'abbé Jouitteau.

Annalen des K. K. Naturhist. Hofmuseums, Wien. Aus., Band VII, No. 3, contains: Meteoreisen-Studien., II, von E. Cohen.

Földtani Közlöny, XXII Kötet, 11-12 Füzèt, Nov.-Dec., 1892, contains: Beiträge zur Kenntniss der Chemischren constitution des Pyrits, von Josef Loczka; Uber die erdbeben der Lander der ungarischren Krone, sowie des Occupations-Gebietes. II, Ueber die Siebenburgischen erdbeben im Jahre, 1888, Prof. Dr. Anton Koch; Bericht über die Kroatisch-Slavonisch-Dalmatinischen, sowie über die Bosnisch-Herzegovinischen erdbeben in den Jahren, 1887 und 1888, Dr. M. Kispatic; Ueber ein einfaches Quecksilber-Seismometer, Alex N. Kalecsinszky.

Bull de la Soc. Geol. de France, XIX, No. 2, contains: Sur une carte des environs de Barcelone, de M. J. Almera, Collot; Recherches sur les Echinides de l'Aptien de Grandpré, J. Lambert; Apercus restrospectifs sur la Geologie de la Tunisie, A. Pomel; Sur la possibilite du transport des galets dans l'appareil digestif des Poissons, L. Vaillant.

XX, No. 3, contains: Sur la possibilité du transport des galets dans l'appareil digestif des Poissons, L. Vaillant; Fossilisation du test des

Mollusques aprés séjour dans l' œsophage, Chaper; Sur la continuité de phénoméne du plissement dans le bassin de Paris, M. Bertrand; Sur la classification des travaux miocènes de l'Algérie et reponse aux critiques de M. Peron, A. Pomel; Contribution a l'étude du terrain tertiaire d' Alsace (Suite): Kleinkembs et lac sundgovien, M. Mieg, G. Bleicher et Fliche.

XX, No. 6, 1892, contains: Note sur la classification et le parallelisme du système Miocène, Deperet; Sur quelques points de la Géologie du Cantal; Sur la station du Schweizerbild, Boule; Etude préliminaire des terrains jurassiques de Normandie; Sur la possibilité d' admettre un dimorphisme sexuel chez les Ammonitides, Munier-Chalmas; Sur l' étage Alenien, Haug; Sur la dalle des Eaux chaudes et la vallée d'Aspe, Stuart-Menteath; Sur les collections géologique de la Mission de la Manche, Ramond; Sur la constitution géologique de la vallée de l'Ubaye, Kilian et Haug; Sur les émissions granulitiques dans le massif du Pelvoux, Lory; Sur la continuation vers le sud des plis de la dent du Midi, Haug.

Notes on the Microscopical Character of some Rocks from the Counties of Quebec and Montmorency, W. F. Ferrier, Geol. Sur. of Canada.

Note Rectificative sur les Belemnites aptiennes, par E. Renevier. Bull. Soc. Vaud. Sc. Nat., XXIX, 1893.

Géologie du Chablais et Faucigny-Nord, MM. Renevier et Lugeon. Bull. Soc. Vaud. Sc. Nat., XXIX, 1893.

Illustrations of the Fauna of the St. John Group, G. F. Matthew, vii.

Geol. Sur. of N. S. Wales, Vol. III, pt. III, 1893, contains: On the occurrence of Leucite-Basalt at Lake Cudgellico, G. A. Stonier; Notes on the Rosebrook Caves, near Cooma, W. S. Leigh; The Australian Geological Record for 1891, R. Etheridge, Jr., and W. S. Dun.

Zeit. für Prak. Geol., July, 1893, contains: Die geologische Landesuntersuchung des Konigreiches Sachsen, H. Credner; Bildung von Erzlagerstatten durch Differentiationsprocesse in basischen Eruptivmagmata, J. H. L. Vogt; Versuche über die mechanische Wirkung heisser, stark gepresster und rapid bewegter Gase auf Gesteine, G. A. Daubrée.

Die geologische Entwickelung, Herkunft und Verbreitung der Saugethiere, Karl A. Zittel; Sitz. der Math.—Physik Class. Akad. d. Wiss., 1893. Band xxiii., Heft. ii.

Die Jurabildungen des Kahlberges bei Echte, Inaugural-Dissertation, J. Perrin Smith, Jahr. der Conigl. Preuss. Geol. Landessanstalt und Bergakademie zu Berlin für das Jahr, 1891.

Annual Report of the Department of Mines and Mining of New South Wales for the year 1892.

CORRESPONDENCE.

The Osar Gravels of the Coast of Maine. To the Editor, American Geologist: In the courteous review of my article on the Osar Gravels of the Coast of Maine, at p. 122 of your current volume, (which article, by the way, was not a summary of my report, but only of a single topic), your reviewer, after referring to the hypothesis that the subglacial streams bore their debris onward to their debouchures in the open sea, says: "If this were the case, however, we should expect large submarine deposits of gravel and sand, like the materials of the osars, to have been amassed at those places. *The absence of such deposits* seems to render this view very doubtful, etc."

The mooted questions of interpretation, so far as Maine is concerned, between the rival sub- and super-glacial hypotheses have been treated in detail in my report, and need not further be referred to here. But the words which I have italicized seem to assume that such deposits as are above described are absent. This involves an important question of fact which appears to demand immediate attention, partly to prevent misapprehension and partly to obtain new facts if possible.

1. The consequences of the hypothesis under review were correctly stated by you—there ought to be accumulations of glacial sediments in the sea near the mouths of the glacial rivers. Since the southern ends of the osars are near the present shore line, the accumulations which were amassing at the time the most southern of the coastal gravels were being deposited, would now be, on my hypothesis, beneath the ocean. The question now arises whether there are such bodies of glacial sediments on the sea bottom. In order to solve the problem, I examined the most detailed of the charts of the Coast and Geodetic Survey, but found grave practical difficulties. The soundings were not made by geologists nor for a geological purpose. They are often one-fourth to one-half mile apart. These are sufficient for the purposes of navigation but do not afford data for mapping submerged osars. The charts cover only a few miles of the ocean, probably only a third of the breadth of that portion of the present sea area which was covered by ice at the time of maximum glaciation. The soundings often show hills on the floor of the ocean, but we do not know what they are composed of. Here and there the bottom is stated to be muddy, sandy, gravelly, etc., but at too great distances to be of much help. Do any of your readers know whether the Coast Survey observers distinguished between unmodified till and water-rolled gravel? Occasionally there are reaches of sand and gravel that are suggestive of glacial marine deltas. We have to consider the probability that much of the coarse gravel would by this time have become covered by clay. On the whole the data were too few to be regarded as conclusive.

While, then, I have not been able to find positive affirmative proof that bodies of glacial sediments exist beneath the ocean, yet, on the other hand, I know of nothing that proves they are *not* there. For years I have been trying to gather from captains of fishing vessels and others facts regarding this question. It will be a great favor if you or any of your readers will publish observations bearing on the subject.

2. As for that portion of the ice-covered area that was submerged in late glacial time but has since been elevated above the sea, there is no absence of such accumulations of glacial sediments as are above de-

scribed. On the contrary, there is an abundance of them scattered all over the submerged parts of Maine. I have described them under the name of glacial marine deltas.* They vary in size from one-fourth of a mile in diameter up to areas of 100 or more square miles. The structure of the larger deltas is often complicated, since sometimes more than one glacial river helped to form a single confluent delta, and sometimes a portion of a delta was deposited in a glacial lake which ultimately became a bay of the sea by the melting of the ice on the seaward side. There are in the state dozens of these deltas each having areas of four square miles or more, and often they are known to attain a depth of more than 100 feet in places. At intervals of five to twenty miles most of the longer osars expand into marine deltas separated by reaches of gravels deposited between ice walls and showing no tendency to spread into delta form. The successive deltas found in the course of a single glacial river form an important aid in mapping the approximate positions of the ice-front at different periods of the recession of the ice. Several of the osars expand into three, and one into perhaps five, of these retreatal deltas. At their landward ends the glacial marine deltas consist of reticulated ridges of coarse water-rounded matter, boulders, boulderets and cobbles, with coarse gravel. Going southward the ridges become broader, confluent at their bases and lower, and finally merge into a rolling plain which, in the larger deltas, becomes at last quite level. At the same time the material becomes gradually finer, passing from gravel to sand and finally clay. At the proximal ends of the deltas the fossiliferous marine clays cover the gravel ridges or their flanks, and were plainly deposited later than the coarse gravels. Distally the delta clay passes by insensible gradations into fossiliferous clay which is stratigraphically continuous with the delta, and therefore must have been deposited simultaneously with it in the open sea. I know of no instance of continuous deltas, that is, such as would be formed off the ice front during a continuous retreat of the ice and the uninterrupted flow of a glacial river, bringing sediments into the sea all the time of the retreat. These and many other details complicate the question of interpretation, and in a brief article only a small part of the facts can be discussed.

The deltas here referred to are retreatal glacial deltas, formed subsequently to the osars of the coast itself and while the ice front was retreating over the then submerged region lying north of the present shore. They are an essential part of the development of the osars and show all the signs of matter swept by glacial rivers into the sea, where the currents were gradually checked. Both in their topographical and stratigraphical relations they are very different from the fluviatile deltas that were at a later period brought into the elevated sea of that time by the present rivers, when they first began to flow. In the interior of the state, in consequence of the greater differential postglacial elevation of the land toward the north and west, these fluviatile deltas

*Classification of the Glacial Sediments of Maine, American Journal of Science, August, 1890.

reach elevations A. T. of 450 or perhaps 475 feet. In one case, that of the Androscoggin river, the fluviatile delta plainly extends from the old elevated shore line all the way down to sea level. As far into the interior as the fossiliferous marine clays extend, this fluviatile delta overlies them. In the other valleys the raised fluviatile deltas seem to end twenty or more miles north of tide water. At least, if they were originally deposited continuously to the present shore, they were so narrow in the coast region that they have either disappeared by erosion, or have become so merged in the flood plain and recent deposits as not readily to be distinguished.

The great transporting power of the glacial streams is attested by the belt of marginal kames and overwash aprons found along the margin of the ice-sheet for 2,000 miles or more. Analogy requires us to postulate a corresponding body of glacial sediments on the floor of the gulf of Maine, more or less mixed with berg droppings and with till deposited during re-advances of the ice. Excluding these, I infer that the submarine glacial sediments formed during the final retreat of the ice closely resemble the glacial marine deltas that have since been elevated above the sea for our inspection. GEO. H. STONE.

Colorado Springs, Aug. 8, 1893.

THE HAMILTON BEDS OF CALLAWAY CO., MO. On the 16th of June in company with Mr. D. K. Greger of Fulton, Mo., we visited a very interesting outcrop of Hamilton rocks, about seven miles southeast of the county seat of Callaway.

Along a small creek we found an exposure of sandy shales over a quarter of a mile in length and twenty-five feet in hight, the lowest five or six feet being very sandy, blue, and crowded with brachiopods, corals and bryozoa.

Upwards the beds become yellowish (partly due to exposure), less sandy, and disintegrate into a yellow clay.

An *Orthoceras*, a *Pleurotomaria?*, a *Naticopsis?*, a *Euomphalus* and two or three large lamellibranchs (all internal casts), occur at the base of the exposure, along with *Stropheodonta navalis*, *S. cymbiformis*, *S. subcymbiformis*, *S. kemperi*, *S. inflexa*, *S. altidorsata*, *S. boonensis*, *S. callawayensis*, *S. quadrata*, *S. æquicostata*, a small *Productella*, a *Cyathophyllum*, a *Monticulipora*, an *Alveolites?*, two species of *Aulopora*, bryoza, and a coral-like sponge(?).

From the middle layers were obtained a large fine *Spirifera* like *eurutines*, *Spiriferina annæ*, *Cyrtia missouriensis*, *C. occidentalis*, *Orthis iowensis*, *Streptorhynchus chemungensis*(?), *Productella callawayensis*, *Stropheodonta* sp?, two species of *Crania*, *Atrypa reticularis*, *Spirorbis* sp., *Cornulites* sp?; while from a horizon still higher in the exposure were collected a large variety of *Atrypa reticularis*, *Orthis iowensis*, and the *Spirifera* like *eurutines*.

Two crinoids, a *Melocrinus* and a *Taxocrinus*, are, perhaps, confined to the middle and upper beds, although stem joints and short columns occur throughout the depth of the outcrop.

A single fish tooth was picked up on the slope and probably came from the top, as it is identical with the teeth from the shales immediately under the Lithographic limestone at Louisiana, Mo.

In Mr. Greger's collection we saw a small pygidium of what seems to be a *Proetus* from the same shale.

Of the ten above mentioned *Stropheodontæ* described by Prof. Swallow from the locality, there are, perhaps, but four or five good species, as a full collection of these fossils shows.

At one point we saw resting under the shales what appeared to be the Saccharoidal sandstone, but a disturbance of the strata at that point rendered a decision unsatisfactory.

A gentle slope above the entire exposure seems to indicate upper shales, giving a much greater depth to the beds than that observed.

The Burlington limestone, doubtless, overlies the Hamilton of Callaway county, but we did not see the contact.

At other exposures which we did not have time to visit, Mr. Greger found limestone over the shales, carrying *Favosites hamiltonensis*, a large and beautiful spiny *Zaphrentis* (?), *Strombodes* or *Cyathophyllum*, *Spirifera fornacula* (?), an *Athyris*, a *Terebratula* (?), a *Euomphalus*, *Stropheodonta* sp.? and *Atrypa reticularis*.

A very large, flat *Stropheodonta* came from another exposure of shales.

A careful search among these shales and limestones will bring to light fully fifty species of fossils, many of them new to science.

As to the area covered by the Hamilton of central Missouri, we can only conjecture, but are inclined to think that exposures will be met with in adjoining counties, giving a fauna quite as rich as those from the same horizon in Iowa and Illinois. Starting from the Coal Measures which are the surface rocks at Fulton, Mr. Greger measured all the outcrops along a line due east for a distance of four miles, and, with his permission, we use his observations and measurements.

Beneath the Coal Measures at Fulton, he found fifteen feet of ferruginous sandstone, between which and seventy-five feet of conglomerate is a soft, light yellow clay, twelve feet in depth.

A gray limestone twelve feet thick and a brown-red limerock, four feet deep, which Mr. Greger supposes to be Burlington, underlies the conglomerate.

Three feet of yellow sandy shale without fossils separate the Burlington from the Hamilton.

Of the Hamilton itself he makes out the following members:

Gray limestone (fossiliferous), 5 feet.

Soft brown fossiliferous shale, 10 inches.

Blue shaly limestone with fossils, 6 feet.

Brown shale, with *Stropheodonta*, *Atrypa*, etc., 8 feet.

Lighter shale with *Orthis iowensis*, *Cyrtina*, *Spirifera*, etc., 8 feet.

Blue-gray limestone, shaly, with fossils, 8 feet to edge of drift in Crow's Fork creek.

Our guide and companion on the trip to Snyder creek, Mr. D. K.

Greger, is an energetic and intelligent collector, and to him is due the discovery of a number of new and interesting collecting localities.

Louisiana, Mo., July 14th, 1893. **R. R. ROWLEY.**

PERSONAL AND SCIENTIFIC NEWS.

ALTHOUGH THE STATE OF IOWA is almost wholly covered with a mantle of drift, or products derived from the drift, still examples of glacier planing and scoring are not numerous and the few that are known are limited in extent. Professor Calvin was able to show to Mr. McGee, at Iowa City, the only glacier markings that he, as author of the *Pleistocene History of Northeastern Iowa*, has seen within the limits of the area covered by his memoir. Professor Calvin now reports another exposure of glacial planing at the old woolen mill on Clear creek, a few miles west of Iowa City. Quite recently the stream cut around the end of the dam at the old mill, carrying away a portion of the bank, which there consists of loess to a depth of twenty or thirty feet, resting on a bed of sand, pebbles, and small striated boulders. In this way the underlying Devonian rocks were exposed over a considerable area, and the surface affords the best example of glacial planing and scoring yet seen within the limits of Iowa. The planed stratum at the old mill, like that at Iowa City, consists of very fine grained, compact, brittle limestone, that, while worthless for any economic purposes, still resists the solvent action of percolating surface waters to an unusual degree. In general the indurated rocks of Iowa have the surface in contact with the superficial materials eaten away or corroded to a depth sometimes of several inches, and thus the effects of glacier action have been very generally obliterated.

SOUTH AMERICAN PALEONTOLOGICAL EXPLORATION.—M. Alide Mercerat, formerly assistant paleontologist at the Museo Publico de La Plata (Argentine Republic), has just returned to Buenos Ayres from his exploration in Patagonia, undertaken more especially in view of paleontological researches. M. Mercerat started at the end of September last, stopping at Chubut and the Toras island. His Patagonian exploration extended from the Rio Santa-Cruz to the Strait of Magellan, comprising all the region between the Atlantic coast and the cordilleras of Chili. The results of this journey are so interesting, and important in the finding of great deposits of fossil vertebrates, that he proposes to return again and resume his explorations in the spring of 1894. For the present he has just sent to Paris a description of a very curious fossil reptile found in the Lias of Patagonia, which he calls *Scaphosaurus*

Marcousianus, a new genus and a new species, dedicated to Mr. Marcou, the learned geologist of Cambridge, Massachusetts. (*Revue Scientifique*, 8 July, 1893, p. 58, Paris.)

THE LONGEST EXCURSION arranged for the summer meeting of the Geological Society of America was that to the Lake Superior region. Those taking part in this excursion met at Iron Mountain, Mich., on the forenoon of Aug. 7th, and disbanded at Ironwood, Mich., Saturday afternoon, Aug. 12th. The Menominee, Marquette and Gogebic iron ranges were visited and their structure and economic products studied. At Houghton, Mich., the famous copper mines, the contact between the Eastern sandstone and the Keweenawan traps, and the Michigan Mining School, attracted the attention of the geologists. Many thanks are due to the leaders of the excursion, Profs. Van Hise and Wadsworth, for this profitable trip which proved enjoyable to all. The following were present on this excursion:

Dr. Florence Bascom, Columbus, Ohio.
Dr. W. S. Bayley, Waterville, Me.
Dr. Robert Bell, Ottawa, Canada.
Prof. C. Le Neve Foster, Lecturer in the Royal School of Mines and Crown Mine Inspector, Llandudno, North Wales.
Dr. A. C. Gill, Northampton, Mass.
Dr. U. S. Grant, Minneapolis, Minn.
Mr. L. S. Griswold, Boston, Mass.
Prof. J. A. Holmes, Raleigh, N. C.
Mr. Lucius S. Hubbard, Houghton, Mich.
Mr. Hjalmar Lundbohm, Geologist in charge Geological Survey of Sweden, Stockholm.
Dr. H. B. Patton, Houghton, Mich.
Prof. S. L. Penfield, New Haven, Conn.
Prof. R. A. F. Penrose, Chicago, Ill.
Mr. J. H. Pratt, New Haven, Conn.
Prof. I. C. Russell, Ann Arbor, Mich.
Mr. A. E. Seaman, Houghton, Mich.
Prof. C. R. Van Hise, Madison, Wis.
Dr. M. E. Wadsworth, Houghton, Mich.
Mr. H. V. Winchell, Minneapolis, Minn.
Prof. N. H. Winchell, Minneapolis, Minn.
Mr. Arthur Winslow, Jefferson City, Mo.

And the following students from the Michigan Mining School:

A. A. Abbott.
H. C. Beehler.
G. B. Church.
R. E. Cranson.
James Fisher.
Donald Gillies.
M. E. Kirk.
E. H. McDonald.
R. T. Mason.
L. L. Tower.
S. R. Treugrove.
A. L. Waters.

GOV. ALTGELD, OF ILLINOIS, APPOINTED WM. F. E. GURLEY, of Danville, Ill., state geologist of that state, in place of Josua Lindahl, resigned.

MR. W. J. MCGEE RESIGNED HIS POSITION on the U. S. Geological Survey, July 1st, and has been appointed to the Bureau of Ethnology, of which he has charge.

A SPECIMEN OF THE WELL KNOWN FOSSIL *Arthrophycus harlani*, originally described from the Medina sandstone of New York, has lately been sent to Prof. J. W. Judd from the Gold Coast Colony in Western Africa, and placed by him in the collection of the British Museum of Natural History, at South Kensington, London.

PROF. JAMES HALL HAS RECEIVED HIS COMMISSION as state geologist of New York, from governor Flower. Since 1883 this appointment has been controlled by the regents of the university of the state of New York, but an enactment of the last legislature placed it upon its original footing, the venerable state geologist having first received his commission from governor Marcy, in 1837. In retaliation for this encroachment upon their prerogatives the regents have removed Prof. Hall from the directorship of the New York State Museum of Natural History, over which he has presided since 1866. Prof. J. M. Clarke, assistant palæontologist, and Mr. F. J. H. Merrill, assistant geologist, were also removed at the same time, but Mr. Clarke was immediately reappointed by Prof. Hall, and Mr. Merrill was appointed by the Board to the position of assistant director of the custodial department of the museum.

THE FIRST NUMBER OF *The Glacialists' Magazine*, for August, comes to us from the publisher, F. H. Butler, 158, Brompton Road, London, S. W. It is a monthly magazine of glacial geology, edited by Percy F. Kendall, Lecturer on Geology at the Yorkshire College, Leeds, England, assisted by Warren Upham, C. E. De Rance, and J. Lomas. Annual subscription price, five shillings.

MEETINGS OF THE GEOLOGICAL SOCIETY OF AMERICA and the American Association for the Advancement of Science were held in Madison, Wis., Aug. 15-22. Thirty-seven fellows of the Geological Society were present, from its membership of about 220; and the total attendance of the American Association was 290, from a membership slightly exceeding 2,000. Besides the Pleistocene papers of these meetings, which are elsewhere noticed in this number, the following papers were read before the Geological Society:

On the study of fossil plants. Sir J. WM. DAWSON.

On a new species of *Dinichthys*.—On a new *Cladodus* from the Cleveland shale.—On a remarkable fossil jaw from the Cleveland shale. E. W. CLAYPOLE.

Origin of the Pennsylvania anthracite. J. J. STEVENSON.

The Magnesian series of the northwestern states. C. W. HALL and F. W. SARDESON.

On the succession in the Marquette iron district of Michigan. C. R. VAN HISE.

The Arkansas Coal Measures in their relation to the Pacific Carboniferous province. JAMES PERRIN SMITH.

Dislocation in the strata of the lead and zinc region of Wisconsin and their relationship to the mineral deposits, with some observations upon the origin of the ores. W. P. BLAKE.

Geology of the Sand-hill region in the Carolinas. J. A. HOLMES.

Prof. Joseph Le Conte, in his address as the retiring president of the American Association, spoke on "The Present State of Science regarding Mountain Ranges;" and Mr. C. D. Walcott's address as vice-president of Section E was entitled, "Geologic Time as indicated by the Sedimentary Rocks of North America." The following are titles of the papers read before Section E, excepting those on Pleistocene geology:

Use of the name "Catskill." JOHN J. STEVENSON.

Section across the coastal plain region in southern North Carolina. J. A. HOLMES.

Notes on further observations of temperature in the deep well at Wheeling, W. Va. WILLIAM HALLOCK.

Recent investigations in the Cretaceous formation on Long Island, N. Y. ARTHUR HOLLICK.

Character of folds in the Marquette iron district. C. R. VAN HISE.

The fossil sharks of Ohio. E. W. CLAYPOLE.

Hillsdale county geology, Michigan. HORATIO P. PARMELEE.

Exhibition of trilobites showing antennæ and legs. CHAS. D. WALCOTT.

Remarks on the genus *Arthrophycus* Hall.—On the value of pseudo-algæ as geological guides.—Studies in problematic organisms,—the genus *Fucoides*. JOSEPH F. JAMES.

Northward extension of the Yellow Gravel in New Jersey, Staten Island, Long Island, and eastward. ARTHUR HOLLICK.

The emergence of springs. T. C. HOPKINS.

After these meetings, the forenoons of the three days, Aug. 24-26, were occupied by sessions of the World's Congress on Geology, held in Chicago as auxiliary with the Columbian Exposition. These sessions were well attended by geologists of the United States and Canada, with a few from foreign countries. Reports of the Congress and notes of some of the papers read are deferred to our next number.

THE AMERICAN ASSOCIATION ELECTED, as its president for the next meeting, the distinguished anthropologist, Dr. Daniel G. Brinton, of Media, Pa.; and as officers of Section E, Prof. Samuel Calvin, of Iowa City, Iowa, vice-president, and Prof. Wm. M. Davis, of Cambridge, Mass., secretary, The meeting will be held in August, 1894; and it is understood that its place, though not yet decided upon, will be some city in the Eastern states.

BY INVITATION OF THE BOSTON SOCIETY OF NATURAL HISTORY, the Geological Society of America will hold its next winter meeting in Boston, Mass., during the holidays following Christmas.

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THE

AMERICAN GEOLOGIST

VOL. XII. OCTOBER, 1893. No. 4.

THE GENUS WINCHELLIA.

By LEO LESQUEREUX.

(PLATES VIII AND IX.)

Ord. BERBERIDACEÆ.

Genus WINCHELLIA, LESQX.

Leaves trifoliate; terminal leaflet large, cuneiform to the base, enlarged above, truncate, trilobate and dentate at the apex; lateral leaflets attached to the stem a little lower than the base of the median lobe, scarcely half as broad, though nearly as long, obliquely truncate and coarsely dentate at apex, oblong, narrowed to a short petiole; nervation tripalmately ternate; nerves thick; lateral primaries much branching, especially on the lower side. Petiole thick and long.

WINCHELLIA TRIPHYLLA, SP. NOV. PL. VIII, FIG. 1.

Characters of the genus. The leaf is preserved nearly entire, and is, including the petiole, 24 cm. long; the petiole is 5 cm. from the base of the lateral leaflet and 2½ cm. between the terminal and the lateral ones.

This leaf evidently belongs by its characters to the order of the *Berberidaceæ*, having a marked affinity of characters to the leaves of *Podophyllum* and especially to those of *Achlys triphylla* D. C., one of which is figured for comparison, on Pl. IX. A number of peculiar fruits discovered a long time ago in the lignitic of Brandon, Vermont, but of which the relation was not at first recognized, were described as *Carpolites brandonianus* Lesqx. in Am. Journ. Sci., vol. XXXII, No. 1861, and figured in Prof. Hitchcock's Geol. Rep. of Vermont, vol. I, p. 229, figs. 111-113, 118. Later a comparison of the fossil pods with those of *Jeffersonia diphylla* has evidenced the réference of these remains to this genus. Two of the fruits of Brandon are represented Pl. viii, figs. 2, 3, with a pod of *Jeffersonia diphylla*, fig. 4, copied from Gray, *Genera*, No. 34, fig. 10. The order of the *Berberidaceæ* is represented by 5 species in the Tertiary of France, Germany and Italy, but as yet no plant referable to it had been recognized by fossil remains in North America.

Habitat, Yellowstone river, near the mouth of Powder river, communicated by Prof. N. H. Winchell.

EXPLANATION.

Plate VIII.

Figures.

1. Winchellia triphylla, *Sp. nov.*

2, 3. Carpolithes brandonianus *Lesqx.*

4. Jeffersonia diphylla *Gray.*

Plate IX.

Achlys triphylla *D. C.*

NOTE. Among the fossil leaves sent to Dr. Lesquereux in 1884 for description for the Geological and Natural History Survey, was a fine, large leaf from Montana, which had been donated to the University Museum by the late Col. G. W. Clough. There having been some delay in the publication of Lesquereux's report, he requested permission to incorporate this material in a large work on Cretaceous flora on which he was then engaged for the United States Geological Survey. The description, with figures, was thus sent to Washington. The specimen was returned to the University of Minnesota, where it still is.

Recently, when Rev. Mr. Herzer chose the same name for a new genus of Carboniferous tree (finally published as WINCHELLINA, *Am. Geol.*, XI, 286) inquiry was made by the writer, of Prof. Lester F. Ward, as to the probable future publication of Prof. Lesquereux's description of *Winchellia*, and as to the propriety of abandoning it and allowing the name to be applied to the new Carboniferous tree. He replied as follows:

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY.
Washington, D. C., April 12, 1893.

PROF. N. H. WINCHELL,
State Geologist of Minnesota,
Minneapolis, Minnesota.

Dear Prof. Winchell:—Yours of the 8th inst. relative to the genus Winchellia is received. I hardly know what to advise. The plant that Lesquereux so named is a very interesting and important one, and it is not at all probable that anything like it has ever been found elsewhere or described in any work. I should be very glad, therefore, if Prof. Lesquereux's desire to name it after you could be carried out.

I, of course, know nothing of the Carboniferous plant which it is proposed to name in honor of your brother Alexander, but, on general principles, I should say that unless wide comparisons are made with all the forms that have heretofore been named from the Carboniferous there might be danger that the name would be preoccupied. The Carboniferous flora is so vast and the literature so great that I would certainly recommend great care in this matter, and I take this opportunity to offer to the author of the genus all the information that we possess at Washington in making this point certain. It is very disappointing to name a genus in honor of one so worthy as your brother certainly was, to find afterwards that the plant has been previously called by some other name.

* * * * * * * * *

The history of the genus Winchellia Lx., so far as I know it, is as follows: On the 19th of April, 1886, Prof. Lesquereux wrote me a letter transmitting a set of photographs of drawings he had had made of fossil plants from the Cretaceous of the west, and was then describing for publication. Of the thirty plates thus represented, the last, or thirtieth one, contains a beautiful figure, almost perfect, of a trifoliate leaf of Winchellia together with three fruits, which were figured on the supposition that they might belong to a similar genus. His account of it was as follows: "Winchellia is a new genus of a group of the Berberidaceæ, of which we had no fossil representative as yet. The specimen figured comes from the Yellowstone N. P. railroad, on the south side of the river, about a mile above the mouth of Powder river, where the bluff is cut by the R. R., about one hundred feet above the river. Do you know perhaps the plant or that locality, or the precise geological stage of it? From the character of the leaf I consider it as Tertiary, for it has a remarkable affinity to *Achlys triphylla*, of California, of which I have had a drawing made to be published in order to show the relation of the fossil. Figs. 2 and 3 are fruits abundantly found in the lignitic deposits of Brandon, Vt., whose affinity had not as yet been recognized. I described them formerly as *Carpolites brandonianus*." There was another unnumbered plate showing a full-sized leaf of the Californian plant *Achlys triphylla* for comparison with Winchellia.

I heard nothing more of the matter until Prof. Lesquereux sent on the manuscript of his Flora of the Dakota group, his last large work, which has been edited since his death by Prof. Knowlton and published as Monograph XVII of the U. S. Geological Survey. This manuscript contained besides the matter relating to the Dakota group, descriptions and figures of a considerable number of plants from other formations. These it was undesirable to include in the volume, as it was to be devoted exclusively to the Dakota, and I have thus far held the MS. and drawings awaiting an opportunity to work this material into a work now in preparation relating to the Upper Cretaceous, to which most of it belongs, and this will eventually be done and full credit given to Prof. Lesquereux. Winchellia is among these and is fully described.

As I said at the outset, it is a difficult matter to advise, and I should be very glad to hear from you again on the subject. I assume that you have in your museum the original specimens upon which Prof. Lesquereux's descriptions and figures are based. I remain,

Yours with respect,

LESTER F. WARD.

After the publication of *Winchellina* it seemed desirable that Lesquereux's genus should also be published, and as nearly as possible under the same auspices, in order that it might be evident that there was an effort on the part of all the parties concerned to avoid the imputation of synonymy in the employment of two generic names so similar. It would be, further, an act of justice to the memory of Lesquereux that his unpublished work should not be allowed to lose its value by longer delay—and especially so, since a third paleontologist had by this time applied the same name to a genus of Silurian mollusks.* These facts and considerations being communicated to Prof. Ward, he very courteously replied as follows:

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY.
Washington, D. C., May 18, 1893.

PROF. N. H. WINCHELL,
State Geologist of Minnesota,
Minneapolis, Minnesota.

My Dear Sir:—Yours of the 10th has been several days under consideration, and I have been somewhat in doubt what course to pursue. I certainly neither desire nor merit any of the credit that may belong to the publication of Winchellia. On behalf of the U. S. Geological Survey, therefore, I take the responsibility of authorizing and requesting you to publish the entire data relating to this plant in the state reports of Minnesota or elsewhere, as you see fit. With what I have

*Subsequently cancelled before publication.

already written you, and the much more that you know yourself, you will be in a position to give the history as fully as it can be given, and the rest belongs to Lesquereux and will be given to him by science.

I shall be quite content if I have been instrumental in carrying out Prof. Lesquereux's evident desire to name this interesting fossil plant in your honor. This so clearly expressed desire on his part should be sufficient to overcome any feeling of delicacy that you might otherwise have about taking the initiative in making his wishes known and, at the same time, adding an important contribution to science. I inclose Prof. Lesquereux's descriptions and drawings.

Yours very sincerely,

LESTER F. WARD.

MOUNT ST. ELIAS IN ALASKA AND MOUNT ORIZABA IN MEXICO.

By A. LINDENKOHL,* Washington, D. C.

PLATE X.

Petermann's Mittheilungen for January, 1892, contained an article upon the hight and geographical position of Mt. St. Elias in Alaska (vol. 38, pp. 19-22). The hight of 18,099±100 feet, obtained by Prof. Russell's measurements of a base and angles in the vicinity of Icy bay in 1891, was stated to be the most reliable determination. The latitude was computed at 60° 17′ 51″ and the longitude at 140° 55′ 30,″ from these observations in connection with those made by Dr. W. H. Dall near Port Mulgrave in 1874. It was claimed that these figures possessed a sufficient accuracy for all ordinary purposes; but, at the same time, it was intimated that the boundary survey between British Columbia and Alaska, in the course of execution by the U. S. Coast and Geodetic Survey, would probably soon furnish an entirely new survey of the Mt. St. Elias region by more rigorous methods than the preceding ones.

Since the publication of that article this survey has been made (in the summer of 1882) by Messrs. J. E. McGrath and J. H. Turner, the same officers who had been engaged during the two preceding years upon similar work on the Yukon and Porcupine rivers, and the necessary computations have been recently completed. A greater interest has been mani-

*From Petermann's Geogr. Mittheilungen, 1893, No. 6. [Translated for the AMERICAN GEOLOGIST.]

fested here in Washington and on the Pacific coast in the results of this survey than is ordinarily bestowed upon the determination of the position and hight of a mountain summit. This Arctic colossus not only enjoyed the reputation of being the culuminating peak of the North American continent, serving as a conspicuous monument of the western limit of the British possessions, but there was also considerable interest manifested to learn how the three preceding determinations which were so strangely discrepant would agree with this last one. This disagreement chiefly concerned the hight of the mountain which had been determined by Dr. Dall in 1874, as 19,500±400 feet; by Mr. Kerr in 1890 as 15,350 feet; and by Prof. Russell in 1892 as 18,099 feet.

The first official announcement of the result of the latest measurements was made by Dr. T. C. Mendenhall, superintendent of the U. S. Coast and Geodetic Survey, at a meeting of the National Geographic Society in Washington on April 28, 1893 (see Nat. Geogr. Mag. vol v, pp 63-67). From this communication and collateral information kindly furnished by Dr. Mendenhall, the following résumé has been compiled for publication in Petermann's Mittheilungen.

Latitude of Port Mulgrave.

The astronomical observations for determination of latitude, longitude and azimuth were made on the south end of Khantank island near Port Mulgrave, about 420 meters to the northwest from the spot where Dr. Dall in 1874 made similar observations. The latitude was determined by the measurement of circummeridian altitudes of the sun's limb, and also by star observations by Talcott's method. The latter have not yet been reduced; the former give the following result: Latitude of Port Mulgrave, 59° 33′ 50″. Dr. Dall's determination of latitude making allowance for difference in position, becomes 59° 33′ 51.6.″

Longitude of Port Mulgrave.

The longitude was obtained by comparison with that of Sitka by chronometer transportation, the surveying steamer, *Hassler*, making six round trips between these two places for this purpose. The result was 139° 46′ 48″ W. L. for Port Mulgrave. Dr. Dall obtained for his station 139° 46′ 15.9″

which gives by reduction 139° 46′ 34.9″ for the new station. The difference between the two determinations amounts, therefore, only to thirteen seconds of arc.

Triangulation.

While Mr. Turner was engaged upon the astronomical work, Mr. McGrath measured a base of 6,831 meters (or about four miles) on the western shore of Yakutat bay, which he connected by a system of triangles with the astronomical station lying to the eastward, and also with Mt. St. Elias, about 47 miles distant to the northwest. The angle which is subtended by this triangulation at Mt. St. Elias is about 20°, whilst the corresponding angle of Prof. Russell's work is only 5° 23′ 38″; hence far more certainty is attached to the position of Mt. St. Elias as derived from the observations of Messrs. McGrath and Turner.

Besides the horizontal angles, vertical angles were measured at each of the five occupied stations shown by the sketch. A greater weight was allowed to the zenith distances measured at the astronomical station, for the reason that a better instrument had been employed and that they extended over a longer period of time than the rest. The coefficient of refraction was obtained by reciprocal observation between this station and Mt. Hoorts, which has an elevation of 2,076.5 feet and was found to be =0.083.

The following series gives the means of the daily measurements of zenith distances of Mt. St. Elias taken from the astronomical station, each day's result being the mean of three sets of six repetitions each, the observations being made near noon.

ZENITH DISTANCE OF MOUNT ST. ELIAS.

June 11, 1892	87°	20′	50.3″
June 18, 1892	87	20	64.2
June 27, 1892	87	20	51.8
June 28, 1892	87	20	51.3
July 9, 1892	87	20	57.1
July 10, 1892	87	20	49.8
July 11, 1892	87	20	44.8
July 13, 1892	87	20	40.6
July 23, 1892	87	20	59.8
July 29, 1892	87	20	36.1
Aug. 1, 1892	87	20	53.6
Aug. 11, 1892	87	20	52.0
Aug. 17, 1892	87	20	50.8
Aug. 18, 1892	87	20	41.2
Mean of 14 days	87	20	50.2±1

The close agreement of these daily means, the greatest difference being only 28″, not only stands as proof of the accuracy attained by the observations, but also indicates a remarkable steadiness of atmospheric refraction.

The following table gives the hight, above mean high tide, for each of the five occupied stations, also the elements for the determination of the hight of Mt. St. Elias, namely, the computed distances and the measured zenith distances, and finally the resulting hights:

DETERMINATION OF THE HIGHT OF MT. ST. ELIAS.

STATIONS.	Hight above mean high tide.	Distance to Mt. St. Elias.	Zenith distances of Mt. St. Elias.	Hight of Mt. St. Elias.
North Base.	3.0 m.	75,871 m.	86° 08′ 56″	5,490.6 m., or 18,014 ft.
South Base.	7.4 "	75,393 "	86 07 26.4	5,490.2 " " 18,012 "
Mt. Hoorts.	633.0 "	98,708 "	87 33 09	5,491 6 " " 18,017 "
Ocean Cape.	21.8 "	102,841 "	87 20 31	5,490.8 " " 18,015 "
Ast. Sta....	3.0 "	103,322 "	87 20 50.2	5,486.3 " " 18,000 "

Adopted mean hight, 18,010 feet.

The tide observations which were made at Port Mulgrave by the hydrographic party during the same season indicate a hight of 4¾ feet for the greater one of the two diurnal tides above the mean level of the sea; hence we may assume 18,015 feet as the hight of Mt. St. Elias above the mean sea level.

Mt. St. Elias therefore is 84 feet lower than measured by Prof. Russell, but decidedly within the limit of his assumed probable error; it is 1,485 feet lower than computed by Dr. Dall; but 2,665 feet higher than reported by Mr. Kerr. There is the same good agreement between the zenith distances and azimuths measured by Dr. Dall at Port Mulgrave, in 1874, and those by Turner in 1892, as there is between the latitude and longitude observations.

What had long been suspected is now proved to be a fact, that Dr. Dall's only error consisted in putting too great confidence in the accuracy of his position at sea, which involved both the distance and hight of the mountain.

The survey of 1892 furnishes the following position of Mt. St. Elias: Lat. 60° 17′ 35″ N., Long. 140° 55′ 20″ W. of Greenwich. The position computed in 1891, and given in Petermann's Mittheilungen (vol. 38, p. 21) was Lat. 60° 17′ 51″, and Long. 140° 55′ 30″.

The magnetic variation was determined on Sept. 2, 3, and 4, near the astronomical station, and found to be 29° 58 ′9″ east.

*Mount Orizaba.**

The hight of Mt. St. Elias obtained in 1892 has direct bearing upon the question of the highest peak on the North American continent. Towards the early part of 1892 it was in suspense between Mt. St. Elias and Mt. Orizaba in Mexico, with a lead of about 200 feet in favor of the latter. This supposition has been confirmed by the measurements made by Mr. J. T. Scovell of Terre Haute, Ind., in the years 1891 and 1892.†

In 1891 Mr. Scovell reached the altitude of 14,000 feet by levelling, and thence he made two ascents of the peak, making two barometric determinations of its hight, which gave a mean of 18,179.16 feet. In 1892 he commenced his survey at Chalchicomula, the elevation of which, 8,313.571, feet he took from the profile of the railroad to Vera Cruz, and from this point he carried a line of levels until he reached the elevation of 13,000 feet. Here he measured a base of 1,550 feet, and observed the necessary angles for the computation of the hight of the peak above each end of the base. Thus he obtained as the mean hight, 18,314.156 feet. The publication of this result caused some surprise in our geographical circles, as this hight is greater than Orizaba had been previously credited with. To make sure that no error had crept into the calculation, Mr. C. A. Schott, at the suggestion of Dr. Mendenhall, made an independent computation of Mr. Scovell's observations, which gave 18,315.8 feet as the hight. The small difference of 1.6 feet is probably a consequence of the employment of different coefficients of refraction.

Without committing myself to the accuracy of decimal fractions, the contemplation of the above figures does not appear to leave any alternative for St. Elias but that of lowering its flag in sight of Orizaba.

[*Commonly so-called from the city on its eastern slope; but its native name is Citlaltepetl, meaning star mountain. See AM. GEOLOGIST for last June, p. 426, and articles by Mr. J. T. Scovell in Am. Naturalist, vol. xxiv, pp.761-5, Aug., 1890, and in Science, vol. xxi, pp. 253-7, May 12, 1893.—EDS.]

†Am. Naturalist, Oct., 1892, pp. 804-5.

NEW OCCURRENCES OF PARALLEL INTERGROWTHS OF THE MINERALS ALLANITE AND EPIDOTE.

By Wm. H. Hobbs, Madison, Wis.

In April, 1888, I made mention of the observations of parallel intergrowths of allanite and epidote in the porphyritic granite of the vicinity of Ilchester, Maryland.* Dr. G. H. Williams† subsequently found them to have a wide distribution in the granites of the vicinity. Professor A. Lacroix‡ of Paris has since described similar parallel growths of these minerals in the pyroxene amphibole gneiss of Finisterre, France, and in the pyroxene wernerite gneiss of the nieder-österreichischen Waldviertel and the wernerite gneiss of Oedegaarden in Norway. Professor W. C. Brögger§ has also mentioned very similar growths from the pegmatite dikes of Arendal, in Norway, with three distinct zones. The two inner ones are doubtless allanite possessing zonal structure, and the outer one epidote. Professor Brögger thinks that this epidote is at least in some cases not original, but of pseudomorphic origin. Another description of allanite-epidote intergrowths is by Dr. Frank D. Adams‖ and is from a granite from Wrangell island, Alaska.

Mr. R. B. Green of Ishpeming, Mich., lately a student in geology at the University of Wisconsin, while making a microscopical examination of a suite of rocks collected by professor Van Hise came upon intergrowths of these minerals in a granite from the vicinity of Needleton, Colorado. Dr. Van Hise has called my attention to a rock from the Medicine Bow range in southern Wyoming in which he has found the same intergrowths. Within the last two years I have found allanite-epidote growths at a number of localities in the gneiss of southern Berkshire county, Massachusetts, and particularly on Warner mountain in Sheffield. It is probable that other

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*Johns Hopkins University Circulars, No. 65, April, 1888. (See also Tschermak's mineral. u. petrograph. Mittheilungen, xi, p. 1; also Am. Journ. Sci., vol. xxxviii, pp. 223-228, Sept., 1889.)

†Guide to Baltimore, with an Account of the Geology of its Environs. Baltimore, 1892.

‡Bull. de la société franç. de minéralogie, xii, No. 4, 1889.

§Zeitschrift für Krystallographie, xvi, p. 99, 1890.

‖Canadian Record of Science, 1891, p. 344.

occurrences have been found by other observers which have not been reported, and it is likely that others have been passed by because they have not been recognized. The numerous observations which have already been reported are sufficient to show that allanite-epidote intergrowths have considerable importance in granitic and gneissic rocks.

Very recently has appeared a paper by Keyes* which gives the results of further study of these two minerals in the Maryland granites. The special interest of the paper consists, as is indicated by its title, in the argument for the original nature of the epidote. Epidote has generally been considered as always of secondary origin. Rosenbusch expresses this view in his "Physiographie" as follows: "Der Pistazit oder Epidote tritt wohl nirgends in den Eruptivgesteinen als primärer Gemengtheil auf."† It has occasionally, however, been hinted that such might not always be its nature. In discussing the origin of the Ilchester epidote, the present writer‡ called attention to the fact that, though the granite of Ilchester is much stretched, similar intergrowths of allanite and epidote have been found by Prof. Williams in the Woodstock granite, which shows no evidence of cataclastic structure. Dr. Keyes in the paper cited gives the following arguments for the original nature of the epidote: Its presence in fresh or but slightly altered rocks, the inclusion of the mineral in sphene, and the formation of biotite in cracks of the epidote. His argument from idiomorphic character would not seem to me to be valid, since minerals like staurolite and garnet, which can be shown to be of secondary development, frequently possess remarkably well defined idiomorphic outlines. He has, however, as it seems to me, brought forward sufficient evidence to show that, in some cases at least, the epidote of the allanite-epidote intergrowths is original.

University of Wisconsin, September 9th, 1893.

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*Epidote as a primary Component of eruptive Rocks. Bull. Geol. Soc. Am., vol. iv, pp. 305–312, 1893.

†Mikroskopische Physiographie (3te Auflage) Stuttgart, 1892, vol. i, p. 610.

‡Tschermak's min. und petrog. Mittheilungen, vol. xi, p. 6, 1889.

NOTE ON CRETACEOUS IN NORTHERN MINNESOTA.

By HORACE V. WINCHELL, Minneapolis, Minn.

In 1887 Cretaceous shale was found by the writer on the Little Fork, Big Fork or Bowstring and Rainy Lake rivers* in the northern part of Minnesota. A few fragments of fossils and two or three cycloid fish scales, together with lignite and brown coal fragments were all the organic remains that were noticed at that time. The presence of lignite in the drift of the southern portion of the state and the blue clay itself had suggested the idea of the former presence of Cretaceous sediments over some portion of the northern half of Minnesota, before their actual discovery, and the opinion had been expressed by the state geologist that the area north of the Hight of Land had all been covered by the Cretaceous ocean. A summary of the Cretaceous in Minnesota is given by Dr. C. A. White in his "Correlation Paper" (Cretaceous). Bulletin 82 of the U. S. Geological Survey.

Since 1887, however, there have been no further localities noted until recently. The discovery of the vast hematite deposits of the Mesabi range has stimulated exploration work in this unsettled region, and new facts have been brought to light bearing upon the distribution of Cretaceous sediments.

In the fall of 1892 the attention of the writer was directed by Mr. Uno Sebenius to a test pit sunk for iron ore in the northeast quarter of the southwest quarter of section 20, Twp. 58 N., R. 19 W., Fourth principal meridian. Mr. Sebenius had collected fossils from the material thrown out of this pit. These he kindly placed at my disposal, and they, with others which I myself collected at the same spot, were sent to Dr. C. A. White, of the U. S. National Museum, who examined them with the aid of Mr. T. W. Stanton, and sent me the following letters in reference to them:

Washington, D. C., March 24th, 1893.

MR. HORACE V. WINCHELL.

Dear Sir: I have examined the small collection of fossils which you obtained from the Mesabi range in northern Minnesota, and, although they are all in an imperfect condition, I do not hesitate to refer them to the Upper Cretaceous. The following genera are represented by the

*Sixteenth Annual Report, Minnesota Geol. Nat. Hist. Survey, pp. 403, 404, 406, 409, 430, 431, 434.

collection:—*Ostrea, Inoceramus, Modiola, Pinna, Yoldia ?, Trigonarca, Actæon ?, Trochus ?* and *Fasciolaria.* A part of the species represented by the specimens constituting this collection are evidently new. Some described species are thus represented, and others are probably referable to described species, but they are too imperfect to admit of satisfactory determination.

The *Yoldia ?* referred to is much like the *Y. microdonata* of Meek and Hayden, reported to have come from the Dakota group of Kansas. The *Inoceramus* cannot be distinguished from the *I. fragilis* of Hall and Meek. This is a characteristic species of the Colorado formation. For this reason, and because that formation is known to be represented at other localities in Minnesota, I think there is little, if any, reason to doubt that the deposit from which you obtained these fossils represents a portion of the Colorado formation as it is developed in the great interior part of the continent.

This discovery of a Cretaceous deposit at a point so far to the northeast in Minnesota, is a matter of much geological interest, and, together with other similar discoveries in that state, leaves no room for doubt that the Cretaceous sea covered a large part, if not all, of its present area.

Very truly yours,

C. A. WHITE.

Notes on the collection of Mr. H. V. Winchell from northern Minnesota. Received May 8th, 1893.

In addition to the Inoceramus, Modiola, and one or two others that were sent in the first lot from the same locality, there are several other forms each represented by a single specimen, as follows:

1. Placenticeras (Sphenodiscus) sp. undet.
   (Collected by Samuel Sanford.)
   Part of the inner whorls of a form related to P. (Sphenodiscus) lenticulare Owen, from which it differs in having a broader umbilicus and more simple septa.
2. Pholadomya ....
   Resembles P. subventricosa M. and H., though neither the type nor Mr. Winchell's specimen is well enough preserved to make the comparison satisfactory.
3. Barbatia...... An imperfect cast.
4. A Reptilian tooth.

C. A. WHITE.

The discovery and determination of these fossils verify the observations made in 1887, and further determine that the strata belong in the Colorado group of the Upper Cretaceous. The fossils occur in greenish-blue shale lying beneath the glacial till. The shale is conglomeratic with fragments of the underlying taconyte which contains the ore deposits of the Mesabi. Some strata are hard and sandy, instead of conglomeratic. The dip is not known, for the pit is full of water. It is evident that the pit penetrated the strata to a greater depth than thirty feet, without going through their entire thickness at this point. Fragments and masses of comminuted lignitic material are found pervading the sediments, sometimes in such abundance as to impart a black color to the whole. Small scales of pearly mica are numerous, and there are occasional small cubes of pyrite. The conglomerate is heavy, being composed of iron ore and taconyte fragments cemented by sesquioxide of iron. It is completely consolidated into a firm, hard rock which resists fracturing and rings with blows from a hammer.

Five miles east of the locality above mentioned the same Cretaceous shale is found in another pit and was penetrated about one hundred feet by a churn drill. This is in section 18, Twp. 58 N., R. 18 W. Here the dip is about horizontal. The same lignitic material is found, but very little of the conglomerate. A piece of wood resembling white cedar was found at a depth of 85 feet from the surface of the ground. Its length exceeded one foot, and it is said to have been found in a vertical position embedded in the blue shale. It may be the fragment was forced into the shale by glacial action, and is not of Cretaceous age, although it strongly resembles other semi-fossilized pieces found in the Cretaceous of this vicinity. No other fossils were obtained at this place.

A third locality about seven miles northeast of the last is in the S. E. ¼ N. E. ¼ section 6, Twp. 58-17. At the depth of 60 feet lignitic Cretaceous shale and the same peculiar conglomerate mentioned above were found. No fossils were observed. The thickness of undoubted Cretaceous did not exceed ten feet. Underneath it are flat strata of soft white, yellow or red kaolin, more or less mixed with sand and stained with iron oxide. At the depth of 150 feet this had changed to a harder, more siliceous phase of the taconyte. The diamond drill at this pit went to the depth of 248 feet and stopped in hard taconyte. The kaolin was at first supposed to be Cretaceous, and even now it is difficult to draw the line between the two formations.

The Cretaceous shale found in 1887 is on the north side of the divide between waters flowing north and south, and at some distance from that divide; the sediments here described are on the south side of the divide, but nearly up to its summit at an elevation of about 1,600 feet above tide. The inference is, therefore, inevitable that most of the highest land in northern Minnesota was submerged in the Cretaceous ocean and covered by its sediments. Attention is called to the fact that these recent sediments rest upon the very ancient Taconic (Upper Huronian?) or upon the most ancient Archæan. No Silurian, Carboniferous or Devonian strata intervene, and it is doubtful if they were ever present. During all the ages between the primordial and the age of reptiles the rocks of northern Minnesota were raised above the waters, dry land, subjected to the forces of erosion and chemical disintegration. This fact has considerable bearing on the question of the genesis of the Mesabi iron ores, and tends to confirm the theory advanced by the writer in another place.*

The area at present occupied by Cretaceous is unknown, the mantle of glacial drift covering the underlying rocks to the depth of one hundred feet or more a few miles south of the Mesabi range. There is in St. Louis county an extensive swamp occupying a flat tract of land running for nearly fifty miles in an east-west direction between the Duluth and Iron Range railroad and the Mississippi river. The discovery of Cretaceous sediments on the northern edge of this basin suggests the possibility of a considerable thickness of the same sediments in its central portion. From what is known of the geology of the area north of the Mesabi range it is safe to assert that the most promising field for the discovery of workable brown coal deposits in Minnesota is under this same great swamp.

REVIEWS OF THE ICE AGE AT THE WORLD'S CONGRESS ON GEOLOGY.

Eight papers relating to the Glacial period were presented to the World's Congress on Geology in its session on Saturday, August 24th, as follows:

Glacial Succession in the British Isles and northern Europe. Prof. JAMES GEIKIE, Geological Survey of Scotland. (Absent; read by Prof. R. D. Salisbury.)

*Twentieth Annual Report, Minn. Geol. Survey.

Glacial Succession in Sweden. HJALMAR LUNDBOHM, Geological Survey of Sweden.

The Succession of Glacial Deposits in Norway. ANDREW M. HANSEN, Edemarken, Norway. (Absent; read by Prof. T. C. Chamberlin.)

Glacial Succession in Switzerland. Dr. ALBRECHT HEIM, Zurich. (Absent; read by Prof. Salisbury.)

The Succession of the Glacial Deposits of Canada. Dr. ROBERT BELL, Canadian Geological Survey.

Glacial Succession in the United States. Prof. T. C. CHAMBERLIN, University of Chicago.

Pleistocene Climatic Changes. WARREN UPHAM, Geological Survey of Minnesota.

Evidences of the Diversity of the Older Drift in northwestern Illinois. FRANK LEVERETT, U. S. Geological Survey.

Previous to the session the following summary of the time relations of the glacial drift and associated Pleistocene formations, as given in several of these papers, was written on the blackboard, affording a convenient comparison of the sequence of events constituting the Ice age in European countries and in the United States.

GREAT BRITAIN.
(*Geikie.*)

10. Upper buried forest.
9. Valley morines.
8. Lower buried forest.
7. Ground and terminal moraines; 100 ft. beaches.
6. Fresh-water alluvia.
5. Upper boulder-clay; lowland Purple drift of southern England.
4. Marine and fresh-water accumulations.
3. Lower boulder-clay of lowlands.
2. Forest beds of Cromer.
1. Weybourn crag, and Chillesford clay.

SWEDEN.
(*De Geer. Lundbohm.*)

Recent. *Mya arenaria* beds.
Postglacial.
- *Cardium.*
- *Ancylus.*

3. Baltic ice-sheet; *Yoldia* beds.
2. Interglacial.
1. Greatest glaciation.

NORWAY.
(*Hansen.*)

Postglacial.
- Recent.
- Last warm.
- Subglacial.
- Boreal.

Deutero-glacial.
- 2. Epiglacial.
- 1. Ra-epoch.

Interglacial

Protero-glacial.
- 2. ....
- 1. ....

SWITZERLAND.
(*Heim.*)

7. Present epoch.
6. Postglacial.
5. Last glaciation.
4. Last interglacial.
3. Second glacial; greatest ice-sheet.
2. First interglacial.
1. First glacial.

UNITED STATES.
(*Chamberlin.*)

11. Postglacial.
10. Lake deposits; Champlain depression.
9. Late moraines.
8. Stout moraines.
7. Readjustment interval.
6. Re-invasion; outer terminal moraine.
5. Post-lœssian interval.
4. Second till and lœss.
3. First known interval.
2. Lowest till.
1. Advance.

Professor JAMES GEIKIE, in the first paper of this series, reviewed the varied history of the Ice age in Scotland and in England, where an ice-sheet at one time stretched south to the Thames. In a recent paper before the Royal Society of Edinburgh, he published his conclusions that Great Britain has experienced during the Pleistocene period no less than five separate cold epochs with more or less extensive glaciation. The same opinion he now extends to the continental glaciated portions of Europe, since he finds there a very good and complete parallelization with the glacial and interglacial deposits of the British Isles.

Mr. HJALMAR LUNDBOHM stated that his studies of the glacial drift in Sweden sustain the sequence of Pleistocene epochs worked out by the careful and widely extended observations of Baron Gerard de Geer. During the early maximum glaciation, the mammoth inhabited portions of Europe not enveloped by the ice-sheet, and at this time the ice-shed whence drift was transported both east and west coincided nearly with the Scandinavian mountian range. Later, after an interglacial epoch, the Baltic ice-sheet, as it has been called by De Geer from its sending a large lobe south and southwest over the basin of the Baltic sea, formed prominent moraines in Finland, northern Germany, and southern Sweden. The ice-shed then did not coincide with the hight of land in Scandinavia, but lay at a considerable distance to the east; so that when this ice-sheet was melting away its waning central part became a barrier of glacial lakes pent up in the deep valleys between it and the mountains. Following the recession of the Baltic ice-sheet, the sea had access to the Baltic basin by broad straits across southern Sweden, admitting the *Yoldia arctica* to the vicinity of Stockholm; but soon a rise of the land shut out the ocean wholly from the Baltic so that it became a great lake, forming beaches with *Ancylus* and other fresh-water genera. The uplift continued till some tracts were raised probably 100 feet higher than now, since which time the land has sunk but is now again slowly rising. These oscillations may belong only to the borders of Sweden, while the elevation of its central part may have been continuous. All the marine molluscan fauna of Pleistocene times still survives, though the Yoldia noted is found only in arctic seas; but many of the great mammals of Europe in the Ice age have become extinct.

Mr. ANDREW M. HANSEN sent a very interesting and comprehensive paper. He finds in Norway little direct evidence of an interglacial epoch, but believes that the mammoth remains of Europe must be wholly of interglacial or preglacial age. During interglacial times he thinks that mesolithic man may have been present in other parts of Europe, if we adopt the recent classification of the early stages of culture in the stone age as paleolithic, mesolithic, and neolithic. The erosion of the Scandinavian fjords he attributes to glacial rather than stream action, since they are in so many instances much deeper inside than outside the coast line; and no evidence is found for formerly higher altitude of the country as a cause of the ice accumulation. The Ice age in Norway seems hardly to have ceased, as there remain a hundred glaciers, some of which are of great extent. In the deuteroglacial epoch the ice-sheet had its greatest hight east of the mountain range, and on the west it terminated in the fjords, not reaching the outer coast line. The recession of this ice-sheet was rapid, and a part of the postglacial epoch was warmer than the present time. The recent and last warm stages of the postglacial epoch are estimated to have comprised about 5,000 years, the whole of this epoch being 7,000 to 9,000 years. The deutero-glacial epoch, divided into the stage marked by the formation of the raer or eskers and a subsequent stage of ice advance, included perhaps 15,000 or 25,000 years; the interglacial epoch, some 15,000 years; and the protero-glacial epoch, which also is thought to comprise two or more divisions, may have occupied 100,000 to 150,000 years.

Dr. Albrecht Heim noted the temperate facies of the floras enclosed in beds underlain and overlain by till in the valleys of the Alps and adjoining country. Three distinct glacial epochs are recorded, of which the second witnessed the greatest extension of the confluent glaciers. He very confidently asserts that the Pleistocene period was characterized in Switzerland by at least three alternating cycles of cold and succeeding warmth, attended respectively by great accumulations of ice and its almost complete departure.

Dr. Robert Bell claimed that the glacial drift of Canada should be especially well studied in forming any general theory of the Pleistocene glaciation of this continent. All of Canada, excepting its northwestern corner west of the Mackenzie valley and perhaps a narrow strip bordering the east side of the Rocky mountains in Alberta, was enveloped by the ice-sheet. From the Laurentide highlands and the area of

Hudson and James bays, a *mer de glace* flowed outward in all directions, and the high mountains of northern Labrador projected above its surface. Everywhere the drift is largely derived from the local rock formations. Its considerable thickness and varied deposits imply a long and diversified history, but definite division of the period into glacial and interglacial epochs has not been fully determined. Probably moderate oscillations of the ice border may be adequate for the explanation of such beds as are known in Canada between deposits of till. Deep preglacial rock decay was followed by a great amount of glacial erosion. Before the Ice age the land was much elevated, but when the ice-sheet retreated it was lower than now, so that fossiliferous marine beds were spread above the till along the St. Lawrence and Ottawa valleys and about Hudson bay. On the higher parts of the country stratified gravel, sand, and clay were deposited by the waters discharged from the melting ice.

Prof. T. C. CHAMBERLIN estimated the length of the principal interglacial epoch in the northern United States to be much longer than the postglacial epoch, as shown by the erosion of rock gorges of the Delaware, Susquehanna, and upper Ohio rivers subsequent to the deposition of the early glacial gravels of the highest terraces. The pebbles and cobbles of crystalline rocks contained in gravels of the Mississippi valley near Natchez, which are referred to glacial derivation from the Archæan regions of the upper Mississippi and lake Superior by those who appeal to great uplift of the continent as the cause of its glaciation, may instead have come from nearer areas of such rocks in the Ozark district of Missouri. The successive times of ice accumulation and advance appear to have been much longer than the times of its retreat. The most important interglacial stage of ice retreat, perhaps uncovering all the northern United States, was attended by the deposition of the greater part of the loess. With the re-advance of the ice-sheet, and during the stages of halt in its later departure, the remarkable marginal moraines which cross the northern states and Canada were formed. These number twelve to twenty in order from south to north, so far as already explored, and others will doubtless be found beyond these. Between the times of moraine accumulation, the lobes of the ice border were often much changed in their relations to each other, so that, although the moraines are in general approximately parallel, they often are found interlocking and sometimes the newer extend obliquely across the older. When the ice-sheet re-advanced after the deposition and considerable erosion of the loess, the land was somewhat higher than now: but no great altitude is indicated for that or any other time in the long continued and diversified records of the Ice age. At its end, as long before when the loess was mostly deposited, the land was depressed, being lower than now at the north where the Champlain marine beds overlie the till.

Mr. WARREN UPHAM directed attention to the uniqueness of the climatic conditions during the glacial portion of the Quaternary era. Liberal estimates of the length of this era, from the beginning of the preglacial uplifts of drift-bearing countries to the present time, range from 100,000 to 200,000 years, the lower of these figures being regarded by the speaker as the more probable. During a portion of this time continuously cold or cool climates with plentiful snowfall covered extensive regions in both the eastern and western hemispheres, and in the present temperate and higher latitudes about each pole, with deep ice-sheets, producing the glacial drift. But for the whole of the far longer Tertiary and Mesozoic eras, together probably a hundred times as long as the Quaternary, no record of extensive glaciation has been found in any part of the world. So exceptional climate in the Glacial period doubtless resulted from unusual causes, and these could not be astronomic, for in that case frequent glacial periods would have occurred during the preceding long eras. Great epeirogenic uplifts of the glaciated countries to form plateaus with cool climate all the year are thought to have given all the precipitation of moisture in the form of snow, by which the ice-sheets were amassed. Beneath the vast weight of the ice the land finally sank, but for a while the accumulation of ice went on faster than the rate of sinking, so that the greatest extent of the glaciation was reached about the same time with the maximum depression of the land, by which a warm climate was restored along the ice border. A chiefly rapid retreat of the ice ensued, interrupted at times by series of colder years and much snowfall, whereby the ice front was caused to halt or re-advance, forming marginal moraines. The relationship of the moraines to the glacial lake Agassiz demonstrates that only a few decades of years were enough for the accumulation of the highest and broadest belts of morainal drift; and the growing forests on the Malaspina ice-sheet in Alaska show how only moderate advances of the principally waning ice-sheet would envelop forest trees and a rich flora of temperate species between deposits of boulder-clay or till. All the records of both the European and American glacial and modified drift seem to be explained by the climatic vicissitudes of one general accumulation and advance of the ice-sheets, followed by a fluctuating recession. The Glacial period was short, as shown by the continuance of all its marine mollusks; but many mammals of that time are now extinct, while man, a "living soul," brought into existence during the Quaternary era, gives it a second title, Psychozoic.

Mr. FRANK LEVERETT exhibited a map of Illinois, showing the moraines and divisions of the drift which have been found by him in that state, and spoke of the two formations of till, one above the other, and each bearing a soil and leached subsoil, with an eroded surface, preceding the deposition of the loess. These older drift deposits bear testimony of a great lapse of time, with movements of moderate uplift and subsidence, previous to the chief interglacial epoch, which appears to have been long, for the valleys then cut by the streams are larger than those channelled in the later drift.

In the discussion following these papers, Prof. G. F. WRIGHT urged that the rock erosion of the rivers flowing from the glaciated area in the coastal and Appalachian region was done during a preglacial time of higher altitude. The early gravel terraces are to be regarded, he thinks, as remnants of valley drift flood plains that filled the rock gorges to their tops and overspread the rock terraces and loops of the old river courses left during the preglacial erosion. In general there is a remarkable parallelism of the extreme glacial boundary and the retreatal moraines, implying, as he believes, that the extra-morainic drift was produced in the same glacial epoch with the moraines. The glacial retreat was geologically rapid, but was many times somewhat interrupted, these stages of halt or re-advance being marked by the moraines.

Mr. W J McGee congratulated the Congress on having so large a series of papers from observers and explorers of the glacial drift, giving the results of their inductive studies.

Major C. E. Dutton cautioned glacialists against proceeding further with theories than the observed facts warrant. He believes that it is yet too early to assign safely the causes of the Ice age; but he cannot accept the astronomic theory of Croll and Geikie, and inclines to look rather to geographic conditions. The careful notation of observations should be continued, with less of hasty interpretations and generalization.

Prof. Chamberlin, summing up the main conclusions of these papers, stated that his view of the Ice age in the United States gives it a tripartite division, two epochs of glaciation having preceded the longest of the interglacial epochs. He agrees somewhat nearly with Hansen and Heim, making the early times of glaciation long and the ice in the middle glacial epoch more extensive than in the latest, to which the moraines mostly belong.

Prof. Salisbury remarked that a distinct glacial epoch need not comprise a long time in a geologic sense, but may be distinguished by important though not prolonged changes in the conditions of the ice action, attitude of the land, and processes of drift accumulation. Forest beds enclosed in till might be formed in Alaska, near the seaboard, by short ice advances; but the forest beds of Iowa and Illinois, in the interior of the continent, imply truly interglacial followed by glacial climates. The comparative depths of oxidation of the early and late drift indicate a very long interval between their epochs of formation.

Mr. Leverett replied to Prof. Wright's suggestion concerning the parallelism of the successive boundaries of the ice, that in Illinois notable irregularities and intercrossing occur in the courses of the four outer border lines which he has traced.

The papers and their discussion extended this session to 1:30 p. m., when the Congress adjourned, without taking up the question proposed at the end of the program for a special discussion. This question was: What are the Principles and Criteria to be observed in the Correlation of Glacial Formations in Opposite Hemispheres? In part, however, it had been under consideration by most of the foregoing contributors and speakers, the general view of all being that the glaciations of Europe and North America were essentially contemporaneous and much alike.

A DIAGONAL MORAINE.

By FRED. G. PLUMMER, Tacoma, Wash.

Among many interesting discoveries made during a recent exploring trip to the craters of Mt. St. Helens, in the state of Washington, one in particular seems to me so unusual as to call for special mention.

Our route contoured the north flank of the mountain, crossing many lateral and several recent terminal moraines. The glaciers were small at this elevation and were insignificant compared with those upon the mountain proper. Climbing over a low lateral moraine, I found between it and a higher moraine that formed a spur of the mountain, a small glacier with the typical wavy surface and without crevasses. Its inclination was twenty degrees.

Upon its surface, crossing the glacier diagonally from southeast to northwest, was a small moraine. It was perfectly straight and regular in form, about 300 feet long, 20 feet wide at the base, 5 feet high and with a slightly convex crown of about four feet. It resembled an unfinished railroad grade and was strikingly different from all of its surroundings. Upon careful examination I found it to be composed of the same rocks as other moraines but with this difference, that they were more worn and rounded and all of much smaller and more uniform size. At the foot of the side slopes the line of demarcation was cleaner and better defined than that of any other moraine I have observed. At its upper end or source (?) it abuts against an old lateral moraine which was possibly a portion of the former terminal moraine of a higher and larger glacier. At this point there was the sound of running water which probably came from a snow field above and made its way through the rocks without showing upon the surface. The gradation from the rocks of this old moraine to those of the diagonal moraine was observable but did not cover over ten feet of length of flow. At the lower end of the diagonal moraine there was no gradation and no dump, nor were there any traces indicating that its lower end had been trailed along the slope of the lateral moraine. After some search I fail to find that such a formation has been observed before.

NOTE.—I would suggest that the "diagonal moraine" described by Col. Plummer may be of the nature of an osar. The rounded and assorted material of which it is composed appears to have been deposited in a tunnel by an englacial stream and afterward brought to the surface by the melting of the ice.—I. C. RUSSELL.

REMARKS ON SPECIFIC CHARACTERS IN ORTHOCERAS.

By AUG. F. FOERSTE, Dayton, Ohio.

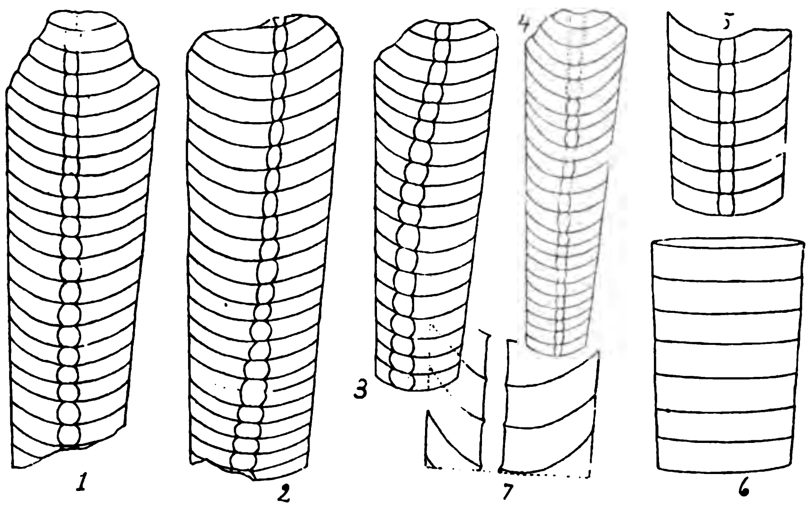
Species of Orthoceras, when examined closely are found to be subject to considerable variation. Within the limits of the same species, the apical angle, the hight of the chambers, the concavity of the septa, and the curvature of the sides of the individual annulations forming the siphuncle, may vary. In fact in any large suite of specimens it would not be difficult to find variations in these characters within the same specimen. The detection of such variations is often the result of extremely careful measurements, but in other cases, both of species and individuals, variation may often be recognized even on hasty examination. In proportion as the student is supplied with a larger collection the differentiation of the species naturally becomes more difficult. The examination of the exterior markings of the shell then becomes a means of considerable assistance; to such an extent, in fact, that the genus has been divided by Hyatt into a series of subgenera, based chiefly upon distinctions of the various types of surface ornamentation. These are mainly of two kinds, annular and longitudinal. Annular ornamentations evidently originated in variations in growth of the thickness of the shell, and annularly striated species of Orthoceras may be considered as of later origin than smooth forms. Annular striations correspond to the striæ of growth, the concentric ornamentation of brachiopods and lamellibranchs, and the transverse ornamentation of gasteropods. In their simplest form they consist of mere annular surface wrinkles, which within the limits of the same species may be distinct or obsolete. They are quite commonly more distinct towards the larger end of the shell than towards the apical end. It is practically impossible to determine definitely at times whether there be two species at hand, one smooth and the other annularly wrinkled, or whether the specimens form only a single species. Safety lies only in the study of large collections of such variable forms. A more advanced type of this kind of ornamentation is represented by species in which the wrinkles have assumed the character of transverse or annular striæ, more or less equally distant, and at equal diameters of the shell, showing comparatively equal distinctness. But in the same way as the hight of the chambers will vary, so the number of striæ in a given distance will be found at times to vary.

Of quite a distinct type of transverse ornamentation though having their origin also in variations of growth, are the transverse annulations of certain types of Orthoceras. These are due not so much to the variation in thickness of the shell, as to the contraction and expansion of the diameter of the body cavity around which the shell is deposited. They correspond, after a fashion, to the stronger concentric corrugations of brachiopods and lamellibranchs, but still better to the transverse or vertical ribs of gasteropods. These vary in their hight and prominence. In somewhat the same way longitudinal striæ may be due to variations in the thickness of the shell along certain more or less equally distant vertical lines, as they may be due to the form of the exterior portions of the body cavity within. Their relative degrees of constancy has not been studied in connection with the preceding facts.

The study of Orthoceras is still further complicated by the fact that in many instances the specimens of a locality exist only in the form of casts of the interiors of the chambers and siphuncle. While their discrimination is manifestly of considerable local interest, it is extremely doubtful how far general science is benefitted by their publication. The frequent impossibility of identifying such previously described forms with the much more perfect material found later elsewhere, simply leads to a confusion in the terminology of the genus, for all advance in actual knowledge must be based upon material with good superficial as well as interior characters. Though there is no hope for such a decision yet science would gain if only those species were recognized as having priority, which were based upon surface as well as other characters, and which, for reasons I hope to show later, also include a description of the siphuncles.

It is especially among forms with smooth shells that discrimination between species often becomes well-nigh impossible. Under such circumstances it would seem as though almost any character would be seized upon which could shed additional light upon the subject. In a general way this has been done in discriminating between the strongly annular siphuncle of the forms classified as Actinoceras, and the less annulated forms of Orthoceras. But there are other distinctions between the siphuncles of various species, which are capable of more specific application. One of these consists in the relation which the diameter of the siphuncle bears to the general diameter of the shell; another, in the degree of convexity exhibited by the individual annulations of the siphuncle, taking account of all the variations between those with practically straight sides and the more convex ones. At times it is even serviceable to distinguish between species having the siphuncle regularly very eccentric, moderately so, or central, and finally those in which the position of the siphuncle varies. It is a mistake to conclude that because sometimes in the same species the characters of the siphuncle vary considerably, no assistance can be gained from its examination. In some forms the characters of the siphuncle are remarkably constant and are of considerable value in assisting to discriminate between species. It is evident that these variations should be studied from numerous individuals of the same species, as, indeed, experience has taught us to do with the apical angle, the hight of chambers, and other features generally used for discrimination. In such a study the relative width of the siphuncle, and the relative convexity of the individual annulations will also have their value. No specific description can be considered complete which doesn't also give the characters of the siphuncle and the extent of its variations, for it has often happened that when internal characters have received their full share of attention, new light is cast upon their generic and specific distinctions.

While studying the species of Orthoceras from the Clinton group a very interesting case of constancy under variation came to notice. At the bottom of the Clinton group in Huffman's quarry, southeast of Dayton, Ohio, occurred at one place a white and very compact limestone full of various species of Orthoceras. In one of these species with a smooth shell, *Orthoceras erraticum* Foerste, in all the fragments examined, the siphuncle below is distinctly annulate, and excentric. Above, it changes its position until it becomes more nearly central, and at about this point the siphuncle begins to change its character and to become more nearly cylindrical. Higher up the siphuncle becomes excentric again, but towards the other side of the shell still retaining its cylindrical character. The case has seemed so interesting that the three largest fragments are here figured. In 1 the change of position of the siphuncle is not noted because the section passes vertical to the plane of the curvature of the siphuncle, but the cylindrical character of the upper annulations is well seen. In 2, the change of position is well seen, and the cylindrical character of the upper annulations would be more distinct if the section had passed a little deeper at this end. In 3, the upper portion with the more cylindrical annulations is evidently broken off, although the beginning of the change can be noted. Here is an instructive instance of variation within the limits of the same species, which may even afford some lessons in the development of the group. It has been noted in one Clinton and some earlier forms that in those species which have the annular character most strongly developed, *i. e.*, Actinoceras, a smooth exterior shell generally prevails. In that case the more typical forms of Orthoceras with a cylindrical siphuncle may be considered as a later development and the species here figured might be cited as a case in which such a change was taking place. On the other hand, the change in the character of the siphuncle here described might be claimed as simply a return, later in life, to ancestral characters. To determine this question it will be necessary to make a much more general study of the characters of the siphuncle in earlier (Middle Silurian) species than has yet been done.



In a distinct species (fig. 4) with a smooth shell, from the Clinton, at Todd's Fork, north of Wilmington, Ohio, the subcentral portion is more constant, and the width of the siphuncle increases with that of the shell, as it normally should do.

In a third species, Orthoceras ignotum *Foerste*, 6, the characters of the siphuncle are quite constant. It is cylindrical, 5, 7, and always moderately excentric, as in 7; figure 5 is cut at right angles to the plane passing through the siphuncle and the center of the shell, and so does not show this excentricity. The chamber cavities are always higher, and the apical angle lower than in O. erraticum so that the shell can be distinguished easily, even by fragments from the upper end. It forms a good instance of a species with the character of the siphuncle constant throughout. It is found at Hanover, Indiana, and at many localities of the Clinton of Ohio, especially at Huffman's quarry, near Dayton, Ohio.

THE MINERAL DEPOSITS OF SOUTHWEST WISCONSIN.

By WILLIAM P. BLAKE, New Haven, Conn., and Shullsburg, Wis.

The numerous and copious reports of geological surveys made in the lead and zinc region of Wisconsin leave, perhaps, but little room for any original work, or for descriptive details of the nature and origin of the deposits not already given in the exhaustive memoirs of Percival, Whitney and Chamberlin and their associates. However, since the completion of the last survey, in 1879, much more attention has been given than before to the exploration of the ores of zinc, especially of late years, since the region has been better opened up by railways and the zinc industry of the country has assumed large proportions, giving a constantly increasing demand for zinc ores.

A residence of more than a year in the region, and the active direction during that time of mining operations over a considerable area, have familiarized me with the forms and peculiarities of many of the deposits; and it appears probable that some observations upon them, especially from the mining and commercial standpoint, may interest the members of the Institute. A few notes on the structure of the deposits from the mineralogical and chemical standpoints have already been presented by me to the Wisconsin Academy of Arts and Sciences.*

The presence of lead-ore in the soil at many points along the Mississippi river was well known to the aborigines, and early attracted the attention of the frontier traders, who purchased from the Indians the ore and even lead smelted out by the squaws. The demand for the lead-ore soon increased, and it became one of the early and potent factors determining the settlement of southwestern Wisconsin, and the development of its mining and agricultural resources. The mines of that section, together with those of Missouri and the Mississippi valley, may be said to have been the cradle of mining in the western United States. The deposits of ore being at or near the surface, and being numerous and widely distributed, afforded to poor men an opportunity to mine on their

* December Meeting at Madison, 1892, "Notes on the Structure of the Ore Deposits of Southwest Wisconsin."

own account with little or no capital. The "diggings," which have often been termed "poor men's mines," soon attracted a large population. Laborers and miners were drawn thither from Cornwall and other mining centers, and those not bred to the use of the pick, gad, and windlass soon gained an experience in the use of tools and methods most useful to them in the new fields of the great west and in the mountain ranges sloping to the Pacific.

We are also largely indebted to the lead- and zinc-deposits of Wisconsin for the early institution of mineral and geological surveys by the general government, and also for the state surveys, by which the progress of geological work in America was greatly promoted. No pure love of science for its own sake, however, moved and stimulated either national or state legislatures to vote money for such surveys. It was in every case the hope of gain and the expectation of promoting the revenues of the state that led to the organization of geological surveys in those days, and that really lie in most instances at the root of the sources of state appropriations at the present day.

The chief centers of shipment of ores are Shullsburg and Benton, both within the region drained to the Mississippi by the Shullsburg branch and the Fievre river debouching at Galena. A series of mines extends from below Benton to and beyond Shullsburg. Some of the most prominent are the Von Dusko, Buncombe Hill, Bennett Brothers, Diamond Joe, Byrne's, Coltman's, Blende, Ida Blende, Sallie Waters, Raisbeck's, Leary and Coulthard, and Cuba City; the Zinc Carbonate Co.'s mines (with mill), and the mines of the Wisconsin Lead and Zinc Co., including the Monte Christo, Helena (with mill), Blaine and Logan, McCarty, Galena Level, Little Giant (with mill), Oakland Level, Wagner or McFeeley, Bonanza, Stop-line, Hempstead or Old Elevator diggings, and others. There are numerous shafts, tunnels, and drainage-adits, some of great length and draining extensive areas. The shafts seldom exceed 80 feet in depth. Most of the ores are hoisted by hand-windlass or trammed out of the tunnels, but open-cut mining for "dry-bone" (earthy smithsonite) has been successfully practiced in some places.

AREA AND GEOLOGY.

The lead- and zinc-ore region of Wisconsin extends through portions of Grant, Lafayette, and Iowa counties, and has an area of about 1,776 square miles. It lies just north of the Illinois state-line and south of the Wisconsin river, extending in a general north-easterly direction from the Mississippi. This is also the general direction of the groups of deposits and of the main lines of ore-occurrence.

The geology is simple. The ore-deposits are confined to nearly horizontal strata of dolomite and limestone of Lower Silurian age, which lie between the Potsdam sandstone and the equivalents of the Cincinnati or Hudson River shales. These strata, enumerated from below upwards, include the Lower Magnesian limestone, the St. Peter's sandstone, the Trenton limestone, and the Galena limestone,* or dolomite, this last having a vertical thickness of from 125 to 200 feet, and being the galena-bearing rock. It rests upon the beds of the Trenton limestone, a compact blue limestone generally known in the lead- and zinc-region as "glass-rock," from its brittleness and conchoidal fracture. The two formations are separated in the neighborhood of Shullsburg and New Diggings, in Lafayette county, by thin layers of a brown bituminous shale called "oil-rock," upon which, in that vicinity, the zinc-deposits spread out and end, though in other districts they are known to extend lower into the blue limestone.

The oil-rock, so far as yet known, attains its greatest development in the mines in the vicinity of Shullsburg † and along the Shullsburg branch, notably at the Dry-Bone diggings and at the Galena Level, where it is overlaid by a strong sheet of sphalerite and barite with crystallized galenite.

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* The Cliff limestone of Owen (1840), known also as the Upper Magnesian limestone, but including other formations as high in the geologic series as the Helderberg limestones of the Devonian. The area of the Galena limestone, which may be taken as limiting the occurrence of lead-ore and also zinc-ore, is given by Strong (*Geol. Wis.*, II., p. 684) at 969 square miles.

† Notably in some mines of the Hempstead; at the Butler shaft on the Little Giant tract; and at several other places on the property of the Wisconsin Lead and Zinc Co. At the Galena Level it underlies an extensive sheet of jack (blende), and is interstratified therewith. The oil-rock, when dry, burns with a bright flame and much smoke, and it yields upon distillation a thick, viscid petroleum.

FORMS OF ORE-DEPOSITS.

The ores are found in vein-like sheets in vertical and inclined crevices and in cavern-like enlargements along the course of such crevices known as "openings." Again, the ores form flats or sheets extending for some distance laterally between the strata, but, in my experience, generally resting upon the comparatively impervious strata of the brown shales, the latter being often partly decomposed and forming beds of blue clay.

Observation confirms in general the theoretic conclusions of Whitney, Chamberlin, and others regarding the genesis and distribution of the ores. The ores everywhere present the same general sequence of lead-ore in the upper portions of the diggings, with carbonate of zinc gradually passing into sulphide of zinc below, which last is associated with pyrite of the marcasite variety.

In the lead-region the ore-deposits are seldom referred to as "veins" or "lodes," although so far as they extend vertically in the formations they have what we generally term vein-structure to a remarkable degree. They are called "crevices" or "openings," and sometimes "sheets," "pitches," or "runs."

Although there is locally great diversity in the ascertained or supposed direction of the ore-bearing crevices, varying from northwest and southeast to northeast and southwest, or from north and south to east and west, the major axis or direction of the principal groups of deposits appears to be northeasterly and southwesterly, approximately coincident with the general geologic structure of the State, as shown by the trend of the uplifts further north, by the direction of the Baraboo axis, and by the direction of the mound-formations —the remnants of the shales which have, for the most part, been swept away.

DIRECTION OF CREVICES.

So far as my experience extends (it has been chiefly in the region beyond and below Shullsburg to New Diggings), the crevices with the northeast trend are the most common and persistent, and are crossed at intervals by other crevices, of less extent, at right angles, giving what are called "10 o'clocks," or having a direction nearly N. 20° to 30° W. This general parallelism of the ore-bearing groups with the structure of the region is significant of some relationship or dependence which has not hitherto been fully investigated. Percival gave great attention in detail to the direction of the crevices, and generally refers to them as "norths and souths" and "easts and wests," while recognizing the general bearing as quartering or northeasterly and southwesterly—his east and west ranges being in fact the same as those approximating a northeasterly and southwesterly course. He says: "The term east and west is applied to the leading ranges, although they may deviate even 45° from a due east and west course."* He also pointed out the fact that the traces of order and connection in the surface arrangement appear no less remarkable than in the vertical arrangement, and that the ore-bearing ranges in their bearing (direction) and grouping have been governed by some general laws, and have not been merely local accidents.†

Horizon of Ore-Deposits.

The question whether the ores of lead and zinc are confined merely to the horizon of the Galena limestone and to the upper portions of the Trenton or extend much lower, even into the Lower Magnesian limestone, has been much discussed by the successive geologists of Wisconsin since the days of Percival, who favored the view of the deep-seated source of the ores and their presence in the lower formations. This view was emphatically discouraged by Whitney and by Chamberlin, whose conclusions have been generally accepted, and no effort has been made to test the question practically by a deep shaft, as has been several times proposed.

Chief Deposits of Blende.

The bulk of the blende comes from bedded or horizontally distributed ore and not from vertical or inclined crevices. The deposits show less irregularity of formation than those of galenite, being for the most part below the general water level, and not affected by oxidation and the attendant solution of the rocky walls and the formation of irregular caverns.

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* Report of 1855, p. 76.

† Percival's Report of 1856 (second report, published after his death), page 63.

But the beds are not without cavernous spaces or "openings," such as are ordinarily called "vugs." We may make two broad or comprehensive divisions or groupings of the deposits into 1. Irregular and brecciated deposits; and 2. Regular sheets or beds.

In the irregular and brecciated we may include most of the dry-bone derived from the oxidation of the blende in place, which dry-bone continues to occupy the same places and passes downwards into unchanged blende. Sometimes the original bedding of the rocks is but little changed, and there is no disturbance, but in other places there is great confusion and breaking up of the bedding with the accumulation of irregular masses of rock, surrounded and invested with a coating of ore, by which the rocks are united into one mass.

BRECCIATED DEPOSITS.

In all of the deposits of blende and pyrite, not only in those formed in the midst of a breccia but in the regularly formed horizontal beds, there are places where the ores have been broken across, with the layers disjointed, so as to show faulting of these layers on a small scale, but such breaks have been recemented and reunited as strongly as before. It is evident that there has been movement, probably in most cases by the falling down of masses of ore by their own weight, when perhaps the rocks below became eaten away or the soft clays became washed out, thus removing the support.

In the case of the brecciated deposits, where no distinctly regular flat sheets are seen, the original bedding of the rocks themselves is obliterated or destroyed by the falling-in. It is not always easy to decide whether the broken condition of the beds is the cause or the effect of the percolation of mineral solutions, but I incline to the view that, in most cases, it is the result of the flow of the solutions of acid salts of the metals which have eaten away the rocks below without fully replacing them in bulk, and that being so undermined the rocks have fallen in from time to time, and in the confused masses of fragments the zinc and iron sulphates have found the most favorable conditions for deposition or replacement.

THE VARIETIES OF ORE.

There are now four different kinds of ore shipped from the Wisconsin mines, namely:

Chemical compound.	Mineral species.	Local name.
Lead sulphide.	Galenite.	Mineral.
Zinc carbonate.	Smithsonite.	Bone.
Zinc sulphide.	Sphalerite or blende.	Jack.
Iron sulphide.	Pyrite or iron pyrites.	Sulphur.

Of these, the zinc-ores largely preponderate, and the production is increasing with the constantly growing demands of the spelter and the white zinc-oxide industries.

The lead-ore is not now so much sought as formerly, and most of the old deposits are regarded as exhausted, although now and then new discoveries are made. The production may be regarded, however, as chiefly incidental to the exploitation of the zinc-deposits. As these are followed, new deposits of lead-ore are sometimes uncovered, and in some of the zinc-deposits a little galena is intermingled with the carbonate and with the blende.

The bulk of the shipments of lead-ore is in the form of coarse lump-galenite in large sheets ("sheet mineral"), or masses ("chunk mineral"), or in crystalline masses as broken out from the deposits and culled by hand. When in large cubical crystals the ore is known as "block-ore" or "cog-wheel mineral," or "dice-mineral," if in smaller cubes. The name "mineral" for all forms of lead-ore is in general use. When the galenite is the product of separation by jigging from either drybone or jack, it is of course broken up into small pieces and finer, and it is then somewhat contaminated with residues of pyrite and of jack, or possibly barytes, by which its per centage is lowered. It is sold by the "thousand" (thousand pounds), and the price varies with the market value of pig-lead and the immediate needs of the smelters. In 1892 it ranged from $20 to $25 per thousand pounds, or from $40 to $50 per ton. It has special value to smelters by reason of its purity, being without arsenic, antimony, or silver, and thus furnishing a clean lead for corroding.

The total shipments of zinc- and lead-ores from Benton, the principal ore-shipping railway station in the southwestern part of the lead- and zinc-region, amounted in 1892 to 13,800,000 pounds, of which the lead-ore was 800,000 pounds, or only about 6 per cent. of the whole. This may be taken as representative of the present ratio of production by weight, though in the case of some new discovery of lead-ore the shipments for a season may be greatly increased.

The lead-ores are sent largely to the works of the Pennsylvania Lead Company, at Pittsburgh, and some go to Aurora, near Chicago. Formerly the galenite was smelted at the local furnaces; but since the opening up of the country by railways all this has changed; local smelting has been given up and the furnaces are dismantled and in ruins.

ZINC-ORES—SMITHSONITE.

Smithsonite, or "bone," as mined and sent to market, is usually in three grades or sizes, the result of the methods of sorting and cleaning:

1. The large masses or picked bone, culled by hand as mined, and comparatively free from rock or other substances.

2. The washed or jigged bone, in smaller fragments, cleaned as far as possible from iron oxide, blende, and rock.

3. The finer portions or "smittems," more or less contaminated with heavy ochery clay, limonite and ferruginous rock, which cannot be removed.

Of these sizes the first, being the cleanest and carrying the highest percentage of oxide, commands the highest price. The value of the second grade varies greatly according to the presence of more or less limonite, which is not easily separated. The third is the lowest grade and the least desirable, as it is too fine to be cleaned by culling. In selling these ores at the close of the season's work, it is customary to sell the whole together at an average price per ton for all grades, since it would be difficult to dispose of the smittems alone.

Dry-bone is used for the manufacture of white zinc-oxide for paints, and is not used for the production of spelter.

Although by opening up new deposits of this ore the production may be temporarily increased for some years, it is easy to foresee that, with the large and ever increasing demand, the supply will diminish and the value will advance. Missouri supplies more "jack" than "bone," and the Wisconsin deposits are at present the most available for the latter product. Some ore has been obtained from New Mexico, but the deposits are too far away to permit all the grades of ore to be marketed. Only the very highest grades bear the great cost of transportation. There are also deposits in Arkansas, but these are also difficult of access and are now idle. The smithsonite or "bone" is sent chiefly to the works of the Mineral Point Zinc Oxide Works, at Mineral Point, in Iowa county, Wisconsin, on the line of the Chicago, Milwaukee & St. Paul railway, and some now goes to the newly established works of the Lanyon Zinc Oxide and Paint Co., at Waukegan, on the shore of Lake Michigan, about 30 miles north of Chicago. A few shipments are made to the St. Louis works of Page & Crouse, and a new establishment at Dubuque, Iowa, is projected. The value of the best grades during the year 1892 ranged from $18 to $24 per ton, delivered on the rail. The quality of even the best grades varies at different localities. At some, the bone is light-colored; at others, it is more or less discolored by iron oxide or ocher; manganese oxide is rare. Thick, solid crusts of compact and vitreous ore, like some obtained in England, are seldom seen. Zinc silicate is but rarely found. Mineralogically, the specimens are not beautiful, but they sometimes have the form of very interesting casts or replacements of crystals of calcite.

Although the attention of the miners had been directed, before the year 1855, to the commercial value of the dry-bone (smithsonite), which they were then throwing away as useless, it was Percival, the poet and geologist, who first effected a practical utilization of this ore by sending two barrels of it to the works of the New Jersey Zinc Co., at Newark, N. J., where its value was practically demonstrated.*

BLENDE—"BLACK-JACK."

The blende of Wisconsin is very different in its appearance from the ruby-red variety of the Missouri mines. It is, instead, generally of a dark color, and hence appropriately called "black-jack;" but this color is seemingly due not so much to the presence of combined iron as to organic matter. This is partly destroyed by heating, and the blende then becomes lighter in color. The proportion of zinc in the clean blende compares well with that of any other locality, ranging from 60 to 64 per cent. or more. Some of the deposits yield

*Percival, in his first Report, 1855, wrote, p. 97: "The ores of zinc, although very abundant in many instances, particularly in the flat and pitching sheets and in the lower openings, have never yet been turned to any account. There can be no doubt that they must be hereafter sources of profit when we consider the large and increasing demand for zinc, both in its metallic form and as an oxide (zinc-paint)."

a considerable proportion of the light honey-yellow or amber-colored variety, generally known by the miners as "resin-jack." I have not yet seen any colorless and perfectly transparent blende in the Wisconsin ores, or in those of any locality in the Mississippi valley.

The jack, like the carbonate ore or bone, is prepared for market in three principal grades or conditions:

1. The massive, hand-sorted, culled jack, cleaned as far as possible from all rock, pyrite, bone, and lead.
2. The medium-sized fragments or "sieved jack," picked out from the mixed and broken stuff of the mine and cleaned by washing.
3. The jigged ore and "smittems."
4. To the above we may now add the dressed-jack from the roasting process.

The first commands the best price and is most desired by the smelters, though often carrying a considerable amount of pyrite in thin scales, which cannot be removed by the culling-hammer. The second grade contains a still greater admixture of pyrite. If pyrite is abundant in the original mass it cannot be profitably removed by hand, and the mixed ore is laid aside as unmerchantable, though sometimes sales are made to smelters at a greatly reduced price. The same observations apply to the jigged jack. If comparatively free of pyrite, it commands a good price, but it is generally impossible to obtain any large amount not thus contaminated. In the culling and sorting, employment is given to many boys during the summer months, the clean lumps of jack, freshly cleansed from the dirt of the mine by free washing, being picked out by hand at so much per box or per hundredweight.

The chief market for the Wisconsin blende is at the spelter works of Wenona, Peru, and La Salle, Illinois, the route of delivery or transportation being by the Illinois Central railroad branch southwards from Warren.

Occurrence of Barite.

Barite (heavyspar) is an occasional associate of the deposits of blende, and usually occupies a medial position in the veins, being formed upon the horizontal sheets of jack, and generally in heaviest layers upon the lower side of the opening. It is rarely crystalline, but forms in rounded, snow-white mamillary masses, contrasting sharply with the dark-brown or black of the jack. Any galenite present is usually associated with, or planted, in the midst of this barite.

We may easily account for the formation of sheets of barite in the veins upon the hypothesis that carbonate of baryta, a soluble salt flows downwards from the surrounding rocks into the fissures and beds, and there meeting with sulphate of lime in solution, formed by the decomposition of the walls during the deposition of zinc blende, is changed into the insoluble sulphate, calcite being formed at the same time. In fact, we find numerous crystals of calcite planted upon the surfaces of barite.

Barite is objectionable, commercially, in connection with either the blende or galena. It is so heavy that it is separated with difficulty from galenite in the jigs, and it cannot be separated from the jack; consequently, in the treatment of mill-stuff containing heavyspar a mixture of jack, heavyspar, and pyrites is obtained; and although by the new process now employed the pyrite can be removed, the barite remains. Although innocuous metallurgically, its weight and bulk increase the cost of handling, freighting, and smelting, and make the blende-concentrate nearly valueless. In some of the deposits the barite may be nearly all separated by careful hand-culling, and, when clean, can be sold at a price which pays a little more than the cost of breaking and saving it.

Pyrites—Marcasite.

The pyrites, generally known to the miners as "sulphur," is chiefly marcasite. It occurs next to the walls of the crevices, or coating the masses of dolomite, and is tightly attached to them, while the blende is superimposed. As mined, the two minerals are broken and thrown down together, and the coarser parts are then separated by hand. The layers of marcasite vary from one-sixteenth of an inch to several inches in thickness, and when thick enough to detach from the sheets of blende, the marcasite is saved for sale. At the Helena mine large quantities have been saved and sold at $3 per ton. It carries a little iron oxide on the surface, a little adhering rock, some calcite, and a trace of jack. Analysis of the piles in bulk shows 46 per cent. of sulphur. It is a very free-burning pyrite, and does not contain arsenic or antimony.

It is a desirable article for the production of sulphurous acid, and is used also by smelters to add to charges which require more iron sulphide.

In the operation of hand-sorting and culling the blende from the rock and pyrites (much of this work being done with the hammer), considerable quantities of "smalls" or chips are made from which the blende cannot be separated by hand. There are also large deposits of mixed blende and pyrites where the two minerals are so mingled that they cannot be separated by culling. In fact, the deposits of zinc-blende in heavy sheets free of pyrites or sufficiently so to be made available as a commercial product by hand-sorting are rare, and even in such mines there are portions which are avoided or left standing because separation cannot be effected even in a mill. For in milling and concentrating zinc-ores as they come from such deposits, while it is feasible to separate thoroughly any rock or flint, and also to take out the much heavier galena, a concentrate is obtained which carries not only the blende but the pyrites which was present. Such concentrates are not fit to use for the production of spelter and are not marketable. The treatment of such concentrates for the separation of the pyrite and the production of a clean high-grade merchantable zinc-blende is the subject of another paper.—*Trans. Am. Inst. Min. Eng.*

A NEW CYCAD.

By T. H. McBride, Iowa City.

Plate XI.

In 1868, Mr. W. Carruthers described under the generic name *Bennettites* certain fossil cycadaceous plants from the Lower Green Sand of the Isle of Wight.* The most striking and apparent features of the genus Bennettites would seem to be its elliptical outline and the circumstance that the flower buds arise irregularly from the inner bark and among or between the leaf-bases. Certain fossils obtained by the writer, near Minnekahta, in South Dakota, seem not only to belong

* See Trans. Linnæan Society, Vol. 26, p. 675 seq. London, 1868.

to this genus but to illustrate its character unusually well. The specimens described were found (in company with forty or fifty more) weathered out on a hill top. The rocks below and above are sand, and if I may judge by such knowledge as I have at present, the fossils under present discussion are from the Lower Cretaceous or Jura-Trias.

Bennettites dacotensis, n. s. Macbride. Plant for the most part silicified, plainly elliptical in section; the measurements for the specimen before me are: girth three feet six inches; hight thirteen inches, longer diameter fourteen inches, shorter, eleven and one-half. The pith large, simply cellular, punctate where weathered, destitute of fibro-vascular bundles, surrounded by a woody cylinder which is from an inch to one inch and a quarter in thickness. The wood is divided at regular intervals by numerous medullary rays about one-half an inch in width. A thin rind or bark surrounds the woody cylinder and supports the bases of the leaves and leaf structures. Leaves not known; their bases as perceived are fusiform or lozenge-shape in cross-section, one-half inch by one inch in dimensions, and show the remains of numerous equally developed fibro-vascular bundles. Between the leaf-bases are numerous intervals filled up with structures (perhaps paleæ) imperfectly preserved. Where the surface of the fossil is best preserved, the leaf-bases appear to have rotted away to a considerable distance inwardly, and the entire surface is pitted, and presents a clathrate or reticulate appearance. Rising through the outer conglomeration of tissues, leaf-bases and adhering structures, appear numerous buds (fruit-buds?); these are about two inches in diameter and of equal hight, attached to the rind by a short cylindrical stem, and made up, outwardly, at least, of rather slender, scale-like leaves arranged in circular whorls.

In habit the plants were solitary or in groups or clusters of two or three, apparently from the same base, and sometimes reached much greater dimensions than those recorded—being sometimes at least two feet high.

The present species is near *Bennettites gibsonianus* Carr., from which it may be distinguished by greater size and by the fact that in our species the fibro-vascular bundles of the leaf-stems are of uniform size and distribution, and do not form a horse-shoe shape in cross-section as is said to be the case in the English species.

Iowa City, Ia., Sept., 1893.

EXPLANATION OF PLATE XI.

BENNETTITES DACOTENSIS Macbride.

Fig. 1. Lateral view of a large, perfect individual, showing lateral buds and other characteristics. Leaf-bases have rotted out, leaving lozenge-shaped pits.

Fig. 2. Portion of surface of another individual a little less than one-half natural size, showing transverse sections of leaf-bases and distribution of fibro-vascular bundles.

EDITORIAL COMMENT.

THE COLUMBIAN EXPOSITION.

Geological Maps.

The display of geological maps, charts, sections, etc., in the Exposition is large. As in other departments, some countries are fully represented, others are "conspicuous by absence."

The following notes on the geological maps exhibited are merely an attempt to outline some of the chief features of this part of the exhibition. They make no pretense to completeness, partly in consequence of the large number and variety of maps, partly because of the great difficulty of obtaining full information, and largely on account of the way in which the material is scattered over the 500 acres of ground enclosed within the walls. These reasons, and especially the last, made the task of completing an exhaustive list hopeless from the first.

It would be invidious to select any one country or any two or three countries for prominent notice, because conditions, experience and age are factors of immense importance in the problem. No regard therefore must be attached to the order in which these exhibits are here mentioned. This is chiefly dependent on the order in which they were examined.

Japan has an excellent geological display. The survey of the empire is about half finished, on a scale of one-millionth part, and a sketch-map shows by signs the part surveyed, the part mapped, and the part only reconnoitered. The outlying Kurile and Loo Choo islands are included by inlets on the margin, their scale being one-half that of the chief map. These contain only volcanic and Tertiary rocks, but the large insular parts of the empire show Paleozoic, Mesozoic, and Tertiary strata, all inclining to the northwest and southeast from the main axial line. The age of all these deposits is established by a small but excellent set of fossils from each.

This map is based, as stated by the Japan Commissioner, Mr. Kanda, upon a topographical survey made about one hundred years ago by a single individual surveyor named Ino, whose work, though done with rude instruments, was found on examination so closely accurate as to need little revision.

A model of a gold mine, showing the antique method of working employed before the Restoration and the beginning of European influence, is placed in the middle of the Japanese court, and is a striking illustration of the changes that have since been introduced.

The results of the survey are as yet only in part reduced to form and published in Japanese. Some have been already translated into German, and the whole will ultimately appear in these two languages and in English.

Canada makes a very large and fine exhibit of her well-known maps and sections issued under the direction of Dr. Selwyn. Prominent among them is a large map of the whole Dominion from sea to sea, with all the results obtained down to 1892. Accompanying this are a number of detailed maps. The western part of the Dominion, including the Rocky mountains, is as yet only reconnoitered, and a reconnaissance map is shown giving our knowledge to date. It is not necessary to go at length into any minute description of these publications, as they are familiar to all American geologists and full details may be obtained from the office of the Canadian survey at Ottawa. It will be sufficient to add that in so extensive and difficult a country, where the hard rocks are often quite inaccessible, it is not surprising that detailed work is slow. In the Canadian court are many very beautiful specimens of native minerals and illustrations of their application to the arts.

Among the most prominent exhibits in many of the buildings is that of New South Wales. This young but vigorous southern land is, however, the only exhibitor from the Australian colonies. This fact perhaps results from her different fiscal legislation.

Unfortunately the revised geological map of New South Wales had not arrived at the time of our examination, but enough is shown to prove that excellent work is being done in this survey. Fossils from all the formations occurring in the colony are on exhibition to prove the age of the strata. Foremost among these and most interesting to paleontologists in this country are the Carboniferous forms of Mesozoic aspect illustrating the *Glossopteris* flora so long a source of difficulty in correlating these southern strata. A good catalogue of the maps and publications of the survey may be obtained from the Commissioner, Mr. Carne.

Mexico, with a very creditable exhibit along other lines, shows a geological map of that republic, indicating to what point the work of the survey has progressed under Don Antonio del Castillo, the director. Her material is very widely scattered through the buildings. In minerals, as might be expected, she makes a fine display, especially in her so-called onyx and the new pink garnets, or grossularite.

In the various displays from Germany are many excellent maps general and special. It could hardly be otherwise. A large relief map of the Hartzgeberge, by Dr. Krantz of Bonn, sells at the low price of fifty dollars, and one of the classic locality of Coblentz on the Rhine for twenty. It is quite superfluous to praise the execution of these or any other maps issued by the German surveys, as they are conceded generally to have no superiors. Examination of the specimens shown will amply confirm this opinion.

Among the minor exhibits having considerable interest is a model of the island of Trinidad, showing the pitch lake from which the best asphalt for street pavements is obtained. This is one of the most singular deposits known. The lake, which occupies only a small part of the island, has an area of 132 acres, and is said to contain six million tons of the mineral. Its surface is in most places hard enough to bear up men and horses, except in the middle of the day, when it becomes soft sometimes to a depth of several feet. In two spots the pitch is so nearly liquid that to venture upon it is not safe. Photographs show these effects. In one a man is being dragged out by main force, the pitch streaming off him in long clammy lines. In another a workman is shown over shoes in the lake. About forty per cent. of the contents is bitumen, the rest being water and dirt. In the wet season water lies on its surface, and shrubs grow to a hight of six or eight feet. Their roots may be seen in the pitch.

Near this exhibit is an enamel floor-map of the United States, showing the coal-fields. It is, of course, on a small scale and makes no pretense to close accuracy, but it is instructive, especially as on the surrounding shelves are samples of all the coals from the various fields.

France is well represented by the maps and other publications of her geological survey in the Manufactures building, and with Great Britain has, perhaps, one of the finest displays of the kind which the Exposition contains.

Messrs. Howell and Ward have in the gallery of the Mining Building a large exhibit of their well-known models of interesting and instructive parts of the world. Among these are the Yosemite valley, the Colorado cañon, the Eureka district of Nevada, the high plateau of Utah, the Henry mountains, the Leadville region, the Yellowstone park, the Uinta and Wahsatch mountains. In the exhibit of the latter are also to be seen models of the classic region of Auvergne, in France, of Vesuvius, and of Palma (von Buch), of Etna (E. de Beaumont), and of Mt. Blanc, the last of which is worthy of careful study by all who have visited, and all who intend to visit, the Alps, not less than by the orographical geologist.

Among the articles exhibited by the French colonies is a model of New Caledonia, on a scale of one-five-hundred-thousandth, constructed of successive layers of Bristol board and intended to illustrate the mines and mining. As it is not geologically colored, no information regarding the strata can be obtained from it.

In another building (Anthropology) is an actual section of the famous pipestone quarry of southwest Minnesota, containing a layer of the catlinite itself showing a glaciated edge. It well illustrates the position of the mineral as a thin band of red shale in a thick bed of hard quartzite, the Potsdam of the Minnesota Survey.

Spain, in the Mines and Mining building, exhibits a geological map of the peninsula by Dr. M. Fernandez de Castro (1889, Madrid). Portugal is included and brought down to 1891. The map measures ten by eight feet, and shows that all the geological formations are present in that country.

A map of Cuba hangs in the adjoining court.

In the Transportation building the same country shows through its government an excellent and beautiful set of models of various places of interest, chiefly fortresses, such as Carthagena, Bilbao, Jaca, St. Juan de Ulloa, and San Sebastian, illustrating their defensive works and the surrounding country.

A similar model of New York harbor, with a series of accompanying maps, may be seen in the United States Government building.

Arkansas exhibits a large relief map of the state seven feet by eight, constructed by Dr. Branner on a horizontal scale of three miles to an inch, and a vertical scale of 2,000 feet to an inch. The flat eastern part with its swamps is shown bordering the Mississippi river, with only one projecting range, Crowley's ridge. The map brings out well the manner in which streams flowing through highly elevated horizontal strata cut deep and winding gorges, as does the White river, for example. It emphasizes also the difference between the work of such streams and that of the Arkansas, much of whose course lies in the folded strata of the northwest part of the state.

Pennsylvania of course stands among the foremost of the States in her geologico-geographical exhibits. The fine series of relief maps of the Lehigh valley and other regions, most of which are the work of Mr. E. B. Harden, must be seen to be appreciated. The coal pillar illustrating the full thickness of the Mammoth seam forms a very striking picture of the anthracitic wealth of the Keystone state.

Nothing can give so accurate and forcible a view of geography as these relief maps, and when the day comes in which copies of them on a small scale can be made cheaply and supplied to the schools, as is done in several of the countries of

Europe, then we may hope to see geography promoted from a mere unmeaning and idle catalogue of names and boundaries to be a useful branch of study and of scientific training.

Hardly, if at all, second is the great relief map of New York by Ward of Rochester, which leaves little to be desired. To stand and study this is an education in itself. It is as if one were elevated in a balloon and gifted with more than telescopic eyesight. All the great physical features of the Empire state lie spread out before the eye. The two mountain regions of the Adirondacks and the Catskills are prominent; and the gorges of the Hudson, Niagara, and Genesee, and lakes Chautauqua, George, Champlain, and Ontario, the St. Lawrence and Mohawk, Hudson and Genesee rivers, the great trap ridge forming the Palisades, Long Island, with New York harbor, all combine to present a picture which conveys, especially to those unaccustomed to such bird's-eye views, a lesson in geography which is not readily forgotten. The only regret felt on looking on it is that in some way or other its maker did not contrive to indicate by color the geologic system of the strata that make the state, an addition which would have given it in the eyes of the geologist a value as great as that which it now possesses for the geographer.

Close by the map of New York stands another about as large, but not so well executed, and absolutely without name or reference, a fact which reminds one of the chief omission throughout the Exhibition.

Alongside of the two above-mentioned maps hangs the geological map of Kansas, seemingly quite away from its connections.

In the Mines and Mining building the State of Minnesota has a series of 20 maps constructed by the Geological survey, showing all the natural features of its surface, as well as the principal climatic characteristics. Another, also contributed by the state survey, exhibits the aboriginal geography and the French explorations. Specially noteworthy in this exhibit is the series of contoured topographical maps which bring out admirably the outline features of the surface.

Mr. H. C. Frick, of Homestead, has on exhibition a large relief map of the Connellsville coke region with a section. The map is not geologically colored, but is intended merely to illustrate the mode of making coke. In the model the coke-ovens are apparently alight, each having a small gas jet burning over it.

Worthy of especial notice both by the geologist and the well-driller is an admirable section from Olean, N. Y., to Massillon, O., exhibited by the Standard Oil Co., and compiled from the records of numerous wells sunk through the region. Its horizontal scale is three inches to a mile, and its vertical scale is one inch to a hundred feet. Differences of opinion may exist among geologists regarding the details of parts of the correlation of strata in this section, but no one can study it without learning some of the geological lessons which it can teach. The capricious distribution of the oil-sands is a very striking object lesson to the too confident adventurer, and an evident explanation, needing itself no interpretation, of the uncertainty of the results of drilling in unexplored territory. The section also illustrates the well established doctrine of the increasing sandiness of the deposits eastward, indicating that the material was brought in from that direction.

The relief map of New Jersey with a horizontal scale of one inch to the mile possesses a peculiar feature in being constructed on a varying vertical scale. The first 200 feet of elevation are represented by an inch to 400 feet, the next 300 feet by one inch to 600 feet, and all above that line by one inch for every 1,000 feet. The intention obviously is to reduce the objection against too large a vertical scale without at the same time rendering the map so flat as to lack relief. It is a device worth consideration.

In the anthropological department are some maps bearing on the much mooted question of the day and the hour—glacial man. Prof. G. F. Wright, of Oberlin, shows in his exhibit two maps illustrating the glacial phenomena of Ohio, and Mr. Moorehead has a detailed map of Fort Ancient, and of the Hopewell mounds, in which some of his most recent investigations have been carried on, and where much of his exhibited material was found. He has also two models of graves which he opened, in one of which a skeleton still remains.

We can only mention the numerous models of some of the most important and interesting mounds, such as Clark's work on Paint creek, Ross county, Ohio, and the group in Anderson township, Hamilton county, Ohio, and Fort Hill in Highland county, all by Mr. W. H. Gunn, of Cincinnati.

In the Illinois building lies a large relief map of the state, showing many details of the glacial geology. Such a map of a prairie state lacks much of the striking relief of New York but to the student of the Ice age there is much material for observation here. The representation of the leading moraines has been attempted, and the course of some of the larger lobes of the ice-sheet may be readily traced. Inquiry for the geological map of the state elicited the reply that it had been removed from the building to receive some recent revision and alteration.

Numerous other exhibits of similar nature might be enumerated, but the above-mentioned will serve as fair samples of what the geologist will find at the Exposition. To describe or even to enumerate the whole would require a long search and a patient and continued examination, for material more or less directly connected with geology is met with in the most unlikely places, and the visitor will chance upon such objects where he would never expect them. The multiplicity of geological work cannot but strike him, and as the world is not yet half investigated, the geology of the future will be a vast and inexhaustible topic, and its literature simply colossal.

Auxology.

The student of palæontology who aspires to attainment in Messrs. Buckman and Bather's newly denominated departure, *Auxology*, will have to wrestle, for a generation at least, with a bewildering terminology of the stages of growth and decline. Prof. Hyatt, whom palæontologists of the "new school" will always delight to honor, introduced a series of terms for these stages, and though many of them are tongue-twisters and possibly not of the purest Attic in their composition, still we had become measurably familiar with them by their adoption in his own memoirs on the cephalopods and their use in the well known publications of Jackson and Beecher, the former on the pelecypods, the latter on the brachiopods. The English critics of this terminology are not alone acute students of ontogeny and phylogeny, but are purists indeed, and in their paper on "The Terms of Auxology," published first in the *Zoologische Anzeiger* (Nos. 405, 406, 1892) and reprinted in the GEOLOGIST for July, 1893 (pp. 43-49), they have anatomized, or, rather, knifed these partially adopted terms, and, of course, replaced their victims with new creations, more correct in form, undoubtedly more satisfactory to Plato, but, alas! more numerous. Much of Buckman and Bather's work is well done. The terms applicable to the development of the individual (ontogeny) had before been somewhat irregularly applied also to the development of the race (phylogeny). Here two distinct series of terms are made, those for phyletic stages being formed by the simple prefix *phyl-*, to the ontic term for the corresponding stage, and the outcome of this simplicity is such a word as (we tremble at writing it) *phylhypostrophic*. We do not criticise this nomenclature; it is so admirable in many points that we regret it could not have been the first on the field, but looking at the whole matter from the standpoint of the working palæontologist who feels that he can no longer continue to use the customary paraphrases to express these various ontic and phyletic conditions, we must deplore, nay, lament, that a series of terms which have entered into some of the most philosophical literature of recent palæontology, and which have served an excellent purpose in spite of their etiated etymology, must be superseded by others scarcely more euphonious or digestible. There may be some, we do not say that we are of them, who would rather cast purisms to the wind and stick to the earlier terms, than undergo again the mental strain of assimilating such a nomenclature, but as it is evident that the old names must go, the future student who wishes to grasp the work of Hyatt, Jackson and Beecher will need a diagram at his elbow.

But it is in no wise certain that Buckman and Bather's terminology will meet with general adoption. Without Prof. Hyatt's endorsement it certainly will not be extensively employed by American workers, and it would be rather surprising if it fully commended itself to him. So there is a possibility of still another modification, and until this unknown quantity takes on a palpable expression, the old paraphrases must still be employed, or more diagrams will be necessary.

Here is already a faint rumble of the breakers ahead. In a recent interesting account of the development of the shell in the brachiopod, *Zygospira recurvirostra*, we meet with the term *nepiastic*, which appears to be employed for the same ontic growth stage as that to which Hyatt first applied the word *silphologic*, afterward discarding it for *nepionic*, and which Buckman and Bather have called *brephic*. Nepiastic is not defined, but unless our reading is at fault it is here used for the first time, and it is not at all evident why, with already three terms to express the same thing, there is any urgent demand for a fourth. If it has come to stay we hope it may prove better than any of its predecessors, but it seems a timely though trite remark that the last thing out, whether in science, the arts or the world of affairs, is not always the best.

REVIEW OF RECENT GEOLOGICAL LITERATURE.

Eleventh Annual Report of the United States Geological Survey to the Secretary of the Interior, 1889-90. By J. W. Powell, Director. —Part I. Geology. pp. xv, 757, with 66 plates, and 120 figures in the text.—Part II. Irrigation. pp. xiv, 395, with plates 67-96, and figures 121-124. Washington, 1891. This report, which bears an imprint as if published two years ago, comes to us, and to the working geologists and public libraries of the country, more than three years after the end of the fiscal year to which it relates. The administrative reports of the director and the chiefs of divisions of the Survey fill 185 pages, and these are accompanied by two papers or memoirs, the first being entitled, The Pleistocene History of Northeastern Iowa, by W J McGee, and the second, The Natural Gas Field of Indiana, by Arthur John Phinney.

Mr. McGee's memoir, occupying 389 pages, of which the most salient points have been given in the Am. Geologist for last March, at page 178, is superbly illustrated with 60 plates, including five folded maps in the pocket of the volume, and with the entire 120 text figures. It is a work of great value, discussing many phases of the drift from new points of view, and bringing the history of the Ice age vividly and impressively to the imagination of the reader; but perhaps in some places it may be criticised for prolixity and too obvious rhetorical effort. The doctrine of the division of the Ice age by interglacial epochs is very confidently maintained.

Dr. Phinney's work was done under the general supervision of Mr. McGee, who contributes an introductory discussion of 28 pages, beyond which the memoir comprises 126 pages, with 5 plates, treating of the geologic structure of Indiana, the conditions of gas accumulation, gas pressure and its measurement, the gas field, with records of the borings within it and also outside of its area, and the care of gas wells.

The second part and volume of this report presents the work of the U. S. Irrigation Survey, giving details of the hydrography and capabilities for irrigation of a large number of river systems in the great arid region of the western half of our national domain, including portions of the upper Missouri and Yellowstone basins, the South Platte and Arkansas basins in Colorado, the Rio Grande basin in Colorado, New Mexico and Texas, the Gila basin in Arizona, the Truckee and Carson basins of the lake Lahontan district in California and Nevada, and the Snake river basin in Idaho and Oregon.

Mineral Resources of the United States, calendar year 1891. By DAVID T. DAY, chief of the Division of Mining Statistics and Technology, U. S. Geol. Survey. pp. vii, 630. Washington, 1893. Price 50 cents. In the summary given at the beginning of this report, previous to its detailed accounts of all our mining industries, the total value of the year's metallic product of the United States is given as $302,307,922, of which the following are the seven principal products: pig iron, $128,337,985; silver, $75,416,565; gold, $33,175,000; copper, $38,455,300; lead, $17,609,322; zinc, $8,083,700; and quicksilver, $1,036,386. The five other metals mentioned are each produced in comparatively small amounts, namely, aluminum, $100,000; nickel, $71,099; tin, $25,058; antimony, $47,007; and platinum, $500.

The total value of the non-metallic products is stated to be $353,790,-416, of which the twelve leading products are: bituminous coal, $117,-188,400; Pennsylvania anthracite, $73,944,735; building stone, $47,294,-746; petroleum, $32,575,188; lime, $35,000,000; natural gas, $15,500,084. cement, $6,680,951; salt, $4,716,121; phosphate rock, $3,651,150; limestone for iron flux, $2,300,000; mineral waters, $2,996,259; zinc white, $1,600,000.

The production of pig iron was one-fifth less than in 1890; but silver, gold, copper, lead, and zinc, each show some increase. There was also an increase in the production of bituminous and anthracite coal, phosphate rock, and mineral waters; but natural gas decreased from $18,742,725 in 1890.

Second Report of the Bureau of Mines, for 1892, printed by order of the legislative assembly of Ontario. By ARCHIBALD BLUE, Director. pp. v, 264. Toronto, 1893. This is a very full statement of the present condition of all mining interests and mineral resources of the Province of Ontario. Its summary of mineral production gives a total value of $5,374,139, which exceeds that for 1891 by $668,466, the principal increase being in nickel and copper. Separate values of the chief products are as follows: nickel, $590,902; copper, $232,135; quarried stone, $880,000; lime, $350,000; brick, $1,210,600; drain tile, $100,000;

pottery, $80,000; salt $162,700; petroleum, $1,400,435; and natural gas, $160,000.

Geology of Colorado and Western Ore Deposits. By ARTHUR LAKES, Professor of Geology at the State School of Mines, Golden, Colo. pp. 314, 12mo, with 28 plates (maps, sections, and fossils), and several figures in the text. Denver, Colo. The Chain & Hardy Co., 1893. Miners and prospectors will find this a very convenient and useful handbook of geology, chiefly descriptive of metalliferous rock formations and of the modes of occurrence of the ores of the Rocky Mountain or Cordilleran belt. It treats most in detail the mining districts of Colorado, presenting in concise form the results of the U. S. Geological Surveys by Hayden and Emmons; and beyond the limits of this state it comprises brief descriptions of the chief mining districts of each of the states and territories of the Great Basin and Pacific slope of British Columbia, and of Alaska.

Ueber angebliche Spongien aus dem Archaicum. By HERMANN RAUFF. (Neues Jahrbuch für Mineralogie, etc., Jahrg. 1893, ii Bnd., 1tes Heft, pp. 56–67.)

In the Bulletin of the Natural History Society of New Brunswick, No. ix, pp. 42–45, 1890, Mr. G. F. Matthew claims to have discovered sponge remains in the upper Laurentian of New Brunswick at not less than 25,000 feet below the base of the Cambrian. Two different species are indicated occurring at distinct horizons, one termed *Halichondrites graphitiferus*, the other *Cyathospongia* (?) *eozoica*. The former occurs in graphitic slates and consists of masses of long, thin, needle-like "acerate spicules" usually in parallel sets; the latter is to all appearances a hexactinellid from the quartzites beneath the graphitic slates. Rauff holds both species up to doubt. He finds that the "spicules" of *Halichondrites graphitiferus*, as represented by Matthew, cross one another in the mass at a pretty constant angle, from 55–67°, thus forming a series of triangular and equiangular meshes. Attention is called to the similar triangular striation of the surface of plates of graphite, the angle made by the striæ being about 60° or varying therefrom within narrow limits, and it is suggested that the so-called *Halichondrites* may be of similar crystallic origin. The objections raised to the spongioid nature of *Cyathospongia ? eozoica* are less dependable. Matthew described this body as composed of rectangularly intersecting spicular bands of the first order, with interstitial cruciate spicules of small size, and the figure given by him might well serve as a representation of the structure of some of the reticulate sponges from the slates of Little Metis or Holland Patent, though its enlargement (x80) shows that the texture must be much finer than in any of these. Rauff estimates from this enlargement that the actual diameter of the cruciate spicules is only about .025 mm., which, he says, is a "verdächtige Kleinheit," as the smallest spicule given by Schulze, in his Hexactinellida of the Challenger Expedition has nearly twice this size. Some weightier ground than this, or even than the inherent improbability of a silicious sponge being preserved in so ancient and so greatly modified a quartzite, is necessary to impugn Matthews's determination, for it is a fact that minute hypodermal pentacts are known to occur in at least one of the lower Carboniferous (Keokuk group) hexactinellids, having not more than one-half the diameter of those assigned by Matthew to his *C. eozoica*, and associated in the same skeleton with tetracts or pentacts 20,000 times as large.

On the Development of the Shell of Zygospira recurvirostra. By CHARLES SCHUCHERT. (Proc. Biological Society of Washington, vol. viii, pp. 79-82, pl. xi, 1893).

A brief account of the developmental phases of this brachiopod, followed by observations indicating the lines of phyletic departure within the limits of the genus. An interesting structural feature is found in the youngest specimen observed, viz: a concave plate in the apical portion of the pedicle valve, "continuous with the wall of the delthyrium, but apparently not attached to the rostral cavity." The author suggests that this peculiar structure coexisting with a brachiopod possessing at maturity deltidial plates, may indicate that the spondylium-bearing brachiopods, like the genera *Protorthis* and *Clitambonites* or their ancestors, are the parent stock of genera possessing deltidial plates but without the spondylium.

A Classed and Annotated Bibliography of the Palæozoic Crustaceæ 1698-1892; to which is added a Catalogue of North American Species. By ANTHONY W. VOGDES. San Francisco, June, 1893.

This work appears as one of the "Occasional Papers" of the California Academy of Sciences and covers 412 pages. It is the second edition of Capt. Vogdes' Catalogue, first issued as Bulletin No. 63, U. S. Geological Survey, 1890. The new edition is greatly improved in many respects; it is much larger than the first, all supplements and addenda having been incorporated, and it is vastly superior in typography, paper and press work. Indeed, it is in all points a most creditable work, and even though it still shows need of more careful proof-reading, and some important papers are conspicuous by their absence, yet the author is entitled to lay to his soul the flattering unction that he has produced the very best bibliography and catalogue extant of any group of fossils, a credit to his patient industry and to the academy which has supported him. He deserves, and has already received, the appreciative thanks of workers in this department everywhere.

The Geology of Carmelo Bay. ANDREW C. LAWSON and JUAN DE LA C. POSADA. Bulletin of the Department of Geology, Univ. of Cal., vol. i, pp. 1-50, 1893. Berkeley. Price, 25 cents.

In this tract we have an investigation carried on by Dr. Lawson and one of his geological students into the structure of the country around Carmelo bay. Going to the spot to see an intrusion of granite into Mesozoic strata and an exhibition of metamorphic rocks, both of which were reported in the "Geology of California," the author was surprised to find both statements erroneous. Investigation was set on foot with the results detailed in the treatise above named.

The phenocrystalline granite which forms the basal layer on which repose sandstones of Eocene (?) age was heavily eroded before the latter were deposited. Both series have been subjected to deformation which has resulted in folding and crumpling the sandstones and in faulting and shearing the granite. Both were again eroded before the Miocene deposits were laid upon them. To the former the author applies the term "Tejon series" and to the latter that of the "Monterey series." Above both are various beds of conglomerate, sandstone, gravel and clay—the "terrace formation."

A description of the "St. Lucia granite," as the basal mass is called, comes next, accompanied by an account of the dykes of later granite, pegmatite, etc., which traverse it. By evidence obtained elsewhere the date of the former is shown to be pre-Cretaceous.

The evidence of the Eocene date of the lower series in the absence of fossils is indirect, being derived from a correlation with similar rocks in Malpaso cañon. But the Monterey series has yielded characteristic Miocene fossils. Among the deposits of this series is a white shale 1,000 feet in thickness, containing in many places infusorial remains. This bed is believed by the author to be the product of the fine ash of a very acid volcanic eruption.

Then follows a technical description of a new mineral found in the volcanic series for which the name "iddingsite" is proposed. It is said to be characteristic of the series, for which as a whole the term "*Carmeloite*" is devised.

Abundant evidence was found of the former occupation of the shores of Carmelo bay by the sea, up to 800 feet of elevation, in terraces, beaches and deltas, with cliffs showing borings of Pholades. Later elevation is therefore indicated to that amount.

The authors indicate their conclusions thus:—

"The Pliocene corresponds to the period of more or less continuous depression of the coast till the land was at least 800 feet lower than at present and the Quaternary corresponds to the more or less continuous uplift which has affected the coast since the maximum depression was reached."

Regarding the off-shore submarine channels to which attention has lately been drawn, Dr. Lawson says that there is no evidence of elevation since Miocene times above their present altitude. He inclines to regard the submarine valley which heads in Carmelo bay as a continuation of the old cañon of the San José which has all the characters of a fault, while the depression in which lies Monterey bay is, he thinks, a synclinal valley and not a channel of erosion.

The Soda-Rhyolite north of Berkeley. CHARLES PALACHE. Bulletin of the Department of Geology, Univ. of Cal., vol. i, pp. 61–72, 1893. Berkeley. Price, 10 cents.

This tract contains an account of a volcanic sheet about one hundred feet thick which lies near Berkeley, Cal., and is of late Cretaceous or early Tertiary age. It presents three appearances which are described, the porphyritic, spherulitic and glassy facies. Analyses of all are given, which, though showing differences in composition, yet justify the single term applied to the whole intrusion.

Geology of the Eureka District, Nevada, with an atlas. ARNOLD HAGUE. U. S. Geol. Sur. Monograph, xx, Washington, pp. 394, quarto; six petrographic plates.

This is another of those standard publications which have rapidly brought the United States Geological Survey to the front amongst the geological organizations of the world. It is a work which has been prosecuted with that *otium cum dignitate* which should characterize an investigation which had to fear no cessation from lack of time or resources. Begun in the administration of Clarence King, in 1880, it has continued, with various interruptions, to the rendering of the report, June 20, 1891, covering a period of eleven years. Mr. Hague was assisted by Mr. C. D. Walcott and Mr. J. P. Iddings. The former reported the "Paleontology of the Eureka District," in 1884, and it was published as Monograph viii of the U. S. Geol. Survey. Mr. Iddings' report on the volcanic rocks of the district, though now nearly nine years old, is a thorough discussion of those petrographic structures and mineral characters which till then had been but little studied in America. Mr. Hague's contribution, which constitutes the bulk of the text of the volume, is strictly a geological report, presenting in one systematical review the results of the separate special researches, with the field observations, and deducing such general statements as the facts warrant. The atlas consists of thirteen sheets, the topographical portion of which was under the direction of Mr. F. A. Clark. The geological coloring and the structural sections are by the various field-observers. The atlas is dated 1883, but was not issued until final correction and the completion of the text. Some of the summary results of this volume appeared in the "Third Report of the Director," in 1882, accompanied by a geological map similar to sheet iv of the atlas.

A convenient "outline of this volume" prepared by the author precedes the text, and from this the following summary is condensed:

The area reported on is about 20 miles square, embracing mountains that reach the altitude of 9,000 to 10,500, presenting a rough aspect, and rising about 3,000 feet above the adjoining valleys. Paleozoic sedimentary rocks constitute the mountains and the valleys, the latter, however, being more or less covered with Quaternary detritus from the mountains. These indurated rocks embrace but one unconformity from base to summit, so far as recognized, and took their place as a part of a broad continental land mass after the deposition of the upper Coal Measures limestone. Their thickness is 30,000 feet, with Cambrian, Silurian, Devonian and Carboniferous all represented by characteristic faunæ. Various folding and faulting have broken up these strata into great blocks, which constitute the principal mountains.

The Cambrian rocks, 7,700 feet in thickness, are divided into five epochs. The lower, middle and upper Cambrian are all exposed.

Conformable over the Cambrian are the Silurian rocks. In the midst of the Silurian (*i. e.* between the Eureka quartzite and the Lone Mountain limestone) is an unconformity. Both the Trenton and the Niagara formations are included within the Lone Mountain epoch, the latest of the recognized Silurian.

The Devonian follows, with imperceptible gradations from the limestones of the Lone Mountain epoch, and has a total thickness of 8.000 feet, and consists of two epochs, the Nevada limestone and the White Pine shale. The black shale is characterized by a fragmentary upper Devonian flora.

The Carboniferous, with a thickness of 9,300 feet, is made up of rocks of four epochs, fossils occurring in the limestones. Three salient features mark the life of the lower Coal Measures: first, the occurrence near the base of the limestone of a fresh water fauna; second, the varied development of the lamellibranchiates, a class which has heretofore been but sparingly represented in the collections of fossils from the Cordillera; third, the mingling near the base of the horizon, of Devonian, lower Carboniferous and Coal Measure species in gray limestone directly overlying beds characterized by a purely Coal Measures fauna. Coal seams occur in the first range east of the Eureka mountains.

Each orographic block is described in detail, beginning with those composed of the oldest rocks, and the relations of the different mountain masses to each other are pointed out.

In the general discussion of the Paleozoic rocks the author shows that from a pre-Cambrian continent in Nevada a vast amount of detritus was furnished to a sea which lay toward the east. The Eureka region lay not far from the eastern border of this land mass, as indicated by the abundance of coarse mechanical sediments in the paleozoic strata. There were alternating elevations and depressions. The final break-up was followed or accompanied by igneous ejections, the relations of which with the different orographic blocks are brought out by a cross-section.

Pre-Tertiary igneous rocks play but a subordinate part. Some were found to cut Silurian strata, but their age cannot be fixed any more closely. They appear principally as dikes.

The Eureka district affords no direct proof of the age or duration of volcanic energy, although evidence based upon observations elsewhere in the Great Basin points to the conclusion that the lavas belong to the Tertiary era, and probably the greater part of them to the Pliocene epoch. They broke out in four ways: first, through profound fissures along meridional lines of displacement; second, following lines of orographic fracture, they border and encircle large uplifted masses of sedimentary strata; third, they occur as dikes penetrating the sedimentary rocks; fourth, they occur in one or two relatively large bodies, notably Richmond mountain and Pinto peak, along lines of displacement. The sequence of lavas was: hornblende-andesyte, hornblende-mica-andesyte, dacyte, rhyolyte, pyroxene andesyte, and basalt. The lavas display a great variety of volcanic products in both chemical and mineral composition. They are all derived from a common source, a homogeneous molten mass. They are due to a process of differentiation by molecular change within the molten mass under varying conditions of pressure and temperature. Starting with a magma of intermediate composition, the extreme products of such a differentiation are rhyolyte and basalt.

The ores of the district are in rocks of the Cambrian, Silurian and Devonian periods, extending through 17,000 feet of strata, the most productive being found in the Cambrian, this not because of their geologic age, or their chemical constitution, but rather because of greater proximity to favorable structural conditions. The ores are later than the rhyolytes and consequently are of Pliocene or post-Pliocene age. They originated from below, and were accumulated as sulphides. They were subsequently oxidized by atmospheric agents, mainly surface waters percolating through the rocks.

Systematic lists of fossils are given by Mr. Walcott in an appendix.

Microscopical petrography is discussed by Mr. Iddings in another appendix, illustrated by several plates.

The Geology and Paleontology of Queensland and New Guinea. Robt. L. Jack and Robert Etheridge, Jr. 68 plates and a geological map of Queensland, in six sheets. Two volumes, text and plates, 1892. Brisbane and London. (Dulau & Co.)

While the collection of the material and the stratigraphical studies in the field have been done mainly by Mr. Jack, the purely paleontological work has been done more recently by Mr. Etheridge. By their joint labors a very valuable publication has resulted. The aim is to collect into a compact, systematic form all that is known both of the stratigraphy and of the paleontology of Queensland. The map which accompanies the work will prove a very great addition to the geological literature of Australia, while the fine plates of fossils will fix, forever, the paleontological values of the data on which nearly all the conclusions of the authors are based.

There are no recognized fossiliferous terranes older than Devonian, although there is a large series of metamorphic slates and schists, as well as of granites and gneisses, estimated at over five miles in thickness, whose age is undetermined. The suggestion has been made that these embrace some of the Cambrian and Silurian, but no fossils have been discovered to reveal their age; Mr. Jack is inclined to the opinion that the greater portion of them will prove to be of Permo-Carboniferous and Devonian. Yet some of them are overlain by Devonian rocks containing characteristic fossils (p. 23), and in the map attached to the report the metamorphic rocks are classed provisionally as Lower Silurian.

The fossils named are chiefly those that have before been described in papers published in various places by Owen, Etheridge and Carruthers, Woods, Feistmantel, Nicholson and Etheridge (fil.?), McCoy, Sowerby, Dana and others. To these have been added, however, numerous new species. The original descriptions are quoted, and each chapter is preceded by a general account of the geology, economical products and the distribution of the rocks in which the fossils are found. Thus the work constitutes a manual of the geology of Queensland. The fossils named are distributed amongst the Devonian, Permo-Carboniferous, Trias-Jura, Lower Cretaceous, Upper Cretaceous, and Post-Tertiary. The work concludes with a chapter on the petrographical characters of some of the crystalline rocks, by A. W. Clarke, accompanied by eight colored plates of microscopical characters.

"*Geological Survey of Georgia. The paleozoic group. The Geology of ten counties in northwestern Georgia. Resources.*" J. W. SPENCER, State Geologist. Octavo, pp. 406; plates and geological map. Atlanta, 1893.

This is almost the sole official result* of another spasmodic effort on the part of the State of Georgia to execute a geological survey of her domain. While one of the earliest of the States of the union to engage in an official investigation of her geology (by John Ruggles Cotting, in 1836), Georgia has been unfortunate or misguided in her efforts, and her results, which ought to have been as voluminous and important as those of any State, have been quite meagre and unimportant.

Dr. Spencer was appointed state geologist in January, 1889. Four and a half years have been spent. Dr. Spencer has had one or more "assistants." This report, however, is entirely from the pen of Dr. Spencer, and while it shows numerous signs of haste both in composition and in proof-reading, and presents therefore, in some respects, a rather slip-shod aspect, it is an important and valuable report. Indeed, it is by far the most important contribution ever made to the geology of that state. What it may lack in completeness is not due to inefficiency on the part of its author, but rather to the highly unfavorable and unfriendly conditions by which he has been surrounded. The report itself exhibits a masterly grasp of the geological problems of northwestern Georgia, and is specially full and praiseworthy in the chapters relating to the economic resources.

After a brief synoptical statement of geologic agencies, processes, and phenomena, as illustrated more particularly in northwestern Georgia, the geological groups of the region are treated serially. The report does not embrace the Mesozoic or Tertiary rocks of the state, but treats of the Cambrian, Silurian, Devonian and Carboniferous systems, and of these strata it gives a very full and lucid exposition. Then follows the local geology of ten counties.

The economic features are not only represented on the accompanying map, but are discussed seriatim, viz: Iron ores and their modes of occurrence; Local distribution of brown ores; The composition of the brown ores; Red iron, or "fossil" ore; Local distribution of fossil ore; Composi-

*A short "First Report of Progress" was issued in 1891.

tion of fossil ore; The iron furnaces; Manganese; Local distribution of manganese ores in the Knox series; Origin of Manganese and iron ores; Aluminum ores; Beauxite; Aluminum, its sources and uses (by R. L. Packard); Coal; Limestone, limerocks, cement rocks; Sandstones; Slates; Clays and brick pavements; Waterpowers and timbers; The location of roads and their relationship to the physical and geological features; Good roads *versus* bad roads; Formation and characteristics of soil of the paleozoic belt of Georgia; Geological and chemical relationship of the soils of the paleozoic formations; Geological relationship of the soils of the Agricultural Experiment Station of Georgia, and of the College Farm.

The volume closes with "acknowledgements and progress of the survey," embracing the law of the survey, approved November 12, 1889. The "table of contents" is immediately before the index, where it will rarely be seen for the uses for which such a table is intended.

Throughout the progress of this work the chief has been handicapped by the appointment and bare-faced maintenance on the survey of *political* assistants, whose work he would not accept, among which was the farcical discovery of worthless diamond mines. Furthermore, the survey has been attacked by interested but unscrupulous gold miners, who, without his indorsement, could not put their lands upon the market. These found no sanction with the state geologist. In short, according to the statements of the Georgia public press, the governing board was the most incompetent and worst that any survey has ever known. We congratulate the author of this report on accomplishing what he did, and on his manful resistance of the political machinations that surrounded him up to the moment of the completion of the volume.

Ore Deposits of the United States. By JAMES F. KEMP, Professor of Geology in the School of Mines, Columbia College. 8vo, pp. xvi., 302, with 60 illustrations; Scientific Publishing company, New York, 1893. Price $4.00.

This work represents principally the material which Prof. Kemp collected and used in his class lectures at Cornell University and Columbia College. The subject is divided into two parts. The first is a general discussion of the geology and structural relations of ore deposits in general. Their genesis is discussed and the more recent views of prominent investigators are given. The three principal divisions of Prof. Kemp's scheme for the classification of ore deposits are: I. Of igneous origin; II. Deposited from solution; III. Deposited from suspension. The instances mentioned of the first class are wholly iron ores, and all those in the third class are iron ores except gold placers. Under the second class, therefore, are included all other varieties of ore deposits, of whatever mineralogical or structural peculiarities.

The second part is devoted to a systematic description of the mineral deposits of the United States, with a brief notice of the geological age and manner of occurrence of the more important deposits of each variety of ore, the extent of its development, and the value of its product. This portion of the book is in the main a compilation and synopsis of the scattered memoirs and articles which have appeared in the various scientific journals, and in the publications of geological surveys and engineering societies. The literature of our mineral resources is so widely scattered as to be inaccessible to any but a student who has abundance of time and a library specially devoted to such subjects, at his disposal. Herein lies one great value of a work of this sort. It brings together the reliable accounts from all sources, and presents them in a condensed and systematic treatise. It is a task requiring mature experience, technical as well as practical knowledge, and fine discrimination; and the labor involved is immense. That this work has been faithfully done by Prof. Kemp is attested by the unusually full and accurate bibliographical notes, which to the student are invaluable, and by a study of the text.

We cannot help wishing that our author had allowed himself more latitude. His accounts are rather brief. The ore deposits of this vast country cannot be described in 200 pages. Twice that space could have been devoted to their description at no expense either of lucidity or interest, and the usefulness of the work thereby enhanced. In some instances the statistical and historical portions are not up to date. Statements of the total production of ore from a district in which the output of the last two years is omitted are not complete nor satisfactory, particularly in regions where there has been great development during those two years. There would appear to be some reason for these omissions in the delay which attends the publication of the reports by the United States Geological Survey on the Mineral Resources of the United States, were it not for the fact that quite accurate and full statistics are given in such works as "The Mineral Industry," and in the various trade journals soon after the close of each calendar year.

The publishers have done their part well. The illustrations are clear and type good. It may, however, be considered questionable whether it is entirely fair to the purchaser or good taste in the publisher to insert 20 pages of advertisements in any standard publication. It is a damage to the book and to the library that contains it, and smacks of cheap methods and trade trickery.

These defects, if such they be, are but minor points in a work which marks an epoch in this age of marvelous progress in all that pertains to industrial development. We have long felt the need of such a volume as this, and are sure it will find an honored place in many a library. Appreciating the wide range of the subjects embraced and the impossibility of any individual acquiring a personal knowledge of it all, we feel that Prof. Kemp has rendered to economic geology and to mine owners and operators a service which places him in the front rank with such authorities as Von Cotta, Whitney and Phillips. H. V. W.

RECENT PUBLICATIONS.

I. Government and State Reports.

Geol. Survey of N. J. From the Annual Report of the State Geologist for 1892. Surface Geology. Report of Progress, R. D. Salisbury.

Geol. Survey of Alabama. Report on the Geological Structure of Murphree's Valley and its Minerals and other Materials of Economic Value. A. M. Gibson, Asst. Geologist.

U. S. Geol. Survey, 11th Annual Report. Part I contains: The Pleistocene History of Northeastern Iowa, W J McGee; The Natural Gas Field of Indiana, A. J. Phinney.

Part II contains: Report on Irrigation, Major J. W. Powell.

Geol. Sur. of La. A preliminary Report upon the Hills of Louisiana, South of the Vicksburg, Shreveport and Pacific Railroad, to Alexandria, La., Otto Lerch. Part II, 1893.

II. Proceedings of Scientific Societies.

Proc. and Trans. of the Nova Scotian Institute of Science, Vol. I, Pt. 2, contains: Notes on concretionary structure in various rock formations in Canada, T. C. Weston; Evidence of the post-glacial extension of the southern coast of Nova Scotia, W. H. Prest; The Geology of Cape Breton—the Lower Silurian, E. Gilpin; Catalogue of Silurian Fossils from Arisaig, Nova Scotia, H. Piers.

Trans. of the N. Y. Acad. of Sciences, Vol. XII, 1892-1893, contains: On Recently Discovered Deposits of Diatomaceous Earth in the Adirondacks, Chas. F. Cox; Additions to the Palæobotany of the Cretaceous Formation on Staten Island, A. Hollick; Plant Distribution as a factor in the Interpretation of Geological Phenomena, with special reference to Long Island and Vicinity, A. Hollick; Preliminary Contribution to our knowledge of the Cretaceous Formation on Long Island and Eastward, A. Hollick; On an Occurrence of Gabbro (Norite) near Van Artsdalen's Quarry, Bucks Co., Pa., J. F. Kemp; On Phosphate Nodules from the Cambrian of Southern New Brunswick, W. D. Matthew; On Antennæ and other Appendages of *Triarthrus Beckii*, W. D. Matthew; Rare Faces on Pyrite Crystals, from the Kingsbridge Ship Canal, A. J. Moses; Notes on the Clays of New York State and their economic Value, H. Ries; A Geological Reconnaissance in the Vicinity of Gouverneur, N. Y., C. H. Smyth, Jr.; Petrography of the Gneisses of the Town of Gouverneur, N. Y., C. H. Smyth, Jr.

CORRESPONDENCE.

The Reproduction of Arms in Crinoids. In the cabinet of Dr. Welch at Wilmington, Ohio, the son of Dr. L. B. Welch, who furnished so many specimens to U. P. James, of Cincinnati, and other paleontologists, there is a small crinoid considered by him to be *Dendrocrinus casii* Meek. It is interesting, however, as being one of two specimens of this species found by the elder Dr. Welch, illustrating the power of crinoids to reproduce their arms. The figure drawn from the original

fragmentary specimen is sufficiently explanatory. The power of starfish to reproduce their arms is often seen on the living specimens of the seashore. But few persons have access to living crinoids, and their studies in this direction must be made upon fossil forms as in the present case. AUG. F. FOERSTE.

PERSONAL AND SCIENTIFIC NEWS.

THE WORLD'S CONGRESS ON GEOLOGY, an auxiliary of the Columbian Exposition, was held in Chicago during the week August 21 to 26. Its sessions occupied the forenoons, leaving the afternoons for attending the World's Fair. The program for the first three days and portions of the later days consisted of the following papers by women who are teachers and special students of geology:

Methods of teaching Geology. Miss MARY HOLMES, Rockford, Ill.
Physical Geology. Miss MARY K. ANDREWS, Belfast, Ireland.
Chemical Geology. Miss LOUISE FOSTER, Boston, Mass.
Granites of Massachusetts and their Origin. Mrs. ELLA F. BOYD, Hyde Park, Mass.
Artistic Geology. Mrs. S. MAXON-COBB, Boulder, Colo.
The Geology of Ogle County. Mrs. C. M. WINSTON, Chicago.
The Fossils of the Upper Silurian. Mrs. ADA D. DAVIDSON, Oberlin, Ohio.
Crinoidea and Blastoidea of the Kinderhook group as found in the quarries near Marshalltown, Iowa. Dr. JENNIE MCGOWEN, Davenport, Iowa.
The Evolution of the Brachiopoda. Miss AGNES CRANE, Brighton, England.
The Mastodon in northern Ohio, postglacial or preglacial. Miss ELLEN SMITH, Paynesville, Ohio.
Paleontology. Miss JANE DONALD, Carlisle, England.
Glacial Markings. Miss THOMSON, Newcastle, England.

General sessions of the Congress were held from 10 to 1 o'clock on the last three days of the week. On Thursday Dr. A. R. C. Selwyn presided, and after the address of welcome by Hon. Charles C. Bonney, President of the World's Congress Auxiliary, eight papers were presented, as follows:

The Geology of Brazil. Dr. O. A. DERBY, Director of the Geological Survey of Sao Paulo. (Absent; read by title.)
The General Geology of Venezuela. Dr. ADOLPH ERNST, Special Delegate from Venezuela to the Columbian Exposition. (Absent; read by title.)
Pre-Cambrian Rocks of Wales. Dr. HENRY HICKS, London, England. (Absent; read by Prof. C. R. Van Hise.)
The Classification of the Rock Formations of Canada, with special reference to the Paleozoic Era. HENRY M. AMI, Geological Survey of Canada.
The Cordilleran Mesozoic Revolution. Dr. A. C. LAWSON, University of California. (Absent; read by Prof. R. D. Salisbury.)
The Oil Shales of the Scottish Carboniferous System. HENRY M. CADELL, late of the Geological Survey, Scotland. (Absent; read by Prof. J. A. Holmes.)

The Pre-Paleozoic Floor in the Northwestern States. Prof. C. W. HALL, University of Minnesota. (Absent; read by title.)

Distribution of Pre-Cambrian Volcanic Rocks along the Eastern Border of the United States and Canada. Prof. GEORGE H. WILLIAMS, Johns Hopkins University.

After the reading of these papers they were briefly discussed by Mr. C. D. WALCOTT, Prof. H. S. WILLIAMS, Dr. SELWYN, Mr. AMI, and others.

A special discussion, by Profs. JOSEPH LE CONTE, H. S. WILLIAMS, and others, was then taken up, on the question: Are there any Natural Geological Divisions of World-wide Extent? Professor LE CONTE spoke affirmatively, citing as one of these divisions the Quaternary or Psychozoic era. This has been characterized by ice-sheets in northern and southern temperate latitudes; by the appearance of man, whence the era receives its name referring to its place in the ascending scale of life; and by great epeirogenic movements, as the uplift of the Sierra Nevada probably 10,000 feet above its former hight, and the overthrusting and upheaval of the St. Elias range, besides probably equally grand changes in portions of the Alp-Himalayan mountain belt. The world-wide, or certainly very extensive, epeirogenic and climatic disturbances of this era, the latter probably resulting from the former, and great changes of the mammalian faunas, especially the advent of man, mark this as a distinct and world-wide geologic time division. In earlier times, the next preceding similarly important and general faunal changes, likewise attended and doubtless chiefly caused by great earth movements of continent and mountain building, were at the end of the Cretaceous period, and far earlier at the close of the Carboniferous and Permian ages. By these three stages of exceptionally rapid and general extinction of old and evolution of new species, the history of life on the earth is naturally divided into the Paleozoic, Mesozoic, Cenozoic, and Psychozoic eras.

On Friday Prof. Joseph Le Conte and Mr. Hjalmar Lundbohm presided, and the program comprised the following eleven papers:

Huronian versus Algonkian. Dr. A. R. C. SELWYN, Geological Survey of Canada.

On the Migration of Material during the Metamorphism of Rock Masses. ALFRED HARKER, St. John's College, Cambridge, England. (Absent; read by Mr. Arthur Winslow.)

Wave-like Progress of an Epeirogenic Uplift. WARREN UPHAM, Geological Survey of Minnesota.

Eruptive Phenomena of Brazil. Dr. O. A. DERBY, Geological Survey of Sao Paulo. (Absent; read by title.)

Zur Nereiten Frage. Dr. H. B. GEINITZ, Dresden. (Absent; read by title.)

Genetic Classification of Geology. W J MCGEE, Bureau of Ethnology.

Precious Stones and their Geological Occurrence. Dr. GEO. F. KUNZ. (Absent; read by title.)

The Extent and Lapse of Time Represented by Unconformities. Prof. C. R. Van Hise, U. S. Geological Survey.

The Phylogeny of Plants. Prof. Lester F. Ward, U. S. Geological Survey. (Absent; read by title.)

The Phylogeny of the Classes of Vertebrates. Dr. O. Jaekel, Berlin, Germany. (Absent; read by title.)

Restoration of Clidastes (illustrated). Prof. S. W. Williston, University of Kansas.

In the discussion following these papers, Prof. Van Hise replied to Dr. Selwyn that the term Algonkian is more comprehensive than Huronian. Above the Huronian system it includes the Keweenawan of the Lake Superior region. Its time extent probably surpasses the Cambrian, and is comparable to the whole of the Paleozoic. The grand time divisions as eras, according to the terminology used by the United States Geological Survey, are the Archean, the Proterozoic (receiving the Huronian, Keweenawan, and other Algonkian series which may hereafter be discriminated), the Paleozoic, Mesozic, and Cenozoic.

The question proposed for special discussion, terminating this session, was: What are the Principles and Criteria to be observed in the restoration of Ancient Geographic Outlines? Mr. W J McGee displayed maps of the Lafayette, Columbian, and Champlain submergences of the coastal border through the Eastern, Atlantic, and Gulf states, and reviewed the principles by which he has restored its Neocene and Pleistocene geography.

Mr. C. D. Walcott spoke of his studies of the Cambrian outlines of North America, from which he thinks the continent to have been chiefly permanent, though undergoing many oscillations and minor changes, from that very early time.

Prof. H. S. Williams suggested that small land uplifts in areas of narrow and shallow seas may change oceanic currents and thus produce great changes of the marine faunas.

The venerable Prof. James Hall, coming in at this time, was warmly welcomed and spoke briefly of his work for geology, which began sixty years ago. Fifty-three years ago he attended the first meeting of the Society of American Naturalists and Geologists, at which twenty were present. That society after about ten years became the American Association for the Advancement of Science.

Prof. T. C. Chamberlin thinks that during the Lafayette epoch the sea extended up the Mississippi embayment to Cairo. The deposition of the Loess along the Mississippi valley was dependent partly on lacustrine conditions, and partly on broad river floods; but later, when the moraines were formed, the land stood at its present elevation or higher. Two Quaternary epeirogenic uplifts of moderate vertical amount are recognized in this central part of the continent, one before and the other after the depression which is recorded by the loess.

Prof. J. W. SPENCER does not accept the doctrine of the general permanence of the continents, nor that the earth's contraction is the cause of its epeirogenic movements. The late Tertiary or Quaternary deep subsidence of the West Indies shown by submarine valleys, and great uplifts elsewhere during the Pleistocene period, as learned by Russell for the St. Elias range, must be taken into account in the restorations of former coast lines.

The presiding officers for the Saturday session, major J. W. Powell and Dr. O. A. Derby, being absent, their places were occupied by Prof. Dr. Groth, of Munich, and Prof. James Hall. This session was devoted to papers on the glacial drift and history of the Ice age, of which a report is separately presented in the preceding pages.

At its close the congress voted its thanks to Dr. Josua Lindahl, Profs. Chamberlin and Salisbury, Mrs. Louise F. Lowery, and other members of the local committees whose efficient work led to this important gathering of geologists and geological papers.

MISSOURI NOW FURNISHES TWO-THIRDS OF THE ZINC MINED IN THE United States, and Jasper county supplies most of it. Missouri is also second in the production of lead. Lead and zinc occur in quantity in one-fourth of the state. Lead and zinc are now mined in about 21 counties, and have been mined in 31, and been found in 40 counties, and the production of Jasper county alone reaches over $75,000 a week. Iron has been mined in 14 counties, and occurs quite abundantly in 26 counties. Coal is or has been mined in 47 counties of the state, and may be found under an area of 23,100 square miles. This fact is ascertained by geological examinations. Over 50 counties contain valuable ore deposits or else good quarries of building stone.

Over one-third of the state owes its prosperity to mining operations. The first two State Geological Surveys defined the boundary and area of the coal fields. A preliminary report of Bates county was published in 1874. It was republished and widely circulated; the result was the building of railroads and development of coal mines, and the growth of the mining town of Rich Hill. Black slate generally overlies coal beds, but there are also black slates of older age. Previous to the establishment of the Ohio Geological Survey, enough money had been spent in profitless searching for coal on those black slates to pay for the Geological Survey. So it has been in New York and elsewhere—and in Missouri, I have found where such slates had been shafted through in searching for coal to no profit. G. C. BROADHEAD.

THE

AMERICAN GEOLOGIST

VOL. XII. NOVEMBER, 1893. No. 5.

[PALEONTOLOGICAL NOTES FROM BUCHTEL COLLEGE.—No. 5.]

ON THREE NEW SPECIES OF DINICHTHYS.

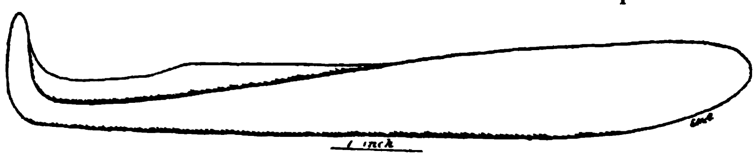
By E. W. CLAYPOLE, Akron, O.

Among the material which has recently come to hand we have the means of defining three new species of *Dinichthys* by parts of their dentition. It seems to the writer on the whole wiser to follow this plan than to risk the multiplication of names and perhaps synonyms by using other parts of the fishes as means of defining species, both because these other parts are less characteristic and because they are also less frequently found.

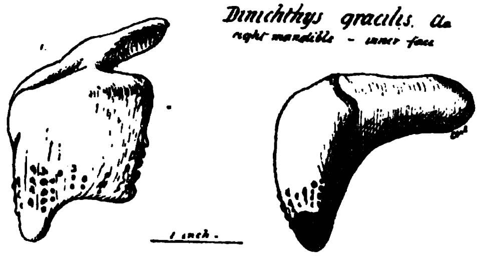
Of the species of *Dinichthys* thus far discovered the dentition of the greater number is more or less known, some of the teeth having been described in at least eleven of the fourteen species hitherto named. It may occasionally be possible by a careful employment of the process of exclusion to determine that a new form is non-descript, but it is safer to characterize by the dentition in our present state of ignorance regarding the structure of the whole of these great placoderms.

In accordance with this plan, therefore, I here define three species of *Dinichthys* from some parts of the organs of the mouth.

The first, of which figures are given herewith (*D. lincolni*) is based upon a premaxillary of moderate size, measuring about one inch and a half in a vertical and one inch in a horizontal direction. The angle made by the two limbs, so to speak, of the tooth is about 90°. The usual blunt cusp extends about half way along the vertical part of the tooth, and at the side of this is a plate or flange, as in other species, nearly an inch wide, as shown in the figure. The cusp projects about half an inch beyond the flange. So far there is little that is remarkable. But the surface of this premaxil-



Dinichthys gracilis. a.
right mandible - inner face



front *inner face*

Dinichthys Lincolni
right premaxillary

lary is ornamented in a fashion singular for a tooth. These organs are usually quite smooth, for securing better penetration, but this one is dotted over, as may be seen from the figure, with tubercles of various size and arrangement. At one side five or six of them project from the vertical edge, almost like small teeth. Some of those in the middle of the row have been broken off, so that it is not possible to determine their original length, but the perfect ones are at least one eighth of an inch high. On the front face of the tooth are nine or ten vertical rows of similar but lower tubercles, with from three to six in a row and less prominent than those on the edge. On the other (outer ?) edge are about six more. Two or three are also scattered on the back of the flange above mentioned, so that they are to be found more or less over the whole exposed surface of the tooth.

The root or inserted part presents no feature worthy of special notice, but closely resembles that of the other species of Dinichthys.

The tuberculated surface of this tooth is its main feature, so far as its definition is concerned. No other Dinichthys is known in which such a character occurs. At the same time there may be noted a certain resemblance between it and the premaxillary of *D. hertzeri*, of the Huron shale, in that the latter possesses a row of denticles on its edge analogous to some of the tubercles of the present species. As the two must be considered almost contemporaneous, this may be an indication of relationship.

The super-scapula and the dorso-median of *D. tuberculatus* from Warren, Pa., also show a similar tuberculated ornamentation, but nothing more is known of that species. It is, however, from the Chemung, whereas the form here described was found in the Marcellus shale.

I propose to put upon this species the name of its discoverer, Dr. D. F. Lincoln, of Geneva, N. Y., and to call it *Dinichthys lincolni.*

I am indebted to Dr. Lincoln for calling my attention to the fossil, and to Prof. J. M. Clarke, of Albany, for the loan of the specimen from the State collection and permission to describe it. I am also indebted to the latter gentleman for the opportunity of adding to this article the following extract from what was, in all probability, the last, or almost the last, letter on his favorite subject that was penned by the late Dr. Newberry, through another hand, after he had been struck down by the attack which caused his death some months afterwards:

Prof. J. M. Clarke.

MY DEAR SIR: I received the fossil from the Marcellus shale which you sent me, in due time, but just about then I was arrested in mid-career by a partial paralysis of my right side. I have been slowly recovering since, and, should no accident occur, shall be able to resume my duties and studies within a few months.

I have delayed writing you about the fossil until I should return to New York and look over some fossils from the Marcellus which I have there. I am about starting, however, on a health-trip to the South and shall not be able to do that before I go. I therefore return the specimen with the following notes:

It appears to be the premaxillary of a species of *Dinichthys* or of an allied genus which is characterized by a very coarse and smooth tuberculation of its external bone surface. I have some bones with the same ornamentation from the Marcellus at Schoharie, but they are too imperfect for description.

The ornamentation is most like that of *Aspidichthys* (Pal. of Ohio and Monograph) and your specimen and those I have from Schoharie may represent a species of that genus of which we know very little.

"The specimen was found in the Marcellus shale at the foot of Slate Rock fall, near Geneva, Ontario Co., N. Y., 25 feet below the basal limestone of the Hamilton group, in October, 1890." DR. LINCOLN.

Another specimen recently found by Dr. Clark of Berea is of so aberrant a form from that of the other dinichthyids that I was at first inclined to doubt its generic alliance. But as it is of the same type, and only differs in such modifications as allow the recognition of every part, I have deemed it wiser to put it into the same genus reserving the possibility of future change when other parts of the fish shall become known.

Fortunately the specimen was extracted from the matrix in an absolutely perfect condition, so that no difficulty is met with in recognizing every part. It is remarkable in the first place for its uncommon size, measuring fourteen inches in length, and secondly for its attenuated form, which is in striking contrast with the ordinary massive premaxillary of *Dinichthys*. The terminal cusp is four inches long and about one inch across at its middle, smooth and tapering. The flange alluded to in the description of *D. lincolni* widens the tooth to two inches. No tubercles or other ornaments mark its surface, which is perfectly smooth and polished. The lower (upper or inserted) part of the tooth spreads out into a flat base, roughened as usual for insertion into the bone or cartillage of the skull, differing in this part very little from the ordinary structure of the teeth of the genus.

A side view, as given in plate XII, shows that the tooth does not form at its middle a right angle but curves regularly from base to tip, the extreme ends being at an angle of about 120° with each other.

It is not always wise to infer the size of an animal from a single organ, but it is not possible to avoid the impression that we have here an unmistakable indication of a fish, whether truly a Dinichthys or not, which must have rivalled all but the very largest known species of its genus. It may have been more slender and consequently like its tooth, less massive, but a head capable of carrying and using so formidable a weapon must have belonged to a fish porportionately large and powerful.

The essential characters of this species are its great size, its slight curvature and the narrowness of the flange.

In honor of its discoverer I propose to name it from him *Dinichthys clarki*. It comes from the Cleveland shale near Berea, O., and is in the collection of the finder.

A third species of the genus recently found by the same collector is in remarkable contrast to the massive form and proportion which the earlier discoveries led us to assign to Dinichthys. The best specimen yet known shows not only the mandible but several of the bones of the head, some of which are recognizable in their crushed condition, but others are at present undescribed. Sufficient data, however, are at hand for the characterization of the species, as in the other cases, by the mandible which is exceedingly slender. A complete specimen measures about ten inches in length by an inch in breadth (see fig.). It is straight and thin, turned up sharply in front as shown in the figure to form the mandibular tooth which stands almost at right angles to the axial line of the mandible and is bluntly pointed. Behind this is the usual space, and then the bone rises into a trenchant blade as in *D. terrelli*, meeting the corresponding sheartooth of the upper jaw which, though broken and displaced, is yet distinctly visible in the suborbital bone. It therefore belongs to the group of which the species quoted above is the type, rather than to that represented by the older *D. hertzeri*.

The essential characters of the new species here defined are the extreme slenderness and straightness of its mandible, a feature in which it differs from all others already defined and which leads me to confer upon it the name *Dinichthys gracilis*.

It comes from the Cleveland shale, near Berea, O., and was found by Dr. Clark, in whose collection it remains.

AN ATTEMPT TO ESTIMATE THE THICKNESS OF THE ICE-BLOCKS WHICH GAVE RISE TO LAKELETS AND KETTLE-HOLES.

By J. B. Woodworth, Cambridge, Mass.

Several writers have ascribed the origin of kettle-holes in moraines, kames and sand-plains to the melting out of masses of ice, the remnants and outliers of the vanishing ice-sheet. The same agency has been appealed to in the case of the numerous lakelets and ponds, with steep sides, which interrupt the surface of glacial sand-plains, as in the district of southern New England. This explanation is satisfactory for all the examples which have been studied, and it now seems desirable to go a step further and to inquire into the dimensions of these outliers of the ice.

The length and breadth of the detached ice-masses are approximately indicated by the corresponding dimensions of the existing depressions. The level of the bottom of the ice-block, below the surface of the completed deposit about it, is equal to the depth of the depression plus the depth of material coming to rest upon the bottom on the melting of the ice, plus that which has been washed or blown in during the post-glacial epoch.

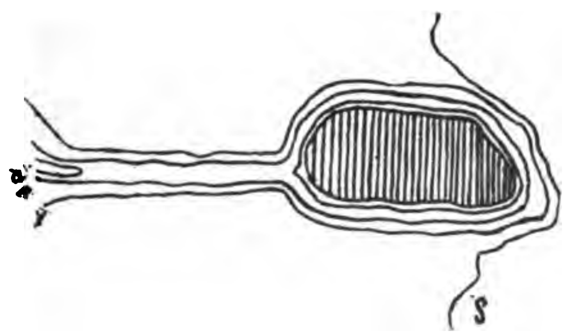
The question is whether the plain or other glacial deposit originally extended over the mass of ice, as some authors have implied, thus burying the ice, or whether the outlier still rose above the deposit when deposition about it had practically ceased. In the following discussion I hope to show that both of these conditions are manifested in particular instances.

The structure of those stratified deposits which covered basal remnants of the ice-sheet affords of itself, by the disturbed bedding, proof of the once underlying ice. The typical kettle-holes and the irregular, inosculating depressions in many kame-fields fall largely in this group, where the thickness of the ice may not at the time of completed deposition have exceeded one hundred feet, if in most cases it did not fall far short of this estimate.

An outlier, however, may have risen high above the deposits at its base and yet not have been deeply imbedded in the drift. Setting aside these possible cases, I propose to deal only with those instances in which the ice occluded a depth of sediment sufficient to leave a depression upon its liquefaction. The point is to distinguish a depression of this nature from one of the kind previously described, particularly when the cavity is at present the seat of a body of standing water.

There seems to me a solution of this question resting on the assumption that, if the mass of ice rose high above the gravels and sands accumulated about its sides by the waters flowing past it and from its own surface, the melting of this upper ice, particularly if continued after the subsidence or diversion of other waters, would create a drainage channel leading away from the side of the mass over the plain or kame-field to lower ground.

I was led to conceive this proposition on observing that many of the ponds shown on the Massachusetts topographical atlas sheets, even where they have now no outlet, exhibit an old drainage furrow, often ten or more feet above the level of highest water in the pond, leading to a river system or to the sea. In January of this year, I was so fortunate as to see a miniature illustration of an ice-mass, with its attendant depression, and drainage furrow going forth from the lower side of the surrounding plain, on the gently sloping, sandy beach at Hull, Mass. On the same beach were other likewise miniature examples, in which the ice had disappeared and the water in the pit had shrunk below the level of the furrow. The accompanying generalized contour-map will serve to illustrate these pits on the beach as well as the glacial ponds having a length of a mile or more.



Generalized contoured map of a glacial lakelet, with drainage flume eroded by water from the ice standing above the level of the plain or surrounding drift deposits. Contour intervals from 10 to 20 ft.

The following are instances cited from the region of Cape Cod:

On the Wellfleet atlas sheet: Baker's pond and the Twin Cliff and Flat ponds have a distinct furrow or flume.

On the Yarmouth sheet: Cedar pond has a furrow leading north down the inside of the moraine into Quivet creek. Steep pond must once have drained into Long pond.

On the Barnstable sheet: Peter's pond has a dry channel one-half mile long, entering Wakely pond, which is in turn drained by the Mashpee river. The Hog ponds seem also to have drained into the Mashpee. Long pond, near Newtown, is another example with an overflow channel now dry. Shubael pond has a flume passing out on the east side and then turning south toward the sea. The southern of the three Cotuit ponds has a good drainage crease on the east also leading south to the ocean.

In other instances on the Barnstable sheet, the ponds at present overflow and the flumes are occupied by small streams, generally too small for the valleys. Great, Mashpee, Santuit, and Lovell's ponds belong to this class. These lakelets are from three-eighths of a mile to a mile in width and of corresponding lengths, figures which give an idea of the horizontal dimensions of the ice-blocks to which the ponds owe their origin. Of the hight of the masses, we can best judge by the cross-section of the old drainage lines, since these depend upon the volume of water supplied by melting above the level of the surrounding plain. This judgment should be corrected by an allowance for the thickness of ice between the level of the plain and the bed of the furrow, but in general this may be neglected.

On the Falmouth sheet, Ashumet pond has a broad valley leading to Green pond, a drowned glacial waterway. Jenkins' pond and its minor neighbors are connected by dry furrows. Coonemossett pond, drained now on the west into Great pond (creek), has an old furrow on the east leading into Green pond (creek). Long pond has an old furrow, occupied by lakelets, leading into the sea. John pond is unique in having at present two outlets, one on the north into the Quostinet river, the other on the south into Child's river, both through furrows. It seems likely that other ponds in the glacial district, having two outlets, may have, in the closing stage of the ice period, been held open by ice-hills, the drainage of opposite sides of which gave rise to more than one furrow, through which the present pond waters escape.

In the case of adjacent ponds lying in the same general depression, examples of which are included in the above list, it is probable that the connecting furrow where wide and having kame-like sides, arose from the melting out of a narrow isthmus of ice connecting the larger masses; but where, as in so many cases. there is a well defined drainage line, beginning at the down-stream side of a large isolated pond, it seems highly probable that its existence depends upon an outflowing stream and nothing else. We have to suppose then that in most of these ponds the ice even as late as the construction of the surrounding plains, rose high enough above the flanking gravels to furnish by its melting streams of considerable volume, though possibly of short duration.

This conclusion is true, of course, only on the supposition that the melting took place on a land surface lying above the sea-level. Had the Cape Cod district, whence these examples are taken, been submerged at the time I speak of, we should expect to find the marks of tidal fluctuations in the form of deltas or sand bars built backwards into the ponds from the old furrows, and these, too, in the hypothesis of submergence, would have been largely shaped by the movements of the oceanic water. That the ponds and their furrows have not been subject to tidal invasion is proved by the absence of deltas in these situations. These ponds are then of themselves evidence of a subaerial origin of the adjacent stratified drift plains.

When the ice-mass was buried or just escaped covering, having no sufficient elevation or mass above the general surface to create temporary streams, excurrent furrows would not arise. Even a considerable mass of ice might protrude above the sand-plain and yet fail to originate a surface drainage system by reason of the ease with which large amounts of water may percolate through these porous deposits. Prof. G. F. Wright, in his book on "The Ice Age in North America," gives an illustration of an ice-mass "one hundred or more feet thick" seen by him about half a mile in front of the Muir glacier, in the process of melting and with its sides encumbered with gravels. To this ice-mass he ascribes the origin of kames with an encircled kettle-hole. From his description and the reproduced photograph, I am led to suppose that the ice of the ponds with furrows much exceeded one hundred feet in altitude.

It would be possible with good contoured maps in hand to prepare a bird's eye view of the successive stages of the ice retreat, by sketching in the sites of ponds and kettles the ice-masses which once protruded from them. With carefully conducted field observations, followed up by calculations on the rate of melting of ice and the volume of the excurrent stream shown by the furrows (knowing the horizontal dimensions of the outliers of ice), it seems possible to obtain more minute results than have been roughly outlined in this paper.

In conclusion, it seems safe to say that, while there was every gradation in thickness of the outliers, we are able to indicate the site of blocks having a thickness of 100 feet or less, as well as to point out those masses which may have had an elevation of 200 or 300 feet above our sand-plains when these were fairly developed.

OBSERVATIONS ALONG THE VALLEY OF GRAND RIVER, MICHIGAN.

By E. H. Mudge, Belding, Mich.

The lower peninsula of Michigan, as a field for glacial study, possesses many interesting features. The peculiarities of its surface configuration and the remarkable courses taken by some of its rivers present problems worthy of thoughtful consideration.

The latest state report bearing on this region was published in 1876 by Dr. C. Rominger, then state geologist. This report devotes a brief chapter to the topography of lower Michigan, with incidental reference to glacial phenomena; but, so far as the writer knows, no recognized authority has ever studied thoroughly the glacial history of this territory. Acting on the suggestion of Prof. Wright, in his work on "The Ice Age in North America," that local observers may add something to our knowledge of this and kindred subjects, the following observations along the valley of Grand river are respectfully submitted.

With a map of the state before us, let us note the course of this important stream. It has its source in the southern part of Jackson county. Thence it flows nearly north, with a slight trend to the west, to the center of Ionia county, a distance of about seventy-five miles by direct route. At this point it turns squarely to the west and continues in this general direction to lake Michigan. The distance from the point where the direction changes to the mouth of the river is about seventy miles. It is thus seen that the great bend is not far from the middle of the river's length.

According to the railway surveys the depot in the village of Muir, located at the great bend, is 76 feet above the level of lake Michigan. The depot site is some ten or fifteen feet above the ordinary level of the river, so that the elevation of the latter is only about 60 feet above its mouth. A little calculation will show that the descent from this point to the lake is only about ten inches to the mile; and if the meanderings of the stream are taken into consideration, the fall per mile will be reduced to probably six or eight inches. The elevation of the headwaters of the river is from 450 to 500 feet above the level of the great bend. This is an average of six feet or more per mile, by direct route, which would be reduced to perhaps four feet per mile by following the river's course. Thus it is seen that the stream consists of a rapid northerly flowing portion, and a somewhat sluggish westerly flowing portion.

In studying the early history of this stream, and the causes which established its northerly course, the surface configuration of the state and the direction of glacial movement must be considered. According to Prof. Chamberlin's glacial maps (U. S. Geological Survey, Sixth Annual Report, page 312, and Seventh Annual Report, page 155, showing all the southern drift boundary across the United States), a glacial lobe of considerable prominence occupied Saginaw bay and valley during the departure of the ice-sheet, extending across the state southwestward nearly to the Indiana line. Directly across the path of this glacial stream, and extending from northwest to southeast across Jackson and adjacent counties, lies the watershed on the west side of which the St. Joseph, Kalamazoo and Thornapple rivers originate. On the opposite side of this watershed and parallel with it flows the Grand river, passing successively by the head-waters of the rivers above named and within a few miles of them; and it is important to notice that it continues so close to the western limit of its drainage area that it has no tributaries of importance on that side for considerably more than half its length. If the writer's theory be correct, this peculiarity is due to the glacial conditions above described. When the retreating front of the glacier passed to the northeast side of the water-shed, the accumulating waters found a way of escape by flowing to the north along the ice-front before rising high enough to cross the water-shed. Flanked on one side by the elevated land and on the other by the wasting glacier which supplied its waters, the river pursued its northern course until the point we have designated as the great bend was reached. These conditions existed long enough to permit the stream to establish its present channel.

An interesting feature of this part of the river's course is the deep gorge cut through the Carboniferous rocks at Grand Ledge. At this point the rocks are at or near the surface over a considerable area, across which the river has eroded its channel to a depth of about fifty feet. The writer has examined this gorge somewhat minutely, with reference to the light it might throw on certain glacial problems. We believe that it testifies to the relative briefness of the period since the close of the glacial epoch. The river occupies no valley proper. The country adjoining the gorge is comparatively level, and the traveler reaches the brink of the cliff almost before he is aware of it. Though the sandstone strata are not especially hard, there has been practically no recession of the side walls of the gorge. Their base is almost at the water's edge, with only space for a narrow footpath along its margin. At some points one can almost hurl a stone from cliff to cliff. Though there are no data present on which to base an estimate of the age of this gorge, the conditions above described indicate its geologic briefness. It is further interesting to note that there were probably steep rapids at this place in early time. The distance from the deepest part of the gorge to the point down the stream where the rocks finally disappear under the drift is less than a mile. When the stream first began flowing over the rock area a channel must have been speedily formed in the loose drift below, allowing the water to rush down the sloping surface of the more unyielding rock at a violent rate.

An examination of the river valley below the great bend shows that the stream in its formative period encountered at this point an entirely new set of conditions. The valley above this point exhibits only insignificant glacial flood terraces, or they are entirely absent. Below, however, they are a prominent feature, the valley becoming broad, flat-bottomed, and capacious. It consists of the meandering stream channel, the present flood terrace or flats, and a glacial flood terrace some feet higher, on which are built the towns of Muir, Ionia, Saranac, Lowell, and Grand Rapids. The distance between the drift bluffs at Ionia is not less than a mile, contrasting greatly with the narrow upper valley. The change from the one condition to the other takes place very abruptly at the great bend. It is evident that a great glacial flood once rushed down this valley; and it is also plain that this torrent came not from the south through the upper Grand valley, but from the east, through the valley now occupied by the Maple river, which enters the Grand at the great bend. It issued from the western front of the Saginaw valley glacial lobe; and if we correctly interpret the valley evidences, it was one of the most important glacial outlets in this part of the country. The upper Grand river was but a branch or feeder of the main stream. The latter continued to occupy the great depression which crosses the state at this place until the glacial front had receded over the low watershed into the Saginaw valley. It then dwindled in size until it is now represented by the rather inferior stream known as the Maple river, a mere branch of the more important Grand river.

Having determined with reasonable certainty the origin of the Grand river and its tributary, the Maple, it is interesting to inquire what became of their combined waters as they proceeded on their western course. Lake Michigan and the adjacent territory, as well as lake Huron with the Saginaw valley, and also lake Erie, were occupied by a great glacial lobe, a portion of the continental glacier. During the retreat of this part of the ice-sheet it became divided into three lobes, namely, an eastern one, moving outward westerly from the basin of lake Erie, the comparatively small Saginaw valley lobe in the center, and the western lobe filling the basin of lake Michigan. When the upper Grand river was making its way along the western front of the Saginaw lobe, the edge of the Lake Michigan lobe was not very many miles away. The glacial torrent crossed the intervening space and reached its margin. Of this we are quite certain, but concerning its further course we can only conjecture. Perhaps it passed directly beneath the great ice mass which blocked its way, to issue again in augmented proportions at its far southern extremity. This conclusion seems as reasonable as any. Otherwise it must have found an outlet over the higher lands to the south along the glacial margin. But a rise sufficient for this would have backed the water clear across the area of exposed land surface, flooding the country on both sides of the river channel. There seems to be no evidence of such an inundation; on the other hand, the condition of the valley as above described indicates the presence of a wide flowing stream. The most reasonable conclusion, then, appears to be that the original river actually flowed from beneath one glacial lobe and disappeared beneath the other,—a circumstance perhaps not parallelled in any other part of the country.

It may be that at a still earlier period of its history this capacious and fruitful valley was occupied by an entirely subglacial stream, which was first uncovered along the middle of its course by the melting away of the ice which previously had joined the Lake Erie and Lake Michigan glacial lobes into one continuous ice-field.

It would be interesting to follow the history of this river system back to still remoter times, involving a study of the preglacial topography of the Carboniferous area of Michigan, but we are not at present prepared to undertake the task.

[NOTE.—Further study in the correlation of the many retreatal moraines of the glacial lobes mentioned in this paper may lead to the conclusion that, when the stratified drift of the lower part of the Grand river valley was being deposited, the Lake Michigan lobe had shrunk so far as to wholly uncover that part of the valley and to give to the glacial lake Michigan an outlet past Chicago to the Des Plaines, Illinois, and Mississippi rivers. The lake then had a level at Chicago only some 20 or 25 feet above its present hight, the lowest place of the watershed being about 15 feet above the lake.—EDS.]

A NEW FUNGUS FROM THE COAL MEASURES.

By H. HERZER, Berea, O.

(PLATE XIII.)

Genus: DACTYLOPORUS, Herzer.

Dactyloporus archæus Herzer.

A remarkable advance in our knowledge of the Carboniferous flora is made in the discovery of a fungus characterized by a well-developed trunk, pileus and sporiferous arrangement, distinguishing itself from those that were rhizoid or epiphytal in habitat, infesting bark and leaves of trees. It is a fungus of unusual size, generically allied to Polyporus as to its sporiferous tubes, and again to Agaricus by its pileus and trunk —a somewhat comprehensive type and a Goliath among its lilliputian relatives. Although enclosed within a lump of pure, bituminous, soft coal, none of the parts have undergone the least carbonization. The whole mass is of dirty brownish-yellow, mineral substance, chalky and brittle, like rotten bone. The pileus has experienced a lateral crushing, so that its organization is disarranged and has become to some extent a mingled mass. The trunk is underlying the pileus and is separated from it by one-half inch coal, and their connection is broken; also its basal part is wanting, left with nearly one-half of the pileus in another chunk that could not be found, so that the whole length of the growth cannot be ascertained.

The trunk, No. 1, plate XIII, is compressed to one-half of its thickness (more flattened than here given), is 8 in. long, longitudinally ribbed, with smooth exterior, easily separating from the coal; interiorly marked by large ducts, No. 2, little exaggerated in figure, the walls of which are of a rusty-brown color, causing a columnar structure. The pileus, No. 3, transverse section, presents a somewhat homogeneous mass with lamellular parts. No. 4 is evidently the hard upper crust of the pileus. No. 5 presents isolated bundles of sporiferous tubes; two of them are lying across the pileus, six of them being imbedded in the mass; they are dactyliform, cylindrical and smoothly enclosed as with a phosphatic coating. The here enlarged tubes are compressed and still so well preserved as to show each one as distinct as in a recent Polyporus, even a loose filamentous mural texture for adherence to each other. On the mycelium, (No. 6, a magnified part of it), can be seen pitted marks of removed tubes.

Apparently the sporiferous arrangement was not a compact mass of tubes, covering the whole under surface of the mycelium, as in Polyporus, but consisted of isolated bundles vertically suspended from the pileus in stalactitic manner. On one Polyporus in my collection, the sporiferous tubes have shrunk and torn from each other in irregular, unsymmetric masses, but in our Carboniferous genus, we have, it seems, a deviation from recent growths. Judging from the length of the tube-bundles, the thickness and length of the trunk, which must have been at least one foot, and from the preserved part of the pileus, measuring 6 inches across, we have before us a very large and most remarkable form of that age.

It was found in Coal No. 5, Canal Dover, Tuscarawas Co., Ohio.

THE TERMS OF BIOPLASTOLOGY.*

By Professor A. HYATT, Boston, Mass., U. S. A.

I have written the following paper which is an abstract of one read before the Boston Society of Natural History, entitled "Bioplastology and the related Branches of biologic Research," partly in reply to a critical paper by Mr. Buckman and Mr. Bather, and partly as a new contribution in the same field.

I propose to describe in a brief way the four different lines of research which are usually designated by the popular terms growth, heredity, acquired characteristics, and the correlations of development of the individual (ontogeny) with the evolution of the group to which it belongs (phylogeny); the object being to explain the relations of these to each other and to give adequate reasons for the substitution of scientific terms for the popular names heretofore used.

AUXOLOGY OR BATHMOLOGY.

Messrs. Buckman and Bather, both well known for their original and instructive researches on paleozoölogy in England,

*From "Zoologischen Anzeiger." No. 426 u. 427. 1893.

have recently in a joint paper under the title of "The Terms of Auxology"* justly criticised the nomenclature employed in my paper to designate the stages of growth and decline in the individual. They have also proposed in view of the correlations which have been shown to exist between the transformations that occur in the stages of development and decline in the individual and those that characterize the evolution of the group to which it may belong, to designate the study of these correlations by the new term "auxology." This term is open to the objection that it is derived from *αὔξη*, meaning simply progressive growth up to and including the adult stages; and, although in common with others I have felt that it has claims to be retained, there are good reasons why it should be restricted in application, if adopted, to researches upon growth. I have placed two terms at the head of this chapter partly because I have not had time to consult the proper judges, physiologists, and obtain their decision, and partly because I am undecided in my own opinion.

Cope in his "Method of Creation of Organic Forms"† used the term Bathmism from *Βαθμός*, meaning a step or threshold, to designate growth force, and it is therefore questionable whether the term Bathmology should not be substituted for Auxology in order to give uniformity to the nomenclature.

It is not necessary to discuss this here and the facts are merely mentioned to call attention to this question and bring out expressions of opinion.

Dr. C. S. Minot, who has given the first demonstration of the fundamental law of growth‡ has shown that the common notions with regard to the action of this force in organisms are erroneous. His plotted curves of the actual additions in bulk of the body by growth during equal intervals of time in guinea pigs show that these increments are in steadily decreasing ratio to the increase of weight of the animal from a very early age. He was so much impressed by these facts

*Zool. Anz. No. 405. p. 406. 1892. Republished in the AMERICAN GEOLOGIST, vol. XII, p. 43.

†Proc. Am. Phil. Soc., Dec., 1871, and "Origin of the Fittest," p. viii, etc.

‡"Senescence and Rejuvenation." Journ. Phys., xii. No. 2, 1891, and address on "Cert. Phen. of growing old," Am. Assoc. Adv. of Sci., XXXIX. Aug., 1890.

that he characterized the whole life of the individual as a process of senescence or growing old.

Naturalists have as a rule understood the differences between the organic molecular increase that takes place within cells, which is the simplest form of growth, and that which follows this and builds up the tissues of the body by the division of cells. Both of these processes, although distinct from each other, result in additions to the bulk of the whole body of the organism and come properly under the head of growth. But while both are thus constructive so far as the body is concerned, only one can be considered constructive or anabolic, while the other is essentially destructive or catabolic so far as the cell itself is concerned.

The function of nutrition and the nature of the organic structure are the two essential factors of growth, and this term, *i. e.* growth, also obviously applies to the morphology of metabolism, consisting of intra-cellular increase, or anabolism, and cellular development, or catabolism, and the phenomena resulting from the alternating action of these in ontogeny. This at once shows that growth is not simply progressive addition to the bulk of the body, since the multiplication of cells by fission is in itself catabolic or developmental so far as the cells are concerned. Further than this the ultimate results of catabolism are of the nature of reductions as is shown by Minot's work, by Maupas's observation on the old age of the agamic cycle in Infusoria, and the results of late researches on amitosis in cellular fission. These and the actual reduction of the body taking place in extreme senility show, that the term growth covers decrease in bulk due to development and use, as well as increase.

When one passes beyond this and attempts to deal with the characteristics of ontogeny or phylogeny he at once finds himself in the presence of other forces, such as heredity and other processes, namely, the acquisition of new characters and the renewal of the powers of growth in nuclear substances by means of conjugation.

The manifestation of growth energy in brief arises from two factors, or at any rate, is always found associated with two, a living organism and assimilation of nutritive matter, and is an obvious result of their union.

GENESIOLOGY.

The term heredity has been used in two senses, one expressing the results of the action of an unknown force which guides the genesis of one organism from another, and a second in which it implies the force itself. Clearness of statement demands that some other term than heredity should be used, and I consequently propose to designate the study of the phenomena by the term genesiology from γένεσις, meaning that which is derived from birth or descent; this force itself as genetic force; and the principle of heredity thus becomes genism.

The continuity of the same element in the agamic division of unicellular bodies as in Protozoa makes it comparatively easy to explain the transmission of likeness, but this is growth of the ontogenic cycle. Maupas shows this clearly and continually speaks of the growth, full grown virility, and senility of his generations of unicellular, agamic protozoans. In fact they are obviously in a disunited form the equivalent of the colony of protozoans, and secondarily, although more remotely, the equivalent of the single metazoan, or individual, which is essentially a cycle of agamic cells reproducing by fission.

While this likeness of agamic daughter cells to the original agamic mother cell which has disappeared in them may be considered a manifestation of heredity, it is also a form of growth and readily separable from the more complicated relations of organisms produced by conjugation of two forms. When the transmission of likeness is complicated with the effects of conjugation the difficulties increase until finally in the bodies of the metazoa they culminate in a problem of surpassing difficulty. Heredity is as plainly written in the life history of the protozoan and in the growth of cells, in the tissues in the budding of the metazoa and the parthenogenesis, as in these more complicated forms, but the phenomena of transmission occurring after conjugation can be separated from growth and considered upon entirely distinct lines.

The theories offered show this. Thus the corpuscular theories, whether gemmules or biophors or pangenes are assumed, assert the need of minute bodies for the transmission of characters, while on the other hand the dynamic theories, more in accord with physical phenomena, assume that there is a transmission of molecular energy through growth. Some of these views support Hering's theory of what may be called mnemegenesis, namely, that heredity is a form of unconscious organic memory, and this from my point of view is the only satisfactory one yet brought forward.

Heredity is obviously manifested for the most part in the developmental results of growth and appears chiefly in the cytoplasmic structures which Dr. Minot so clearly places before us as constantly increasing with age, while the comparative size of the nucleus which represents the power of growth force decreases. Whether this be granted or not,it can hardly be denied, that, in describing the development of organisms along ontogenetic and their evolution along phylogenetic lines, we are dealing with cycles of progression and retrogression which are quite distinct from the growth of the body as determined by the laws that govern its increase and reduction in bulk, and that one cannot describe the study of both series of phenomena under the same general term without danger of confusion.

Genism, in brief, is the transmission of likeness from one ontogenic cycle to another of the same species. It appears to be due to the same factors as the perpetuation and rejuvenescence of the cycles themselves, namely, the union of two forms of distinct ontogenic cycles of the same species or kind.

Ctetology.*

Weismann and his supporters deny that ctetetic or acquired characters are inheritable, but it is safe to make the assertion that this will not be maintained by the students of bioplastology. Within the limits of my own experience in placing the genetic relations of varieties and species of fossil cephalopods and other groups through geologic time, although I have tried to analyze the behavior of all kinds of characteristics, I have failed to find any such distinctions. If Weismann's theory is true it ought to be practicable to isolate in each type some class or classes of modifications that would be distinguishable by the fact that they were not inherited.

The only known cause of modification as demonstrated by the suitability of variations in existing characteristics, and

*Κτητός, something acquired.

by the more direct demonstration of experimentation, is the physical forces of the surroundings. These certainly have the power to originate modifications either through their assumed direct action upon the growth of the parts, or through their power to excite internal reactions and consequent modifications of parts and organs.

It is certainly not a very acute analysis of the facts which attributes to external causes exclusive power in producing modifications in many cases, as has been largely done by experimental zoölogists. For example, Brauer and the author have both pointed out this defect in the accepted explanations of the famous Schmankewitsch experiments upon *Artemia*, and the same may be said of the explanations of all experimenters who do not take into account the reactions of the organisms themselves. I mean here not simply the passive structural organization but the active internal reactions usually called effort by the Neo-Lamarckian school. The use of the word effort is, however, misleading, since it has inseparable association with consciousness, and I have suggested entergogenesis, entergogenism, and entergogenic from ἐντός, within, and ἔργον, work or energy.

The physical forces of the surroundings must act through medium of entergogenic movements and this is shown clearly in the nature of modifications produced which are extra growths, substitutions or characteristics due to changes of functions, etc., or partial or absolute obliteration of these due to the failure of genetic force to repeat characteristics in the presence of opposing influences and superimposed characteristics as in accelerated development.

Ctetology should also, however, include the study of the action of physical forces when they either actually do produce direct effects upon organisms or may be assumed to act in this way. Changes in light, food, heat and moisture may cause modifications that cannot be included under the head of entergogenic reactions without danger or confusion.

Maupas gives exceedingly instructive examples of this class and quotes other authorities who have investigated these effects in Protozoa.

Beddard gives a number of examples of such modifications in his "Animal Coloration" and Semper has also discussed the same subject more extensively in his "Natürlichen Existenzbedingungen der Thiere."*

The use of the term entergogenesis makes it practicable to indicate the essential distinction existing between the modifications produced through the mediation of internal forces and those arising as the direct results of the action of external forces by means of the term ectergogenesis and ectergogenic.

These explanatory remarks serve to show that ctetology is a branch of research which needs to be isolated from researches upon growth and genesiology, since it is devoted to the study of the origin of acquired characteristics and therefore necessarily considers all of the internal reactions of the organisms in response to the action of physical forces, as well as the more obscure reactions of structures which are produced solely by (or supposed to be produced by) the direct physical or chemical action of external physical forces.

BIOPLASTOLOGY.

The separation of auxology (or bathmology), genesiology, and ctetology, shows also that the study of the correlations of ontogeny and phylogeny is distinct from either of these; and this branch of research can be designated by the term bioplastology from *Βίος*, life, and *πλαστός*, meaning moulded or formed.†

To sum up in a few words the rather ambitious aims of this

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*Translation by Minot, MacMillan, 1892.

†Bioplasm, bioplast, bioplastic have already been used by Beale and others for the living cell and its contents, but the term "bioplastology" has not been used nor have the names proposed by Beale been generally adopted. If they were, bioplasmology would cover the requirements of students of such phenomena; and there is already in use plasmology with about the same meaning, and histology for the descriptive side of the study of cellular structures.

Biogeny has been used in extra-scientific literature by Fiske with the same meaning as Bioplastology,and Haeckel has named the law of embryonic and ancestral correlation the law of biogenesis, but there is a strong objection to both of these. Biogenesis is the name given to the theory of the origin or genesis of life from life in contra-distinction to the assumption of spontaneous generation, or abiogenesis, and has a well established place in scientific literature. Therefore while the law of correlation of the stages of development and those of the evolution of the phylum, may, if one chooses, be called a law of biogenesis, it is more accurate to consider it *a law of correlation in bioplastology or better still the law of palingenesis* or regular repetition of ancestral characters, which exactly expresses what the discover Louis Agassiz saw and described.

comparatively new recruit in the army of investigation, it aspires to show that the phenomena of individual life are parallel with those of its own phylum and that both follow the same law of morphogenesis, that not only can one indicate the past history of groups from the study of the young, and obviously the present or existing progression or retrogression of the type by means of the adult characters of any one organism, but that it is also possible to prophesy what is to happen in the future history of the type from the study of the corresponding paraplastic phenomena in the development of the individual.

Whether these claims are well founded or not, the nomenclature to be employed is a matter of importance and should be accurate, appropriate, and convenient for those who are interested in this work, and this abstract has been written in large part as a contribution towards this object.

Ontogeny.

Messrs. Buckman and Bather have proposed to substitute a set of improved terms for those previously used by myself, and both are given in the following table:

Ontogenic Table of Terms (I).

Hyatt, 1888.		*Buckman and Bather, 1892.*
1. Embryologic	1. Embryonic	1. Embryonic
2. Naepionic	2. Brephic	2. Infantile or Larval
3. Nealogic	3. Neanic	3. Adolescent
4. Ephebolic	4. Ephebic	4. Adult or Mature
5. Geratologic	5. Gerontic	5. Senile
a. Clinologic	a. Catabatic	a. Declining
b. Nostologic	b. Hypostrophic	b. Atavic

It would be a waste of time, even if I felt so disposed, to attempt to defend the nomenclature of the first column in this table. The use of terminations derived from λόγος in this way is not defensible and was due to the careless habits of the early history of terminology, still extant in the use of "morphological" instead of "morphic" and in the obligatory use of "physiological" and "geological," etc.

The nomenclature of 1888 is inadequate not only on account of etymological faults, which do not, however, trouble me as much as they do those who regard linguistic purity with higher respect, but because the system is insufficient and unsymmetrical.

This last objection applies with equal force to some of the terms proposed by Buckman and Bather. These gentlemen were hampered by the desire to perpetuate the older terms now in use in this country and for which I alone am unluckily responsible. This is also my own condition, and although I would willingly now suggest an entirely new method, I find after having framed and tested a new one, that it is better not to interfere any farther than is absolutely necessary with the nomenclature of 1888.

The table printed below, Table II, therefore, is made up of a set of terms which are substantially the same as those suggested by Buckman and Bather, except in the use of nepionic, and in it I have also followed a suggestion kindly sent me in a letter by Mr. Buckman, in adopting the prefixes "ana," "meta," and "para" for the designation of the substages of development. This has the great advantage of adding to the means of expressing observations accurately, quite as well as the use of an entirely distinct word and at the same time preserving in each term a direct reference to the period to which it belongs. Thus one can speak of the metanepionic or ananeanic substage without referring to the stage in which they occur, and yet the reader will at once recognize to what stage the substage mentioned is to be referred.

Recent researches have, in my opinion, clearly demonstrated that all stages of development from 2–4 inclusive, like the embryonic stage 1, and the senile stage 5, will have to be subdivided in studying many groups. These subdivisions are also relatively important and their differences are often well defined.

I now propose the following nomenclature which does, it is hoped, fuller justice to every stage.*

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*It is my grateful duty to add that I have had the unremitting help of Dr. C. E. Beecher, of New Haven, and have consulted with Dr. Jackson, of Cambridge, and Mr. Clarke, of Albany, and also with Mr. Buckman, and I wish to express to these gentlemen my indebtedness for suggestions and advice of essential importance. Except in the retention of one term, "nepionic," the nomenclature is more theirs than mine. I also desire to thank Prof. Reynolds of New Haven, and Prof. William Goodwin, of Cambridge, for the earnest help they contributed to the formation of a table of terms which for reasons given above was not used, as well as for advice which influenced the framing of the one finally adopted.

ONTOGENIC TABLE OF TERMS (II).

Structural Conditions.	*Stages.*	*Stages.*	*Substages.*	*Substages.*
Anaplasis (Haeckel.)	Embryonic	Embryonic	Several.*	No popular names.
	Larval or young	Nepionic	ananepionic, metanepionic, paranepionic.	
	Immature or adolescent	Neanic	ananeanic, metaneanic, paraneanic.	
Metaplasis (Haeckel.)	Mature or adult	Ephebic	anephebic, metephebic, parephebic.	
Paraplasis	Senile or old	Gerontic	anagerontic, metagerontic, paragerontic.	

The necessity of subdividing the embryonic stage is admitted and in all probability this really includes several stages with their respective substages, but the discussion of this problem must be left to the future. The former subdivision of the gerontic stage into two substages seems to have met with general acceptance, but the terms remain to be settled. Buckman and Bather have proposed catabatic to replace my old term clinologic, which is an improvement, but their term proposed, hypostrophic, from ὑποστροφή, meaning a turning around and back, is not equally good. While this is better than the term formerly employed, "nostologic," it is longer and not preferable to "nostic" from νοστός†, signifying a return in the sense of a journey back to one's home. This par-

*These stages were enumerated and more or less described under the name of protembryo, mesembryo, metembryo, neoembryo, typembryo, in my paper on "Values in Classification of stages of Growth and Decline" and to these Jackson added phylembryo in his "Phylogeny of the Pelecypoda," p. 289.—See "Values of Classification of the Stages of Growth and Decline," Am. Nat., Oct., 1888, and "Genesis of the Arietidæ," Smithsonian Contributions, No. 673, 1889, also Mem. Mus. Comp. Zoölogy, xvi, No. 3.

†Neither of these words has any authority for the termination "ic," but unless one can make some such "corruptions" it is often impracticable to manufacture a consistent set of terms according to the method here adopted. It is obvious that scientific convenience occasionally requires such heroic methods,and this seems to be a case in which it is justifiable.

If the new set of terms here proposed is adopted, there will be no need of employing either "catabatic" or "nostic." These will then be superseded by "anagerontic" and paragerontic," or by all three terms used for the stages in the table, if the characteristics justify their application. It was necessary, however, to discuss these terms because two distinct sets of names have been employed for the subdivision of the senile period.

agerontic substage is not, in my opinion, "atavistic" or "reversionary," as it is defined by Buckman and Bather. Reversions are the returns or recurrence of ancestral characteristics in genetically connected organisms which have been for a time latent in intermediate forms. I do not think that we can include in this category purely morphic characteristics which habitually recur in the same individual as the result of paraplasis, or which occur in the paracme of a type more or less invariably. In the individual the smooth round shell of the whorl of the paragerontic substage after it has lost the progressive characteristic of the ephebic stage cannot be considered as reversions. They are simply analogies in form, not structurally similar characteristics. A better known and more easily understood case is the resemblance of the lower jaw of the infant before it has acquired teeth, and that of the extremely old human subject in which these parts have been lost and the alveoli and the upper parts of the bony mandible have disappeared through resorption. The forms are similar, but no one would venture to consider the infant's cartilaginous jaw and that of the old man as similar in structure.

The best example of similar phenomena in the phylum known to me is the close resemblance of form between the straight *Baculites* of the Cretaceous or Jura and *Orthoceras* of the Paleozoic. These two are often confounded by those ignorant of the essential differences existing in their structure. One is a Mesozoic straight form derived by degenerative processes of evolution from the highly ornamented progressive *Ammonitinæ* of the Mesozoic, and the other is a near relative of the primitive ancestral forms of the nautiloids in the Paleozoic. One occurs in the paracme and the other in the early epacme of the group of chambered shells. They are widely distinct in their structural characteristics and these differences are greater in the young than at any subsequent stage of their ontogeny. *Baculites* has a close coiled shell in the nepionic period, as has been lately demonstrated by Amos P. Brown of Philadelphia, and *Orthoceras* is straight from the earliest stage. The return of a similar form in *Baculites* in the later periods of development in obedience to the law of the cycle does not carry the structure back with it to a repetition of the orthoceran siphuncle and sutures.

The term used by Buckman and Bather, "brephic," derived from *βρεφιχός*, is perhaps etymologically preferable to nepionic, but unluckily it was not used in 1888. Nepionic* has been used by authors on this side of the Atlantic in several essays and is found in the Century Dictionary, and therefore, consistently with the principles adopted by Buckman and Bather and myself to depart from established terms as little as practicable, it should be perpetuated. It has not deserved the sharp criticism of these authorities, since it is not an "impossible corruption of the Greek." It is a convenient term and not worse etymologically than one those authors themselves adopted and another which they proposed. Embryonic has a precisely parallel history, there being in Greek no authority for the use of the termination "ic," but this is adopted by them without comment. Hypostrophic derived from *ὑποστροφή*, also having no authority for its termination in "ic," was one of the terms proposed by them. So far as the purity of the language is concerned, I see no reason why they should not do this, since there is no Greek word to which "hypostrophic" could be referred that would make confusion.

The Phylum.

Buckman and Bather propose to use the prefix "phyl" for forms occurring in the phylum which represent in their adult development the stages in the evolution of the phylum which correspond with those of the ontogeny, and give an instructive table in which Haeckel's physiological terms are placed side by side with those proposed for the morphic phenomena. In following out the same ideas the following table has been constructed, which differs from theirs only in the use of nepionic as stated above, and in the interpolation of phylanaplasis, etc., as correspondents of anaplasis in ontogeny.

Summary Table (III).

Ontogeny or Ontogenetic Development.		*Phylogeny or Evolution of the Phylum.*		
Structural Conditions.	Stages.	Structural Conditions.	Stages.	Dynamical.
Anaplasis	Embryonic Nepionic Neanic	Phylanaplasis	Phylembryonic Phylonepionic Phyloneanic	Epacme.
Metaplasis Paraplasis	Ephebic Gerontic	Phylometaplasis Phyloparaplasis	Phylephebic Phylogerontic	Acme. Paracme.

*Originally taken from *Νήπιος*, but there is a form *Το νήπιον*.

The Cycle.

Phylum expresses genetic connection, cycle the totality of the phenomena whether morphic or physiologic, which is exhibited by ontogeny, phylogeny, or the physiological phenomena alone. Thus one can describe the cycle of the phylum in its rise and decline, the epacme, acme and paracme as purely dynamical phenomena exhibited by the increase in numbers of forms, etc., or the cycle of the ontogeny as shown by the increasing complexity of the development and its decline, the anaplasis, metaplasis and paraplasis of the individual, or one may describe the cycle as exhibited by the embryonic, nepionic, neanic, ephebic and gerontic stages, or the cycle of the phylogeny as exhibited by the corresponding stages of evolution designated by their appropriate prefix "phyl."

There appears to be real need of two terms under the head of cycle, one for ontogeny and the other for phylogeny. It is proposed to use in this way ontocycle or ontocyclon for the ontogeny, meaning the cycle of the individual, and phylocycle or phylocyclon for that of the phylum. This will make it practicable to use the terms monocyclon or monocyclic, polycyclon or polycyclic, etc., to describe the number of cycles observed. Thus the ammonoids are polycyclic, the *Arietidæ* are decacyclic, the genus *Coroniceras* is an incomplete monocycle.

It is not necessary to defend these terms before students of bioplastology; they will be tested and if convenient adopted. For the benefit of others it may be mentioned that the cycle is of all degrees of development in ontogeny. Thus Insecta are apt to stop at the ephebic period and in many other animals there is a similar limitation.

Those who try to find a complete cycle of metamorphoses in their own special lines of research will often be disappointed and probably question that it exists at all. Thus for several years I could not find any evidence of its existence among certain cephalopods, those having a primitive organization like *Endoceras* and *Orthoceras*, but I have since seen well marked senile stages in these shells.

Stages of Morphogenesis.

As remarked by Buckman and Bather, "it is possible to trace the evolution of one character from its first appearance to its final loss right through the history of a long line of individuals." They also say "the various characters that go to the formation of an individual or a race, at any period of its development, may themselves differ greatly from one another in the degree of their own development," and further, "for the designation of the successive stages in the history of a character, the ontogenic terms might be used with the addition of the prefix morpho-, *e. g.*, morphobrephic (here nepionic), 'morphephebic.'" These suggestions are useful, but they appear to me to cover both ontogeny and phylogeny, while according to the title used by these gentlemen, "Stages of individual Morphogenesis," they were meant to apply only to ontogeny.

If one traces the history of any one character, something which every student of bioplastology must habitually do in actual practice, throughout a chain of individuals, whether these are members of one variety or of one species, or whether they lead into distinct species, as they are apt to do, he is studying the phylogeny of that characteristic. It would seem, therefore, that the prefix "phyl" would be applicable in such cases, whereas the use of a single term for both the phylum and the individual, especially the prefix "morpho," would be likely to be confusing.

DESCRIPTION OF SOME NEW SPECIES OF CRINOIDS, BLASTOIDS AND BRACHIOPODS FROM THE DEVONIAN AND SUB-CARBONIFEROUS ROCKS OF MISSOURI.

By R. R. Rowley, Louisiana, Mo.

(Plate xiv.)

Melocrinus gregeri (nov. sp.).

(Plate xiv, fig. 1. Side view of the body, natural size.)

Body obconical. The four basals slightly excavated for the reception of the column. The three smaller of these four plates, pentagonal; the fourth hexagonal. First radials, six to seven sided, large, about as wide as long. Second radials hexagonal, width and length about equal. Third radials or axillary plates heptagonal, width and length equal, supporting above two plates, five to six sided. A short arm-like plate rests upon each of these first radials of the second series. No higher plates preserved on the type specimen.

First interradial plate hexagonal, length and width equal and resting between the upper sloping sides of the first radials and the lower lateral sides of the second radials. Next series of two plates; third, three; fourth, four, smaller. Vault and interradial plates meet in such a manner as to make it difficult to say where the latter cease and the former begin. First azygous interradial is quite as large as first radials, and heptagonal. In all there seem to be but thirteen plates in the azygous area, rather irregularly arranged, three forming a straight line and surrounded laterally and above by a horseshoe-shaped figure of eight somewhat smaller plates. Vault plates rather large, polygonal, strongly tumid. Vault slightly sunken. Base of a rather slender, almost lateral anal tube. Calyx plates not only strongly tumid, but each of the larger ones supports a conspicuous central spiniferous node.

The radiating ridge-like ornamentation so characteristic of the calyx plates of this genus of crinoids is almost wanting in this species, appearing as short cross-bars along the lines of plate union. Column, rays and arms unknown. The first was seemingly rather small compared with the great body. Hight of the body $1\frac{1}{2}$ inches, greatest breadth $1\frac{9}{16}$ inches.

The great size of the body of this species, the strongly tumid character of all the body plates, the very conspicuous central spines of the the larger calyx plates, and the almost entire absence of the usual ornamentation of this genus, will serve to characterize this magnificent crinoid.

Collected from the Hamilton beds of Callaway Co., Mo., and presented to the author by Mr. D. K. Greger, in whose honor the specific name is given.

There is a much smaller species of Melocrinus, associated with *M. gregeri*, in Callaway Co., which has less tumid plates, but is provided with spine-like nodes and short radiating ridges, noticeable only near the lines of union of the plates.

Taxocrinus concavus (nov. sp.).

(Plate XIV, fig. 2. Side view of the body, natural size.)

Calyx, a low, flat cup. Base concave, so that on a side view only the tips of the basals can be seen. A stem joint obscures the under basals if such be present. Four of the basals are probably pentagonal, extending upward between the first radials fully half the length of the latter and nearly meeting the large interradials above. The first radials and basals curve inward to form the basal concavity. The fifth basal plate is apparently quadrangular, truncate above and entirely separating the first radials. First radials large, once and a third as wide as long, pentagonal. Second radials nearly three times as wide as long, less broad than the first radials, quadrangular. Third radials a shade wider than the second radials, pentagonal, over twice as wide as long. Three plates in the second series, the third supporting two simple arms. The slightly sunken interradial areas and the rounded, convex character of the radials give a pentagonal look to the calyx. A large nine to ten sided plate with apparent minute plates, laterally placed, fills the four interradial areas, extending upward to the second plate of the second radial series. Azygous interradial filled by five irregularly arranged plates from four to six sided, the lowest and largest resting on the upper truncate side of the basal. A single, small, axillary plate resting between the short, sloping upper lateral sides of the first and second radial plates of the second series. The arms entire in the type, short, strong, twenty in number, simple and made up of from 18 to 20 heavy pieces. The arms give off from the inner side a few strong pinules. Arms infolded or overlapping at top. Column moderately large, round, several joints being hidden in the basal concavity on a side view of the specimen. The whole fossil has a robust appearance and is one of the most beautiful crinoids yet discovered in our state. Hight of specimen from base to top of infolded arms, about one inch. Breadth quite as great.

Found in the Hamilton beds of Callaway Co., Mo., by Mr. D. K. Greger, an intelligent and excellent collector. Type in the author's collection.

This species seems to possess some characters at variance with *Taxocrinus* and in some respects recalls the generic descriptions of both *Gnorimocrinus* (W. and Sp.) and *Forbesiocrinus* (DeK. and L.).

Batocrinus shepardi (nov. sp.?).

(Plate XIV, fig. 8. Side view of the body, natural size.)

Calyx deep cup-shaped. Each of the three basals is five sided, about twice as wide as long, flattened laterally and below and bearing nodes and depressions. First radials a shade wider than long, six sided and each having an X shaped elevation. The second radials are quadrangular and wider than long. Third or bifurcating radials five-sided, wider than long, and each supporting on the sloping upper faces from one to two, five or six sided secondary radial pieces above which are the arm-bearing plates, fifteen or sixteen in number. There are from one to three interradial plates to each area, the largest being from eight to ten sided. The other two when present are very small. There are from six to seven plates in the anal interradius, the lowest and largest being six sided and a little less than the first radial in size. The fifteen or sixteen arm openings are directed outward. All of the calyx plates are prominent, being tumid or sculptured. The plates of the dome are nodose or contain angular prominences. Base of the proboscis rather strong. Column and arms unknown. Columnar facet of medium size and round. Hight of type $\frac{3}{4}$ inch, width little less than $\frac{1}{2}$ inch.

From the Burlington limestone at Springfield, Mo.

Named in honor of Prof. E. M. Shepard of Drury College. Types in the author's collection.

Granatocrinus mutabilis (nov. sp.).

(Plate XIV, fig 4. Side view of a large globose specimen, enlarged two diameters. Fig. 5. Side view of an elongate specimen, natural size. Fig. 6. Specimen with a very convex base, natural size. Fig. 7. Basal view of fig. 6, enlarged two diameters. Fig. 8. Top view of another specimen, two diameters. Fig. 9. A small Pentremites-like specimen, natural size.)

Body globose to oval. Base slightly convex, sometimes very much so. Basal plates three in number, the largest quadrangular. The radials in length equal the hight of the body, ornamented by longitudinal granular lines. Interradial and anal pieces small and confined to the dorsal side of the body. Ambulacra of medium width, extending the entire length of the body, except in specimens with very convex bases. Side pieces numerous. The ambulacra do not extend beyond the general surface of the body and are on a plane with the upturned edges of the radial pieces. The lower part of each ambulacrum forms a slightly projecting foot. Anal opening of medium size. Spiracles very small. Length of the largest specimen $\frac{5}{16}$ of an inch; of the smallest $\frac{2}{16}$.

Among the specimens from which the description was made out is quite a great deal of variation in outline and general appearance as well as size. Three different forms are figured. One specimen has a length twice as great as the width, another a greater width than length. The small specimen with a very convex base and proportionately broad ambulacra mimics a true Pentremites. Two others have the exact outline of *Pentremites conoideus* in miniature. There is greater range in outline and characters in this little blastoid than we have seen in other species. It may be compared with *G. pisum* and *G. exiguum*.

Collected from the Chouteau limestone, three miles east of Curryville, Mo. Types in the author's collection.

Spirifera mundula (nov. sp.).

(Plate XIV, fig. 10. Ventral valve, natural size. Fig. 11. Cardinal view, natural size. Fig. 12. Outline, of cross section, natural size.)

Shell transversely elongate, the width being nearly three times the length. Plications on both valves few, simple and not very distinct, about fourteen being all that can be counted to the valve. Mesial fold small, more elevated than the plications and with a slight central sulcus. Sinus narrow and rather shallow. Both the mesial fold and sinus without plications. A few indistinct lines of growth cross the ribs on both valves. Viewing the shell lengthwise of the cardinal area (fig. 12.) the outline or cross section is singularly rounded. Beak of the ventral valve incurved. Cardinal area occupies the entire width of the shell and is narrow and of almost uniform width. Foramen small, triangular. Length of type $1\frac{5}{6}$, width $\frac{5}{16}$, thickness $\frac{6}{16}$ of an inch.

This elegant little Spirifera comes from the Lower Burlington limestone at Louisiana, Mo. The collection contains two specimens.

Spirifera aciculifera (nov. sp.).

(Plate XIV, fig. 13. Cardinal view, two diameters. Fig. 14. Ventral valve, two diameters.)

Shell somewhat cyrtina-form, small, width a little greater than length. On the ventral valve there are about seven small but distinct plications, either side of the sinus, which latter is well defined but without plications. On the dorsal valve there are six costæ either side of the mesial fold but none on the fold itself, which is distinct and slightly flattened on top.

Cardinal area less than the width of the shell, triangular and high, like Cyrtina. Foramen high, triangular. Beak of the ventral valve slightly incurved. The outline of the shell is semicircular, the lateral extremities being rounded. Entire surface covered by the bases of small needle-like spines. Length of shell $\frac{5}{32}$, width $\frac{7}{32}$, hight $\frac{4}{32}$ of an inch.

One of the rarest fossils in the Louisiana (Lithographic) limestone at Louisiana, Mo. The collection contains two specimens.

Cyrtina burlingtonensis (nov. sp.).

(Plate XIV, fig. 15. Cardinal view, natural size. Fig. 16. Dorsal valve, natural size. Fig. 17. Profile of a larger individual, natural size.)

The length and width of this shell about equal. Either side of the mesial fold on the dorsal valve there are two plications, the first being little less strong than the mesial fold itself. Either side of the sinus on the ventral valve are two strong and one almost obsolete plications. Sinus of moderate depth and well defined. Cardinal area less than the width of the shell, giving a rounded shape to the extremities of the dorsal valve. Area triangular, hight a little less than the width. Foramen long, triangular, uncovered in the half dozen specimens examined. Beak of ventral valve slightly incurved in all the specimens. A few distinct lines of growth cross the plications of both valves. The few strong costæ, rounded lateral extremities and incurved beak will serve to identify this handsome little shell. The type specimen has a length and width of $\frac{7}{16}$ and thickness of $\frac{5}{16}$ of an inch.

From the lower Burlington limestone, Louisiana, Mo. The collection contains six specimens.

Strophalosia beecheri (nov. sp.).

(Plate XIV, fig. 18. Ventral valve, natural size. Fig. 19. Cardinal area, natural size.)

Shell subcircular. Ventral valve convex and highest about the middle. Without striations or plications. Distinct lines of growth cross the valve. Irregularly distributed spine bases. Spines moderately strong and apparently long. Cardinal area less than the width of the shell. Deltidium distinct but small, triangular, twisted to conform to the twisted beak of the ventral valve. Beak not incurved. To a small flattened area for attachment, on the ventral valve near the beak, is due probably the twisted character of the latter. Unfortunately the dorsal valve is not present in the only specimen yet discovered. Length of shell $\frac{9}{16}$, width $\frac{10}{16}$ of an inch.

In honor of Prof. C. E. Beecher, of Yale college, New Haven, who lately published a review of the American species of Strophalosia, this unique specimen is named specifically.

Type specimen from the Louisiana (Lithographic) limestone at Louisiana, Mo., and in the author's collection.

Louisiana, Mo., Sept., 1893.

EXPLANATION OF PLATE XIV.

MELOCRINUS GREGERI (n. sp.).

Fig. 1. Side view of the body, natural size.

TAXOCRINUS CONCAVUS (n. sp.).

Fig. 2. Side view of the body, natural size.

BATOCRINUS SHEPARDI (n. sp.).

Fig. 3. Side view of the body, natural size.

GRANATOCRINUS MUTABILIS (n. sp.).

Fig. 4. Side view of a large specimen, enlarged two diameters. Fig. 5. An elongate specimen, natural size. Fig 6. Specimen with prominent base, natural size. Fig. 7. Base of same specimen, enlarged two diameters. Fig. 8. Top of another specimen, enlarged two diameters. Fig. 9. A small individual, natural size.

SPIRIFERA MUNDULA (n. sp.).

Figs. 10, 11 and 12. Dorsal and cardinal views and cross section, natural size.

SPIRIFERINA ACICULIFERA (n. sp.).

Figs. 13 and 14. Cardinal and ventral views, enlarged two diameters.

CYRTINA BURLINGTONENSIS (n. sp.).

Figs. 15 and 16. Cardinal and dorsal views, natural size.

Fig. 17. Profile of a larger specimen, natural size.

STROPHALOSIA BEECHERI (n. sp.).

Figs. 18 and 19. Ventral and cardinal views, natural size.

THE KENT SECTION AND GRYPHÆA TUCUMCARII MARCOU.

By E. T. DUMBLE and W. F. CUMMINS, Texas Geological Survey.

Kent, a station on the Texas and Pacific railroad, four hundred and fifty miles west of Fort Worth, and one hundred and sixty-three miles east of El Paso, is situated on the northeast slope of the Davis mountains, which rise in gradually ascending peaks and ridges to the south and southwest. The railroad here follows a valley eroded in the Cretaceous foot-hills, and it is in these hills, north and south of the road, and within a radius of a mile from the depot, that we find our section. We desire to call attention to the occurrence of *Gryphæa dilatata* var. *tucumcarii* Marcou at this locality, where a stop-off of one day is ample time to permit a fair study of the section from the Paluxy sands to the top of the Fort Worth limestone.

A little less than a mile west of the station there is a small branch or creek running north, which crosses the railroad and shortly afterward turns eastward and is lost sight of amid the undulations of the hills. On the east bank of the creek, just by the side of the railway track, an excavation some sixteen feet in diameter has been made by the railroad company in expectation of getting water, and this gives us a clear section of sixty feet, the details of which are reproduced in the rock materials forming the creek-banks and hill-slopes north and south of the road. The dip of the beds here found is very slight toward the Davis mountains. From the creek to the beginning of the hill section there is a small flat so covered with drift that the underlying beds cannot be determined. In the hill section, although detritus-covered in places, many washes afford a clear section of about three hundred and fifty feet. The following is the section made by ourselves at our last examination, the measurements being from barometer readings:

Washita Division.

FEET.

1. Interbedded limestones and calcareous clays.................. 20

   The surface of the limestone shows many fragments of fossils, but it is difficult to obtain specimens sufficiently well preserved for identification. *Natica planata* Roem., and *Cerithium bosquense* Shum., are found, also a plicate oyster, an Exogyra, and an Epiaster of indeterminable species.

2. Massive limestone, the beds attaining a thickness of three feet in places, interbedded with thin seams of clay............. 30

   In these layers of limestone are found great numbers of *Exogyra plexa* Cragin, while the lower portion of the beds, which are somewhat less compact, afford a number of fossils, among which are the following: *Exogyra plexa* Cragin, *Gryphæa pitcheri* Mort., *Pecten texanus* Roem., *Natica* sp. ind.

3. Interbedded limestone and marly clays, limestones more compact than those below.................................. 210

   This may be divided into three zones:

3a. From Plexa bed to upper Gryphæa bed 50
3b. From Upper Gryphæa bed to Pyrina bed 110
3c. From Pyrina bed to top of "4" 50

From "3a" the following fossils were collected: *Cardium multistriatum* Con., *Terebratula wacoensis* Roem., *Epiaster whitei* Clarke, *Pholadomya sancti-sabæ* Roem., *Pecten texanus* Roem., *Homomya alta* Roem., *Cyprimeria crassa* Mk., *Gryphæa pitcheri* Mort., *Nautilus texanus* Shum., *Rostellaria* sp. ind., *Holectypus* sp. ind.

In "3b" and "3c" the following forms were found: *Terebratula wacoensis* Roem., *Pecten texanus* Roem., *Enallaster texanus* Roem., *Holectypus planatus* Roem., *Pyrina parryi* Hall, *Pyrina* sp., *Lima wacoensis* Roem., *Pholadomya sancti-sabæ* Roem., *Natica* sp. ind., *Cerithium bosquense* Shum., *Gryphæa pitcheri* Mort. var., *Diplopodia streeruvitzii* Cragin.

4. Interbedded agillaceous limestone and marly clays, the limestone in weathering crumbling readily into rounded fragments. Fossils well preserved. Among those found are: *Epiaster elegans* Shum., *Holaster simplex* Shum., *Nautilus texanus* Shum. 40

5. Blue shaly clays interbedded with brittle yellow limestone of more or less concretionary structure. There are three beds of this limestone which are persistent.

5a. Upper or O. quadriplicata limestone, underlying No. 4 and containing *Ostrea quadriplicata* Shum., *Plicatula incongrua* Con., *Pecten texanus* Roem., *Gryphæa pitcheri* Mort.

5b. Middle or G. tucumcarii limestone. This bed, which has a thickness of four feet, is separated from the last by about ten feet of blue shaly clay and is highly fossiliferous, containing: *Schlœnbachia leonensis* Con., *S. peruviana* von B., *Gryphæa Pitcheri* Mort., *G. dilatata* var *tucumcarii* Marcou, *Cyprimeria crassa* Mk., *Ostrea subovata?* Shum., *Pecten texanus* Roem., *Terebratula wacoensis* Roem., *Trigonia emoryi* Con., *Epiaster* sp. ind., *Turritella seriatim-granulata* Roem., *T. marnochii* White, *Cardium multistriatum* Con.

5c. Lower bed. This bed is six feet below 5b, and in places separates into thinner bands of limestone and shale, while at others it appears as a compact bed of limestone. The fossils contained in it are neither numerous nor very well preserved. The following were collected: *Pecten texanus* Roem., *Schlœnbachia leonensis* Con., *Lima wacoensis* Roem., *Gryphæa pitcheri* Mort 30

Fredericksburg Division.

6. ? Caprina limestone. In the immediate line of our section there is no exposure of this bed, the space in which it should

occur being occupied by drift material to the bank of the creek mentioned above. It is probably absent.

7. Comanche Peak limestone. Along the west bank of the creek and in the well is an exposure of Comanche Peak limestone somewhat more siliceous than farther east, but with its characteristic fossils, among which was: *Schlœnbachia acuto-carinatus*, etc.. 40

8. Texana bed. The well material showed the top of the Texana bed to be a dark blue crystalline limestone composed of *Gryphœa pitcheri* and *Exogyra texana* en masse. In its outcrops on the ravine it also showed its metamorphosed character, and on weathering showed ferruginated seams. The base consists of a yellow compact crystalline limestone well filled with *Ostrea crenulimargo* Roem., the shells of which retain their white color and are not altered to the color of the rock as is the case with the fossils of the upper bed............................ 4

Bosque Division.

9. The Paluxy sands are present, as is usual west of Double mountain, in the form of purple and red sands and brown packsands, and are interbedded toward the bottom with quartzitic layers. They contain but little gravel, and what there is is of small size.. 20

The *G. tucumcarii* bed forms the top, or occurs in the slope, of the numerous spurs running out from the hills proper, and it has for this reason a greater areal exposure, comparatively, than any of the beds above it. For the same reason the *G. tucumcarii*, although quite abundant in places, is also much broken, but several perfect specimens, showing both valves, were secured by digging. Where the *G. tucumcarii* were most abundant the other forms were rarer, but even where the *G. pitcheri* formed the chief fossil of the bed the *tucumcarii* was not entirely wanting. The other fossils mentioned are for the most part well preserved and occur in considerable numbers, as may be seen from the fact that we have twenty specimens of *S. leonensis* from this horizon at this locality. In this bed the concretionary character of the limestone is quite marked, the center of the concretions frequently being formed by some fossil such as *Schlœnbachia leonensis*, and the stratigraphic continuity of the bed was proved by tracing it foot by foot around the entire area worked. No disturbances of any kind were found.

The following table will give the recorded stratigraphic range in Texas of the fossils found in the Washita division of the Kent section:

	Bosque		Fredricksburg.					Washita.		
	Alt'n'g.	Paluxy.	Texana.	Comanche.	Caprina.	Kiamitia.	Ft. Worth.	Denison.	Arietina.	Vola.
Diplopodia streeruvitzii *Crag*										
Enallaster texanus *Roem*				*			*		*	*
Epiaster whitei *Clarke*	*		*				*			
Epiaster elegans *Shum*				*			*			
Holaster simplex *Shum*							*			
Holectypus planatus *Roem*	*			*			*		*	
Pyrina parryi *Hall*				*			*			
Terebratula wacoensis *Roem*							*		*	
Cyprimeria crassa *Mk*			*							
Exogyra plexa *Crag*						*				
Gryphæa pitcheri *Mort*			*	*		*	*	*		*
Gryphæa tucumcarii *Marcou*										
Ostrea quadriplicata *Shum*							*	*		
Ostrea subovata *Shum*				*			*			
Plicatula incongrua *Con*										
Trigonia emoryi *Con*							*			
Pecten texanus *Roem*			*	*			*	*	*	*
Pholodomya sancti-sabæ *Roem*							*			
Homomya alta *Roem*				*			*			
Lima wacoensis *Roem*				*			*		*	
Cardium multistriatum *Con*	*		*	*			*			
Cerithium bosquense, *Shum*			*							
Turritella seriatim-granulata *Roem*				*			*			
Turritella seriatim-granulata, var. marnochii *White*							*			
Natica planata *Roem*							*			
Nautilus texanus *Shum*							*			
Schlœnbachia leonensis *Con*							*			
Sclœnbachia peruvianus *von B*			*	*			*			

Since, therefore, in the Kent section, we have Prof. Marcou's *G. dilatata*, var. *tucumcarii*, in the same bed with such typical Cretaceous forms as *G. pitcheri*,* *Schlœnbachia leonensis*, *S. peruvianus*, *Terebratula wacoensis*, etc., it must here be considered a true Cretaceous form. Its discovery in this connection simply adds one more to the list of fossils occurring in the Washita division of the Cretaceous of Trans-Pecos Texas, whose close resemblance to well-known

* By *G. tucumcarii* is meant the form figured by Prof. Marcou, Geology of North America, Zurich, 1858, Pl. iv. fig. 3, and in Report of U. S. and Mexican Boundary Survey, Pl. 21, fig. 3a, 3b, 3c. The *G. pitcheri* of this bed is the form figured by Prof. Marcou, loc. cit., Pl. iv, figs. 5 and 6. The Texas Geological Survey has a large number of specimens of both species from the type localities, and typical specimens are not to be confounded with each other or with other forms of Gryphæa by any one at all familiar with them, although varietal forms of one may be indistinguishable from the other.

Jurassic types would, under any less conclusive evidence of its Cretaceous age warrant its reference to the Jurassic.

This section also extends the recorded range of the following fossils: *Cerithium bosquense* from the Texana beds to the Fort Worth limestone,* *Cyprimeria crassa* from the Texana beds to the Fort Worth limestone, and *Exogyra plexa* from the Kiamitia clay to the top of the Fort Worth limestone. Furthermore, it gives the horizon of *Diplopodia streeruvitzii* and *Plicatula incongrua*, which were hitherto uncertain.

THE PLEISTOCENE ROCK GORGES OF NORTHWESTERN ILLINOIS.

By Oscar H. Hershey, Freeport, Ill.

Cause of formation of gorges.—The portion of northwestern Illinois extending from the glacial boundary on the southeast side of the "driftless area," east and south 30 to 50 miles, is underlain by one of the oldest drift sheets in North America. Its formation probably dates from the time of the maximum extension of glacial ice in the Mississippi valley, and hence it is a portion of what is commonly known as the "earlier drift." After the ice which formed this drift sheet had disappeared from the region, the land remained uncovered for a period of time during which the till sheet was deeply oxidized and leached and a soil formed at its surface. Following this was a depression of the land, probably some hundreds of feet and the deposition of a bed of silt or loess over the till. No very important changes have been effected in the region since then, as the ordinary agencies of erosion and soil formation have been at work continuously to the present time.

Northwestern Illinois is a comparatively hilly region. From a partially completed basal plain of erosion, the streams since early Tertiary time have excavated broad valleys, several hundred feet in extreme depth, with gently sloping sides, deeply cut by ravines. Glacial abrasion of the rock surface has been slight, not enough to destroy the chief features of the preglacial topography: and the amount of drift, especially of the ground

*Determined by F. W. Cragin.

moraine or till sheet, is not sufficient to obscure the original contours of the land. Therefore the exact size and shape of the preglacial valleys can be very easily determined.

The ground moraine is accompanied by a complex system of gravel and sand beds of Glacial age, occurring in the form of ridges and knolls, and collected into belts which cross the country more or less parallel to each other. Their chief development is in the valleys, which they sometimes follow, but just as frequently they trend obliquely across, and in quite a number of cases they cross a small valley at right angles to its course. In this way many of the preglacial valleys have become partially filled, at certain points, with glacial gravels and sands. Obviously, on the melting of the ice-sheet from northwestern Illinois, and when the gravel beds had settled to their permanent positions, small lakes and ponds must have come into existence in those valleys which were partially filled with drift at some given point. The ponded water, in seeking an outlet, flowed over the lowest place in the rim of its basin, and so determined the future course of the stream. Now, it so happened that in quite a number of cases, the gravel and sand bed closing the valley rose to such a hight that the stream was completely blocked in that direction, and began to cut its outlet through the solid rock at the side of the original valley. In course of time an entirely new valley was formed, which can be very readily distinguished from those which are preglacial in age.

Rock gorges, by which term are meant very narrow valleys having steep, almost precipitous sides, composed of solid rock strata, occur in nearly all parts of the district in northwestern Illinois under discussion, and in nearly every case can be traced to the above cause. If each gorge indicates the presence, at one time, of a small lake or pond, as it evidently does, a map of the region made in early Glacial times would probably show a surface thickly studded with small lakes. For the county of Stephenson it has been calculated that the amount of water surface must have been at least one twenty-fifth part of its area.

Description.—The following table has been prepared from measurements and estimates of the dimensions of a few of these rock gorges:

Number.	Situation.	Drainage area.	Length.	Breadth.	Depth.	Cubic contents.	Width of bottom.	Width of present stream.	Ratio, width of bottom to width of stream.
		Sq.m.	Ft.	Ft.	Ft.	Cubic yds.	Ft.	Ft.	
1	1 m. N. of Freeport..	¼	950	140	29	140,000	50	5	10 : 1
2	5 m. N.W. of Freeport	4	850	240	44	330,000	175	25	7 : 1
3	3 m. S. of Freeport...	10	2050	235	36	640,000	200	20	10 : 1
4	Cedarville...........	29	3250	160	57	1,100,000	133	25	5.3: 1
5	Cedarville............	1½	225	175	15	21,875	150	5	30 : 1
6	3 m. W. of Freeport..	1	950	100	25	88,000	80	8	10 : 1
7	4 m. W. of Freeport..	5	1100	165	30	202,000	145	10	14.5: 1

No. 1 is at the present time occupied by running water only in spring and during periods of excessive rainfall. Several of the others represent a portion only of the real gorge. Only those parts were measured that are entirely of glacial and postglacial age, as in other portions it is difficult to eliminate preglacial erosion. In valleys of this class, extending over only a portion of the stream's course, the cubic contents are to be considered in relation to the length of the measured portion. More importance is attached to the width of the trough than to the amount of material removed.

The Cedarville gorge (No. 4 of the table) may be taken as the type, and a description of it will apply, with some modifications, to all the others. Cedar creek, situated in the central part of Stephenson county, flows in a general southwest direction into Richland creek. After traversing a broad valley with gently sloping sides covered with drift and loess, it suddenly enters a deep, narrow gorge with steep, rock-bound walls. The contraction of the valley from 3,000 to 160 feet is conspicuous and readily attracts attention. The old valley can be traced around by the south, but is partially filled with sand ridges. The sides of the gorge are at some places perpendicular, but generally slope at an angle of about 30°. The bottom is flat, and consists of a bed of dark brown alluvium, through which the stream meanders, sometimes touching one side and sometimes the other, undermining the walls and widening the valley. After about three-fifths of a mile the stream enters a small preglacial valley and the gorge widens, but the same cañon-like character prevails to its end. A small tributary occupies a portion of the old valley, and when Cedar creek again enters this valley the significant fact is learned that a stream one-tenth as large as the main creek flows in a valley ten times as large.

Comparison with postglacial valleys.—From the published accounts of valleys in the newer drift, and from personal examination of such gorges as those of the Wisconsin river at the Dells, and the Niagara river below the falls, it is found to be the rule that the great majority of postglacial rock gorges are but little, or often not at all, wider than the streams which occupy them. Frequently their sides are perpendicular walls of bare rock, with the stream touching the base on either side of the cañon. The streams also are contracted to less width in the gorge than where the valley is wider and the drainage gradient less. Postglacial time has not been of sufficient length to allow the excavation of the valleys to proceed in many cases to such an extent as to drain the lakes above them.

But in the rock gorges of northwestern Illinois we find quite a different state of affairs. Not a single lake or pond remains, and the swamp areas that do exist are due to the postglacial deposition of river alluvium. And not only have the gorges been cut to the normal drainage gradient, but they have been widened to many times the width of the present streams flowing in them.

The determination of the exact length of time that would be required in the erosion of the Pleistocene valleys is impossible at the present time, as many of the governing conditions are not thoroughly understood. One of the chief factors is the size of the streams which carried on the excavation. Although there is no direct evidence bearing on the width of the early streams, it is probable that they were larger and more efficient than those of the present day. But even though they may have carried away twice as much water as at the present time, they are not likely to have been much wider within the gorges than those which now occupy them, for, as the eroding power depends largely on the strength of the current, a concentration of the waters would occur within the narrow parts of the valley. That they were not nearly so wide as the present gorges is evident, for it would be preposterous to suppose that a stream 50 feet wide could flow from a drainage basin of less than a fourth of a square mile, or one 175 feet wide from four square miles of land surface.

The table shows that the constricted valleys have bottoms varying from five to thirty times as wide as the present streams. An examination of a score or more has shown the average ratio to be not less than 10:1.

Widening of valleys by the undermining and general degradation of the walls is relatively a much slower process than is the first cutting of the gorge to the water level. Granting that the Pleistocene streams, with their supposed greater size and efficiency as compared with those which have existed in the region in postglacial times, would have been able to cut an outlet for the lakelets back of them in a period equal in length to that which has been occupied in the erosion of the newer drift, the phenomena of the rock gorges would still seem to indicate at least *ten* times as long a period of erosion.

But this difference is further emphasized when we come to compare the erosion of till in the region of the newer drift and the erosion of solid limestone rock in that of the earlier drift. The great majority of lakelets in the former region owe their continued existence to the want of time to enable their outlets to cut down through a barrier of till. The streams of northwestern Illinois have excavated their gorges almost entirely in Galena limestone, a tolerably resistant material, as is shown by its frequent occurrence along streams in perpendicular bluffs. A comparison of the amount of erosion effected on the newer drift in the vicinity of lake Michigan and in the earlier drift region of northwestern Illinois has convinced me that there is not much difference in the amount of excavation, relative to the size of the streams, in till in one region and solid rock in the other. Now, it seems evident that the erosion of a given amount of Galena limestone would take at least ten times as long as for an equal amount of till.

It has been determined to the satisfaction of most glacialists that the ice-sheet last retreated from the regions whose valleys have been selected for comparison, namely, around the head of lake Michigan, the Kettle moraine in Wisconsin, and the vicinity of Niagara falls, about 6,000 to 10,000 years ago, with a probable average of 7,000 years. As the length of time occupied in the erosion of the Pleistocene rock gorges under discussion was apparently not less than ten times as great as on this newer drift, 70,000 years is probably the minimum length of time in which they may have been formed.

Portion of gorge erosion effected during different divisions or sub-epochs of the Glacial period.—For the present purpose it will only be necessary to divide this erosion into two portions, that which preceded the deposition of the loess, and that which has been accomplished since.

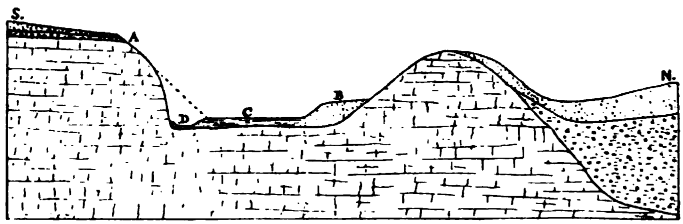
1. Many of the present streams of northwestern Illinois, although very muddy, derive their sediment from the loess of the uplands and from the alluvium along their banks. Very little is derived from the rock bluffs at the foot of which they flow through small parts of their course. They are deep and incapable of carrying (except by floating ice), even in flood time, anything larger than fine sand, and throughout the greater part of the year they can only move the finest silt particles. Hence there is no sediment to grind away the rock, and weathering and solution of the limestone—a slow process —is the chief way in which the valleys are being enlarged. It seems not improbable that the formation of the rock gorges under discussion was practically completed at the close of the Glacial period.

2. While the loess was in process of formation no erosion was being carried on within the valleys, and subsequently the streams had to remove the 8 or 10 feet of stiff yellow loess clay before they could again attack the rock. This may have taken the greater part of the remainder of the Glacial period, although there is evidence that a considerable amount of rock has been removed from the majority of the gorges since the loess was laid down. A portion of this evidence will be presented farther on, and I will dismiss the subject here with the statement that the amount of rock so removed is apparently less than one-fifth of the cubic contents of the gorge.

Were there no other evidence bearing on the subject, for the above reasons alone it would be considered probable that a comparatively small amount of rock excavation has been accomplished since the deposition of the loess.

3. The following is a cross-section of a gorge and a portion

of the old deserted valley of a small tributary of the Pecatonica river five miles northwest of the city of Freeport.



A. Drift. B. Loess. C. Alluvium. D. Present stream.

The obstruction in the old valley is a ridge of sand. The greatest depth of the gorge is 60 feet, which certainly is less than the hight to which the sand ridge must at one time have attained. Its crest is now only about 30 feet above the level of the creek, and the fact that it is completely covered with loess shows that the removal of the upper 30 feet or more was accomplished before the deposition of the loess. It is evident that the bottom of the gorge had been lowered at least to half of its depth during the same time. This is only one of a number of similar cases.

4. It has been shown that lakes existed at one time in various parts of northwestern Illinois, but repeated searches have failed to reveal any deposits overlying the loess in any of the old lake basins. It does not seem probable that every vestige of such deposits would have been removed, without the destruction of the loess, throughout large tracts of the lake basins; and this is considered conclusive evidence that the lakes had ceased to exist, and hence that their outlets had been cut down to the present bottoms of the gorges previous to the deposition of the loess.

5. The foregoing figure shows a remnant of loess resting on the bottom of the gorge along the north side. This from certain characteristics which it possesses, is known to be *in situ.* The bluff immediately back of it as well as all along that side of the valley, is not perpendicular as it should be if it had been eroded within a very recent period, but is a moderately steep slope of 20° to 30°. Atmospheric degradation has reduced its slope to that amount since its base was last undermined by a stream. That this degradation occurred previous

to the formation of the loess seems evident, else there should be a considerable talus on the silt at its base. As the figure shows, the bluff on the opposite side of the valley is steep, almost precipitous up to a certain hight, above which it is inclined at about the same angle as the other side. Apparently a large part of this gorge is pre-loessial in age. Indications of the presence of loess in other gorges have been observed. At Martintown, Green county, Wisconsin, the Pecatonica river has cut for itself a new course, and the western slope of the gorge is almost completely mantled with loess.

The evidence that has so far been presented for the pre-loessial age of a large part of the erosion of the gorges under discussion is merely made use of as corroborative of that which is now to follow.

6. Along Yellow creek, in the southern part of Stephenson county, there is a series of rock gorges of glacial and post-glacial age, scattered along its course for a distance of seven miles. A study of these has shown that they are all of about the same width, varied slightly, however, according to the depth of the gorge. Now one of the series, at the village of Bolton, is so completely *buried under loess* and other deposits of about the same age that for a long time its existence was unknown. Its width is about 400 feet, which is the average for all the gorges along Yellow creek, although the width of the old valley is nowhere less than 3,000 feet.

The lower gorge is situated immediately south of Freeport and is peculiar from the fact that the stream no longer flows in it, being turned into an old valley to the south of it. But that it is of the same age as the rest of the gorges in this region is pretty certain for many reasons. It has the same width, depth, shape, and relative position as have the others; and it is cut at right angles by preglacial tributaries of the old valley, showing its much more recent age. The entire absence of drift also favors the hypothesis of its Glacial age, for had it been in existence before the glaciation of this region, it could not fail to have received a heavy deposit of drift, as have all the old valleys in its vicinity.

This gorge is almost completely *buried under loess*, and there has been no running water in the form of a stream in it since this was deposited. Hence its erosion was entirely pre-loessial. The supposition is that the old valley had become obstructed by a series of gravel ridges, one spur of which remains, by till, heavy deposits of which are exposed on the south side of the valley, and by other deposits of Glacial age. remnants of which can still be found. Subsequently, during the deglaciation interval which followed, the gorge just mentioned was excavated, together with other gorges farther up the creek, and at the same time the obstruction of the old valley was being removed by erosion. Then came the deposition of the loess, after which, because an unusually thick deposit of loess had been laid down in the gorge, whereas the obstruction in the old valley had previously been almost removed, the creek again regained the old course.

It is natural for us to believe that several successive gorges cut by the same creek, in the same time, in the same kind of rock, and with other conditions alike, would differ but little from each other in dimensions and shape. Now by comparing these two gorges, which are evidently pre-loessal, in age, with the others along Yellow creek, we may be able to determine, approximately, the amount of erosion that has been accomplished in them, both before and since our great time-mark, the deposition of the loess. It will thus be found that a large part, perhaps four-fifths or more, of the erosion of all the gorges was accomplished in the deglaciation interval which preceded the loess.

A comparison of the relative size and shape of the gorges which are undoubtedly pre-loessial, with the figure on page 320, shows the probability that the situation of the dotted line, representing an ideal restoration of the gorge just previous to the deposition of the loess, is approximately correct. Similar comparison may be extended to all the gorges of the region, and in the majority of cases we find that the amount of rock removed in post-loessial times is apparently represented by a triangular section, the perpendicular of which now forms a precipitous bluff.

The history of the Pleistocene rock gorges of northwestern Illinois appears to have been as follows: *a*. Obstruction of old valleys by the early drift. *b*. Formation of lakes. *c*. Excavation of deep, narrow gorges, similar to those of postglacial age on the later drift, and consequent destruction of lakes.

d. Widening of gorges to perhaps eight or more times the width of the streams flowing in them. *e.* Reduction of perpendicular bluffs to moderate slopes of 20 to 30°. *f.* Partial filling of gorges by loess. *g.* Removal, in most cases, of loess. *h.* Erosion of portions of the walls of the gorge, cutting back the slopes to perpendicular bluffs. *i.* A period (the present) of very slow erosion.

I have endeavored to show, by means of these rock gorges, that the deglaciation interval, and perhaps interglacial epoch, whose chronological position is between the formation of the drift sheet of northwestern Illinois and the deposition of the loess, was relatively a very long one. Fifty thousand years is considered a minimum, and perhaps twice that time not too great, for the accomplishment of the work which belongs to this epoch.

EDITORIAL COMMENT.

The Columbian Exposition.

The Standard Oil Company's Exhibit of Petroleum.

The Standard Oil Company never does anything shabbily. The master minds which control that vast aggregate of capital and power have attained success more by strict attention given to the smallest details of their business than by any other single factor. This characteristic of thoroughness is finely illustrated by the individual enterprises of the controlling spirits in the organization. The University of Chicago, the Pratt Institute, the great hotels of St. Augustine, speak not alone of the wealth and public spirit of their founders, but the ideas embodied in them tell also a story of organization and thoroughness which have made the business success of the Standard Company possible.

The people of the United States expected that the corporation which had introduced to the world a new illuminant, created so many new lines of industry, and amassed such colossal fortunes for its owners, all within the last quarter of a century, would present a handsome and instructive exhibit at the Columbian Fair, and they have not been disappointed.

Occupying the central portion of the north gallery in the Mining Building, the visitor sees a beautiful colonnade in which graceful Ionic columns alternate with tall lamps and vases of oils. A lighthouse occupies the center, about which is a unique mechanical device which, changing every few seconds, exhibits the names of many of the products which the Standard Company is constantly shipping to all parts of the world.

The exhibit is eminently educational in its entire conception and execution. The history of crude oil from its origin in the rocky strata, through the several stages of transportation, refining, by-products, and distribution to the consumer, is shown in a clear and satisfactory manner. The amount of naphthas, illuminating oils, and residua obtained from a barrel of crude oil is shown quantitatively by the different materials themselves, arranged around a huge bottle (the largest ever made), of crude petroleum, while radiating from this center in eleven cases are exhibited the different by-products manufactured from petroleum, viz: the naphthas, burning oils, lubricating oils, paraffine oils, waxes, candles, vaseline, pomades, soaps, etc.

Alongside illuminating oils of every grade, is shown, in a historical series, the evolution of lamps from the hollowed-out stone of the Esquimaux, the shell of the Ainos, and the clay lamps of East India, down to the modern lamp, ornamented and decorated in the highest style of art.

The crude oil exhibit is particularly fine and complete, there being a specimen from each oil pool in the United States to the number of two hundred or more.

The geology of petroleum has also received especial attention. In addition to a very complete collection of "sands," in which the oils occur, a large profile section from Olean, New York, westward through Pennsylvania and Ohio to Ft. Wayne, Indiana, showing the distribution of the oil sand reservoirs in the column of rocks, ornaments the front of the exhibit, while the windows at the back are filled with interesting transparencies of subjects connected with the oil industry. One of these (a map of the United States showing the oil-producing regions) is the largest single photograph ever executed.

Not the least interesting of the geological exhibits is a huge cylinder of glass more than twenty feet high, filled with the drillings from a well in the famous McDonald region of Pennsylvania. The well which this column of drillings represents is known as W. C. Herron, No. 2, drilled by the Forest Oil Co. Through the kindness of F. H. Oliphant, of Oil City, the geologist for the Standard Co., the detailed record of this well is given below, as follows:

Mouth of well above tide		1121 feet	
Clay and gravel	0 to	8 feet	
Slate and shells, coal streaks at bottom	34 to	42 feet	
Coal, Pittsburgh	8 to	50 feet	
Slate	4 to	54 feet	Barren Measures 566
Limestone	10 to	64 feet	
Slate	3 to	67 feet	
Limestone	25 to	92 feet	
Slate, soft	3 to	95 feet	
Slate	52 to	147 feet	
Sand and shells	115 to	262 feet	
Slate	102 to	364 feet	
Sand shells	7 to	371 feet	
"Hurry up" sand	45 to	416 feet	
Slate, cased 8¼ inches at 482 feet	159 to	575 feet	
Sandstone (Mahoning), some shells	41 to	616 feet	
Slate, light	36 to	652 feet	Lower coal measures 302
Slate, dark	122 to	774 feet	
Slate	32 to	806 feet	
Sand shells	42 to	848 feet	
Slate	38 to	886 feet	
Sand and shells	32 to	918 feet	
"Salt sand," (salt water at 925 feet)	158 to	1076 feet	No. XII. or Pottsville 299
Slate	10 to	1086 feet	
Sandstone	59 to	1145 feet	
Sandstone, with some slate	14 to	1159 feet	
Sand and shells	26 to	1185 feet	
Sand and shells, some salt water	19 to	1204 feet	
Sandstone	13 to	1217 feet	
Slate (Mauch Chunk)	31 to	1248 feet	
"Big Injun" oil sand (Pocono)	175 to	1423 feet	Venango, Meadville & Sharpsville beds 320
Sand shells	20 to	1443 feet	
Slate	40 to	1483 feet	
Sand shells and slate	10 to	1493 feet	
"Squaw sand"	12 to	1505 feet	
Slate	38 to	1543 feet	
Sandstone (gas sand?)	25 to	1568 feet	

Slate		210 to 1778 feet	
Sand shells		30 to 1808 feet	
Slate		27 to 1835 feet	Crawford shales 352
Shells and slate		10 to 1845 feet	
Slate		75 to 1920 feet	
"Hundred foot" sand	Sand shells ("Ganty" sand)	32 to 1952 feet	
	"Fifty foot" sand	55 to 2007 feet	
Slate		68 to 2075 feet	
Slate and shells		45 to 2120 feet	
Slate		30 to 2150 feet	Venango oil sand group 397
"Gordon" oil sand, some oil		30 to 2180 feet	
Slate		52 to 2232 feet	
Shells (4th sand)		12 to 2244 feet	
Slate		40 to 2284 feet	
Sand, 5th sand, oil at 2292 feet		33 to 2317 feet	
Sand shells		7 to 2324 feet	
Slate and sand shells		23 to 2347 feet	
Slate to bottom		37 to 2384 feet	

In this record have been indicated the probable equivalents of the classified series of surface beds given in White's Penna. reports, Q^2, Q^3, and Q^4. This particular oil well was not a large producer, but it was only one-half mile distant from the famous Mathews well which poured forth such an enormous flood of oil, its maximum output being about seven hundred barrels per hour, for a day or two, from the "5th sand" of the above record.

The visitor often wonders what will become of this magnificent exhibit, collected and arranged at such great expense (about $200,000), and constituting such a valuable means of imparting instruction. Most certainly it should be kept together, and we would suggest that no more appropriate place could be found than the University of Chicago, whose foundations have been laid so broad and deep by the chief organizer and controlling spirit of the Standard Company, Mr. John D. Rockefeller.

Professor Hyatt's Rejoinder.

Prof. Hyatt's recent paper on the "Terms of Bioplastology," which is reproduced in this number, from the "Zoologische Anzeiger" of August last, is welcome to students of morphology as it helps to simplify the earlier befogging terminologies which had gone far to disprove the old proverb: "Hard words break no bones." Though it adds one more series to the list, yet its simplicity and fulness, its equal applicability both to the individual and the phylum, and its etymological correctness, ought to insure it long life and ameliorate the embarrassments of the student. A spirit of philanthropy will leave it undisturbed.

REVIEW OF RECENT GEOLOGICAL LITERATURE.

Notes on some fossil plants from the Trinity Division of the Comanche series of Texas. W. M. FONTAINE. (Proc. U. S. Nat. Mus., Vol. XVI, pages 261-282, plates XXXVI-XLIII, 1893.)

A collection of fossil plants made by "J. W. Harvey,"* of Glen Rose, Texas, belonging to the Glen Rose member of the Trinity division of Prof. Hill, constitutes, with the careful descriptions which Prof. Fontaine has given, the first important information we have had of the character of the flora of that problematical formation. It will be remembered, however, that in the last (Third) annual report of the Texas Survey Mr. Cummins has described and figured an angiospermous plant, *Sterculia drakei*, which he found in the vicinity of Tucumcari mountain in beds supposed to be the equivalent of the Comanche, but probably from some higher horizon than the Glen Rose. There is some evidence of a break, by non-conformity, above the Glen Rose, or "alternating beds," and below this break is what is known as the Trinity division. This division has been considered the base of the Cretaceous, both by Prof. Hill, and by the present members of the Texas Survey, while Mr. Marcou stoutly maintains that the Trinity is upper Jurassic.

Prof. Fontaine, after a description of the fossils, which are Equiseta, ferns, cycads and conifers, embracing 23 species, concludes as follows:

"A typical Mesozoic flora is composed of only four elements. These are ferns, cycads, conifers and Equiseta. The flora of this type seems to have reached its culmination in the Jurassic, but many of its plants were continued, with diminishing numbers, through the lower Cretaceous, ending with that epoch. The Wealden of different parts of the world appears to have been the fresh-water and marsh equivalent of the lower portion of the Neocomian, which, in its typical development, represents the marine deposits of the Lower Cretaceous. The typical Wealden contains no element in addition to the four given above, but the lower Potomac formation, as seen in Virginia, appears to coincide in age with the greater part of the Neocomian, and this gives us, so far

*Prof. Hill has given some facts concerning this collection, and the work of the late "W. M. Harvey." AM. GEOL., X, 328.

as is yet known the first appearance of angiosperms. The older portion of the lower Potomac contains, with a great predominance of Jurassic types, a number of old forms of angiosperms, such as Ficophyllum, Proteæphyllum, Rogersia, etc. In the upper beds of the same angiosperms become more abundant, and they are more modern in type, while the Jurassic element is much diminished. The plants found at Glen Rose show, so far as can be judged from so imperfect a collection, that the Trinity flora finds its closest resemblance in the older portion of the lower Potomac. There is, however, this important difference: No trace of angiosperm, even the most archaic, has been found in the Texas region. We have only the four elements of the typical Jurassic flora. This then makes the Trinity flora somewhat older than the oldest Potomac. The absence of the angiosperms and the presence of the forms that are found indicate decidedly that the Trinity flora is not younger than the earliest stage of the Cretaceous. The number of plants found to be identical with certain of those of the oldest Potomac shows that there is little difference in the age of the two formations. The plant-bearing portion of the Trinity is somewhat older than the basal Potomac strata, but the difference in age cannot be great."

According to the determinations of Prof. Hill the molluscan marine fauna associated with these plants is Neocomian or basal Cretaceous.

The Flora of the Dakota Group. A Posthumous Work, by Leo Lesquereux. Edited by F. H. Knowlton. Monographs of the U. S. Geol. Survey, vol. xvii, pp. 400, with 66 plates. Price $1.10. Washington, 1891. This monograph, which was received a few months ago, presents in systematic order a full list of all the plant species thus far discovered from the Dakota sandstone formation, chiefly in Kansas, Nebraska and Minnesota. Many of the species had been before described by Lesquereux in 1874 and 1883, in his volumes VI and VIII of the final reports of the U. S. Geol. Survey of the Territories, under the direction of Dr. Hayden. A part of these are here simply noted in the catalogue, with references to the places of their original description; but subsequent discoveries of better specimens of a large number of these plants, and the accession of many new species, led to the present work. Even after this work was once completed and forwarded early in 1888 for publication, it was recalled to include the exceptionally rich collections of the Dakota flora obtained during that year by Mr. Charles H. Sternberg, Judge E. P. West, and others in Ellsworth county, Kansas. These latest additions gave 110 new species, with which the entire known flora of this formation is brought up to 460 species. Its European correlative, the Cenomanian formation of Middle Cretaceous age, has supplied only about 110 plant species; but the Cenomanian schists of Atane, Greenland, whose flora has been so thoroughly studied by Heer, contain 274 species. The nearest relationship of the Dakota flora is with that of the Atane beds, the two having 39 species in common, while the whole number of Dakota plants known elsewhere, including these of Atane, is 66. Perhaps the next most close affinity is shown by the Senonian or Upper Cretaceous beds of Patoot, Greenland, in which 17 Dakota species are found; and 12 Dakota plants occur in the Amboy clay of New Jersey.

The Dakota flora comprises 6 ferns, 12 cycads, 15 conifers, 8 monocotyledons and 429 dicotyledons; while the schists of Atane have yielded 31 ferns, 8 cycads, 27 conifers, 8 monocotyledons and 197 species of dicotyledonous plants. The greater abundance of ferns and conifers in Greenland was probably due, as Lesquereux suggests, to the difference of some thirty-five degrees in latitude and the probably moister and cooler climate at the north. Although the oldest known traces of dicotyledonous species are the leaves of poplar trees in the Cretaceous schists of Kome, Greenland, next underlying the Atane beds, this class of plants multiplied very rapidly so that in the next epoch they generally covered the land and doubtless formed extensive and majestic forests. The Dakota fossil leaves were evidently derived from trees and shrubs growing close on the borders of marshy tracts, or, perhaps, on alluvial lands occasionally overflowed, where they were buried and fossilized. They are generally found flattened in the planes of sedimentation, being neither crumpled, rolled nor lacerated; and sometimes all the leaves of one locality belong to a single species, while at a short distance another group of leaves represents other species, genera or even families. The author reached the conclusion, from the study for this volume, that "the flora of North America is not, at the present epoch, and has not been in past geological times, composed of foreign elements brought to this continent by migration, but that it is indigenous."

It is stated by the editor that scarcely any changes in the manuscript were made, beyond such as were called for by Prof. Lesquereux's notes, written during his examination of the new Kansas collections, which occupied the closing year of his life, so far as strength remained for scientific work. Mr. Knowlton also appends a notice of the life of Lesquereux, with an autobiographical letter addressed in 1884 to Prof. L. F. Ward, and an extract from Prof. Edward Orton's biographical article in the AMERICAN GEOLOGIST of May, 1890.

Gasteropoda and Cephalopoda of the Raritan clays and Greensand marls of New Jersey. By ROBERT PARR WHITFIELD. Monographs of the U. S. Geol. Survey, vol. xviii, pp. 402, with 50 plates and 2 figures in the text. Price, $1.00. Washington, 1892. This report of work done for the Geol. Survey of New Jersey supplements the previous volume by the same author which forms the ninth in this series of monographs, treating of the brachiopods and lamellibranchiates of these formations. The fossils described in both volumes exist chiefly in the form of casts, except in the case of the cephalopod shells of which many fragments are obtained. It has been, therefore, a task of unusual difficulty to determine the species and prepare their illustrations. Besides the species which are described and figured, numerous others are in too imperfect condition to permit publication.

The strata yielding these shells have been denominated, in ascending order, the Raritan clays, Camden clays, and Lower, Middle and Upper marls. Excepting the highest layers of the Upper marls, which bear an Eocene molluscan fauna, the whole series is of Upper Cretaceous age, clearly related to beds of the southern states, and equivalent with the Ft. Pierre and Fox Hills formations of the upper Missouri region. The Lower green marls, which are the most richly fossiliferous, contain 303 species of mollusca; and next to this in order of abundance is the Eocene division of the Upper green marls, which have 79 molluscan species. The forms described in the present work comprise 136 gasteropoda and 22 cephalopoda from the Cretaceous beds, and 52 of the former class and two of the latter from the Eocene. Most of these are restricted, so far as known, to New Jersey. The number of the Cretaceous gasteropods found elsewhere is 17, wholly belonging to the southern states; and of Cretaceous cepholopods eight, of which six are common to the southern states and Dakota. Among the Eocene gasteropods, nine occur in Alabama and one other in South Carolina.

Cretaceous Fossil Plants from Minnesota. By LEO LESQUEREUX. pp. 1-22, with Plates A and B, forming chapter I in vol. iii, Final Report of the Geol. and Nat. Hist. Survey of Minnesota; Feb. 15, 1893. Fifty-five specimens submitted by Prof. N. H. Winchell, the state geologist, to Prof. Lesquereux, were found to represent 28 species. Two, a pine and a sequoia, are gymnosperms. All the others are dicotyledons, belonging to eighteen genera, which are distributed to the three great subdivisions of this class of plants, seven being Apetaleæ, two Gamopetaleæ, and nine Dialapetaleæ. At the epoch of their earliest appearance, a diversity and perfection of development is displayed similar to that of the present day. Eight of the species, belonging to an equal number of genera, namely, Sequoia, Populus, Alnites, Ficus, Diospyros, Cissus, Dewalquea, and Protophyllum, are new. Twenty-three species were obtained from the Dakota sandstone on the Cottonwood river near New Ulm, three near Mankato, two in Goodhue county, and two at Austin in Mower county.

The Microscopical Fauna of the Cretaceous in Minnesota with additions from Nebraska and Illinois. By ANTHONY WOODWARD and BENJAMIN W. THOMAS. pp. 23-54, with Plates C, D, and E, forming chapter II in the volume before noted; Feb. 15, 1893. In this paper are described 30 species, belonging to 18 genera, of foraminifers, mostly found in the glacial drift but originally derived from Cretaceous beds. The samples of the till or boulder-clay examined were supplied by Prof. N. H. Winchell from Meeker county, Minn., by Prof. G. D. Swezey from Nebraska, and by the authors from their own collections in the vicinity of Chicago. Much of this drift abounds with remains of Foraminifera, radiolarians, coccoliths, rhabdoliths, sponge spicules, and other microscopic organisms, many of which are identical with species now living in the Atlantic, Mediterranean, and other oceanic waters. Samples of Cretaceous shales collected by H. V. Winchell on the Little fork of Rainy river, and of soft limestone from the Niobrara formation near New Ulm, Minn., were found to be well charged with the same organisms. Their plentiful occurrence in the till at Chicago leads to the belief that the Cretaceous ocean, which is known by remnants of its deposits to have reached across nearly or quite the entire state of Minnesota, also extended east to the region about the northern part of lake Michigan, whence the Cretaceous Foraminifera were probably supplied to the Illinois glacial drift.

Sponges, Graptolites and Corals from the Lower Silurian of Minnesota. By N. H. WINCHELL and C. SCHUCHERT. pp. 55-95, with Plates F and G, and seven figures in the text, forming chapter III in the volume before noted; June 6, 1893. The species described with figures in this paper are *Receptaculites oweni* Hall, *Ischadites iowensis* Owen (sp.), *Lepidolites dickhauti* Ulrich, *Anomalospongia reticulata* Ulrich, *Rauffella filosa* Ulrich, *R. palmipes* Ulrich, *Cylindrocœlia minnesotensis* Ulrich, *Heterospongia subramosa* Ulrich, *Hindia parva* Ulrich, *Solenopora compacta* Billings, *Diplograptus pristis* (Hisinger) Hall, *D. putillus* Hall, *Climacograptus typicalis* Hall, *Lichenaria typa* (gen. et sp. nov.) W. and S., *L. minor* (n. sp.) Ulrich, *Columnaria* (?) *halli* Nicholson, *Streptelasma profundum* (Conrad ms.) Owen, *S. parasiticum* (n. sp.) Ulrich, *S. corniculum* Hall, *S. breve* (n. sp.) Ulrich, *S. rusticum* Billings, *Protaræa vetusta* Hall (sp.), and *Aulopora* (?) *trentonensis* (n. sp.) W. and S. These fossils occur in the Trenton, Galena, and Hudson River formations of southeastern Minnesota, beyond which their known geographic and geologic range in the case of species found elsewhere is also noted.

On Lower Silurian Bryozoa of Minnesota. By E. O. ULRICH. pp. 96-332, with 28 plates, and figures 8-20 in the text, forming chapter IV in the volume before noted; Jan. 15, 1893. This elaborate monograph comprises descriptions of 156 species of Bryozoa, referred to 49 genera. Seventy-five of the species and seven genera are new, being here described for the first time. Many others are also of Mr. Ulrich's publication, but in previous reports or journals, notably the Journal of the Cincinnati Society of Natural History. They are found in great abundance in the Trenton and Galena shales and limestones from Minneapolis and St. Paul southward through the Lower Silurian portion of the state.

"It is a singular fact," remarks the author in writing of the geologic distribution of this faunal class, "that no remains whatever of Bryozoa are known from rocks of earlier date than the Chazy limestone of the Lower Silurian system. Here the class suddenly leaps into a prominence, not only in the way of individual representation, but in the matter of diversity of structure, that is both surprising and difficult of explanation. Nor was it, as might be expected, the simpler types that prevailed here. On the contrary, it is the more complex types like the *Trepostomata* and *Cryptostomata* that are the most abundant and diverse in their development. What may be even more surprising is that every suborder known in the fossil state was represented before the close of the Lower Silurian era."

The plates illustrating this report are admirably executed, and give usually several figures for each species, some of which appear in one or more varieties besides the type.

The Lower Silurian Brachiopoda of Minnesota. By N. H. Winchell and Charles Schuhert. pp. 333-474, with plates 29-34, and figures 21-34 in the text, forming chapter v in the volume before noted; June 6, 1893. Without counting numerous subgenera and varieties which are noticed in this chapter, it gives descriptions and figures of 79 species, under 27 genera. Ten are new species, and a considerable number besides are by the same authors, having been described in the Am. Geologist for May, 1892.

In noting the manner of occurrence of these shells in the Trenton shales of St. Paul and Minneapolis and other localities thence southward, the following remarks are given concerning the stages of growth often represented: "Much can be accomplished in the discovery of young specimens 1 mm. in size up to maturity. These small specimens cannot be picked up on the hillsides, nor on the quarry dumps, but usually where adult examples of a species are abundant, there, also, will be found all individuals from the youngest to the mature shells. Collectors discovering such localities should not fail to carry away a small sample of the shale to be washed carefully in a pan until the water is colored no longer by the residuum. After drying, what remains should be sifted into various sizes to facilitate examination with the hand lens. If the sample proves to contain young specimens, it will be only a matter of washing and picking to secure of a species a complete series of specimens from less than 1 mm. in length to the adult size. Such series are of great value in classification, and much yet remains to be done in this direction. A great deal can also be learned by local collectors in regard to the evolution, introduction and disappearance of the species in these shales." The authors follow Hyatt's nomenclature in their descriptions of successive growth and development stages; and the classification agrees substantially with that presented by Schuchert in the Am. Geologist for last March.

A Monograph of the British Palæozoic Phyllopoda (Phyllocarida Packard), by T. Rupert Jones and Henry Woodward. Part ii, Some Bivalved and Univalved Species, pp. 73-124, pls. xiii-xvii. London, 1892. (The Palæontographical Society, volume for 1892).

Under a grant from the British Association for the Advancement of Science, these eminent authorities on the fossil Crustacea, together with R. Etheridge, sr., whose name does not appear in this publication, undertook, some years ago, the monographing of the British species of Palæozoic Phyllocarids. After various preliminary papers which have taken the form of annual reports to their patron society, and which purported to be, in the main, essays toward the classification of these fossils, a finished report (Part I) was published by the Palæontographical Society in 1888, embracing the Ceratiocaridæ of Great Britain. This second part, without entering upon any elaborate classification, discusses first, *Phyllopodous forms with hinged or folded valve-like carapaces* (including *Hymenocaris*, *Lingulocaris*, *Saccocaris* and *Caryocaris*, all Salter's genera and the last three still very imperfectly and unsatisfactorily known), and, second, *shield-like phyllopodous carapaces sutured along the back*: the fossils which have been described as *Aptychopsis*, *Peltocaris*, etc. Under this caption the opportunity is taken of making some reference to the fossils known as *Discinocaris*, *Cardiocaris*, *Spathiocaris* and *Ellipsocaris*, which were believed by their describers to represent rostrate phyllopod (or phyllocano) carapaces, having not remote relation to *Peltocaris*; and herein a very instructive illustration is afforded of a structural similarity in organs having not only totally distinct functions, but belonging to widely different organisms. *Peltocaris*, which was the first of this group of genera to be described, is a nearly circular body divided by a median suture, and with a broad triangular notch at one end. The fact that this notch is sometimes filled by a triangular plate led to the inference, unquestionally accurate, that the fossil represented the carapace of some rostrate crustacean. *Discinocaris* and *Aptychopsis*, which, with *Peltocaris*, are from Ordovician and Silurian faunas, were the next to be described; and these also showed the same rostrate structure, with some slight modification in outline and contour, *Discinocaris* not having the median dorsal suture. Then followed the descriptions of *Cardiocaris* and *Ellipsocaris* by Woodward, and *Spathiocaris* by Clarke, all from the Devonian, and all having, like *Discinocaris*, no median suture, but possessing the anterior triangular cleft of the proper size for a rostrum, though such a plate has never been found in one. These non-sutured bodies, whether Silurian or Devonian, are alike in every palpable feature, barring the persistent absence of the rostrum in the latter. They are tenuous carbonaceous plates, without any very positive evidence of division into lamellæ, their surface always covered by regular concentric ridges; and, adding the median suture, the same is true of *Peltocaris* and *Aptychopsis*. Some of these Devonian bodies were referred to, long ago, by De Verneuil, Keyserling and F. Roemer as *Aptychi* of goniatites, and this function was fairly demonstrated for at least one form, *Spoteocaris koeneni*, by Kayser's discovery of a specimen in the body chamber of *Gon. intumescens*, which it precisely fitted. Woodward afterward illustrated other goniatites which contained forms referred to *Cardiocaris*, so that one can no longer hesitate to hold with these authors that "some of the so-called little shield-like fossils which came from goniatitiferous Devonian strata will have to be referred to Goniatites." And yet *Discinocaris*, which is almost indistinguishable from some forms of "*Cardiocaris*" occurs in strata which antedate the appearance of goniatites. There are still some points in regard to these bodies so necessary of explanation as to lead to the belief that we have not yet got at the whole truth concerning them. For example, the

American species of *Spathiocaris*, *S. Emersoni*, has been locally found by hundreds, but never yet, so far as known, in any intimate or suggestive association with goniatites, and the only evidence which American specimens have afforded of the possibility of the cephalopodous nature of these fossils is that furnished by one figured upon plate 35 (fig. 22) of the Palæontology of New York, vol. vii, a very small *Dipterocaris*-like shield resting upon the chamber wall of a goniatite, the diameter of whose aperture is many times the length of the debatable body.

Sveriges Kambrisk-siluriska Hyolithidæ och Conulariidæ, by GERARD HOLM. With an English summary. (Sveriges geologiska Undersökning, Ser. C, No. 112) pp. i-ix, 1-158, pls. 1-6, 4to, 1893.

Nothing so elaborate upon these families commonly referred to the Pteropoda (a view to which the author, in common with Neumayr, demurs), more especially upon that of the *Hyolithidæ*, has before appeared, and the work is in every respect an admirable contribution to the systematics and structure of these fossils, fully illustrated with finely drawn and beautifully printed plates.

The genus *Hyolithus* (this form of the word is preferred to *Hyolithes*) is given a comprehensive meaning and is made to embrace a number of generic designations which have quite generally been accorded an independent value, such as *Pharetrella* Hall, *Camarotheca* and *Diplotheca* Matthew, *Orthotheca*, *Ceratotheca* and *Bactrotheca* Novak.*

As far as the 44 Swedish species (37 new) are concerned, the genus is divided into two subgenera, *Orthotheca* and *Hyolithus* s. str., the distinction being based wholly upon the form of the aperture; in *Orthotheca* it is in one sloping plane, while that of *Hyolithus* s. str., is in two planes which form a re-entrant angle at their junction. *Conularia* (Family *Conulariidæ*) is treated without subgeneric division under 16 species, and appended is a description of the new family *Torellellidæ*, erected to embrace the new genus *Torellella*, with two species. The latter are small tubular fossils, very slowly tapering, nearly circular in cross-section and with a straight aperture; resembling shells of *Salterella* and *Coleolus*. One of the species (*T. lævigata*) is from the lower Cambrian, the other (*T. tænia*) from the lower Silurian. These three families and genera are treated as having no close relationship either among themselves or to the pteropods. Instructive chapters on classification, distribution and preservation accompany these descriptions.

Larval Forms of Trilobites from the Lower Helderberg group; by C. E. BEECHER. (American Journal of Science, Aug. 1893, pp. 142-147 pl. 2.)

This number of the American Journal contains two highly important papers on the trilobites, one a remarkable contribution on their anat-

*As incidental reference is made to the genus *Clathrocœlia* Hall, a name introduced for a supposed pteropodous shell from the Hamilton group of New York, it may be well to observe that this name is to be expunged from scientific nomenclature, as the fossils upon which it was based prove to be but the thickened posterior wing of the lamellibranch *Actinopteria decussata*.

omy by W. D. Matthew, noticed in the September number of the GEOLOGIST, the other on the primitive stages of some highly specialized forms, *Acidaspis* and *Phaëthonides*. All embryonic stages that had already been described by Barrande, Ford, Walcott and Matthew were of early and less complicated types. The larva of *Acidaspis* (*A. tuberculata* Conrad) has a predominating cephalon, no thoracic segments, and a small, obscurely separated pygidium. That of *Phaëthonides* has about equal development of cephalon and pygidium, but the thorax is also undifferentiated. Compared with Barrande's earliest stage of *Sao*, in which neither thorax nor pygidium is separated, these forms would seem to be derived or secondary. A remarkable feature in both is the presence of conspicuous surface spines, which cover the cephalic and pygidial margins in *Acidaspis* but are not marginal in *Phaëthonides* except on the pygidium, while several longitudinal rows extend over the entire test. These features are shown to be specific characters whose presence upon the larval test indicates the action of the law of earlier inheritance. In some concluding remarks the author infers that these early larvas in which the distinction between cephalon and pygidium is obscure or wanting are comparable to the *nauplius* of the Crustacea. It is also suggested that the earlier segmented stages of those forms resembled immature conditions of certain of the Isopods. The investigations of Matthew, jr., have also indicated that in the nature of their appendages the trilobites approach the Isopods, the latest evidence thus tending to confirm the idea of Dean Buckland of over a half century ago.

Materialen zur Kenntniss der Devonischen Fauna des Altai's; by TH. TSCHERNYSCHEW. (pp. 1-40, pls. i-iii, 1893.)

A group of about twenty species from the limestones of the Krjukowsk mine in the southwestern Altai indicates a lower Devonian fauna. One of the most characteristic forms is a large *Phacops* (*P. altaicus*) similar to the *P. bombifrons* and *P. logani* Hall, of the American lower Devonian, but without the duplicate pygidial ribs of those species. Species of *Bronteus, Harpes, Proetus, Goniatites latiseptatus*, etc., afford a correlation with the European lower Devonian.

Protospongia rhenana; by CLEMENS SCHLÜTER. (Zeitschr. der deutsch. geolog. Gesellsch. Jahrg. 1892, pp. 615-618.)

To this genus the author refers a hexactinellid sponge from the lower Devonian Hunsrück roofing-slates, at Gemünden. *Protospongia* has not before been reported from faunas later than Cambrian or earliest Silurian (Ordovician), and there are some considerations, notably the large size and coarse reticulation, which ally this fossil more nearly with members of the genera *Dictyospongia, Ectenodictya*, etc.

On Palæosaccus Dawsoni Hinde. *A new genus and species of Hexactinellid Sponge from the Quebec Group (Ordovician) at Little Métis, Quebec, Canada*; by G. J. HINDE. (Geological Magazine, III, x, pp. 56-58, pl. iv, 1893.)

 This name is given to a cylindrical or sack-like sponge whose wall is composed of unusually large and *rhombic* meshes, features distinguishing it from *Protospongia*, *Cyathospongia* and *Dictyospongia*. In the spicular structure so far as made known there are few distinctive differences from the genera named.

Sur le Rouvilligraptus Richardsoni de Cabrières; by CHARLES BARROIS. (Ann. de la Soc. Géol. du Nord, vol. xxi, p. 107, 1893).

Prof. Barrois has identified in Cabrières the Canadian (Quebec) species *Graptolithus richardsoni* Hall, and proposes to designate it by the generic term *Rouvilligraptus*.

Surface Geology of New Jersey, Report of Progress, 1892. By ROLLIN D. SALISBURY, pp. 33-166, with two plates, maps of eskers near Ramsey's in Bergen county, and nine figures in the text. (From the Annual Report of the Geol. Survey of N. J., Trenton, 1893.)

Four months of last year were spent by Prof. Salisbury and several assistants in the detailed examination of the glacial drift and associated deposits of a considerable part of northern New Jersey, which are here described, with explanations of their origin so far as they seem to be determined at the present stage of the work. The report begins with a section devoted to definitions and the criteria for discrimination of the several varieties of glacial and modified drift. Outside the well defined terminal moraine, which was traced across the state by Cook and Smock, much true glacial drift or till is found in many places to a distance of several miles, occurring in general most abundantly near the moraine. At greater distances, to nearly twenty miles, it sometimes exists in patches which are completely separated from each other. The isolation of these areas of till is regarded as the result of subaërial denudation, giving evidence of a much greater amount and longer period of erosion than the moraine and the drift sheet north of it. Scattered boulders are found on many tracts beyond the moraine where other drift deposits are very scanty or wholly absent.

Eskers or osars, which had not before been reported in New Jersey, were discovered in several localities. In the vicinity of Ramsey's, close to the northern boundary of the state, and about a dozen miles west of the Hudson river, a somewhat complex system of eskers has been mapped by Prof. G. E. Culver, who finds them associated with north to south belts of stratified valley drift of which they constitute a part. Kames, or short gravel ridges, knobs and hillocks, are far more common; and kame areas, or markedly undulating and knolly tracts of sand and gravel, occur in many places, chiefly in valleys or on low land, and in some cases south of the terminal moraine. Other formations of modified drift which have an extensive development are overwash plains from the front of the moraine, and terraces and plains along the principal valleys, the latter including the well known Trenton gravels. All these deposits are unhesitatingly ascribed to streams flowing from the ice-sheet. Whether the land was more depressed than now in its relation to the sea level during any part of the Glacial period or afterward, is left an unsettled question.

The shore lines, deltas, outlet, and bed of the glacial lake Passaic, which was provisionally mapped and named by Cook in 1880, have been carefully explored. This lake filled a portion of the Passaic river basin which must have been dammed by the ice-sheet during its greatest advance and the early stages of its recession, having an outlet 331 feet above the present sea level, a maximum area of nearly 200 square miles, and a depth exceeding 100 feet. The shore features and other evidences of lacustrine action, however, are mostly inconspicuous, implying that lake Passaic existed during only a brief time.

Intimately associated with the history of the Glacial period and deposition of the drift, was the erosion of the preglacial Yellow gravel, which had been spread as a plain with its surface 200 to 400 feet above the present level of the sea, where it is now found capping the highest hills, 150 to 200 feet or more above the lowlands. Upon and within the lower and secondary portion of this gravel, redeposited during late stages of its erosion, are strown abundant and large boulders, occasionally glaciated, which are referred by Prof. Salisbury to an early part of the Ice age. The Yellow gravel appears originally to have extended northward upon the now drift-covered area, and southward it is probably continuous as the Lafayette formation along the coastal plain of the Atlantic and Gulf states, while its lower redeposited portion seems to have been contemporaneous and correlative with the Columbia formation.

Iowa Geological Survey. Volume I. First annual report for 1892, with accompanying papers. 4to, pp. 472. Des Moines, 1893. Plates, map and figures.

This report embraces the following: Report of the State Geologist (Calvin); Report of the Assistant State Geologist (Keyes); Geological Formations of Iowa (Keyes); Cretaceous deposits of Woodbury and Plymouth counties with observations on their economic uses (Calvin); Ancient Lava flows in the strata of Iowa (S. W. Beyer); Distribution and relations of the St. Louis limestone in Mahaska county, Iowa (H. F. Bain); Annotated catalogue of minerals (Keyes); Some Niagara lime-burning dolomites and dolomitic building stones of Iowa (G. L. Houser); Bibliography of Iowa Geology (Keyes).

These chapters are put together in a handsomely printed and well-bound volume, making a book, which, regardless of the value of its contents, presents an appearance and promise of thorough, careful and energetic work on the part of its managers and authors. Its size and style are uniform with the final reports of the late survey of Iowa conducted by Dr. C. A. White, issued in 1870.

In the general review of the geologic formations Mr. Keyes puts the Sioux quartzyte of Dr. C. A. White, found in Lyon county, in the extreme northwestern corner of the state, amongst the "Crystalline rocks," quoting Irving's description, which, however, does not make it to be crystalline, but a distinctly fragmental rock, remarking that Irving placed it in the Huronian, a terrane from which Irving specially excluded crystalline rocks (excepting such as are eruptive in the Huronian). He refers to Winchell's having considered it Potsdam, but seems to understand that Winchell's Potsdam is "upper Cambrian," whereas if there be anything which Prof. Winchell has maintained respecting the Potsdam, *i. e.*, the Potsdam at Potsdam, N. Y., it is that it is not upper Cambrian, but much older, and unconformable below the upper Cambrian. There has been great confusion in the use of the term Potsdam because of its having been applied erroneously to two widely different formations, both in New York state and Vermont, and in the Northwest. This confusion, which culminates in a single sentence on p. 17, is increased by all such as persist in putting into the Potsdam such beds as those at Saratoga, N. Y., containing an upper Cambrian fauna (well known long as a characteristic locality for the New York Calciferous), and such beds as the St. Croix, in the west, which contain a similar fauna, since no such beds, nor such a fauna are found at Potsdam, N. Y., but only such as exist in the Sioux quartzyte. Winchell regards the true Potsdam as a part of the true Huronian, and the true Huronian as a synonym of the Taconic, and the whole, of course, as "lower Cambrian," as that term is defined by Walcott. Those strata to which the term Potsdam has also been applied, belonging to the "upper Cambrian," containing the Dikellocephalus fauna, are separated *everywhere* from the true Potsdam by a great non-conformity. The misfortune has been that this non-conformity has never been identified fully in the immediate vicinity of Potsdam, and was wholly unknown and unsuspected until the wider relations and extension of the two formations were studied. It is now known in Vermont, in eastern New York, New Jersey, Pennsylvania, Michigan, Wisconsin and Minnesota. It also occurs in the Black Hills, S. Dak. This break separates the upper Cambrian from the lower, or, more correctly, the Cambrian from the Taconic.

Mr. Keyes, however, is "at home" in the description of the Carboniferous. He gives important illustrated sections of the stratigraphy of the Coal Measures of Central Iowa, taken along the line of the Des Moines and Raccoon rivers. He illustrates a marked non-conformity between the Coal Measures and the St. Louis limestone. The lower or calcareous member of the Carboniferous he styles the "Mississippian series," and this includes the Kaskaskia, St. Louis, Augusta and the Kinderhook limestones, while the "Pennsylvanian series" takes in all the Coal Measures. He affirms that in the overlap of the Coal Measures over older rocks the shore line passed over Lower Carboniferous, Devonian, and even Silurian rocks, which had formed an ancient surface, with hills and vales, ridges and gorges. This general submergence was followed by many minor oscillations, producing great and sudden variations in the lithology of the cotemporaneous strata.

Prof. Calvin, in his discussion of the Cretaceous of Woodbury and Plymouth counties, regards the chalk (Niobrara), the shales (Fort

Benton) and the sandstone (Dakota) as together constituting a grand group varying locally as submergence progressed—the Colorado group, of Hayden—the submergence reaching probably as far east as the Mississippi river in northeastern Iowa. The later Cretaceous, therefore, is farthest east.

Mr. Beyer describes certain quartz porphyries met with in the sinking of a deep well in the town of Hull, Sioux county. These are evidently a part of the acid eruptives accompanying the Sioux quartzyte, and, taken in connection with the olivine diabase described in Minnehaha county, S. Dak., by Culver and Hobbs (Wis. Acad. VIII, 206-210, 1892) and with other stratigraphic and lithologic relations, it forms a strong link connecting the Sioux quartzyte taxonomically with the Pewabic quartzyte of northern Minnesota, both being at the base of the Taconic.

Mr. Keyes' "Bibliography of Iowa Geology" is a very extended cross-reference dictionary or index, and on it was necessarily spent a very large amount of the time covered by the report. It is the most voluminous portion of the book. It will be very useful for reference for all future students of the geology of the state, and cannot be too highly commended.

The volume closes with that indispensable accompaniment of a first-class publication, a good index.

With this publication the Iowa survey takes its place in the front rank of state surveys. It is to be hoped it will be maintained until the enterprise is completed, which would be a credit to the State and to the country.

Geology, by A. J. JUKES-BROWNE, F. G. S. (Whittaker's Library of Popular Science.) This little work is intended to give in short a sketch of geology as the science is now understood. It deals with geological topics in simple language,introducing as few technical terms as possible. But it is not a mere popular outline evading all real difficulties by ignoring their existence.

At the outset it treats of the materials whereof rocks are made and the great problems of erosion and deposition are here discussed. Then the structure and origin of igneous rocks are taken up and volcanoes, lava flows and eruptions are explained.

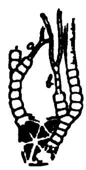
The second part is entitled "How the rocks were brought into the position which they now occupy" and in it the topics of elevation and depression, consolidation, contraction, tilting and contortion, faulting, and thrusting are discussed. This leads to metamorphism and the metamorphic rocks, their formation, origin, and exposure by subsequent erosion of overlying strata.

Part the third enters on palæontology and the various life systems of the strata pass in review, with illustrations, and the author concludes with the geographical geology of the British Isles.

The work is well printed and illustrated, though the figures are familiar. Indeed we could not look for new ones in a work of this nature and scope.

CORRESPONDENCE.

THE REPRODUCTION OF ARMS IN CRINOIDS. In the cabinet of Dr. Welch at Wilmington, Ohio, the son of Dr. L. B. Welch, who furnished so many specimens to U. P. James, of Cincinnati, and other paleontologists, there is a small crinoid considered by him to be *Dendrocrinus casii* Meek. It is interesting, however, as being one of two specimens of this species found by the elder Dr. Welch, illustrating the power of crinoids to reproduce their arms. The figure drawn from the original fragmentary specimen is sufficiently explanatory. The power of star-fish to reproduce their arms is often seen in the living specimens of the seashore. But few persons have access to living crinoids, and their studies in this direction must be made upon fossil forms, as in the present case.



AUG. F. FOERSTE.

ADDITIONAL MODELS AT THE FAIR.—Will you allow me to call the attention of your readers to two models in the Columbian Exposition, not mentioned in your reference to this subject in the October GEOLOGIST. The first of these is a model of part of the valley of the upper Moselle, in the exhibit of the geographical service of the French army; on the same scale, horizontal and vertical (1:20,000 I think), executed with extreme nicety, and to my eye the finest geographical model in the fair. It is ideal in accuracy and delicacy; far above any products of our American studios.

The second is the great model of California, in the California State building, made by Mr. W. D. Johnson, topographer of the U. S. Geological Survey, lately engaged in work in California. Being of a large area, it is somewhat exaggerated vertically; but not so much as to give bad impressions of form. It is tinted to give the natural colors of the landscape, subdued by atmospheric effect, as if viewed from a great altitude. Its execution is remarkably successful; and of this rather than of the vertically exaggerated model of New York I should say it "leaves little to be desired." The New York model is so violent in its relief, that erroneous ideas must be gained from it.

While your article was professedly upon "Geological Maps," it naturally touched upon geographical models as well; but in omitting mention of the French model and of Johnson's California, the best models of the exhibition were neglected, and undue prominence given to inferior work.

W. M. DAVIS.

Cambridge, Mass., Oct. 14, 1893.

THE ST. JOHN GROUP. May I ask your attention to one or two points in your notice in the Sept. number of the GEOLOGIST of my article, No. VII, on the St. John group.

As originally used this name was given to a series of sandstones, slates and shales, whose age was not definitely known by included fossils, but was determined as pre-Devonian by overyling plant-bearing beds.

Subsequently the discovery of primordial fossils in its lower part caused it to be relegated to the Cambrian system. Group after group of fossils of different horizons in the Cambrian system have in these later years been added, until now we know it to contain the whole series of Cambrian deposits. Finally the discovery of the Quebec graptolites in the upper part of the St. John group presented the terrane in a new point of view, and prevented us from considering it a strictly Cambrian formation.

Still we find that even the Quebec or Arenig fauna of these rocks has a strong Cambrian facies; as for instance in the presence of Clonograptus and Dictyonema among the graptolites, and Parabolinella and Cyclognathus among the trilobites. In fact all the trilobites are of Cambrian types; Cyclognathus is but a Peltura with a smooth glabella; and Parabolinella is a subgenus of Parabolina, an essentially Cambrian genus.

The St. John group still has an originality and value as typical of the peculiar development of the earliest Palæozoic rocks along the Atlantic border. It is thus of value as a regional name, though it has lost its claim to general application by the progress of geological discovery.

At the time of the discovery of the Arenig types in the St. John group, the alternative of separating the Arenig horizon presented itself to the writer, and would have commended itself to some. But such a course would have introduced an entirely artificial division, and would have been of no practical benefit; it would have broken up a natural terrane, which, as the St. John group, can be exactly defined, and traced over the surface of the country; but no one can separate from it at all points, the beds containing the Ordovician fauna. Furthermore, in its present distribution the St. John group consists almost entirely of Cambrian strata, for the enormous denudation to which it has been exposed has removed the Ordovician beds from extensive areas of the basins in which this group is found. G. F. MATTHEW.

St. John, N. B., Sept. 25, 1893.

PERSONAL AND SCIENTIFIC NEWS.

RECENT LOSSES TO SCIENCE.—Among the recent losses to science we must include Dr. John Rae, the Arctic explorer, who, though rather a geographer than a geologist, has been a conspicuous figure in both fields for many years, his life extending from 1813-1893.

Mr. Jas. W. Davis, who was more intimately connected with geology, and who has fallen at the early age of 47, was an illustration of the way in which some of our best workers combine the pursuit of Science with the ordinary labors of a busy life. He was engaged in the cloth-dyeing business and was prominent in many political and educational movements, besides being thrice mayor of Halifax, where most of his working life was spent. His chief geological work was on fossil fishes of the Carboniferous and later rocks.

Two well-known students of the fossil Polyzoa have passed almost together from among us, G. R. Vine and G. W. Shrubsole. Both, like Mr. Davis, crowded their scientific labors into lives full of the daily business of life—bread-winning—and all three may be quoted as encouragement to those who plead want of time as an excuse for not gratifying a taste and desire for science. If another example is needed it may be found in Max. von Hantken, of Budapest, lately dead, who, while Hungarian minister of education, found time to act as director of the Hungarian survey and professor of palæontology in the university of the capital city.

Professor Cragin's return.—Since the publication, about the last of June, of his Contribution to the Invertebrate Paleontology of the Texas Cretaceous, which forms a part of the Fourth Annual Report of the Geological Survey of Texas, Prof. Cragin has made a personal examination of the Cretaceous horizons of Texas and Indian Territory, obtaining from them a large private collection rich in the new forms recently described by him, as well as in others hitherto little known or of special zoological or geological interest. Though temporarily engaged in geological work in Kansas, his address is now again Colorado Springs, Colorado, whither he will return to continue his work in Colorado College.

Dr. W. H. Dall describes, in the Proceedings of the U. S. National Museum (vol. xvi, 1893, pp. 471-478, with a plate), a small collection of marine molluscan shells, which were obtained and deposited in the museum many years ago from the Penjinsk gulf of the Okhotsk sea by Dr. William Stimpson, a member of the Ringgold and Rodgers exploring expedition. Five of the six species are regarded as new, but they mostly have their closest affinities with tropical or subtropical shells of southern Japan, China, western Africa, and Australia. Lignite occurs with the shell-bearing strata, which, like the marine beds overlying Eocene lignites in Alaska, are probably of Miocene age. The climate indicated would have a summer sea-water temperature of 70° and a winter average of 60°, with a minimum never approaching the freezing point; whereas the present climate causes the gulf to be ice-bound during more than half the year. The region lies on the opposite side of the pole from the plant-bearing formations in Greenland which give abundant testimony of a similar warm Miocene climate.

THE

AMERICAN GEOLOGIST

VOL. XII. DECEMBER, 1893. No. 6.

GEOLOGIC TIME; AS INDICATED BY THE SEDIMENTARY ROCKS OF NORTH AMERICA.*

By CHARLES D. WALCOTT, Washington, D. C.

CONTENTS.

INTRODUCTION.

Of all subjects of speculative geology few are more attractive or more uncertain in positive results than geologic time. The physicists have drawn the lines closer and closer until the geologist is told that he must bring his estimates of the age of the earth within a limit of from ten to thirty millions of years. The geologist masses his observations and replies that more time is required, and suggests to the physicist that there may be an error somewhere in his data or the method of his treat-

*Vice-Presidential address before Section E, A. A. A. S., Madison, Wis., Aug. 17, 1893.

ment. The geologist realizes that geologic time cannot be reduced to actual time in decades or centuries; there are too many partially recognized or altogether unknown factors; but he can approximate the relative position of certain formations and by comparison of their sediments, dimensions and contained record of life with estimated rates of denudation, sedimentation, and organic growth, form a general estimate of their relative time duration. It is my purpose to-day to take up the consideration of the evidence afforded by the sedimentary rocks of our continental area and largely of a distinct basin of sedimentation with a view of arriving, if possible, at an approximate time period for their deposition. Before so doing, I will briefly refer to a few of the opinions that have been held by geologists on geologic time and the age of the earth. Soon after geology emerged from its pre-systematic stage, in the latter part of the eighteenth century, and assumed an independent position among the inductive sciences, speculations on the age of the earth began. Dr. James Hutton, the founder of modern physical geology and the predecessor of Lyell, in advocating the uniformitarian theory, was the first to argue that the rate of destruction of one land area was the means of measuring the duration of others, and that the continents were formed of the ruins of pre-existing continents, but that in our measurement of time such periods were of indefinite duration.*

It was not, however, until 1830, when Sir Charles Lyell published the results of his profound and philosophical studies of geologic phenomena, that the broad outlines of the law of uniformity, as opposed to the doctrine of geologic catastrophes, was firmly established. This work rendered possible a computation of the age of the earth on the principle that geologic processes were the same in the past as at present. He based his estimate of time on a rate of modification of species of mollusca since the beginning of the "Cambrian period," and divided the geologic series into twelve periods, assigning 20,000,000 years to each for a complete change in their species,—or 240,000,000 years in all. This estimate excluded the "antecedent Laurentian formation."†

The hour at our disposal does not permit of mentioning at length the views of other geologists. Dr. Charles Darwin thought that two hundred millions of years could hardly be considered sufficient for the evolution of organic forms,‡ and Rev. Samuel Haughton assigned 1280 millions of years to pre-Azoic time, and remarked that the globe was habitable, in part at least, for a longer period§. At a later date he estimated a minor limit to geologic time of two hundred millions of years.‖ Dr. James Croll estimated 72 millions years for the time duration since the first deposition of sedimentary rocks, while Sir Alfred R. Wallace thought that 28 millions would suffice.** Of the value of

*Theory of the Earth; or an Investigation of the Laws observable in the Composition, Dissolution and Restoration of Land upon the Globe. Trans. Royal Soc., Edinburgh, vol i, 1788, pt. 1, p. 304.

†Principles of Geology, 10th Ed., vol. 1, 1867, p. 301.

‡Origin of Species, American Ed., from 6th Eng. Ed., 1882, p. 286.

§Manual of Geology, 3rd Ed., 1871, p. 101.

‖Nature, vol. 18, 1878, pp. 267-268.

**Stellar evolution and its relations to geological time, 1889, pp. 48-49.

this estimate he says: "It is not of course supposed that the calculation here makes any approach to accuracy, but it is believed that it does indicate the order of magnitude of the time required."* Dr. Alexander Winchell reduced geologic time still more in his estimate of 3,000,000 years for the whole incrusted age of the world.† Later writers, however, do not accept this, as we find Sir Archibald Geikie concluding on the basis of denudation and deposition that the sedimentary rocks would have required 73 millions of years for their deposition, if denudation was at the rate of one foot in 730 years; or of 680 millions of years if at the slower rate of one foot in 6,800 years.‡ Mr. T. Mellard Reade adopted one foot in 3,000 years as the rate of average denudation throughout geologic time, and obtained a result of 95 millions of years as the time that has elapsed since the beginning of Cambrian time.§ M. A. de Lapparent is one of the few European continental geologists that has written on geologic time. On the basis of mechanical denudation and sedimentation he thinks that from 67 to 90 millions of years would suffice, at the present rate of sedimentation, for everything that has been produced since the consolidation of the crust.‖ The two most recent writers who have taken their initial datum point or "geochrone" from the consideration of late Cenozoic or Pleistocene phenomena have differed materially in their results. Mr. W J McGee estimated that the mean age of the earth is 15,000 million years, and that 7,000 million had elapsed since the beginning of Paleozoic time.** In a subsequent note he modifies this conclusion and gives as a mean estimate 6,000 million years, of which 2,400 million have elapsed since the beginning of the Paleozoic. This is based on a minimum estimate of the age of the earth of 10 million years and a maximum estimate of five million million (5,000,000,000,000) years.†† Prof. Warren Upham concludes that Quaternary time comprises about 100,000 years. He applies Prof. Dana's time ratio and finds on this basis that the time needed for the earth's stratified rocks and the unfolding of its plant and animal life must be about 100 millions of years.‡‡

From the foregoing estimates of geologic time the only conclusion that can be drawn is that the earth is *very old* and that man's occupation of it is but a day's span as compared with the eons that have elapsed since the first consolidation of the rocks with which the geologist is acquainted.

When I began the preparation of this paper it was my intention to carefully analyze the sedimentary rocks of the entire geologic series as

*Island Life, 2d Ed., 1892, pp. 222-223.

†World Life, or Comparative Geology. Chicago, 1883, p. 378.

‡Presidential Address; report of 62d meeting British Assoc. Adv. Sci., 1892, p. 21.

§Measurement of Geological Time, Geol. Mag., vol. 10, 1893, pp. 99-100.

‖De la mesure du temps par les phenomenes de sedimentation. Bull. Soc. Geol. France, 3d ser., vol. 18, 1890, pp. 351-355. La Destinee de la terre ferme et duree des temps geologiques. Revue des questions scientifiques, July 1891. Pamphlet, Bruxelles. pp. 1-38.

**American Anthropologist, vol. 5, 1892, p. 340.

††Science, vol. 21, 1893, p. 309.

‡‡Am. Jour. Sci., vol. 45, 1893, pp. 217-218.

exposed upon the North American continent. I soon found, however, that the time at my disposal would make this impracticable, and I decided to take up the history of the deposits that accumulated in Paleozoic time on the western side of our continent, in an area that, for convenience, I shall call the Cordilleran sea.* This was chosen as (1) I was personally acquainted with many of its typical sections; (2) there was a broad and almost uninterrupted sedimentation during Paleozoic time, and (3) there is a prospect for obtaining more satisfactory data as a basis of calculation, since calcareous deposits are in excess of those of mechanical origin.

We will now consider certain points in relation to the growth or evolution of the North American continent, as the deposition of mechanical sediments depends to a considerable extent on the character of the adjoining land area, and chemical sedimentation is also influenced by it.

Growth of the Continent.

The Algonkian sediments were deposited in interior and bordering seas that filled the depressions and extended over the margins of the Archean continent. From the great thickness of mechanical sediments it was evidently a period of elevated land and rapid denudation. With the close of Algonkian time extensive orographic movements occurred that outlined the subsequent development of the continent. The lines of the Rocky mountain and Appalachian ranges were emphasized and the great basins of sedimentation west of them defined. Subsequent movements have elevated the old and formed new sub-parallel ranges. These movements were often of long duration and also separated by great intervals of time, as is shown by the long continued base levels of erosion during which the great thickness of calcareous deposits accumulated in the Cordilleran and Appalachian seas. Since Algonkian time the growth of the continent has been by the deposition of sediments in the bordering oceans and interior seas and lakes within the limits of the continental plateau; and it is considered that the relative position of the continental plateau and the deep sea have not materially changed during that period. How much the deposits on the continental border have increased its area is unknown, as at present they are largely concealed beneath the waters of the ocean. During Paleozoic time the two areas of greatest known accumulation were the Appalachian and Cordilleran seas, where 30,000 feet or more of sediments were deposited. In the Cordilleran sea sedimentation was practically uninterrupted (except during a short interval in middle Ordovician time) until towards the close of Paleozoic time. In the northern Appalacian sea it continued without any marked unconformity, from early Cambrian to the close of Ordovician time, and, south of New York, with relatively little interruption, until the close of Paleozoic time. Certain minor disturbances occurred along the eastern border of the sea, but they were not of sufficient extent to affect a general conclusion, —which is that the depression of the areas of deposition within the

*See page 357.

continental platform continued without reversal of the subsidence during Paleozoic time. During Cambrian, and it may be late Algonkian time, the extended interior Mississippian region was practically leveled by denudation, the eroded material being carried into the Cordilleran and Appalachian seas and, probably, to a sea to the south.

The sedimentation of the Mississippian area in Paleozoic time between the Appalachian and the Cordilleran seas, was small as compared to that which accumulated in the latter. In Devonian time there does not appear to have been any sedimentation in the western portion of it west of the 94th meridan and east of the Cordilleran sea, and it was slight in the same interval in the Appalachian sea south of the 37th parallel*. There is little if any evidence in the sediments of Paleozoic time to show that they were deposited in a deep, open ocean; on the contrary, they were largely accumulated in partially enclosed seas or mediterraneans and on the borders of the continental plateau. The former is particularly true of the sedimentation of the Cordilleran and Appalachian seas and the broad Mississippian sea.

The close of the prolonged period of Paleozoic sedimentation was brought about by what Dana has termed the "Appalachian revolution." The topography of the continent was more or less changed, and the conditions of sedimentation that followed were unlike those that preceded. This revolution raised above the sea level a considerable portion of the Cordilleran and the Appalachian sea beds and also of the Mississippian sea, east of the 96th meridian and north of the 34th parallel. In its effect it may be compared to the Algonkian revolution† that preceded the deposition of the Paleozoic sediments.

With the opening of new conditions the sedimentation of the Mesozoic time began upon the Atlantic border and over large areas of the western half of the continent with the deposit of mechanical sediments—sands, silts, etc.,—during Jura-Trias time. They are of a character that naturally follows a period of disturbance of pre-existing conditions and the formation of new basins of deposition with more or less elevated adjoining land areas. At its close orographic movements affecting the positions of the beds occurred upon the Pacific and Atlantic coasts and also, to a more limited degree, throughout the Rocky mountain region. This does not appear to have extended over the plateau region or the central belt between the 97th and 105th meridians.

The Cretaceous formations have their greatest development between the 97th and 112th meridians in Mexico and the United States, in a broad belt which extends from the boundary of the latter to the northwest into the British Possessions as far as the 61st parallel. They

*The non-occurrence of Devonian sediment has not yet been fully explained. It has been suggested that the sea beyond the reach of mechanical sedimentation was too deep for the deposition of calcareous deposits. It is more probable that the sea was shallow and an area of non-deposition, or that its bed was raised to form a low, level land surface at a base level of erosion that was subjected to very slight degradation.

†The term "revolution" is used to describe the culmination of a long series of phenomena that finally resulted in a distinctly marked epoch in the evolution of the continent. The "Appalachian revolution" began far back in the Paleozoic, and culminated in the later stages of the Carboniferous, and the Algonkian revolution probably began far back in Algonkian time.

were of marine origin until towards the close of the period when a prolonged orographic movement elevated a large area of the continent above sea level and locally upturned the Cretaceous strata in the Rocky mountain area. The shoaling of the sea was followed by the formation of great inland lakes in which fresh water deposits succeeded the marine and estuarian sediments. Over the coastal regions they were of marine origin throughout.

The Tertiary sediments deposited on the Cretaceous are marine on the Atlantic, Gulf of Mexico and Pacific coasts, and of fresh water origin in the Rocky mountain and Great Plains areas—where they were deposited in the great inland lakes outlined in the previous period.

Geographic Conditions accompanying the Deposition of Paleozoic Sediments in the Cordilleran Sea.

The assumed area of the Cordilleran or Paleo-Rocky Mountain sea includes over 400,000 square miles between the 35th and 55th parallels. To the eastward, during lower and middle Cambrian time a land area is thought to have extended from east of the 111th meridian across the continent to the Paleo-Appalachian sea. This land was depressed toward the close of middle Cambrian time, and the Mississippian sea expanded over the wide plateau-like interior region, from the gulf of Mexico on the south to the lake Superior region on the north; westward it penetrated among the mountain ridges between the 105th and 111th meridians, laying down the upper Cambrian deposits that are now found in New Mexico, Arizona, eastern Utah, the western half of Colorado, Wyoming, Idaho, and Montana, and still further north into Alberta and British Columbia. During Ordovician, Silurian, Devonian and Carboniferous time this entire Mississipian region, except portions in Devonian time, appears to have been covered by a relatively shallow sea that was coextensive with the Appalachian sea and that communicated freely with the Cordilleran sea. During this same age, however, the Rocky mountain area of New Mexico, Colorado, Utah, Wyoming and Montana formed a more or less well defined boundary of ridges and islands between the Cordilleran and the interior sea up to the 49th parallel. To the north of the latter the conditions appear to have been the same as on the eastern side of the continent, where the Appalachian sea communicated freely with the Mississipian sea. From the data that we now have I think that the Paleozoic (Mississipian) sea extended at times over nearly all of the area subsequently covered by the Cretaceous and the later formations between the gulf of Mexico and the Arctic ocean. This belt is bounded almost continuously on the east and west by Paleozoic rocks that extend from the Arctic ocean to Mexico, and whether of Cambrian, Ordovician, Silurian or Devonian age they carry essentially the same fauna throughout their extent. In the outcrops of lower strata that rise up through this Cretaceous area, the Cambrian, Ordovician and Carboniferous rocks are found encircling the pre-Paleozoic rocks. Instances in which the Archean rocks have been met with immediately beneath the Cretaceous in borings in Dakota and Minnesota are along the eastern border of the area, next to the Archean rocks, —where it is probable that the Cretaceous overlaps the Paleozoic to the Archean.

The western side of the Cordilleran sea seems to have been bounded by a land area that separated it from the Paleozoic sea, which extended through central California and the Pacific border of British Columbia and Vancouver's Island. From the position of the Carboniferous deposits of California at the present time it appears that this land varied from 100 to 150 miles in width and was practically continuous along the western side of the Cordilleran sea. This view is further strengthened by the fact that the Carboniferous fauna of California has certain characteristics which are not found in the Carboniferous of the Cordilleran area. Our knowledge of the conditions north of the 55th parallel is limited by the want of accurate geologic data. If Cambrian and Carboniferous rocks were not deposited in the Mackenzie river basin and also on the eastern side of the area now covered by Cretaceous strata, the inference is that during Cambrian and Carboniferous time there was a land area to the east and north of the northern Cordilleran sea that may have been tributary to the latter.

Source of Sediments Deposited in the Cordilleran Sea.

The sediments deposited in every sea or lake are derived from land areas either by mechanical or chemical denudation.

Mechanical denudation results from the action of the waves and currents along the shore and the agency of rain, frost, snow, ice, wind, heat, etc., on the land. Rain is the most important factor and the result depends mainly upon its amount and the slope or the gradient of the land. The general average of denudation for the surface of the land areas of the globe, now usually accepted, is one foot in 3,000 years. This varies locally, according to Sir Archibald Geikie, from one foot in 750 years to one foot in 6,000 years*. Of the rate of denudation during Paleozoic time about the Cordilleran sea we know very little, but I think that it was relatively rapid in early Cambrian time and during the deposition of the arenaceous sediments of the Ordovician and Carboniferous. The material forming the argillaceous shales of the Cambrian and Devonian was supplied to the sea more slowly. These conclusions are sustained by the slight change in the character of the faunas where interrupted by the sands and pebbles of the Ordovician and Carboniferous and the marked change between the base and summit of the argillaceous shales. As a whole I think we are justified in assuming a minimum rate of mechanical denudation—of considerably less than one foot in one thousand years—for the area tributary to the Cordilleran sea.

Chemical denudation is the removal of material taken into solution by water. Mr. T. Mellard Reade has discussed this phase of denudation in an admirable manner.† He came to the conclusion from what was

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*Brit. Assoc. Adv. Sci., Sixty-Second Meeting, 1893, p. 21.

†Proc. Liverpool Geol. Soc., vol. 3, pt. 3, 1877, pp. 212-235. Chemical Denudation in relation to Geological time. 1879, pp. 1-61.

known of the volume of water discharged into the ocean per year, the average amount of material in chemical solution, and the area of land surface drained by the rivers, that an average of 100 tons of rocky matter is dissolved per English square mile per annum. Of this he says: "If we allot 50 tons to carbonate of lime, 20 tons to sulphate of lime, 7 to silica, 4 to carbonate of magnesia, 4 to sulphate of magnesia, 1 to peroxide of iron, 8 to chloride of sodium, and 6 to the alkaline carbonates and sulphates we shall probably be as near the truth as present data will allow us to come."* By the use of the data given by Mr. John Murray, in a paper on the total annual rainfall on the land of the globe, and the relation of rainfall to the discharge of rivers,† I obtain 113 tons as the total amount of matter in solution discharged into the Atlantic basin per annum from each square mile of area drained into it. Of this 49 tons consist of carbonate of lime and 5.5 tons of sulphate and phosphate of lime.‡

Mechanical sediments. With the geographic conditions described as prevailing during Paleozoic time, the source of mechanical sediments later than the middle Cambrian must have been from the broken area on the eastern side that extended 100 or 200 miles to the eastward and to a much greater extent from the land along the western side of the sea. The enormous deposit of from 10,000 to 20,000 feet of mechanical sediments in early Cambrian time is explained by the assumption of favorable topographic conditions of denudation following the Algonkian revolution and the presence of a land area over the interior portion of the continent and also, in all probability, between the western side of the Cordilleran sea and the western border of the continent. During this period the conformable pre-fossiliferous strata of the Cambrian accumulated and about 6,000 feet of the lower fossiliferous rocks as they occur in the Eureka district of central Nevada. Following the depression of the continent, which carried down the central area and also introduced the upper Cambrian (Mississippian) sea into the Rocky mountain area of Colorado, etc., there were deposited of mechanical sediments in central Nevada:

Ordovician sands	500 feet
Devonian fine argillaceous muds	2,000 "
Lower Carboniferous sands	3,000 "
Upper Carboniferous conglomerate and sands	2,000 "
	7,500 "

making a total of 7,500 feet of mechanical sediments, the remaining portion of the section (15,150 feet) being limestone.

The following table exhibits the relative thickness of mechanical and chemical deposits in the Cordilleran sea, after the middle Cambrian subsidence:

*Loc. cit., p. 229.

†Scottish Geol. Mag., vol. 3, 1887, pp. 65-77.

‡Total amount removed in solution per annum by rivers, 762,587 tons per cubic mile of river water. Total discharge of river water per annum into the Atlantic, 3,947 cubic miles. Area drained, 26,400,000 square miles. Amount of carbonate of lime per annum, 326,710 tons per cubic mile of river water; of sulphate and phosphate of lime, 37,274 tons.

	Wasatch.	Central Nevada.	Southwest Nevada.	Montana.	Alberta.
Mechanical Sediment.....	10,000	7,500	2,500	1,000	4,600
Chemical Sediment.......	10,400	15,150	13,000	4,000	15,000
Ratio	$\frac{1}{1}$	$\frac{1}{2}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{1}{3}$

If an average is taken of the mechanical sediment deposited subsequent to the close of middle Cambrian time, it will be found to be about 5,000 feet for the entire area, which, I think, does away with any necessity to assume an additional hypothetical land area for the source of the mechanical sediment. The fine sand composing the quartzites and the silt forming the shales, as well as the fine conglomerate of later deposits, were derived from the adjoining land areas, and, in all probability, currents swept through from the ocean to the south or north, distributing the mud and sand contributed from the rivers and streams along the shores.

Chemical Sediments. The present supply of the carbonate of lime, silica, etc., contained in sea-water is derived from waters poured into the sea by rivers and streams. The Cordilleran sea undoubtedly received a large contribution from the adjoining land areas, but a considerable amount was possibly derived from an oceanic current that circulated through it as the southern equatorial current of the Atlantic now sweeps through the Caribbean. From the vast deposits of carbonate of lime it might be assumed, *a priori,* that the waters of a Mississippi or Amazon were poured into it, but there is not any evidence of the existence of such a river, although the tributary area may have been very large in Cambrian and Carboniferous time, if the drainage of the country west of Hudson's Bay was to the westward.

Conditions of deposition. With free communication into the open ocean on the south, and probably on the north, during most of Paleozoic time strong currents must have circulated through the Cordilleran sea. The broad distribution of mechanical sediments of a uniform character clearly shows this to have been the case, especially in pre-Silurian time. The present known distribution of the mechanical sediments indicate that they were mainly brought into the sea from the west,* although a vast amount was derived from the land on the eastern side in pre-Ordovician time; they were quite evenly distributed over the sea bed, except where local accumulations of silt and sand occurred near the larger sources of supply, or in the direction of powerful currents within the sea.

The conditions of the deposition of the carbonate of lime are less clearly understood than those governing mechanical sediments, and I shall enter upon the discussion of them at considerable length. There are three methods by which it usually is considered that it may be deposited: 1. Agency of organisms; 2. Chemical precipitation; 3. By mechanical methods.

*Geol. Expl. Fortieth Parallel, vol. 1, 1878, p. 247.

It is the general opinion of geologists that limestone rocks are the result almost entirely of the consolidation of lime removed from the sea water through the agency of life, and that they consist of the remains of foraminifera, crinoids, corals, etc., or their fragments, embedded in a more or less crystalline matrix resulting from subsequent alteration of the original deposits. This, however, has been seriously questioned. Sorby, in giving his general conclusions of an extensive microscopic examination of limestones states that:

Even if it were possible to study in a detached state the finer granular particles which constitute so large a part of many limestone formations, it would usually be impossible to say whether they had been derived from organisms which can decay down into granules, or from other organisms which can only be worn down into granules, or from ground-down older limestone, or, in some cases, from carbonate of lime deposited chemically as granules. * * * The shape and character of the identifiable fragments do, indeed, *prove* that much of this must have been derived from the decayed and worn-down calcareous organisms; and very often we may reasonably *infer* that the greater part, if not the whole, was so derived; but at the same time, it is impossible to *prove*, from the structure of the rock, whether some or how much was derived from limestones of earlier date, or was deposited chemically, as some certainly must have been.*

In their memoir on coral reefs and other carbonate of lime formations in modern seas, Messrs. Murray and Irvine show that temperature of the water has a controlling influence upon the abundance of species and individuals of lime-secreting organisms; high temperature is more favorable to abundant secretion of carbonate of lime than high salinity.†

Taking the samples of deep-sea deposits collected by the Challenger as a guide, the average percentage of carbonate of lime in the whole of the deposit covering the floor of the ocean is 36.83; of this it is estimated that fully 90 per cent. is derived from pelagic organisms that have fallen from the surface water, the remainder of the carbonate of lime having been secreted by organisms that lay on, or were attached to, the bottom. The estimated area of the various kinds of deposits, the average depth, and the average percentage of carbonate of lime to each are shown in the following table:

TABLE SHOWING THE ESTIMATED AREA, MEAN DEPTH, AND MEAN PERCENTAGE OF $CaCO_3$, OF THE DIFFERENT DEPOSITS.‡

Deposit.		Area, square miles.	Mean Depth in fathoms.	Mean per cent. of $CaCO_3$.
Oceanic Oozes and Clays...	Red clay.............	50,289,600	2,727	6.70
	Radiolarian ooze...	2,790,400	2,894	4.01
	Diatom ooze.........	10,420,600	1,477	22.96
	Globigerina ooze....	47,752,500	1,996	64.53
	Pteropod ooze.....	887,100	1,118	79.26
Terrigenous Deposits.....	Coral sands and muds...........	3,219,800	710	86.41
	Other terrigenous deposits, blue muds, etc..........	27,899,300	1,016	19.20

*Quart. Jour. Geol. Soc., London, vol. 35, 1879, pp. 91-92.
†Proc. Royal Soc., Edinburgh, vol. 17, 1890, p. 81.
‡Loc. cit., p. 82.

"We have little knowledge as to the thickness of these deposits, still such as we have goes to show that in these organic calcareous oozes and muds, we have a vast formation greatly exceeding in bulk and extent the coral reefs of tropical seas; they are most widely distributed in equatorial regions, but some patches of Globigerina ooze are to be found even within the Arctic circle, in the course of the Gulf Stream."*

The percentage of carbonate of lime contained in deposits accumulating at different depths, obtained from 231 samples collected by the Challenger, is shown in the following tabulation:

"14	cases	under	500	fathoms,	m. p. c.	86.04
7	"	"	500 to 1,000	"	"	66.86
24	"	"	1,000 to 1,500	"	"	70.87
42	"	"	1,500 to 2 000	"	"	69.55
68	"	"	2,000 to 2,500	"	"	46.78
65	"	"	2,500 to 3,000	"	"	17.36
8	"	"	3,000 to 3,500	"	"	0.88
3	"	"	3,500 to 4,000	"	"	0.00
1	"	"	4,000	"	"	trace."

The fourteen samples under 500 fathoms are chiefly coral muds and sands, and the seven samples from 500 to 1,000 fathoms contain a considerable quantity of mineral particles from continents or volcanic islands. In all the depths greater than 1,000 fathoms the carbonate of lime is mostly derived from the shells of pelagic organisms that have fallen from the surface waters, and it will be noticed that these wholly disappear from the greater depths.†

By a series of experiments Messrs. Murray and Irvine found: "That although sea water under certain conditions may take up a considerable quantity of carbonate of lime in solution, yet it is unable permanently to retain in solution more than is usually found to be present in sea water, and it is owing to this that the amount of carbonate of lime is so constantly low. The reaction between organic matter and the sulphates present in sea water (to which we have referred) tends also to keep the amount of carbonate of lime in solution at about one-half (0.12 grms.) of what it might contain (0.28 grms. per litre). This peculiarity of sea water in taking up a large amount of amorphous carbonate of lime and throwing it out in crystalline form, accounts for the filling up of the interstices of massive coral with crystalline carbonate in coral islands and other calcareous formations, so that all traces may ultimately be lost of the original organic structures.‡

The authors explain the disappearance of shells and lime deposits in the greater depths of the ocean by their being dissolved by the carbonic acid in the water which is present in larger quantity at great depths and also is produced by the decomposition of the animal matter of the shell and of the various organisms living in the water and on the bottom. They conclude that:

On the whole, however, the quantity of carbonate of lime that is secreted by animals must exceed what is re-dissolved by the action of sea water, and at the present time there is a vast accumulation of the carbonate of lime going on in the ocean. It has been the same in the

*Loc. cit., pp. 82-83.
†Loc. cit., p. 84.
‡Loc. cit., pp. 94-95.

past, for with a few insignificant exceptions all the carbonate of lime in the geological series of rocks has been secreted from sea water, and owes its origin to organisms in the same way as the carbon of the carboniferous formations; the extent of these deposits appears to have increased from the earliest down to the present geological period.*

In their report on deep sea deposits, collected by the Challenger expedition, Messrs. Murray and Renard state that the chemical products formed *in situ* on the floor of the ocean nearly all originate in a sort of broth or ooze, in which the sea water is but slowly renewed. Many of them appear to be formed at the surface of the deposit,—at the line separating the ooze from the superincumbent water, where oxidation takes place. In the deeper layers of the deposit a reduction of the higher oxides frequently occurs, and at the surface of the mud or ooze there are many living animals as well as the dead remains of surface plants and animals.† They also conclude that practically all the carbon of marine organisms must ultimately be resolved into carbonic acid, the quantity of that acid produced in this way must be enormous, and cannot but exert a great solvent action not only on the dead calcareous structure, but also on the minerals in the muds on the floor of the ocean.‡ Of the effect of this destructive action, they say: "In all cases, however, calcareous structures of all kinds are slowly removed from the bottom of the ocean on the death of the organisms, unless rapidly covered up by the accumulating deposits, and in this way protected to a certain extent from the solvent action of the sea-water. It is evident from the Challenger investigations that whole classes of animals with hard calcareous shells and skeletons, remains of which one might suppose would be preserved in modern deposits, are not there represented; although they are now living in immense numbers in the surface waters or on the deposits at the bottom in some regions, yet all traces of them have been removed by solution. A similar removal of calcareous organic structures has undoubtedly taken place in the marine formations of past geologic ages."§

From the preceding statements it is evident that initially the greater part of the carbonate of lime is taken from the sea water by organic agency, but in the working over of this material in the chemical laboratory at the bottom of the sea a considerable portion is taken up by the sea water as amorphous carbonate of lime and thrown out in the crystalline form to form the matrix of the undissolved shells, etc.||

Mr. Bailey Willis has recently studied the question of the deposition of carbonate of lime, and states that "chemists describe two conditions under which bicarbonate of lime may be decomposed into neutral carbonate and carbonic acid: 1st, by diminution of the tension of the carbonic acid in the atmosphere; 2d, by agitation of the solution."

*Loc. cit., p. 100.

†Report on the Scientific Results of the Voyage of H. M. S. Challenger. Deep-Sea Deposits. 1891, p. 337.

‡Loc. cit., p. 255.

§Loc. cit., p. 277. In this connection I wish to ask the student to read Messrs. Murray and Irvine's remarks on pp. 97-99, Proc. Royal Soc. Edinburgh; vol. 17, 1890.

||Proc. Roy. Soc. Edinburgh, vol. 17, 1890, pp. 94-95.

"Theoretically either one of three things may occur to the neutral carbonate of lime, if it be thrown out of solution by either one of these processes. The carbonate may be redissolved, deposited as a calcareous mud, or built into organic structures." He studied some recent limestone deposited in the Everglades of southern Florida and found it to be formed of fragments of shells embedded in calcite. He states that "Under the microscope the unaltered structure of the organic fragments is strikingly different from that of the coarse holocrystalline matrix, in which it is apparent that the crystals developed in place. Were this a limestone of some past geologic period it would be concluded, on the evidence of the crystalline texture of some parts of it, that it had been metamorphosed and that the organic remains now visible had escaped the process which altered the matrix. But the observed conditions of its formation preclude the hypothesis of secondary crystallization."* Apparently the crystalline matrix is one primary product, and the calcareous mud is another, which being precipitated in the solution remains an incoherent sediment.

I think we may accept the conclusion that the deposition of carbonate of lime is by both organic agency and chemical precipitation. It is not necessary to speak of deposition by mechanical methods except in relation to the deposition of chemically derived granules. This probably takes place, and may be a very important factor in the formation of limestones, in seas receiving a large supply of calcium from the land. Calcareous conglomerates do not enter as a prominent deposit in the Cordilleran area.

There is no evidence in the marine geologic formations of this continent that they were deposited in the deep sea; on the contrary, they are unlike such deposits and bear positive evidence of having been laid down in relatively shallow waters. Limestones with ripple-marks and sun cracks occur, and beds of ripple-marked sandstones alternate with shales and limestones. The more massive limestones, however, appear to have accumulated in deeper water. The conditions in the Cordilleran sea were, I think, more favorable for rapid deposition than in the deep open ocean, but probably not as favorable as about coral reefs and islands. The limestones and often the contained fossils clearly indicate the presence of many of the same conditions of deposition as described by the authors I have quoted. More or less decomposed shells occur in nearly every limestone; and a large proportion of limestones, especially the non-metamorphic marbles, clearly show that they were deposited under the influence of the agencies at work in the laboratory of the sea. Willis states that this occurs in the shallow waters of the Everglades of Florida, and there is no *a priori* reason why it did not occur throughout geologic time;—on the contrary, there is no doubt that it did.

Rate of deposit in former times. It has frequently been assumed that in the earlier epochs the conditions were more favorable for rapid denudation and in consequence thereof the transportation and deposition of sediment was greater. Prof. Prestwich considers† that prior to

*See Mr. Willis' article in Journal of Geology, Chicago, July-August, 1893.
†Geology, vol. I, 1886, pp. 60-61.

the sedimentary rocks the land surface consisted of crystalline or igneous rocks subject to rapid decomposition owing to the composition of the atmosphere and to their inherent tendency to decay. They must have yielded to wear and removal with a facility unknown amongst mechanically-formed and detrital strata where erosion operates. He thus accounts for one of the factors that gave the large dimensions and thicknesses of the earlier formations. Mr. Wallace thinks that geological change was probably greater in very remote times,* stating that all telluric action increases as we go back into the past time and that all the forces that have brought about geological phenomena were greater.†

Dr. Woodward says on the opposite view, that in the earliest geological periods each bed of sand, clay, limestone, etc., had actually to be formed, and that later deposits had the older sedimentary ones to furnish material, and, therefore, the newer deposits were laid down more rapidly.‡ This does not impress me strongly; but from my experience among the Paleozoic rocks I agree with Sir A. Geikie, that "we can see no proof whatever, nor even any evidence which suggests that on the whole the rate of waste and sedimentation was more rapid during Mesozoic and Paleozoic time than it is to-day."§

Prof. Huxley, in his Presidential address to the Geological Society of London in 1870, treats of the distribution of animals, and says of his hypothesis that it "requires no supposition that the rate of change in organic life has been either greater or less in ancient times than it is now; nor any assumption, either physical or biological, which has not its justification in analogous phenomena of existing nature."‖

In the Grand Canyon of the Colorado, Arizona, there are 11,950 feet of strata of Algonkian age extending unconformably beneath the Cambrian. There is nothing in this section to indicate that the conditions of deposition were unlike those of the strata of Paleozoic and Mesozoic time. The sandstones, shales, and limestones are identical in appearance and characteristics with those of the latter epoch. The deposition of sulphate of lime and gypsum occurred abundantly in the upper portions of the series, and salt is collected by the Indians from the deposits formed by the saline waters issuing from the sandstone 8,000 feet below the summit of the series. The sandstones and shales were deposited in thin, even laminæ and layers, and the sun cracks and ripple marks give evidence of slow, uniform deposition. In the upper or Chuar terrane, there are 235 feet of limestone. And in one of the layers of limestone, 2,700 feet below the summit of the Chuar terrane,

*Island Life, 2d Ed., 1892, pp. 223-224.

†Sir William Thompson (Lord Kelvin) inferred from his investigations upon the cooling of the earth, that the general climate cannot be sensibly affected by conducted heat at any time more than 10,000 years after the commencement of superficial solidification. Treatise on Natural Philosophy, Cambridge, 1883, vol. I, pt. 2, p. 478.

Of the degree of the sun's heat we know so little that conjectures in relation to it have little force against the conditions indicated by the sedimentary rocks and their contained organic remains.

‡Geol. England and Wales, 2d Ed., 1887, p. 23.

§Rept. Sixty-second Meeting Brit. Assoc. Adv. Sci., 1892, p. 19.

‖Quart. Jour. Geol. Soc., vol. 26, 1870, p. lxiii.

I find abundant evidence of the presence of spiculæ of sponges and what appear to be worn fragments of some small fossils. There is absolutely nothing to indicate more rapid denudation and corresponding deposition in this early pre-Cambrian series than we find in the Paleozoic, Mesozoic or Cenozoic formations.

Paleozoic Sediments of the Cordilleran Sea.

The great sections of sedimentary rocks in Arizona, Nevada, Utah, Montana, and in Alberta, B. A., all bear evidence that the sediments of which they are built up were deposited in a connected and continuous sea that extended from the vicinity of the 34th parallel, on the south, to the Arctic ocean on the north. Judging from the data now available the width of this sea varies from 300 miles in Nevada to 500 miles on the line of the 40th parallel, and, with interruptions by mountain ridges, to 250 miles on the 49th parallel. It appears to have narrowed northward in Alberta and British Columbia. Roughly computed, it covered, south of the 55th parallel, 400,000 square miles, exclusive of any extension westward into northern-central California and southwestern Oregon and to the eastward over the area subsequently covered by the great interior Cretaceous sea. There is also an addition that might be made to allow for the contraction of the area by the later north-and-south faults and thrusts. Dr. G. M. Dawson estimates that in the Alberta and British Columbia area the width of the zone of Paleozoic rocks has probably been reduced one-half by the folding and faulting, or from 200 to 100 miles.* The area assumed for the Cordilleran sea is on this account probably one-half less than it was before the Appalachian revolution.

The Wasatch section, on the eastern side of the area under consideration, has 30,000 feet of strata, of which 10,400 feet are limestone.† Further to the west, 250 miles W. S. W., at Eureka, Nevada, there are 30,000 feet of strata in the entire section, and of this amount 19,000 feet are referred to limestone.‡ In the Pahranagat range and vicinity, 200 miles south of the Eureka section,§ the limestones of the Paleozoic measure over 13,000 feet in a section of 15,500 feet. This section includes only 350 feet of the upper beds of the lower quartzite series, which is upwards of 11,000 feet in thickness in the Schell Creek range of eastern Nevada.‖

On the eastern side of the area, in Montana, 300 miles north of the Wasatch section of Utah, the deposit of Paleozoic sediment is less in volume. Dr. A. C. Peale's section gives 3,800 feet of limestone in 5,000 feet of strata.** This does not include the 6,000 feet or more of sediments that occur below the fossiliferous Cambrian. I believe that the Paleozoic section will be found to be considerably thicker to the west-

*Bull. Geol. Soc. Am., vol 2, 1891, p. 176.

†Geol. Expl. Fortieth Parallel, vol. I, 1878, pp. 155-156.

‡Mon. U. S. Geol. Survey, vol. 20, 1892, p. 178.

§Loc. cit., pp. 186-200.

‖Geol. and Geog. Surveys west of 100th Merid., vol. 3; Geology, 1875, p. 167.

**Author's manuscript.

ward, in Idaho. Continuing to the north 450 miles, the sections measured by Mr. R. G. McConnell give 29,000 feet of Paleozoic strata, including 14,000 feet of limestones.* In a "Note on the Geological Structure of the Selkirk Range," Dr. Geo. M. Dawson describes a section containing upwards of 40,000 feet of mechanical sediments, which he refers largely to the Cambrian.†

The Paleozoic limestones extend to the north, on the line of the eastern Rocky mountains, to the Arctic ocean. In latitude 55° to 60° N. the Devonian limestones are over 2,500 feet in thickness, and there are other still lower Paleozoic rocks that have not yet been studied in detail. The Devonian limestones extend 700 miles in the valley of the Mackenzie, from Great Slave lake to below Fort Good Hope.‡ No Carboniferous limestones have been described from this region.

Tabulating the sections south from the 55th parallel and allowing for a great thinning out of the sediments in Idaho and Montana, we obtain an approximate general average of 21,000 feet of strata, of which 6,000 feet are limestone over an area estimated to include 400,000 square miles. Each square mile includes 27,878,400 cubic feet of limestone for each foot in thickness and 167,270,400,000 cubic feet for a thickness of 6,000 feet, which, with an average of 12.5 cubic feet to the ton, gives 13,381,632,000 tons of limestone and impurities per square mile. The result of ten analyses of clear limestones within the central portion of the area gives an average of 76.5 per cent. of carbonate of lime.§ Taking 75 per cent. as the proportion of pure carbonate of lime (after deducting 50 per cent. to allow for arenaceous and argillaceous material in partings of strata, etc.), there remain 5,018,112,000 tons per square mile; multiplying this by 400,000 the result gives the number of tons of carbonate of lime that were deposited in what we know of the Cordilleran sea in Paleozoic time,—or 2,007,244,800,000,000 tons, or two billion million tons in round numbers.

The following mode of presentation of the above was suggested by Mr. Willis:

In order to proceed with a calculation of the period required to form this thickness of 15,000 feet of mechanical sediment plus 6,000 feet of calcareous sediment, it is necessary, 1st, to compute the cubic volumes of the sediments; 2d, to estimate the area from which they were derived; and 3d, to divide the cubic contents of the sediments by this land area. The result thus obtained represents the depth of erosion required to furnish the whole deposit, from which we may estimate the time under different assumptions of the rate of erosion.

But if we express amounts in cubic feet or tons the figures pass all comprehension; therefore to simplify the statement it is well to use a mile-foot as a unit of volume, that is, the volume of 1 mile square and 1 foot thick. (1 mile-foot=.79 kilometer-meter.) This is equal to 223,000 tons, if 12½ cubic feet of limestone equal one ton.

Thus stated, mechanical sediments covering 400,000 square miles and 15,000 feet thick contain 6 billion mile-feet (4,740 million kilometer-

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*Geol. and Nat. Hist. Sur., Can.; Ann. Rep., 1866, pp. 17D-30D.

†Bull. Geol. Soc. Am., vol. 2, 1891, p. 168.

‡Rept. Expl. Yukon and Mackenzie Rivers Basins, N. W. Terr., Geol. and Nat. Hist. Sur. Canada, vol. 4, (1888-89) 1890, pp. 13D-18D.

§Geol. Expl. Fortieth Par., vol. 2; Mon. U. S. Geol. Survey, vol. 20.

meters); and calcareous sediments covering the same area and 6,000 feet thick correspond to 2 billion and 400 million mile-feet (1,896 million kilometer-meters). In the calcareous sediments a liberal allowance of one-half may be made for arenaceous and argillaceous matter in the limestone and partings, and analyses of ten clear limestones within the central part of the area give a little more than 75 per cent. of carbonate of lime. Applying these reductions we get 900 million mile-feet (711 million kilometer-meters) of pure carbonate of lime.

Duration of Paleozoic Time in the Cordilleran Area.

Estimates from mechanical sedimentation. The land area tributary to the Cordilleran sea was larger before the depression of the continent, towards the close of middle Cambrian time, than during subsequent Paleozoic time. It included a portion of the region to the eastward and probably a belt of land extending well towards the Pacific coast of the continental plateau. The interior (Mississippian) region, west of the 90th meridian, probably drained into the sea to the south, forming a Cambrian Mississippi river prior to middle Cambrian time. This limits the Cambrian drainage into the Cordilleran sea to an area estimated at 1,600,000 square miles. The average thickness of mechanical sediments deposited before upper Cambrian time is estimated at from 10,000 to 15,000 feet. Taking the minimum of 10,000 feet and the assumed drainage area of 1,600,000 square miles and the rate of denudation at one foot in 1,000 years, it would have required 2,500,000 years to carry to the sea and distribute the 10,000 feet of sediment. This means the deposition of .048 of an inch per year, which is very small if the supposed conditions of denudation and transportation were as favorable as the character and mode of occurrence of the sediments indicate. If one-fourth of an inch per year is assumed as the rate of deposition, the 10,000 feet of sediment would have accumulated in 480,000 years or, in round numbers, in 500,000 years, which increases the rate of denudation to one foot in 200 years.*

In dealing with the post-middle Cambrian mechanical sediments we

*By Mr. Willis' method (ante, p. 358) the mechanical sediments of the Paleozoic age for the area under consideration correspond to six billion mile feet. Of this total the greater part, namely, two-thirds or four billion mile-feet, are of Cambrian age. Dividing this volume by the land area just given, 1,600,000 square miles, we get 2,500 feet as the depth of erosion during the formation of the Cambrian mechanical sediments. Assuming different rates of erosion we may obtain times differing as follows:

Cambrian Mechanical Sediments.

Rate of erosion over land area of 1,600,000 square miles.	Time in years for erosion of 2,500 feet.	Rate of deposition over sea area of 400,000 square miles for strata 10,000 feet thick.
1 foot in 3,000 years.	7,500,000	1 foot in 750 years, or .016 inch per annum.
1 foot in 1,000 years.	2,500,000	1 foot in 250 years, or .048 inch per annum.
1 foot in 200 years.	500,000	1 foot in 50 years, or .24 inch per annum.

In view of the evidence of rapid accumulation contained in the strata themselves the most rapid rate of deposition here stated, namely, .24 inch per annum, is considered as the most probable.

have a somewhat different problem, but, as a whole, rapid deposition is indicated. For instance, the Eureka quartzite of the upper Ordovician is a bed of sandstone, varying from 200 to 400 feet in thickness, distributed over a wide area, perhaps 50,000 square miles. It is made almost entirely of a white, clean sand that was deposited in so short an interval that the Trenton fauna in the limestone beneath it and in the limestones above it is essentially the same. The sand appears to have been swept rapidly into the sea and distributed by strong currents. The same is true of the 3,000 feet of the lower Carboniferous sand and the 2,000 feet in the upper portion of the Carboniferous, while the shales of the upper Devonian accumulated more slowly. In this connection we must bear in mind that during the long periods in which the calcareous sediments forming the limestones were being deposited, the tributary land areas were in all probability base-levels of erosion, and chemical denudation was preparing a great supply of mechanical material that, on the raising of the land, was rapidly swept into the sea and distributed. In this manner the time period of actual mechanical denudation was materially shortened, yet, on account of the manifestly slower deposition of the Devonian shales, the rate of denudation should be assumed as less than during Cambrian time.

In post-Cambrian time the area of the land surface was materially reduced by subsidence, which did not, however, greatly extend the Cordilleran sea, and it may fairly be estimated at 600,000 square miles. The depth of mechanical sediments already estimated is 5,000 feet and their volume 2,000,000,000 mile-feet. Dividing the volume by the area of erosion we get 3,300 feet as the depth of erosion required.

Again applying different rates of erosion with allowance for slow progress of degradation during Devonian time, we have:

POST-CAMBRIAN MECHANICAL SEDIMENTS.

Rate of erosion over land area of 600,000 square miles.	Time required for removal of 3,300 feet.	Rate of deposition in sea of 400,000 square miles, for 5,000 feet of strata.
1 foot in 3,000 years.	9,900,000 years.	1 foot in 1980 years, or .006 inch per annum.
1 foot in 1,000 years.	3,300,000 years.	1 foot in 660 years, or .09 inch per annum.
1 foot in 200 years.	660,000 years.	1 foot in 132 years, or .18 inch per annum.

The rate of one foot in 200 years is assumed as the most probable and 660,000 years as the time required for the removal and deposition of the 5,000 feet of post-Cambrian mechanical sediments.

There is one factor that may need to be taken into consideration in estimating the time duration of the deposition of the mechanical sediments of the Cambrian and pre?-Cambrian of the northern portion of the Cordilleran sea that would materially lengthen the period. Dr. George M. Dawson describes the Nisconlith series, especially in the Selkirk range of British Columbia, as composed of "blackish argillite-schists and phyllites, generally calcareous, with some beds of limestone and quartzite, 15,000 feet."* It is correlated with the Bow River series which contains, in the upper portion, the lower Cambrian fauna. The presence of these calcareous beds indicates a slower rate of deposition than we have estimated for the lower portion of the Cambrian series over the greater part of the Cordilleran sea; but as yet the correlation with the sediments of the Cordilleran sea is not sufficiently well established to warrant our allowing a greater time period to the Cambrian on this account.

Estimates from chemical sedimentation. We have estimated that the Paleozoic sediments of the Cordilleran sea contain 2,007,244,800 million tons (900 million mile-feet) of carbonate of lime which was derived by organic or chemical agencies from the sea water to which it was contributed by the land. If oceanic circulation could be excluded from the problem we might proceed directly to estimate the time required to obtain this amount of lime from the land area tributary to the Cordilleran sea. It may be well to make such an estimate on the basis that the area of denudation tributary to the Cordilleran sea in post-middle Cambrian time had 600,000 square miles from which 30,000,000 tons of carbonate of lime and 12,000,000 tons of sulphate of lime were derived per annum;† if we assume T. Mellard Reade's rate of erosion—of 50 tons of carbonate of lime and 20 tons of sulphate of lime per square mile per annum. If all of the 42,000,000 tons (equal to 18.8 mile-feet) per annum were deposited within the limits of the Cordilleran sea, it would have taken 47,790,000 years for the accumulation of the carbonate of lime now estimated to have been deposited in the Cordilleran sea. Such a result is manifestly a maximum, based on the consideration of one set of phenomena. In addition, however, the geographic conditions appear to have been favorable to the free circulation of oceanic currents through the Cordilleran sea, and the temperature was favorable to extensive evaporation and to the development of organic life, as shown by the occurrence of corals in the middle and upper portions of the Paleozoic, from the Mackenzie river basin on the north to southern Nevada on the south. These conditions would reduce the time necessary for the deposition of the carbonate of lime.

Ocean water of the present time contains in solution 151,025,000 tons of solid matter per cubic mile which is divided among various salts. A comparison of the matter in the sea and river water shows that the sea contains 3.85 parts of magnesium to one of calcium and river water contains three parts of calcium to one of magnesium. The silica and alumina of the river water disappear in sea water, while the sodium is accumulated. It is from these considerations and the fact that limestones are so largely formed of carbonate of lime that I have taken the latter as a basis for estimates upon the rate of chemical sedimentation,

*Bull. Geol. Soc. Am., vol. 2, 1891, p. 168.

†Messrs. Murray and Renard consider that organisms have the power of secreting the carbonate of lime from the sulphate of lime contained in the sea water by chemical reaction. For an account of the chemical action that takes place in the sea water see report of the Deep-Sea Deposits of the Challenger Expedition.

 an allowance being made for the presence of silica, alumina and magnesium in the limestones.

Rate of deposition in recent deposits. Of the rate of deposition in recent deposits Messrs. Murray and Renard state, in their report on the deep-sea deposits, that: "It must be admitted that at the present time we have no definite knowledge as to the absolute rate of accumulation of any deep-sea deposit, although we have some information and some indications as to the relative rate of accumulation of the different types of deposits among themselves. The most rapid accumulation appears to take place in the Terrigenous Deposits, and especially in the Blue Muds, not far removed from the embouchures of large rivers. Here no great time would seem to have elapsed since the deposit was formed, so far at least as the materials collected by the dredge, trawl, and sounding tube are concerned.

"Around some coral reefs the accumulation must be rapid, for, although pelagic species with calcareous shells may be numerous in the surface waters, it is often impossible to detect more than an occasional pelagic shell among the other calcareous debris of the deposits.

"The Pelagic Deposits as a whole, having regard to the nature and condition of their organic and mineralogical constituents, evidently accumulate at a much lower rate than the terrigenous deposits, in which the materials washed down from the land play so large a part. The Pteropod and Globigerina oozes of the tropical regions, being chiefly made up of the calcareous shells of a much larger number of tropical species, must necessarily accumulate at a greater rate than the Globigerina oozes in extra-tropical areas or other organic oozes. Diatom ooze, being composed of both calcareous and siliceous organisms, has, again, a more rapid rate of deposition than the Radiolarian ooze, while in a Red Clay there is a minimum rate of growth."*

Prof. James D. Dana estimates that the rate of increase of coral reef limestone formations, where all is most favorable, does not exceed perhaps a sixteenth of an inch a year, or five feet in a thousand years. Of this he says: "And yet such limestones probably form at a more rapid rate than those made of shells."†

Messrs. Murray and Irvine, in their valuable paper on coral reefs and other carbonate of lime formations in modern seas, calculate the total amount of calcium in the whole ocean to be 628,340,000 million tons; also they estimate that 925,866,500 tons of calcium are carried into the ocean from all the rivers of the globe annually. At this rate it would take 680,000 years for the river drainage from the land to carry down an amount of calcium equal to that at present existing in solution in the whole ocean. They say further: "Again, taking the 'Challenger' deposits as a guide, the amount of calcium in these deposits, if they be 22 feet thick, is equal to the total amount of calcium in solution in the whole ocean at the present time. It follows from this that if the salin-

*Report on the scientific results of the voyage of H. M. S. Challenger; Deep-Sea Deposits. 1891, pp. 411-412.

†Corals and Coral Islands, 3d Ed., 1890, pp. 396-397.

ity of the ocean has remained the same as at the present during the whole of this period, then it has taken 680,000 years for the deposits of the above thickness, or containing calcium in amount equal to that at present in solution in the ocean, to have accumulated on the floor of the ocean."* According to this calculation the mean rate of accumulation over existing oceanic areas is $\frac{22}{680000}$ or .000032 feet per annum.

Was deposition of chemical sediments more rapid during Paleozoic time? It has been claimed that the quantity of lime poured into the ocean in earlier times was greater than during the later epochs of geological history,—this arising from the more rapid disintegration of the Archean, crystalline, and volcanic rocks. It is undoubtedly a fact that the ocean was stocked in Archean and Algonkian times with matter in solution that produced salinity, but we have no evidence from chemical precipitation that more calcium was poured into it than could be retained in solution. The Laurentian limestones are crystalline, but, as has been shown, this texture is consistent with either chemical or organic origin. The unaltered limestones of the Algonkian rocks of the Colorado Canyon section show traces of life in thin sections, and they may, to a great extent, be of organic origin. There is no evidence in the texture, bedding, or composition of ancient limestones to indicate that they were deposited under conditions of salinity or of supply differing materially from those of the present, and I do not find that we have reason to believe that the deposition of the carbonate of lime was more rapid in the Paleozoic than during the Mesozoic and Cenozoic times, even though the supply from the land may have been greater. Where the conditions were favorable for the deposition of lime, as in the Cretaceous sea of northern Mexico, we find evidence of an immense accumulation of calcareous sediments. Of the amount of calcareous deposits in the seas outside of the continental areas that are not open to our inspection, we know nothing; but judging from the deposition that is going on today in the great oceans, the accumulation of calcareous sediment has gone on in the past as steadily and uninterruptedly as at present, subject to varying conditions of temperature, life, depth of water, etc.

Area of deposition in Paleozoic time. We have no proof that the salinity of the sea or the amount of calcium contained in it has varied from age to age since Algonkian time. If it has not, all of the calcium poured into the ocean during 2,000,000 years would have about equalled the amount now contained in the limestones of the Cordilleran area. We have, however, to account for the calcium deposited in the interior Mississippian sea and the seas over other portions of this continent and other continental areas and on portions of the floor of the ocean that are not now accessible for observation. It is also to be considered that the land areas subject to denudation in Paleozoic time were, in all probability, of no larger extent than at the present time.

The area of dry land to-day is estimated to be 55,000,000 square miles, and of oceans 137,200,000 square miles.†

*Proc. Royal Soc. Edinburgh, vol. 17, 1890. p. 101.

†Dr. John Murray, Scottish Geog. Mag., vol. 4, 1888, p. 40.

Mr. T. Mellard Reade estimates the area of the Paleozoic formations of Europe at 645,600 square miles in the total area of 3,720,500 square miles. His estimate of the Paleozoic area is of that which is exposed at the present time and does not include that which is concealed beneath other formations. I think it will be a minimum estimate to consider that an equal area is covered by the later formations, which, with that exposed, would give in round numbers 1,290,000 square miles, or one-third of the land area of Europe. In North America nearly one-half of the total area was covered by the Paleozoic sea; in South America it was considerably less; and we know too little of the Asiatic and African continents to place any estimate upon their Paleozoic areas. I think, however, if we take one-fourth of the present land area as the territory covered by the Paleozoic seas we shall be considerably within the actual amount, even if we add to the surface of the continents the margins of the continental platforms now beneath the sea. Deducting the one-fourth from the total land area, there remain 41,250,000 square miles as the land area undergoing denudation during Paleozoic time. It may be claimed that large areas in the archipelago region of the Pacific and in the Arctic ocean may have been land areas at that time. To meet this, 8,750,000 square miles may be added to the 41,250,000 giving a total of 50,000,000 square miles as the land area of Paleozoic time.

The estimated areas of the various deep sea deposits of to-day containing a large percentage of the carbonate of lime, are as follows: Globigerina ooze, 49,520,000 square miles, mean percentage of carbonate of lime 64.53; Pteropod ooze, 400,000 square miles, percentage of carbonate of lime 79.26; coral mud and sand, 2,556,000 square miles, mean percentage of carbonate of lime 86.41. In addition to this, Diatom ooze covers an area of 10,880,000 square miles, with 22.96 percentage of carbonate of lime; and the mean percentage of carbonate of lime in the Blue Mud and other terrigenous deposits that cover 16,050,000 square miles is 19.20. If we consider only those deposits containing over 64 per cent. of carbonate of lime, we have 52,500,000 square miles, over which there is at the present time a deposition of the carbonate of lime being made. We have roughly estimated that in Paleozoic time the area of the Paleozoic sea, in which deposits were being accumulated, was over 13,000,000 square miles. It does appear that there is any good reason to suspect that the area of deposition of the carbonate of lime in the open ocean during Paleozoic time was not fully equal to that of the present time. Adding this area of 52,500,000 to the 13,750,000, we have over 66,000,000 square miles as the probable area in which calcium was being deposited in Paleozoic time.

Conditions favorable for a rapid deposition of the carbonate of lime. The conditions most favorable for the rapid accumulation or deposition of the carbonate of lime through organic or chemical agency are warm water and a constant supply of water through circulation by currents; this is shown by the immense abundance of life where the margin of the continental plateau is touched by the Gulf Stream. Another favorable condition is the supply of carbonate of lime by river water directly into the ocean in the vicinity where the deposition of lime is going on either through organic or inorganic agencies. This is well illustrated by the conditions produced by the Gulf Stream. The oceanic currents, passing along the northeastern coast of South America, sweep the waters of the Amazon through the Caribbean sea into the gulf of Mexico, where they meet the vast volume of water coming from the Mississippi. These are poured out through the narrow straits between Florida and Cuba, and carried northward over the sloping margin of the continental plateau. Under such favorable conditions the deposit must be much greater than in areas where there is little circulation and the supply of calcium is limited to the average which is contained in sea water. If to the preceding there be added extensive evaporation within a partially enclosed sea, the rate of deposition of matter in solution will be largely increased.

Estimate from deposition of calcium derived from Cordilleran sea and the outer ocean, and from the deposition of mechanical sediments. The area over which calcareous deposition was going on during Paleozoic time we have estimated at 66,000,000 square miles, which includes the areas of the seas over the continental platforms and those of the surrounding oceans. As the conditions appear to have been more favorable for the deposition of lime in the Cordilleran and Appalachian seas, we will assume that it was four times that of the open ocean.* With a land area of 50,000,000 square miles (ante. p. 364) and a rate of chemical denudation of 70 tons per square mile per annum, the total calcium contributed to the ocean per year during Paleozoic time would be 3,500 million tons, or 3.78 times as much as that estimated per annum at the present time, which is 925,866,500 tons (ante. p. 362). This would have provided 50.7 tons for deposition per annum per square mile in the 65,000,000 square miles of ocean and seas and 202.8 tons for deposition per annum per square mile in the 400,000 square miles of the Cordilleran and 600,000 square miles of similar seas. On this basis 81,120,000 tons (36.4 mile-feet) were contributed per annum from the ocean water to the deposit in the Cordilleran sea; adding to this the 42,000,000 tons (18.8 mile-feet) contributed per annum by the denudation of the surrounding area to the Cordilleran sea, we have 123,120,000 tons (55.2 mile-feet) as the amount available for deposit per annum in the Cordilleran sea. At this rate it would have required 16,300,000 years to have deposited the 2,007,244,800 million tons (900 million mile-feet) of *calcium* in the Cordilleran sea; adding to this the 1,200,000 years estimated for the deposition of the mechanical sediments, we have a total of 17,500,000 years as the duration of Paleozoic time.

In reviewing the preceding estimates we must consider that through-

*Under the reduction of 50 per cent. for the interbedded and intermingled mechanical sediments and 25 per cent. for other material than calcium deposited from solution, the apparent amount of calcium deposited in the Cordilleran sea was greatly reduced. If this same ratio of reduction is applied to other Paleozoic limestone areas I doubt if over 1,000,000 square miles will be found to contain as large an average amount of calcium per square mile as the Cordilleran area. On this account 1,000,000 square miles is the area taken for the greater rate of deposition of calcium during Paleozoic time.

out I have increased the various factors above those usually accepted; —thus for mechanical sedimentation, the erosion of one foot in 200 years is used. If the usually accepted average of one foot in 3,000 years is taken the time period must be increased fifteen fold (21,000,000 years), or the area of denudation from 1,600,000 square miles to 24,000,000,—or three times the present area of the North American continent.

In the estimate for the amount of chemical denudation the largest average is taken—70 tons of calcium per square mile per annum—and the assumption made that all calcium derived from the adjoining drainage area was deposited within the Cordilleran sea. Again, the total supply provided per annum to ocean waters of Paleozoic time is taken as 3.78 times greater than the amount annually contributed to ocean waters to-day; of this, four times as much is assumed to have been taken out per annum per square mile as was taken by the remaining area in which calcium was being deposited.

The area of the Cordilleran sea is given as 400,000 square miles, but it was probably 600,000, if not much more. It may be claimed that the area tributary to the Cordilleran sea was greater than I have estimated. The evidence, such as it is, is against such a view. As a whole I think the estimate of 17,500,000 years for the duration of Paleozoic time in the Cordilleran area is below the minimum rather than above it.

If the estimated rate of the deposition of coral limestones—five feet in 1,000 years—given by Prof. James D. Dana is correct, the 19,000 feet of Paleozoic limestone in central Nevada would have required 3,800,000 years to have accumulated under the most favorable local conditions surrounding a coral reef. With the exception of large deposits of corals in Devonian rocks no appearance of a coral reef is recorded in the Cordilleran area.

Time-Ratios of Geologic Periods.

The time ratio adopted by Prof. James D. Dana for the Paleozoic, Mesozoic and Cenozoic periods is: 12; 3; and 1, respectively.* Prof. Henry S. Williams applies the term *geochronology*, giving the standard time-unit used the name *geochrone.* The geochrone used by him in obtaining a standard scale of geochronology is the period represented by the Eocene. His time-scale gives 15 for the Paleozoic; 3 for the Mesozoic; and 1 for the Cenozoic, including the Quaternary and the Recent.†

The Rev. Samuel Haughton obtained the following time-ratios from the maximum thickness of strata as they occur in Europe:

Scale of Geological Time.

Period.	From Theory of Cooling Globe.	From Maximum Thickness of Strata.
Azoic	33.0 per cent.	34.3 per cent.
Paleozoic	41.0 "	42.5 "
Neozoic	26.0 "	23.2 "
Total	100.0 "	100.0 "

*Manual of Geology, 1875, p. 586.

†Journal of Geology, Chicago, vol. 1, 1893, pp. 294-295.

He draws from this the principle:—"*The proper relative measure of geological periods is the maximum thickness of the strata formed during those periods.*"*

In considering the time-ratios for the Paleozoic, Mesozoic and Cenozoic rocks of the North American continent as given by Dana and Williams, I think that a too small proportion has been given to the Mesozoic and Cenozoic. In the Mesozoic of the western-central area occur the coal deposits of the Laramie series and the great development of limestones (from 10,000 to 20,000 feet) in the Cretaceous of Mexico. The limits of this paper do not permit a discussion of the available data bearing upon geologic time ratios; but from a comparison of the Paleozoic, Mesozoic and Cenozoic strata and the geologic phenomena accompanying their deposition, I would increase the comparative length of the Mesozoic and Cenozoic periods so that the time-ratios would be: Paleozoic, 12; Mesozoic, 5; Cenozoic, including Pleistocene, 2.

Duration of Post-Archean Geologic Time.

Taking as a basis 17,500,000 years for Paleozoic time and the time-ratios, 12, 5 and 2, for Paleozoic, Mesozoic and Cenozoic (including Pleistocene), respectively, the Mesozoic is given a time duration of 7,240,000 years; the Cenozoic, of 2,900,000 years; and the entire series of fossiliferous sedimentary rocks, of 27,650,000 years. To this there is to be added the period in which all of the sediments were deposited between the basal crystalline Archean complex and the base of the Paleozoic. Notwithstanding the immense accumulation of mechanical sediments in this Algonkian time, with their unconformities and the great differentiation of life at the beginning of Paleozoic time, I am not willing with our present information to assign a greater time period than that of the Paleozoic,—or 17,500,000 years. Even this seems excessive. Adding to it the time period of the fossiliferous sedimentary rocks, the result is 45,150,000 years for post-Archean time. Of the duration of Archean or pre-Algonkian time I have no estimate based on a study of Archean strata to offer. If we assume Haughton's estimate of 33 per cent. for the Azoic period and 67 per cent. for the sedimentary rocks, Archean time would be represented by the period of 22,250,000 years. In estimating for the Archean, Haughton included a large series of strata that are now placed in the Algonkian of the Proterozoic of the U. S. Geological Survey; and I think that his estimate is more than one-half too large; if so, ten million years would be a fair estimate, or rather conjecture for Archean time.

Period.	Time Duration.
Cenozoic, including Pleistocene................	2,900,000 years.
Mesozoic..	7,240,000 "
Paleozoic.......................................	17,500,000 "
Algonkian.......................................	17,500,000 "
Archean...	10,000,000(?) "

It is easy to vary these results by assuming different values for area and rate of denudation, the rate of deposition of carbonate of lime, etc.; but there remains after each attempt I have made that was based

*Nature, vol. 18, 1878, p. 268.

on any reliable facts of thickness, extent and character of strata, a result that does not pass below 25 to 30 million years as a minimum and 60 to 70 million years as a maximum for post-Archean geologic time. I have not referred to the rate of development of life, as that is virtually controlled by conditions of environment.

In conclusion, geologic time is of great but not of indefinite duration. I believe that it can be measured by tens of millions, but not by single millions or hundreds of millions of years.

Description of Map.

On the map the hypothetical areas of the Cordilleran, Mississippian and Appalachian seas are clearly indicated. The land area west of the Cordilleran sea is numbered No. 1, and the Californian sea and the area of Paleozoic deposits of western British Columbia, No. 10. The northern extension of the Cordilleran sea (No. 9) is continued as the Paleozoic-Devonian sea to the Arctic ocean. The early Cambrian land area (No. 2) east of the Cordilleran sea must have been more or less covered by water during later Paleozoic time. The area now covered by Mesozoic deposits, indicated by No. 3, was presumably covered by the westward and northward extension of the Paleozoic-Mississippian sea. The area east of the Appalachian sea is indicated by No. 4; and the supposed land barrier between the Hudson Bay and the Mississippian sea by No. 6; it is not improbable that during Ordovician or Silurian time a sea may have connected the two latter seas. The region to the south, indicated by No. 5, is supposed to have been covered by the southward extension of the Appalachian, Mississippian and Cordilleran seas. It is now covered by deposits of Mesozoic and Cenozoic age.

A more detailed description of the map can be gained from the section on the growth of the continent and on the geographic conditions accompanying the different depositions of Paleozoic sediments in the Cordilleran sea.

THE ORIGIN OF PARALLEL AND INTERSECTING JOINTS.

By W. O. Crosby, Boston, Mass.

Since the general abandonment of the contraction hypothesis as an adequate explanation of parallel and intersecting joints, two theories have claimed the attention of geologists: the torsion theory, so ably presented by Daubrée,* and the earthquake theory, proposed eleven years ago by the present writer.† The torsion theory is strongly supported by experiment, for the results obtained are certainly strikingly analogous to the phenomena observed in the natural ledges; and I

*Géologie Expérimentale, pp. 300-374.

†Proc. Boston Society of Natural History, XXII, 72-85.

have never doubted that it is a valid explanation admitting of a wide application.

As a rule, where the rocks are free, or nearly so, from shrinkage cracks, or joints due to contraction, and have not been exposed to severe crushing or shearing strains, they are traversed by two similar systems of nearly vertical joints crossing at large angles, and with, usually, no decisive indications that the two systems are not of the same age. Now Daubrée's experiments show that while simple plication yields a single system of longitudinal or strike joints, and the development of a transverse system would require a shifting of the axis of bending, torsion gives simultaneously two systems intersecting at large angles, but both oblique to the axis of torsion. These appear to exhibit all the normal characteristics of actual joints, including irregular examples and the not infrequent instances where one joint ends squarely against another without cutting it.

According to the earthquake theory, on the other hand, the different systems of joints dividing any given mass of rock were developed in succession, the normal direction of each system being parallel with the earth-waves producing them. It has been shown,* however, that this will be true of the second system only in case the direction of the second series of earth-waves is approximately at right angles to the first series, or they have a high velocity of shock. For, while the first earthquake of sufficient energy to break the rocks will develop a system of joints at right angles to its path, the sheeting of the rocks thus resulting will cause the second system to cut the first at large angles, regardless of the direction of the vibrations, in obedience to the principle that oblique strains would, if not developed instantaneously, be relieved by slipping along the joints of the first system and the formation of a series normal to them.

The fact that an occasional joint terminates against another without intersection is shown by experiment to be consistent with the torsion theory; but it is also readily explained by the earthquake theory, since each sheet determined by the first system of joints would, when subsequently exposed to endwise or oblique shocks, naturally break somewhat independently of

*Proc. Boston Soc. Nat. Hist., XXII, 80; XXIII, 244.

the adjacent sheets. In fact, while the earthquake theory yields readily two systems of parallel joints crossing at large angles, it does not necessitate actual or mutual intersections, but the joints of the later system must, obviously, be often less continuous than those of the first system; while the torsion theory demands equality between the two systems in this respect. It is a legitimate corollary of this paragraph that when one joint appears to cut and slip another of a different system it is quite possibly the older rather than the younger of the two; and the same caution is required in determining the relative ages of veins and dikes which may subsequently occupy or follow the joint cracks.

The torsion theory calls for only two systems of joints; and the earthquake theory accounts with difficulty for more than two systems, although a third system is conceivable under this theory and in extreme cases, perhaps, a fourth system. The question may fairly be raised, however, as to whether, in most cases, the joints apparently referable to third and fourth systems are not better explained as the irregular examples, which, as the experiments have shown, originate simultaneously with the regular rectangular systems. If strains developed as uniformly as possible in homogeneous plates of glass yield these irregular fractures, much more should they be expected in such a heterogeneous mass as the earth's crust.

The products of the two theories are, so far, strikingly similar; although the joints of unlike directions are simultaneous in the one case and successive in the other. The strongest contrast between joints due to torsion and those due to vibratory movements arises from the fact that the torsional strains must, at least as a rule, be developed with extreme slowness, while the earthquake shock reaches its breaking intensity almost instantaneously. If the torsion were attributed to, that is, regarded as a phase or consequence of, the swift, vibratory movement of the earthquake, then, of course, the two theories would be merged in one. In any other case the torsional strains must arise from the secular warping or deformation of the earth's crust. No argument is required to show that a strain that is suddenly developed must result in more regular fractures, and fractures less influenced by the structural inequalities of the medium, than one that is slowly developed;

and in this direction lies the most serious objection to the torsion theory, the contrast between the two theories here being similar to that between the earthquake theory and the old contraction hypothesis. Strains developed under the conditions that obtain in the earth's crust, by simple plication, torsion, or shrinkage, must, in the nature of the case, approach the breaking point so gradually that, unless the rock is of an extremely homogeneous character, the yielding by rupture will be distributed over a considerable period of time. The rock gives way at the weakest point first, and throughout the breaking is influenced by every detail of texture and structure, the final result being far more irregular than under the instantaneous and alternating stresses that mark the passage of an earthquake.

In all cases, therefore, where the joint-structure of the rocks exhibits a high degree of regularity, we may fairly regard the torsion theory, at least in its present form, as inapplicable, as not affording an adequate explanation. This conclusion is particularly safe in those cases where jointing of exceptional regularity is observed in rocks of coarse and irregular texture. It is certainly well-nigh inconceivable that the remarkably plane and regular jointing of the Roxbury puddingstone and the coarse Newport conglomerate, in which the hard pebbles of quartzite, felsite and granite, and the yielding matrix, have been neatly divided as by one swift stroke of some Titan's sword, can be the product of slowly developed torsional strains. The torsion theory also fails most signally to explain the very perfect and regular parallel and intersecting joints sometimes observed in unconsolidated deposits, as in the Miocene clays of Virginia* and even in the glacial clays of New England.

The preceding paragraphs may be summarized as follows: A single system of joints, dividing the rock into sheets but not into blocks, appears to be best explained by earthquake vibrations, or by simple plication if not of a high degree of regularity. Two systems of unlike character are also best explained by the earthquake theory; but two systems of similar character may be referred to the torsion theory, unless, again, they exhibit the regularity indicative of instantaneous stresses;

*Proc. Boston Society of Natural History, XXIII, 245.

while joints of even moderate regularity are not satisfactorily explained by torsion if occurring in incoherent deposits or in rocks of irregular structure.

Jointing is the most universal of rock structures, and with respect to the universality of the agents, there is little to choose between the two theories under discussion. The observations of professor Niles* and others confirm the belief which, no doubt, exists independently of specific facts in the minds of most geologists, that the relatively superficial strata of the earth's crust are very generally, if not almost everywhere, in a state of strain—compressive, tensile, or torsional; and it will be readily conceded that probably all parts of the earth's crust have been traversed by severe earthquakes.

It has occurred to me, however, during the past year, while preparing a set of lecture notes on joint structure, that some of the perplexities of the subject would be removed by combining the torsion and vibration theories. It is a familiar fact that when a body is in a state of strain a shock or jar will often precipitate the yielding or collapse. If the strain is near the breaking intensity, a very slight shock is sufficient; and in such a case the directions of the fractures will be determined wholly by the pre-existing strain and not in any sensible degree by the vibrations. The function of the latter is simply to bring the strain *instantly* to the breaking intensity and thus insure straight and regular fractures along the predetermined lines. Torsion yields simultaneously two rectangular systems of fractures; while the earthquake vibrations produce plane and regular fractures in almost all kinds of rocks. In other words, if co-operating, torsion would natually determine the directions of the fractures, and the vibrations the time and mode of breaking. Simply conceive, then, that, as must often happen, while a torsional or plicating strain is being slowly developed in the rocks and is yet considerably below the breaking intensity, they are traversed by an earthquake of moderate severity. Although the shock is insufficient in itself to break the rocks, it will precipitate the breaking that is imminent through bending. Simple plication would then yield one system of regular joints, and torsion two systems. The main point is that the torsional strain,

*Proc. Boston Society of Natural History, xviii, 272.

instead of continuing to develop slowly and reaching the breaking intensity by insensible degrees, culminates, under the influence of the shock, instantaneously, accomplishing its work, at last, swiftly instead of sluggishly. The vibrations are merely the last straw, or the finger that pulls the trigger and releases the accumulated energy.

I have repeated Daubrée's experiments with sheets of glass, obtaining similar results; and have also modified them, to note the effect of a sudden shock. Strips of glass 24 inches long and from 3 to 5 inches wide were tested in a horizontal position on an ordinary table, one end being held by a stationary clamp, while the other was attached by a hinge in the axis of torsion to a fixed support or fulcrum. The lever was long enough so that it could be weighted and the torsional strain in the glass thus carefully regulated. The shock was applied, at first, by striking the table, to which the apparatus was firmly fastened, with a hammer, the glass being entirely free from the table except at its extremities. Before applying the shock, however, the lever was first weighted until it seemed that the strain on the glass must be near the breaking point, and then the strain was materially diminished, to make sure that the glass was not dangerously near collapsing before the passage of the vibrations. A smart blow with the hammer then precipitates the breaking; and the result is similar to that obtained by torsion alone, except that the fractures are likely to be fewer, if the torsional strain is not near its maximum. The directions of the vibrations make, apparently, but little difference; and in every trial two rectangular systems of fractures, making equal angles with the axis of torsion, were obtained. The breaking or jointing of the glass was most regular and perfect when a sharp blow with a light hammer directly upon the end of the glass itself, sent vibrations through it bearing some resemblance to an actual earthquake. When the torsional strain is slight, strong vibrations are required to precipitate the breaking and the fractures are irregular and mainly transverse, tending to cut the axis of torsion at ninety degrees instead of forty-five degrees. But if the torsional strain is great a very slight shock suffices and the result is, with glass, indistinguishable from that obtained by torsion alone. To those who accept this explanation of parallel and intersecting joints the more concise expression, rectangular joints, may seem equally appropriate and descriptive.

One important consideration affecting the validity of the earthquake theory that appears to have been overlooked hitherto is that, just as a fountain cannot rise above its source and the brightness of sunlight cannot exceed that of the solar photosphere, so the energy of an earthquake must always be greatest at its focus. Most earthquakes, except, possibly, in volcanic districts, may be assumed to originate in the formation of a fissure by a tensile or shearing strain, or in the slipping of the rocks along a pre-existing fissure, that is, in the formation of a fault. The rupture or movement in which the earth-waves take their rise will occur just so soon as the slowly accumulating strain overcomes the cohesion of the rocks or the friction of the opposing walls. In other words, the energy of the earthquake is barely sufficient at its source to break the rocks. But as the vibrations spread from the source this energy is rapidly dissipated. Hence, we can scarcely expect that the earthquake, unaided by strains due to other causes, will break the rocks, except in the immediate vicinity of the focus, unless, indeed, the vibrations chance to pass into some formation that is much less elastic and more easily broken than the one in which they originate, as when the shock emerges from the earth and enters the walls of buildings. The idea, therefore, that an earthquake shock will give rise to a series of fractures parallel with the initial rupture—a system of joints—is essentially untenable, or at least does not admit of general application. Torsion and plication, on the other hand, although equal to the task of breaking the rocks, are powerless to produce the highly regular fractures observed in many formations. The arguments thus point very distinctly to a fusion or co-operation of the two causes. The parallel joints observed in unconsolidated clays may, apparently, be best explained by the passage of strong vibrations into the clay from adjacent or underlying hard rocks, the influence of torsion being reduced to a minimum here.

When performing Daubrée's experiment—breaking strips of glass by simple torsion—for the first time I was astonished, since no pains were taken to obtain strips of uniform width and each must have possessed a weakest line, to find that the breaking was not localized, but quite uniformly distributed, the glass being shivered from end to end, in some cases into hundreds of rectangular fragments. I am satisfied, upon reflection, that the only rational explanation of this phenomenon is that the glass does actually break first at its weakest point and so suddenly, being a highly elastic substance, that the resulting shock or jar, spreading swiftly toward either end of the sheet, precipitates the breaking through the entire length. Applying this explanation to the earth's crust, it is seen that earthquake vibrations arising independently of the torsional strains with which they co-operate are not strictly necessary to the satisfactory working of the composite theory here proposed.

Plain indications are not wanting that the joint-structure of the rocks is developed, as a rule, very early in their history. That is sufficiently obvious for the contraction joints, including the sun-cracks in clay and the columnar jointing of eruptive rocks, and for the parallel and intersecting joints of the Quaternary and Tertiary clays and marls. In the older stratified rocks, the dikes and veins, where occurring, usually conform in direction with the joints of this class. This is conspicuously the case in the Boston basin, the numerous dikes traversing the beds of conglomerate and slate showing a close correspondence in trend and hade with the joint-planes. The dikes must be later than the joints; and yet we have reason to believe that the dikes themselves are, geologically speaking, nearly as old as the strata which they intersect. As soon as the sediments are sufficiently hardened to make joint-cracks a possibility, they are broken or jointed by the first torsional or vibratory strains of adequate intensity to which they are exposed; and ever afterward similar strains, unless of unusual intensity, are relieved by slipping along the existing fractures, which are thereby, in many cases, we may suppose, kept open and prevented from healing by slow cementation, but are converted into minor faults with the attendant slickenside phenomena.

EDITORIAL COMMENT.

THE COLUMBIAN EXPOSITION.

A hasty glance taken in August, 1893, at the ores of the noble and of the useful metals in the Mines and Mining Building.

The Mines and Mining building is, like all the buildings of the Chicago Exposition, well designed for the object in view, tastefully decorated and well situated. Its longer sides run approximately northwest and southeast, parallel with the Electricity building and between the Administration building and the lagoon. It is 700x360 feet in area, and has a wide gallery on the inside.

THE UNITED STATES.

ARIZONA.

In the southeast corner is a space of about 40x60 feet devoted to this state.

A very striking mass of spike and feather silver in a brown earthy matrix; a fine block of silver-gold ore, showing vein and gangue, from the Night Hawk mine; ores of lead, silver and gold from Gold Bend, Cougar Boss (horn silver) and State of Maine, with cerussite crystals and pseudomorphs; gold and silver ores from the Jersey Lily, Dixie, Roach, Grey Eagle, Wren, Silver Belt, Pic Nic, Queen, Iron Bearing, Golden Star, Line Tree, Johnson, Little Jack, Anderson and Mocking Bird; gold ore from Blue Belt, Rustler, Myrtle, Storm Cloud, Husted, Morning Star, Gold Leaf and La Venezia; silver and copper from the Alice, Gold Leaf (gold, silver and copper, Hassayampe district), Snow Clad (lead and silver), Stagner, Mammoth (copper and cinnabar); large masses of gold ore from the Congress mine, Leadville (gold and silver), Bullard (gold, silver and copper), Silver Chord (gold, silver and lead), Turkey Creek District Union (gold), Big Bug district, Col. Caney (gold, silver and copper, Hassayampe district), Nancy Hanks (gold and silver, Blade Rock district), Homestake (gold and silver, Big Bug district), Wasp (gold and silver, Cherry Creek district); a show case containing specimens of beauty from various districts and large masses from Little Grace (gold, Big Bug district). Bellick (gold and silver, Martinez district), the Reward Pinal Co., near Casa Grande (silver and copper).

On a pedestal at the west side of the exhibit is a fine large mass from the Blue Jay mine, 70 oz. silver, Helvetia district. In cases are shown the Pioneer (silver, Pioneer district), Contact No. 2 (silver and lead, Globe district). In cases on the west side are specimens of different classes of ore and the middle products of their treatment. In the northwest case is a complete collection of ores of the gold, silver and copper mines in the Tombstone district representing the Goodenough, Silver Cloud, Comet, Mammoth, Emerald, Rattling Boy, Empire, Tough-nut, Sunset, Bonelli, Sulphuret, etc. On the west wall (Pima county), Bonanza (Oro Blanco district), El Capitan (Olive Camp district), Rebus (silver, Greaterville district); Grasshopper (gold, silver, copper and lead, Washington Camp district), Lota (gold, silver, lead, Silver Hill district), Live Oak (silver, lead, Greaterville district), Lone Jack (Silver Mill district), Blue Bird (silver, copper and lead, Olive Camp district), Hard Shell (Patagonia district), Silver Glance (silver-lead), New York (gold, silver, lead, Oro Blanco district), Allen (gold, silver, copper, Washington Camp district), Woffenden (gold, silver, Tucson Mt.), Austerlitz and Foraker (gold, Oro Blanco), Mary (gold and silver, Silver Hill district), Shentlebrand (gold and silver, Oro Blanco), Montana (gold and lead, Harshaw district), Cimmonas (gold, silver, copper, lead, Washoe district), Electra and Crown Jewel, Lime Cap, Peabody, Golden Rule, (silver, lead, Cochise district), Finale (ditto, Swisshulme district), Mohave county.

Gold-silver ores from New Eldorado (Minn. district), G. A. R. (White Hills district), Tuckahoe, Tintic and Prosperity, Silver Hill and Distaff, Pay Roll and Rainbow (Wallapin). Silver and silver-lead ores from Empire No. 2 (Mullassin), Elkheart, Silver Hill, Twins, Cupel, and Champion (Wallapin).

A fine mass of argentiferous galena is exhibited from the Prosperity, and an argentiferous manganese wad from the 200 ft. level of the Rattlesnake Mining Co., Tombstone district. On the east side of the division, gold ore from the Venus (Oro Blanco); silver lead from the Wedge (Olive camp), gold, silver, lead and copper from the Washington and Annie. (Olive camp), Choctaw (silver, lead, Oro Blanco), Christmas

Gift (silver, Hanshaw) and granite country rock of Lucky Cuss (gold, silver, Tombstone district).

Among the copper and other ores and products may be noticed the ingots of copper from the Copper Queen, with native copper and malachite, and large masses of malachite in rocks on pedestal in the centre of the exhibit.

In addition to the above specimens in which copper is associated with the ores of the noble metals are the following specimens of copper ores by themselves:—

In the center case is a beautiful and complete set of minerals and products of the Copper Queen with a column six feet high and a smaller one on top three feet high of vein matter showing large quantities of malachite and azurite, and plates of chrysocolla. On the north wall is a small cabinet of malachite and azurite minerals. On benches is displayed the product of the Old Dominion Copper Co., of Globe. Adjoining this is a set from Gila Co., and Arizona onyxes from the Big Bug quarry.

On a north shelf may be seen large blocks of ore from the Arizona Copper Co., malachite and azurite and the copper product of the mine. On the west wall containing specimens from Pima Co. are copper ores from Lone Star, Wisconsin, and Ida (the latter argentiferous) of the Hartford district. Among these latter and from the same district and county is zinc ore (smithsonite) from the Camp.

The gems consisting of turquoise from the Gem mine, Wallapin district, Mohave Co, Rock Gulch, Virginia Queen mine, will be treated in another report.

Of the rock products of Arizona are two beautiful columns of tan-colored fine-grained sandstone labeled "Grown near Flagstaff, Arizona, without irrigation."

CALIFORNIA.

Of course the visitor is reminded of the prominent place occupied in the world by California as a gold producer by the following prominently displayed statistics:

United States yield of gold from 1848 to date..	$1,900,000,000.
California yield of gold from 1848 to date......	1,300,000,000.

Auriferous gravels from Calaveras county; models of nuggets from Dutch Hill, Plumas county; gold quartz from

Fresno, Nevada county (Grass Valley), Calaveras, Amador, Los Angeles; country rock from these mines.

Antimony. Fine ores of this metal including stibnites from San Benito county; antimony regulus, etc.; copper ores from Plumas, Fresno, Mariposa, Nevada, Inyo, del Norte and Calaveras counties.

Tin. Blocks of stanniferous ore from the Temescal mines, Riverside county.

Manganite. Tuolumne county, Santa Clara.

Iron. Magnetite from Plumas county, (fine cubes with truncated edges, chromic); a set from Alameda, San Mateo county; magnetite, Lassen, El Dorado, and San Bernardino counties; hematite, San Luis Obispo; quartz crystals, minerals, rocks, building stones, asphalt and oils, and onyx.

The collection, though small for the importance of the state which it represents, is well labeled and intelligently arranged. As in many other cases, many of the exhibits which properly belong here, have been placed in the California building and in the Manufactures and Liberal Arts building for the purpose of mere display and advertisement. On the whole, what there is of the collection is very satisfactory.

Colorado.

The great silver (and gold) State which ought to be in the van of the exhibitors has not a representation of her ores worthy of her, except, perhaps, in products of the furnace, which are not in all cases, or at least are not stated to be, from her own ores. Some private firms and public institutions exhibit. Among the exhibits are minerals and ores from Gunnison, minerals (including ores) of Colorado, "minerals," "silver ores," minerals from Cañon City, minerals and ores from Ouray, gold ores from Cañon City, minerals from Crested Butte, gold ores from Leadville, minerals and ores from Silverton, and silver blossoms from Denver. Besides these there were products from fourteen smelting works labeled "Smelting and new processes." While some of the individual specimens are interesting, there is no attempt to supply a systematic exhibit from the state.

Connecticut and Florida

Do not properly find place in a list of States exhibiting the precious and useful metals.

IDAHO.

There are some 290 odd exhibits from various localities, among which are gold, silver, copper and lead ores, including a heterogeneous collection by the State itself. Four exhibits of tin from Boisé City, Silver City and Albion, besides one each of palladium and antimony from Gibbonsville, complete the exhibit of useful metals. Thirty-seven localities contribute copper ores, some of them fine specimens.

Idaho produced about 100,000 oz. of gold in 1892 from placers.

The De Lamar mine in Owyhee county exhibits native silver. The Cœur d' Alene district furnishes argentiferous lead in enormous quantities. In the year 1892, according to a late authority, its product of silver was 1,903,000 ozs., and of lead 73,000,000 lbs. Her display is a very handsome one.

IOWA

Shows lead ore from the lower magnesian limestone, and some iron ore.

KENTUCKY

Shows limestone ore and limonites from Pergan Bank and Clear Creek and limonites from Lyon and Estill counties, and Grand Rivers; kidney ore from Mt. Savage, limestone ore from Ashland, and limonites from Beaver creek and Olympia. Besides these an exhibit of the same ore from Middlesborough, Bee Spring, Reedyville and Greenville, Kentucky, and by the Trigg Furnace Co., from Trigg.

MICHIGAN.

Of the enormous mineral wealth which is included in the state, the following sources attain representation: Iron ore, from the Gogebic and Menominee ranges; hematite, from the Negaunee, and magnetic ore, from the Champion mine; also ores from Ishpeming.

The copper ores represent the Ahmeek, Allouez (copper-bearing) conglomerates; native copper from the Arnold mine, Keweenah; amygdaloids, from the Atlantic mine; conglomerate, from the Calumet and Hecla, with the commercial copper made from these, and amygdaloids, native coppers, battery and tailing samples, dressed mineral, etc., from the Franklin, Huron Mills, Kearsarge, Mendota, National, Osceola, Peninsular, Quincy, State of Michigan, Tamarack, Jr., Tamarack, Tamarack-Osceola and Wolverine.

MISSOURI.

Zinc blende, calamine, galena, magnetite and limonite, with cerussite, wolfram and silver ores, are exhibited, but principally scattered as collections of private exhibitors, so that their educational value is impaired, especially in the catalogue, where they are given without uniform geographical definitions. From what is shown the immense mineral wealth of this state appears very clearly.

Washington University, St. Louis, has a collection of martite and millerite, besides the more common minerals which accompany it as gangue. Besides these are the concentrates of the Iron Mountain ore, the St. Genevieve copper ores, concentrates from the Empire Zinc Company, at Joplin, and from the Doe Run and St. Joseph lead companies.

MINNESOTA.

This exhibit was very tasteful. On the east side of the space were cases of:

1. Fragments of soft blue hematite, No. 1 Bessemer, Mesabi range, Mesabi Chief Iron Co.
2. Adams Mining Co., hard blue ore, No. 1 Bessemer.
3. Soft blue hematite, Adams Mining Co., No. 1 Mesabi range.
4. Ditto, Lone Jack Iron Co., Mesabi.

Other cases contained soft and hard blue Mesabi range ore, from the McKinley Iron Co., Biwabik Iron Co., Iron King Iron Co., and Bessemer Iron Co., soft ore. A column of hard and specular ore, Vermilion range, Tower mine; another of blocks from the Chandler mine. Altogether the hard and soft ores were represented from mining companies as follows: The Adams, Bessemer, Biwabik, Franklin, Hale, Iron King, Lake Superior, Lone Jack, McKinley, Mesabi Chief, Minnewas, Mountain, New England, Ohio, Rouchleau & Ray, Snively, Standard, Virginia, Wyoming, Minnesota, Chandler, Zenith and Pioneer, from Ely.

Building stones, slate, jasper, agates, clays, terra cotta, etc., were on exhibition, besides pig iron from the Duluth Furnace Co., and a working model of a mine from the Chandler Iron Co., of Ely.

MONTANA.

Montana being recognized as in the van of the copper-silver-gold producing States, is well represented. Seventy-eight gold ores are exhibited from Butte, from the following mines: Maiden, Yogo, Argenta, Rochester, Helena, Alpine, Missoula, Lo Lo, Judith, Neihart, Pioneer, Silver Star, Basin, Zozel, Virginia City, Champion, Big Hole Cañon, Red Mountain, Elkhorn, Wisconsin, Medhurst, Sheridan, Georgetown, Snow Creek, Cooke City, and Placer; silver and silver lead from 179 localities, including most of the above, besides Wolf Creek, Castle, Townsend, Libby Creek, Jefferson, Drummond, Carpenter Creek, Bannock, Moccasin, Highland, Elliston, Elkhorn, Clancy, Wickes, Snow Creek, St. Louis Gulch, Red Mountain, Vipard, Judith, Lion City, Robertson, Phillipsburgh, Stone Station, Gould, Running Wolf, Sage Creek, Robinson, Tenderfoot Creek, Chester, Dewey's, Pilgrim Creek, Corbin, Dunkelburg, Blue Wing, Rimini,Garrison, Beaver Creek, Twin Bridges, Virginia Gulch, White Sulphur Springs, Granite, Alhambra.

Lead from many of the preceding localities, with silver, and by itself, from Missoula, Vipard, Phillipsburg (Bowie mine), Castle, Townsend, New Leadville, New Chicago, Helena, Bonnar's Ferry, Argenta, Zozel.

There are sixty-one exhibits of copper as native copper, simple copper ore or silver-copper. Of these, native copper is shown from the Blue Bird and Anaconda, Butte; copper ores from Sheep Creek and Helmville, Maiden, Black Pine, Vipard, Native Copper, Corbin; copper ore (gray copper, and chalcopyrite), from Bannock, Zozel, Lion City, Lo Lo, Cooke City, Missoula, Pilgrim Creek, Phillipsburg, Argenta, Lexington, Dunkelburg, Camp Creek, Horse Cañon, Helena, Neihart, Argenta, Arlee, Elkhorn, Dry Wolf Creek, and Sheep Creek; silver copper ores from Maiden, Butte, Judith, Clancy, and Carpenter Creek.

Besides these the unique exhibit of the Montana *statue of Justice*, cast in solid silver, should be accredited to this state. It is, according to F. J. V. Skiff, "cast in solid silver worth $61,800, and resting on a plinth of gold representing $230,000." Its model was an Irish girl whose charms were supplemented by various Americans.

There is also a very fine display of gold nuggets, and a still more unusual and scientifically valuable collection of gold crystals. In addition to these a specimen of copper pyrite holding large pieces of native gold, which is very interesting, as also the tetradymite and montanite shown in association with gold.

A large piece of translucent ruby silver from Granite, is nearly free from impurities and is said to assay 10,000 ounces per ton.

New Jersey.

The space was smaller than the mining interests of New Jersey required, but it was neatly arranged. A relief map of the state on the topographical basis of the Coast and Geodetic Survey, the horizontal scale being one inch to the mile or $\frac{1}{63360}$, and three vertical scales, presents the salient features of this important commonwealth. A very characteristic and interesting collection of minerals from Sterling Hill and Mine Hill, including calamine, rhodonite, willemite and franklinite, forms the principal feature of interest in the exhibit.

It is to be regretted that at the times of the visits to this State exibit neither catalogue, description nor attendant were found. The assemblage of building stones was worthy of notice.

New Mexico.

A case of copper, silver, and crystallized ores from Socorro county and lead carbonates from Cook's peak, Grant county, were well displayed, and argentiferous galena, zinc blende, and lead carbonates from the same locality were collected in a case. Following this was a fine exhibit of coals. Gold and silver in trachyte from the Jicirillas Mts., ten miles north of Eureka, White Oaks, Lincoln county; argentiferous galena from the Hermosa district, Pelican mine, Sitna county; a stand of Sierra county ores and cases of minerals complete the most striking objects in the New Mexico exhibit.

Briefly, there are 65 exhibits of ores of the noble and useful metals, and 32 of copper exclusively. Of the first, 48 are ores of gold, either alone or, more usually, associated with silver and other metals. Fifty-seven are silver ores, either by themselves or associated with gold, lead or iron ores. Twenty-four are lead ores by themselves or with silver, and eight are ores of iron.

These represent the counties of Bernalolla, Dona Ana, Grant, Lincoln, Rio Arriba, San Miguel, Santa Fé, Sierra, Socorro, Taos and Valencia. The copper ores are from Bernalillo, Colfax, Grant, Rio Arriba, San Miguel, Santa Fé, Sierra, Socorro, Taos, and Valencia.

Besides these ores are certain bituminous and baked bituminous coals passing as anthracites, marbles, kaolins and clays, gypsum, and sodium carbonates, sulphur, borax, and alum, and models of silver-mining companies' properties by Mrs. Ellis Clark; a relief model of mines near Las Animas peak, a relief model of the Illinois mine, and a very fantastic miner's cabin built of ores, with the appropriate burro, and the hunting shirt and unkempt beard of the human figure.

New York.

There are eleven iron ore exhibits from Ancram, Chateaugay, Clinton, Ontario, Port Henry, Spragueville, Tilly Foster, Poughkeepsie, etc., which comprise all that properly comes within the limits of this report. They are familiar to all geologists and mining engineers and need not be specially described.

South Carolina.

The display of South Carolina was exclusively phosphates, and many important, if somewhat local, metal industries were entirely omitted.

North Carolina.

Cases of gold ore, gold nuggets, copper ores, hand specimens of the rocks and blocks of building stones, with a handsome column of granite from Mt. Airy, constitute the collection from this state. The official catalogue represents the collection as very large and one would suppose it to be complete, including magnetites, titaniferous ores, limonites, pyrites, bornite, copper ores and minerals, cassiterite, corundum, gems, and various building stones. These may have been there, but if so were arranged in such a manner that it was not easy to find them.

Taking into consideration the importance and the riches of North Carolina it cannot be said that her display was calculated to give the casual visitor a true idea of her great importance as one of the most prominent producers in the sisterhood of States, of gold, silver, precious stones, manganese, iron, copper, mica, graphite, kaolin and coal.

OREGON.

The exhibits from this state are not only interesting, but claim a careful study by the geologist and mining engineer.

From the *Sparta* and *Cornucopia* districts are displayed the gold placer ores of the Saw Mill gulch, the Basin, and the Boyer. Of free gold are exhibits from the Olla Woodman, Little Pittsburg, Crystal Palace, Tom Payne, and Ore Dell; free gold and silver from the Union Quartz, the mother lode of Shanghai; gold and silver from the Gold Hill; gold from the Cumberland, and Hidden Treasure No. 1; free gold with sulphurets from the Silver Queen, the Gold Ridge, and the Legal Tender; gold, silver and lead from the Galena Quartz mine. From the *Davenport* district, Ashland, are shown free milling gold from the Anderson, St. Patrick and Blowfly; free milling gold and silver from the Park, Silver Cap, Roper, and Happy New Year; gold from the Ophir, and gold and silver from the Lucky Shepherd, Loomas Extension, and Summit; gold in sulphurets from the Banner, Gold Spike, Hope and Hidden Treasure; gold and silver in sulphurets from the Stonewall Jackson, Paul Cabbin; mercury and cinnabar from the Cinnabar lode. From the *Waldo* district, gold and platinum from placers; copper from the Cowboy copper mine, and the Queen of Bronze, and with the ore from the former, also silver and gold. From the *Wagner Creek* district, free milling gold, and silver from the Cleveland quartz mill. From the *Jacksonville* district, placer gold from the Wulf, Farmer's Flat, and Cement; gold quartz from Huffin & Beekman No. 2, and gold in sulphurets from the Charity lode; gold and silver quartz from Jacksonville and Lost Silver lode. From the *Williams Creek* district, free milling gold from the Granite, Bone of Contention, and Little Fritz; free gold in sulphurets from the Tip Top, Exchequer, Horsehead, Southern Belle, and the Rising Star.

From the *Main Applegate* district, placer gold in blue gravel, from the Johnson and the Terry Burnes, and gold quartz from the Buckeye. From the *Willow Springs* district, placer gold from the Centennial, the Mardon, and the Willow Springs;

free milling gold from the Comstock, and in sulphurets from the Morning mine, and the Schump. From the Missouri Flat district, free milling gold in sulphurets from the Mountain Lion. From the *Lucky Queen* district, free milling gold, and gold in sulphurets from the Gold Bug. In the *Louse Creek* district, free milling gold, and gold in sulphurets, from localities not mentioned. From the *Meadows Creek* district, silver from the Reynolds mine. From the *Gold Hill* and the *Blackwell* districts, free milling gold and gold in sulphurets from the Cold Spring, Salem, Homestake, Braden east and west, and north and south, Knott ledge, Copper Queen, Maybelle, and Blue lode.

Magnetic iron is also represented in this district from the Garfield and a locality unnamed.

The *Galls Creek* district produces free gold with galena from the Tin Pan, and free milling gold from the Last Chance. The *Grant's Pass* district shows free milling gold and gold in sulphurets from the Jewett and the Orme. The *Rogue River* district shows gold in sulphurets from the Gray Mule and elsewhere. The *Foot's Creek* is represented by gold ores and gold from the Gold Ores and Horse Shoe Quartz mines.

The *Grave Creek* district, Leland, exhibits placer gold from Browning and Tom East; free milling from the Dividend and Mary Ann, sulphurets from the Bonanza and Tiger. Gold with silver and galena from the Star Quartz, and without galena from St. Jacobs and the Mac.

From the *Wolf Creek* district placer gold from the Placer, and free milling gold from the Banner. From the *Coyote* district placer gold is represented from Placer, Morris Gulch, and Marshall, and free gold and gold in sulphurets from the Sarah Belle, Quartz, Little Anaconda, Marshall and Mossback. From the *Sardine* district, gold sulphurets are shown from the Buckskin. From *Cow Creek* district placer gold represents the Nash Hydraulic mine. From the *Excelsior* district nickel ore is brought from the Riddle and Oregon mines. From the *Oakland* (Douglas county) arsenic, realgar, and orpiment are taken from a locality unnamed. From the *Bohemia* district free milling gold and gold in sulphurets represent the Annie, Chrisman, Evening Star, the Music and the Golden Star, while silver-holding galena with traces of gold are taken from the Rathburn claim.

From the *Black Butte* district mercury and cinnabar from Black Butte. From the *Lantiam* district, free milling gold and gold in sulphurets come from the Canal Fork and the Bonanza. From the *Bald Mountain* district, gold, silver and copper from the Cascade. From *Columbia* county, limonite ores from the Bunker Hill iron mine. From *Clackamas* county pig iron from the Oswego mine. From the *Shugill Bar* district, placer gold sand from Snake river. From the *East Eagle* district, gold free and in sulphurets from the sheep rock. From the *Sangre* district, free gold and concentrate from Susan gulch, Summit, Buffalo, Golden Eagle, Nellie Grant, Last Chance, Lost Bonanza, North Star and Big Foot. From the *Hinkly* or *North Powder* or *Telecaset*, gold from War Eagle and Kiel, Skyline and Homestake; gold in sulphurets from Treadwell No. 2, Ext. 2, 3, 4, Old Kentuck and Monumental. From the *Rock Creek* district, gray copper, antimonial silver and gold sulphurets from the Chloride, and gold in sulphurets from the North Star, Chicago and Mountain Belle. From the *Elkhorn* district, gold free and in sulphurets from the Robbins, Bonanza and Baisley Elkhorn. From the *Cracker Creek* district, free gold and gold in sulphurets from the Winchester, Amazon, Columbia, Appomattox, Golconda, Eureka and Excelsior, North Pole, Esmeralda, California and Gold bar; free gold and silver from the Golden Rule, and gold and silver in sulphurets from the Eagle. From the *Bonanza*, free gold from the Richmond and Bonanza. From the *Fort Sumter*, free milling gold from the Lazy Jim. From the *Virtue* and *White Swan* districts, free gold from the Black Swan, White Swan, Polar Bear, Laura, Virtue, Cambria, Emma, Gunsta, Uncle Dan and Herbert. From the *Gold Hill* district, gold and silver from the Oasis, Cleveland and Iron Clad, and gold from the Bonanza. From the *Carrer Creek* district, gold free and in sulphurets from the Carver Creek, and silver from the Bay Horse. From the *Granite* or *Greenhorn* district, gold and silver in sulphurets from the Buffalo, Red Cloud and Virginia; gold and silver from the Montana and Ajax; silver from the Morris mine; and antimonial silver and sulphurets from the Monumental group. From the *Olive Creek* district, silver gray copper and pyrite from the Intrinsic. From the *Fox* district, free gold from the Black Butte. From the *Shasta* district, free gold from the Red, White and Blue, and the Red Oxide.

To resume, Oregon occupies a position almost alone among the metal-producing States. Four hundred and twenty quartz gold mines, twenty-five silver mines, six copper mines, nine magnetic and hematite iron mines, and one nickel mine (of which the product is not yet utilized) contribute to the mineral exhibit of this state. The Virtue mine, near Baker City, has already produced two millions of gold, the assay value of part of its output reaching as high as $10,000 per ton.

From 1876, or the date of the Centennial Exposition at Philadelphia, to the end of 1892, the date of the Quadricentennial Exposition of Chicago, Oregon has produced $16,-200,000 in gold, and about $1,000,000 in silver.

Charcoal iron of the best quality is manufactured from brown hematite at Oswego. The nickel ore is a garnierite found near Riddle Station, Douglas county,

PENNSYLVANIA.

The exhibit from Pennsylvania is very striking to the non-professional eye and the parts are tastefully arranged, but there is a notable lack of the systematic, lithological and mineralogical collections which one has a right to demand from a State which has had two geological surveys lasting over twenty years. It has an instructive series of exhibits of iron furnace charges and products.

Iron. Cases of the iron ores of York county and other localities are noticeable, but they are not arranged in a way to give the observer any idea of their relative importance or their differences of constitution. Many ores from well-known localities are not represented at all.

Zinc. Ores and products from the zinc works and slabs of zinc from the Lehigh Zinc company are shown.

Nickel. Millerite from the Gap mine in Lancaster county.

Manganese ore, locality not noted

Besides these there are exhibits in coal, of which a splendid column of anthracite fifty feet in hight dominates the entire State collection, and in building stones.

It is not the purpose of this article to notice these latter, but attention should be called to an abuse in misapplying a common word. This is not honest and it ought to be checked. The writer refers to the use of the term granite for rocks which are simply diabases, dolerites, diorites or gabbros. Several instances of this were noticed in the labels of some rocks from Gettysburg, and some from Lancaster county. It is bad enough for a company to adopt a false name which it believes will aid in selling its commodity. The morality of this kind of thing cannot be defended, but it is quite inexcusable for the State, through its agents, to allow such rocks as "Conewago *Granite*" to bear this name in a collection which is intended to instruct the unscientific visitor as to the resources of the state.

The models of scientific objects and of the apparatus of the industries are various and creditable. Such are the model of the Philadelphia & Reading company's coal breaker; and a model of an iron furnace in use 400 years B. C. Still more interesting to the student of science are the raised models of the southwest end of the anthracite coal field, and the fine relief map of Pennsylvania on a scale of two miles to the inch ($\frac{1}{126720}$), and a vertical scale of $\frac{1}{24000}$. The same may be said of the relief models of Blair, Bradford, and Huntington counties; of the Cornwall iron mines; the floor of the Mammoth anthracite bed, Schuylkill county; and the floor of the Mammoth vein, Panther Creek basin.

Of the colored map of Pennsylvania, purporting to represent the geology of the state, and dated 1893, like the preceding (from the late second geological survey of Pennsylvania), not so much can be said. Only an obsolete style of lithological classification is attempted. To this is added a parallel column containing the geological systems, without, however, clearly defining to what lithological groups these latter divisions apply. Errors protested against, ten years ago, by the assistants to whose labors they were ascribed, still find a place on the state map.

The collection of building stones is very creditable, including a large slab of black Pennsylvania marble.

On the whole the exhibit from Pennsylvania is pleasing and somewhat imposing to the eye of the unscientific passer-by.

Only those who have personal acquaintance with the large resources of this great state will appreciate how much of value has been omitted.

South Dakota.

Gold and silver smelting ores from the Cora Mining company, Red Cloud Mining company and Keystone Mining company; gold ore from Lawrence county and Hawkeye. Lead and silver ores from the Tornado, Lawrence county, Spruce gulch, Posslan and the Belle Eldredge. Siliceous ores for the chlorination process are shown from the Buxton and Mark Twain, Lawrence county.

A column of ores from the Homestake (the largest gold-producing mine in the United States) from Pennington county.

Tin ore from the Cyclone and Custer.

A specimen of carved sandstone by Reardon of Buffalo Gap, Custer county, indicates a good fine-grained building stone and praiseworthy native talent.

Tennessee.

A small space was divided between Tennessee and Louisiana. Products of the former were (besides bituminous and cannel coals, sandstone, marble, fire clay, and bricks made from it) hematite with 50 p. c. Fe. from the Eureka mine: iron ores from the Walden Ridge mines (all the above from Harriman); and specimens marked magnetite from Carter county, 60 p. c. Fe., which were mostly hematite with a partial admixture of magnetite,

The display was very unsatisfactory and showed that the important mining interests of this state had been unaccountably neglected.

Louisiana.

The only exhibit from Louisiana was the Petite Anse rock salt, of which a block had been carved to represent "Lot's (not Lottery's) wife." Iron pyrites, black oxides, gold and silver quartz, zinc ore and quartz are given also in the catalogue, but were not observed.

Utah.

Gold, silver and lead ores are shown from the districts which follow: Ophir, Willard, Park City, Stockton, Minersville, Ashley Fork, Big Cottonwood, Silver Reef (no lead), Willard, Beaver (no lead), Eureka, Tintic, Bingham, Cañon, Fish Springs, Marysville, Stockton, Park City, Horn Fork, Lake Side, St. George, Little Cottonwood, Cedar City, La Plata (no gold).

Iron ores from the Big Blowout, Black Jack, Bullion Beck, Carissa, Eureka Hills, Keystone, Mammoth, Northern Spy, "Now I Have It," Ogden Cañon, Red Rose, Red Warrier, Tate and Trowbridge mines.

Zinc ores from Baby McKee, Ben Harrison, Bonanza, Brooklyn, Bullion Beck, Chicago, Climax, Deseret, Eureka Hills, Highland, Jim Fisk, Keystone, Last Chance, Lexington, Lucky Boy, Nast, Niagara, Northern Spy, North Star, Ophir Hill, Patro, Red Rose, Sampson, Shoo Fly, Silver Spar, Spanish, Stewart, Tiawaukee, Trowbridge, Turn Green, Utah, Utah Queen, York, Yosemite No. 1 and Yosemite No. 2 mines.

Tellurium from the Buckhorn, Carr Fork and Northern Light mines.

Copper from the Alabama, Anchor, Argenta, Ashley, Barbee, Black Jack, Bonanza, Brooklyn, Brush Creek, Buckeye Reef, Bullion Beck, Bully Boy, Bunker Hill, California, Calumet, Carissa, Carr Fork, Catherine, Centennial (with antimony), Chicago, Copperbuilt, Copperopolis, Copper Stain, Crescent, Dalton, Daly, Daly West, Deseret, Dixie, Dragon, Dyer, Eureka Hills, Glencoe, Hempstead, Honorine, Jim Fisk, Keystone, La Plata, Leeds, Legal Tender, Lion, Mammoth, Mayflower, Mona, Northland, Northern Spy, North Star, "No You Don't," Oil Shales, Ontario, Ophir Hill, Plumbago, Queen, Red Rose, Sevier, Shoo Fly, Silver King, Silver Spar, Southern Star, Selenide of Mercury, Stormout, Sundown, Sunrise, Trowbridge, Utah Queen, Vindicator, Wardleigh, Webster, White Reef, Woodside, Yosemite 1 and 2 mines.

Antimony, or quicksilver, or both, from Baby McKee, Ben Harrison, Bismuth (Bi.), Brooklyn, Bullion Beck, Bully Boy (Sb. and Hg.), Carissa and Climax (Sb.), Copperbuilt (Sb. and Hg.) Copperopolis, Coyote, Dalton (Sb., Hg.), Dragon, Eureka Hills, Highland, Homestead, (Sb., Hg.) Keystone, Last Chance, Lexington, Lucky Boy, Mammoth, Maxfield, Mercury (Hg.), Nast, Niagara, Northern Spy, North Star, Petro, Plumbago (Sb. and Hg.), Red Rose, Red Warrior, Reed and Goodspeed.

Rob Roy, Rough and Ready, Sampson, Sevier (Sb. and Hg.), Stewart, Tiawaukee, Troybridge, Turn Green, Utah, Webster (Sb. and Hg.), York, Yosemite No. 1 and Yosemite No. 2.

Since the year 1868 Utah has yielded in silver and gold $136,000,000, of which $12,300,000 was obtained during 1892. The counties of Summit, Great Salt Lake, Tooele, and Beaver have furnished the larger part of this. During 1892 its lead mines yielded about 70,000,000 lbs. of lead, and its copper mines 2,000,000 lbs. of copper. Besides these riches Utah has bituminous and semi-bituminous coals in large amounts, of which some of the former produce a good coke.

VIRGINIA.

Coals and yellow ocher from Chesterfield county; gossan ore, pig iron, limonite and gothite from Pulaski City; pyrite and limonite from Bland county; needle iron ore, limonite and manganese ore (Jordan vein) from Buena Vista; bath, zinc, Pulaski spelter and zinc ores, including smithsonite and recently discovered zinc blende from Wythe county, constitute the bulk of the Virginia exhibit. Zinc and iron ores, magnetite and manganese, lead ore from Austinville, with coal from the famous Pocahontas coal mine, tin ore, marble and other building stones, kaolin, asbestos, gypsum and mineral waters were scattered about with such little regard for systematic arrangement that the objects were hard to find, and the value of the collection to a student seriously impaired.

WASHINGTON.

Here was a column of gold, silver and copper ores from Okanogon, Stevens county; cases of argentiferous galena from the Mitalene district; gold and silver quartz from the Rainbow and Coyote, Okanogon county; silver from the Green Horn mine, Okanogon county; silver from the Mayflower and the First Thought mines, Ruby Hill; silver-lead from the Beston mine, Cascade mining district, Skagit county, and from the Eagle mine.

Silver-copper from the Chewelah, Okanogon county; silver-gold from the Michigan Cascade district, Skagit county; silver-copper from the Eagle mine, Chewelah, Okanogon county; silver-gold, Cowboy mine, Salmon River district, Okanogon county; silver from the Lone Star, Okanogon county, "Cornicopia;" silver, Okanogon county; silver-lead, Midas mine, Cascade mining district, Skagit county; silver and lead, Grover Cleveland, Okanogon county.

A very striking star-shaped monument of gold, silver and copper ores embellishes this exhibit.

Hematite is shown from the "Ellum" mining district, Kittitas county, also a 60 p. c. ore from the Conqueror mine, Ellum, Kittitas county; other specimens from the Tacoma iron mine, 58 to 62 p. c. Fe., vein 7 feet wide, of Kittitas county; magnetite (?) specimens from the Princeton mine, Cle Ellum mining district, 65 to 70 p. c. Fe., vein 12 feet thick.

West Virginia.

Iron ores are shown from the following counties: Barbour (Boggs), Braxton (Durbin), Grant, Greenbrier, Berkeley, Kanawha, Marion, Ohio, Putnam, Raleigh (Harper's Ferry), and Wayne, besides other localities.

The exhibit of coals is good, as stated in the official catalogue, but there was nothing observed to represent ores of lead, tin, or other useful metals.

Wisconsin.

Gold ores are shown from Bentley and Pratt (gold and silver quartz); lead ore from Milwaukee, Benton, Shullsburg, Plattville, New Diggings, Hazel Green, Buncombe, Linden, Leadmine, Argyle, Highland, Belleville, Lancaster, Mineral Point, and Darlington; iron ores from Huriey, Ashland and Belleville; zinc ores from New Diggings, Shullsburg, Benton, Leadmine, Hazel Green, Etna, Linden, Highland, Plattville, Mineral Point, Buncombe; copper ores from Shullsburg, Buncombe, Mineral Point, Jefferson county, Belleville, Ashland and Superior.

Wyoming.

This State occupied a small floor space, 30x42 feet, on which were exhibited Rock Springs, Sweetwater, Kent mine and Sage Creek coals; bricks of sodium sulphate; a case of copper-gold ores from the Elkhorn Mining Co., Silver Crown district; asphaltum from the Rattlesnake district, Navrone county; asbestos, Carbon county; gold and silver ores from Carbon county; fine hematite from the Mons mine in Laramie county; tin ore from Sand Creek: gold ores from Atlantic, Carbon; lead containing silver as argentiferous galena from the La Plata, as carbonate from Black Butte and Carbon county; and hematites from Hartville, John Harper gulch. Rock Creek, Rawlins, and by an exhibiter from Cheyenne. The hematites from Carbon county, near Rawlins, are of fair appearance. A pyramid of iron ores is composed from four of the mines of the Wyoming Railway and Iron Co., in Laramie county. Hard and soft iron ores occurring in irregular and lens-shaped masses in chlorite and micaceous schists are said to furnish an excellent Bessemer ore. There are also exhibits of petroleum from Fremont, Natrona, Cook, Johnson, Weston counties. Some copper ores, building stones, asbestos, fire clay, gypsum, sulphur, stream tin, marble and moss agates are also included in Wyoming's representation.

The United States.

There is a very well conceived and carefully executed column near the Pennsylvania exhibit giving the amounts of certain valuable products which are produced in the United States per second. At the base is a large block of bituminous coal on which rests a smaller cube of anthracite, supporting a cube of limestone, on which rests a cube showing the amount of natural gas in its equivalent of coal: on this come petroleum, iron ore, granite, salt, red sandstone for building (brownstone), and twenty-five cubes, ever diminishing upwards, which represent the production of gold, silver, precious stones, etc. The design is a very good one and is well adapted to impart an idea of the enormous value of the mineral wealth of this country.

REVIEW OF RECENT GEOLOGICAL LITERATURE.

Development of the Brachial Supports in Dielasma and Zygospira. By Charles E. Beecher and Charles Schuchert. (Proc. Biological Soc., Washington, vol. viii, pp. 71-78, pl. x, 1893.)

The relation of the brachiopoda with spiral brachial supports to those in which these calcified supports take on the abbreviated form known as the *loop*, has been a fruitful subject of speculation, or, rather, of not over-shrewd guessing, by writers on these animals.

It has also been tacitly assumed, that the variations in the form of the loop which are known to occur in recent terebratuloids during the process of individual growth, were not manifested by palæozoic loop-bearing species. Both of these important points, which, up to the time of publication of this remarkable paper were lacunæ in our knowledge, have now been most admirably and conclusively covered.

Considering the latter subject first, the authors have shown by means of a series of preparations of the well-known *Terebratula*, or *Dielasma turgida* Hall, from the St. Louis limestone, that the loop in the earliest observed growth stage (length of shell .8 mm.) consists of a simple coalescence of the crural processes forming, at their anterior extremities a hinge-plate of precisely the form of that of the mature *Centronella* and essentially like that of *Rensselæria*. With later growth a resorption of the anterior portion of the triangular plate immediately sets in, and soon results in the normal form of the loop in *Dielasma*, which is shorter than in the majority of palæozoic terebratuloids, though constructed on the same plan. Thus the important facts are established: 1st, that the loops of palæozoic terebratuloids are subject to metamorphoses, and 2d, that *Centronella* and *Rensselæria* are primitive terebratuloid types, the earlier condition of whose brachial supports could not have differed from the discrete crural processes of the rhynchonelloids; and (though the authors make no such inference) that the *Ancylobrachia* as a whole, have been derived from this much earlier stock. The Silurian shells which have been supposed to possess long, reflected loops, and have been referred to the genera *Waldheimia* and *Hallina*, have been shown to be spiriferous.

A series of preparations of the brachial supports in early conditions of *Zygospira recurvirostra*, a Trenton limestone species, have furnished even more surprising results. In the earliest observed phase, the calcified support is in the secondary centronelliform stage, shown in *Dielasma*; that is, consists of two simple crural extensions, coalesced and expanded anteriorly, and has the apical portion of the plate resorbed. In the process of growth the progressive modification of the plate by resorption produces, first, the *Dielasma*-stage, and subsequently a continued growth of each lateral process forward, beyond the angles made with the transverse band, results in a slight upward curvature of these lateral processes, then in a single complete revolution, which is the stage where this growth ceases in *Hallina*. A continuation of this spiral growth affects the completed spirals of *Zygospira*, with introverted apices and broad jugal band. The transverse band or ascending lamellæ of the loop in *Dielasma* and the jugal band (*jugum*) of *Zygospira* are thus shown to be similar remnants of the primitive centronellid plate. The *Helicopegmata* (spire-bearing brachiopods), or at least the division of them with introverted spirals (*Atrypidæ*) are forms attaining the *brachidium* by a series of metamorphoses and deriving their origin from the *Ancylobrachia*. "A further natural conclusion is that the *Ancylobrachia* are older and more primitive than the Helicopegmata," and that both have had their inception in the *Rhynchonellidæ*.

These significant results afford a charming exhibition of the achievements of intelligent zeal in the handling of a most difficult subject. Only one familiar with the present requirements of the study of the fossil brachiopods can appreciate the author's good fortune in securing material adapted to such investigations, and comprehend the degree of patient labor necessary for its elucidation.

Trematobolus: An Articulate Brachiopod of the Inarticulate Order. By G. F. MATTHEW. (Canadian Record of Science, Jan., 1893, pp. 276–279.)

This new brachiopod genus is described from the St. John group of Hanford Brook, N. B. It is interesting as showing, first, an hitherto unknown combination of the form and muscular characters of *Obolus* with the long pedicle channel of *Schizambon* opening near the center of the pedicle-valve; and secondly, well developed articulating processes on the pedicle-valve, with grooves or sockets on the opposite valve for their reception. Other genera have shown tendencies to span the conventional chasm between the edentulous and dentate brachiopods; *Barroisella* of the linguloids, *Spondylobolus* of the oboloids, and now *Trematobolus* evinces a similar inclination among the siphonotretoids. There is, however, no evidence that any of these forms has left progressed descendants.

Outline of the geological and physical features of Maryland. BY GEORGE H. WILLIAMS AND WILLIAM B. CLARK. Extract from the World's Fair book on Maryland prepared by the members of the faculty of Johns Hopkins University; 67 pages, with a geological map of the state and 16 plates: Baltimore, 1893. Price $1.00. By far the most pleasing and valuable part of this paper is the geological map of Maryland, which is the second geological map of the state ever published; the first was issued in 1860, and since that time the geologist has had no convenient method of obtaining an idea of the areal distribution of the various rock series in that state, as the first map is hard to obtain and needs many corrections. This new map was compiled from all the available data and brings up to date our knowledge of the extent of the different formations and indicates the areas to which future stratigraphical and structural work should be directed. The practical value of the map is greatly enhanced by Prof. Milton Whitney's designations of the soils peculiar to each formation. The authors are to be congratulated upon the production of such a pleasing and harmonious piece of chromolithography; it is certainly a good example of what can be done in this line in America.

The first part of the paper is devoted to a consideration of the physical features of the state. As regards topography, Maryland can be divided into three pretty distinct provinces, each well marked by certain definite characters. These areas are known as the Coastal plain, the Piedmont plateau and the Appalachian region. In the Coastal plain is included the eastern half of the state; it is characterized by broad, level-topped stretches of country, which are cut by sluggish streams and tidal estuaries, which extend up to the eastern edge of the Piedmont plateau. The land of the Coastal plain rises gradually from the coast towards the interior and reaches in places an altitude of 300 feet or more. The Piedmont plateau includes about one-fourth of the state. Here the country is broken by low, undulating hills, rising higher towards the west. The streams are rapid and are actively cutting down their channels. The Appalachian region forms the western part of the state. Here are a series of parallel mountain ranges, with deep valleys between them, and the whole is cut at almost right angles by the Potomac river. Many of the ranges reach a hight of 2,000 feet above sea level and some of over 3,000. A number of pages are devoted to the climate of the state, and there are several charts showing the temperature, precipitation, etc., for different parts of the year.

The state of Maryland, although of small size, is so situated that it presents an almost complete sequence from the most ancient to the recent formations. The three different topographical provinces are also geological provinces, so that in a general way it can be said that the Piedmont plateau is occupied by the ancient crystalline and semi-crystalline rocks, the Appalachian region by the Paleozoic and the Coastal plain by the Mesozoic and Cenozoic deposits.

The Piedmont plateau is regarded as having a fan structure, the axis of the fan starting from the Great Falls of the Potomac and running in a general northeasterly direction; this axis is not coincident with nor parallel to the line between the more crystalline rocks to the east and the less crystalline to the west, but lies in the latter. The country rocks of the eastern part of this plateau are mostly gneisses which now show no evidence of a clastic origin, but their sedimentary character may be inferred from the rapid alternations of beds of different composition and from the nature of the rocks intercalated with them,—marbles, and quartz schist. Three types of igneous rocks have broken through and more or less modified the gneisses; these eruptives are, in the order of their ages, gabbro, peridotite and pyroxenite, and granite. In many places these have been subjected to intense dynamic action and have undergone profound alteration. The western part of the plateau is composed of little crystalline or semicrystalline rocks; towards the east these become more crystalline and stand nearly vertical. The geological position of these rocks has not been positively proven by fossils, but it is very probable that they are Cambrian sandstones, Trenton limestones and Hudson river shales in a more or less metamorphosed condition. It is here that more detailed stratigraphical work is needed. The Newark (Triassic) sandstone occurs along the western edge of these rocks and overlaps them to some extent.

The Appalachian province shows an almost complete sequence of the sediments of the Paleozoic. On the east the Blue ridge and the Great valley exhibit faulted Cambrian, Trenton and Hudson River rocks, beneath which in places are older eruptives,—rhyolite, basalt and granite. The province west of this exhibits in the most characteristic manner the typical Appalachian structure; it is composed of Silurian and Devonian rocks more or less closely folded. Beyond this is the Alleghany plateau of less sharply folded Devonian and Carboniferous strata. Here lies the coal industry of Maryland. The well known names and numbers of the Pennsylvania survey are used in the descriptions of the formations of the Paleozoic.

The Coastal plain is composed of little consolidated or unconsolidated gravels, sands, marls and clays. A number of formations are represented, as follows:

Cenozoic	*Pleistocene* (Columbia).	
	Pliocene (Lafayette).	
	Miocene (Chesapeake).	
	Eocene (Pamunkey).	
Mesozoic	*Cretaceous*	Upper (Severn).
		Lower (Potomac).

Of these the Pamunkey and Chesapeake are of special interest because of the large numbers of fossils to be found in them; these Eocene and Miocene fossils are well known to geologists by the papers of Say and of Conrad, but they still offer opportunity for much more investigation. The history of the Coastal plain is quite complex, there being many periods of more or less marked elevation and erosion and of depression and deposition, with the consequent unconformities.

After the description of the various formations a brief resumé is given of the periods of elevation, submergence, folding and erosion to which the rocks of Maryland have been subjected since the earliest times. Although of necessity written in a popular and sometimes elementary manner, this paper will be welcomed by geologists and students as furnishing what we have not elsewhere,—a concise account of what is at present known concerning the geology of Maryland.

Correlation Papers, Cretaceous. By Charles A. White. pp. 273, with 3 plates, and 7 figures in the text. (Bulletin No. 82, U. S. Geol. Survey, 1891. Price 20 cents.) Seven Cretaceous regions of North America are separately described in this memoir, namely, the Atlantic border, Gulf border, Texan, North Mexican, South Interior, North Interior, and Pacific border. In the classification of the formations by their fossils they are assigned to eight horizons or divisions which are paleontologically distinct, namely, in ascending order, the Potomac, Comanche, Kootanie, Shasta, Dakota, Maritime or Interior (comprising the Colorado and Montana sub-horizons), Chico-Tejon, and Laramie. Of these the first four are classed together as Lower Cretaceous, and the second four as Upper Cretaceous, the latter including both the Earlier and Later divisions of the series studied by Meek and Hayden on the upper Missouri. It is not assumed, however, that the division here made is precisely equivalent with that established in Europe; and especially it has not been found practicable to define so clearly as in Europe the lower and upper limits of the system. The synonymy of the formations, springing from independent studies by many geologists, is shown in a series of tables, which represent nineteen of the principal published Cretacous sections of this continent and afford at the same time a view of the author's correlations. In each table or section the twenty-six letters of the alphabet, equally spaced, stand for the whole duration of Lower Cretaceous and again in like manner of Upper Cretaceous time. Thus the supposed relative lengths and equivalency of the local formations of each region are very definitely stated. On the map of known Cretaceous areas the North Interior region should be extended eastward from North and South Dakota to cover likewise continuously, although less deeply, considerable tracts of western Minnesota and northwestern Iowa. Bibliographic references, with brief annotations, occupy 35 pages, followed by a concise historical sketch of the progress of discovery and exploration of our Cretaceous areas.

Correlation Papers, Eocene. By WILLIAM BULLOCK CLARK. pp. 173, with two maps. (Bulletin No. 83, U. S. Geol. Survey, 1891. Price 15 cents.) In the Atlantic and Gulf coast region the separation between the Cretaceous and Eocene is determined with a general concurrence of opinion among geologists, as shown in this report; and the later Tertiary or Neocene is found unconformably overlying the Eocene, with fossils that readily distinguish the two horizons. The Eocene there is wholly marine and is more or less clearly assigned to three horizons, lower, middle, and upper. On the Pacific coast two very distinct divisions are recognized, namely, the Tejon group, of marine origin, represented in California, Oregon, and Washington; and the brackish Puget group, found in Washington alone. Lacustrine Eocene beds cover broad continuous tracts on the eastern and western flanks of the Rocky mountains, and are scattered in smaller basins from Colorado to Nevada and from Montana to Texas. Here the system comprises the following members in ascending order, as correlated by Dr. Clark: the upper portion of the Laramie group, the Arapaho, Denver and Puerco beds, and the Wasatch group, belonging to the Lower Eocene; the Manti and Amyzon beds, and the Wind River and Green River groups, all regarded as co-extensive, or nearly so, with the middle epoch of this period; and the Huerfano beds, and the Bridger and Uinta groups, forming the third and upper part of the series. For each of the three chief regions of our Eocene formations, near the eastern and western coasts, and in the Cordilleran mountain belt and adjacent plains, a detailed historical sketch is given, with plentiful citations of the publications relating to them; and the same and other works are also noted in a final bibliography of 12 pages. Like each of the preceding and following correlation papers, this essay has a good index, permitting quick reference to its contents and making it a most convenient and valuable handbook in field work and research.

Correlation Papers, Neocene. By WILLIAM HEALEY DALL and GILBERT DENNISON HARRIS. pp. 349, with three maps and 43 figures of sections and profiles in the text. (Bulletin No. 84, U. S. Geol. Survey, 1892. Price 25 cents.) The junior author, Mr. Harris, examined the literature of earlier reports of surveys by the several states and by the national government, and prepared the sixth chapter, on the fresh water Neocene deposits of the interior region of the United States, and the concluding seventh chapter, which is an annotated list of the names (exceeding two hundred) which have been applied to our Cenozoic beds and formations, with indications of the origin of the names and citations of authors and dates. Dr. Dall has revised and correlated the data relating to the Neocene formations, mostly marine, which are extensively developed along the coastal plain of the Atlantic and Gulf of Mexico and more narrowly and less continuously along the Pacific coast, and has written the chapters on Florida, British Columbia, and Alaska. To this work Dr. Dall brought his intimate knowledge of our Tertiary and recent molluscan faunas, and the fruits of his years of observation in Alaska and Florida, for each of which exceptionally copious description and discussion are presented.

Lyell's Miocene and Pliocene are united under the term Neocene, but the former terms are also much used throughout the work; and the relationship of the preceding Eocene strata and of the succeeding Pleistocene and recent formations leads in many portions, especially in treating of Florida, to the consideration of the entire Cenozoic system, extending through the Tertiary and Quaternary eras to the present time. The Miocene period in the eastern United States is defined as beginning with an uplift by which central Florida was first raised above the sea to form an island, and ending with a similar vertical movement which permanently united this island with the mainland to the north and west and probably also united North and South America. As thus defined, the Miocene comprises two epochs. During the first, typified by the Chipola beds, a warm-water marine fauna reached north to New Jersey, the conditions there resembling those now at the isthmus of Panama; and the supposed Miocene leaf-beds of Greenland were perhaps synchronous. The second, or Newer Miocene epoch, to which the Ecphora bed and Chesapeake formation belong, was characterized by the extension of a relatively cold-water fauna southward to Florida and the Appalachicola river.

The marine Pliocene, well developed in western Florida, and extending thinly northward to South Carolina, and perhaps to southeastern Virginia, is marked by a return to the Floridian region of a warmer, chiefly Antillean, invertebrate fauna; but many of the Chesapeake species survived the change and are still living on the northern shores of the gulf of Mexico. During the middle part of the Pliocene period Florida and even the interior of the continent were reached by a very remarkable immigration of South American terrestrial vertebrates, and others came into the Florida peninsula from the northern fauna. "The rhinoceros, the wild horse, the llama, the Columbian elephant, the mastodon, the glyptodon, and various enormous tortoises wandered along the shores of the lakes and through the marshes, while the saber-toothed tiger lay in wait." Some of the great Pliocene mammals, as the mastodon, continued their existence during the Glacial period, and it is found difficult, in the southern states, to draw a definite plane for the base of the Pleistocene or Quaternary deposits.

Eocene limestone strata, referable to the Vicksburg or highest division of that series, are known to have a thickness of 1,066 feet, from 212 to 1,278 feet, in a boring at St. Augustine, at which depth the bottom was not reached; but the combined maximum thicknesses of the Neocene formations of Florida are probably somewhat less than 1,000 feet, of which about one half consists of the Jacksonville limestone and associated beds. Over most of the peninsula the Neocene is estimated not to exceed 250 feet, and in many places to be less than 100 feet.

Above the bed rocks two conspicuous sand formations cover the greater part of Florida. The lower is a very fine-grained, yellowish, clayey sand, sometimes 50 feet thick; and the upper is a snowy white, more gritty sand, seldom exceeding a few feet in depth. The yellow sand forms the main mass of the abundant low sand hills and ridges of the central and southern lake district, having contours, as Prof. Shaler has remarked, like the kames of New England. This deposit, according to Dr. Dall, is the residuary product from the decay and subaërial erosion of the soft Tertiary limestones. The white sand he thinks attributable to marine transportation from the coastal region north of Florida during some part of the Pleistocene period, when the state sank beneath the sea level; but apparently it may instead be an extreme result from subaërial leaching and bleaching of the underlying residuary sand, the area not having been submerged at any time in this period.

Dr. Dall decides from his study of Florida that it had no great changes of level during late Tertiary and Quaternary times, while the Antillean region and the Atlantic coast northward, probably with nearly all of North America, have experienced important epeirogenic movements of uplift and subsidence, which at the north have been supposed to account for the accumulation and departure of the land-ice of the Glacial period. Some important considerations which have been brought forward by Prof. Shaler, however, go far toward establishing an opposite conclusion for the Floridian peninsula. He states that fresh water was obtained in the boring before mentioned, at St. Augustine, to a depth of 900 feet, being succeeded below by saline water to the bottom, from which he infers an uplift of the land at least somewhat more than 900 feet above its present hight, allowing the salt water originally enclosed in these marine beds to be drained out, its place being taken and since held by fresh water notwithstanding the subsequent depression. Shaler also mentions, in "Nature and Man in America," that a powerful spring of fresh water wells up strongly in the sea "a few miles to the south of St. Augustine and three or four miles from the coast-line." Subterranean stream courses are thus known to reach far beneath the present sea level, and their channelling in the porous limestones must have taken place when the peninsula was considerably elevated.

An explanation may thereby be found for the surprising inequality of contour of the residuary sand deposits in the lake district of Florida, where hundreds and even thousands of small lakes and lakelets, mostly having no outlet, lie in the hollows between the sand hillocks and ridges. If the base-leveled Pliocene plain was for a geologically short time uplifted 1,000 feet, more or less, the water of rains soaking through the porous soil and rocks must have channelled caverns and long tunnels into which much of the superficial sand would be carried. Since the land afterward sank to its present hight, these passages are partly beneath the sea level, and the plane of saturation of the rocks and soil is so much higher than before that the multitudes of lakes, very unusual and anomalous in unglaciated regions, are gathered in the hollows from which the sand was removed by the underground drainage.

Correlation Papers, the Newark System. By ISRAEL COOK RUSSELL. pp. 344, with 13 plates and four figures in the text. (Bulletin No. 85, U. S. Geological Survey, 1892. Price 25 cents.) The Newark system, consisting of sedimentary beds with extensive trap dikes and sheets, referred by Russell approximately to the latter part of the Triassic and the early part of the Jurassic eras, is confined to the Atlantic border of North America, and occupies narrow tracts whose longer axes trend in general northeast and southwest, in parallelism with the folds of the Appalachian mountain belt. From the most northerly exposures, in Nova Scotia, southwest to the most southerly outcrops, in North Carolina, is a distance of about 1,200 miles; and the entire area of the system now remaining is about 10,000 square miles. Professor Russell concludes that probably all the Newark tracts from Massachusetts and Connecticut southward were originally united, and that possibly this great belt also continued northeast to the Acadian area. Three-fifths of the volume are devoted to a very complete index of the literature of the Newark system, by authors, subjects, and localities. This name of the system, referring to its development in the vicinity of Newark, N. J., was first used in 1856 by W. C. Redfield, being the earliest term applied to it without expression of opinion concerning its equivalence with geologic systems in Europe.

CORRESPONDENCE.

ORIGIN OF PECONIC BAY AND OF SHINNECOCK HILLS. The Shinnecock hills form part of the so-called backbone of Long Island, but the vertebral column at this point is pushed a little out of place and bends southward into the Shinnecock bay.

If we look at a map of Long Island and observe the contour of Peconic bay we will find that this beautiful sheet of water indents the shore on the north side of the Shinnecock hills, and in fact the two bays, already mentioned, are almost connected by the depression at Canoe place.* Another longer arm stretches out from Peconic bay to-

*A canal now connects the Shinnecock and Peconic bays.

wards Southampton. The terminal moraine or backbone then recedes again to the north, as do the waters of Peconic bay, showing that the action of glacial floods had some effect on the Shinnecock hills which are really kame formations.

I had noticed, on the west end of the island, that, wherever the flood of waters was great, the marginal kames became more prominent and were pushed further southward. Last winter, in looking over volume 40 of the American Journal of Science, I found a paper by Prof. James D. Dana, entitled "Long Island Sound in the Quaternary." In this paper he points out the fact, that there is a deep channel in the sound connecting seemingly with the Mattituck river or pond, and he infers therefrom that Peconic bay owed its origin to the action of subglacial streams coming in at this point. I was gratified to find my own conjectures thus confirmed, as in my pamphlet on the formation of Long Island, page 15, I had said, "Block Island sound, Gardiner's, Great and Little Peconic bays were originally formed by subglacial streams that came from the mainland." When this was written I was not aware of the existence of the old channel referred to by Prof. Dana, but a careful study of the west end of the island had convinced me that all of the indentations of the western shore were the same in origin.

A few weeks ago I paid a visit to Mattituck, and walked from there to the sound, the distance of about two miles, and found the depression, at this place, corresponding in every way to those so familiar to me on the west end of the island. The Mattituck stream, of course, did not form the whole of the Peconic valley, as there were numerous other streams flowing under the ice-sheet from the mainland, but there is every evidence that the flood of waters was greatest through the Mattituck channel.

Professor Dana informs me that as early as 1870, in a paper on the New Haven region, he pointed out a probable connection between the sound and Peconic bay. I knew nothing of this when my pamphlet was written in 1885, so that the same conclusion was reached by independent investigation. What I want to say now, however, is this, that my recent visit to Mattituck has convinced me that the glacial rivers flowing in at this point not only formed the Peconic valley, but that they had a good deal to do in the formation of the Shinnecock hills, and is it not very suggestive that the depression at Canoe place is nearly opposite the old channel in the sound ?

Of course, all connection is now lost in the waters of Peconic bay, and there are other difficulties in the way of the solution of the problem, but, as professor Dana says, this makes the study all the more interesting. That water had much to do in the formation of the Shinnecock hills, and, in fact, with the whole of the terminal moraine, no one can deny, but a careful study of Long Island would, I think, convince the most skeptical that the ice-age was no "*nightmare*."

JOHN BRYSON.

Eastport, L. I., Nov. 2, 1893.

PERSONAL AND SCIENTIFIC NEWS.

THE ANNUAL SCIENTIFIC MEETING OF THE NATIONAL ACADEMY OF SCIENCES was held in the senate chamber at Albany, N. Y., Nov. 7-9, Prof. O. C. Marsh presiding. The following papers were read:

American Palæozoic Cockroaches (by title), SAMUEL H. SCUDDER.
Additional Researches on the Motion of the Earth's Pole, SETH C. CHANDLER.
Biographical Memoir of A. H. Worthen (by title), C. A. WHITE.
Biographical Memoir of W. P. Trowbridge (by title), C. B. COMSTOCK.
The Geological Map of the State of New York, JAMES HALL.
On a new form of Telescopic Objective, as applied to the twelve-inch Equatorial of the Dudley Observatory, CHARLES S. HASTINGS.
On the Structure and Development of Trilobites (by request), CHARLES E. BEECHER.
Double Stars, ASAPH HALL.
Latitude Determinations at the Sayre Observatory (by title and request), CHARLES L. DOOLITTLE.
Insect Voices (by request), JOSEPH A. LINTNER.
Edible and Poisonous Fungi (by request), CHARLES H. PECK.
A New Process of Printing in Color, EDWARD S. MORSE.
On Reaction, Times and the Velocity of the Nervous Impulse (by title and request), J. MCKEEN CATTELL and CHARLES S. DOLLEY.
The Palæontology of the State of New York; the present condition of the work, JAMES HALL.
Certain Histological Relations Between the Subalpine Plants of the White Hills and of the Labrador Coast, GEORGE LINCOLN GOODALE.

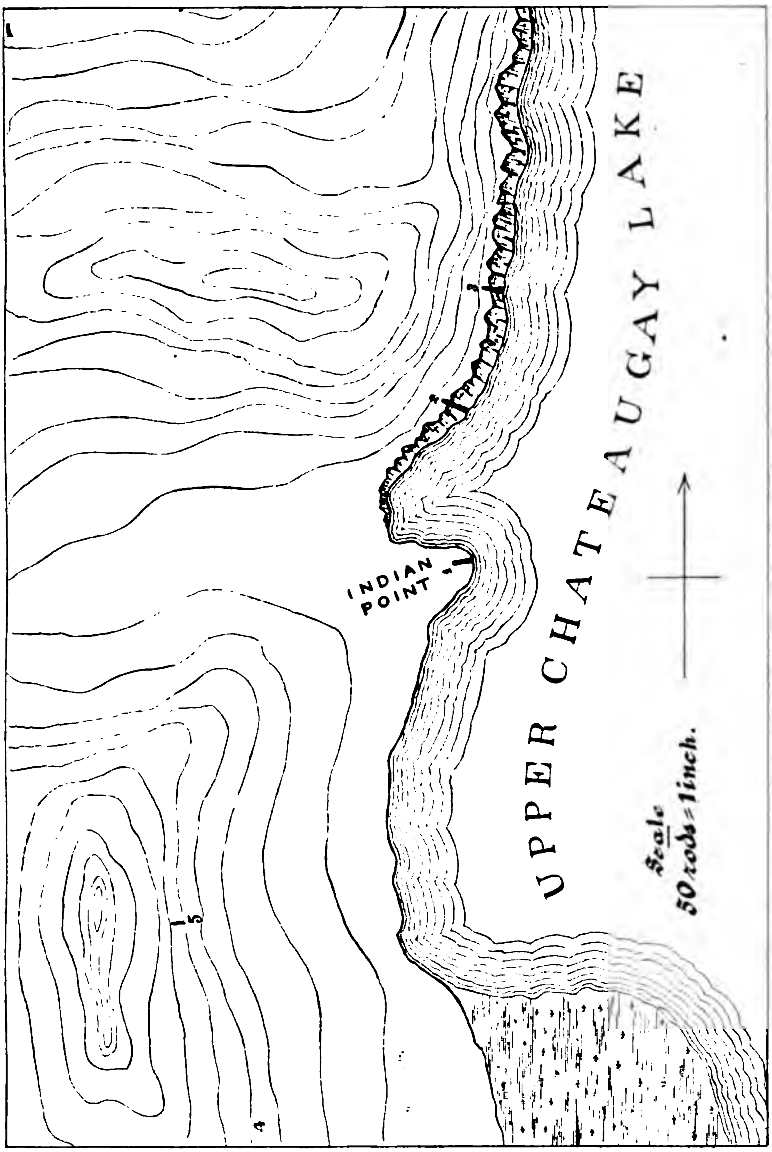
The interest of the meeting centered mainly in the dedication of the new building and equipment of the Dudley Observatory in Albany, and the tenor of the discussions was therefore largely astronomical. Prof. James Hall gave an account of the progress made during the seasons of 1892-3 upon the new geological map of New York, and of the work accomplished in various lines of palæontological research, on brachiopoda, sponges, and corals. Prof. Beecher's paper added new determinations in regard to the anatomy of the trilobites.

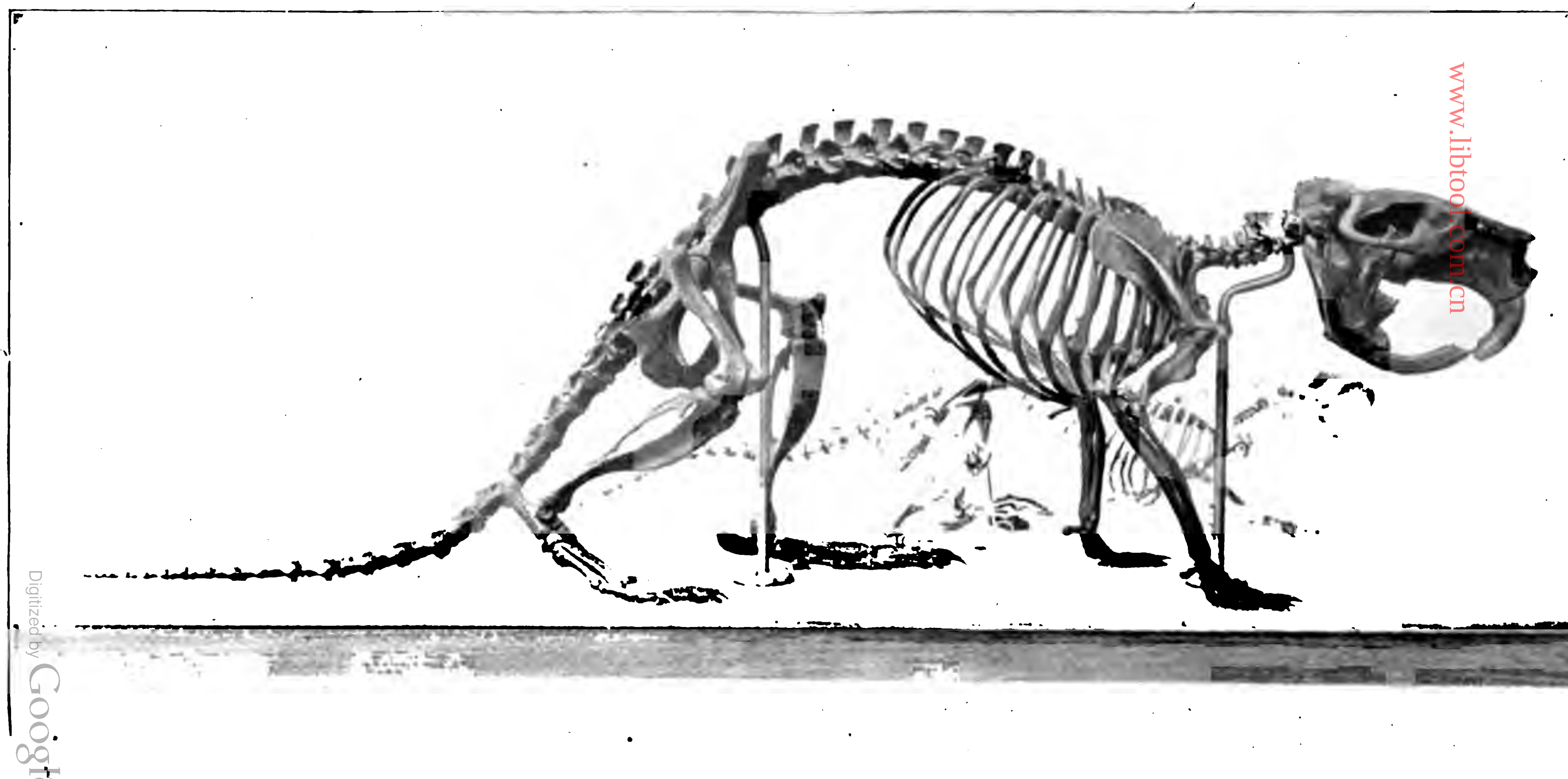
MISS MARIA OGILVIE IS A YOUNG ENGLISH WOMAN who a few years ago at the Ladies' college in Edinburgh won a $1,500 prize, a gold medal, and a $500 scholarship. Then she went to London university, took the zoology medal and captured a few other prizes, together with the degree of bachelor of science. She studied in Munich university, and did a great deal of original geological exploration in South Tyrol. The results of this work have been embodied in a paper published by the Geological Society. The difficulties were not slight. Every summit had to be scaled and the various strata traced. Some of the summits ranged from 8,000 to 9,000 feet in hight.

INDEX TO VOL. XII.

ERRATA.

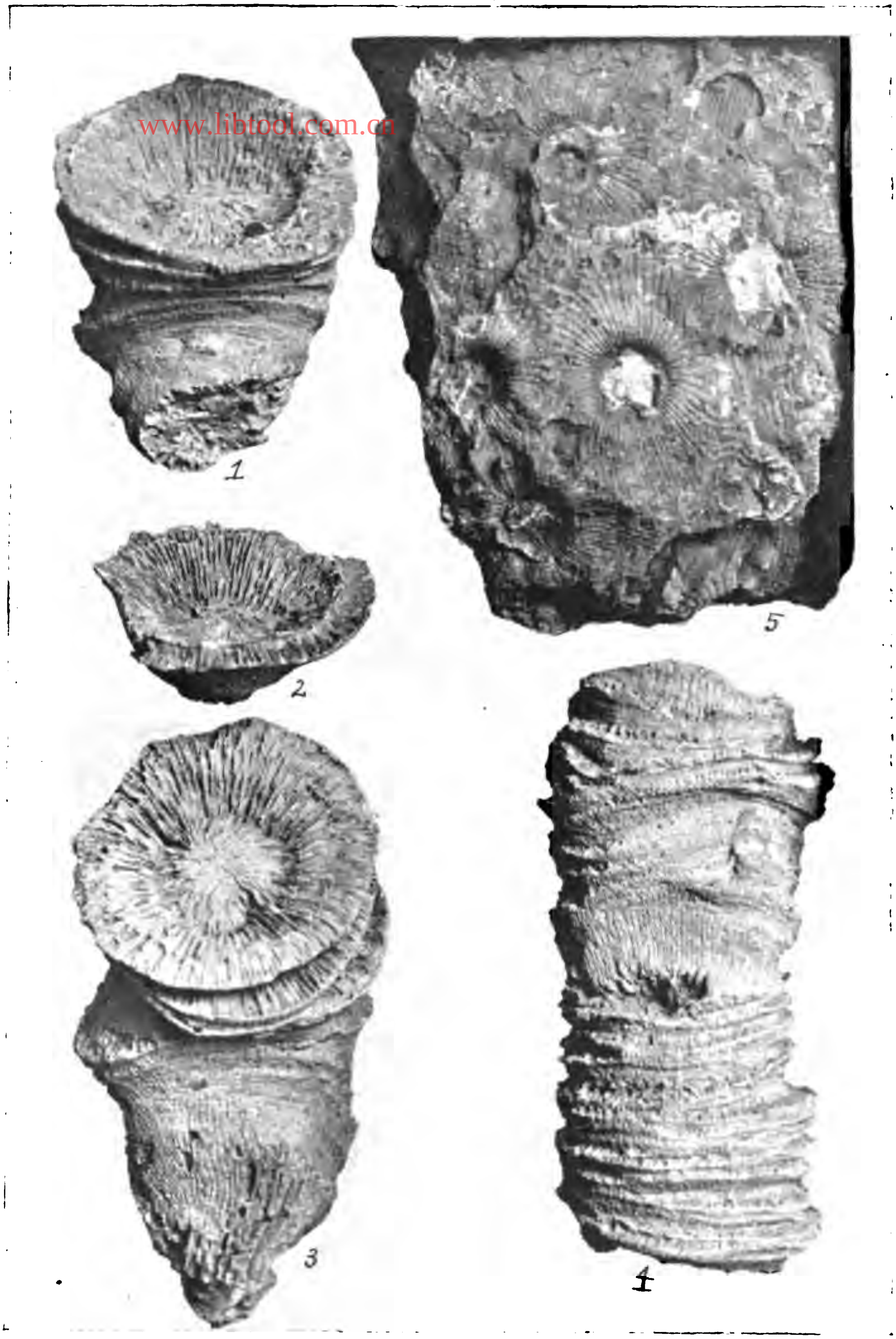
On p. 108, in the title of the paper, for 1859 read 1839.
On p. 193, line 23, for "Retrograptus" read Retiograptus.
On p. 193, line 39, for "rotundiformis" read rotundifrons.
On p. 218, line 7 from the bottom, for 1882 read 1892.
On p. 270, line 21, for H. Piers read H. Ami.


UPPER CHATEAUGAY LAKE
INDIAN POINT
Scale
50 rods = 1 inch.



CASTOROIDES OHIOENSIS Foster.

[As mounted by Profs. H. A. Ward and Jos. Moore.]

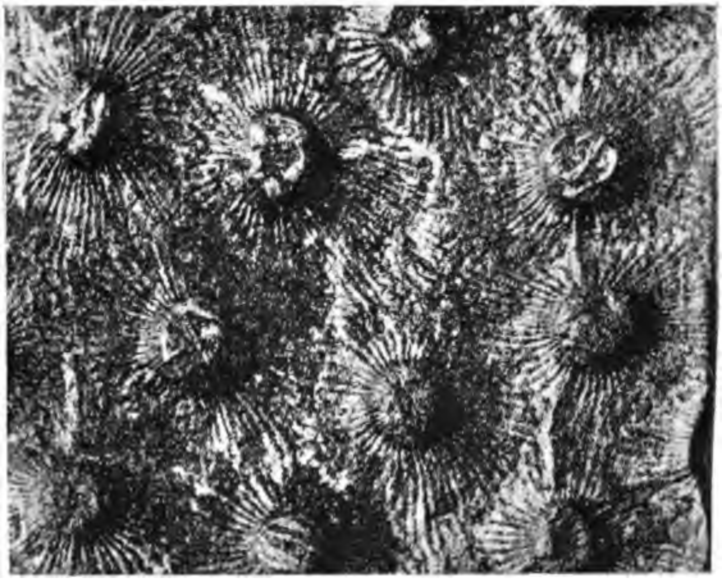


PTYCHOPHYLLUM EXPANSUM Owen sp.

Fig. 1, Short, conical individual with deep calyx.
Fig. 2, Very short, comparatively young corallum, corresponding in dimensions to Owen's *Cyathophyllum corinthium.*
Fig. 3, Corallum of average proportions with explanate calyx.
Fig. 4, Portion of an elongated, cylindrical corallum of the type described as *Cyathophyllum undulatum et multiplicatum.*

STROMBOIDES GIGAS Owen sp.

Fig. 5, Portion of a corallum showing the characteristic features of this species.



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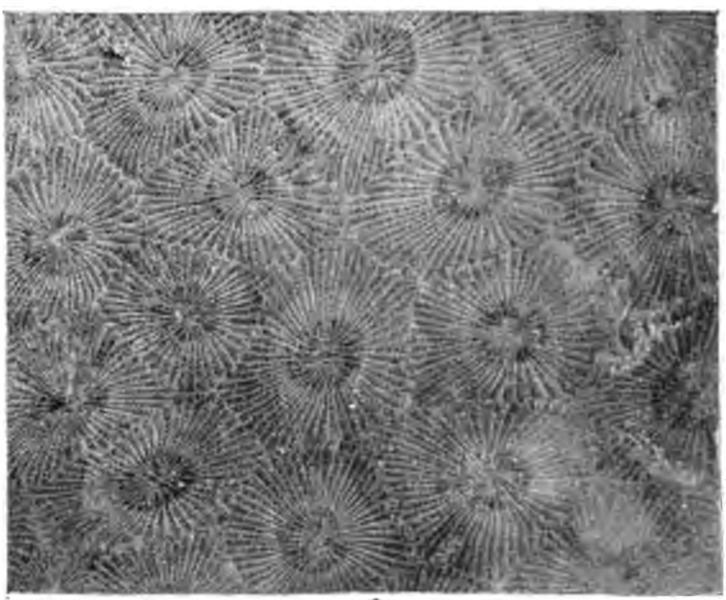
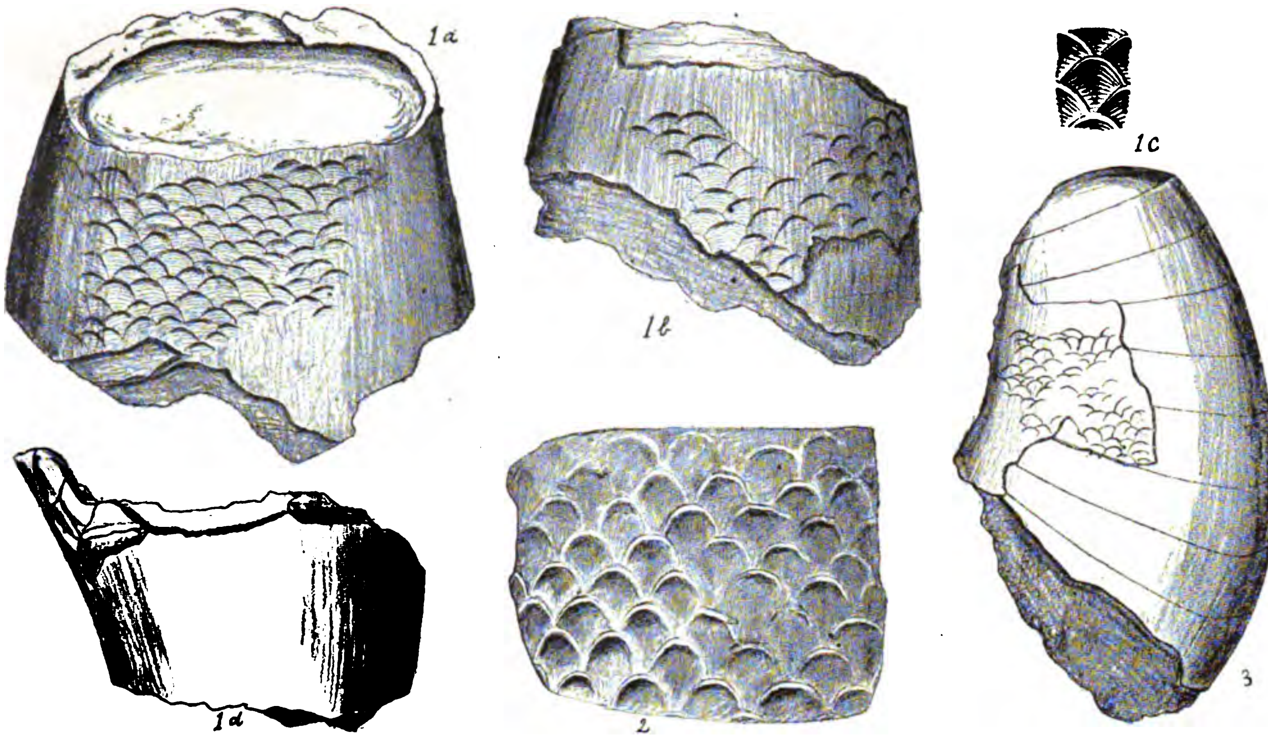


2

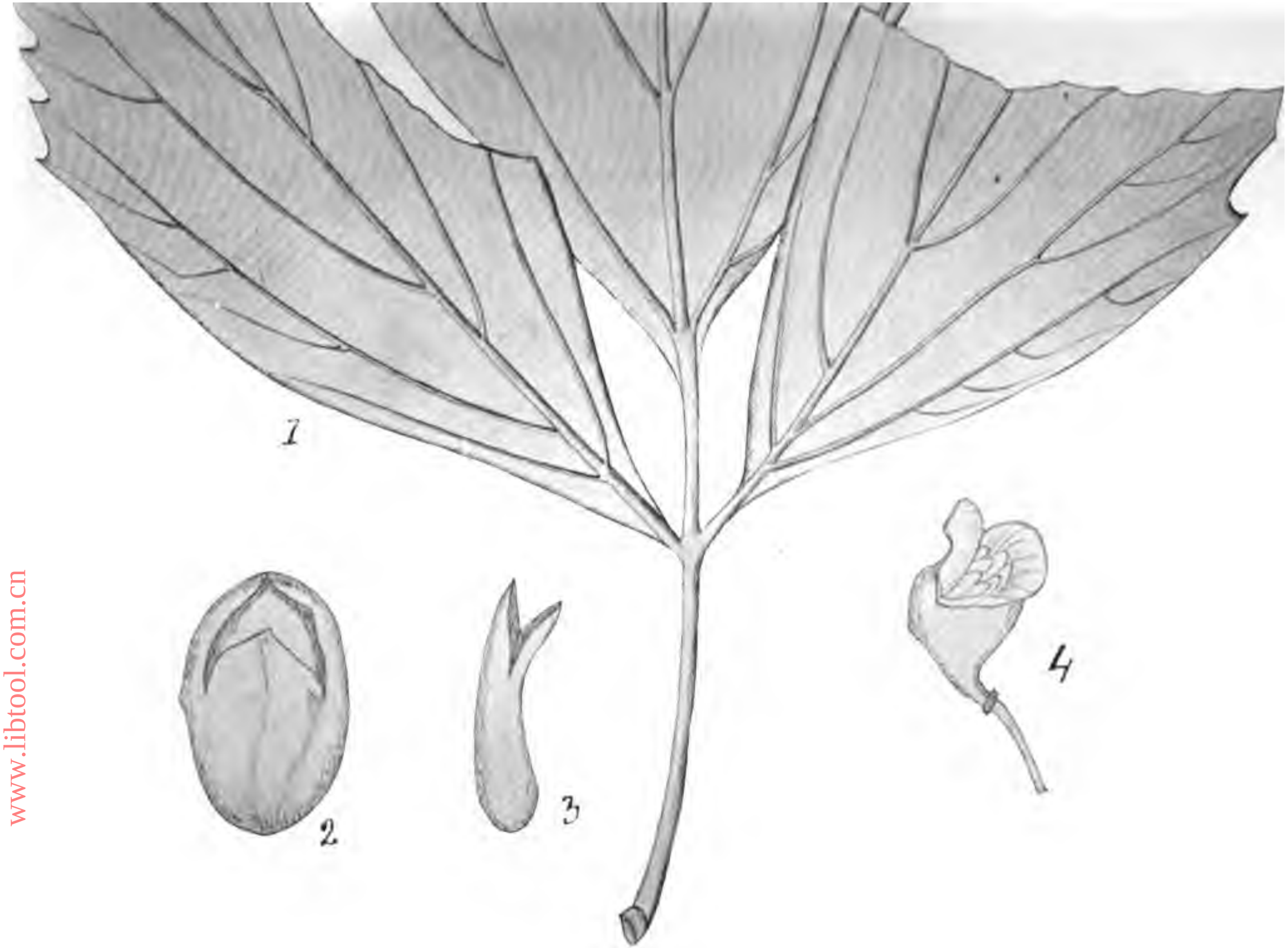
PHILLIPSASTREA BILLINGSI Calvin.

Fig. 1, Portion of the weathered surface of a large corallum, showing size and general features of the corallites.

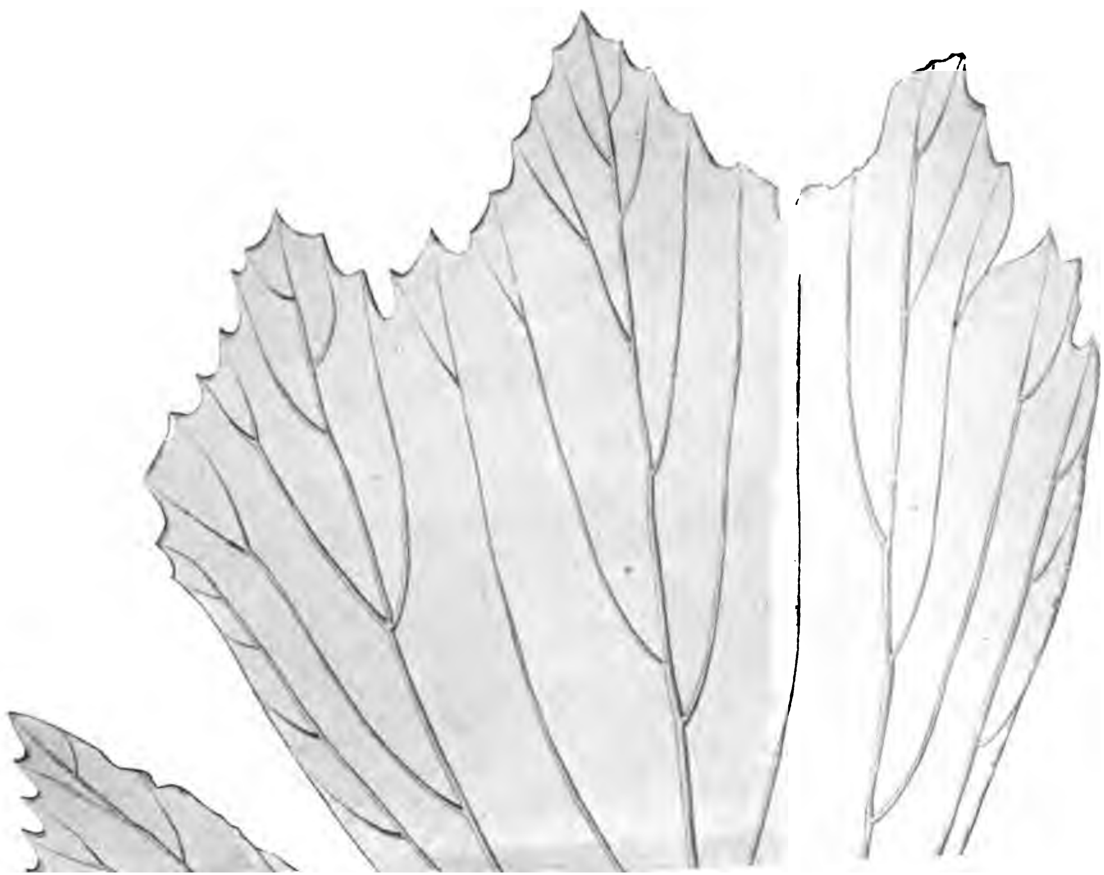
Fig. 2, Portion of polished surface of another corallum, showing details of structure.



SO-CALLED SILURIAN LAND PLANTS.

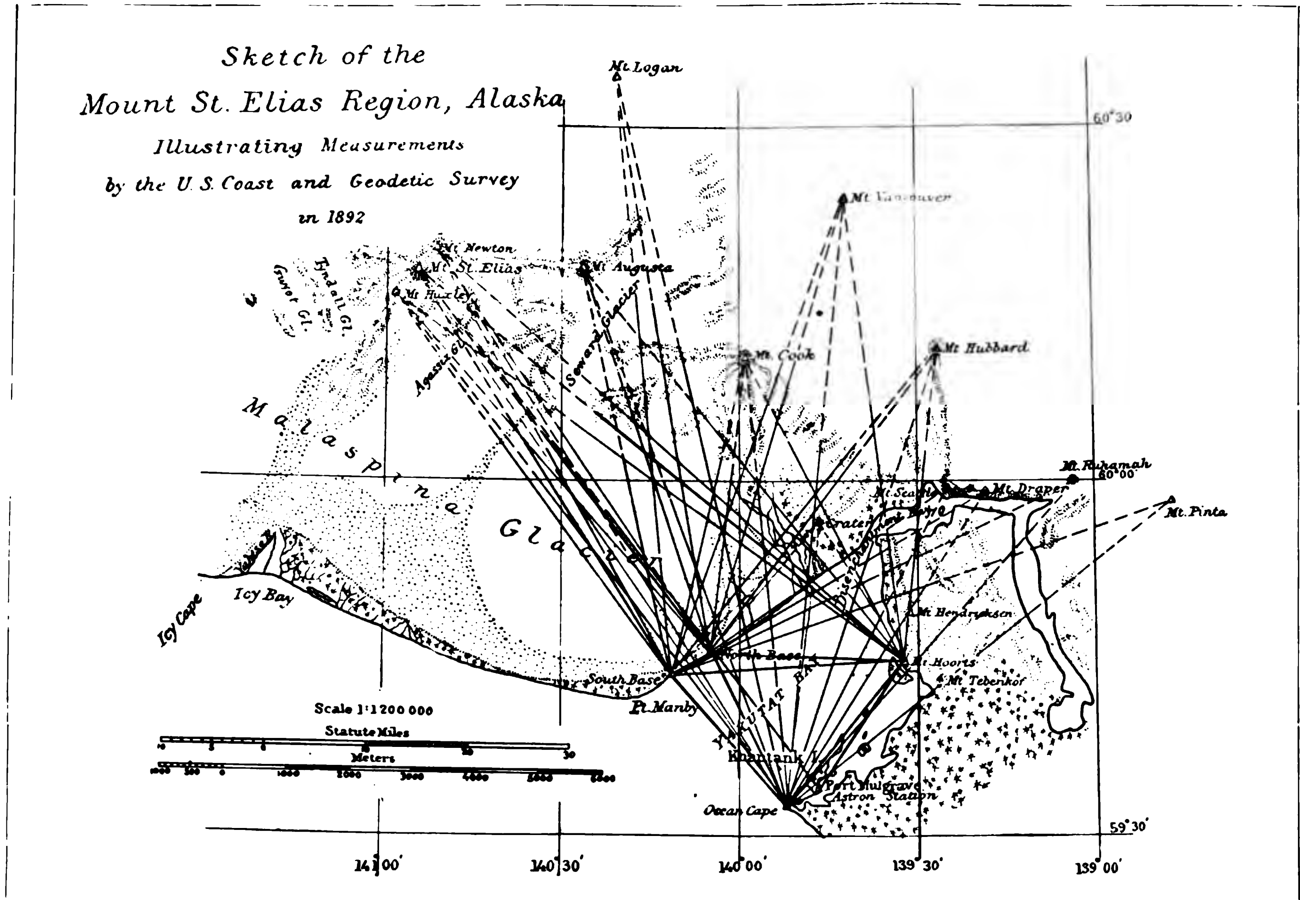


WINCHELLIA TRIPHYLLA.



ACHLYS TRIPHYLLA

). C.


Sketch of the
Mount St. Elias Region, Alaska
Illustrating Measurements
by the U. S. Coast and Geodetic Survey
in 1892
Mt. Logan
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Agassiz Gl.
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Icy Bay
South Base
North Base
Pt. Manby
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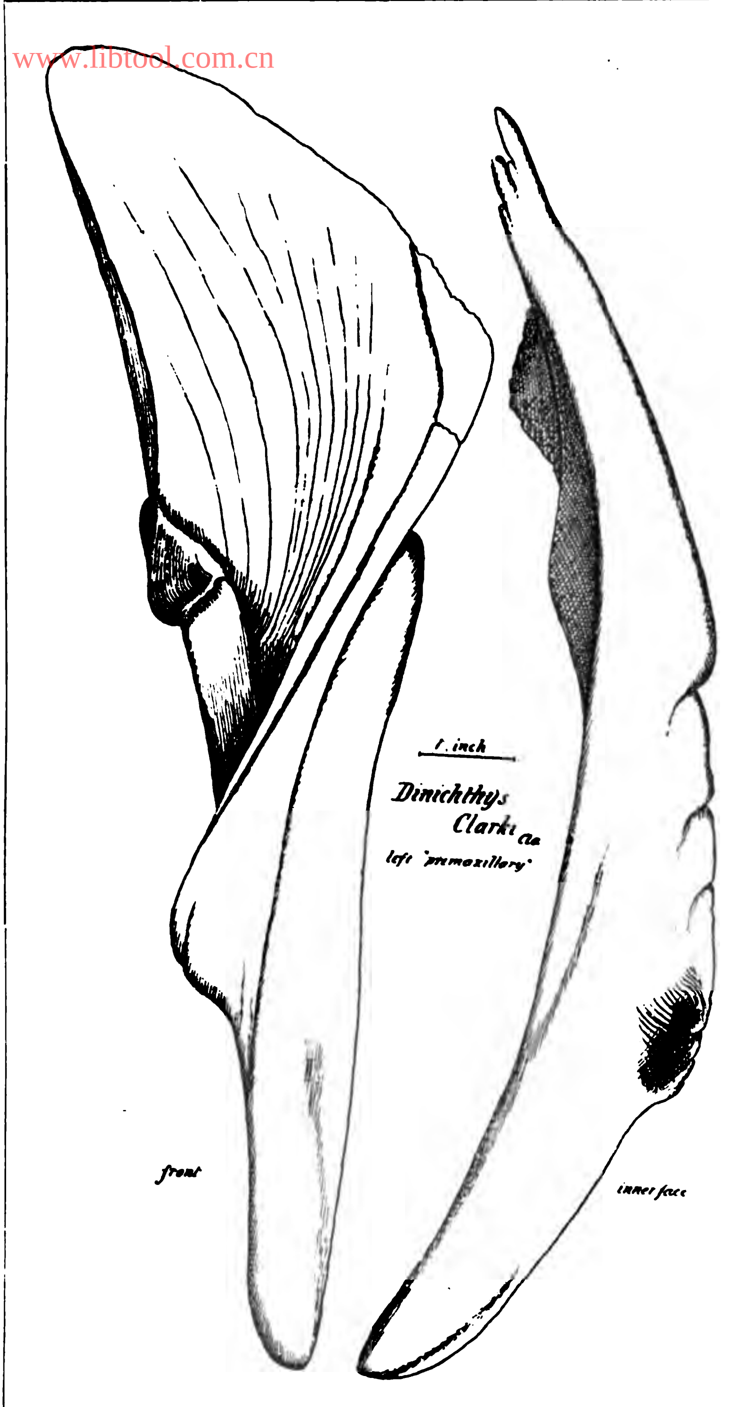
Khantank
Ocean Cape
Port Mulgrave
Astron Station
Mt. Hoorts
Mt. Tebenkof
Mt. Hendricksen
Mt. Draper
Mt. Rukamah
Mt. Pinta
60° 30'
60° 00'
59° 30'
141° 00'
140° 30'
140° 00'
139° 30'
139° 00'
Scale 1:1 200 000
Statute Miles
Meters

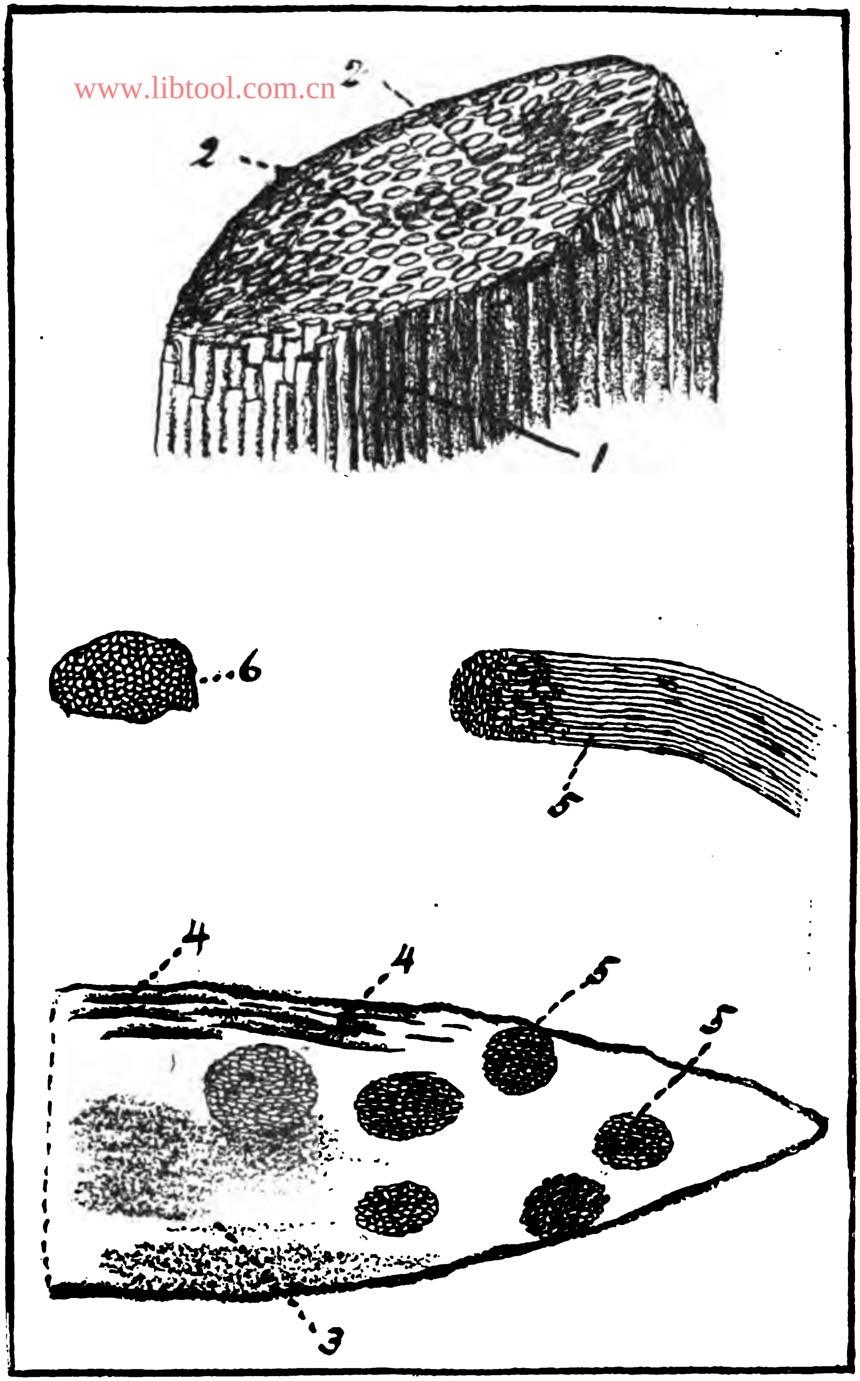
FIG. 1.

FIG. 2.

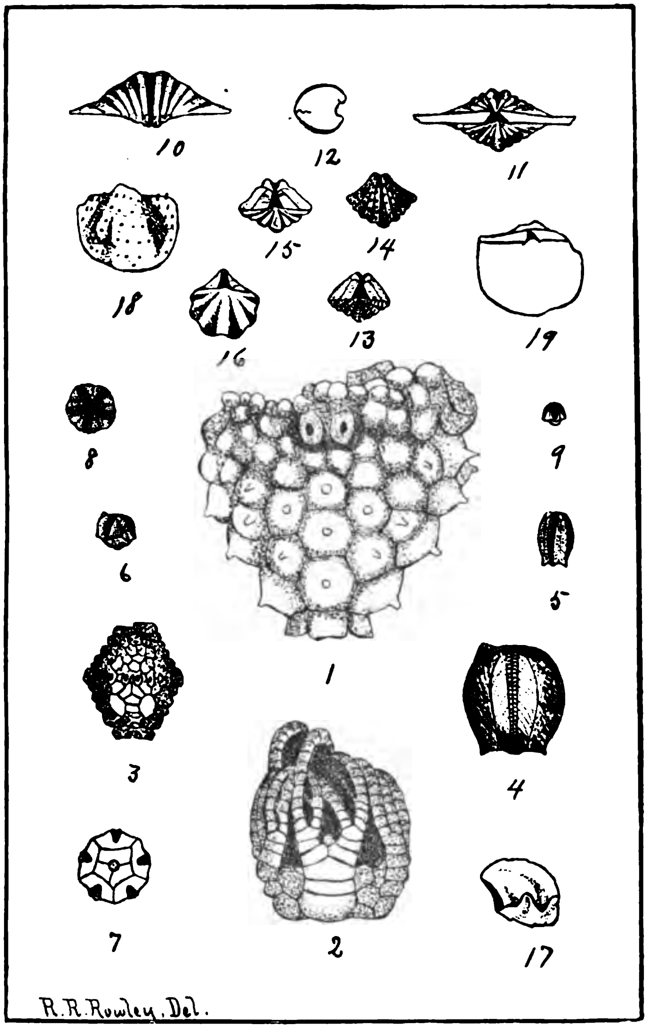
BENNETTITES DACOTENSIS Macbride.



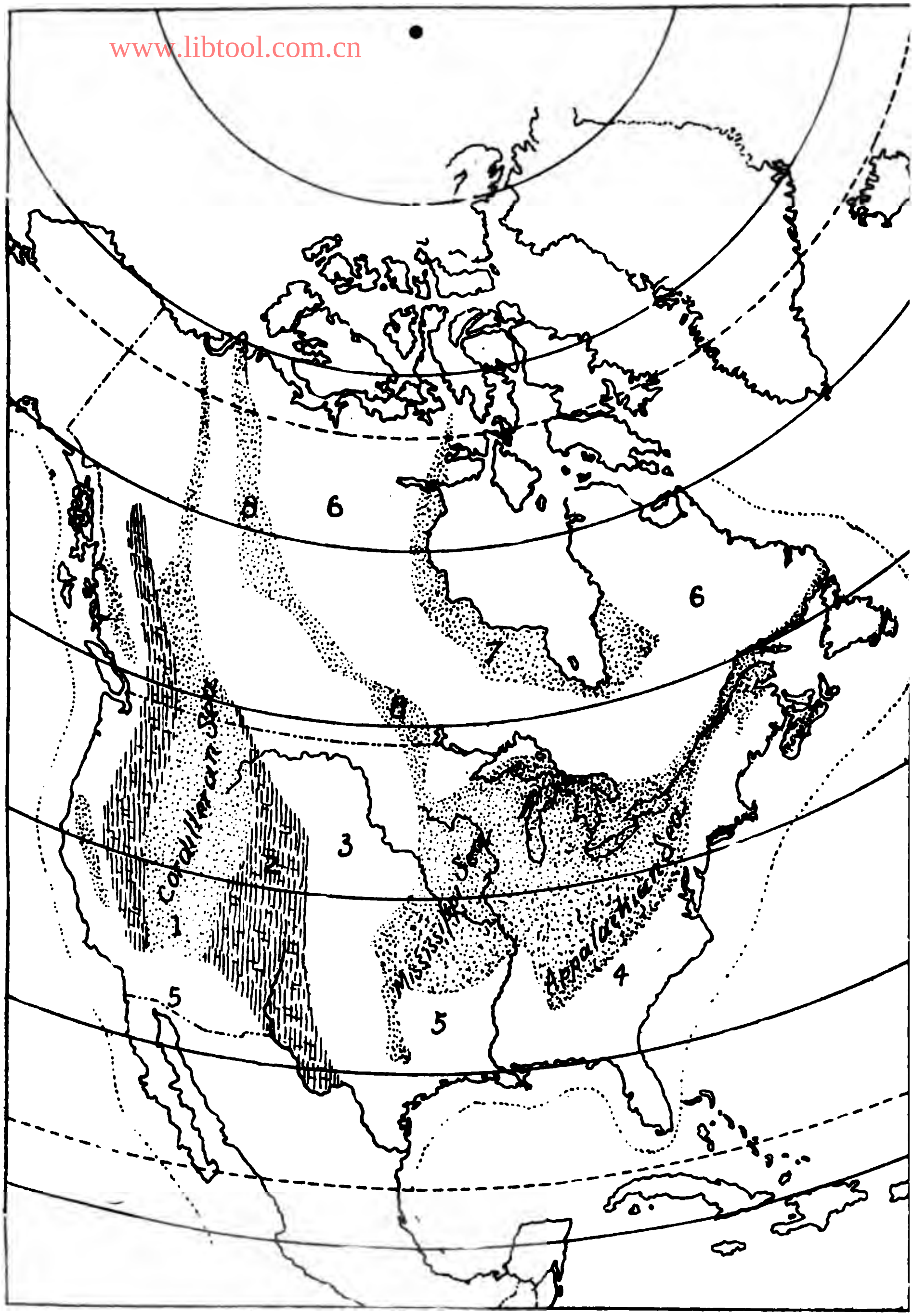
DINICHTHYS CLARKI Claypole.



A NEW FUNGUS FROM THE COAL MEASURES Herzer.



FOSSILS FROM MISSOURI Rowley.



MAP OF NORTH AMERICA,
Illustrating Mr. C. D. Walcott's Paper.

[JU]LY, 1893. VOL. XII, NO. 1.

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[S]ingle Numbers, 35 Cents. 11,990 Yearly Subscriptions, $3.50

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THE GEOLOGICAL PUBLISHING COMPANY, MINNEAPOLIS.
Entered at the Minneapolis Post-office as second-class matter.
ALFRED ROPER, PRINTER, MINNEAPOLIS, MINN.

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CEMBER, 1893. VOL. XII, No. 6.

THE AMERICAN GEOLOGIST

A MONTHLY JOURNAL OF

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