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THE DAWN OF REASON

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OR

MENTAL TRAITS IN THE LOWER ANIMALS

BY

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To My Father

WHO, WHILE NOT A SCIENTIST, HAS YET TAKEN

AN INTELLIGENT AND APPRECIATIVE

INTEREST IN MY WORK

THIS BOOK IS RESPECTFULLY DEDICATED

PREFACE

Most works on mind in the lower animals are large and ponderous volumes, replete with technicalities, and unfit for the general reader; therefore the author of this book has endeavored to present the evidences of mental action, in creatures lower than man, in a clear, simple, and brief form. He has avoided all technicalities, and has used the utmost brevity consistent with clearness and accuracy. He also believes that metaphysics has no place in a discussion of psychology, and has carefully refrained from using this once powerful weapon of psychologists.

Many of the data used by the authors of more pretentious works are second-hand or hearsay; the author of this treatise, however, has no confidence in the accuracy of such material, therefore he has not made use of any such data. His material has been thoroughly sifted, and the reader may depend upon the absolute truth of the evidence here presented.

The author does not claim infallibility; some of his conclusions may be erroneous; he *believes*, however, that future investigation will prove the verity of every proposition that is advanced in this book. These propositions have been formulated only after a twenty-years study of biology in all of its phases.

Some of the data used in this volume have appeared in *Appleton's Popular Science Monthly*, *Lippincott's Magazine*, *Worthington's Magazine*, *New York Medical Record*, *Recreation*, *Atlantic Monthly*, *American Naturalist*, *Scientific American*, *Home Magazine*, *Popular Science News*, *Denver Medical Times*, and *North American Review;* therefore the author tenders his thanks to the publishers of these magazines for their kindness in allowing him to use their property in getting out this work.

"WAVELAND," OWENSBORO, KY.,
January 9, 1899.

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DAWN OF REASON

MENTAL TRAITS IN THE LOWER ANIMALS

INTRODUCTION. — CONSCIOUS AND UNCONSCIOUS MIND

MIND is a resultant of nerve, in the beginning of life, neuro-plasmic, action, through which and by which animal life in all its phases is consciously and unconsciously, directly and indirectly, maintained, sustained, governed, and directed.

This definition of mind is widely different from the definition of those metaphysical scientists who directed pyschological investigation and observation a decade ago. They held that psychology had nothing in common with physiology and morphology; that *psychos* stood upon an independent pedestal, and was not affected by, and did not affect, any of the phenomena of life.

In these days it is becoming an accepted fact that morphology, physiology, and psychology are intimately related and connected, and that a thorough knowledge of the one implies an equally thorough knowledge of the others.

Morphology and physiology, until a comparatively recent time, led divergent paths; but, thanks to such men as Haeckel, Romanes, Huxley, Wolff, and many others, this erroneous method of investigation, to a great extent, has ceased.

"The two chief divisions of biological research — Morphology and Physiology — have long travelled apart, taking different paths. This is perfectly natural, for the aims, as well as the methods, of the two divisions are different. Morphology, the science of forms, aims at a scientific understanding of organic structures, of their internal and external proportions of form. Physiology, the science of functions, on the other hand, aims at a knowledge of the functions of the organs, or, in other words, of the manifestations of life." [1]

Indeed, physiology has so diverged from its sister science, morphology, that it completely and entirely ignores two of the most important functions of evolution, heredity and adaptation. This has been clearly shown by Haeckel, who has done much towards bringing about a change of opinion in these matters.[2]

Morphology and physiology are interdependent, correlated, and connected one with the other; and, as I will endeavor to point out as my argument develops itself, psychology is, likewise, intimately associated with these two manifestations of life.

[1] Haeckel, *Evolution of Man*, Vol. I. p. 20.

[2] *Ibid.*, p. 21 *et seq.*

It will be noticed that as forms take on more complexity, and as organs develop new and more complex functions, *psychos* becomes less simple in its manifestations, and more complex in its relations to the internal and external operations of life.

Keeping in view the definition of mind as advanced in the opening paragraph of this chapter, it at once becomes evident that even the very lowest forms of life possess mind in some degree. It is true that in the *monera*, or one-celled organisms, the nerve-cell is not differentiated; consequently, if I were to be held to a close and strict accountability, my definition of mind would not embrace these organisms. Yet, some small latitude must be allowed in all definitions of psychological phenomena, especially in those phenomena occurring in organisms which typify the very beginnings of life.

I am confident that, notwithstanding the fact that the nerve-*cell* is not differentiated in these primal forms, nerve-elements are, nevertheless, present in them, and serve to direct and control life.

Mind makes itself evident in two ways — consciously and unconsciously. The conscious manifestations of mind are volitional, while the unconscious, "vegetative," reflex operations of mind are wholly involuntary.

Although the unconscious mind plays fully as prominent a rôle in the economy of life as does the conscious mind, this treatise will not discuss the former, except indirectly. Yet, an outline sketch as to what is meant by the *unconscious* mind will be necessary, in order that the reader may more fully comprehend my meaning when discussing *conscious* mind.

A brief investigation of the anatomy, physiology, and psychology of the medusa, or jelly-fish, will serve to illustrate the operations of the unconscious mind as it is to be noticed in its reflex and "vegetative" phases. The higher and more evolved phases of the unconscious mind will not be discussed in this work, except incidentally, perhaps, as they may appear, from time to time, as my propositions are advanced, and the scheme of mental development is elaborated.

The medusa (the specimen that I take for study is a very common fresh-water individual) has a well-developed nervous system. Its transparent, translucent nectocalyx, or swimming-bell, has a central nervous system which is localized on the margin of the bell, and which forms the so-called "nerve-ring" of Romanes.[1] This nerve-ring is separated into an upper and lower nerve-ring by the "veil," an annular sheet of tissue which forms the floor of the swimming-bell, or "umbrella," and through a central opening in which the manubrium, or "handle," of the umbrella passes down and hangs below the margin of the bell.

[1] Romanes, *Jelly-Fish, Star-Fish, and Sea-Urchins*, p. 16.

The nerve-ring is well supplied with epithelial and ganglionic nerve-cells; their function is wholly reflex and involuntary; they preside over the pulsing or swimming movements of the nectocalyx. This pulsing is excited by stimulation, and is analogous, so far as movement is concerned, to the peristaltic action of the intestines. Situated on the margin of the bell are a number of very minute, round bodies, the so-called "eyes." These eyes are supplied with nerves, one of whose functions is volitional, as I will endeavor to show in my chapter on Conscious Determination.

The manubrium, or handle, is also the centre of a nerve-system. Nerves proceed from it and are spread out on the inner surface of the bell. These nerves preside over digestion, and are involuntary. Certain ganglia in the manubrium appear to preside over volitional effort. I have never been able, however, to locate their exact position, nor to determine their precise action. They will be discussed more fully in the next chapter.

The nervous system of the nectocalyx is exceedingly sensitive, responding with remarkable quickness to stimulation. When two or three minims of alcohol are dropped into a pint of water in which one of these creatures is swimming, the pulsing of the nectocalyx is notably increased in frequency and volume.

Romanes determined that the centres governing pulsation were located in the nerve-ring of the swimming-bell, and that each section of the necto-calyx had its individual nerve-centre.[1]

The pulsing of the nectocalyx occasions a flow of water into and out of the bell. This current brings both food and air (oxygen) to the animal, which is enabled to take these necessary life-sustainers into its system through the agency of vegetative nerve-action, a phase of the unconscious mind.

The unconscious mind made its appearance in animal life many thousands of years before the conscious mind came into existence. The latter psychical manifestation had its origin in sensual perception, which, in turn, gave rise to mental recepts and concepts.

In order fully to understand the origin of mind, it will be necessary to investigate the senses as they are observed in the lower animals. The first manifestation of conscious mind, which is, as I believe, conscious determination, or, volitional effort, is directly traceable to stimuli affecting the senses. This primal operation of conscious mind, and the manner in which it is developed from sensational perceptions, will now be discussed.

[1] *Jelly-Fish, Star-Fish, and Sea-Urchins*, p. 65 *et seq.*

CHAPTER I

THE SENSES IN THE LOWER ANIMALS

I AM inclined to believe that the primal, fundamental sense, — the sense of touch, — from which all the other senses have been evolved or developed, has been in existence almost as long as life.

It is quite probable that it is to be found in the very lowest animal organisms; and, if our own senses were acute enough, it is more than probable that we would be able to demonstrate its presence, beyond peradventure, in such organisms.

The senses of taste and smell, according to Graber, Lubbock, Farre, and many other investigators, seem to be almost as old as the sense of touch. My own observations teach me that certain actinophryans,[1] minute, microscopic animalcules, can differentiate between the starch spores of algæ and grains of sand, thus showing that they possess taste, or an analogous sense.

On one occasion I was examining an actinophrys (*Actinophrys Eichornii*), which was engaged in feeding. It would seize a rotifer (there were numerous *Brachioni* in the water) with one of its

[1] Vide the writer, *N. Y. Medical Record*, August 15, 1896.

pseudopodia, which it would then retract, until the captured Brachionus was safely within its abdominal cavity. On the slide there were several grains of sand, but these the actinophrys passed by without notice.

I thought, at first, that this creature's attention was directed to its prey by the movements of the latter, but further investigation showed me that this was not the case.

After carefully rinsing the slide, I placed some alga spores (some of which were ruptured, thus allowing the starch grains to escape) and some minute crystals of uric acid upon it. Whenever the actinophrys touched a starch grain with a pseudopod, the latter was at once retracted, carrying the starch grain with it into the abdominal cavity of the actinophryan; the uric acid crystals were always ignored.

I conclude from this experiment, that the actinophrys, which is exceedingly low in the scale of animal life, recognizes food by taste, or by some sense analogous to taste.

Many species of these little animals, however, are not as intelligent as the Eichorn actinophrys; they very frequently take in inert and useless substances, which, after a time, they get rid of by a process the reverse of that which they use in "swallowing." By the latter process they put *themselves* on the outside of an object — in fact, they surround it; by the former, they put the *object* outside by allowing it to escape through their bodies.

The sense of sight makes its appearance in animals quite low in the scale, therefore the reader will pardon me if, while discussing this sense, I prove to be a bit discursive. The subject is, withal, so very interesting that it calls for a close and minute investigation.

One of the immutable laws of nature declares that animals which are placed in new surroundings, not fatal to life, undergo certain changes and modifications in their anatomical and physiological structures to meet the exigencies demanded by such a modification of surroundings. Thus, the flounder and his congeners, the turbot, the plaice, the sole, etc., were, centuries and centuries ago, two-sided fishes, swimming upright, after the manner of the perch, the bass, and the salmon, with eyes arranged one on each side of the head. From upright fishes, swimming, probably, close to the surface of the sea, they became dwellers on its bottom, and, in order to hide themselves more effectually from their enemies or their prey, they acquired the habit of swimming with one side next to the ground, and of partially or wholly burying themselves in the mud, always, however, with one side down. They thus became flat fishes, losing the coloring of their under surfaces, and their eyes migrating across their foreheads and taking up positions on the upper surfaces of their heads.

Again, when animals are placed among surroundings in which there is no need for some special organ, this organ degenerates, and passes wholly or partially into a rudimentary condition, or, entirely out of existence. These latter effects of changed conditions on animals are especially noticeable in the effect of continual darkness on the organs of sight of those creatures which, owing to said mutations, have been compelled to dwell in darkness for untold ages.

The mole, far back in the past, had eyes, and gained its livelihood above ground in the broad light of day; but, owing to some change in its surroundings, it was forced to burrow beneath the surface of the earth; consequently its organs of sight have degenerated, and are now practically worthless as far as *vision* is concerned. All moles, however, can tell darkness from light, consequently, are not wholly blind — a certain amount of *sight* remains. This is due to the fact that, although the optic nerve, on examination, is invariably found to be atrophied or wasted, there yet remain in the shrivelled nerve-cord true nerve-cells; these nerve-cells transmit light impressions to the brain.

Even if the optic nerves, and, in fact, all of the structures of the eye, were absent, I yet believe that the mole could differentiate between daylight and darkness. The sensitive tufts and filaments of nerve in the skin, undoubtedly, in many instances, respond to the stimulation of light, so that totally blind animals, animals with no rudimentary organs of vision whatever, and the inception of whose ancestors, themselves wholly blind, probably took place thousands of years ago, show by their actions that light is exceedingly unpleasant to them. Thus, I have seen actinophryans taken from the River Styx in Mammoth Cave (which is their natural habitat), seeking to hide themselves beneath a grain of sand which happened to be drawn up in the pipette and dropped upon the glass slide beneath the object-glass of my microscope.

I have repeatedly seen the blind fish of Mammoth Cave seeking out the darkest spots in aquaria. In point of fact, I think it can be demonstrated that light is directly fatal to these fishes; they soon die when taken from the river and placed in aquaria where there is an abundance of light.

These fish, although they have rudimentary eyes, never have the slightest remaining trace of nerve-cells in the wasted optic nerve (that is, I have never been able to discover any), thus showing that their appreciation of light is not derived through the agency of their eyes. An eyeless spider (*Anthrobia*) taken from the same cavern showed a like distaste for light, and yet, in this insect, there is absolutely no vestige of an eye or its nerves.

Finally, a friend of mine, a youth of eighteen, totally blind since birth, can differentiate between daylight and darkness. On one occasion I carefully blindfolded him and led him into the well-lighted office of a brewery (he had never been in a brewery before), and asked him if it were light or dark. He answered that it was almost as light as day. I then conducted him into the dark beer vaults, and as soon as he passed the door he exclaimed, "How cold and dark it is here!" Thinking that he might possibly associate darkness with coldness, I asked him if this were the case. "No," he replied, "I *see* the darkness and I *feel* the cold; they are not the same."

In these animals — and I include man — continuous darkness has modified sensibility (sense of touch) to such an extent that it has partially taken on the functions of the useless organs — the eyes; these creatures *see* with their skins.

I do not believe that there is a creature in existence to-day, whether it has eyes or not, which cannot tell the difference between night and day. Professor Semper says that in the Pelew Islands he found a small fresh-water creature, whose generic name is *Cymothoe*, in pools where daylight penetrated, that was absolutely blind.[1] We have fresh-water Cymothoe living in our own waters that are close kin to the Pelew islander mentioned by Semper, and which are not blind. Along the middle of their backs, over the edge of each segment,

[1] Semper, *Animal Life*, p. 83.

there is an oblong dark spot. This little collection of coloring-matter is covered by a transparent membrane, the cornea, and has a special nerve leading to the brain, if I may use the word. These spots are primitive eyes, the analogues of which are preserved by many of the true worms. I am inclined to believe that Semper would find primitive eyes of some form or other in the Cymothoe he mentions, if he were again to examine it. The insects, etc., which dwell in caves, and which have eyes, are new arrivals; they have not dwelt long enough in total darkness to have experienced the full effects of changed surroundings. They show, however, that they are beginning to feel such effects, for there is more or less diminution in the color-cells of the eyes and body coverings. My experiments on fish and frogs show, conclusively, that the color-producing function is directly due to light stimulation. The longer fish and frogs are kept in total darkness, the lower is the number of color-cells and the smaller is the amount of coloring-matter. This accounts for the fact that all animals which have dwelt in darkness for untold ages are absolutely colorless. Pigmented or colored fishes, nevertheless, having well-developed organs of vision, have been taken from such depths (over a mile) as to preclude the possibility of a single ray of daylight.[1] These fishes, however, are phosphorescent, and

[1] Hickson, *The Fauna of the Deep Sea*, p. 150 *et seq.*

thus furnish their own light. Moreover, I am inclined to believe that the vast depths of the ocean, in certain localities, lie bathed in a continuous phosphorescent glow, so that creatures living there neither lose their color nor their eyes, sufficient light being present to prevent degeneration. Where eyeless and colorless fishes are brought up from great depths, there the ocean is not phosphorescent, but is in absolute darkness.

The preceding observations indicate that the sense of sight is a very old sense, and that it is to be found in a primitive form (ocelli) in animals of exceedingly low organization. That this is true, I will now attempt to demonstrate.

Sight is the result of the conversion of one form of motion into another — a conservation, as it were, of energy. Thus, waves of light coming from a luminous body are arrested by the pigment-cells of the retina in our eyes and are transmuted into another form of motion, which is called nerve energy (in this instance, sight). It would seem that as far as sight (*vision* is not included) is concerned, eyes of very simple construction would amply satisfy the needs of thousands of creatures whose existence does not depend upon vision. This supposition is undoubtedly correct; there are many creatures in existence to-day with eyes so exceedingly simple that they can form no visual picture of objects — they are only able to discriminate between light and darkness. Primitive eyes appear in animals very low in the scale of life; probably the most remarkable of these early organs of sight are to be found in the medusa, or jelly-fish. This creature, with its bell-shaped body and pendent stem, bears a striking resemblance to an umbrella; noting this resemblance, naturalists have given the name *manubrium*, "handle," to the stem. Around the edge of the umbrella, and situated at regular intervals, are certain round, cell-like organs, which vary considerably in number. Some species have only eight, while others have sixty, eighty, and even (in Œquorea) as high as six hundred.[1] These so-called "marginal bodies" are the eyes of the jelly-fish. By many biologists these organs are considered to be ears; they contain within their capsules transparent bodies, which some scientists deem otoliths, or "hearing-stones." Experimentation and microscopical examinations, however, have taught me very recently to believe otherwise. In these marginal bodies there is always a deposit of pigment; this is, unquestionably, a primitive retina, while the transparent disk is, indubitably, a primitive lens. That these creatures can tell the difference between light and darkness is a fact easily demonstrated. Time and again have I made them follow a bright light around the wall of the aquarium in which they were confined. On one occasion I made some

[1] Lubbock, *Senses, Instincts, and Intelligence of Animals*, p. 84.

medusæ tipsy, and their drunken gravity as they rolled and staggered through the water in pursuit of the light was as sorrowful as it was instructive; their actions in this respect were those of intoxicated men. After I had siphoned off the alcoholized water and replaced it with pure, they rapidly regained their normal status; whether or not any of them felt any evil effects from their involuntary debauch, I am not prepared to state.

The eyes of sea-urchins are rather highly developed, having corneæ, retinæ, and lenses. The lens generally lies in a mass of pigment, and, as Lubbock remarks, looks like a brilliant egg in a scarlet nest.[1] The eyes are scattered over the dorsal surface of the creature's body, and are commonly situated just beneath the skin; they are, however, sometimes elevated on pear-shaped bulbs. The eyes of starfish are generally quite primitive in character, as far as I have been able to determine, being simply pigmented spots which are supplied with nerves; in several species, however, I have been able to make out lenses. The eyes are arranged along the rays or arms, and vary in number.

Even the stay-at-home and humble oyster has eyes (not the round, fleshy muscle called the "eye" by gourmands and epicures, but bright

[1] "In Solaster or Asteracanthion the lenses look like brilliant eggs, each in its own scarlet nest." — LUBBOCK, *Senses, Instincts, and Intelligence of Animals*, p. 132 *et seq.*

spots around the edge of the mantle) — primitive eyes, it is true, yet amply sufficient for the needs of a domestic, non-travelling, home body like the oyster.

In most of the worms the eyes are simple ocelli — spots of pigment supplied with nerves. These eyes can discriminate between light and darkness, which is all that is required of them; but in the Alciope, a small sea-worm, these organs are brought to a high degree of perfection. This worm is exceedingly transparent, so that when observing it, it is difficult to make out more than its large orange eyes and the violet segmental organs of each ring. It looks like an animated string of violet disks surmounted by a pair of orange-colored eyeglasses. The eye of this creature is strikingly like that of a human being; it has a cornea, an "eye-skin," a lens, vitreous humor (posterior chamber), and retina.

Another aquatic worm, Myrianida, is still more remarkable, not only on account of its eyes, but also on account of the wonderful way in which it reproduces its young. When seen swimming in the water it presents the appearance of a long, many-ringed worm, which impels itself through and by the aid of its hundreds of flat, oar-like legs. Closer inspection reveals the startling fact that this seemingly single worm is really a multiple worm — six or more individuals being joined together, thus forming a living chain. This creature reproduces itself by fissigemation; that is, when the young worms arrive at a certain age they separate from the parent worm and begin life as individuals. These in turn eventually become multiple worms and divide into individuals, and so on *ad infinitum*. The tail worm, or that section farthest from the head, is the oldest and is always the first to leave its comrades and take up a separate existence. The adverb *always* in the above sentence is, strictly speaking, not exactly accurate, for on one occasion I saw the separation occur at the second head from the tail, thus producing twins. The two sections came apart, however, in a very few seconds after their departure from the colony. I am inclined to believe that this deviation from the normal was due to accident; probably to manipulation. This annelid is really "many in one" until the very moment of division; the alimentary canal, nerves, blood-vessels, etc., extend in unbroken continuity from the head of the parent worm to the tail of the last section. In every fourth (sometimes fifth) ring two round, dark-colored spots will be observed; these spots are ocelli, and some of them eventually become the eyes of young worms. These organs even in their embryonic state possess sight, for they have special nerves and pigment-cells; they can differentiate between light and darkness.

The snail carries its eyes in telescopic watch-towers. This animal is, for the most part, nocturnal in its habits, and, since prominent and commanding view points are assigned to its organs of sight, one would naturally expect to find a comparatively high degree of development in them; and this supposition is correct. The eyes of the creature are in the extreme tips of its "horns," and consist of (1) a cornea, (2) a lens, and (3) a retina. Lubbock is rather disposed to decry the visual powers of the snail;[1] my conclusions, drawn from personal observations, are, however, directly the opposite. The position of the eyes at the extreme tips of the horns naturally indicates that they subserve a very useful purpose; otherwise they would not have attained such prominence and such a high degree of development. Actual experimentation declares that the garden snail can see a moving white object, such as a ball of cotton or twine, at a distance of two feet. In my experiments I used a pole ten feet in length, from the tip of which a white or dark ball was suspended by a string. The ball was made to describe a pendulum-like movement to and fro in front of the snail on a level with the tips of its horns. Time and again I have seen a snail draw in its horns when it perceived the white ball, to it an unknown and terror-inspiring object. I have likewise seen it change its line of march, and proceed in another direction, in order to avoid the mysterious white stranger dancing athwart its pathway. Dark-col-

[1] Lubbock, *loc. cit. ante*, p. 140.

ored objects are not so readily perceived; at least, snails do not give any evidence of having seen them until they are brought within a foot of the creatures under observation. A snail will generally see a black ball at twelve or fourteen inches; sometimes it will not perceive the ball, however, until it has been brought to within six or eight inches of its eyestalks. During the season of courtship snails easily perceive one another at the distance of eighteen or twenty inches. I have often watched them at such times, and have been highly entertained by their actions. The emotional natures of snails, as far as love and affection are concerned, seem to be highly developed, and they show plainly by their actions, when courting, the tenderness they feel for each other. This has been noticed by many observers of high authority, notably Darwin, Romanes, and Wolff.[1] Mantagazza, a distinguished Italian scientist, in his *Physiognomy and Expression*, writes as follows: "As long as I live I shall never see anything equal to the loving tenderness of two snails, who, having in turn launched their little stone darts (as in prehistoric times), caress and embrace each other with a grace that might arouse the envy of the most refined epicurean."[2]

Darwin tells us that two snails, one of them an invalid, the other in perfect health, lived in the

[1] Romanes, *Animal Intelligence*, p. 27.

[2] Mantagazza, *loc. cit.*, p. 97.

garden of one of his friends. Becoming dissatisfied with their surroundings, the healthy one went in search of another home. When it had found it, it returned and assisted its sick comrade to go thither, evincing toward it, throughout the entire journey, the utmost tenderness and solicitude.[1] The healthy snail must have used its sight, as well as its other senses, to some purpose, for, if my memory serves me correctly, we are told that the sick snail rapidly regained its health amid its new surroundings.

The crayfish also has its eyes at the tips of eyestalks, but the eyes of this creature are very different, indeed, from the eyes of the snail. They are what are known as compound eyes, a type common to the crayfish and lobster families. Viewed from above, the cornea of a crayfish is seen to be divided into a number of compartments or cells, and looks, in this respect, very much like a section of honeycomb. The microscope shows that in each one of these cell-like compartments there is a transparent cone-shaped body; this is called the crystalline cone. The apex of this cone is prolonged into an exceedingly small tube, that enters a striped spindle-like body called the striated spindle; the entire structure is called a visual rod. Nerve-fibrils emanating from the optic nerve enter the striated spindle at its lower extremity, and in this way nervously energize the visual rod.

[1] Darwin, *Descent of Man*, pp. 262, 263.

There is a deposit of pigment about the visual rod which arrests all rays of light save those which strike the cornea parallel to the long axis of the crystalline cone. We see from this that the visual picture formed by a crayfish's eye must be made up of many parts; it is, in fact, a mosaic of hundreds of little pictured sections, which, when united, form the picture as a whole. Each visual rod receives its impression from the ray or rays of light reflected from the object viewed which strike it in the line of its long axis; the other rays are stopped by the layer of pigment-cells. When the impressions of all the visual rods are added together, the sum will be a mosaic of the object, but such a perfect one that the junction of its many portions will be absolutely imperceptible.

The crayfish can see quite well. It has been thought that this creature uses its sense of smell more than its sense of sight in the procurement of its food. This is undoubtedly true where the animal is surrounded by water that is muddy, or that is otherwise rendered opaque. The odoriferous particles coming from the food being carried to the creature by the water, it follows them until it arrives at this source.

It is different, however, in clear water and on land. I have seen crayfish rush down stream after bits of meat thrown to them, thus showing that here, at least, the sense of sight directed them. Again, I have enticed crayfish from clear streams by slowly dragging a baited hook in front of them. Moreover, when high and dry on land, I have seen them follow with their eyes and bodies the tempting morsel as it waved to and fro in the air above their heads.

The female crayfish carries her eggs beneath her tail, and, when they have hatched out, the young find this sheltering member a safe and cosey dwelling-place until they have grown strong enough to enter life's struggle. At such times, the mother crayfish is quite brave, and will do battle with any foe. With her eyestalks protruded to their utmost extent, she vigilantly watches her enemy. Her eyes follow his movements, and her sharp nipper is held in readiness for immediate use.

Actual experimentation has taught that these animals can descry a man at the distance of twenty or twenty-five feet. When approaching a crayfish "town" for the purpose of making observations, I use the utmost caution; otherwise, each inhabitant will retreat into its burrow before I can come close enough to observe them, even with my field-glasses.

The gyrinus, or "whirligig beetle," whose dwelling-place during the greater portion of its life is, like that of the crayfish, in ponds and streams, has remarkably acute vision. This insect is a true cosmopolite, however, and is as much at home on dry land as it is in the water. All seasons seem to be alike to it, just so the sun shines; for, during the hottest days of summer and the coldest days of winter (that is, if there is sunlight and no ice on the water), it may be seen on the surface of ponds and streams, gyrating hither and thither in a seemingly mad and purposeless manner.

Several of these creatures will be seen at one moment floating on the water, still and motionless; the next moment they will be darting here and there over the surface of the water, their black and burnished backs shining in the sunlight like brilliant gems. Suddenly, it is "heels up and heads down," and they disappear beneath the surface, each of them carrying a bubble of air caught beneath the wing-tips; or, as the late William Hamilton Gibson expresses it, "they carry a brilliant lantern that goes gleaming like a silver streak down into the depths, for a bubble of air is caught beneath their black wing-covers, and a diamond of pure sunlight accompanies their course down among the weeds until they once more ascend to the surface."[1] This little beetle is well provided with eyes, for it has a large pair beneath its head, with which it sees all that is going on in the water below, and another pair on the sides of its head, with which it keeps a bright lookout above. That it has remarkably keen vision with the latter pair, any

[1] William Hamilton Gibson, *Sharp Eyes*, p. 307.

one who has tried to steal upon them unawares can testify.[1]

The queerest of all queer-eyed animals is, probably, the Periophthalmus, a fish inhabiting the coasts of China, Japan, India, the Malayan Archipelago, and East Africa.[2]

I use the word coasts advisedly, for this strange creature when in pursuit of its prey leaves the sea and comes out on the sands, thus existing, for the greater portion of its life, in an element which, according to the general nature of things, ought to be fatal to it. The laws of evolution have, however, eminently prepared it for its peculiar mode of life, for its gill-cavities have become so enlarged that when it abandons the sea it carries in them a great quantity of water which yields up the necessary supply of oxygen.

Its locomotion has been provided for likewise, for continued use along certain lines has so developed its pectoral fins that the creature uses them as legs, and jumps along at a surprising rate of speed.

[1] I have a distinct purpose in introducing these and other queer-eyed individuals while discussing the sense of sight. I wish to demonstrate through one or more of them the correlation of morphology, physiology, and psychology, as formulated in the first chapter of this work. This is one of the most important facts in the doctrine of evolution, and upon it is based the law of progressive psychical development from the simple manifestations of conscious determination in the lowest organisms to the most complex operations of the mind in man.

[2] Semper, *Animal Life*, p. 374 *et seq.*

Its eyes are very large and prominent, and possess, for a fish, the peculiar faculty of looking around on all sides, hence its name, "periophthalmus," which is derived from the Greek words, *περί*, around, and *ὀφθαλμός*, eye. These eyes are situated on top of the animal's head, and present a very grotesque appearance.

The favorite food of this fish is Onchidium, a naked mollusk. And, in the matter of eyes, this last-mentioned creature is itself worthy of remark. Its cephalic, or head, eyes are like those of other mollusks of its genus, and are not worthy of special mention, but its dorsal eyes, sometimes several dozen in number, are truly remarkable. These eyes, although they are very simple in structure, in type are the same as those of vertebrates, having corneæ, lenses, retinæ, and "blind spots." (In the vertebrate eye, the spot where the optic nerve pierces the external layer of the retina is not sensitive to light impressions; hence, it is called the "blind spot.")

When this mollusk sees periophthalmus bounding over the sands (and that it does see is beyond all question), what does it do? It contracts a thousand or so of little bladder-like cells in the skin of its back, thereby discharging a hailstorm of minute concretions in the face of its enemy. The fish, terrified and amazed by the volley, often turns aside, and the mollusk is saved. Thus we see that its dorsal eyes are of great service to onchidium.

The Greeks were, unwittingly, very near an anatomical truth when they ascribed to certain monsters, called cyclopes, only one eye apiece, which was placed in the centre of their foreheads. The cyclopean eye exists to-day in the brains of men in a rudimentary form, for in the pineal gland we find the last vestiges of that which was once a third eye, and which looked out into the world, if not from the centre of the forehead, at least from very near that point. There is alive to-day a little creature which would put to shame the one-eyed arrogance and pride of Polyphemus, and Arges, and Brontes, and Steropes, and all the rest of the single-eyed gentry who, in the days of myths and myth-makers, inhabited the "fair Sicilian Isle." The animal in question is a small lizard, called Calotis. Its well-developed third eye is situated in the top of its head, and can be easily seen through the modified and transparent scale which serves it as a cornea. Many other lacertilians have this third eye, though it is not so highly organized as it is in the species just mentioned. A tree lizard, which is to be found in the mountains of East Tennessee and Kentucky, has its third eye quite well developed. This little animal is called the "singing scorpion" by the mountaineers (by the way, all lizards are scorpions to these people), and is a most interesting creature. I heard its plaintive "peep, peep, peep," on Chilhowee Mountain a number of times before I became aware of the fact that a lizard was the singer. On dissection, the third eye will be found lying immediately beneath the skin; it has a lens, retina, and optic nerve.

Thus we see that the sense of sight is to be found in animals very low in the scale of life. From a simple accumulation of pigment-cells which serves to arrest light rays (in simple organisms such as rotifers) to that complex and beautiful structure — the human eye — the organs of vision have been developed, step by step.

We will also see in the course of this discussion that, just as these simple and primal organisms have given place to more complex forms, just so have the operations of mind become higher and more involved. We see, in periopthalmus, a creature exceedingly well adapted by form, function, and intelligence to its manner of life. We must admit, in fact, the correlation and interdependence of morphology, physiology, and psychology in the evolution of this creature from its ancestral form to its present status.

The primitive organ of audition as it is to be observed in creatures of simple, comparatively speaking, organization is as simple as is the anatomy of the animals in which it is found. Commonly, it is a hollow hair, which is connected by a minute nerve-filament with the sensorium. Sound vibrations set the hair to vibrating, which in turn conveys the vibrations to the nerve-filament, and so on to the auditory centre. Sometimes the hair is not hollow; in this case, the root of the hair is intimately associated with nerve-filaments which take up vibrations.

It is highly probable that the majority of the lower animals, especially those which are sound-producers, can hear just as we hear. It is also highly probable that the so-called deaf animals can hear, just as we hear when we have either been born deaf, or through disease have lost the power of hearing — by *feeling* the sound waves.

Owing to our own lack of acuteness, all of the problems involved in this question of audition in the lower animals will, probably, never be definitely settled; yet, reasoning by analogy, we can, approximately, solve some of them.

By far the larger number of entomologists locate the auditory organs of insects in their antennæ. I have only to mention the names of such men as Kirby, Spence, Burmeister, Hicks, Wolff, Newport, Oken, Strauss, Durkheim, and Carus, who advance this opinion, to show what a formidable array of talent maintains it. Yet my observations lead me to believe otherwise, though these authorities are in part correct. As far as Lepidoptera are concerned, and certain of Hemiptera, they are right — the antennæ in these creatures are the seat of the organs of audition. But in Orthoptera, in most of Coleoptera, Hymenoptera, and Diptera, and in certain bugs (Hemiptera), they are located elsewhere. The habit that almost all insects have of retracting their antennæ when alarmed by noise, or otherwise, has done much to advance and strengthen the opinion that these appendages are the seat of insect ears; yet I am confident that in nine cases out of ten the antennæ are retracted through fear of injury to them, and not through any impression made on them by sound. The antennæ are the most exposed and least protected of any of the appendages or members of the insect body; hence their retraction by insects when alarmed is an instinctively protective action. They shelter them as much as possible in order to keep them from being injured. Again, although the antennæ of most insects are provided with numerous sensitive hairs, or setæ, we have no right to assume that these hairs are auditory; no "auditory rods," otoliths, etc., are to be found generally in antennæ, yet there are exceptional instances. Leydig found auditory rods in the antennæ of *Dyticus marginalis* (Furneaux[1]), the giant water-beetle, and I myself have observed them in *Corydalis cornuta* and other neuropterous insects. I am inclined to believe that the entire order of Neuroptera has antennal ears, and should therefore in this respect be classed with Lepidoptera.

In grasshoppers and crickets the ears are situated in the anterior pairs of legs. If the tibia of

[1] Consult Furneaux, *Life in Ponds and Streams*, p. 325.

a grasshopper's anterior leg be examined, two (one before and one behind) shining, oval, membranous disks, surrounded by a marginal ridge, will be at once observed. These are the tympana or ear-drums of the ear of that leg. Where the trachea, or air-tube, enters the tibia it becomes enlarged and divides into two channels; these two channels unite again lower down in the shaft of the tibia. The tracheæ of non-stridulating grylli are much smaller than those of sound-producing grasshoppers. The same may be said of the tibial air-tubes of the so-called dumb crickets. In grasshoppers and crickets the ear-drums lie bathed in air on both sides — the open air on the external side and the air of the air-tube, or trachea, on the inside. Lubbock calls attention to the fact that "the trachea acts like the Eustachian tube in our own ear; it maintains an equilibrium of pressure on each side of the tympanum, and enables it freely to transmit atmospheric vibrations."

In grasshoppers the auditory nerve, after entering the tibia, divides into two branches, one forming the supratympanal ganglion, the other descending to the tympanum and forming a ganglion known as Siebold's organ. This last-mentioned ganglion is strikingly like the organ of Corti in our own ear, and undoubtedly serves a like purpose in the phenomenon of audition. The organ of Corti is composed of some four thousand delicate vesicles, graduated in size, each one of which vibrates in unison with some particular number of sound vibrations. The organ of Siebold in the grasshopper's ear begins with vesicles, of which a few of the first are nearly equal in size; these vesicles then regularly diminish in size to the end of the series. Each of these vesicles contains an auditory rod, and is in communication with the auditory nerve through a delicate nerve-fibril. I have observed that each of these nerve-fibrils swells into a minute ganglion immediately after leaving its particular vesicle; the function of these ganglia is, I take it, to strengthen and reënforce nerve-energy. No other observer mentions these ganglia, as far as I have been able to determine; they may have been absent, however, in the specimens studied by others, yet in the specimens studied by myself — the "red-legged locust" (*Melanoplus femur-rubrum*, Comstock)[1] and the "meadow grasshopper" (*Xiphidium*), they were always present.

That grasshoppers, locusts, and crickets can hear, no one who has observed these creatures during the mating season will for one instant deny; they hear readily and well, for in most of them the sense of hearing is remarkably acute.

Immediately behind the wings of flies two curious knobbed organs are to be observed; these are considered to be rudimentary hinder wings by entomologists, and are called the halteres. Bolles

[1] Consult Comstock, *Manual for the Study of Insects*, p. 110.

Lee and others of the French scientists call them *balanciers*. This latter name I consider the correct one, for these organs unquestionably preside over alate equilibrium: they are true balancers. I do not propose to enter into any discussion as to whether these organs are rudimentary wings or not; suffice it to say that they appear to me to be organs fully developed and amply sufficient to serve the purposes for which they were created. Whether or not in the process of evolution there has occurred a change of function, is a point which will not be discussed in this paper. As they now exist, I deem them to be auditory organs of Diptera (flies, gnats, etc.).

The semicircular canals are, to a great extent if not entirely, the seat of equilibration in man. Any derangement or disease of these canals interferes with equilibration; this is well shown in Ménière's disease, in which there is always marked disturbance of the equilibrating function.

If the balancers of a horsefly be removed, the insect at once loses its equilibrium; it cannot direct its flight, but plunges headlong to the ground. The same can be said of *Chrysops niger* — in fact, of the entire family of Tabanidæ, of the gall gnat (*Diplosis resinicola*, Comstock), and of the March flies (*Bibionidæ*). These widely differing flies constitute the material from which I have derived my data; I will venture to assert, however, without fear of contradiction, that what has been said about the flies mentioned above is equally true of all flies.

When the knobbed end of the balancers of the horsefly (*Tabanus atratus*, Comstock)[1] are examined with the microscope, the cuticle will be found to be set with minute hairs or setæ; some of these hairs penetrate both cuticle and hypoderm, are hollow, and receive into their hollows delicate nerve-fibrils. These nerve-fibrils pass inward toward the centre, and enter ganglia, which in turn are in immediate connection with the great nerves of the balancers. There is but one nerve in the insect's body that is larger than the balancer nerve, and that is the optic nerve; hence, it is natural to infer that the balancer nerve leads to some special sense centre. This centre in my opinion is, unquestionably, the seat of the auditory function.

It has been demonstrated beyond doubt that analogous hollow hairs, or setæ, are prominent factors of audition in many animals, notably crustaceans, such as the lobster, the crab, and the crayfish, and many of the insect family; hence, it is logically correct to conclude that the hollow hairs on the balancers of flies are likewise auditory hairs. Moreover, there are grouped about the bases of these knobbed organs certain rows of vesicles, which contain auditory rods almost identical in appearance with the auditory rods of the grasshopper. Indeed, I have found those in the upper

[1] Consult Comstock, *loc. cit. ante*, p. 455.

row of vesicles to be precisely similar in appearance to the rods found in Melanoplus.

I have determined that in the horsefly (*Tabanus atratus*) there are six rows of these vesicles, and that they are graduated in size. There are in the knobs of the balancers minute spiracles (I do not think that these have been pointed out before by any other observer) through which air passes into the large, vesicular cells which make up the greater portion of the knobs; spiracles are also to be found in the shafts of the balancers, thus providing an abundance of air to the internal structures of these organs and allowing for the free transmission of sound vibrations.

I am well aware of the fact that in considering these organs to be the ears of flies, I antagonize Lee and others who consider them olfactory in character.[1] The position I take in regard to these organs is, however, a tenable one, and one that cannot easily be overthrown.

The ears of Lepidoptera (butterflies) are situated in their antennæ. This fact has been clearly demonstrated by Lubbock, Graber, Leydig, and Wolff. Newport has made an especially exhaustive study of the antennæ of insects; and he, too, places the organs of audition in these appendages.[2] But in Coleoptera my experiments and microscopi-

[1] Bolles Lee, *Les Balanciers des Diptères;* quoted also by Lubbock, *Senses, Instincts*, etc., pp. 110, 111.

[2] Newport, *The Antennæ of Insects*, Entomol. Society, Vol. II.

cal researches compel me to assert that I differ somewhat from the conclusions of the above-mentioned authorities. These gentlemen locate the ears of beetles also in their antennæ. Lubbock bases his conclusions on an experiment of Will—an experiment which, if it had been carried a little further, would have demonstrated the fact that the ears of beetles are not in their antennæ, but are, on the contrary, in their maxillary palpi.

Will put a female Cerambyx beetle into a box, which he placed on a table; he then put a male Cerambyx on the table, some four inches from the box. When he touched the female she began to chirrup, whereupon the male turned his antennæ toward the box, "as if to determine from which direction the sound came, and then marched straight toward the female." Will concluded from this that the ears of the beetle were located in its antennæ.[1]

Seeing that Will's experiment as described by him was incomplete, I took a pair of beetles belonging to the same family (genus *Prionus*), and determined the true location of their ears by a system of rigid exclusion. These beetles, when irritated, make a squeaking chirrup by rubbing together the prothorax and mesothorax.

When I irritated the female she began to chirrup, and the male immediately turned toward the

[1] Will, *Das Geschmacksorgen der Insecten*, Wiss. Zool.; quoted also by Lubbock, *Senses, Instincts*, etc., p. 96.

small paper box in which she was confined. I then removed the antennæ of the male, and again made the female stridulate; the male heard her, and at once crawled toward her, although his antennæ were entirely removed.

This showed conclusively that the organs of audition were not located in the antennæ, as Will supposed and as Lubbock advocates. I then removed the maxillary palpi of the male, after which the insect remained deaf to all sounds emanating from the female.

Again, I took an unmutilated male, which at once turned and crawled toward the chirruping female. I then removed its labial palpi, leaving maxillary palpi and antennæ intact; it heard the female and made toward her. The maxillary palpi were then removed (the antennæ being left *in situ*), and at once the creature became deaf.

If the maxillary palpi of long-horned beetles be examined, certain vesicular organs, each containing a microscopic hair, will be observed in the basal segments; these, I take it, are auditory vesicles. In some of the Coleoptera I have found auditory rods in the apical segments, though this is by no means a common occurrence. In Cicindelidæ and Carabidæ these auditory vesicles are exceedingly small, and require a very high-power objective in order to be clearly seen.

In justice to other observers I must say, however, that I am inclined to believe that in all beetles the antennæ in some way aid or assist audition, but they are adjuncts, as it were, and not absolutely necessary. It is a matter of easy demonstration to show that some of these insects hear less acutely where they are deprived of their antennæ. I presume they are about as necessary in audition as are the external appendages of the human ear; this, however, is mere supposition, and has no scientific warrant for its verity.

I have purposely said but very little about the senses of touch, taste, and smell in this discussion of the senses in the lower animals. These three senses have been so exhaustively treated by Lubbock in his *Senses, Instincts, and Intelligences of Animals*, that I could not hope to introduce any new data in regard to them. Graber, Frey, Leuckart, Farre, Hertwig, and a host of others have likewise investigated these senses most thoroughly.

As to the senses of sight and hearing, the matter presented a different aspect. I was confident that I could add somewhat to the knowledge already formulated, consequently I have treated these senses at some length. Technicalities and the details of microscopic investigation, especially microscopic anatomy, have been omitted; they have no place in a work like this.

CHAPTER II

CONSCIOUS DETERMINATION

Conscious determination, or, effort induced by conscious volition, is the basic mental operation upon which is reared that complex psychical structure which is to be found in the higher animals, and especially in man — the highest product of evolutionary development.

By conscious volition is not meant that consciousness which appertains to the child of two or three years, who, at that age, recognizes the *ego*. Ego-knowledge, while undoubtedly present in some of the higher animals, such as the dog, monkey, horse, cat, etc., is not a factor in the psychical make-up of any of the lower animals (insects, crustaceans, mollusks, etc.). But consciousness, so far as volition or choice is concerned, enters into the *psychos* of animals exceedingly low in the scale of animal life.

We have seen in the chapter on the senses in the lower animals, that animals possess one or all of the five senses — touch, taste, smell, sight, and hearing; we will see in a later chapter that some of them likewise possess certain other senses which man has lost in the process of evolution.

Now, let us very briefly discuss the *modus operandi* through which and by which conscious determination and other psychical manifestations arise from the physical basis — the senses.[1] I have asserted, and, as I believe, I have demonstrated elsewhere, the interdependence and correlation of physiology and psychology. Furthermore, I wish to be plainly understood as also asserting the physical basis and origin of all psychical operations whatever they may be.

Mind is always associated, according to our experience and knowledge (and this question must be studied objectively) with a peculiar tissue which is only to be found in animal organisms. This tissue is called nerve, and is made up of cells and, broadly speaking, prolongations of cells which are called nerve-fibres.

Certain accumulations of nerve-cells called ganglions (ganglia) are to be found scattered throughout the structure of animals. Experiment and observation teach that these ganglia subserve a

[1] "Sensorial impression is at the bottom of all our ideas, all our conceptions, though it may at first conceal itself in the form of a binary, ternary, quaternary compound; and, on our methodically pursuing the inquiry, it is easily recognizable — just as a simple substance in organic chemistry may be always summoned to appear, if we sit down with the resolution to disengage it from all the artificial combinations which hold it imprisoned." — LUYS, *The Brain and its Functions*, p. 252.

governing influence over nerve-action; hence, they are called nerve-centres.

Nerve-tissue is found in all animals above and including Hydrozoa, according to Romanes;[1] I am inclined to believe, however, that it is present in animals even lower than Hydrozoa, for I have been able, on more than one occasion, to verify Professor Clark's observations in regard to the protozoan, *Stentor polymorphus*, which, as he asserts,[2] has a well-developed nervous system. Moreover, I have seen, in my opinion, unquestionable acts of conscious determination enacted by this little creature, as I will point out further along in this chapter.

Nerve-tissue has the peculiar faculty of transmitting impressions made upon it by stimuli. When a nerve is acted on by a stimulus, the impression wave is transmitted along the in-going nerve to the ganglion; here, the stimulus is transferred to the out-going nerve, which, going to the muscle, causes it to contract.

This form of nerve-action is called reflex action, and reflex action is, in the beginning, the germ from which spring volition (choice) and all of the higher psychical attributes.

Again, it is to be observed, as animals become more highly organized, that nerves have the power of discriminating between stimuli, and "it is this

[1] Romanes, *Mental Evolution in Animals*, p. 24.

[2] Clark, *Mind in Nature*, p. 64 *et seq.*

power of discriminating between stimuli," as Romanes puts it, "*irrespective of their relative mechanical intensities*, that constitutes the physiological aspect of choice" (volition). It is also through the faculty of discrimination that the special senses, upon which the entire psychical structure depends, have been evolved.

The fact of this power of discrimination has been so clearly and so beautifully demonstrated by Romanes, that I present his experiment and observations, as detailed by him in his magnificent work, *Mental Evolution in Animals*:—

"I have observed that if a sea-anemone is placed in an aquarium tank, and allowed to fasten on one side of the tank near the surface of the water, and if a jet of sea-water is made to play continuously and forcibly upon the anemone from above, the result of course is that the animal becomes surrounded with a turmoil of water and air-bubbles. Yet, after a short time, it becomes so accustomed to this turmoil that it will expand its tentacles in search of food, just as it does when placed in calm water. If now one of the expanded tentacles is gently touched with a solid body, all the others close around that body, in just the same way as they would were they expanded in calm water. That is to say, the tentacles are able to discriminate between the stimulus which is applied by the turmoil of the water and that which is supplied by their contact with the solid body, and they respond to the latter stimulus notwithstanding that it is of incomparably less intensity than the former."[1]

When a stimulus passes over a nerve to a ganglion, it leaves upon it an impression which remains for a shorter or longer time as the stimulus is great or small. Now, when a stimulus is again applied to the nerve, the impression wave follows in the footsteps, as it were, of the first impression wave, and the ganglion reflects or transfers it just as before, thus showing that nerve has another peculiar quality — that of *memory*.

Again, when two or more reflexes are excited by the same stimulus or stimuli, the ganglion learns to associate one with the other, thus showing that it possesses another quality — that of the association of ideas (stimuli and reflexes).

All of these operations are, in their beginnings, exceedingly simple; yet, as organisms increase in complexity, these simple beginnings become more complex and more highly developed.

Heretofore, the operations described have been entirely ganglionic (reflex) and utterly without that which we call consciousness. Now, since consciousness, as I understand it, is simply a knowledge of existence, and since this knowledge of existence is only to be had through sensual perceptions, and, since sensual perceptions are excited undoubtedly by coördinated stimuli, then, "there cannot be coördination of many stimuli without

[1] Romanes, *Mental Evolution in Animals*, pp. 48, 49.

some ganglion through which they are all brought into relation. In the process of bringing these into relation, this ganglion must be subject to the influence of each — must undergo many changes. And the quick succession of changes in a ganglion, implying as it does perpetual experiences of differences and likenesses, constitute the raw material of consciousness."[1]

However quick this succession of changes may be, there must be an interval of time between the application of the stimulus and the response to that stimulus, hence, the element of time enters into all psychical operations that are not distinctly reflex. Even in the reflexes there is a time element, but it is distinctly shorter than the time interval that enters into the make-up of a conscious psychical operation. This can easily be demonstrated, as has been done, time and again, by actual experiment.

"With this gradual dawn of consciousness as revealed to subjective analysis, we should expect some facts of physiology, or of objective analysis, to correspond; and this we do find. For in our own organisms we know that reflex actions are not accompanied by consciousness, although the complexity of the nerve-muscular systems concerned in these actions may be very considerable. Clearly, therefore, it is not mere complexity of ganglionic action that determines consciousness. What, then,

[1] Spencer, *Principles of Psychology*, Vol. I. p. 435.

is the difference between the mode of operation of the cerebral hemispheres and that of the lower ganglia, which may be taken to correspond with the great subjective distinction between the consciousness which may attend the former and the no-consciousness which is invariably characteristic of the latter? I think that the only difference that can be pointed to is a difference of rate of time."[1]

The gradual cultivation of the senses (evolution), during which the special adaptations of their motor reactions are gradually developed, is a necessary prerequisite to the formation and elaboration of conscious volition.[2] In the foregoing pages I have very briefly discussed this cultivation of the senses and the development of their motor reactions. I have likewise outlined the origin of volition from sensual perceptions; it now becomes necessary in this discussion of mind, in the lower animals, to study those organisms in which volition (choice) first makes its appearance in the shape of conscious determination.

Stentor polymorphus is exceedingly interesting on more than one account. Its queer, trumpet-like shape, with its flaring, bell-like, open mouth (if I may use such a term to indicate its entire cephalic extremity), surmounted by rows of vibratile cilia, its pulsating contractile vesicle, its ability to move from place to place by swimming, are all

[1] Romanes, *Mental Evolution in Animals*, pp. 72, 73.

[2] Maudsley, *Physiology of Mind*, p. 247.

interesting features; but, when it is ascertained to be the first creature in the entire Animal Kingdom in which a true nervous system is to be found, then it becomes doubly interesting.

This protozoan has been a favorite subject for study with microscopists, but Professor Clark of Harvard was the first observer to note and call attention to its nerve-supply. Says he in his note calling attention to this discovery: —

"The digestive and circulatory systems are the only parts of the organization essential to life that are known to investigators; but recently I have been led to believe that I have discovered the *nervous system*, or at least a part of it, and that too in the very region of the body where there is the most activity, and therefore more likely than elsewhere to have this system most strongly developed. Immediately within the edge of the disk (*bell*) there runs all around a narrow faint band, which lies so close to the surface that it is difficult to determine precisely that it is not actually superficial. From this band there arise, at nearly equal distances all round, about a dozen excessively faint thin stripes, which converge in a general direction toward the mouth." [1]

This band Professor Clark very correctly, as I believe, assumes to be a part of Stentor's nervous system; for, with a medium high-power lens (× 500) I have been able to make out ganglionic enlarge-

[1] Clark, *Mind in Nature*, pp. 64, 65.

ments both in the circular band and in the stripes. These ganglia are the brain of this infusorian. When the animalcule is stained with eosin, the nervous system can very readily be made out and followed throughout all of its ramifications.

On one occasion, while I was studying the contractile vesicle (heart) of one of these animalcules, I saw it evince what seemed to me to be unquestionable evidences of conscious determination.

Just above the creature, which was resting in its tube (it builds a gelatinous tube into which it shrinks when alarmed or disturbed in any way), there was a bit of alga, from which ripened spores were being given off. Some of these spores were ruptured (probably by my manipulations) and starch grains were escaping therefrom.

The Stentor, from its location below the alga, could not reach the starch grains without altering its position. I saw it elevate itself in its tube until it touched the starch grains with its cilia. With these it swept a grain into its mouth, and then sank down in its tube. I thought, at first, that this was the result of accident, but when the creature again elevated itself, and again captured a starch grain, I was compelled to admit design!

By some sense, it had discovered the presence of starch, which it recognized to be food; it could not get at this food without making a change in its position, which, therefore, it immediately proceeded to do!

Here was an act which required, so it seemed to me, correlative ideation, and which was doubly surprising, because occurring in an animal of such extremely simple organization. This observation was substantiated, however, by the testimony of Professor Carter, an English biologist, which came to my notice a week or so thereafter. This investigator witnessed a similar act in an animalcule belonging, it is true, to another family, but which is almost, if not quite, as simple in its organization as Stentor. He does not designate the particular rhizopods that he had under observation, yet from his language, we are able to classify them approximately. His account is so very interesting that I take the liberty of quoting him in full.

"On one occasion, while investigating the nature of some large, transparent, spore-like elliptical cells (fungal?) whose protoplasm was rotating, while it was at the same time charged with triangular grains of starch, I observed some actinophorous rhizopods creeping about them, which had similar shaped grains of starch in their interior; and having determined the nature of these grains by the addition of iodine, I cleansed the glasses, and placed under the microscope a new portion of the sediment from the basin containing these cells and actinophryans for further examination, when I observed one of the spore-like cells had become ruptured, and that a portion of its protoplasm, charged with the triangular starch grains, was slightly protruding through the crevice. It then struck me that the actinophryans had obtained their starch grains from this source; and while looking at the ruptured cell, an *actinophrys* made its appearance, and creeping round the cell, at last arrived at the crevice, from which it extricated one of the grains of starch mentioned, and then crept off to a good distance. Presently, however, it returned to the same cell; and although there were now no more starch grains protruding, the *actinophrys* managed again to extract one from the interior through the crevice. All this was repeated several times, showing that the *actinophrys* instinctively knew that those were nutritious grains, that they were contained in this cell, and that, although each time after incepting a grain it went away to some distance, it knew how to find its way back to the cell again which furnished this nutriment.

"On another occasion I saw an *actinophrys* station itself close to a ripe spore-cell of *pythium*, which was situated on a filament of *Spirogyra crassa;* and as the young ciliated monadic germs issued forth one after another from the dehiscent spore-cell, the *actinophrys* remained by it and caught every one of them, even to the last, when it retired to another part of the field, as if instinctively conscious that there was nothing more to be got at the old place.

"But by far the greatest feat of this kind that ever presented itself to me was the catching of a young *acineta* by an old sluggish *amœba*, as the former left its parent; this took place as follows:

"In the evening of the 2d of June, 1858, in Bombay, while looking through a microscope at some *Euglenæ*, etc., which had been placed aside for examination in a watch-glass, my eye fell upon a stalked and triangular *acineta* (*A. mystacina?*), around which an *amœba* was creeping and lingering, as they do when they are in quest of food. But knowing the antipathy that the *amœba*, like almost every other infusorian, has to the tentacles of the *acineta*, I concluded that the *amœba* was not encouraging an appetite for its whiskered companion, when I was surprised to find that it crept up the stem of the *acineta*, and wound itself round its body.

"This mark of affection, too much like that frequently evinced at the other end of the scale, even where there is mind for its control, did not long remain without interpretation. There was a young *acineta*, tender and without poisonous tentacles (for they are not developed at birth), just ready to make its exit from its parent, an exit which takes place so quickly, and is followed by such rapid bounding movements of the non-ciliated *acineta*, that who would venture to say, *a priori*, that a dull, heavy, sluggish *amœba* could catch such an agile little thing? But the *amœbæ* are as unerring and unrelaxing in their grasp as they are unrelenting in their cruel inceptions of the living and the dead, when they serve them for nutrition; and thus the *amœba*, placing itself around the ovarian aperture of the *acineta*, received the young one, nurse-like, in its fatal lap, incepted it, descended from the parent, and crept off. Being unable to conceive at the time that this was such an act of atrocity on the part of the *amœba* as the sequel disclosed, and thinking that the young *acineta* might yet escape, or pass into some other form in the body of its host, I watched the *amœba* for some time afterwards, until the tale ended by the young *acineta* becoming divided into two parts, and thus in their respective digestive spaces ultimately becoming broken down and digested." [1]

In the discussion of conscious and unconscious mind, I called attention to the marginal bodies of the nectocalyx of the jelly-fish. These bodies in the "covered-eyed" species are protected by hoods of gelatinous tissue; in the naked-eyed species the hoods are absent. The marginal bodies in both species are practically identical as far as general make-up is concerned, being composed of an accumulation of brightly-colored pigment-cells, embedded in which are several minute clear crystals. Nerve-fibres connect these bodies with the sensorium ("nerve-ring").

Jelly-fish seek the light, and they can be made to follow a bright light from one side of the

[1] Carter, *Annals of Natural History*, 3d Series, 1863, pp. 45, 46; quoted also by Romanes, *Animal Intelligence*, pp. 20, 21.

aquarium to the other by manipulating the light in the proper manner. Even where a slight current is set up in the water, they will swim against it in their efforts to reach the light.

When two or more of the marginal bodies are excised, no effect seems to follow such excision, but as soon as the last of these bodies is cut out, the creature falls to the bottom of the tank without motion.

When a point in the nectocalyx is irritated with a point of a needle or by a vegetable or mineral irritant, the tip of the manubrium will turn toward, and endeavor to touch, the spot irritated. It does not turn at once, as it would were its movements the result of reflex action; it moves deliberately as though actuated by volition.

The above experiments and observation seem to indicate the presence of conscious determination in the medusa; in fact, there seems to be a distinct element of choice in these psychical manifestations.

While engaged in watching a water-louse, I saw it swim to a hydra, tear off one of its buds, and then swim some distance away to a small bit of mud, behind which it hid until it devoured its tender morsel. Again it swam back to the hydra and plucked from it one of its young; again it swam back to the little mud heap, behind which it once more ensconced itself until it was through with its meal. When we remember that this little creature was among entirely new surroundings (for I dipped it from a pond in a tablespoon full of water which I had poured into a saucer), we will appreciate the fact that the water-louse evinced conscious determination and no little memory. It probably discovered the hydra accidentally; it then, as soon as it had secured its prey, swam away, seeking some spot where it could eat its food without molestation. But when it sought the hydra again and swam back to its sheltering mud heap, it showed that it remembered the route to and from its source of food supply and its temporary hiding-place.

At the base of a large terminal ganglion in the neuro-cephalic system of the common garden snail, lying immediately below and between its two "horns," will be found, I am satisfied, the centre governing its sense of direction. For, when this portion of this ganglion is destroyed, the snail loses its ability of returning to its home when carried only a short distance away; otherwise, it can find its way back to its domicile when taken what must be to it a very great distance away, indeed. Beneath the stone coping of a brick wall surrounding the front of my lawn, and which, on the side toward my residence, is almost flush with the ground, many garden snails find a cool, moist, and congenial home. Last summer I took six of these snails, and, after marking them with a paint of zinc oxide and gum arabic, set them free on the lawn. In time, four of these marked snails returned to their home beneath the stone coping; two of them were probably destroyed by enemies. Again, the same number of snails were marked, after the base of the above-mentioned ganglion had been destroyed, and likewise set free. Although they lived and were to be observed now and then on the trees and bushes of the lawn, none of them ever returned to the place from which they were taken beneath the stone coping. I have performed this experiment repeatedly, always with like results.

These experiments show that the snail is capable of conscious effort; furthermore, they indicate that this little animal is the possessor of a special sense which many of the higher animals have lost in the process of evolution. I refer to the sense of direction, or "homing instinct," so-called, which will be treated at length in the chapter on Auxiliary Senses.

Darwin has very beautifully demonstrated the senses of touch, taste, and smell in the angle-worm; provisionally he denies it, however, the senses of sight and hearing.[1] I think he is in error as to these last two senses.

Angle-worms are nocturnal in their habits, hence, we should expect, from the very nature of things, to find them able to differentiate between light and darkness. And experiments show, very conclu-

[1] Darwin, *Formation of Vegetable Mould.*

sively, that they are very sensitive to light. My vermicularium is made of glass, consequently, when one of its inmates happens to be next to the glass sides, which very frequently occurs, it is easy to experiment on it with pencils of strong light. If a ray of light is directed upon an angle-worm, it at once begins to show discomfort, and, in a very few moments, it will crawl away from the source of annoyance, and hide in some tunnel deep in the earth of the vermicularium. Again, when the worms are out of their tunnels at night, a strong light shining on them will at once cause them to seek their holes.

If the back of an earthworm be examined with a high-power lens (× 500), small points of pigment will be seen here and there in its dorsal integument; these, I believe, are primitive eyes (ocelli). I think that the worm is enabled to tell the difference between light and darkness through the agency of these minute dark spots, which serve to arrest the rays of light, thus conveying a stimulus to nerve-fibrils, which, in turn, carry it to the sensorium.

Any country schoolboy will tell you that worms can hear. He points to his simple experiment (pounding on the earth with a club) in proof of his assertion. For, as soon as he begins to pound the ground in a favorable neighborhood, the worms will come to the surface "to see what makes the noise." Darwin assumes that the worms feel the vibrations, which are disagreeable to them, and come to the surface in order to escape them. I do not deny the possibility or the probability of this assumption; I do deny, however, that it proves that worms are deaf.

If the third anal segment (abdominal aspect) of a worm be examined, two round, disk-like organs incorporated in the integument will be found; these organs are supplied with special nerves which lead to the central nerve-cord. Experiments lead me to believe that these are organs of audition.

When I tap the earth of my vermicularium with a pencil, the unmutilated worms will come to the surface; but, when the organs described above are removed, the worms so mutilated will not respond to the tapping, but will remain in their tunnel. The worms are not appreciably impaired by such mutilation; on the contrary, they seem to thrive as well as those to which the knife has not been applied.

In creatures which possess, in all probability, the senses of touch, taste, smell, sight, and hearing, we would naturally expect to find some evidences of conscious determination; and we do.

Certain leaves are the favorite food of earthworms, while certain other leaves are eaten by them, but not with avidity. When these two kinds of leaves are given to worms, they will carefully select the favorite food and will ignore the other, thus unmistakably evincing conscious choice. Their avoidance of light is probably the result of conscious determination, and not reflex, as some observers maintain.

Oysters taken from a bank never uncovered by the sea, open their shells, lose the water within, and soon die; but oysters kept in a reservoir and occasionally uncovered learn to keep their shells closed, and live much longer when taken out of the water. This is an act of intelligence due directly to experience without even the factor of heredity.[1] It is an instance of almost immediate adaptation to surrounding circumstances.

A gentleman fixed a land-snail, with the mouth of the shell upward, in a chink of a rock. The animal protruded its foot to the utmost extent, and, attaching it above, tried to pull the shell vertically in a straight line. Then it stretched its body to the right side, pulled, and failed to move the shell. It then stretched its foot to the left side, pulled with all of its strength, and released the shell. There were intervals of rest between these several attempts, during which the snail remained quiescent.[2] Thus we see that it exerted force in three directions, never twice in the same direction, which fact shows conscious

[1] Dicquemase, *Journal de Physique*, Vol. XXVIII. p. 244; quoted also by Darwin, MS.; by Bingley, *Animal Biography*, Vol. III. p. 454; and by Romanes, *Animal Intelligence*, p. 25.

[2] Consult Romanes, *Animal Intelligence*, p. 26.

determination and no slight degree of intelligence.

A ground wasp once built a nest beneath the brick pavement in front of my door. The entrance of the nest was situated in the little sulcus, or ditch, between two bricks. While the wasp was absent, I stopped the entrance with a pellet of paper, and, when the little housekeeper returned, she was nonplussed for a moment or two, when she discovered that her doorway had been closed. The wasp, after examining the pellet of paper, seized it with her jaws and tried to pull it away; but, since she stood on the brick and pulled backwards (toward herself), the edge of the brick interposed, and she could not dislodge the obstacle. Finally, she got down into the little gully between the two bricks, and pulled the pellet away from the opening of the nest without any further trouble. Three times I performed the experiment, the wasp going through like performances each time. At the fourth time, however, she went at once into the little space between the bricks, and then removed the wad of paper without difficulty. I stopped the hole five or six times after this, but she had learned a lesson; she always got into the sulcus between the bricks before attempting to remove the paper. She had discovered the fact that she could not remove it when she stood upon the surfaces of the bricks, owing to the interposition of their sides, and that she could drag it away if she got down into the little ditch and pulled the paper in a direction where nothing opposed. In this instance there was not only conscious determination, but also a distinct exhibition of memory. It took the wasp some time to learn that she had to pull in a certain direction before she could remove the pellet of paper; but when she had once learned this fact, she remembered it. And this brings us to another quality of mind — memory — which will be discussed in the next chapter.

CHAPTER III

MEMORY

In discussing memory as it is to be observed in the lower animals, I think it best to divide the subject into four parts; viz., *Memory of Locality* (*Surroundings*), *Memory of Friends* (*Kindred*), *Memory of Strangers* (*Other Animals not Kin*), and *Memory of Events* (*Education, Happenings, etc.*).

Memory of Locality. — There can be no doubt but that the rhizopods observed by Carter displayed memory of locality. He distinctly asserts that he saw the actinophrys, after it had incepted a starch grain, "crawl away to a good distance" and then return to the spore-cell from which it was taking the grains of starch. The creature must have remembered the route to and from the spore-cell. The same must be said of the water-louse observed by myself, which not only came back to the source of its food-supply, but also returned to a certain lurking-spot at which it hid itself each time until it had eaten the hydra buds. It must be remembered that a journey of one inch, to these minute little creatures, is, comparatively speaking, an immense distance. Each grain of sand, each particle of decayed vegetable matter, etc., is, to these microscopic animalcules, a gigantic boulder, a mighty muck heap. These obstacles in the path undoubtedly serve as landmarks to the wandering myriads of microscopic animalcules.

It can be demonstrated that the snail has memory of locality. This creature is essentially a homing animal, as I will show in the chapter on Auxiliary Senses, consequently we would naturally expect to find it possessing memory of locality. An interesting observation by Mr. Lonsdale, an English observer, which has been often quoted, clearly proves that this creature does possess this psychical function. Mr. Lonsdale placed two snails in a small and badly kept garden. One of them was weak and poorly nourished, the other strong and well. The strong one disappeared and was traced by its slimy track over a wall into a neighboring garden where there was plenty of food. Mr. Lonsdale thought that it had deserted its mate, but it subsequently appeared and conducted its comrade over the wall into the bountiful food-supply of the neighboring garden. It seemed to coax and assist its feeble companion when it lingered on the way.[1]

Marked bees and ants invariably return to places where they have found food-supplies, thus showing the possession of a memory of locality and

[1] Darwin, *Descent of Man*, pp. 262, 263.

route. It is very interesting to watch a marked ant during her journey back to her nest, after she has been carried away and placed among unfamiliar scenes and surroundings. At first, owing to her fright, she will dash away helter-skelter; but soon recovering, she will head in the direction of home, and moderate her pace until she creeps along at a very cautious and circumspect gait, indeed. Every now and then she will climb a tall grass-blade or weed and take observations. After a while she sees certain landmarks, and her speed becomes faster; soon the surrounding country becomes familiar, and she ceases to climb blades of grass, etc., now she is in the midst of well-known scenes, and at last she fairly races into her nest.

In this instance the ant is led at first by her sense of direction alone; as soon, however, as she comes to country which she has hunted over, and with which she is familiar, memory comes into play and the sense of direction ceases to act, or, if it acts at all, it acts unconsciously.

Sand-wasps build their nests in the ground, and, when leaving their tunnels in search of food for the prospective grubs, always circle about them and observe the lay of the land before taking their departure. Numerous sand-wasps build in the interstices between the bricks of a pavement in front of my house. When one leaves her tunnel she will fly about the orifice for several seconds (taking observations) before she finally flies away. When she returns, she hovers about the orifice, or, rather, in its neighborhood, until she is quite certain that it is the entrance to her home, when she will dart in with such rapidity that the eye can scarcely follow her movements.

On one occasion, I covered the pavement surrounding the entrance with newspapers, leaving, however, about three inches on all sides of the orifice uncovered. When the wasp returned she seemed to be completely at a loss what to do. She hovered about for at least an hour, and then flew away.

Thinking that this experiment was too great a tax on the wasp's intelligence, I tried the following, which seemed to me to be nearer a natural happening than the former experiment. I believe that, in studying mind in the lower animals, one's experiments should be as near nature as they can possibly be.

As soon as the wasp had left her tunnel, I covered the surface of the bricks and the interstices between them, for several feet around the orifice of the tunnel, with sand. This might have happened, naturally, through the agency of the wind.

When the wasp returned, it was perfectly apparent that she did not recognize her domicile. She flew here and there and round about, but she would not alight. Finally, I swept the sand away, when she at once flew to her nest and entered.

In my opinion, these experiments prove very clearly the presence of memory of locality in these insects. The sense of direction, which a vast majority of the lower animals possess in some degree, is, however, of material assistance to their memory; this special sense will be fully discussed in another chapter.

Most of the beetles are homing animals; that is, they have certain spots to which they will return after excursions in search of food. Heretofore, observers have held to the opinion that beetles made their homes wherever they happened to be; but close study of marked individuals, especially of *Carabidæ* and *Cicindelidæ* has taught me otherwise. Some of the long-horned beetles appear to be rovers, but these are always males, and their roving habits are due to sexual promptings. The females are, however, to a great extent, homing animals, and do not wander far after they have once established a home. Being creatures which recognize certain surroundings as home, they must, necessarily, have some memory of locality. This proposition is new, being formulated and advanced by myself alone, therefore I expect that it will be negatived by many investigators. All that I ask, however, is that *marked* specimens of the different genera be closely watched; I am confident that if this plan be followed, the truthfulness of this proposition will soon be universally acknowledged.

Reptiles and certain fishes are homing animals, and this habit is especially noticeable in the land or box terrapin. One of these animals had its home for many years in my lawn, and I have often satisfied myself in regard to its knowledge of locality. I have frequently taken it several hundred yards (its usual "using-place" is circumscribed at about one hundred yards) away from its home and set it free.

At first, led by its sense of direction, it would turn towards home and slowly crawl in that direction. It would not feed *en route*, but seemed intent only on arriving at its home as quickly as possible. Finally, when it arrived among familiar surroundings, it would begin to feed, but would still make its way homeward. It clearly and unmistakably indicated by its actions that it had a memory of locality.

This treatise on mind in the lower animals is, mainly, a study of psychical manifestations as they are to be observed in insects; therefore, the higher animals will only be studied incidentally. Suffice it to say that, among the higher animals, evidences of memory of locality are very abundant, and are so patent that they do not need discussion.

Memory of Friends (Kindred). — This phase of mind in ants has been closely studied and graphically described by Sir John Lubbock. Most of his experiments and observations have been verified by myself, therefore the reader will pardon me if I quote freely from his valuable work, *Ants, Bees, and Wasps*.

The observations of Huber, Ford, Lubbock, and other observers declare that ants can remember and recognize their kindred after having been separated from them for several months. "Huber mentions that some ants which he had kept in captivity having accidentally escaped, met and recognized their former companions, fell to mutual caresses with their antennæ, took them up by their mandibles, and led them to their own nests; they came presently in a crowd to seek the fugitives under and about the artificial ant-hill, and even ventured to reach the bell-glass, where they effected a complete desertion by carrying away successively all the ants they found there. In a few days, the ruche was depopulated. These ants had remained four months without any communication." [1]

On one occasion, I took ten *Lasius niger* and confined them in a specially constructed formicary so that they could not possibly leave the nest. I supplied these colonists with a gravid queen, so they very quickly became satisfied with their new home. Four months thereafter, I put three of these ants, previously marked with a paint of zinc oxide

[1] Huber, p. 172; quoted by Lubbock, *Ants, Bees, and Wasps*, p. 120; also by Kirby and Spence, *Introduction to Entomology*, Vol. III. p. 66; also by Newport, *Trans. Ent. Soc.*, London, Vol. II. p. 239.

and gum arabic, into their former nest. They were at once recognized by their kindred, which began to caress them with their antennæ and to remove the paint from their bodies. In the course of a half hour, the paint had all been removed, and I lost sight of them among the other ants.

A month after the performance of this experiment, I took three marked ants from the parent nest and placed them in the new nest. They were at once recognized by the colonists, which received them, as it were, with open arms and began to cleanse their bodies by removing the paint. In both of these experiments the recognition appeared to be instantaneous; there was no hesitancy whatever.

On the other hand, when performing like experiments with *Lasius flavus*, it took the ants (on two occasions) some little time to recognize their kindred; when the marked ants were put into the nest they were at once seized by the other ants, which pulled them about the nest for some time. They were finally recognized, however, and the paint removed from their bodies by the busy little tongues of their kindred.

This would seem to indicate that *Lasius niger* had a better memory than *Lasius flavus;* whether the failure of the latter to recognize their friends at once was due, however, to faulty memory or not, is a psychical problem that will, probably, never be solved.

Lubbock's experiments with *Myrmica ruginodis* clearly demonstrate that these ants can recognize their kin. Says he:—

"On August 20, 1875, I divided a colony of *Myrmica ruginodis* so that one half were in one nest, A, and the other half in another, B, and were kept entirely apart.

"On October 3, I put into nest B a stranger and an old companion from nest A. They were marked with a spot of color. One of them immediately flew at the stranger; of the friend they took no notice.

"October 18.—At 10 A.M. I put in a stranger and a friend from nest A. In the evening the former was killed, the latter was quite at home.

"October 19.—I put one in a small bottle with a friend from nest A. They did not show any enmity. I then put in a stranger, and one of them immediately began to fight with her."[1]

These experiments show that *Myrmica ruginodis* recognize their kin at sight, and that they are able to remember and recognize one another after long separations.

Lubbock states that *Lasius flavus* accept others of the same species as their friends, no matter how great a distance lies between the nests. His experiments were made with ants taken from contiguous nests as well as those located some distance apart, and, in one instance, with ants taken from a nest

[1] Lubbock, *Ants, Bees, and Wasps*, p. 121 *et seq.*

in another part of the country. He states that, in the last-mentioned experiment, "in one or two cases they seemed to be attacked, though so feebly that I could not feel sure about it; but in no case were the ants killed."[1]

My experiments and observations with this ant are directly the reverse. As long as the individuals experimented with belonged to contiguous nests, and were, probably, derived from the same root-stock, there was no fighting; but, in the case of ants taken from opposite sides of the house, which, probably, sprang from two different sources, there was, invariably, much fighting, in which not a few of the combatants lost their lives. Whether or not the American species of *Lasius flavus* are naturally more pugnacious than the English species, I know not; if they are, then this fact will account for the difference in behavior of the two species to a certain extent, though not entirely.

Others of the social Hymenoptera — for instance, bees and wasps — remember kindred. On one occasion, I clipped the wings of a wasp, and, after she had learned that she could no longer fly, placed her on a strange nest. She was at once attacked, and was soon stung to death. I kept a wasp confined in a glass for three weeks, carefully feeding her meanwhile, and then placed her on the nest from which she had been taken. She was at once

[1] Lubbock, *loc. cit. ante*, p. 124.

recognized by the other wasps, which caressed her with their antennæ, and licked her with their tongues.

Bees, though they seem able to recognize kindred, and to remember them also for some time, do not show these faculties of the mind as plainly as do wasps and ants. This is probably due to the fact that bees are a later development, socially speaking, and are not as psychically mature as the other social insects.

In the higher animals the memory of kindred, especially in monkeys, is quite well developed, and is so well known that it does not need demonstration.

Memory of Strangers (*Animals other than Kin*). — The recognition of enemies can be noticed in animals quite low in the scale of life, and, although this psychical phase is almost universally instinctive, it carries with it certain elements of consciousness. As we ascend the scale, however, we discover that certain animals are capable of remembering other animals after a hostile encounter with them; thus, a pet squirrel remembered the turtle which had bitten him after two years had elapsed, and a white mouse showed, very plainly, that he had not forgotten the pet crow from whose clutches he had been rescued, even after three years had passed by. I might enumerate quite a number of instances like these, but think it hardly necessary; any one who has paid any attention to natural history has seen evidences of this phase of memory in animals. I will, however, give one more illustration of this form of memory, which, in my opinion, is quite remarkable. In my front yard, last summer, there dwelt a large colony of bumblebees. One day, in a moment of idleness, I tossed a tennis ball, with which I was teaching a young dog to retrieve, into the nest. The dog dashed after it, scratching up the ground and barking loudly; immediately the bees sallied forth, pounced upon the dog and stung him severely. During the entire summer this dog could never come near the nest without being stung; his companions, two in number, trotted to and fro on the path near which the nest was located without being noticed in the slightest degree by the bees. The disturber, and, to them, would-be ravisher and destroyer of their home, however, was always assailed and put to flight. He eventually learned to give that portion of the yard a wide berth, and could not be coaxed into coming within thirty yards of the home of his savage little foes.

Instances of memory of individuals, incited by friendship or regard, between animals of different species is quite rare among the lower animals (insects, reptiles, etc.), yet, I have fortunately been able to note this phase of memory as occurring in several animals, comparatively speaking, low in the scale of intellectual development. I have every reason for believing that even the toad remembers individuals, at least, it remembers the sound of some particular voice or whistle. It most certainly remembers localities and places, and that, too, when unaided by its sense of direction which it possesses in a high degree. A toad which I had under observation, and which I was in the habit of feeding, would come at my call or whistle, and this it learned to do after only two weeks of teaching. It would do this even in the middle of a hot summer day (toads feed at dusk and during the night), showing, thereby, that it remembered that this call meant food.

I have strong reasons for believing that certain spiders possess this phase of memory; at least, a certain lycosid once evinced such unmistakable evidences of a recognition of my individual person, that more than one observer became convinced that she knew me from other people. At the time these observations were made, I was confined to the house by sickness.

In my room and dwelling beneath my table was a large black spider, one of the most beautiful of her species. When I first made her acquaintance she was very timid, and would run to her den if I made the slightest motion. As time passed, however, she grew bolder and would come to the edge of the table which was close beside my bed, and regard me intently with her beady black eyes. Finally she became so tame that she would take flies and insects from my fingers. She learned to know me so well that she could easily tell the difference when others came into the room. When I would leave the room for a short outing, on my return I would find her waiting for me on the top of the table. When others entered the room, she would hide herself in her den, and remain there, very frequently, until they took their departure.

It has been known for quite a while that in the nests of ants there are always to be found other insects, which appear to dwell in perfect harmony with the real builders and owners of the domiciles. Some of these creatures (the aphides, for instance) are brought into the nests by the ants themselves, which use them as we do cows, milking from their bodies a clear, sweet fluid, which they greedily lap up with their tongues. But there are other animals in the teeming formicary which seem to subserve no useful purpose other than that of ministering to the ants' love of pets or playmates. One notable little alien in certain ant communities is a minute claviger beetle (so called from its peculiar claviger, or club-shaped antennæ), which seems to be a well-beloved friend and companion, and which is always treated with great kindness.[1] These little beetles sometimes leave the nest, and may be observed sunning themselves at the entrance. The busy workers are never so busy but that they can spend a fraction of a second for the purpose of caressing their diminutive playmates.

[1] Consult Lubbock, *Ants, Bees, and Wasps*, pp. 75, 76.

On one occasion, a swarm was about to take place in one of my formicaries. The young princes and princesses had emerged and had congregated about the entrance; they seemed loath to take wing and fly away on their honeymoon jaunt out into the unknown world. The workers were gently urging them to depart, sometimes even nipping them slightly with their mandibles. Several little clavigers could be seen running here and there and everywhere through the crowd of anxious workers and timid young males and females. They irresistibly reminded me of a lot of little dogs in a crowd of men around some centre of excitement or attraction. I have seen dogs, on more than one occasion, act in just such a manner. The ants, notwithstanding their evident worry and excitement, seemed to notice their little pets, and to give them, every now and then, an encouraging pat, as it were, on their backs or heads.

The clavigers are not the only pets in a formicary; several other species of beetles and one bug also live in ants' nests, and seem to occupy places in the affection of the masters of the home akin to those which dogs, cats, and other pets occupy in our own affections.

It has been asserted, most frequently by superficial observers, however, that the reptilian *psychos* is exceedingly low; this is a popular error, for many reptiles give evidence, on occasions, of a, comparatively speaking, high degree of intelligence. Especially is this true in regard to their memory of individuals.

I kept for some time in my room, some years ago, a male black snake (*Bascanion constrictor*). Whenever this creature became hungry, he would follow me about the room like a dog or a cat. He would wind his way up my legs and body, until his head was on a level with my own; he would then bow repeatedly, darting out his tongue with inconceivable rapidity.

He would never attempt to crawl up the legs of a visitor (some visitors knew "Blacky" quite well and were not at all afraid of him), thus showing that he knew me personally.

Again, a friend sent me two Floridian chameleons, which dwelt in my desk, and which, in course of time, became very tame. My desk is a combination bookcase and writing-table, and these creatures passed most of their time among the books, changing color so perfectly, especially when alarmed, that it took a very sharp eye indeed to descry them when they were quiescent. When I sat at my desk writing they would jump down on my head or shoulders and explore my entire body, running here and there and everywhere about me, sometimes tickling me with their sharp little claws until I, too, was forced into making a tour of discovery, in order to bring them once more to the light. But let a stranger enter the room, and, presto! they were gone in the twinkling of an eye.

I left home on one occasion and was gone for two months. When I came to my room and sat down at my desk, I looked about for my little pets, and could not see them. I had come to the conclusion that they had either died or escaped from the room, when suddenly I saw a tiny little head peep out from between two books and as suddenly disappear. I pulled out a writing-pad and went to work, keeping a watch, however, for my shy little friends. They gradually became bolder and bolder, until all at once they seemed to recognize me, first one and then the other leaping to my shoulders. In a few moments they were making their usual tour over my person. In this instance these lizards remembered me after an absence of at least two months; it took them about two hours fully to recall my personality, yet they did it in the end.

Birds remember individuals, and testify their love or hatred for such individuals in actions that are unmistakable. Thus, an eagle in Central Park, for some — to me — unknown reason, took a great dislike to myself, and, whenever I approached its cage, would erect its crest and regard me in the most belligerent manner. On several occasions it even left its perch and flew to the bars in its desire to attack me. A large, handsome gobbler belonging to my mother has shown the house boy that it is war to the death between them. This turkey never fails to attack the boy whenever opportunity offers; no other person is ever molested by him.

A lady writes me as follows: "Last week my brother" (a lad of twelve) "killed a snake which was just in the act of robbing a song-sparrow's nest. Ever since then, the male sparrow has shown gratitude to George in a truly wonderful manner. When he goes into the garden the sparrow will fly to him, sometimes alighting on his head, at other times on his shoulder, all the while pouring out a tumultuous song of praise and gratitude. It will accompany him about the garden, never leaving him until he reaches the garden gate. George, as you know, is a quiet boy, who loves animals, and this may account, in a degree, for the sparrow's extraordinary actions."

I am perfectly convinced that the nesting birds on my place know me, and that they remember me from one nesting-time to another. I have repeatedly approached my face to within a foot of setting birds without alarming them. On one occasion I even placed my hand on a brooding cardinal, which merely fluttered from beneath it without showing further alarm; yet no wild bird has ever evinced toward myself any special degree of friendship. When I was a lad I remember that a certain decrepit old drake would follow me like a dog, and appeared to enjoy himself in my society. I could not appreciate his friendship then, and greatly fear that I was, at times, rather cruel to the old fellow.

One of the queerest friendships that ever came under my observation was that which existed between a bantam cock and a pekin drake. The cock was the most diminutive specimen of his kind that I ever saw, being hardly larger than a quail, while the drake was almost as large as a full-grown female goose. These two birds, so widely dissimilar as to genus and species, were always together. If "One Lung" (the cock) took it into his head to go into the garden and flew over the fence, "Chung" (the drake) would solemnly waddle to a certain hole in the fence well known to himself, and, by dint of much pushing with his strong, yellow feet, would squeeze himself through, and rejoin his companion with many a guttural quack and flirt of his tail. If "Chung" desired to take a bath, he would make for the brook, where "One Lung" would soon join him, always remaining, however, on the bank, where he would strut about and crow continuously. On one occasion, a chicken-hawk attacked the cock, which, though it defended itself valiantly, was in great danger of being destroyed. The drake soon became aware of what was happening, and hurled himself, with many a squawking quack, like a white avalanche against the hawk, and, with one quick blow of his horny, flat bill, laid this pirate of the air dead at his feet! He then examined the cock, with low-voiced exclamations issuing from his throat all the while. Then, finding him uninjured, he flapped his wings and quacked loud and long, as if in thankfulness. As for "One Lung," he pecked the dead hawk several times, then hopped up on its body and crowed as loud as he could, as if to say, "Look-what-I-have-do-o-o-ne!"

"One Lung" was taken to a neighboring farm for breeding purposes by his owner, and "Chung" moped and appeared utterly inconsolable during his absence. When the bantam was finally brought home, the drake recognized him "afar off" and came hurrying to meet him with flapping wings and much vociferation. He caressed him with his bill, and appeared to make a close examination of his person. These birds have always passed the night close together, the bantam roosting among the branches of a low bush, while his faithful companion squatted on the ground at its root.

Several years ago I knew a hen which was devotedly attached to an old white horse. When the horse was confined to the stable, the hen was always to be found in his stall, either in the manger, on the floor, or perched upon his back. This last position was a favorite one, and it was only abandoned when the hen was in search of food. When the horse was out on pasture, the hen went with him and stayed close beside him until nightfall, when she always returned and roosted on one of the stall partitions.

Many cow owners of my town are in the habit of turning out their cows in the morning, allowing them to roam about in the search of grass during the day. As there are many large open commons in the immediate neighborhood of town, the cows easily find an abundance of food. In my early morning walks I repeatedly noticed a large red cow which was always accompanied by a small black dog. When the cows came back into town in the evening, many of them passed my house, and among the number was the red cow and the dog in attendance. I became very much interested in the cow and dog, and, one evening, followed the former to her home. I asked her owner if he had trained the dog to follow the cow, whereupon he disclaimed all knowledge of any dog, declaring that he had not allowed a dog on his premises for many years. The next morning I was at his cow-house before the animal was turned out. When this occurred I followed her. A few blocks from her home, she was met by the dog, which bounded about her and showed his delight by wagging his tail. When she returned home in the evening he accompanied her until he arrived at his own home (the place where he met her in the morning), when he left her and crawled through a hole in the fence. His owner declared that his dog had been leaving home early in the morning and returning in the evening during the entire spring and summer (it was then September), and that he had often wondered where he stayed during the day. This queer friendship continued until November, when some miscreant put an end to it by shooting the dog. Neither the favored cow nor any of her companions (there were, sometimes, at least a hundred cows on the commons grazing together) appeared to pay the slightest attention to the dog or to notice him in any way. The dog kept close to his friend, the red cow, during the day, sometimes sitting gravely on his haunches and watching her eat, at other times frisking about her, as though asking for a romp. When she started to return home he followed close at her heels.

Another of my dog acquaintances struck up a friendship with a hog, and seemed to be highly pleased when he was allowed to play with his porcine friend. What is more wonderful, the hog appeared to be just as fond of his dog friend, and always greeted him with a series of delighted grunts. If permitted, they would play together for hours at a time. The dog was the bitter enemy of other hogs, and would worry them at every opportunity.[1]

I have had many friends among the lower animals, but have always gained and retained their good-will through their appetite. Some of these creatures will be considered queer pets, for instance, grasshoppers, spiders, and crickets, yet they were very interesting and often showed much intelligence. The lower animals, with the single

[1] These animals sometimes did not meet for months, yet they never forgot each other, and their friendship continued for several years.

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exception of the dog (I do not include the cat, for I doubt her friendship), rarely accept man as a companion and friend spontaneously. Their appetites or the exigencies of their surroundings very frequently occasion them to act in a friendly manner towards man, simply in order to induce him to befriend them. It is the rarest thing in the world for them to experience disinterested friendship for him. As I have said elsewhere in this paper, a few instances of disinterested and spontaneous affection of animals, other than dogs, for human beings are, however, on record, and I am happy in being able to record another.

In 1882 there was received at the Fair Grounds in St. Louis, Missouri, a consignment of South American monkeys. Among the lot were several large individuals of a species then unknown to me, and which remain unknown to me to this day. When I entered the monkey house I went at once to the cage of the newcomers. One of the creatures, after examining me very carefully, uttered a peculiar cry, and then leaped to the bars and began jabbering at a great rate. I told the keeper that I believed that the monkey wished to make friends with me; that the tones of its voice were decidedly pacific. He laughed at the idea, and declared that this same animal had bitten him severely when he was removing it from the box in which it had been shipped to the cage in which it was then confined. I said nothing more, but, going behind the rail, inserted my hand between the bars of the cage. The monkey immediately seized it with its paws, kissed it, and then licked it with its tongue. It then drew its head down beside it, murmuring all the while in low tones. It showed great pleasure when I scratched its head and body, and, in fact, seemed to regard me with the greatest affection. When the keeper, in his astonishment, drew near, the monkey bounded toward him, chattering and showing every indication of great anger. This animal never forgot me, but always recognized me the very moment I entered the monkey house.

In the same house there was a large dog-faced ape (chacma) named "Joe," whose friend and companion was a little white and black kitten. "Joe" called no living thing, except the cat, his friend; he had many acquaintances, but only one friend. He would tolerate me, and even invented a name for me, so the keeper declared, yet his friendship never got beyond tolerance. But he loved the cat, and the cat seemed to love him — that is, as much as a cat could love. He could not bear to have her taken from his cage; whenever this was done he would rage up and down his den, coughing, growling, and yelling like a mad creature. When she was restored to him he would seize her by the nape of the neck and carry her to the back of his cage, from which coign of vantage he would growl forth maledictions on the heads of his tormentors.

In order to test this monkey's memory, the cat was removed from the cage, and another cat was substituted. "Joe" at first appeared to be afraid of the new cat, and retired to the rear of his den. He would avoid the cat, whenever she approached him, by moving about the cage. Finally, he became very angry, and seizing poor puss, he broke her back and then pulled her head from her body! This was done so quickly that the tragedy was over before we could make a move to prevent it.

At the end of three months his pet was returned to him. The kitten had grown considerably during this interval, yet "Joe" recognized her at once, and welcomed her with many extravagant acts denoting joy and satisfaction.

All of the higher animals, such as the dog, horse, cat, ox, elephant, monkey, etc., possess this phase of memory.

Memory of Events (*Education, Happenings, etc.*). —The memory of events and their sequences is a faculty of the mind that is to be noticed in animals very low in the scale of life. In fact, psychical development is based almost wholly upon this mental attribute. The vast majority of what are now entirely instinctive habits were, in the beginning, the results of sensual perceptions formulated and remembered (consciously and unconsciously), which gave rise to conscious ideation; this conscious ideation, in turn, became instinct.

This part of my subject is treated at length in the chapter on Reason, therefore I will only introduce here certain evidence of this phase of memory as it is to be observed in the lower animals, especially in insects. A wasp of the variety commonly called "mud-dauber" last summer built her nest on the ceiling of my room in one corner. The windows of this room remained open night and day during the hot summer months, so her nest was easy of access. One day, while the wasp was busy about her home, I closed all the windows and awaited developments. At length she flew toward a window, against which she landed with a thump which for a moment or two completely dazed her. The wasp soon discovered that she was barred from the outer world by some transparent, translucent substance; she then proceeded on a voyage of discovery, flying around the room and searching here and there and everywhere for an exit. She finally found a small hole in a window casing which communicated with the outside; through this she made her escape from the room. Upon opening the window I saw her examining the passage through which she had come, going through it repeatedly. She finally flew away, but shortly returned with a pellet of mud. Notwithstanding the fact that all the windows were then open, the wasp went at once to the hole in the casing, through which she made her way into the room and thence to her nest on the ceiling. She never again, so far as I was able to ascertain, made an exit or an entrance through the windows, but always made use of the hole in the casing. This little creature undoubtedly gave unmistakable evidences of ratiocination; she found that a transparent barrier had been placed in her way — a barrier so translucent and transparent that she could not see it until she actually felt it. She therefore concluded that she would never again risk injury by flying through the windows. What is most remarkable about this instance is that this insect derived her knowledge from a single experience, and at once profited thereby. The wasp remembered the event — her experience with the window glass — and avoided a like occurrence by going through the hole in the casing. Her experience was a bit of education.

There are many people alive to-day, probably, who saw the trained fleas which were on exhibition in the large cities of the United States some thirty or forty years ago. These little creatures had been taught to perform military evolutions, to dance, to draw miniature carts, to feign death, etc., at the command or signal of their owner and trainer. The mere fact that they possessed memory enough to learn, retain, and remember their lessons is not proof positive of reason, but the fact of their having restrained their natural tendency and desire to escape, when they could so easily gratify such a desire or tendency, is a potent factor in an argument for their possession of the ratiocinative faculty. Their teacher explained that he "brought them to reason" by keeping them at first in a glass vessel, where they jumped and bumped their heads to no purpose against the transparent walls of their prison. Thus their vaulting ambition was held in check, and they learned to reason from cause and effect.

It is a well-known fact that many of the higher animals can be taught to do many things entirely foreign to their natures. This is brought about entirely through the faculty of remembering events. I am confident that many of the lower animals, insects, crustaceans, reptiles, are likewise the possessors of this faculty, and are capable of being taught. I, myself, have succeeded in teaching a toad to hop over a stick at the word of command. Again, I taught two chameleons to take certain positions and to retain them at feeding time. These little creatures remembered their lesson, and at my whistle would "line up" on the particular book that I had designated as their dining-table. We have seen that fleas are capable of being highly educated, hence it is reasonable to presume that other insects, specially and generically akin to the flea, likewise possess the faculty of remembering events. Of course, this faculty is necessarily more highly developed in some animals than in others; it differs in degree of development, not in kind.

CHAPTER IV

THE EMOTIONS

CAREFUL observation and investigation lead me to believe that, in many of the higher animals, all the fundamental emotions, such as love, hate, fear, anger, jealousy, etc., are present. Books on natural history fairly teem with data in support of this proposition. Such authorities as Romanes,[1] Darwin,[2] Semper,[3] and Hartmann,[4] give instance after instance in support of the dictum that the emotional nature of many of the higher animals is highly developed.

Man has been called the Laughing Animal, because, so it has been claimed, he alone of all animals expresses emotion through the agency of the smile or through laughter.

This is a grave mistake, for both the dog and the monkey, in certain instances, have been known to express pleasure through the agency of the smile. And, in the case of certain monkeys, the

[1] Romanes, *Animal Intelligence.*
[2] Darwin, *Descent of Man.*
[3] Semper, *Animal Life.*
[4] Hartmann, *Anthropoid Apes.*

action of the facial muscles was accompanied by cachinnatory sounds.

"Tom," a capuchin monkey of the St. Louis, Missouri, zoölogical garden (Fair Grounds), was quite a noted "laugher," and his facial expressions as well as the sounds he uttered were so evidently laughter, pure and simple, that the most casual observer was able to recognize them as such.

"Stranger," a half-bred spaniel belonging to my kennel, invariably expressed pleasure with smiles. The action of the facial muscles, as well as the facial expression engendered by this action, was widely different from like phenomena when the dog showed his teeth in anger.[1]

Young chimpanzees chuckle and smile when one they love returns to them after an absence of some little time. Their eyes sparkle and grow bright, while very evident and easily recognized smiles flit over their countenances.[2]

Young orang-utans likewise chuckle and grin when tickled, and, as Wallace observes, give expression to unmistakable smiles. "Dr. Duchenne — and I cannot quote a better authority — informs me that he kept a tame monkey in his house for a year; and when he gave it, during meal-times, some choice delicacy, he observed that the corners of its mouth were slightly raised; thus

[1] Compare Darwin, *Expression of the Emotions*, p. 120.

[2] Martin, *Natural History of Mammalia*, Vol. I. pp. 383, 410; quoted also by Darwin, *loc. cit. ante*.

an expression of satisfaction, partaking of the nature of an incipient smile, and resembling that often seen on the face of man, could be plainly perceived in this animal."[1]

A dog belonging to Mr. Henry Barklay, of Paducah, Kentucky, not only smiles when pleased, but also gives utterance to an unmistakable chuckle. When I first saw and heard this manifestation of delight, I thought that the animal had been taught the accomplishment; his master assured me, however, that such was not the case, that both the smile and the chuckle were natural and inborn traits of the dog.

I think it hardly necessary to give more data on this point; suffice it to say that it is a fact beyond dispute that certain monkeys and dogs are "laughing animals," and that man is *not* the only animal that expresses emotion through the agency of the smile and laughter!

On one occasion during very hot weather, one of the combs in my bee-house became loosened at the top through melting of the wax. The weight on the comb dragged it down, and suddenly it broke from its supports and sagged over against a neighboring comb. It was perfectly apparent to me that if something were not done at once, the comb would continue to sag until it broke away from all its connections, and would then be precipitated to the floor of the hive. The bees like-

[1] Darwin, *loc. cit. ante*, p. 133.

wise recognized this impending calamity, and clearly showed that they did by the noise and tumult which arose among them as soon as they discovered the precarious situation of the endangered comb.[1]

The loud buzzing which they immediately set up clearly indicated their dismay and consternation. It seemed to me very much like the noisy vociferation of conflicting counsels, which would undoubtedly arise among the people in some orderly town were they suddenly threatened by some unforeseen and unheard-of catastrophe.

The tumult among the bees continued for four or five minutes, when, suddenly, order was evolved out of chaos, and they set to work to prevent the fall of the comb, showing almost, if not altogether, as much intelligence as human beings would evince under like circumstances.

They shored up the endangered comb by building a thick pillar of wax between it and a neighboring comb, thus effectually fixing it so that it could sag no further. When this had been done, they re-affixed the top of the comb to the ceiling of the hive by a broad, thick bar of wax; the pillar used in propping up the comb was afterwards removed and the wax used elsewhere.

In this instance, these little creatures at first clearly evinced the emotions of fear, dismay, consternation, and grief; afterwards, they just as

[1] Compare Huber, Vol. II. p. 280.

clearly showed fortitude and joy; for, after the supporting pillar had been built, I saw the queen, surrounded by a crowd of courtier-bees, on the comb near it, and am fully convinced that she had been brought out by her rejoicing subjects to view the results of their brave struggle against an utterly unforeseen but now happily averted calamity.

On another occasion I witnessed the terrible grief of a community of bees at the death of their queen, which was seized with illness (a sudden and overwhelming diarrhœa, to which bees, at times, are very subject) while making a progression through her domains, and fell to the floor of the hive and died before she could be conveyed back to the royal cell. I was, therefore, able to see the conduct of the bees during her illness and after her death.

When she fell to the floor, the bees seemed to know at once that something out of the ordinary had happened. The sick queen was immediately surrounded by a dense circle of her subjects, those next to her licking her with their tongues and endeavoring to raise her to her feet.

When she died they were a little slow in recognizing the fact, but when they did realize that she was dead those nearest the dead sovereign set up a loud buzzing. This was transmitted from circle to circle, from bee to bee, until the entire hive was in an uproar. The bees rushed to and fro bewailing their loss, and seemingly crazed by grief.

All work was immediately suspended, and even the young were abandoned and left, for the time being, to shift for themselves. Those bees which returned to the hive laden with honey did not put it into the cells but retained it in their honey-bags. In fact, the entire social economy of the hive was disrupted and disarranged, and this confusion lasted for hours. After about twenty-four hours of mourning for the dead queen the bees recovered their equanimity, and began the work of rearing another queen from a worker larva.

In another chapter of this book (vid. Memory) I have related an instance of complex ideation in a bird. I have reference to the sparrow whose young was saved from a snake, and which remembered the lad who destroyed its enemy. This bird undoubtedly showed gratitude. Another correspondent writes: "Knowing your love for, and your interest in, all animals, I think my experience with two house wrens this summer will entertain you. These birds selected for their home an old boot, which they discovered on a bench in an outhouse. Here they built their nest, and, in the course of time, had the great pleasure of welcoming into the world two interesting 'wrenlets.'

"One day, while feeding my pigeons, I noticed that the old wrens were greatly disturbed by something or other. They kept flying about me, uttering sharp, complaining cries; they would now and then fly to the outhouse, and then back to me. At last it occurred to me that some accident might have befallen the young wrens, so I proceeded to investigate, and soon discovered the trouble.

"Some one, in rummaging about the room, had overturned the boot, which had fallen in such manner that the top pressed against the wall, thus effectually barring the way to the nest. I righted the boot, thereby restoring the children to their parents, much to the delight of all parties concerned. Ever since this episode the male wren has shown his gratitude in an unmistakable manner. He has followed me into the house on several occasions; he has learned where I sit when engaged in sewing, and pays me short visits, flying though the window several times a day, and, wonderful to relate, after the young had learned to fly, he brought them around to my window and evidently gave them to understand that I was their saviour!"

The higher animals, such as the horse, the ox, the dog, the monkey, etc., show the emotions of anger, hate, fear, love, and grief so plainly that "he who runs may read." That these animals possess these emotions is a fact which hardly needs demonstration. They likewise have very retentive memories, sometimes treasuring up an injury for days, months, and years, until an opportunity arrives for them to "get even," thus showing that they are revengeful.

Thus, a dog of my acquaintance had been

severely thrashed last winter by a larger dog. He bided his time, and, this summer, after his antagonist had been handicapped by having that atrocious invention, a muzzle, affixed to his head, he fell upon him, "tooth and toe-nail," and would have killed him had he not been prevented.

Again, some years ago my attention was called to a large mandril by the keeper of the monkey house in the St. Louis Zoölogical Garden, who remarked that "That monkey will do me up some day. I had to thrash him several days ago, and ever since then he has had it in for me."

Not ten minutes after the conversation, while I was in another part of the building, I heard a yell from the keeper, and, on rushing to see what had happened, found that the man's thumb had been almost severed from his hand by the powerful teeth of the mandril. The keeper had been explaining something to some visitors, standing with his back to the animal, and with his hand resting on one of the bars of the cage. The brute saw his opportunity, and, in the twinkling of an eye, seized it and inflicted a severe injury to the individual whom he regarded as his enemy.

During another visit to the above-mentioned monkey house, I accidentally inflicted an injury to a capuchin monkey, "Tom" by name, who was a great friend of mine and who had been taken from his cage and given to me by the keeper. After playing with him for a time, I had placed him on the floor and had resumed my conversation with the keeper. Suddenly, "Tom" gave a loud squall and jumped into my lap, wringing one of his hands and moaning piteously.

He held up his hand towards me, calling my attention to it with many a grimace and cry; he even felt it with his other hand, carefully separating the fingers and gently stroking them. On examination I discovered that the tips of two fingers were bruised and abraded; the little fellow had evidently had them caught in some way beneath the heel of my shoe. He quietly and patiently submitted while we dressed his wounded digits, but removed the bandages just as soon as he was returned to his cage, evidently having more faith in the curative qualities of his own saliva than in the medicaments of man.

In this instance, the monkey clearly indicated that he had been hurt; he pointed out the portion of his body where the injury was situated, and then allowed his friend to "doctor" the injury, although he did not evince an abiding faith in that friend's skill. In contradistinction to the mandril which evinced revenge, the capuchin showed that he was of a forgiving disposition, for, no sooner was he hurt, than he sought consolation from the very person who inflicted the injury.

An English observer, Captain Johnson, writes as follows, when speaking of a monkey which he had shot: "He instantly ran down to the lowest branch of a tree, as if he were going to fly at me, stopped suddenly, and coolly put his paw to the part wounded, and held it out, covered with blood, for me to see. I was so much hurt at the time that it has left an impression never to be effaced, and I have never since fired a gun at any of the tribe."[1]

Another observer, Sir William Hoste, records a similar case. One of his officers saw a monkey running along some rocks, holding her young one in her arms. He fired, and the animal fell. When he arrived at the place where she was lying, she clasped her young one closer, and pointed with her fingers to the hole in her breast made by the bullet. "Dipping her finger in the blood and holding it up, she seemed to reproach him with having been the cause of her pain, and also that of her young one, to which she frequently pointed."[2]

These observations would seem to indicate that monkeys are capable of feeling and of expressing sorrow and reproach. "So intense is the grief of female monkeys for the loss of their young, that it invariably caused the death of certain kinds kept under confinement by Brehm in North America."[3]

By the observant and analytical mind, the various psychical phenomena evinced by the lower animals are not regarded as being either wonderful or extraordinary. Man is a conceited, arrogant indi-

[1] Romanes, *Animal Intelligence*, p. 475.

[2] Romanes, *op. cit.*, p. 476.

[3] Darwin, *Descent of Man*, p. 70.

vidual, and his place in nature has done much toward fostering and enlarging this self-conceit and arrogance. Even in the time of Moses this self-glorification was *en evidence.* The genesis of the world, as related by this famous historiographer, geographer, naturalist, theologian, and lawgiver, plainly shows this. At the present time, science declares, emphatically, that man is but a mammal, whose brain has undergone exceptional evolutionary development. He is but the younger kinsman of other mammals whose evolutionary development has sought other channels; these, in turn, are but younger kin of yet older animals, and so on backwards, to the beginning of life in bathybian protoplasm. The resistless forces of evolution have placed him where he is, and no amount of self-adulation can hide the scientific fact that he is *not* a special creation. All the creatures of the living world are kin, and that force which animated the first moneron, and which we call life, has been transmitted from creature to creature until the present day, absolutely unchanged. There is no reason for believing that life will ever be entirely extinguished, until conditions arise which will render the presence of this force impossible.

When we recognize the fact that intelligent ratiocination is but the product and the result of the psychical action of a certain substance called brain matter, and not the product and the result of the action of an essence or force unconnected with, or outside of, brain; and, furthermore, when we know that these lower animals have receptive ganglia analogous to those possessed by man, analogical deductions force us to the conclusion that these animals should possess mental emotions and functions similar to those of man.

The microscope shows that these animals have notochords, nervous systems, and ganglia, or brains. With a one-sixteenth objective, and an achromatic light condenser, I have been able to differentiate the gray matter in the brain of an ant, and even, on two occasions, to bring out the cells and filaments of the cortex. Here in the brain of an ant, is an anatomical and physiological similarity to the brain of man: therefore, it is reasonable to expect evidences of mental operations in the ant akin to those of man.

That we do find these evidences in abundance can no longer be denied. Sir John Lubbock chloroformed some *Lasius niger* belonging to his formicary. The other ants brought their anæsthetized comrades out of the nest and carried them away; they thought that they were dead. He made some other specimens of the same species intoxicated, and the ants carefully bore their helpless companions back into the nest. The care evinced in helping their intoxicated friends to reach the safe shelter of their nest undoubtedly indicates a sense of sympathy toward the afflicted individuals.

Ants frequently display sympathy for mutilated companions. Whether or not this feeling is ethical or material is not and can not be determined; the fact remains, however, that sympathy is evinced. I myself have observed it on many occasions. I removed the anterior pair of legs from a specimen of *Lasius flavus*, and placed her near the entrance to her nest. In a short time a companion came to her assistance, and, lifting her with her mandibles, carried her into the nest. A specimen of *F. fusca*, destitute of antennæ, was attacked and severely injured by an ant of another species. An ant of her own species soon came by. "She examined," says Lubbock, whom I quote, "the poor sufferer carefully, then picked her up tenderly and carried her into the nest. It would have been difficult for any one who witnessed the scene to have denied to this ant the possession of human feelings." [1]

Not only do they display sympathy toward mutilated and helpless friends, but also toward healthy individuals who may accidentally get into trouble and need assistance. Belt, while watching a column of *Eciton hamata*, placed a stone upon one of them to secure her. The next ant in line, as soon as she discovered the condition of her friend, ran hurriedly backward and communicated the intelligence to the others. "They rushed to the rescue; some bit at the stone and tried to move

[1] Lubbock, *Ants, Bees, and Wasps*, p. 107.

it, others seized the prisoner by the legs and tugged with such force that I thought the legs would be pulled off; but they persevered until they got the captive free. I next covered one up with a piece of clay, leaving only the ends of its antennæ projecting. It was soon discovered by its fellows, which set to work immediately, and by biting off pieces of the clay soon liberated it."

At another time he found a few of the same ants passing along at intervals. He buried one beneath a lump of clay, leaving only the head protruding. A companion soon discovered her and tried to release her. Finding this to be impossible, she hurried away. Belt thought that she had abandoned the unfortunate prisoner, but she had only gone for assistance, and soon returned accompanied by a dozen companions, which made directly for the imprisoned ant and soon set her free. "I do not see how," says Belt in conclusion, "this action could be instinctive. It was sympathetic help, such as man only among the higher mammalia shows. The excitement and ardor with which they carried on their unflagging exertions for the rescue of their comrade could not have been greater if they had been human beings."[1] I have buried *Lasius flavus* beneath sand, and in every instance, sooner or later, they have been dug out by their companions.

[1] Belt, *The Naturalist in Nicaragua*, p. 26; quoted also by Romanes, *Animal Intelligence*, p. 48.

Rev. Mr. White has noticed the same sympathetic help among *F. sanguinea*.[1] Lubbock noticed in one of his nests of *F. fusca*, Jan. 23, 1881, an ant lying on her back and unable to move. She was unable even to feed herself. Several times he uncovered the part of the nest where she was. The other ants at once carried her to the covered part. "On March 4," says he, "the ants were all out of the nest, probably for fresh air, and had collected together in a corner of the box; they had not, however, forgotten her, but had carried her with them. I took off the glass lid of the box, and after a while they returned as usual to the nest, taking her in again. On March 5th she was still alive, but on the 15th, notwithstanding all their care, she was dead."[2]

Dr. Stimson Lambert of Owensboro, Kentucky, a careful and accurate observer, informs me that he has frequently observed the large red ants (*F. rufa*) helping their mutilated or crippled companions.

Ants exhibit another emotion that shows the high development of their psychical or emotional nature. In the tender watchfulness and care of their young they are surpassed by no living creature. As soon as the young ant bursts its pupa case, it is carefully assisted into the world by its foster-mothers. These foster-mothers clean it with their tongues, gently going over the entire surface

[1] White, *Leisure Hour*, p. 390, 1880.

[2] Lubbock, *loc. cit. ante*, p. 107 *et seq.*

of its body, and then feed it. The young ant is conducted by them throughout the whole nest, and shown all the devious passageways and corridors. When it makes its first visit into the outside world, it is always accompanied by several chaperons. This parental love, if I may use the expression, is even extended to the unhatched eggs. If an ants' nest is disturbed by a stroke of a spade or hoe, the little inhabitants will at once begin to remove eggs, pupæ, and young to a place of safety.

This parental love is even evinced by insects who never see their offspring. The butterfly uses the utmost care in selecting a suitable leaf on which to deposit her eggs. She selects one that will be nourishing food for the larvæ when hatched out, and, after carefully observing whether it is preoccupied by the eggs of some other butterfly (in which case she abandons it), she proceeds to deposit her eggs. "Having fulfilled this duty, from which no obstacle short of absolute impossibility, no danger however threatening, can divert her, the affectionate mother dies."[1]

The gadfly uses a like forethought in selecting a place for her eggs. The larvæ of the gadfly (*Œstrus equi*) are developed in the stomach of the horse, so the provident mother attaches the eggs to the hairs of the foreleg between the knee and the shoulder, a place the horse is almost certain to lick with his tongue and, in this manner, convey

[1] Kirby and Spence, *Entomology*, p. 228.

the eggs to his stomach, where they are hatched out. The breeding place of certain of the ichneumons is the body of a caterpillar. The ichneumon may be seen busily searching the bushes for her victim. When she finds it, she inserts her ovipositor into its body and lays her egg. If some other ichneumon has preceded her, she recognizes the fact at once, and will not deposit her egg, but will go in search of another grub. When the egg is hatched, the larva feeds on the body of its host, carefully avoiding the vital organs. The caterpillar retains just enough vitality to assume the pupa state, and then dies. The chrysalis discloses, not a butterfly, but an ichneumon.

The mason wasp (*Epipone spinipes*) builds its cells and lays its eggs, one in each cell. It then hunts and procures spiders, which it deposits in the cells and then seals the openings. These spiders are not killed outright, but are partially paralyzed by the sting of the wasp. The insect thus secures for her young a supply of fresh food. This wasp not only knows the difference between the eggs that will produce female young, but she also makes this knowledge useful. She always supplies the females with more spiders than she does the males. The females are larger and require more food, hence the discrimination. All of this care and forethought is expended on young which the mother will never see. Human love cannot give greater evidences of complete unselfishness.

I once removed a ball of eggs from the web of a spider. The mother clung tenaciously to her treasure, and, when I tried to remove her with a pair of forceps, she bit fiercely at the steel blades of the instrument. In her great love for her offspring she lost all sense of fear. Time and again I removed her several inches from the eggs; she would run about in a distracted way, for all the world like a mother who had lost her baby, until she found the ball of eggs. She would then seize it and attempt to remove it to a place of safety. The naturalist, Bonnet, put a spider and her bag of eggs in the pit of an ant-lion. The myrmeleon seized the egg-bag and tore it away from the spider. Bonnet forced the spider out of the pit, but she returned and chose to be dragged in and buried alive rather than leave her eggs.[1]

Earwigs lay their eggs, and then incubate them after the manner of the hen. When the young are hatched out, the proud mother leads forth the brood and shows unmistakable pride and affection in her children. On one occasion, when a storm was coming up, I saw an earwig marshal her troop of young ones, and lead them to a place of safety beneath the bark of a tree.

M. Geer scattered the eggs of an earwig over the bottom of a box: "The earwig carried them, however, one by one, into a certain part of the box,

[1] Bonnet, *Œuvres;* quoted also by Romanes, *Animal Intelligence*, p. 205.

and then remained constantly sitting upon the heap without ever quitting it for a moment until the eggs were hatched."[1] This, I take it, is at least an instance of love of offspring, even if it is not a higher emotion. From the earwig's habit of watching over her young I am inclined to believe that this insect possesses true mother-love.

Many of the lower animals give unmistakable evidences of the possession by them of the emotions of anger and fear. Ants, centipedes, tarantulas, weevils, etc., as well as many of the crustacea will give battle on the slightest provocation, clearly showing by their actions that anger and hate are their incentives. When alarmed, their actions indicate very plainly that the emotion of fear has seized them.

In the next chapter I hope to show that many of the lower animals possess one or more of the finer emotions, which I have thought best to group under the head of Æstheticism.

[1] Romanes, *loc. cit. ante*, p. 229; quoted also by Bingley, *loc. cit.*, Vol. III. pp. 150, 151.

CHAPTER V

ÆSTHETICISM

"THE man that hath not music in himself, nor is not moved with concord of sweet sounds, is fit for treasons, stratagems, and spoils." The above quotation is the thought of one of the most acute, profound, and accurate psychologists that ever lived. That which he observed to be true among men, strangely enough, a long and systematic course of observation leads me to believe to be equally true among the lower animals; for where-ever it can be observed that animals evince an appreciation for musical sounds, or show discrimination in their perception of harmonious tonal vibrations, such animals, with a single exception — the spider — will be found to be of kind disposition, and not given to "treasons, stratagems, and spoils" other than those required by their struggle for existence. So true is this rule, that the single exception — the spider — proves the verity of the deduction or conclusion. For, like many men, the spider's love for the beautiful, not only in music but in decorative effects as well, is intimately associated with murder-lust; it kills for the love of killing. Many examples of the association of great cruelty and profound love for the beautiful in nature and the arts might be given; it is necessary for my purpose, however, to give but two—Nero and Catherine de' Medici.

That spiders appreciate musical sounds, and that they can differentiate between those sounds that are pleasing and those that are disagreeable to them, I have not a scintilla of doubt. The following facts bearing on this point came under my own observation or were told me by people in whose veracity I believe implicitly, or are vouched for by scientists of world-wide fame.

During one entire summer until late in autumn, a large, black hunting spider (*Lycosa*) dwelt in my piano. When I played *andante* movements softly, she would come out on the music rack and seem to listen intently. Her palpi would vibrate with almost inconceivable rapidity, while every now and then she would lift her anterior pair of legs and wave them to and fro, and up and down. Just as soon, however, as I commenced a march or galop, she would take to her heels and flee away to her den somewhere in the interior of the piano, where she would sulk until I enticed her forth with *Träumerei* or Handel's *Largo*.

On one occasion, while standing beside an organist who was improvising on the swell organ with *viol d'amour* stop drawn, a spider let herself down from the ceiling of the church and hung suspended immediately above his hands. He coupled on to great organ and commenced one of Guilmant's resonant *bravura* marches; immediately the spider turned and rapidly climbed her silken thread to her web high up among the timbers of the ceiling. The organist informed me that he had noticed, time and again, that spiders were affected by music. Several days afterwards I went to the church for the special purpose of experiment; I seated myself at the organ and commenced to improvise on the swell organ with *flute*, *viol d'amour*, and *tremulant* stops out. In a few moments the spider let herself down from the ceiling and hung suspended before my eyes. So close was she that I could see her palpi vibrating rapidly and continuously. I suddenly dropped to great organ and burst into a loud, quick galop; the spider at once turned and ascended towards the ceiling with the utmost rapidity. Again and again I enticed her from her home in the ceiling, or sent her scurrying back, by playing slow *piano* or quick *forte* compositions. She clearly and conclusively indicated that loud, quick music was disagreeable to her. Professor C. Reclain of Leipsic, once, during a concert, saw a spider descend from one of the chandeliers and hang suspended above the orchestra during a violin solo; as soon, however, as the full orchestra joined in, it quickly ascended to its web.[1] This fact of

[1] Reclain, *Body and Mind*, p. 275; quoted by Romanes, *Animal Intelligence*, pp. 205, 206; compare Rabigot, Simonius, and Von Hartmann.

musical discrimination in a creature so low in the scale of animal life is truly wonderful; it indicates that these lowly creatures have arrived at a degree of æstheticism that is very high indeed.

Spiders are decorative artists of no little ability. I saw one which spun a web, beautifully adorned it with a broad, silken pathway, and then used it as a pleasure resort; I also saw a spider which intentionally beautified its web by affixing to it hundreds of minute flakes of logwood dye;[1] thus we see that the æstheticism of spiders is not confined to the love of music, but extends to other fields. In passing, I may state that once, while confined to my room for a long time by sickness, I became intimately acquainted with a wolf-spider which seemed to take an æsthetic delight in her toilet. This lycosid became so very tame that she would crawl upon my finger and allow herself to be brought close to my eyes, so that I could observe her deft and skilful movements while beautifying her person. She learned to know me personally, rapidly running away and hiding herself when visitors entered my chamber, but never showing fear when I alone was in the room. This spider also showed an appreciation for certain musical sounds (the instrument used was the paper

[1] Mr. Willard Bates, a druggist of Owensboro, Kentucky, in whose store this instance of decorative æstheticism occurred, called my attention to the insect, which was busily engaged in beautifying her web.

and comb mouth-organ of childhood); low, soft music would always entice her from her den beneath the table-lid, while loud, quick sounds seemed to frighten and disgust her.

Among animal music-lovers this chapter does not embrace those natural musicians, the crickets, grasshoppers, locusts, frogs, and birds, whose love-songs form such a large part of the æsthetic in nature; yet the instance I am about to relate cannot be omitted, for it clearly indicates a love for musical sounds other than those produced by the creature itself or its mates.

A gentleman,[1] formerly living in the country, but now an attorney-at-law and residing in the town in which I live, told me that, on one occasion, he succeeded in raising two quails from eggs placed beneath a brooding barnyard fowl. These birds grew to maturity, and, what is rare indeed, became so exceedingly tame that they ran about the house and yard with the utmost freedom, showing not the slightest fear, and, seemingly, taking the greatest pleasure in the caresses bestowed upon them by the children of the household. This gentleman comes of a musical family, and, on pleasant summer nights, he and his sisters and brothers were in the habit of going to the stiles some distance away from the house and there singing and playing on the guitar and violin for several hours. The quails roosted on a dresser in the kitchen, but,

[1] Martin Yewell, Esq., Owensboro, Kentucky.

as soon as the music began, they left their roost and flew to the stiles no matter how late in the night it might be, and there they would stay, perched on the shoulders of the musicians, until the concert was over; they would then go back to roost. They seemed to be passionately fond of the singing voice, and would seek out a singer wherever he or she might be, whenever they heard the sound of singing. In *timbre* the human female voice is more nearly akin to that of the quail than to that of any other animal. When a lad, "before my voice changed," I could call up these birds at will by giving their various calls; I did not whistle the songs; I *sang* them. The peculiar quality of the female voice referred to above may be considered by some to have been the cause that influenced these birds; yet my informant distinctly states that *the voice of an adult male equally attracted them.*

The opening movement of Chopin's *Marche Funébre* affects me very disagreeably. The music is, to me, absolutely repugnant. The beautiful melody in the second movement is, however, to me exceedingly agreeable and affords me intense pleasure and gratification. The lower animals are likewise agreeably or disagreeably affected by certain musical sounds. Close observation has taught me the fact that certain musical keys are more agreeable to dogs than others. If a composition in a certain key, the fundamental note of which is agreeable to a dog, be played, he will either listen quietly and intently to the sounds, or will, sometimes, utter low and not unmusical howls in accord or "in tune" with the fundamental note. If the music be in a key not pleasing to him, he will either show absolute indifference, or will express his dissatisfaction with discordant yelps not in accord with the fundamental note of the key.

The bell of a certain church in my town sounds G. A collie, which lives next door to the church, when the bell is rung, never fails to express his delight in the sound. He listens intently while the bell is ringing, occasionally giving utterance to low howls, the notes being either B♭, E♭, or some other note in accord with G. This dog visits a house next door to another church, the bell of which sounds F. He never shows the slightest interest when this bell is rung. When I play compositions in F♯, an English fox-terrier of mine will lie on the floor and listen for an hour at a time. If I change to the key of E♭, B♭, or G, he will soon leave the room.

A question naturally obtrudes itself here in the matter of the dog which barks in accord with the church-bell. Does he do this knowingly (consciously), or is it simply an accident? I believe the former, and consider it the result of an acquired psychical habitude.

That the dog is conscious (self-conscious) that his voice is in accord with the bell, I will not venture to assert, for, knowledge on this point, I take it, is beyond the power of man to acquire. I mean by the word, "knowingly," when I say that the dog knowingly pitches his voice in accord with the bell, not that he has any knowledge whatever of harmony, such as an educated musician possesses, or such even as the inherited experiences of a thousand years of music-loving ancestors would naturally impress upon the mind of a civilized European of to-day, but that he has an acquired imitative faculty (a faculty possessed by some of the negroes of Central Africa as well as by many other savage races), of attuning his voice to sounds which are pleasing to his ears. In support of this proposition I instance the fact of the dog's acquired habit of barking, which has been developed since his domestication. In his wild state the dog *never* barks.

Man himself has done much toward arousing and cultivating the imitative faculty in the dog (which, in the beginning, impelled this highly developed animal to *answer* his master, thus originating the first vocables — barking — in the canine language), by conversing with him. In all probability, it is only an "anatomical barrier and a psychical accident" at best, which prevent the dog from addressing his master through the agency of speech itself!

The dog's voice is exceedingly pleasing to himself, and, most frequently, when "baying the moon," he is listening to his own singing, *not* (as is generally supposed) as it pours forth from his throat, but in a more pleasing manner, as it is breathed back to his listening ears from the airy lips of Echo!

That dogs have discovered that pleasing phenomenon, the echo, I do not question for a single instant. If a dog which is in the habit of "baying the moon" be watched, it will be observed that he invariably selects the same spot or spots for his nocturnal concerts. If you happen to be standing in the neighborhood, you will also notice that there is always an echo, more or less distinct, of his barking; and, if you will observe closely, you will see that the dog listens for this echo, and that he will not resume his song until it (the echo) has entirely ceased. That this is the true explanation of "baying the moon" (where there is not another dog in the distance whose clamorous barkings have aroused a like performance on the part of the animal under observation), the following instance, coming under my own observation, would seem to indicate.

I had frequently noticed that a spaniel crept under a honeysuckle bush in my front yard whenever he gave one of his serenades. Time and again I tried to hear the echo, but in vain, and an almost verified fact seemed in danger of total annihilation. Finally, it occurred to me to dispossess the dog and take his place beneath the bush. I called him out and succeeded with much difficulty in getting beneath the bush, from whence I, imitating his voice, sent several howling barks. My theory was no longer merely theory, but was, instead, a verified fact, for, sharp, clear, and distinct, the echoes of my voice came back from some buildings an eighth of a mile away! Some peculiar acoustic environment made it impossible to get the echo at any place, as far as I could discover, other than beneath the bush.[1]

It is highly probable that the susceptibility of rats and mice to the influence of musical sounds has been known for ages. The legend of the Pied Piper of Hamelin is by no means recent, nor is it confined to European peoples alone; in one form or another it exists among Asiatic, Indian, and Indo-Malayan races. In all the legends, the rats or mice are drawn together by sounds emanating from some kind of musical instrument.

A celebrated violinist told me that, at one period of his life, he lived in a house that fairly swarmed with rats. He noticed that these creatures were peculiarly susceptible to minor chords, or to compositions played in minors, and that quick, lively music would bring them forth from their lurking-places in great numbers. A few abrupt, dissonant discords would, invariably, send them scurrying to their holes.

[1] These observations are original, and, while I am fully convinced of their truth, I would yet like to have them substantiated by other observers. This habit indicates a high degree of æsthetic feeling in the dog.

Another violinist informs me that several mice living in his room are influenced by the music of his violin; when he plays an *andante* movement very softly, they appear to listen intently and to enjoy the music; but when he plays an *allegro* in quick time and loud, they quickly run away. The organist of the First Presbyterian Church of Owensboro, Kentucky,[1] tells me that when he lived in Cuba, New York, a mouse dwelt beneath a bookcase in his room, and that he often performed the following experiment: Seating himself at the piano, he would begin improvising softly. In a few moments the mouse would come from beneath the bookcase, approach the centre of the room, and, standing on its hind feet, would listen intently to the music. A loud chord on the piano would send it scampering away to its home. He would then resume his *pianissimo* improvisation, and the mouse would soon return to its former station near the centre of the room, only to vanish again as soon as the loud chords were struck.

A violinist of Louisville, Kentucky, Mr. Karl Benedik, told me, on one occasion, that he had repeatedly noticed that several mice, which lived in his room, were influenced by the music of his violin. When he played an *andante* movement *pianissimo*, they would appear to listen with pleasure; but when he played an *allegro* in quick *tempo* and *forte*, they immediately ran away.

[1] Professor L. J. Quigley.

Mice not only enjoy the music of others, but sometimes make music themselves. My father enjoyed nightly concerts or serenades, for a long time, from some "singing mice" in his library. I was fortunate enough to hear this novel concert on one occasion. The mice, two in number, came out from beneath the casing of the fireplace. They took places on the hearth, several feet distant from one another, and first one, and then the other, sang. Their songs were low and musical, not unlike the song of the canary, though there were no cadenzas or *fioritura* passages. They seemed to use six notes, these notes being repeated in melodious sequences. I noticed, several times, a run of four notes in ascending scale. On another occasion, in my bedroom, I heard a mouse sing his pleasing little song over and over again.

Miss Ada Sterling, editor of *Fashions*, writes me as follows: —

". . . Anent your paper . . . I have had some curious experiences of a similar nature; one was in an uncarpeted room, the house being deserted at that time. I stood still, planning certain things and humming softly to myself. Presently, a shadowy something caught my eye, and I discovered a little mouse, very young evidently, then another and another, until four were near. I did not attribute their tameness to music, and in surprise turned to see if there were others about. Instantly they scampered off, my action having frightened them.

"When I finally arrived at the conclusion that music had attracted them, I sat down and began to hum, this time with an open sound instead of a closed tone, and in a second the little creatures were out again, standing perfectly still, as if the sound gave them delight. Gradually I swelled the tone, and yet they were undisturbed until I became too bold and gave a clear, sharp, full sound, and this at once frightened them.

"*I experimented in this way for more than a month, never missing my audience once*, and by this time the little creatures, grown so fat and bold as to cause serious damage, were ruthlessly caught and killed.

"I heard Kate Field, about four years ago, when, as the guest of Mr. Stedman, she told several interesting stories, relate an experience of her own, wherein, one night early in her life, she had leaned against the walls of the Campanile, gray and phantom-like in the moonlight, and, singing softly to herself, was surprised at discovering several little lizards lying about on the stones, their heads held alertly in the air as if entranced by the sound of her voice. She, too, experimented with the varying sounds, and from time to time, and evidently looked back upon the experiment as one of rare interest to herself."

Tree lizards will listen completely entranced to the music of a good whistler, and will allow themselves to be captured while thus inthralled. Some lizards are fairly good musicians themselves, notably the tree lizards of the East Tennessee mountains. I have repeatedly heard them singing on the slopes of Chilhowie and adjacent peaks.

Burroughs writes very entertainingly of a singing lizard, or, rather, salamander: ". . . Approach never so cautiously the spot from which the sound proceeds and it instantly ceases, and you may watch for an hour without hearing it again. 'Is it a frog,' I said — 'the small tree-frog, the piper of the marshes — repeating his spring note but little changed amid the trees?' Doubtless it is, but I must see him in the very act. So I watched and waited, but to no purpose, till one day, while bee-hunting in the woods, I heard the sound proceeding from the leaves at my feet. Keeping entirely quiet, the little musician presently emerged, and lifting himself up on a small stick, his throat palpitated, and the plaintive note again came forth. 'The queerest frog that ever I saw,' said a youth who accompanied me and whom I had enlisted to help solve the mystery. No, it was no frog or toad at all, but the small red salamander commonly called lizard." [1]

The sound of the piccolo is very pleasing to these little creatures, and I have frequently collected about me as many as ten or a dozen by sounding this instrument in the still depths of a wood which I knew these salamanders frequented.

[1] Gibson, *Sharp Eyes*, pp. 105, 106; quotation.

Certain snakes are very susceptible to the charm of harmonious tonal vibration; witness the performance of the Hindu snake charmer, who, while handling that deadly poisonous creature, the cobra-de-capello, plays continuously on flageolets, fifes, or other musical instruments.[1] I, myself, have often held tree lizards completely entranced until grasped in my hand, by whistling shrilly and continuously.

I remember, on one occasion, when I was quite young, that a large black snake crawled through a ventilating hole in the wall of the "quarters" or row of brick cottages occupied by the negroes, and took shelter beneath the floor. It was seen by myself and some of my dusky playmates, who immediately carried the tidings to the negro gardener. He called one of the hands from the field, and, after placing him with a loaded shotgun at one side of the hole in the wall, took his station just behind him and commenced to play on his fiddle. In a few moments the snake came out, and was killed by the discharge of the gun in the hands of the other negro. I have been informed, time and again, by negroes that they could charm snakes from their holes with music, but the in-

[1] It has been claimed by some that the cobra is not influenced by the music, but by movements of the Hindu performer, who dances, salaams, etc., continually while giving exhibitions. Very recently, however, Mómsen has proven the contrary by actual experiment.

stance related above is the only one of the snake being led to its death by the bewitching power of musical sounds that has ever come under my immediate personal observation.

Before dismissing the subject of the influence of music on animals, I wish to call attention to the fact that Romanes declares that pigeons and parrots evince an æsthetic enjoyment of musical sounds.

"Moreover," writes he, "the pleasure which birds manifest in musical sounds is not always restricted to the sounds which they themselves produce."

Bingley quotes John Lockman, the celebrated composer, who declares that he once saw a pigeon which could distinguish a particular air. Lockman was visiting a Mr. Lee in Cheshire, whose daughter was a fine pianist, "and whenever she played the air of *Speri si* from Handel's opera of 'Admetus,' a pigeon would descend from an adjacent dovecot to the window of the room where she sat, 'and listen to the air apparently with the most pleasing emotions,' always returning to the dovecot immediately the air was finished. But it was only this one air that would induce the bird to behave in this way."[1]

A correspondent writes me that he has a cock which is passionately fond of the sound of the violin. This bird always flies to the window of

[1] Romanes, *Animal Intelligence*, p. 282; quoted by Bingley, *Animal Biography*, Vol. II. p. 220.

the music-room as soon as he hears the sound of the violin, where he will quietly remain perched as long as the music continues. As soon as the music ceases, he flies down from the window.

Horses very frequently show an appreciation for musical sounds, especially when they are produced by a band of brasses.

Amusement and pastime are, unquestionably, æsthetic psychical characteristics, hence, when we see evidences of these mental operations, we must acknowledge the presence of æstheticism in the animals in which they are to be noticed.

I propose to show that animals low in the scale of life — animals so low and so minute that it takes a very high-power lens to make them visible, have their pastimes and amusements. Also, that many insects and even the slothful snail are not so busily engaged in the struggle for existence that they cannot spare a few moments for play. In our researches in this field of animal intelligence we must not attribute the peculiar actions of the males in many species of animals when courting the females, to simple pastime, for they are the outward manifestations of sexual desire, and are not examples of psychical amusement. I have seen, in actinophorous rhizopods, certain actions, unconnected with sexual desire or the gratification of appetite, which lead me to believe that these minute microscopic organisms have their pastimes and moments of simple amusement. On several occasions while observing these creatures, I have seen them chasing one another around and around their miniature sea. They seemed to be engaged in a game of tag. This actinophrys is not very agile, but when excited by its play, it seems to be an entirely different creature, so lively does it become. These actions were not those of strife, for first one and then another would act the pursuer and the pursued. There were, generally, four or five actinophryans in the game.

One of the rotifers frequently acts as if engaged in play. On several occasions I have observed them perform a kind of dance, a *pas seul*, for each rotifer would be alone by itself. Their motions were up and down as if exercising with an invisible skipping-rope. They would keep up this play for several minutes and then resume feeding or quietly remain at rest. This rotifer goes through another performance which I also believe to be simply a pastime. Its tail is armed with a double hook or forceps. It attaches itself to a piece of alga or other substance by this forceps, and then moves its body up and down in the water for several minutes at a time.

The snail (*H. pomatia*) likewise has its moments of relaxation and amusement. The following instance of play may be considered to be gallantry by some, but I do not believe that I am mistaken, however, when I consider it an example of animal pastime. Two snails approached each other, and, when immediately opposite, began slowly to wave their heads from side to side. They then bowed several times in courtly salutation. This performance they kept up for quite a while and then moved away in different directions. At no time did they come in contact, and careful observation failed to reveal any excitement in the genitalia. I have witnessed the embraces of snails, and the performance described above does not resemble, in the slightest degree, the manœuvres executed at such times by mating individuals.

Swarms of Diptera may be seen on any bright day dancing in the sunlight. Naturalists have heretofore considered this swarming to be a mating of the two sexes. This is not the case, however, in many instances. On numerous occasions, and at different seasons of the year, I have captured dozens of these insects in my net and have examined them microscopically. I found them all to be unimpregnated females; I have never yet discovered a male among them. In some of the Diptera the males emerge from the pupa state after the females; I therefore believe that the females await the presence of the males, and, while waiting, pass the time away in aërial gambols.

Forel, Lubbock, Kirby, Spence, and other naturalists have declared that ants, on certain occasions, indulge in pastimes and amusements. Huber says that he saw a colony of *pratensis*, one fine day, "assembled on the surface of their nest, and behaving in a way that he could only explain as simulating festival sports or other games."[1] On the 27th of September last, the males and females of a colony of *Lasius flavus* emerged from their nest; I saw these young kings and queens congregate about the entrance of the nest and engage in playful antics until driven away by the workers. The workers would nip their legs with their mandibles until the royal offspring were forced to fly in order to escape being bitten. The inciting cause of these movements may have been sexual in character, but I hardly think so.

On the 19th of July, 1894, I saw several *Lasius niger* come out of their nest accompanied by a minute beetle (*Claviger foveolatus*); the ants caressed and played with this little insect for some time, and then conducted it back into the nest.[2]

Many such little animals are kept by the ants as pets. Lubbock says of one of them, a species allied to *Podura*, and for which he proposes the name *Beckia*, "It is an active, bustling, little being, and I have kept hundreds, I may say thousands,

[1] Büchner, *Geistesleben der Thiere*, p. 163; quoted also by Romanes, *loc. cit. ante*, pp. 87, 88.

[2] On one occasion several years ago, I saw a number of young ants of *L. niger* brought out of the nest by five or six old ants, which watched over the young and kept them from straying away. The young ants played about the nest entrance for some time, and were then conducted back into the hive by the old ants. — W.

in my nests. They run in and out among the ants, keeping their antennæ in a perpetual state of vibration."[1] I have frequently noticed an insect belonging to the same genus as the above in the nests of *F. fusca* and *F. rufescens*. They reminded me very much of the important-looking little dogs one sees running about in the crowd on election day.

The females of *Coccinellæ* ("lady-bugs") frequently congregate and indulge in performances that cannot be anything else save pastimes. A beech tree in my yard is called "lady-bug tree" because, year after year, these insects collect there and hold their curious conventions. They caress one another with their antennæ, and gently "shoulder" one another from side to side. Sometimes several will get their heads together, and seem by their actions to be holding a confidential conversation.

These conventions always take place after oviposition, and careful and repeated observation has shown me that they are not connected with procreation or alimentation. I have witnessed many other instances of true psychical amusement in the lower animals, but do not think it is necessary to detail them here. Suffice it to say that I believe that almost every living creature, at some period of its existence, has its moments of relaxation from the cares of life, when it enjoys the gratification of amusement.

[1] Lubbock, *Ants, Bees, and Wasps*, p. 74.

Some birds evince æsthetic taste, notably in the building of their nests, which they ornament and decorate in a manner very pleasing to the eye.

The snakeskin bird gets its name from its habit of using the cast-off skins of snakes for decorative purposes. Not long ago I found a nest in a small wood, not far from the town in which I live, which was beautifully ornamented with the exuviated skin of a black snake (*Bascanion constrictor*). This skin must have been at least five feet in length, and the little artists had woven it into the walls of their nest in such a manner that its translucent, glittering scales contrasted very beautifully with the darker materials of their home.

Humming-birds use bits of lichen and moss to decorate their tiny nests. These materials serve a twofold purpose: they not only render the nest beautiful, but they also serve to protect it by making it resemble the limb on which it is placed. It takes a very acute and discriminating eye, indeed, to locate a humming-bird's nest.

Probably of all the lower animals, the male satin or bower bird of New South Wales has the decorative feeling the most developed. This bird builds a pleasure resort, a summer-house, or, rather, dance hall, which he ornaments profusely with every glittering, shining, striking object that he can carry to his bower in the depths of the forest. This bower is built of twigs, and, when completed, is an oblong, sugar-loaf-like structure, open at both ends. The bird decorates his dancing hall (for he comes here to perform love-dances during the courting season) with bright-colored rags, shells, pebbles, bones, etc.

I once saw a pair of bower birds in captivity (they were owned by Mr. George Hahn of St. Louis), which constructed the dance hall from materials furnished by their owner.

The love of personal cleanliness is, probably, the root and beginning of much that is æsthetic among the lower animals.

When quite a small lad, one of the first lessons set down in my copy-book, after I had graduated in "pot-hooks and hangers," was the trite old saw, "Cleanliness is next to godliness." My Yankee governess, a tall, angular spinster, from Maine, made the meaning of this copy clear to my infant mind, pointing her remarks by calling attention to the Kentucky real estate which had found a resting-place beneath my finger-nails, and which seemed to decorate them with perpetual badges of mourning. I have never forgotten that lesson and firmly believe in its truth.

The love of cleanliness seems to be inherent in the lower animals, with but few exceptions. We have all noticed the cat, the dog, the squirrel, the monkey, and the birds at toilet-making; and we know that they spend a large portion of their time in cleansing and beautifying their bodies. Some of them are dependent on their own ministrations, while others are greatly assisted by humble little servants, whose only remuneration is domicile, the cast-off clothing, or the garbage and refuse from their host's table.

For instance, the common domestic fowl is greatly assisted in its toilet by certain little animals belonging to the family *Liothe*. These little creatures carefully scrape away and eat the scarf-skin, and other epidermal débris that would otherwise impair the health of their hosts.[1] Some of the fish family are entirely dependent on the ministrations of mutualists, as these little hygienic servitors are called, in matters of the toilet. Notably, the gilt catfish, which would undoubtedly die if deprived of its mutualist, the *Gyropeltes*. This remarkable little creature does not live on the body of its host, but swims free in the water, and only seeks him when it is hungry. The skin of the gilt catfish secretes a thick, glairy, mucous exudate, which, if left to itself, would imperil the health of the fish. The Gyropeltes, however, regards this exudate as delicious food and rapidly removes and devours it.

All insects devote some of their time to the toilet, and there is probably no one who has not, at some time or other, noticed the fly, or some other insect, thus engaged. The greatest lover of bodily cleanliness in the whole insect tribe,

[1] Van Beneden, *Animal Parasites and Messmates*, pp. 71, 72.

however, is, I believe, my pet locust, "Whiskers" — so named by a little niece, on account of her long, graceful antennæ. "Whiskers" is one of the smallest of her family, and is a dainty, lovely, agile little creature, light olive-green in color, with red legs. She was reared from the egg, and has lived in my room all her short life. She is quite tame and recognizes me as soon as I approach, often hopping two feet or more in order to light on my coat-sleeve or outstretched hand.[1]

The first thing she does, after reaching my hand, is to seek my little finger and try her jaws on a diamond ring. The diamond seems to puzzle her greatly. She sometimes spends several minutes closely examining it. She will stand off at a little distance and pass her antennæ over every portion of it. Then she will come closer and make a more minute examination, finally essaying another bite with her powerful jaws. A great water drinker, she evidently thinks the stone is some strange kind of dewdrop, hence her persistent efforts to bite it.

"Whiskers" has developed cannibalistic tastes, for the hardened skin around my finger-nails is a favorite *morceau* which she digs out with her sharp jaws and masticates with seeming delight. She

[1] Shortly after the above was written, this interesting little creature met an untimely fate at the hands of an Irish chambermaid, who was a recent importation and who did not understand that all life was held sacred in my house. — W.

nips out a piece of skin, cocks her head on one side, and, looking up at me with her clear, emerald-tinted eyes, her masticatory apparatus working like a grist-mill, she seems to say, "Well! old fellow, this is good."

She passes most of her time on a bit of turf, in a box on my table, where the sun shines bright and warm. She is fond of water, however, and makes frequent excursions to the water-pitcher across the room. How she discovered that it contained water is more than I can tell; but she did, and she visits it often.

It is in her habits of bodily cleanliness, however, that "Whiskers" outshines all other insects. I have watched her at early dawn and have always found her at her toilet. This is her first undertaking, even before taking a bite to eat. She makes frequent toilets during the day, and it is her last occupation at night before sinking to rest on a blade of grass. Her method of procedure is very interesting. She commences by first carefully cleansing her antennæ, drawing each of them through her mouth repeatedly. Then she treats her fore-legs to a thorough scrubbing, going over every portion with her tongue and jaws. With her fore-legs, using them as hands, she then cleans her head and shoulders, if I may use the latter term. Her middle legs and her long "vaulters" are then subjected to the same careful treatment. Her back and the posterior portion of her abdomen are next rubbed down, she using the last pair of legs for this purpose. Finally, standing erect and incurvating her abdomen between her legs, she cleans it and her ovipositor with her jaws and tongue. Her toilet is made twenty or thirty times a day. Invariably, after one of her excursions to the water-pitcher, as soon as she returns to her box this is her first occupation.

Now, having seen that the lower animals possess æsthetic feeling, it is reasonable to suppose that some of them possess some of the acquired higher emotions, such, for instance, as parental affection. The evidence seems to indicate that some of the lower animals do evince such affection, as I will now endeavor to point out.

CHAPTER VI

PARENTAL AFFECTION

It has been claimed that one of the main objections to the doctrine of kinship, which, undoubtedly, exists between all animals, is the wide difference that is to be noted between the solicitude that animals evince for their young, and the tender love of the human mother and father for their children. This difference is more apparent than real; for the ethical love, the refined affection of civilized human parents for their offspring, is but a psychical culmination of the material and matter-of-fact solicitude of the lower animals for the preservation of their kind.

There is a vast difference between the psychical habitudes of a civilized mother and those of an Aleutian squaw or a Niam-niam "pot-boiler": the love of a civilized mother for her child extends throughout its life and even beyond the grave, while the solicitude of her savage sisters (I use the word in its maternal sense) for their offspring ceases as soon as the infant toddler is "tall enough to look into the pot." The latter emotion is closely akin to the maternal solicitude of the higher and lower animals, while the former in its refined ethical excellence shows that it is the result of unnumbered thousands of years of evolutionary growth and development.

The love of kind-preservation is inherent in all animals; it ranks next in psychical strength to self-preservation, and, in some instances, even surpasses this so-called "first law of nature." For it very frequently happens that the mother, both brute and human (and I use the word *brute* as the antithesis of the word *human*, and mean it to embrace all creatures other than man), will lay down her life in defence of her young, seemingly, utterly forgetting this "first law" in her aim to save her offspring from destruction. Thus the spider whose egg-bag I had taken away ran here and there and everywhere in search of it, seemingly totally oblivious of my presence. When I extended it to her, clasped between the blades of a small forceps, she seized it with her mandibles and vainly tried to take it away. When she discovered that this was impossible, she turned with fury on the forceps' blades and bit and tore at them in a perfect frenzy of despairing agony. I removed two of her front legs, yet, even when thus maimed and suffering, she never for an instant forgot her beloved bag in whose silken meshes so many of her young lay hidden. She continued her efforts to drag the bag away, and was so persistent and showed such high courage, that my calloused sensibilities, hardened by much biological research, were touched, and I gave her her treasure, which she bore away in triumph.[1]

I, on one occasion, severed an earwig at the injunction of the thorax and abdomen; the upper portion (the head and thorax) gathered together its brood of young and safely conducted them into a haven of safety beneath the bark of a tree.

In crustaceans we probably find the first unmistakable evidences of maternal love. The female crayfish, with the under surface of her tail covered with impregnated eggs or newly hatched young, will fight to the death in their behalf. I have, time and again, reared crayfish, and have succeeded in taming them to such a degree that they would take food from my fingers; whenever the females of these crustaceans became mothers, however, they became timid and suspicious and would seek out the darkest spots in the tanks where they were kept. If I attempted to handle them they would nip me with their sharp mandibles at the first opportunity that offered; they would allow no interference with their precious offspring if they could possibly prevent it. This is true of the lobster also. This giant crustacean, with her enormous forceps-like claws, generally wages a winning fight with the would-be ravishers of her young.

I once owned a monkey which was exceedingly fond of shell-fish. On one occasion I gave him a

[1] Vide Chap. IV., *The Emotions*, p. 105.

gravid lobster and came very near losing him thereby. Usually he seized the lobster or crayfish by its back and then broke off its forceps; he would then proceed to .suck out its juices and extract its meat. On this occasion, however, the lobster was rendered bold and pugnacious by her burden of young, and managed in some way to close her forceps on one of the monkey's thumbs. He squalled out, and hammered the lobster on the bars of his cage in a vain endeavor to rid himself of his painful encumbrance. I finally loosened her grasp, but not until the flesh on the thumb had been cut to the bone. The wounded hand became inflamed, erysipelas set in, and the poor animal became very sick indeed. He eventually recovered, and ever afterward was exceedingly careful how he handled shell-fish. He approached them with caution, keeping a watchful eye on the dangerous forceps, until, by a quick and sudden dart of his hand, he could seize and tear them off.

It is a mistaken, though quite generally accepted, conclusion that wasps never behold their young, hence can readily be instanced, along with the butterfly and some other insects, as being creatures that evince solicitude for offspring which they never behold. I am quite confident that in the tropics certain of the butterflies live to see their young, for, on one occasion, Dr. Filipe Miranda told me that he was absolutely certain that many of the *Papilioninæ* and *Euplocinæ* of the

Amazon valley lived at least a year and a half. I have kept alive in my room specimens of *Heliconidæ* for six and eight months, while mud-dauber wasps have repeatedly wintered in my room, and have witnessed the outcomings of spring broods. Thus, it not infrequently happens that these insect mothers are gratified by a sight of their offspring, though sometimes they evince painstaking care and solicitude toward creatures which they will never see.

The pond catfish, so common to the ponds and creeks of the middle and southern states, evinces maternal solicitude in a very marked degree. I have frequently seen a school of newly hatched catfish under the guardianship of an anxious and solicitous mother. She would swim around and about her frisky and unruly herd, carefully pressing forward all loiterers and bringing back into the school all stragglers. If a stick were thrown among the little fishes, she would dart toward it, and, seizing it in her mouth, would bear it fiercely away, and would not loose her hold of it until she had borne it some distance from her brood of young ones. Bass, white perch, and goggle-eye carefully guard their eggs and drive away all intruders; they likewise keep watchful eyes on the young for several days after they have been hatched. During such times these fish can be easily taken, for they will seize anything that comes near their nests.

Baker says of the stickleback, that when the fry made their appearance from the eggs, "Around, across, and in every direction the male fish, as the guardian, continually moved." There were three other fish in the aquarium, two tench and a gold carp. As soon as these fish saw the fry, they endeavored to devour them, but were driven off by the brave little father, which seized their fins and struck with all his might at their eyes and heads.[1]

"The well-known habit of the lophobranchiate fish, of incubating their eggs in their pouches, also displays highly elaborated parental feeling. M. Risso says when the young of the pipe-fish are hatched out, the parents show them marked attachment, and that the pouch then serves them as a place of shelter or retreat from danger."[2]

An experimenter, whose name escapes me, on one occasion caught a number of recently hatched catfish and placed them in a glass jar, close to the water's edge. The mother fish soon discovered the presence of her young ones and swam to and fro in front of the jar, evidently much harassed and worried. She eventually came out on dry land and attempted to get into the jar where her young were imprisoned. Truly, a wonderful example or

[1] Baker, *Philosophical Trans.;* quoted also by Romanes, *loc. cit. ante*, p. 245.

[2] Baker, *Philosophical Trans.;* quoted also by Romanes, p. 246; and Yarrell, *Brit. Fishes*, 2d ed., Vol. II. p. 436.

instance of mother love when self was entirely forgotten in solicitude for the offspring!

The Surinam toad hatches her eggs and then carries her young about with her on her back until they are old enough to shift for themselves; the "horned toad" of the southwestern states and Mexico acts in a similar manner toward its young.

I had been informed that snakes evinced parental love for their offspring, but never until a recent spring had I been able to verify this information and give it my unqualified endorsement. In March (1896), on one of the bright warm days of that phenomenal month, one of my dogs attracted my attention by his manœuvres on my lawn. I noticed him walking "stiff legged" about a circumscribed spot, now and then darting his muzzle towards the ground. On going to him I discovered that he had found a lot of snakes, which, influenced by the summer-like weather, had abandoned their den and had crawled out and were enjoying a sun-bath. These snakes were knotted together in a ball or roll, but I quickly discovered that they were all yearlings save one — the mother. I resolved then and there to test the maternal affection of the mother snake for her young, so I killed two of them and dragged their bodies through the grass to the paved walk which ran within a short distance of the nest. The old snake and the remainder of her brood took shelter in the den; I then retired to a little distance and awaited developments. In a very short time the mother emerged from the nest, and, after casting about for a moment or so, struck the trail of the young ones which had been dragged through the grass, and followed it to the dead bodies lying on the pavement. Here she met her fate at the hands of my iceman (whom I had called to witness the great sagacity of this lowly creature), for he had killed her ere I could prevent him.

On one occasion I saw a copperhead (*Ancistrodon contortrix*) in the midst of her young, and they seemed to be subservient to her beck and call. Before, however, I could satisfy myself positively that the old snake really held supervision over her brood, the gentleman with whom I happened to be came upon the scene, whereupon the interesting family disappeared beneath the undergrowth of the forest.

The higher animals sometimes show, unmistakably, that the maternal love of offspring has taken a step upwards, and that it has become, in a measure, refined by the addition of an æsthetic, if not ethical, element. For instance, a dog acquaintance of mine, on the advent of her first puppies seemed to be exceedingly proud of them; she not only brought them, one by one, to her mistress for admiration, but she also brought them in to show to her master, and yet again, to myself, who happened to be visiting her owner at the time. She deposited them, one by one, at the feet of the person whose regard she solicited, and, after they had been admired, she returned them to the kennel. Here, in my opinion, was an instance of pride, which has its prototype or exemplar in the pride of the young human mother who thinks that her baby is the handsomest child that was ever born! The dog's actions cannot be translated or interpreted otherwise. Again (and in this instance, strange to relate, the proud parent was the male), a cat brought his offspring, one by one, from the basement to my room, two stories above, in order to exhibit them! He brought them, one at a time, and, after each had been admired, carried them back to their box in the basement. Loud were his purs and extravagant were the curl of his tail and the arch of his back! No father of the genus Homo could more plainly evince his pride in his baby than did this cat in his kittens. The mother cat came with him on his first trip; she evidently did not quite comprehend, at first, the intentions of her spouse. She soon found out, however, that he meant no harm to her young, so she allowed him to work off his superabundance of pride without let or hindrance.

Birds will defend their young to their uttermost abilities and will often yield up their lives in unequal combats with the ravagers of their nests. Last summer I saw two jays whip in a fair fight a large cat, which had attempted to rob their nest. They seemed to have arranged the order of combat with one another before they attacked the would-be ravisher of their home. The male bird confined his attack to the cat's head, while the female went at its body with beak and talons. The song-sparrow which remembered the boy who killed the snake which was about to devour its young, and whose story I have told elsewhere, undoubtedly cherished and loved its young. The gratitude which could change the timid, wild nature of a bird in such a manner must have had its origin in a feeling, the depths of which can only be equalled in the psychical habitudes of the most refined of human beings! As we ascend higher in the scale of animal life, we find that new and refining elements are added to this love for the preservation of kind, until finally, in the civilized human being, it has lost its strictly material function and has become wholly and entirely ethical and æsthetic. Yet, far back in the beginning, the maternal love or parental love of the civilized human being was, fundamentally, based on no higher emotion than that engendered by an inherent love for kind-preservation.

Animals very frequently turn to man when they find themselves in difficulties and need assistance. The following instance of maternal love and trust in man in a horse was related to me not long ago, by a farmer[1] in whose probity and truthfulness I have implicit confidence. The horse in question,

[1] Mr. Hamilton Alexander, Owensboro, Kentucky.

a mare, had been placed in a field some distance from the house, in which there was no other stock. The animal was totally blind, and, being in foal, it was thought best to place her there in order to avoid accidental injury to the colt when it was born. One night this gentleman was awakened by a pounding on his front porch and a continuous and prolonged neighing. He hastily dressed himself, and, on going out, discovered this blind mare, which had jumped the low fence surrounding the front yard, and which was pawing the porch with her front feet and neighing loudly. She whinnied her delight as soon as she heard him, and at once jumped the fence as soon as she ascertained its locality. She then proceeded toward the field, stopping every now and then to ascertain if he were following, and, when they arrived at the field, the horse jumped the fence (a low, rail structure), and proceeded toward a deep ditch which extended across one corner of the lot. When she came to the ditch or gully she stopped and neighed once or twice. The farmer soon discovered the trouble; the colt had been born that night, and, in staggering about, it had accidentally fallen into the ditch. He got down into the gully and extricated the little creature, much to the delight of its loving mother, which testified her joy and thankfulness by many a grateful and heartfelt whinny.

As I have indicated in the first part of the chapter, parental affection is an acquired emotion which has reached its acme in the civilized human being; yet the germs of this highly developed psychical manifestation are to be observed in creatures low in the scale of animal life. As *psychos* develops, we observe that this emotion becomes purer and more refined, until, in some of the higher animals, such as the monkey and the dog, it can hardly be distinguished from the parental affection of certain savages, who leave their children to shift for themselves as soon as they are "tall enough to look into the pot"; or, until, as Reclus declares of Apache babies, "they can pluck certain fruit by themselves, and have caught a rat by their own unaided efforts. After this exploit they go and come as they list."[1]

We have seen in previous chapters that the lower animals possess one or all of the five senses, — sight, smell, taste, hearing, and touch, — that they evince conscious determination; that they possess memory and clearly indicate that the emotions, in the majority of them at least, are highly developed; that they likewise give evidence of æstheticism both inherited and acquired; and, finally, that they show, unmistakably, that they have acquired, to a certain extent, that most refined of all acquired feeling — parental affection. Now, taking these facts into consideration, it would

[1] Reclus, *Primitive Folk*, p. 131.

be reasonable to suppose that creatures so highly endowed psychically would present evidences of ratiocination.

That many of the lower animals do present such evidences is a fact beyond dispute, as I will endeavor to show in the following chapter.

CHAPTER VII

REASON

THE simplest and truest definition of reason is, I take it, the intelligent correlation of ideation and action for definite purposes not instinctive. The casual observer and a very large majority of the creationists deny the presence of reason in the lower animals, and group all psychical manifestations that are to be observed in animals lower than man under the head of instinct, forgetting that almost every instinctive habit must have been, in the beginning, necessarily the result of conscious determination.

Instinct is, in a certain sense, a process of ratiocination, though its immediate operations may not be due to reason. Instinct involves mental operations; if it did not, it would be simply reflex action. It is heredity under a special name; the father transmits his mental peculiarities as well as his corporeal individualities to his offspring. The experiences of thousands of years leave their imprint on the succeeding generations, until deductions and conclusions drawn from these experiences no longer require any special act of reason in order to bring about certain results. These results, which were, at first, the outcome of special acts of ratiocination, or accidental happenings leading to the good of the creature or creatures in which they occurred, finally became habitual and instinctive.

These special acts of ratiocination are of daily, of hourly, occurrence in the lives of countless myriads of the lower animals, and escape our observation because of the obtuseness of our senses. Every now and then, however, the observer is able to chronicle such an act of reason, and thus adduce the proposition that if the creature or creatures were continually placed in surroundings requiring a like act of reason, that act would eventually become habitual and instinctive on the part of that creature or those creatures. I have witnessed hundreds of acts of intelligent ratiocination in the lower animals that were not called forth by experience and which had not a single faculty of heredity. For instance, several years ago I noticed that one of the combs in a beehive, owing to the extreme heat, had become melted at the top and was in great danger of falling to the floor. The bees had noticed this impending calamity long before I had, and had already set about averting it. They rapidly threw out a buttress or supporting pillar from the comb next to the one in danger, and joined it firmly to it, thus shoring it up and preventing its fall in a most effectual manner. When they had made everything strong and secure, they went to the top of the comb and reattached it to the ceiling of the hive. After this had been done to their satisfaction, they removed the shoring pillar and used the wax elsewhere. In this instance, there was an immediate adaptation of themselves to surrounding circumstances, in which they averted and prevented an utterly unforeseen and unheard-of catastrophe by means as effectual as they were intelligent. Could man do more or reason better? Here was an experience which had not happened to them in hundreds and hundreds of generations, perhaps; which, perhaps, had never happened to them before, and yet, when it did happen, their quick intelligence readily grasped the situation, and they at once set about remedying the evil.[1]

A mud-dauber wasp built a nest in my room, and used an open ventilating window as an entrance and exit. On one occasion this window happened to be closed, and the wasp, not noticing the clear glass, flew against it with great violence. She fell to the floor stunned, but when she had recovered from the effects of the blow, she flew here and there about the room as if looking for another exit. Finally, she discovered a small crevice in the casing, through which she at once crawled. She then went back and forth through this crack until she had become thoroughly familiar with the

[1] Compare Huber, Vol. II. p. 280; see also Chap. IV. of this work.

new road. She never again essayed the window, though it was left open the entire summer.

In this instance the wasp was taught by a single experience to seek out a new road. This experience was wholly new to her, consequently, she must have used correlative ideation for definite purposes in formulating her method of procedure. Although ants, bees, and wasps have highly developed memories, and seem to be likewise in possession of that peculiar function of the mind called by some psychologists "unconscious memory," through which they are, probably, enabled to transmit impressions of comparatively recent experiences to their offspring, I hardly think that the mud-dauber was influenced in her actions by any such inherited instinct. Such a conclusion seems to be unwarranted by the facts in the case. Mud-daubers may have bumped their heads against windows ever since windows came into existence, but not with sufficient frequency to cause them to possess an instinct that taught them to avoid windows.

Again, the ground wasp, whose hole between the bricks of a pavement I stopped with a wad of paper, and which learned to go down into the sulcus between the bricks and to pull the paper in the direction of its long axis in order to remove the obstruction, must have used correlative ideation in order to grasp the problem that was set her to solve.

From certain observation I am inclined to believe that psychical traits which are the result of thousands of years of experience before they become part and parcel of the human *psychos* may become psychic actualities in ants, bees, and wasps in the course of a few generations. The facility with which these creatures adapt themselves to new environments — in which their very organisms, physical and psychical, are changed to a certain extent — is abundant proof of the truth of this conclusion. All experiments with the Hymenoptera amid changed surroundings indicate an intelligent adaptation of themselves to such environment.

The ant is the only animal, except man, which has slaves and domestic animals. Their intelligence is so highly developed that they make a perfect success in rearing their cattle and capturing their slaves. The cattle of the ants are of the order *Aphididæ*. The herdsmen of these aphidian cattle can be seen patrolling the shrubs on which the aphides are grazing. On them devolves the care of the herds. They bring them out in the morning and carry them back at night. They gather the eggs of the aphides, carry them into a specially built nursery, attend them carefully until the young aphides are hatched out, and then carry them to the shrubs most liked by them for food. Some strange sense enables them to recognize one another — an ant of the same species, but coming from another nest, is immediately recognized as a stranger, and at once attacked. If the eggs of one ant colony are hatched out in another of the same species, the young ants are at once known to be strangers and intruders. This far transcends our intelligence. What mother could recognize her infant if it were born in the dark and she had never seen it? Again, if the larvæ of ants are removed, hatched outside of the nest, and then returned, the ants at once recognize them as kinsmen and receive them into the nest.

When we take into the consideration that an ant's brain has gray matter analogous to the gray matter found in the cortex of the human brain, we should not feel surprised when we find striking evidences of ratiocination in these little creatures. The better creatures are able to communicate ideation or thought, the stronger and more frequent are the evidences of their possession of reason. Ants can undoubtedly communicate; how and in what manner, it is not generally agreed.

Some time ago I crushed an ant in a path usually taken by the inhabitants of a nest (which was situated in a hollow tree) in their journeys to and fro. A soldier ant came along presently, and, smelling the blood[1] of her murdered compan-

[1] In order to avoid technicalities I think it best to use synonyms with which the general student is familiar. The non-technical reader will know at once what is meant by the "blood" of the ant. — W.

ion, was seized by a sudden terror and fled away into the nest. She soon returned, however, with thirteen other soldier ants, and made a careful examination of the body and its surroundings. Her companions also examined the corpse, and, having satisfied themselves that their comrade was dead, and that her murderer was not to be found, returned to the nest. Soon afterwards a large worker ant, guarded by two soldier ants, came out, and, proceeding to the body, picked it up, carried it down the tree and away beneath the grass, where I lost sight of them.

In this instance there is every evidence of complex reasoning; the discoverer of the murder hurried away into the nest, where she gave the alarm; the police of the community — the soldier ants — went immediately to the scene of the tragedy, made an examination, and then returned and gave in their report; the undertaker, in the shape of the large worker ant, then went out, got the body, carried it away and buried it; the two soldier ants followed the body to the grave in order to protect it from cannibal ants.

It has been my good fortune to have witnessed several pitched battles between large bodies of ants. In a battle between some black ants and some yellow antagonists of another species, I saw many evidences of intelligent communication. The yellow ants had a commissariat and an ambulance corps; and I frequently saw them drop to the rear during the battle, and partake of refreshments or have their wounds attended to. The blacks, which composed the attacking army, were in light marching order, and had neither of these conveniences and necessary adjuncts. The yellow ants frequently sent back to their village for reënforcements; the ants that had been out on hunting expeditions when the battle was joined were notified as soon as they arrived at the nest, and immediately hurried off to join in the fray. The blacks had discovered a herd of aphides belonging to the yellows, and had sought to surprise the guards and steal the herd; hence the battle. I am glad to report that the black horde was defeated by the brave yellow warriors and had to decamp, leaving many of its number dead upon the field of battle.

On another occasion I saw an army of red ants besieging a colony of small black ants. The object of the red ants was the theft of the pupæ or young of the black ants. These pupæ they take to their own nest and rear as slaves, the enslaved ants to all appearances becoming entirely satisfied with their condition, and working for their masters willingly and without demur. The besieged ants evinced a high degree of reason and forethought, for, as soon as the presence of the besiegers was noticed, strong guards were posted in all of the approaches to the nest, both front and rear. The red ants sent a detachment to surprise the colony from the rear; but they found that surprise was impossible, for they were met by a strong party of their gallant foes which vigorously opposed them. The red ants were, however, eventually victorious, and sacked the town, carrying away with them a large number of pupæ.

I cheerfully bear witness to the fact that the great myrmecologist, Huber, was correct in his description of his experiment with the black slave.[1]

Like Huber, I put some of these red slave-owners into a glass jar in which I placed an abundance of food. Notwithstanding the fact that this food was easy of access, being in fact immediately beneath their jaws, they would not touch it! I then placed a black slave in the jar; she at once went to her masters, and, after thoroughly cleansing them with her tongue, gave them food. These red ants would have starved to death in the midst of plenty, if they had been left to themselves.

This, at first glance, would seem to indicate an utter absence of reason in these red slave-owners. Such a conclusion, however, is by no means true. The facts indicate mental degeneration. So

[1] Huber, *The Natural History of Ants*, p. 249; quoted also by Lubbock, *Ants, Bees, and Wasps*, p. 83; Romanes, *Animal Intelligence*, p. 65; Kirby and Spence, *Entomology*, p. 369 *et seq.*

Our species of blacks and reds differ but very little in form and habits from their European kin; so the experiment may be easily performed by any one at all interested in this remarkable instance of "slave master, and master slave." — W.

utterly subservient had they become to the ministration of the slaves, that they had even lost the faculty of feeding themselves!

Here, we have an example of degeneration in the mentality of an animal incident to the enervating influence of slavery. Sir John Lubbock's remarks anent the four genera of slave-making ants are so interesting that I may be pardoned for quoting them entire. Says he: —

"These four genera" (*Formica sanguinea, Polyergus, Strongylognathus, and Anergates*) "offer us every gradation from lawless violence to contemptible parasitism.

"*Formica sanguinea,* which may be assumed to have comparatively recently taken to slave-making, has not yet been materially affected.

"*Polyergus,* on the contrary, already illustrates the lowering tendency of slavery. They have lost their knowledge of art, their natural affection for their young, and even the instinct of feeding. They are, however, bold and powerful marauders.

"In *Strongylognathus* the enervating influence of slavery has gone further, and told even on the bodily strength. They are no longer able to capture their slaves in open warfare. Still they retain a semblance of authority, and, when aroused, will fight bravely, though in vain.

"In *Anergates,* finally, we come to the last scene of this sad history. We may safely conclude that in distant times their ancestors lived, as so many ants do now, partly by hunting, partly on honey; that by degrees they became bold marauders, and gradually took to keeping slaves; that for a time they maintained their strength and agility, though losing by degrees their real independence, their arts, and many of their instincts; that gradually even their bodily force dwindled away under the enervating influence to which they had subjected themselves, until they sank to their present degraded condition — weak in body and mind, few in numbers and apparently nearly extinct, the miserable representatives of far superior ancestors, maintaining a precarious existence as contemptible parasites of their former slaves."[1]

This is truly a wonderful picture of mental and physical degeneration incident to the enervating influences of slavery. That it is a true one, an abundance of data most emphatically declares. The influence of slavery on the human race (the masters) shows very plainly that man himself quickly, comparatively speaking, loses his stamina when subjected to it.

This fact is but another proof of the kinship of all animals, and the similarity, nay, the sameness, of mind in man and the lower animals; mind is the same in kind, though differing in degree.

When an animal is placed amid new and unfamiliar surroundings necessitating the evolvement of intelligent action in order to meet the necessities

[1] Lubbock, *Ants, Bees, and Wasps*, pp. 88, 89.

of such environment, such an animal evinces ratiocination. I have seen many instances of such action on the part of ants. The following data concerning the natural history of the honey-making ant (*Myrmecocystus mexicanus*) are taken from my note-book.

During the summer of 1887 I spent several weeks in New Mexico, and while there had the great good fortune to discover a colony of honey-making ants. I found these ants in a little valley debouching out of Huerfanos Park, a government reservation, I believe, at that time. The nest was situated on the sandy shore of a small creek, and was a perfect square of three or four feet, from which all grass, weeds, etc., had been carefully removed. Around three sides of this square, viz., north, east, and west, a column of black soldier ants continually patrolled night and day.

Near the southeast corner of this open space the entrance to the nest was situated. The south side of the square was not guarded, but was left open for the entrance and exit of the hundreds of dark yellow workers which were engaged in bringing food to the village. No sooner was a burden put down than it was seized by black workers, which then carried it into the nest. At no time did I see a black worker bringing food to the centre of the square, nor did I ever see a yellow worker carrying food into the nest; the blacks and the yellows never interfered with one another's business.

To test the reasoning powers of these ants, I partially disabled a centipede and threw it into the square a short distance from the patrol line. For a moment or two the line was broken by the warriors hurrying out to do battle with the squirming intruder. But only for a moment or two, for orders were issued by some ant in authority (so it seemed, and so I believe), and the line was established, though somewhat thinned by the absence of soldiers. The messenger was sent to headquarters and reënforcements were sent out, and soon the line was as strong as ever, though hundreds of soldiers were warring with the centipede. The latter was soon killed, and its body was removed piecemeal by the yellow workers, which carried the fragments far beyond the boundaries of the square.

Again, with my hunting-knife I dug a deep trench across the border of one side of the square. The ants seemed dazed at first, but rapidly adapted themselves to their new surroundings. They extended their patrol line until it embraced the entire trench; then a countless horde of yellow workers went to work, and in a day's time filled up the deep excavation level with the surrounding surface! The patrol was then reëstablished on the old line as though nothing had occurred to interrupt the ordinary routine of the colony. Before leaving the valley I dug up the nest and examined the peculiar individuals whose enforced habits give to these interesting ants the name of "honey-makers." Each one of these curious creatures was confined in a separate cell, the entrance to which was very small. Here they lived in absolute seclusion, being fed by the black workers with pollen, the nectar of flowers, tender herbs, etc.

Through some wonderful chemical process this food was turned into a delicious honey, the flavor of which (I ate of it freely) was distinctly winy and aromatic.

Apparently, they had no anal orifices, these passages probably having been obliterated. These imprisoned honey-makers were merely animated bags of honey, and were kept by the other ants solely for the purpose of furnishing a never failing supply of sweet and wholesome food.[1]

The rapidity with which these ants set to work to fill in the trench made by my hunting-knife showed that they recognized, at once, the calamity

[1] Compare Romanes, *Animal Intelligence*, p. 111 *et seq.* At the time when these details were written in my note-book I was unacquainted with Captain Fleeson's and Mr. Edwards's observations, nor had I read Romanes's work on *Animal Intelligence*. I had heard of *Myrmecocystus*, of course, but knew nothing of its natural history. Comparison will show that my observations differ from those of the gentlemen mentioned above. I saw nothing whatever of the web described by Captain Fleeson: the honey-making *solitaires* were simply confined in cells, where they rested on the bare ground; they were not perched upon "a network of squares, like a spider's web." The "outside" workers observed by me were not black, but very dark yellow, while the "inside" workers were bright yellow in color. — W.

that had befallen them, and that they used rational methods in remedying the evil.

The fact that they have evolved the idea of setting aside certain members of the colony as honey-makers, and that there is a distinct recognition of a division, or divisions, in the labor of the inhabitants of the nest, evinces very high psychical development.

In a colony of *Termes*, or white ants, so-called, there are five kinds of individuals. *First*, the workers. These do all the work of the nest, collecting provisions, waiting on the queen, carrying eggs to the nurseries, feeding the young until they are old enough to care for themselves, repairing and erecting buildings, etc. *Second*, the nymphs. These differ in nothing from the workers, except that they have rudimentary wings. *Third*, the neuters. These are much less in numbers than the workers, but exceed them greatly in bulk. They have long and very large heads, armed with powerful mandibles, and are the sentinels and soldiers of the colony. These neuters are blind. *Fourth* and *Fifth*, the males and females. These are the perfect insects, capable of continuing the species. There is only one each in every separate society. They are exempted from all labor, and are the common father and mother of the community.

Termes inhabit tropical countries, and the first establishment of new colonies takes place in this way: In the evening, at the end of the dry season, the males and females, having arrived at their perfect state, emerge from their nest in countless thousands. They have two pairs of wings, and with their aid mount immediately into the air. The next morning they are found covering the ground, and deprived of their wings. They then mate. Scarcely a single pair in many millions escape their enemies — birds, reptiles, beasts, fishes, insects, especially the other ants, and even man himself. The workers, which are continually prowling about their covered ways, occasionally meet one of these pairs. They immediately salute them, render them homage, and elect them father and mother of a new colony. All other pairs not so fortunate perish.

As soon as they are chosen king and queen, or rather, father and mother, they are conducted into the nest, where the workers build around them a suitable cell, the entrances to which are large enough for themselves and the neuters or soldiers to pass through, but too small for the royal pair. Thus they remain in prison as long as they live. They are furnished with every delicacy, but are never allowed to leave their prison. The female soon begins to oviposit — the eggs, as fast as they are dropped, being carried away into the nurseries by the workers. As the queen increases in dimensions, they keep enlarging the cell in which she is confined. Her abdomen begins to extend until it is two thousand times the size of the rest of the body, and her bulk equals that of twenty thousand workers. She becomes one vast matrix of eggs. I once saw a queen which measured three and one quarter inches from one extremity of her body to the other. There is continual oviposition, the queen laying over eighty thousand eggs in twenty-four hours, or one egg every second. As these females live about two years, they will lay some sixty million eggs.

In the royal cell there are always some soldiers on guard and workers administering to the royal pair. The activity and energy of these workers is truly wonderful. In New Mexico, where I found a family of insects closely resembling true *Termes*, I once had an opportunity of observing this extraordinary energy. I broke off a portion of their dome-shaped nest, and in an incredibly short time they had mended the breach and restored their domicile to the same condition it was before I had molested it. If you attack a termite building and make a slight breach in its walls, the laborers immediately retire into the inmost recesses of the nest and give place to another class of its inhabitants, the warriors. Several soldiers come out to reconnoitre, they then retire and give the alarm. Then several more come out as quickly as possible, followed in a few moments by a large battalion. Their anger and fury are excessive. If you continue to molest them, their anger leaps all bounds. They rush out in myriads, and, being blind, bite everything with which they come in contact.[1] If, however, the attack is not continued, they retire into the nest, with the exception of two or three which remain outside. The workers then appear and begin to repair the damaged wall. One of the soldiers remaining outside acts as overseer and superintendent of construction. At intervals of a minute or two it will strike the wall with its mandibles, making a peculiar sound. This is answered by the workers with a loud hiss and a marked acceleration in their movements. Should these ants again be disturbed, the laborers would vanish, and the warriors would take their places, ready and willing to fight to the death in defence of their community.[1]

While it is undoubtedly true that instinct can be highly differentiated, so that in its action it seemingly approaches reason, it is also equally true that instinct, fundamentally, is but a blind impulse. The impulse to fight on the part of these soldier termites is, unquestionably, instinctive, but the psychical habitudes which originate division and partition of labor, which set apart certain individuals (in no wise different from their fellows) as officers and overseers, which, beyond peradventure, are able to incite the laborers to greater effort by commands that are clearly understood and intelligently obeyed, surely such psychical characteristics cannot be embraced in the category of instinctive

[1] Compare Kirby and Spence, *Entomology*.

impulses — mere blind followings-out of inherited impressions!

Instinct is the bugbear of psychology and does more to retard investigation than any other factor. As long as people of the creationist stamp wield the instinct-club, just so long will they be unable to grasp the idea of intelligent ratiocination in the lower animals. A company of men rebuilding a wall which has been overthrown by a tempest are said to be governed and directed by reason, while a company of ants doing precisely the same thing, and with just as much intelligence, are said to be directed by instinct![1]

In the neighborhood of Hell's-Half-Acre, a desolate and rocky valley a short distance from Hot Springs, Arkansas, in 1887, I discovered several communities of harvester ants, and closely and carefully observed their habits. The first time I noticed them was early in the spring, when they seemed to be engaged in planting their grain. They were bringing out the little grass-seeds by the hundreds and thousands, and carrying them some distance from the nest, where they were dropped on the turf. It is possible that these ants were only getting rid of spoiled grain, but I think not, for several of the seeds secured and planted by me

[1] It is often the case that animals find themselves amid surroundings in which they are required to evince original ideation and fail so to do. But, is man any different? How often do we find ourselves checkmated and puzzled by trivial circumstances, which, on being explained, are seen to be exceedingly simple! — W.

germinated. I observed them again in about a month, and the grass was growing finely on the plat where they had deposited the seeds. Not a single stalk of any other kind of grass and not a single weed were to be seen in this model grain-field. The ants had evidently removed every plant that might interfere with the growth of their grain.

I saw them again in August when they were reaping the crop and storing the grain away in their nests. The ants would climb the grass-stems until they came to the seeds; these they would then seize in their mandibles, outer sheath and all, and, by vigorously twisting them from side to side, would separate them from the stalk; they would then crawl down and carry them into the nest. I did not notice here the roads and path-ways so generally found leading to the nests of the Texas variety of the harvester. Around the nests the surface of the ground was smooth and bare, but there were no highways or roads leading to them.

Among the workers I saw some ants whose heads and mandibles were very large. These ants never engaged in any of the agricultural pursuits of their sisters; they were the soldiers and the sentinels of the community. One nest migrated while I had them under observation, and I had the pleasure of witnessing the behavior of these fearless little warriors when on the march. The ants were moving nearer to their grain-fields, and were carrying with them their young, etc. The route, from the old home to the new, was patrolled on either side by soldiers. Every now and then I saw one of these individuals rush aside, elevate herself on her hind legs, shake her head, and clash her mandibles. She acted as if she saw some danger menacing the marching column and would ward it off. Others climbed little twigs or tufts of grass and scanned the surrounding country from these elevated and commanding positions. Others hurried up the laggards and stragglers, and even carried the weak and infirm.

These ants winnow or husk the grain after it has been carried into the nest. All during the harvesting I observed workers bringing chaff from the nest and carrying it some distance away. It is said by Texan observers that the harvesters of that state bring the grain to the surface and dry it, if, perchance, it becomes wet. I have never observed this myself, but accept it as an established fact.[1]

The faculty of computing is among the very last of the psychical habitudes acquired by man, and is an evidence of high ratiocinative ability. Many of the savage races are unable to count above three, — some not above five, — thus demonstrating the truthfulness of the above assertion.

[1] I believe that these observations on the presence of the harvester ant in Arkansas are unique; at least I have been unable to find any data corroborative of this fact. How did a fecundated queen arrive at a spot so far from her usual habitat? — W.

Yet I believe that it can be clearly shown that some of the lower animals and many of the higher animals are able to count.

The mason wasps, or mud-daubers, build their compartment houses generally in places easily accessible to the investigator; therefore the experiments and observations which I am about to detail can be duplicated and verified without difficulty. These interesting members of the Hymenoptera, the *avant-couriers* of the social insects, can be seen any bright day in August or September busily engaged on the margins of ponds, ditches, and puddles in the procurement of building materials. They will alight close to the water's edge, and, vibrating their wings rapidly, will run hither and thither over the moist clay until they arrive at a spot which, in their opinion, will furnish suitable mortar. Quickly biting up a pellet of mud, they moisten it with saliva, all the while kneading it and rolling it between maxillæ and palpi. When it has reached the proper consistency they bear it away to some dry, warm place, such as the rafters of an outhouse or a garret, and there use it in the construction of their adobe or mud nests.

There may be dozens of these nests in the process of construction, and arranged on the rafters, side by side, yet these busy little masons never make the mistake of confounding the houses; after securing mortar they invariably return, each to her own structure. This statement can be easily verified. While the insect is engaged in applying the mortar, take a camel's-hair brush and quickly paint a small spot on her shoulders with a mixture of zinc oxide and gum arabic; then mark the nest. The marked wasp will always return to the marked nest.

As soon as the cells are completed, the wasp deposits an egg in each, and immediately begins to busy herself about the future welfare of the coming baby wasps. Just here these remarkable creatures show that they possess a mental faculty which far transcends any like act of human intelligence; they are able to tell which of the eggs will produce males and which females. Not only are they able to do this, but, seemingly fully aware of the fact that it takes a longer time for the female larvæ to pupate than it does the male larvæ, they provide for this emergency by depositing in the cells containing female eggs a larger amount of food. It is in the procurement and storage of this food-supply that these insects give unmistakable evidence of the possession by them of the faculty of computing.

The knowing little mother is well aware of the fact that as soon as the egg hatches the young grub will need food, and an abundance of food at that; so, before closing the orifice of the cell, she packs away in it the favorite food of her offspring, which is spiders. She knows that in the close, hot cell the spiders, if dead, would soon become putrid and unfit for food: therefore, she does not kill them outright, but simply anæsthetizes them by instilling a small amount of poison through that sharp and efficacious hypodermic needle, her sting.[1]

Each variety of masons uses a different spider; the common blue mason is partial to the beautiful Argiope, which, banded as it is with gray and yellow, is a very conspicuous object when seen on its glistening, upright web.

The wasp larva, as soon as it emerges from the egg-membrane, finds fresh and palatable food before its very nose, and at once begins to eat.

In the case of the male larvæ, five spiders are deposited in each cell, while eight are always placed in the female compartments.[2] If one or more spiders are removed from the cell, the mother wasp does not appear to notice that her food-supply has been tampered with; she completes her quota, five for the males and eight for the females, and then closes the cell, no matter if there remains in the compartment one, two, or three spiders. Her count calls for five or eight, as the case may be, and, when she has put on top of the egg the requisite number according to her count, her responsibility ceases.

[1] As a matter of fact I have kept Argiope under observation in this anæsthetized condition for *thirteen weeks.* — W.

[2] Compare Kirby and Spence, *Entomology*, pp. 231, 232, habits of *Epipone spinipes* in regard to small grubs.

I have never known a mud-dauber to make a mistake in her computation, although I have endeavored to puzzle this little arithmetician time and again. If a wad of paper be placed in a cell after two or three spiders have been deposited, thus partially filling it, the insect knows at once that something is wrong, and will proceed to investigate. She will remove the spiders on top of the paper, will extract the wad, and will then proceed with her count. On the other hand, if several spiders be taken out when the count calls for only one or two more, the wasp does not appear to notice that the cell is almost empty; she finishes her count as if everything were correct, and then seals up the opening with mud.

The quail lays some twelve or fifteen eggs, and seems to be aware of the fact that some of her eggs are missing when several have been removed from the nest. When one of these birds has laid six or eight eggs, if two or three be removed she will abandon the nest and deposit the remainder of her eggs elsewhere. This behavior on the part of the bird has been attributed to her sense of smell; she, detecting the presence of an enemy by the scent of his hand left behind in the nest, recognizes the danger, and therefore abandons the nest. But numerous experiments along this line teach me that smell has nothing to do with it whatever. I have removed eggs with a long iron ladle, the bowl of which I had carefully refrained from touching, and also with sticks freshly cut in the wood, and yet the birds would invariably abandon their nests. On the contrary, when all, or nearly all, the eggs have been laid, several may be removed either with the ladle or with the naked hand, and yet the bird will not abandon her nest. She seems to be able to count up to six or eight; beyond this latter number her faculty of computing does not extend. After the full laying has been deposited in the nest and the process of incubation has become established, a large number of the eggs may be removed, and yet the bird will continue to set until the remaining eggs have been hatched out.

The faculty of computing seems to be present in other birds to some extent; the domesticated guinea-fowl and the turkey sometimes possess it in a marked degree, though in most of these fowls domestication has almost entirely eradicated it. The domestic barnyard hen has had her nest robbed for such a long period of time that she has lost the faculty of counting. But even this meek provider of food for mankind is able, in some instances, to count one: she will not lay in her nest unless a nest-egg be left to delude her. The nest-egg may be wholly factitious and made of china, marble, chalk, stone or iron painted white; the hen does not seem to care so long as it bears some resemblance to an egg.

That the turkey-hen can count, the following instance occurring under my own observation would seem to indicate. The bird had a nest in my garden in which she had deposited three eggs. One day another turkey, seized with a desire of ovipositing, spied this nest and laid an egg therein. The original owner of the nest came along soon after the interloper had left her egg; she examined the nest carefully, and turned the eggs with her beak. Finally she thrust her beak through the shell of an egg and bore it far from the nest before dropping it on the ground. Now, as far as I could tell, the eggs were alike, but the sharper and more discriminating eyes of the turkey undoubtedly saw, on close examination, some peculiarity in color or shape in the stranger's egg, and therefore bore it away and destroyed it. I believe, however, that her attention was arrested at first by the unexpected number of eggs in the nest, and that she was enabled to detect the stranger's egg only after much inspection and comparison.

Many animals have been taught to count, but none of them show that they fully appreciate the value of numerical rotation. Of course, in the vast majority of trained animals, the seeming appreciation is only a trick founded on the sense of smell, sight, touch, or taste.

An instance recently came under my personal observation in which a dog, a high-bred collie, seemingly evinced an abstract idea of numbers. The animal in question received an injury a year or so ago through which she became permanently and totally blind. Recently she gave birth to a litter of six puppies, all of which were uniform in size and markings. Immediately after the birth of the puppies, the dog's owner had mother and young removed from the dark cellar in which they then were, and carried to a warm and well-ventilated room in his stables.

In the darkness of the cellar one of the puppies was overlooked and left behind. As soon as the mother entered the box in which her young had been placed, she proceeded to examine them, nosing them about and licking them. Suddenly she appeared to become very much disturbed about something; she jumped out of the box and then jumped back again, nosing the puppies as before. Again she jumped from the box and then made her way toward the cellar, followed by her astonished owner, who had begun to have an inkling as to what disturbed her. She had counted her young ones, and had discovered that one had been left behind. Sure enough, the abandoned puppy was soon found and carried in triumph to the new home.

So astonished was the gentleman[1] at this blind creature's intelligence that he resolved to experiment further; he removed another puppy and walked away with it in his arms. It was not long before the blind mother showed her distress

[1] Karl Becker, Esq., St. Louis, Mo.

so plainly, that I begged him to return the puppy, which, having been returned to her, she caressed for a moment or so, and then gave herself up to the chief function of maternity, suckling her young.

It is beyond reason to suppose that this dog discovered the absence of her young one through her sense of smell. Granted that to the maternal nose each puppy had an individual and particular odor (which I do not believe), it is hardly possible, nay, it is impossible, that the dog's sensorium had recognized and retained these different scents in the short time which had elapsed since their birth. It is much more reasonable to suppose that the dog knew that she had given birth to six young ones, and that she had counted them when they had been removed to their new home. Again, it is a well-known fact that a dog can retain only one scent at a time; hence, this fact alone would militate somewhat against the idea that the sense of smell was the detecting agent in this case. Nor could it have been the sense of touch; the mother could not have possibly familiarized herself with the individual form of each puppy in so short space of time. It is folly to suppose that each young one had a distinctive taste or flavor; hence the sense of taste must also be eliminated. Thus, by exclusion, there remains but one faculty, the faculty of computing, to account for the dog's actions.

Several years ago there lived in Cincinnati a mule which was employed by a street railway company in hauling cars up a steep incline. This animal was hitched in front of the regular team, and unhitched as soon as the car arrived at the top of the hill. It made a certain number of trips in the forenoon (I have forgotten the number, but will say fifty for the sake of convenience), and a like number in the afternoon, resting for an hour at noon. As soon as the mule completed its fiftieth trip, it marched away to its stable without orders from its driver. To show that it was not influenced by the sound of factory whistles and bells, the following remarkable action on the part of this animal is vouched for by the superintendent of the line, who gave me these data. On a certain occasion, during a musical festival, this mule was transferred to the night shift, and the very instant it completed its fiftieth trip it started for the stables. It took the combined efforts of several men to make it return to its duty. At night there were no bells or whistles to inform the creature that "quitting-time" had come; it thought the time for rest and food had arrived as soon as it had completed its fifty trips.[1]

My meals are always served at regular appointed hours, which never vary throughout the year; and,

[1] These data were given to me at a certain club banquet where I had no facilities for noting them down. I have endeavored to locate the superintendent in question, but without success; I believe, however, that he gave the facts just as they occurred. — W.

since my cook "prides herself" on her punctuality, they are always served on the stroke of the clock. The moment the bell rings, my cat, a large and very intelligent male, takes up a position at the door, and is generally the first to enter the dining room. A few moments before meal-time, Melchizedek (for he is of royal blood and bears a royal name) becomes uneasy, jumping from chair to floor or from floor to chair, and sometimes mewing gently. The moment the bell rings, he is all animation, and shows by his actions that he fully understands its meaning. He never mistakes the sound of the dressing-bell for that of the tea-bell, though the same bell is used. This cat may not be able to count, but that he notes the passage of time I do not for an instant doubt.

Some monkeys give unmistakable evidences of the possession by them of the computing faculty. In 1889 I made the acquaintance of a very intelligent chimpanzee which could count as high as three. That this was not a trick suggested by sensual impulses I had ample opportunity of satisfying myself. The owner of the animal would leave the room, no one being present but myself, and when I would call for two marbles, or one marble, or three marbles, as the case might be, the monkey would gravely hand over the required number. Romanes mentions an ape that could count three, the material used in his experiment being straws from the animal's cage.

The fact that monkeys can count does not appear so remarkable when it is agreed by the best authorities that they are capable of understanding human speech.[1]

Returning for a moment to insects, we find that bees and ants give many evidences of intelligent correlative ideation and action for definite purposes not instinctive. In regard to bees, Huber's experiment with the glass slip proves conclusively, in my opinion, that these creatures *reason*. This experiment is so interesting that it will bear recital.

Huber placed a slip of glass in front of a comb that was under construction. The bees, as if perfectly aware of the fact that it would be difficult to affix the comb to the slippery surface of the glass, curved it at a right angle around the slip of glass and fastened it to the wooden wall of the hive![2]

It is folly to suppose that bees have an instinctive knowledge of glass, hence we are forced to conclude that they were governed in this instance solely by reason.

Furthermore, as the inner surface of the comb was concave, and the outer surface convex, the

[1] Romanes, *Mental Evolution in Man*, p. 369; Darwin, *Descent of Man*, p. 87; Whitney, *Enc. Brit.*, "Philology," Vol. XVIII. p. 769, quoted by Romanes, *super*.

[2] Huber, Vol. II. p. 230; quoted also by Kirby and Spence, *loc. cit. ante*, p. 582.

bees made the cells on the former much smaller, and those on the latter much larger, than usual!

"How, as Huber asks, can we comprehend the mode in which such a crowd of laborers, occupied at the same time on the edge of the comb, could agree to give it the same curvature from one extremity to the other; or how could they arrange together to construct on one face cells so small, while on the other they imparted to them such enlarged dimensions?"[1]

Surely, no "variation of instinct," however complex, can possibly account for such a deviation from the normal!

It is hardly necessary to give more evidence as to the presence of reason in the psychical organisms of the lower animals; I believe that I have clearly demonstrated that some of them do make use of intelligent ratiocination. To prove that this view, *i.e.* that the lower animals reason, is widely held, I need only point to the works of such men as Darwin, Büchner, Forel, Huber, Lubbock, Hartmann, Kirby and Spence, and dozens of others.[2]

We have seen that the lower animals seem to possess very near, if not quite, all of the *funda-*

[1] Kirby and Spence, *loc. cit. ante*, pp. 582, 583.

[2] Darwin, *Descent of Man;* Romanes, *Animal Intelligence, Mental Evolution in Animals, Mental Evolution in Man;* Lubbock, *Senses, Instincts, and Intelligence of Animals*, and *Ants, Bees, and Wasps;* Hartmann, *Anthropoid Apes;* Büchner, *Geisterleben der Thiere;* Huber, *Natural History of Ants*, etc.

mental psychical habitudes of the highest animal of all—*Homo sapiens;* we will now proceed to study certain psychical attributes in the possession of the lower animals which man has lost in the process of evolution. These attributes will be embraced under the heading of Auxiliary Senses.

CHAPTER VIII

AUXILIARY SENSES

WHEN we come to examine the methods by which, or through which, many of the lower animals protect themselves from their enemies, we soon discover that some of these means are very wonderful indeed. It is not my purpose to discuss instinctive protective habits in this chapter; I wish rather to call attention to two *senses*,[1] which are to be observed in certain of the lower animals, and which man and some of the higher animals have lost in the process of evolution. I refer to tinctumutation, the "color-changing" sense, and the sense of direction, or, as it is commonly and erroneously termed, the "homing instinct." Neither of these faculties is instinctive, but they are, on the contrary, true senses, just as hearing, or taste, or smell is a sense. Careful dissections and repeated experiments have shown me, beyond peradventure, that these two psychical habitudes have

[1] I believe that I am the first to claim the *sensual* importance of tinctumutation and the sense of direction or the "homing sense." Heretofore they have been regarded, by all authorities as far as I know, as instinctive in character. — W.

their centres in the brains (ganglia) of animals which possess them.

The chromatic function — and I use this term to designate the faculty of changing color according to surroundings — is possessed by a number of the lower animals. The chameleon is the best known of all the tinctumutants (*tinctus*, color, and *mutare*, to change), though many other animals possess this faculty in a very marked degree. In order to understand the manner in which these changes or modifications of color take place, one must know the anatomy of the skin, in which structure these phenomena have their origin. The frog is a tinctumutant, and a microscopic study of its skin will clearly demonstrate the structural and physiological changes that take place in the act of tinctumutation. The skin of a frog consists of two distinct layers. The epidermis or superficial layer is composed of pavement epithelium and cylindrical cells. The lower layer, or *cutis*, is made up of fibrous tissue, nerves, blood-vessels, and cavities containing glands and cell elements. The glands contain coloring matter, and the changes of color in the frog's skin are due to the distribution of these pigment-cells, and the power they have of shrinking or contracting under nerve irritation. The pigment varies in individuals and in different parts of the body. Brown, black, yellow, green, and red are the colors most frequently observed. The color-cells are technically known as *chromato-*

phores. If the web of a frog's foot be placed on the stage of a microscope and examined with an achromatic lens, the chromatophores can readily be made out. Artificial irritation will immediately occasion them to contract, or, as is frequently the case, when contracted, will occasion them to dilate, and the phenomena of tinctumutation may be observed *in facto.* Under irritation the orange-colored chromatophores, when shrunk, become brown, and the contracted yellow ones, when dilated, become greenish yellow. When all the chromatophores are dilated, a dark color will predominate; when they are contracted, the skin becomes lighter in color. Besides the pigment-cells just described, Heincke discovered another kind of chromatophore, which was filled with iridescent crystals. They were only visible, as spots of metallic lustre, when the cells were in a state of contraction. He observed these latter chromatophores in a fish belonging to *Gobius*, the classical name of which is *Gobius ruthensparri.*[1] I have seen this kind of color-cell in the skin of the gilt catfish, which belongs to a family akin to *Gobius.* The skin of this fish retains its vitality for some time after its removal from the body of the living animal, and the chromatophores will respond to artificial irritation for quite a while. In making my observations, however, I prefer to dissect up the skin and leave it attached to the body of the fish by a broad base.

[1] Semper, *Animal Life*, p. 93.

A few minims of chloroform injected hypodermatically rendered the animal anæsthetic, and I could then proceed at my leisure, without being inconvenienced by its movements. The causation of tinctumutation is now definitely known. The theory that light acts directly on the chromatophoric cells has been proved to be incorrect. Even the theory that light occasions pigmentation is no longer tenable. I have, time and again, reared tadpoles from the eggs in total darkness, yet they differ in no respect from those reared in full daylight. The chromatophores were as abundant and responded to irritation as promptly in the one as in the other. The distinguished Paul Bert declared that the young of the axolotl could not form pigment when reared in a yellow light. Professor Semper, on the contrary, declares Bert's axolotls to be albinos, and states that albinism is by no means infrequent in the axolotl; also that Professor Kölliker, of Würtzburg, reared a family of white axolotls in a laboratory where there was an abundance of light, and that he (Semper) never succeeded in rearing an albino, though there was less light in his laboratory than in that of Kölliker, and his axolotls came from the same stock. Bert made the mistake of confounding albinism with the phenomenon of etiolation in plants; in fact, he gives the name "etiolation" to the albinism noticed in his axolotls.[1]

[1] *Ibid.*, p. 88 *et seq.*

There is a marked difference between the functions of the chlorophyll bodies found in plants and the chromatophores found in animals. The former play one of the most important rôles in the drama of plant life, inasmuch as they subserve a vital function, while the latter act a minor part, because they serve only as an instrument or means of protection.

Light is of great importance in its influence on chlorophyll, which is a microscopic, elementary body on which the vital strength of the plant depends, while it is not at all necessary to the chromatophores, — cell bodies secreting pigmentary matter for the purpose of protection. Of course, when animals are subjected to darkness for very long periods of time, the chromatophores are modified, and, sometimes, are wholly obliterated. They follow a well-known natural law, which declares that, when a function of an organ is no longer of any use to an animal, both organ and function become rudimentary, and finally disappear.

Many animals live for generations in total darkness before losing their pigment. I, myself, have seen black beetles in Mammoth Cave, Kentucky, in the neighborhood of Gorin's Dome, which is far within the depths of the cave. As beetles rarely range over a hundred yards from their place of birth, these insects must have been born in the cave and reared in the dark.

When speaking of light, if not otherwise specified, I mean diffused daylight which carries no heat rays. I believe that heat is a prominent factor in the production of color; the discussion of this point, however, does not properly belong to the subject under consideration.

Some experiments on newts, made by myself several years ago, show that the absence of light does not influence pigmentation, — that is, through several generations. My animals were kept under observation from the extrusion of the eggs until full maturity had been reached, and great care was taken to make experiments as accurate and as conclusive as possible.

Those reared in total darkness or in a red light were always dark-colored; those reared in a yellow light[1] were almost but not quite as dark; while those reared in white ironstone crocks and in diffused daylight were very much lighter, being pearl-gray in color. This apparent (for the microscope showed that it was only apparent) absence of color in the last-mentioned specimens was due to tinctumutation.

[1] Vide Dewar, "The Physiological Action of Light," *Nature*, p. 433, 1877; quoted also by Semper, *loc. cit. ante*, Notes, p. 423. I do not think that the absence of the slight amount of color in the animals reared under the yellow light was due to the "optic current" of Dewar. The microscope showed that the chromatophores were just as large and just as numerous, and that they contained as much pigment, as those reared under the red light. The apparent absence of color was due to tinctumutation. — W.

In most viviparous animals the embryo is developed in almost or absolutely total darkness, yet when it is born it has bright colors. Kerbert has found in the cutis of the embryonic chick, about the fifteenth day, certain pigment-cells. These cells have entirely disappeared by the twenty-third day. It is probable that little, if any, light can reach the chick through the shell and membranes, yet pigment-cells develop and disappear again.[1]

A butterfly emerges from the cocoon arrayed in all the colors of the rainbow; yet it was developed, while in the *pupa* state, in total darkness. It is not necessary to mention further instances; we readily see that pigmentation in animals is not necessarily dependent on light. Neither is tinctumutation the result of the direct influence of light on the chromatophores. Light, however, if not the direct, is the indirect cause of this phenomenon. Lister, in 1858, showed that animals with imperfect eyesight were not good tinctumutants, notwithstanding the fact that they had the chromatophoric function. He showed, by his experiments on frogs, that the activity of the chromatophores depended entirely on the healthy condition of the eyes, — that is, so far as the phenomenon of tinctumutation was concerned. So long as the eyes remained intact and connected with the brain by the optic nerve, the light reflected from the surrounding objects exerted a

[1] Karl Semper, *Animal Life*, p. 422.

powerful influence on the chromatophores. As soon as the optic nerve was severed, the chromatophores ceased to respond to the influence of light and color, no matter how bright and varied they were. The deductions drawn from these experiments are not to be controverted or denied. The chromatophores are influenced by light reflected from objects and transmitted *via* the optic nerve to the brain; from this organ the impression or irritation goes to the nerve governing the contractile fibres of these pigment-holding glands.[1]

Pouchet followed Lister, and confirmed his conclusion by experiments on fishes and crabs. He remarked that the plaice — a fish with a white under-surface and a party-colored back — had the chromatophoric function highly developed. Among a number of specimens which appeared pale on the white, sandy bottom, he met "one single dark-colored fish, in which, of course, the chromatophores must have been in a state of relaxation; and this specimen was as distinct from its companions as from the bottom of the aquarium. Closer investigation proved that the creature was totally blind,[2] and thus incapable of assuming the color of the objects around it, the eyes being

[1] Karl Semper, *Animal Life*, p. 95.

[2] Mr. Gordon Rett has recently called my attention to a blind "angel fish" which shows, most conspicuously, a lack of tinctumutation. This fish was made blind for experimental purposes. — W.

unable to act as a medium of communication between them and the chromatophores of the skin."[1] Thus far Pouchet had only confirmed Lister's observations, although it is highly probable that he was unaware of Lister's experiments. But he went a step further. There are two ways in which cerebral impressions may be transmitted from the brain to the skin: one, by way of the spinal cord and the pairs of nerves arising from it and known as spinal nerves; the other, by two nerves running close to the vertebral column — the sympathetic nerves.

Pouchet cut the spinal cord close to the brain, yet the chromatophores still responded to light impression, showing that they did not receive the message through the cord and spinal nerves. He then divided the sympathetic nerves, and the chromatophores lost at once the power of contraction; he thus demonstrated that the sympathetic nerves were the transmitters of the optical message, and not the cord.

This discovery of Pouchet is, psychologically, of great importance, though he failed to recognize it as such. He was satisfied with its anatomical and physiological significance.

When we remember that the actions of the sympathetic nerves are almost, if not entirely, reflex in character, we at once see the psychological importance of this discovery. This fact

[1] Karl Semper, *Animal Life*, pp. 95, 96.

makes the phenomenon of tinctumutation an involuntary act on the part of the animal possessing the chromatic function, and thus keeps inviolate the fundamental laws of evolution, which, were the facts otherwise, would be broken.[1]

By a series of experiments on frogs I have confirmed the conclusion of Pouchet *in toto*, and have even solved, so I believe and unhesitatingly assert, the puzzling problem of the physiological *modus operandi* of the wonderful phenomenon of tinctumutation.

For a very long time I believed that this function was a distinct sense, and, five years ago, I set to work in search of the sense's centre. After many dissections I found it (in the frog) lying immediately below the optic centres and closely connected with them. Nerve-fibres of the sympathetic can easily be traced and can be seen to penetrate this centre. When this centre is artificially stimulated either with the point of a needle or with a mild electric current, tinctumutation can be incited at will.

Again, when this centre is destroyed (which can be done without injury to the optic centres), the chromatophoric function ceases — the phenomenon of tinctumutation is no longer observable.

That the sympathetic nerves are the carriers of the messages from the optic nerve and the color-

[1] This simple fact of involuntary action renders the sensual nature of the function all the more apparent. — W.

changing centre, can be demonstrated by other means than by excision of the nerve. Atropine, to a certain extent, paralyzes the sympathetic when given in sufficiently large doses, and injections of this drug beneath the skin of a frog render the division of the sympathetic unnecessary. The chromatophores will not respond to light impressions if the animal be placed thoroughly under the influence of atropine.

A large number of the lower animals possess the chromatophoric function. Several years ago, I placed in a large cistern several specimens of gilt catfish. This is a pond fish and is quite abundant throughout the middle United States. It is of a beautiful golden yellow color on the belly and sides, shading into a lustrous greenish yellow on the back and head.

Several months after these fish had been placed in the cistern, it became necessary to clean the latter, and the fish were taken out. They were of a dusky drab color when first taken out, but soon regained their vivid tints when placed in a white vessel containing clear water. They had evidently changed color in order to harmonize with the black walls and bottom of the cistern.

Certain katydids are marked tinctumutants. I took one from the dark foliage of an elm and placed her on the lighter-colored leaves of a locust. She could be easily seen when first placed on the locust; in a few moments, however, she had faded to such an extent that she was barely noticeable.

The larvæ of certain moths, beetles, and butterflies also possess the chromatophoric function. The chromatophores in the larva of *Vanessa* are very numerous, and this grub is a remarkably successful tinctumutant; the same can be said of the larvæ of certain varieties of *Pieris*.

The power of changing color so as to resemble, in coloring, surrounding objects is evidently one of Nature's weapons of defence. In some animals it is developed in a wonderful manner. Wherever it is found it becomes to the animal possessing it a powerful means of defence by rendering it inconspicuous, and in some instances wholly unnoticeable.

After nine years of careful, systematic, and painstaking investigation, I am prepared to affirm that, besides the senses, sight, smell, taste, touch, hearing, and tinctumutation, certain animals have yet another sense, the sense of locality, or of direction, commonly called the "homing instinct." This remarkable function of the mind is not an instinct any more than the sense of sight or smell is an instinct, but is, on the contrary, a true sense; for I have demonstrated by actual experiment that it has a centre in the brains (ganglia) of some of the animals possessing it, just as the other senses have their centres. And, since this centre has been found in certain species, and that, too, in creatures very low in the scale of animal life, it is reasonable to infer that it is present in the brains (ganglia) of all those animals which evince the so-called "homing instinct."

In the process of civilization certain of the five senses in man become dull and blunted; thus, the sense of smell in the Tagals of the Philippine Islands is much more acute than it is in the civilized European, and what is true of the sense of smell is also true of the other senses, save that of touch, in all primitive peoples. This last sense seems to be much more acute in civilized man than it is in savages. This, for certain psychical reasons, unnecessary to detail here, is a necessary result of evolutionary growth and development.[1]

As far as I have been able to learn, after much research in natural history, the anthropoid apes do not show that they possess the sense of direction in a marked degree; thus we see that the immediate ancestors of pithecoid man had already begun to lose this sense, which in man is entirely wanting, and the absence of which should not be a matter of surprise in the slightest degree, but rather a result that should be expected.

Evidences of this sense are to be observed in animals of exceedingly low organization. On one

[1] Compare Tyler, *Anthropology;* De Quatrefages, *The Human Species;* Peschel, *The Races of Man;* Lombroso, *L'Uomo Delinquente;* Ellis, *The Criminal;* the writer, "Criminal Anthropology," *N. Y. Medical Record*, January 13, 1894.

occasion, while studying a water-louse, as I have already described elsewhere in this book, I saw the little creature swim to a hydra, pluck off one of its buds, then swim a short distance away and take shelter behind a small bit of mud, where it proceeded to devour its tender morsel. In a short while, much to my surprise, the louse again swam to the hydra, again procured a bud, and again swam back to its hiding-place. This occurred three times during the hour I had it under observation. The louse probably discovered the hydra the first time by accident; but when it swam back to the source of its food-supply the second time and then returned again to its sheltering bit of mud, it clearly evinced conscious memory of route and a sense of direction.

The common garden-snail is a homing animal, and it will always return to a particular spot after it has made an excursion in search of food. In front of my dwelling there is a brick wall capped by a stone coping; the overhanging edge of this coping forms a moist, cool home in summer for hundreds of snails. Last summer I took six of these creatures, and, after marking their shells with a paint of gum arabic and zinc oxide, I set them free on the lawn some distance away from the wall. In course of time, four of them returned to their homes beneath the stone coping; the other two were probably killed and eaten by blackbirds, numbers of which I noticed during the day feeding on the sward.

The centre of the sense of direction in snails is located at the base of the cephalic ganglion (brain); this ganglion lies immediately between and below the "horns" (eye-stalks), and is composed of several circumscribed and well-marked accumulations or corpuscles of nerve-cells and nerve-filaments.

This sense centre can easily be destroyed without inflicting injury on the circumjacent sense centres. Whenever this is done, the snail loses its sense of direction and locality, and cannot find its way back to its home when it is carried thence, and deposited amid new surroundings. It is not killed by the mutilation, for I have seen marked snails in which this sense centre had been destroyed, alive and apparently in good health, several weeks after having undergone this operation; they found temporary homes wherever they chanced to be.

The limpet is likewise a homing animal, and invariably returns to its home after journeys in search of food. Lieutenant L——, an officer in the British navy, once told me that he had repeatedly had specimens of this animal under observation for months at a time, and that they always had particular spots, generally depressions in rocks, which they regarded as homes, to which they would always return after excursions in search of sustenance. Romanes makes a similar statement.[1]

[1] *Animal Intelligence*, pp. 28, 29.

Some beetles have their homing sense highly developed; thus, in Mammoth Cave, the blind beetle (*Adelops*) has its particular home, and will always return to it even when it is set free at a considerable distance. Notwithstanding the fact these insects are blind, and that darkness reigns in this immense cavern, they have periods of rest corresponding with the diurnal rest-periods of kindred species living in daylight; hence, it is easy to study their habits at home and abroad.

I have frequently marked these beetles and then set them free some distance away from their domiciles; they would hide themselves at once beneath stones or clods of earth, but as soon as they had recovered from their fright they would turn towards home, and would not stop, if left unmolested, until they arrived at their particular and individual homing places. Truly a most wonderful exhibition of the homing sense!

At first, these beetles are, probably, directed and governed by their sense of direction alone, but as soon as they arrive among familiar surroundings, memory comes to their aid.

The agile flea is another "homesteader," and if marked, its favorite resting-place on a dog or cat can easily be determined. After feeding, it will invariably return to a certain spot in order to enjoy its nap in peace; for, strange as it may seem, fleas are sound sleepers, and, what is more, seem to require a great deal of sleep.[1]

Ants are, of the entire insect world, probably the most gifted home-finders. Time and again have I tested them in this, sometimes taking them what must have been, to these little creatures, enormous distances from their nests before freeing them. Of course the ants experimented with were marked, otherwise I could not have watched them successfully. When an ant is taken into new surroundings and set free, it at first runs here and there and everywhere. As soon, however, as it regains its equanimity and recovers from its fright, it turns toward home. At first it proceeds slowly, every now and then climbing tall blades of grass, and from these high places viewing the surrounding country in search of landmarks. As soon as it arrives among scenes partially familiar to it, it ceases to climb grass-blades or weeds, and accelerates its pace. When it arrives among well-known and accustomed surroundings it runs along at its utmost speed, and fairly races into its nest.

The burying beetle has a regular abode, to which it invariably returns after performing the offices of mortician to some defunct bird, beast, or reptile. This insect grave-digger, by the way, is remarkably expert at its business, and will bury a frog or

[1] All insects have periods of rest, during which they seem to be in a state of slumber. Their sleep may not be the physiological slumber of mammals, yet it effects a like purpose in all probability. — W.

a bird in a very short time. As soon as it has buried the dead animal and deposited its eggs, it returns to its domicile beneath some log or stone.

Some snakes likewise are exceedingly domestic, and have their regular dens, to which they resort on occasions. The homing sense seems to be rather highly developed in them, for they can find their way back to their dens from great distances. I have had under observation for the past three years a garden snake, locally known as a "spreading viper"; this snake was brought to me by a friend[1] when it was only a foot long, so I have known her (for it is a female) ever since her infancy. Owing to some antenatal accident, this reptile has a malformed head, so that I can readily recognize her at a distance of fifteen, twenty, or even thirty feet. Last year she reared her first brood of young, which I was fortunate enough to see with her on several occasions. Her den is on my lawn; and in the autumn of last year she conducted her brood to it, where they hibernated until spring. If I remember correctly, on the 29th of March she came out of her den accompanied by a dozen of her progeny, all but four (two pairs) of which I killed.[2] Snakes subserve a

[1] Silas Rosenfield, Esq., Owensboro, Kentucky.

[2] The above was written in the summer of 1897. This interesting specimen was killed by a day-laborer who had been temporarily employed to assist the gardener. An autopsy revealed a bony tumor of the right orbital arch, which, from a little distance, looked like a horn. — W.

very useful purpose in the economy of nature, but it is well to keep them in limits, for, when very numerous, they become dangerous to young birds, especially after they have passed the second year.

With the exception of the anthropoid apes all mammals possess the homing sense in a higher or lower degree; this is true also of birds. Experiments with the nesting robin show conclusively that this bird can find its way back to its nest when carried fifty miles from its home and then set free among wholly unknown surroundings. The well-known exploits of the carrier-pigeon are so familiar that they scarcely need comment. On May 3, 1898, two carrier-pigeons, en route for Louisville, rested for a time at Owensboro, Kentucky; these birds had been set free at New Orleans, Louisiana. The duck and the goose sometimes have this sense very highly developed. I once knew a goose to travel back home after having been carried in a covered basket for the distance of eighteen miles. A drake and duck have been known to return to their home after being carried a distance of nine miles by railway. Instances of home-returning by dogs, cats, horses, etc., are of such common occurrence that I hardly need call attention to them; the following instance is so unique, however, that I will present it: —

In the fall of 1861, a gentleman of Vincennes, Indiana, visited his father at Lebanon, Kentucky;

when this gentleman started to return home, his father gave him a yoke of young steers, which he drove, *via* Louisville, Kentucky, to Vincennes.

Shortly after his arrival at this last-mentioned town, the steers made their escape, swam the river at Owensboro, Kentucky, 160 miles below Louisville, Kentucky, and, in a week or so, were found one morning at the gate of their old home at Lebanon. Directed by their homing sense alone, these animals had made a journey of several hundred miles over a route they had never seen!

Fishermen are aware that certain fish choose localities for lurking-places, which they will share with no other fish. The black bass, and brook trout, and sturgeon, and goggle-eye are familiar examples of fish which have this habit.

On one occasion, I performed the following experiment: I took a black bass from its home near a sunken stump, and, after passing a short piece of thread through the web of its tail and knotting it, replaced it in the river, two miles below its lurking-place. The next day I saw it in its old home, clearly recognizable by the bit of thread which waved to and fro in the clear water as the fish gently moved its tail!

In an examination of phenomena such as have been discussed in this chapter, ay, throughout this book, we must lay aside the dogmatic assertions of our superstitious ancestors, who, to paraphrase Roscoe, "when awed by superstition, and subdued by hereditary prejudices, could not only assent to the most incredible proposition, but could act in consequence of these convictions, with as much energy and perseverance as if they were the clearest deductions of reason, or the most evident dictates of truth." [1]

It will take the human race many, many years to unlearn, and to recover from the effects of the superstitious cult of the shaman, who exists, not only among savages, but also in the most highly civilized races of the world! Superstition is the antithesis of knowledge; in fact, it is but another name for ignorance.

There is yet another exceedingly interesting psychical trait to be noticed in the lower animals, especially in insects; I refer to the instinctive habit, letisimulation (*letum*, death, and *simulare*, to feign). The word "instinctive" must not be used, however, when this stratagem is to be observed in the higher animals other than the opossum; for many of these animals sometimes make an occasional and a *rational* use of it, as I will endeavor to show in the next chapter.

[1] Roscoe, *Life of Leo X.*, p. 3.

CHAPTER IX

LETISIMULATION

THE feigning of death by certain animals for the purpose of deceiving their enemies, and thus securing immunity, is one of the greatest of the many evidences of intelligent action on their part.[1] Letisimulation (from *letum*, death, and *simulare*, to feign) is not confined to any particular family, order, or species of animals, but exists in many, from the very lowest to the highest. The habit of feigning death has introduced a figure of speech in the English language, and has done much to magnify and perpetuate the fame of the only marsupial found outside of Australasia and the Malayan Archipelago. "Playing 'possum" is now a synonym for certain kinds of deception. Man himself has known this to be an efficacious stratagem on many occasions. I have only to recall the numerous instances related by hunters

[1] Instinct does not preclude intelligent ideation. In the lower animals death-feigning is undoubtedly instinctive; yet the recognition of danger, which sets in motion the phenomena of letisimulation, is undoubtedly due, primarily, to intelligent ideation in a vast majority of animals. Otherwise this earth would be a lifeless waste. — W.

who have feigned death, and have then been abandoned by the animals attacking them. I have seen this habit in some of the lowest animals known to science. Some time ago, while examining the inhabitants of a drop of pond water under a high-power lens, I noticed several rhizopods busily feeding on the minute buds of an alga. These rhizopods suddenly drew in their hair-like cilia and sank to the bottom, to all appearances dead. I soon discovered the cause in the presence of a water-louse, an animal which feeds on these animalcules. It likewise sank to the bottom, and, after examining the rhizopods, swam away, evidently regarding them as dead and unfit for food. The rhizopods remained quiet for several seconds, and then swam to the alga and resumed feeding. This was not an accidental occurrence, for several times since I have been fortunate enough to witness the same wonderful performance. There were other minute animals swimming in the drop of water, but the rhizopods fed on unconcernedly until the shark of this microscopic sea appeared. They then recognized their danger at once, and used the only means in their power to escape. Through the agency of what sense did these little creatures discover the approach of their enemies? Is it possible that they and other like microscopic animals have eyes and ears so exceedingly small that lenses of the very highest power cannot make them visible? Or are they possessors of senses utterly unknown to and incapable of being appreciated by man? Science can neither affirm nor deny either of these suppositions. The fact alone remains that, through some sense, they discovered the presence of the enemy, and feigned death in order to escape.

There is a small fresh-water annelid which practises letisimulation when approached by the giant water-beetle.[1] This annelid, when swimming, is a slender, graceful little creature, about one-eighth of an inch long, and as thick as a human hair; but when a water-beetle draws near, it stops swimming, relaxes its body, and hangs in the water like a bit of cotton thread. It has a two-fold object in this: in the first place, it hopes that its enemy will think it a piece of wood fibre, bleached alga, or other non-edible substance; in the second place, if the beetle be not deceived, it will nevertheless consider it dead and unfit for food. I do not mean to say that this process of ratiocination really occurs in the annelid; its intelligence goes no farther, probably, than conscious determination. In the beetle, however, conscious determination is merged into intelligent ideation, for its actions in the premises are self-elective and selective.

Letisimulation in this animal is by no means infrequent, for I have seen it feign death repeatedly.

[1] *Dyticus marginalis.* Vide Furneaux, *Life in Ponds and Streams*, p. 325; foot-note for orthography. — W.

Any one may observe this stratagem if he be provided with a glass of clear water, a dyticus, and several of these little worms. The annelid is able to distinguish the beetle when it is several inches distant, and the change from an animated worm to a seemingly lifeless thread is startling in its exceeding rapidity.

Even an anemone, a creature of very low organization indeed, has acquired this habit. On one occasion, near St. John's, Newfoundland, I noticed a beautiful anemone in a pool of sea-water. I reached down my hand for it, when, presto! it shrivelled and shrunk like a flash into an unsightly green lump, and appeared nothing more than a moss-covered nodule of rock.

Very many grubs make use of this habit when they imagine themselves in danger. For instance, the "fever worm," the larva of one of our common moths, — the Isabella tiger-moth, — is a noted death-feigner, and will "pretend dead" on the slightest provocation. Touch this grub with the toe of your boot, or with the tip of your finger, or with a stick, and it will at once curl up, to all appearances absolutely without life.

A gentleman[1] recently told me that he saw the following example of letisimulation: One day, while sitting in his front yard, he saw a caterpillar crawling on the ground at his feet. The grub crawled too near the edge of a little pit in the

[1] Mr. George Mattingly, Owensboro, Kentucky.

sandy loam, and fell over, dragging with it a miniature avalanche of sand. It immediately essayed to climb up the north side of the pit, and had almost reached the top, when the treacherous soil gave way beneath its feet, and it rolled to the bottom. It then tried the west side, and met with a similar mishap. Not discouraged in the least by its failure, it then tried the east side, and reached the very edge, when it accidentally disturbed the equilibrium of a corncob poised upon the margin of the pit, dislodged it, and fell with it to the bottom. The caterpillar evidently thought the cob was an enemy, for it at once rolled itself into a ball and feigned death. It remained quiescent for some time, but finally "came to life," tried the south side with triumphant success, and went on its way rejoicing. This little creature evinced conscious determination and a certain amount of reason; for it never tried the same side of the pit in its endeavors to escape, but always essayed a different side from that where it had encountered failure.

Many free-swimming rotifers practise letisimulation when disturbed or when threatened by what they consider impending danger. If a "pitcher rotifer" (*Brachionus urceolaris*) be approached with a needle point, it will cease all motion and sink; the same is true of the "skeleton rotifer" (*Dinocharis pocillum*) and numerous others of this large family. Again, if a bit of alga on which there is a colony of "bell animalcules" (*Vorticellæ*) be placed in a live box and then be examined with a moderate power, they can be seen to feign death. The rapidly vibrating cilia which surround the margin of the "bells" give rise to currents in the water which can be easily made out as they sweep floating particles toward the creatures' mouths and stomachs. If the table on which the microscope rests be rapped with the knuckles, the colony will disappear as if by magic. Now, what has become of it? If the microscope be readjusted, a group of tubercles will be observed on the alga; these are the vorticellæ. They have simply coiled themselves upon their slender stems, have drawn in their cilia, and are feigning death. In a few seconds one, and then another, will erect its stem; finally, the entire colony will "come to life" and resume feeding until they are again frightened, when they will at once resort to letisimulation.

Death-feigners are found in four divisions of animal life; viz., among insects, birds, mammals, and reptiles. Indeed, the most gifted letisimulants in the entire animal kingdom are to be observed in the great snake family. The so-called "black viper" of the middle United States is the most accomplished death-feigner that I have ever seen; its make-believe death struggles, in which it writhes and twists in seeming agony and finally turns upon its back and assumes *rigor mortis*, cannot be surpassed by any actor "on the boards" in point of pantomimic excellence.

I do not know of any fish which has acquired this strategic habit, but the evidence is not all in, and some day, perhaps, death-feigners may be found even among fishes.[1]

[1] Letisimulation, apparently, is not confined to animals; we see that certain plants have acquired a habit that is strikingly like death-feigning. We are apt to regard the plants as being non-sentient, yet there is an abundance of evidence in favor of the doctrine that vegetable life is, to a certain extent, percipient. Darwin has shown conclusively that plant life is as subject to the great law of evolution as animal life; he has also demonstrated, in his observations of insectivorous plants — the sun-dew (*Drosera rotundifolia*) especially — that these plants recognize at once the presence of foreign bodies when they are brought in contact with their sensitive glands; * he has likewise shown that plants, in the phenomenon known as circumnutation, evince a percipient sensitiveness that is as delicate as it is remarkable.† Hence, we need not feel surprised when we find, even in a plant, evidences of such a widespread stratagem as letisimulation. The champion death-feigner of the vegetable kingdom is a South American plant, *Mimosa pudica*. In the United States, where in some localities it has been naturalized, this plant is known as the "sensitive plant." A wild variety, *Mimosa strigilosa*, is native to some of the Southern States, but is by no means as sensitive as its South American congener. The last-mentioned plant is truly a vegetable wonder. At one moment a bed of soft and vivid green, the next a touch from a finger and, in the twinkling of an eye, it has changed into an unsightly tangle of seemingly dead and withered stems. In this case death-feigning seems absolutely successful as far as protection is concerned; for surely no grass-eating animal would touch this withered stuff, especially if there were other greens in the neighborhood. Death-feigning in plants, and kindred phenomena, are not due, however, to conscious determination; they are, in all probability, simply the result of reflex action.

* Darwin, *Insectivorous Plants*, Chap. V. *et seq.*

† Darwin, *Power of Movement in Plants*, pp. 107–109.

Recently, I saw this stratagem perpetrated by a creature so low in the scale of animal life, and living amid surroundings so free from ordinary dangers, that, at first, I was loath to credit the evidence of my own perceptive powers; and it was only after long-continued observation that I was finally convinced that it was really an instance of letisimulation.

The animal in question was the itch mite (*Sarcoptes hominis*), which is frequently met with by physicians in practice, but which is rarely seen, although it is very often felt, by mankind, especially by those unfortunates who are forced by circumstances to dwell amid squalid and filthy surroundings. *Sarcoptes hominis* is eminently a creature of filth, and is primarily a scavenger living on the dead and cast-off products of the skin. It is only when the desire for perpetuating its race seizes it that it burrows into the skin, thereby producing the intolerable itching which has given to it its very appropriate name. It is only the females that make tunnels in the skin; the males move freely over the surface of the epidermis. The females make tunnels or *cuniculi* in the cuticle, in which they lay their eggs, and they can readily be removed from these burrows with a needle. While observing one of these minute *acarii* through a pocket lens, as it crawled slowly on the surface of the skin, I wished to examine the under surface of its body. When I touched it with the point of a needle in attempting to turn it upon its back, it at once ceased to crawl and drew in its short, turtle-like legs toward its sides. It remained absolutely without motion for several seconds, and then slowly resumed its march. Again I touched it, and again it came to a halt, and took up its onward march only after several seconds had elapsed. Again and again I performed this experiment with like results; finally, the little traveller became thoroughly chilled, and, after a fruitless endeavor to again penetrate the skin, ceased all motion and died.

Many of the coleoptera are good letisimulants. The common tumble-bug (*Canthon lævis*), which may be seen any day in August rolling its ball of manure, in which are its eggs, to some suitable place of interment, is a remarkable death-feigner. Touch it, and at once it falls over, apparently dead. It draws in its legs, which become stiff and rigid; even its antennæ are motionless. You may pick it up and examine it closely; it will not give the slightest sign of life. Place it on the ground and retire a little from it, and, in a few moments, you will see it erect one of its antennæ and then the other. Its ears are in its antennæ, and it is listening for dangerous sounds. Move your foot or stamp upon the ground, and back they go, and the beetle again becomes seemingly moribund.

This you may do several times, but the little animal, soon discovering that the sounds you make are not indicative of peril to it, scrambles to its feet and resumes the rolling of its precious ball. The habit of making use of this subterfuge is undoubtedly instinctive in this creature; but the line of action governing the use of the stratagem is evidently suggested by intelligent, correlated ideation.

Some animals feign death after exhausting all other means of defence. The stink-bug (*pentatomid*) or bombardier bug (not the "bombardier beetle") has, on the sides of its abdomen near its middle coxæ ("hip bone"), certain bladder-like glands which secrete an acrid, foul-smelling fluid;[1] it has the power of ejecting this fluid at will.

When approached by an enemy, the stink-bug presents one side to the foe, crouching down on the opposite side, thus elevating its battery, and waits until its molester is within range; it then fires its broadside at the enemy. If the foe is not vanquished (as it commonly is), but still continues the attack, the bombardier turns and fires another broadside from the opposite side. If this second discharge does not prove efficacious (and I have rarely known it to fail), the little insect topples over, draws in its legs, and pretends to be dead.

Many a man has acted in like manner. He has fought as long as he could; then, seeing the odds against him, he has feigned death, hoping that his antagonist would abandon him and cease his on-

[1] Comstock, *The Study of Insects*, p. 145.

slaughts. The stink-bug in this seems to be governed and directed by *reason*, though the means used for defence must come under the head of instinct. Many a blind, instinctive impulse in the lower animals is, in all probability, aided and abetted by intelligent ratiocination when once it has made its appearance.

I have seen ants execute a like stratagem when overcome either by numbers or by stronger ants. They curl up their legs, draw down their antennæ, and drop to the ground. They will allow themselves to be pulled about by their foes without the slightest resistance, showing no signs of life whatever. The enemy soon leaves them, whereupon the cunning little creatures take to their feet and hurry away.

The most noted and best known letisimulant among mammals is the opossum. I have seen this animal look as if dead for hours at a time. It can be thrown down any way, and its body and limbs will remain in the position assigned to them by gravity. It presents a perfect picture of death. The hare will act in the same way on occasions. The cat has been seen to feign death for the purpose of enticing its prey within grasping distance of its paws. In the mountains of East Tennessee (Chilhowee) I once saw a hound which would "play dead" when attacked by a more powerful dog than itself. It would fall upon its back, close its eyes, open its mouth, and loll out its tongue.

Its antagonist would appear nonplussed at such strange conduct, and would soon leave it alone. Its master[1] declared that it had not been taught the trick by man, but that the habit was inherited or learned from its mother, which practised the same deception when hard pushed.[2]

Most animals are slain for food by other animals. There is a continual struggle for existence. The carnivora and insectivora, with certain exceptions, prefer freshly killed food. They will not touch tainted meat when they can procure the recently killed, blood-filled bodies of their prey. The exigencies of their surroundings in their struggle for existence, however, often compel them to eat carrion.

Dogs will occasionally eat carrion, but sparingly, and apparently as a relish, just as we sometimes eat odoriferous and putrid cheeses, and the Turks, assafœtida.

Carnivora and insectivora would much prefer to do their own butchery; hence, when they come upon their prey apparently dead, they will leave it alone and go in search of other quarry, unless they are very hungry.

[1] Mr. George Griffiths, Griffiths' Cove, Chilhowee, Blount County, Tennessee.

[2] In the case of the cat and dog the use of this stratagem is not instinctive; it is the rational use of means to obtain a certain desired end. The fact that the dog "inherited the act" from its mother is not a proof of inherited instinct. Instincts are not formed in a single generation. — W.

Tainted flesh is a dangerous substance to go into any stomach, unless it be that of a buzzard. Heredity and environment have made this bird a carrion-eater, hence, like the jackal, the hyena, and the alligator, companion scavengers, it can eat putrid flesh with impunity. Other flesh-eating animals avoid carrion when they can, for long years of experience have taught them that decaying meat contains certain ptomaines which render it very poisonous; hence, they let dead, or seemingly dead, creatures severely alone. Again, these creatures can see no object in mutilating an animal which, in their opinion, is already dead.

In this discussion of the means and methods of protection that are to be observed in the lower animals, I have brought forward only those in which mind-element was to be discerned. Mimicry and kindred phenomena hardly have a place in this treatise, for they are, undoubtedly, governed and directed by unconscious mind, a psychical phase which, as I intimated in the introductory chapter of this book, would be discussed only incidentally.

CONCLUSION

JUDGING wholly from the evidence, I think that it can be safely asserted and successfully maintained that mind in the lower animals is the same in kind as that of man; that, though instinct undoubtedly controls and directs many of the psychical and physical manifestations which are to be observed in the lower animals, intelligent ratiocination also performs an important rôle in the drama of their lives.[1]

The wielders of the instinct club bitterly deny that any of the lower animals ever show an intelligent appreciation of new surroundings, that they ever evince intelligent ratiocination. They close their eyes even to the data collected by the chiefs of their tribe, Agassiz, Kirby, Spence, *et al.*, and go on their way shouting hosannas to omniscient, all-powerful Instinct! When one of the lower animals evinces unusual intelligence, or gives unmistakable evidences of reason, they account for it by saying that "it is only instinct highly specialized, or, at least, a so-called 'intelligent' accident."

So far from being "intelligent accidents" are the ratiocinative acts of some of the lower animals

[1] Kirby and Spence, *Entomology*, p. 591.

(that is, lower than man), that I think that it can be demonstrated analogically that some of these acts are incited by one of the highest qualities of the mind — abstraction.

I do not mean that abstraction which renders the civilized human being so immeasurably superior to all other animals, but rather that primal, fundamental abstraction from which the highly specialized function of man has been developed. The faculty of computing in animals is one evidence of the presence of this psychical trait in its crude and undeveloped state. The quality of abstraction in such ideation is not very high, it is true, yet it *is* abstraction, nevertheless.

Man possesses two kinds of consciousness — an active, vigilant, coördinating consciousness (the seat of which is, probably, in the cortical portion of the brain) and the passive, pseudo-dormant, and, to a certain extent, incoherent and non-coördinating consciousness (the so-called sub-liminal consciousness) whose seat is in the great ganglia at the base of the brain (*optic thalami* and *corpora striata*), and in other ganglia situated in the spinal cord and elsewhere in the body. My fox terrier has a brain which, in all essential details, does not differ from that of man, and my observations teach me that his mind is the same in kind as that of man as far as memory, emotions, and reason are concerned; then why deny him the possession of abstraction in some degree? I do not mean that abstraction which enables a man to soar into realms of thought infinitely above any effort of ideation to be attained by any of the lower animals, but abstraction in its embryonic state. I am convinced, by actual experimentation, that this dog falls into "brown studies" just as man does; may he not then claim one kind of abstraction, if not another?

The elephant, unquestionably, is able to formulate abstract ideas, the quality of which is very high, indeed. Jenkins wrote to Romanes as follows: —

"What I particularly wish to observe is that there are good reasons for supposing that elephants possess abstract ideas; for instance, I think it is impossible to doubt that they acquire through their own experience notions of hardness and weight, and the grounds on which I am led to think this are as follows: —

"A captured elephant after he has been taught his ordinary duty, say about three months after he has been taken, is taught to pick up things from the ground and give them to his mahout sitting on his shoulders. Now the first few months it is dangerous to require him to pick up anything but soft articles, such as clothes, because things are often handed up with considerable force.

"After a time, longer with some elephants than others, they appear to take in a knowledge of the nature of the things they are required to lift, and the bundle of clothes will be thrown up sharply as before, but heavy things, such as a crowbar or a piece of iron chain, will be handed up in a gentle manner; a sharp knife will be picked up by its handle and placed on the elephant's head, so that the mahout may take it by the handle. I have purposely given elephants things to lift which they could never have seen before, and they were all handled in such a manner as to convince me that they recognized such qualities as hardness, sharpness, and weight."[1]

Mr. Conklin, the celebrated elephant trainer, once told me that his elephants not only recognized such qualities as weight, sharpness, and hardness, but also *volume or dimension.*

The kinship of mind in man and the lower animals is indicated also by the phenomenon of dreaming which is to be observed in both. When the active consciousness is stilled by slumber, subconsciousness or ganglionic consciousness remains awake, and sometimes makes itself evident in dreams. I have repeatedly observed my terrier when under dream influence, and have been able to predicate the substance of his dreams from his actions. Like man, the dog is sometimes unable to differentiate between his waking and dreaming thoughts; he confounds the one with the other, and follows out in his waking state the ideas suggested by his dreams.

[1] Romanes, *Animal Intelligence*, pp. 101, 102; see also Kemp, *Indications of Instinct*, pp. 120, 130.

This, with normal man, is always a momentary delusion; with the dog, however, it may last for some little time. Thus, I have seen my dog chase imaginary rats around my room after having been aroused while in the midst of a dream. His chagrin when he "came to himself" and saw me laughing was always strikingly apparent.

The brains of the lower animals are susceptible to the action of drugs, whose effects on them are identical with the effects noticed when the human brain is under drug influence. Alcohol, chloroform, ether, opium, strychnine, arsenic, all produce characteristic symptoms when they are introduced into the circulatory system of the lower animals. Even the very lowest animalcules give this evidence as to the kinship of nerve and ganglionic or brain elements in man and the lower animals.

I have repeatedly noticed the action of alcohol on rhizopods. When small and almost inappreciable doses were exhibited, the little creatures became lively and swam merrily through the water; but, when large doses were given, they soon became stupefied and finally died. I have seen drunken jelly-fish rolling and tacking through the alcohol-impregnated water for all the world like a company of drunkards.[1] They soon became sober, however, when they were placed in fresh water, but remained listless and inert for some time afterward.

[1] Compare Romanes, *Jelly-Fish, Star-Fish, and Sea-Urchins*, p. 227.

Coleoptera, hymenoptera, diptera, in fact, all insects exhibit the characteristic effects of alcohol when under its influence. Horses, dogs, cats, monkeys — all mammals are affected characteristically by alcohol, and it not infrequently happens that they willingly become drunkards.[1]

Animals also appear to become cognizant of the fact that certain substances are medicaments, and they will voluntarily search for and take such substances when they are ill. Bees are perfectly aware of the astringent qualities of the sap of certain trees, notably the dogwood and wild cherry, and, when afflicted with the diarrhœa, can be seen biting into, and sucking, the sap from the tender twigs of such trees. Dogs, when constipated, will search for and devour the long, lanceolate blades of couch-grass (*Triticum repens*); horses and mules, when they have "scours," eat clay; cattle with the "scratches" have been seen to plaster hoof and joint with mud, and then stand still until the healing coating dried out and became firm; and elephants have been known, time and again, to plug up shot holes in their bodies with moistened earth.[2]

Again, the recognition of the rights of property cannot be attributed to instinct, neither can it fall under the head of "intelligent accidents," yet many animals lower than man recognize, to a cer-

[1] Lindsay, *Mind in the Lower Animals*, pp. 81–93.

[2] Romanes, Skinner, Sir R. Tennent, Bingley, Forbes, *et al.*

tain extent, the rights of property. For instance, in 1879, two very intelligent chimpanzees were on exhibition at Central Park. One of these animals claimed as her property a particular blanket, and, notwithstanding the fact that there were other blankets in the cage in which they were confined, always covered herself with this blanket. She would take it away from her companion whenever she wished to use it. Again, two turkeys on my place deposited their eggs in the same nest. The hen which first built and used the nest regarded the spot as her individual home; therefore, whenever she found the other hen's egg in the nest, she would break it with her beak, and then carry it some distance away. This I have seen her do repeatedly.

Many dogs, cats, and other animals regard certain rugs, cushions, etc., as their own property, and resent any interference with them. It seems to me that in all such instances these animals regard themselves as individuals; that they recognize the psychical as well as the physical difference between the *Ego* and the *Tu* as soon as they begin to recognize the rights of property.

Those who hold that instinct governs all actions of the lower animals, usually claim that man is the only tool-user. This is a gross mistake — elephants, when walking along the road, will break branches from the trees and use them as fly-brushes;[1] these

[1] Peal, *Nature*, Vol. XXI. p. 34; quoted also by Romanes.

creatures also manufacture surgical instruments, and use them in getting rid of certain parasites;[1] monkeys use rocks and hammers to crack nuts too hard for their teeth; these creatures also make use of missiles to hurl at their foes;[2] chimpanzees make drums out of pieces of dry and resonant wood;[3] the orang-utan breaks branches and fruit from the trees and hurls them at its foes;[4] the gorilla and chimpanzee use cudgels or clubs as weapons of offence or defence;[5] monkeys make use of sticks in order to draw objects within their reach;[6] spiders suspend pebbles from their webs in order to preserve stability,[7] etc.

I could prolong this list to a much greater length, but think it hardly necessary. I think that I have demonstrated that man is not the only tool-user.

Even such dyed-in-the-wool creationists as Kirby and Spence are forced to admit the presence of reason in insects.

"Such, then, are the exquisiteness, the number, and the extraordinary development of the instincts of insects. But is instinct the sole guide of their actions? Are they in every case the blind agent of irresistible impulse? These queries, I have

[1] Peal, *Nature*, Vol. XXI.

[2] Romanes, *Animal Intelligence*, p. 485 *et seq.*

[3] Lindsay, *Mind in the Lower Animals*, Vol. I. p. 410.

[4] Wallace, *Malayan Archipelago*, p. 41.

[5] Lindsay, *loc. cit. ante*, p. 413.

[6] Belt, *Naturalist in Nicaragua*, p. 119.

[7] Büchner. *Geistesleben der Thiere*, p. 318.

already hinted, cannot, in my opinion, be replied to in the affirmative; and I now proceed to show that though instinct is the chief guide to insects, they are endowed also with no inconsiderable portion of *reason*."[1]

Studied both objectively and subjectively, insects present indisputable evidence of reason. Not the higher abstract reason of the human being, however, but reason in its primal, fundamental state.

The difference between instinct and reason is not generally understood, and, as I believe that most readers can comprehend an illustration much quicker than an explanation, I will use the former in order to bring out this difference.

The hen which sits three weeks on a china egg is influenced by blind impulse — instinct; while the turkey which discovers the eggs of her rival in her nest, and destroys them, is directed by something infinitely higher — by reason. The using of a common nest never occurs among these birds in a wild state, neither is it of so frequent occurrence among domesticated turkeys as to have formed an instinctive habit.

Again, the honey-making ants which left their patrol line in order to slay the wounded centipede may have been, and probably were, influenced by instinct; another and wholly different psychical trait, however, impelled them to fill up the trench

[1] Kirby and Spence, *Entomology*, p. 591.

dug with my hunting knife. This accident could not have occurred, perhaps, to them in a state of nature, or if by any possibility it had ever occurred before, the chances are that such occurrences were few in number, and that they happened at long intervals of time, thus precluding the establishment of an instinctive habit. Nor do I think it possible for this action to come under the head of "specialized instinct," for the same reason. By the very nature of things there can be no such thing as an "intelligent accident"; the term is itself a contradiction, therefore the performance of these ants must be considered an act of intelligent ratiocination.

In this discussion of mind in the lower animals I have endeavored to show that the psychical traits evinced by them indicate that their mental organisms, taken as a whole, are the same in kind as that of man.

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