Home College Series.

Number ✻ *Seventy-Three.*

Hugh M. Smith.

A FEW FACTS

ABOUT ZOOLOGY.

BY MRS. V. C. PHŒBUS.

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J. H. Vincent.

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A FEW FACTS ABOUT ZOOLOGY.

In the air above, the earth beneath, and the waters under the earth, we are surrounded with life. The air swarms with birds, insects, and invisible animalcules; the waters are peopled with innumerable forms, from the microscopic animals, millions of which would not weigh a grain, to the whale so large that, as it sleeps upon the waves, it seems an island; on the earth and in the earth we find life—crawling, creeping, burrowing, boring, leaping, running; life, too, is cradled within life; in the eyes, liver, stomach, brains, and muscles of animals we may find other animals living as parasites, these parasites many times having parasites living upon them. The earth we tread is largely formed of the *remains* of life; the greater part of the Alps, the Rocky Mountains, the chalk cliffs of England, etc., are composed of the shells of microscopic animals, which during past ages have slowly accumulated within the depths of the ocean: from the ruins of this living architecture we build our dwellings, churches, and monuments.

Amid this great diversity of the forms of life there is unity; and this suggests that there is one general plan, but carried out in a variety of ways. "Every animal has something in common with all its fellows; much with many of them; more with a few; and, usually, so much with several, that it differs but little from them." The object of classification is to bring together the like, and to separate the unlike.

Classification.

A classification, if it be a true one, is not man s work, but his discovery. It is really the interpreting of God's plan in creation. He who gets an insight into that plan may joyfully and reverently exclaim, "I think God's thoughts; I trace his designs." "Classification, rightly understood," says Agassiz, "means simply the creative plan of God, as he has expressed it in the forms of life that surround us." The first details may be tedious, but our patience, if we persevere, will be rewarded, and, in the language of this great naturalist, "the long and tedious road will bring us suddenly to a *glorious* prospect and a clearer mental atmosphere, and a new intellectual sensation will amply reward us for a little weariness in the out let."

Upon what must our classification be founded? Upon external resemblance or internal structure? Let us illustrate: The flat roof and the colonnade are the types which distinguish all Grecian temples; they may be built of marble, granite, or wood; their columns may be adorned with the elaborate Corinthian embellishments, or finished in a plainer Doric style; we do not inquire, in order to decide whether it is a Greek temple, about the materials, or the ornamentation; we class all temples as Greek which are built according to the Greek *plan*—the flat roof and colonnade. Cuvier was the first to adopt and apply the principle of internal structure, rather than external resemblance. After years of ripe study he thus announced his conclusions:

"Looking at animals only with reference to their nature and organization, excluding their size, their utility, our greater or less familiarity with them, and all other accessory circumstances, we shall find that there exist *four* principal forms—four general plans, if we may so express it—in accordance with which all animals seem to be molded."

The publication of this statement at first created an extraordinary excitement throughout the scientific world, but, after many investigations, it became accepted by many as a scientific truth. Baer, a German naturalist, went a step farther. Cuvier showed us the four plans as they exist in the adult animal; Baer showed us, not only that they were

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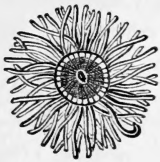
built on four plans, but that they *grew* by four methods of development.

RADIATA.

The radiate type of animal life is characterized by the idea expressed in the word *radiation.* It will probably be best understood by a description of a radiating animal. Fig. 1



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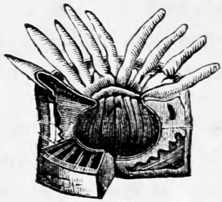


B

FIG. 1.

is a picture of a sea-anemone. At B you will see a central cavity; surrounding its circular opening will be seen tentacles, or feelers, *radiating* from the center opening, or mouth. A shows its upper surface; it is attached to the rocks by a flat disk. These sea-anemones are much admired as animal flowers; they may be frequently seen in the rock-pools around our shores; when in search of their prey they extend their bright-colored tentacles, which so much resemble flowers; when left by the tide they contract into small, round, gelatinous masses.

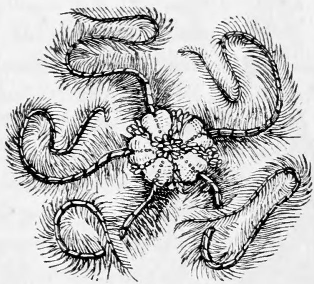


FIG. 2.

The ordinary jelly-fish, or sea-nettle, is another specimen of this somewhat spherical style of animal architecture; it is soft, gelatinous, and bell-shaped, or saucer-shaped; they float mouth downward in the sea; there are tubes radiating from the central cavity to the circumference, and around the margin are tentacles furnished with stinging threads.

The star-fish is another and higher specimen of the radiates. The star-fishes consist of animals with a flat, central disk, with five or more arms radiating from it. Fig. 2 is a picture of the brittle-star; its long, slender arms are not prolongations of the body, as are many of our star-fishes.

Coral Polyps.

These belong to the radiates; they generally grow together in great clusters or colonies. A single polyp, cast off from a group, soon shows the typical form; that is, the tentacles begin to form around the circular opening, which is both mouth and stomach. There is but the one opening, so that fluids must pass in and out the same way. These tentacles or feelers keep up a constant motion, thus causing the water to flow in and out; the limy portion of the sea water is left behind in the thin plates which radiate from the center of the polyp; a new polyp soon appears in the form of a bud from the first; this develops and adds to the limy formation from the sea water; thus each polyp adds its portion to the bony skeleton; at the extremity the growth goes on, forming new polyps, while the stem or limy skeleton is left behind, dead. "In radiates," says Agassiz, "we find no prominent bilateral symmetry, but an all-sided symmetry, in which there is no right and left, no front nor back. Radiates are spheroidal bodies; yet, though many of them remind us of a sphere, they are by no means to be compared to a mathematical sphere, but rather to an organic sphere, so loaded with life, as it were, as to produce an infinite variety of radiate symmetry. The mathematical sphere has a center to which every point of the surface bears identical relations; such spheres do not occur in the animal kingdom." Still ascending, we come to the next division, the sub-kingdom mollusca.

Mollusks.

A mollusk is a soft-bodied animal, without internal skeleton and without joints, covered with a moist skin. In some mollusks the skin is naked—generally it is protected by a shell. The lowest class of mollusks are *headless* animals; the oyster is a good example of this class. It has, like most *acephala*, or animals without heads, a shell composed of two valves, united by a hinge on the back, one of these valves being thick and swollen, while the other is nearly flat. If we lift the shell we find beneath a soft lining or skin covering the whole animal, and called by naturalists the mantle, from the inner surface of which arises a double row of gills forming two pendent folds on the sides of the body. At one end of the body these folds do not meet, but leave an open space, which is the aperture we call the mouth. This is the only indication we find to tell us which is the forward part of the body, but it is enough to establish a difference between the front and hind ends, and to serve as a guide in distinguishing right and left sides. In this class of headless animals we place *oysters, clams, muscles*, and the like. When speaking of them, in reference to the number of their shells, we call them *bi*-valves.

A step higher among the mollusks we find *snails, slugs, cockles, periwinkles*, and the like. The mantle envelops the soft body of these animals, lining their single shell, just as it lined the double shell of the oyster. This class of animals has a fleshy, muscular expansion, on which they move, and which is thence called a foot; except that they move by it, it bears no resemblance to a foot, however. These animals are sometimes without shells; if they possess one, it is a single shell or univalve; these are sometimes flat, simple shells, as in the limpet; sometimes a plain spiral, as the snail; sometimes elaborate spirals with brilliant hues, as in the cowry. In this class, although there is nothing that can be properly called a head, the front end of the animal is distinctly marked by two or more feelers, with which eyes are distinctly connected, as in the garden snail.

Still among the mollusks, but a little higher, we come to animals which have long arms or feelers around the head, serving as organs, by which they move through the water with a rapidity that is wonderful when compared with other mollusks. In these animals the head is distinctly marked, having a depression behind it; the feelers, such as we noticed on the snail, do not exist, and the eyes (which are to be found in the snail at the extremity of the feelers) are placed immediately on the side of the head, and are very large in proportion to the size of the animal; this class includes

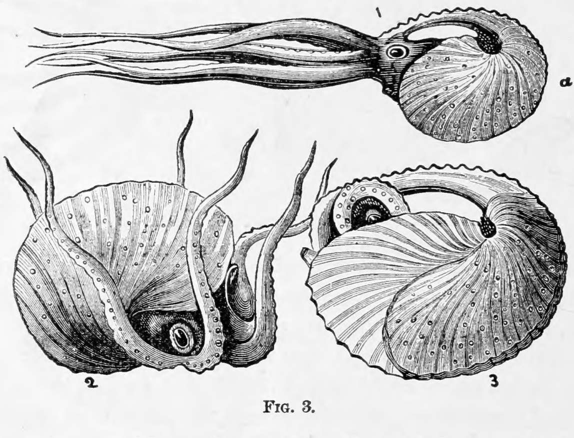


FIG. 3.

cuttle-fishes, squids, and *nautili*. Few of these animals possess a shell; when they do, it is, with one exception, coiled, not in a spiral, but from behind forward. Fig. 3 is a picture of the pearly nautilus. Notice its bright eyes and long feelers. The pearly nautilus has a peculiar shell, called a chambered shell; the animal, as it grows, forms a wall behind it at regular intervals, and always occupies the external chamber, retaining, however, a connection with its past home by a siphon that runs through the whole succession of chambers. These chambered shells were once very abundant. More than two thousand fossil species are known. They have but one living representative — the pearly nautilus. This straggler of a mighty race dwells at the bottom of the Indian Ocean. The shell is well known, but only two or three specimens of the animal have been obtained. Fig. 4 gives a picture of a cuttle-fish. The squid and cuttle-fish have ten arms, the additional pair being longer than the others.

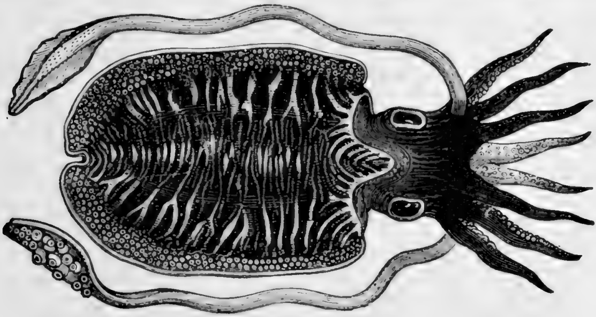


Fig. 4.

There are cuttle-fish and poulps (or devil-fish) so large as even to be dangerous to a man who might be swimming near them, and the stories of novelists, like Victor Hugo, have some foundation in the large size and repulsive aspects of these creatures. They crawl head downward, with their arms on the bottom of the sea, and usually swim backward or forward by means of fins, or squirt themselves backward by forcing water through their funnels.

We must carefully distinguish between affinity and analogy among animals. The former is founded upon identity of plan; the latter upon external resemblance. At first sight there may seem to be, in the cuttle-fish, with its circle of arms, an analogy to the radiating type. In the radiates every tentacle opens into one of the chambers, or is connected with a radiating tube, or, as in the star-fishes, with a locomotive sucker; whereas, in the cuttle-fish the feelers are only external appendages, in no way connected with the essential structural element. We have a striking illustration of this superficial resemblance in the wings of birds and insects. In birds, wings are a typical feature, being attached and forming a part of the internal skeleton; the wing in an insect, on the contrary, is a flattened, dried-up gill, not being built at all on the same plan. We associate them together merely because each is used for flying.

Having now made a hasty survey of two of Cuvier's divisions, the radiates and the mollusks, we come to

The Articulates.

Here we have again three classes—worms, crustaceans, and insects. The lowest of these three classes, the worms, shows us the typical structure with little division into parts. The body is a long cylinder, divided through its whole length by movable joints; the nervous force is scattered throughout the whole body; if cut in two the front part may build up for itself a new tail, while the hind part produces a new head, and both continue to live as new animals. The ease with which the animal sustains injuries does not arise from its intense nervous force, but from the fact that the nervous force is scattered, and not concentrated at any one point. A serious injury to the brain of a backboned animal would kill it at once, for the brain contains the very essence of its life.

The *articulata* are the *jointed* animals. We have already spoken of the worm's body as being formed of a succession of rings or movable joints; this structure is found in earthworms, and in the worms that live on other bodies as parasites, as the tape-worm. Among the articulata we place lobsters and crabs. It may seem at sight that nothing can be more unlike a worm than a lobster; but comparison shows that the jointed plan controls the organization of both. The body of the lobster is divided into a succession of joints or rings like the worm; the fact that the front limbs of the lobster are soldered together, so as to make stiff the front region of the body, inclosing the head and chest, while only the hind rings remain movable, thus forming a flexible tail, does not alter the general structure, which consists, in both worm and lobster, of a body built of articulations or joints.

Highest in this type are the insects; among these are included spiders, centipedes, and winged insects. In all these we find a breathing apparatus far superior to the respiratory organs of the worms, or the more highly organized gills of the lobster.

This apparatus consists of air-holes on the side of the body, connected with a system of tubes extending into the body, and admitting air to all parts of it. In the winged insects this system is very elaborate, filling the body with air to such a degree as to render it exceedingly light, and adapted to easy and rapid flight. A careful examination will not fail to show the jointed character of the insect. This may be readily seen by studying the diagram shown in Fig. 5.

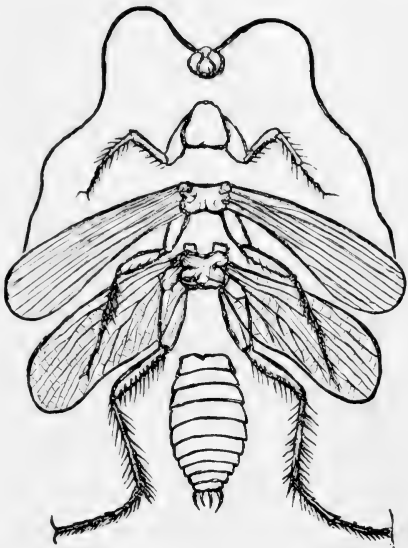


FIG. 5.

The changes which an insect undergoes are well known. You may have seen the various stages in a silk-worm. First an *egg;* then, when hatched, a little worm called a *larva*, whose whole existence is spent in feeding and rapid growth; then it wraps itself in a cocoon and enters the *pupa* state, remaining apparently dead till new organs are developed, when it emerges a perfect winged insect, or *imago*. These are the four

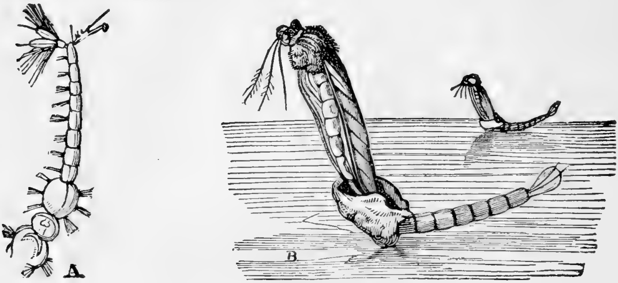


FIG. 6.

stages—egg, *larva*, *pupa*, and *imago*. In Fig. 6 you see these changes as shown in the mosquito. In the picture there is no apparently dead pupa, but you may see the pupa-case, which, being opened, is floating like a boat upon the water, and supporting the mosquito in its efforts to escape. Many a pupa-case upsets, thus drowning its occupant before he has a single chance to try his wings. The pupa of butterflies is unprotected, and is generally suspended by a single thread; the pupa-case is generally ornamented with golden spots, hence the name, *chrysalis*. The pupa of moths is inclosed in cocoons.

THE VERTEBRATES.

We come now to the highest branch of the animal kingdom—that to which we ourselves belong—the vertebrates. Every vertebrate has a backbone; every vertebrate has a solid arch above that backbone, and a solid arch below it, forming two cavities—no matter whether these arches be of hard bone, of cartilage, or even of a softer substance. In the upper cavity are the brain and the organs of sense; in the lower cavity the organs of digestion, respiration, circulation, and reproduction. Every vertebrate has four locomotive appendages, composed of the same substance that forms the backbone: in birds, they appear as wings and legs; in quadrupeds, as four legs; in man, as arms and legs; even where they seem wanting, as in serpents, a minute study of the gradual reduction of the locomotive appendages in various groups of reptiles will show that they, too, are true to this typical plan.

Beginning with the lowest class of vertebrates, we find the fishes; they are cold-blooded, they breathe through gills,

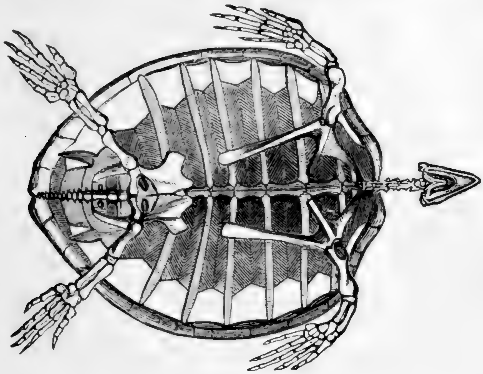


Fig. 7.

and they lay eggs. A step higher come the *amphibia*—amphibious animals—receiving their name from the fact that they are able to exist both on land and in water. They are cold-blooded; they breathe by gills during some part of their lives, but soon or later possess lungs. All undergo changes after leaving the egg, passing through the tadpole state, in which they resemble fishes. We all know these changes in the frog and toad. Still rising, we come to the reptiles, including snakes, lizards, turtles, crocodiles. The structure of the turtle is so peculiar that one might be tempted, on casual examination, to refuse it a place among the backboned animals. Look at the illustration, Fig. 7, and you will clearly see the plan of backbone, notwithstanding the change it has undergone.

In birds we meet warm-blooded and air-breathing vertebrates, egg-laying like the reptiles, amphibians, and fishes, but their eggs are comparatively few in number, and their young are hatched by the mother and fed by the parent birds till they can provide for themselves.

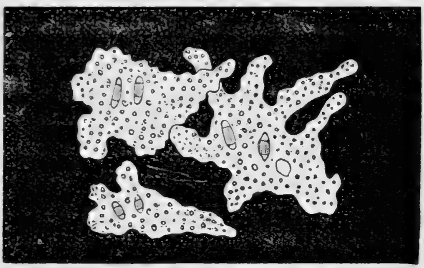
We find some of the fishes showing care for their offspring; a greater care than is shown in most fishes exhibited by reptiles; a still greater brooding tenderness by the birds. At last we rise to the mammalia, a class that is warm-blooded, that breathes through lungs, that bring forth their young alive and nurse them with milk. This group, the mammalia, is the highest group of vertebrates, at the very head of which stands man, looking heavenward, it is true, but nevertheless rooted deeply in the animal kingdom. Even in the lowest members of the mammalia we have the dawning of those family relations, those intimate ties between parents and children, on which the whole social organization of the human race is placed. Man is the crowning work of God on earth; but, though so nobly endowed, we must not forget that we are the lofty children of a race whose lowest forms lie prostrate within the water, having no higher aspiration than the desire for food. We cannot understand the possible degradation and moral wretchedness of man without knowing that his physical nature is rooted in all the characteristics that belong to his type, and link him even with the fish. The moral and intellectual gifts that distinguish him from them are his to use or to abuse; he may, if he will, take thought only for his lower nature, and be a mere backboned animal, or he may rise to a spiritual height that will make that which is his especial distinction the controlling element of his being.

Recapitulation.

The radiates, mollusks, articulates, vertebrates. There are tiny animals whose existence is only made known by the microscope; the term *infusoria* is applied to many of these because they abound in any infusion of matter which is allowed to putrefy. Misguided by their seeming simplicity of structure, Cuvier placed all these in the lowest division, the radiata.

These animalcules are like transparent little globules, and seemed to have no special organization. Further study and improvements in the microscope have proved that they included a great variety of beings, some of them belonging to the mollusks, others to the articulate type; being, in fact, microscopic shrimps, and so far from being a class by themselves, they seem to comprise representatives of every class except the vertebrates. In these investigations many of these *infusoria* have been found to be vegetable in their nature.

Still many naturalists have insisted upon a fifth division, lower than the radiata, called the protozoa. "This division has been proposed to contain that vast cloud of miscroscopic beings on the verge of the animal kingdom which could not be received into either of the subkingdoms." Protozoans, we are told, have no organs; they could not be more simple. They are devoid of muscle, nerves, or stomach; they are as structureless as a drop of jelly; they feel without nerves, move without muscles, and digest without a stomach. In Fig. 9 we have a picture of an animal of this kind; it is so constantly altering



Fig, 9.

its outline that it does not retain the same shape for two successive minutes. It obtains its food by flowing around it, and digests by direct absorption. Here we pause. Is it an animal? We feel that we are on debatable ground, on the border land between the animal and vegetable kingdom, where, as yet, no distinctive line has been drawn. "Probably life is essentially the same in the two kingdoms; and to vegetable life faculties are superadded in the lower animals, some of which are here and there not indistinctly foreshadowed in plants." "It must be said that there are organisms whose phenomena at one period is such as to justify us in speaking of them as animals, while at another period they appear to be as distinctly vegetable." Leaving this debatable ground of the protozoa till scientists have grown sure, we again repeat our four divisions—the radiates, the mollusks, the articulates, and the vertebrates.

Geological Testimony.

In the 16th century some stones were found bearing the impression of a star on their surface. Naturalists puzzled their brains about them. Beside the stony stars, impressions of a peculiar kind were observed in the rocks, resembling flowers on long stems, and called "stone lilies." There are natural divisions of these stems, where they are easily broken, and on each fragment is stamped a star-like impression. We cannot in these few pages tell much of the puzzling theories which naturalists formed of them, but merely the conclusion finally reached.

About a century ago a naturalist found a curious living specimen at Porto Rico, which at first seemed to him a vegetable, so that he called it a marine palm; this, he felt sure, bore some relation to the fossil lilies of the rocks. Cuvier studied this specimen—what was it? At last he saw it was really a star-fish, but a star-fish with a stem; it was now easy to see that the "stone-lilies" were the fossil remains of similar star-fishes. Then began the study of the fossil animals.

"And what does this fossil creation tell us? It says this: that in the Silurian Period, taken in its most comprehensive sense, the first in which are found the remains of life, there were the three classes of radiates, the three classes of mollusks, two of the class of articulata, and one class of vertebrates—the *fishes*. In other words, at the dawn of life on earth, the plan of the animal creation with its four fundamental ideas was laid out; radiates, mollusks, articulates, and vertebrates were present at that first representation of life upon our globe."* Don't misunderstand; don't suppose the same kinds of fishes that now swim in our waters were to be found then; that the same kinds of radiates we now study then adorned the globe. We only mean to state the existence of the four plans, for, though all the types were introduced upon the earth simultaneously, these types have been represented in every great geological period by different sets of animals.

"There is nothing more striking in these early populations than the richness of the types. It would seem as if, before the world was prepared for the *manifold* existences that now find their home upon the earth, when organic life was limited by the absence of many of the conditions that now prevail, the whole wealth of Creative Thought lavished itself upon the forms first introduced upon the globe." After thirty years' study of the fossil crinoids, Agassiz speaks of finding each day some new evidence of the ingenuity, the invention, and the skill shown in varying this single pattern of animal life.

"These crinoids, or sea-lilies, seem," he tells us, "like the productions of one who handles his work with an infinite ease and delight, taking pleasure in presenting the same

* Agassiz's "Method of Study of Natural History."

thought under a thousand different aspects. Some new cut of the plates, some slight change in their relative position, is constantly varying their outlines, from a close cup to an open crown, from a long pear-shaped oval in some to a circular, or square, or pentagonal form in others. An angle that is simple in one, projects by a fold of the surface, and becomes a fluted column in another; a plate that in one is smooth, in another will wear a symmetrical figure drawn upon it in beaded lines." The ornamentation changes, but the pattern, throughout its changes, remains the same. It would require an endless number of illustrations to give even a faint idea of the variety of these fossils.

Why must we always speak of these lower animals by long technical names? Why do we get our best ideas of them from drawings rather than from real life? "When the forms of animals shall become as familiar to children as their A B C, and the intelligent study of natural history from the *objects themselves*, and not from text-books, is introduced into all our schools, we shall have popular names for things that can now only be approached with a certain professional stateliness on account of their technical nomenclature."

"The best results of such familiarity with nature will be the recognition of an intellectual unity holding together all the various forms of life as parts of one Creative Conception."

A FEW FACTS ABOUT ZOOLOGY.

[THOUGHT-OUTLINE TO HELP THE MEMORY.]

1. Vastness of animal life? Theory on which classification is made? Cuvier? Four forms? Baer? Methods of growth?
2. Illustrations of Radiata? Agassiz? Form of the Mollusk? Illustrations? Difference between affinity and analogy? Classes of articulates? Insect types? Peculiarities? Vertebrates? Mammalia the highest group?
3. Recapitulation? Geological testimony? Stone-lilies? Cuvier's discovery? Agassiz again?

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