REVIEWS.

Biologische Studien. Von Dr. ERNST HAECKEL, Erstes Heft. Studien ueber Moneren und andere Protisten. (See Plate V.)

THE volume which Dr. Haeckel has just published contains reprints of several papers already put out by him in the 'Jenaische Zeitschrift,' together with two additional notices of new forms of Monera which we have not previously seen. The monograph of the Monera is already well known to our readers, since it was reproduced in full in this Journal during the year 1869. Succeeding this in the present volume is a series of papers entitled "Contributions to the Plastid Theory." In the first of these Haeckel points out what he means by the 'Plastid theory,' which he discusses in connection with the generally received 'Cell theory.' Just as at one time the cell was conceived to be the simplest living form, as seen in the ovum and unicellular organisms, and just as it was conceived that organisms are built up by aggregations of these simplest morphological units, so must we now admit the existence of still simpler units—the simplest conceivable—mere bits of protoplasm, undifferentiated, without nucleus, living freely as Monera, and possibly also becoming aggregated also to form tissue. That such units should exist is what we were gradually led to expect by the researches of Max Schultze and others, resulting in the abandoning of the cell-wall, and the rise of the all-important protoplasm-theory. It is Haeckel who has discovered them. He calls these simplest units Cytods, and classes Cytods and Cells together under the head Plastids. The cytod being the simplest possible [redacted] form of life, it is this form under which life first appeared, and it is this which we should look to see formed by so-called spontaneous generation. In the course of development the cytod has given rise to the cell by internal differentiation of a nucleus. Since the development of the individual (Ontogeny) is a more or less complete epitome of the development of the species (Phylogeny), we should expect such Plastids as are cells to pass through the cytod condition in their life-cycle, and we find that they actually do. Since the cytod is the earliest form, all organic beings have sprung from it, but all but Monera have passed through the cell stage also, and hence in all the higher forms the cytod condition in the development of the individual is obscure, the ovum appearing first as a cell, though Amœbæ, Gregarinæ, and Radiolaria reproduce by cytods. But we may add to what Dr. Haeckel says on this point, that if we trace the development of the ovarian ovum, we actually can and do follow it back to the cytod condition. Dr. Haeckel would suggest that the disappearance of the nucleus which certainly occurs in some ova, at the time of impregnation (though in others it as certainly persists), is a reversion to the ancestral cytod form and is to be explained in this way. These views give very great importance to the cell-nucleus, and it is well to dwell on this, since there is a tendency to overlook it, even to consider it an artificial product of the reagents used in microscopical investigation. Dr. Haeckel is very firm on this question; he points to a division of labour between nucleus and surrounding plasm, and adduces the observation of the nuclei in the cells of living transparent pelagic organisms to confront those who doubt their living existence. On the other hand, he distinguishes two kinds of cytods. It is not every Plastid devoid of nucleus which is a cytod, for by "degradation" or "retrogressive metamorphosis" (Rückbildung), a cell may lose its nucleus and is not then to be confounded with an ancestral, nucleusless cytod, though like it in simplicity. It is a "sham-cytod" or "dyscytod." Such are the red blood-cells and the horny epidermic scales of mammals. Plastids and cytods have been elsewhere further classified by Haeckel according to such characters as the presence of a wall (cell-wall), &c. It is this modification, then, of the cell-theory, viz., the Plastid-theory, which gives the Monera so much interest in connection with the doctrines of evolution and the question of Abiogenesis.

Following his remarks on the Plastid theory Haeckel gives a detailed account of Bathybius, fully abstracting Huxley's memoir, in which its existence was first made known, published in this Journal in October, 1868, and adding an account of his own researches. The protoplasmic network of Bathybius is considered by Haeckel apart from the coccoliths with which it is often densely studded, but of which it is sometimes destitute. He points out that the separate "cytods" of Bathybius average about ·08 of a millimetre in diameter, reaching ·1 of a millimetre, and their protoplasm is spread out in ramifying branches as in many myxomycetes (Pl. V, fig. 5).

He differs from Huxley, who found the "protoplasm" to consist of a jelly-like matrix, unstainable by iodine, and not affected by dilute acetic acid, enclosing granules which are stained yellow by iodine, and dissolve in acetic acid. Haeckel has, indeed, found this jelly-like matrix in some cases, but these were shrivelled-up masses, not like the ramified Bathybius cytods, and he thinks their form and the jelly-like matrix are due to *post-mortem* change, the matrix having, in fact, been compared by Huxley to a similar substance formed by the death of the protoplasm of the Radiolarian Sphærozoum. This substance Haeckel does not consider to be protoplasm at all, though the granules it encloses are. The true protoplasmic cytods were more abundant in the Atlantic ooze (preserved in strong alcohol), which Haeckel examined; they stained yellow with iodine, orange-yellow with nitric acid, and red with carmine solution in ammonia, which the jelly-matrix does not, though its enclosed granules do. Haeckel considers the carmine staining a reaction of the highest importance in micro-chemical investigations. With very high powers and great care a granular structure was detected in some of the protoplasmic cytods. This was probably the first indication of that *post-mortem* change which gave to Huxley the jelly-like matrix enclosing fine granules.

Some additions are made in this memoir to Huxley's description of the coccoliths and coccospheres. Haeckel remarks upon the great difficulty of satisfactorily investigating these very minute bodies, since it is necessary to get a flat and a side view of the same specimen. Their enormous abundance, however, lessens the difficulty. We have found glycerine jelly or serum a better medium for their examination than Canada balsam. A power of 1200 diameters is necessary. Haeckel distinguishes in all, five zones—a central *nucleus*, sometimes double, lying in a *medullary substance*, which is surrounded by a *medullary ring;* external to this follows the *granular zone*, and then the outermost *marginal ring*. Huxley describes discoliths or simple monodiscous coccoliths, and cyatholiths or amphidiscous coccoliths. Haeckel points out that there are circular discoliths as well as oval ones, which alone were described by Huxley. He also remarks that the cyatholiths are simply two discoliths united by an axial piece, generally a smaller circular discolith with a larger oval discolith. The convexity of the oval discolith varies very much, as also does the length of the uniting axial piece. The exact nature of the connection between the two parts of the cyatholith Haeckel cannot decide, though he thinks that protoplasmic matter present in the *granular zone* of the two takes part in it. He does not determine how their connection came about, whether when very minute or after growth, or whether they were ever separate at all. The coccospheres Haeckel found to be excessively rare. He, however, found the granular zone present in their component coccoliths, which Huxley did not. He found them made up either of oval or round discoliths, or of cyatholiths, the coccoliths in one coccosphere being nearly always of the same kind. He agrees with Huxley that it is improbable that the coccoliths result from the breaking up of the coccospheres. At the same time his detection of the granular zone proves the absolute identity of the two in structure.

The most important part of Haeckel's researches in this matter is now to be mentioned; we have briefly called attention to it in our last volume. In February, 1867, Haeckel found floating on the surface of the sea numbers of a new Radiolarian—allied to the Thalassicollæ—which he proposes to call *Myxobrachia,* and which contains concretions embedded in its extra-capsular sarcode, which are identical with the coccoliths and coccospheres.

Myxobrachia is very large, seeing that it is one of those Radiolarians having but one central capsule, namely, about half an inch long. Two species are distinguished, one *M. rhopalum* (Pl. V, fig. 1), pear-shaped, floating with the larger part just on the surface of the sea, and the stalk-end hanging down; the upper part contains the central capsule: the depending process has an axis of the yellow cells characteristic of Radiolaria, and a mass of calcareous concretions at the end. The second species, *M. pluteus,* looks like an Echinoderm larva; it has exactly the same structure as *M. rhopalum,* but in place of one process depending there are sixteen arranged in three rows (Pl. V, fig. 2). The calcareous concretions in this present the closest resemblance to the coccoliths and coccospheres, but Haeckel will not assert absolutely their identity. Both species are capable of elongating and contracting themselves, and are beset with short pseudopodia. The central capsule (figs. 1, 2 *cc*) is about one millimetre in diameter, perforated by fine pore-canals. It contains a *vesicula intima* (fig. 3), which is constricted into a number of oblong bladders radially, as in *Thalassicolla pelagica.* Between it and the wall of the central capsule are numerous small cells (the truly cellular nature of these probably reproductive bodies, as seen in their nuclei, is important), and protoplasmic fluid. There are also floating in this space numerous blood-red oil-globules. The mass of the body is composed in both Myxobrachiæ of *sarcode jelly,* which is relatively more abundant in this form than in any other of the Monocyttaria, and the whole surface of which is covered with numerous fine and short pseudopodia (fig. 4). Around the central capsule is a mass of clear hyaline corpuscles (figs. 1 and 2 *ac*), which Haeckel has elsewhere called extra-capsular alveoli. They contain each a nucleus and a watery fluid, and are probably true *cells*, as above defined in discussing the nature of plastids. These hyaline cells are probably to be considered as a large-celled form of connective tissue, and are similar to the tissue so common in the lower animals (worms, molluscs, crustacea), known as "Blasengewebe." Besides these extra-capsular cells there are extra-caspular oil-globules and yellow cells which contain starch, the latter being aggregated to form the axis of the finger-like process or processes, each of which has calcareous concretions at its end. Radiating streams of softer protoplasm pass from the central capsule to the surface through the denser, structureless, sarcode jelly.

The coccoliths are to be regarded as spicula of Myxobrachia in all probability. Similar spicula were figured by Haeckel in *Thalassicolla morum*, but *calcareous* spicula were not certainly known before in Radiolaria, though all Radiolaria do not necessarily possess siliceous skeletons. A new Thalassicolla, of smaller size than the large Myxobrachia, was found by Haeckel off the Canaries, which he calls *Th. sanguinolenta*. It presents strong resemblance to Myxobrachia in its alveolar cells and central capsule, and it is suggested that this form may ultimately develop into Myxobrachia. The great peculiarity of the latter is in its finger-like processes with their concretions. It is possible but not likely that the coccolith-like concretions are taken in with food, but the other accompanying Radiolaria do not exhibit them. In any case, if we admit the coccoliths to be the spicula of Myxobrachia their history is not solved, for, says Haeckel, it is very unlikely that the innumerable masses of myriads of coccoliths and coccospheres forming the Atlantic ooze have been derived from Myxobrachiæ, which have sunk to the bottom after their death. He waits for further observation.

The discovery of starch in the yellow cells of Myxobrachia and several other Radiolaria—which cells, by the way, are true cells—is recounted in detail. Both Müller and Haeckel had previously failed in recognising the starch on former occasions with the iodine test (iodine dissolved in potassium iodide), with which he has now succeeded. He attributes this to the use of higher powers (1200 diameters), which enables him clearly to see the *blue* coloration of the *nucleus* of the yellow cells when the test is applied, the blue being again discharged by caustic alkali. The amount of starch thus indicated is something enormous, more than the half of the whole animal's bulk. The physiological significance of this is very great. Haeckel has a laugh by the way at Alexander Stuart, of St. Petersburg, whose remarks on Radiolaria, based on the study of his *Coscinosphæra ciliosa*, are futile, since that form is no Radiolarian at all, but only *Globigerina echinoides*.

Some highly important remarks are made by Haeckel as to the cellular, or rather plastidian, structure of the Rhizopoda. He, as is well known to the reader, separates from the class Rhizopoda the Monera, the Protoplasta or Amœboidea (Amœbæ, Arcellæ, Gregarinæ, &c.), and the Myxomycetes, leaving as true Rhizopods the Acyttaria (Monothalamian and Polythalamian foraminifers), and the Radiolaria (Monocyttaria and Polycyttaria), as well as the small group of the Heliozoa (Actinosphærium Eichhornii, Cystophrys of Archer, and other forms which that writer has made known). Max Schultze has said that the contractile substance of all Rhizopods consists of the naked, free, contractile protoplasm of *one cell*, or of *several cells fused together* so as to form a larger mass of protoplasm. This is true, Hæckel says, for those Rhizopods in which true cells are to be traced. Such cells are found in Heliozoa, for instance, in Actinosphærium, and occur in all true Radiolaria, *e. g.* the yellow cells, the intra-capsular pigment cells, the alveolar cells surrounding the central capsule, and (as he now shows from examination in several cases with reagents) the numerous clear intra-capsular corpuscles, which he feels convinced are true reproductive elements. The objective proof of this subjective conviction he has not, in spite of efforts made in the Canaries, been able to obtain. The probability is that the cells in the central capsule are spores, which either within the capsule or after bursting from it develop each into a multicellular body. Of the cells of such a body some become pigment-cells, some yellow starch-holding cells, some other spores, whilst others, by fusion, form the sarcode mass and the free protoplasm of the Radiolarian. He has convinced himself that *no central capsule exists,* but simply a central mass of cells in the young stages of the Acanthodesmiadæ and Sponguridæ. The young Radiolaria, devoid of central capsule, are the morphological equivalents of the Heliozoa (Actinosphærium, Cystophrys, &c.).

In the Acyttaria, on the other hand, there is absolutely no trace of cell structure. Gromia, Globigerina, and others, give no trace of a nucleus. They are simply cytods, not cells. They reproduce by spore-formation, amounting merely to the separation of a piece of their body-substance.

The Acyttaria are simple cytods or aggregates of cytods, and stand genealogically at the base of the Rhizopoda; the Heliozoa in which the component plastids first develop a nucleus, connect them to the more complex Radiolaria with their central capsule. Hence, it cannot be said with Schultze that the protoplasm of all the Rhizopoda arises from the fusion of *cells*. An artificial classification would lead us to relegate the Acyttaria thus to the Monera as cytods, and to class the Heliozoa and Radiolaria as truly cellular organisms, with the undoubtedly cellular Myxomycetes. A difficulty would arise from the fact that the free plasmodium of the Myxomycetes is devoid of nuclei, and resembles an aggregate of cytods, though the spores are true, nucleated cells. As we have sham cytods, dyscytods (red blood-corpuscles, &c.), so we have sham cytod-aggregates, resulting from the degradation of true cells, and such is the plasmodium of Myxomycetes. The natural or genealogical classification of the Rhizopods is to place the Acyttaria, Heliozoa, and Radiolaria as three steps in the development of the same group.

Magosphæra is the name of a new organism which Haeckel places in a new class, the Catallacta, intermediate between the Flagellata and Protoplasta (Amœboidea). He found it in September last year, in some conferva in salt-water ditches in the Island of Gisoe, off the coast of Norway. He observed its complete life-history, which he figures in a plate in this book. As we noticed on a former occasion, the conversion of definite cilia into protoplasmic pseudopodia was observed in the development of this form by Haeckel, as well as the converse in the ova of certain Siphonophora, and the consequent *identity of ciliary and amœboid-protoplasmic movement* inferred. The successive stages presented by Magosphæra may be thus grouped: A. *Quiescent* (vegetative period). 1. Unicellular quiescent stage (egg). 2. Multicellular quiescent stage (cleavage). B. *Active* (animal period). 3. Multicellular swarm stage (Volvox-like form). 4. Unicellular ciliate stage (Peritricha-like form). 5. Unicellular amœboid stage (Amœba-like form).

A new species of the genus *Vampyrella* of Cienkowski, which forms one of Haeckel's Monera, is also described here as living on a Gomphonema found on the Norway coast; also a new Protomonas (another genus of Monera, described by Cienkowski, for which see the Monograph of Monera in this Journal, 1869) to be called *Protomonas Huxleyi*, and some new Protamœbæ, all of which are figured.

A telling chapter is headed the Plastid theory and the Carbon theory; it contains views which have been already put forward by the author in his general 'Morphology,' and which have been before this expounded to the people of England. Either, says Haeckel, there is one nature manifest in the laws which rule supremely and on every side, or there are two natures—an organic nature, in which necessarily working causes (causæ efficientes) are active, and an organic nature in which specially contrived causes (causæ finales) are at work. The adherents of evolution accept the first, its opponents the latter view. The former hold to a *monistic* and mechanical view of nature, the latter to a teleological and dualistic one. The plastid and the carbon theory—that is, the conception of life as the property of the simplest bits of jelly—of protoplasm as its "materielle Grundlage"—this protoplasm or urschleim being nothing more than a carbon-compound, owing all its wonderful properties to the unique power of complex chemical binding possessed by carbon, enables us to dispense with the second nature. By it and Darwin's law of survival of the fittest, we can hope to account to ourselves for all phenomena by one universal code of laws, and establish the philosophy of Monism.

It is Professor Haeckel's great merit to have discovered life without structure, which was first clearly made known by his 'Researches on Monera.' He claims to have advanced a step towards the goal of biological science, pointed out by Carl Ernst Baer in his classical 'History of Animal Development,' "That fortunate one will win the palm for whom it is reserved to trace back the constructive forces of the animal body to the universal forces or laws of being of the entire world."

Professor Haeckel's remarks on the spontaneous generation question are especially interesting at this time. Approached in the light of his researches and the evolution theory, we must recognise, he says, that the oft-repeated, much be-wondered experiments which are made to prove or to disprove spontaneous generation, are useless. We must go another way to work. We could never hope to see the development of life from inorganic matter as long as cellular organisms were the simplest known to us, nor can we attach value to experiments professing to show this; our chance is, however, bettered by the discovery of the Monera. These we may possibly see developing from matter devoid of life. Of these Bathybius is the most likely to present such a phenomenon. If Monera are not produced at the present time by Abiogenesis, they must have gone on reproducing under their present simple form, unchanged in all essential respects for countless ages. For the consideration of those who would hold living matter to be something mysterious, endowed with a force unlike that which we see in other things, Haeckel submits the following grouping:

a. Natural world: simple combinations of the elements, salts, alcohol, acetic acid, which have been formed synthetically by chemists.

b. Supernatural world: Felspar, Fluorspar, Augite, most other minerals, albumens, chitin, &c.: all bodies which have not been artificially made yet, and which, therefore, are said to have arisen by "creation," that is, by supernatural ways through some external, mysterious, creative power.

An enumeration of the Monera as they now stand finishes this most interesting collection of "studies," with which we will conclude our review.

a. Gymnomonera. *Protamœba* (3 freshwater, 2 marine species). *Protogenes* (1 species, marine). *Bathybius* (1 species, marine).

Lepomonera. *Protomonas* (1 freshwater, 1 marine species).

Protomyxa (1 spec. marine), *Vampyrella* (3 freshwater, 1 marine species), *Myxastrum* (1 spec. marine).

It is probable, the author observes, that the common Actinophrys sol belongs here. Of the 15 known species Haeckel described 11, Cienkowski 3, and Huxley 1. They are widely distributed, occurring in ponds at Jena, in the Atlantic, and off Norway. It is probable that they will prove to be very numerous.

Principles and Practice of Medical Jurisprudence, by Alfred Swaine Taylor, M.D., F.R.S. London: J. and A. Churchill.

If any one will take the trouble to compare this work with those that have preceded it, he will at once perceive to how large an extent the study of medical jurisprudence is indebted to inquiries conducted by the aid of the microscope. It was an early hope of those who had investigated the tissues of the animal body with the microscope, that one day its results would influence decisions in our courts of law, and that its power to detect the nature of blood-produced stains might take from the murderer his too frequent excuse, that the spots of blood on his garments were those of