ON THE ORIGIN AND METAMORPHOSES OF INSECTS*

VIII.

FOR the next descending stage we must, I think, look among the Infusoria, through some such genus as Chætonotus or Ichthydium. Other forms of the Rotatoria, such for instance as Rattulus, and still more the very remarkable form discovered last year by Mr. Hudson,† and described under the name of *Pedalion mira*,

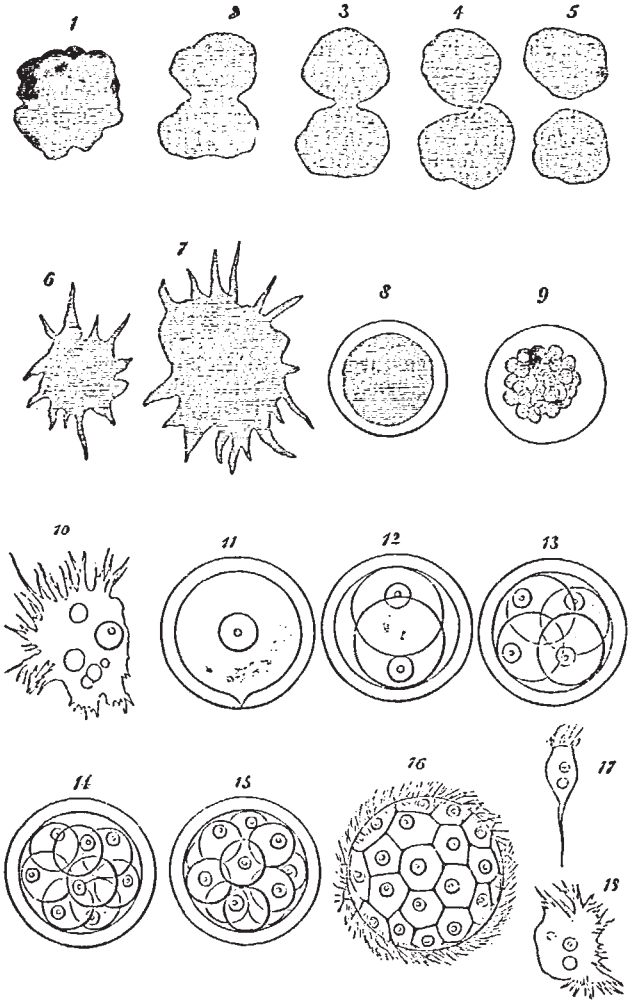

PLATE 5.

Plate 5.—Figs. 1–5, Protamœba. 6–9, Protamyxa Aurantiaca. Haeckel Beit. zur. Monog. der Moneren, Pl. 1. 10–18, Magosphœra planula Haeckel lc., P.l. 5.

seem to lead to the Crustacea through the Nauplius form. Dr. Cobbold tells me that he regards the Gordii as the lowest of the Scolecida; Mr. E. Ray Lankester considers some of the Turbellaria, such genera for instance as Mesostomum, Vortex, &c., to be the lowest of existing worms; that is to say, if we exclude the parasitic groups. Haeckel‡ also regards the Turbellaria as forming the nearest approach to the Infusoria. The true worms seem, however, to constitute a separate branch of the animal kingdom.

We may take the genus Prorhynchus,§ for instance, as an illustration of such a low type (Fig. 59), which consists of a hollow cylindrical body 1½ to 2‴ long, containing a straight simple tube, the digestive organ.

But however simple such creatures as these may be, there are others which are far less complex, far less differentiated; which therefore on Mr. Darwin's principles may be considered still more closely to represent the primæval ancestor from which these more highly developed types have been derived, and which, in spite of their great antiquity, in spite of, or perhaps in consequence of their simplicity, still maintain themselves almost unaltered.

Thus the form which Haeckel has described* under the name of *Protamœba primitiva*, Pl. 5, Fig. 1–5, consists of an entirely homogeneous and structureless substance, which continually alters its form; putting out, and drawing in again, more or less elongated processes, and creeping about like a true Amœba, from which, however, Protamœba differs in the absence of a nucleus. It seems impossible to imagine anything simpler; indeed, as described, it appears to be an illustration of properties without structure. It takes into itself any suitable particle with which it comes in contact, absorbs that which is nutritious, and rejects the rest. From time to time a constriction appears at the centre (Pl. 5, Fig. 2), the form approximates more and more to that of an hour-glass (Pl. 5, Fig. 3), and at length the two halves separate, and each commences an independent existence (Pl. 5, Fig. 5).

In the true Amœbas, on the contrary, we find a differentiation between the exterior and the interior: the body being more or less distinctly divisible into an outer layer and an inner parenchym. In the Amœbas, as in Protamœba, multiplication takes place by self-division, and nothing corresponding to sexual reproduction has yet been discovered.

Somewhat more advanced, but yet of great simplicity, is the *Protomyxa aurantiaca*, discovered by Haeckel† on dead shells of Spirula, where it appears as a minute orange speck, which shows well against the clear white of the Spirula. Examined with a microscope the speck is seen to be a spherical mass of orange-coloured, homogeneous, albuminous, matter, surrounded by a delicate, structureless, membrane (Pl. 5, Fig. 8). It is obvious from this description that these bodies closely resemble eggs, for which indeed Haeckel at first mistook them. Gradually however the yellow sphere broke itself up into smaller spherules (Pl. 5, Fig. 9), after which the containing membrane burst, and the separate spherules, losing their globular form, crept out as small Amœbæ (Pl. 5, Fig. 6), or amœboid bodies. These little bodies moved about, assimilated the minute particles of organic matter, with which they came in contact, and gradually increased in size (Pl. 5, Fig. 7) with more or less rapidity according to the amount of nourishment they were able to obtain. They threw out arms in various directions, and if divided each section maintained its individual existence. After a while their movements ceased, they contracted into a ball, and again secreted round themselves a clear structureless envelope.

This completes their life-history as observed by Haeckel, who found it easy to retain them in his glasses in perfect health, and who watched them closely. It also coincides very closely with that of the Gregarinæ, another group of singularly egg-like organisms.

As another illustration I may take the *Magosphæra planula*, discovered by Haeckel on the coast of Norway.

In one stage of its existence (Pl. 5, Fig. 10) it is a minute mass of gelatinous matter, which continually alters its form, moves about, feeds, and in fact behaves altogether like the Amœba just described. It does not however remain always in this condition. After a while it contracts into a spherical form (Pl. 5, Fig. 11), and secretes round itself a structureless envelope, which, with the nucleus, gives it a very close resemblance to a minute egg.

* Continued from p. 167.
† "On a New Rotifer." *Monthly Microscopical Journal*, Sept. 1871.
‡ Generale Morphologie. V. ii, p. lxxix
§ Gegenbaur. Grund. d. Vergleich. Anat. p. 210. See also Beitrage Zur Naturg. der. Turbellarien. Dr. M. S. Schultze, 1851. Pl. vi, fig. 1.

* Monographie der Moneren, p. 43.
† Monographie der Moneren, p. 10.

Gradually the nucleus divides itself, and the protoplasm also separates into two spherules (Pl. 5, Fig. 12); these two subdivide into four (Pl. 5, Fig. 13), and so on (Pl. 5, Fig. 14), until at length thirty-two are present, compressed into a more or less polygonal form (Pl. 5, Fig. 15). Here this process ends. The separate spherules now begin to lose their smooth outline, to throw out processes, and to show amœboid movements like those of the creatures just described. The processes or pseudopods grow gradually longer, thinner, and more pointed. Their movements become more active, until at length they take the form of ciliæ. The spherical Magosphœra, the upper surface of which has thus become covered with ciliæ, now begins to rotate within the cyst or envelope, which at length gives way and sets free the contained sphere, which then swims about freely in the water (Pl. 5, Fig. 16), thus closely resembling Synura, or one of the Volvocineæ. After swimming about in this condition for a certain time the sphere breaks up into the separate cells of which it is composed (Pl. 5, Fig. 17). As long as the individual cells had remained together they had undergone no changes of form, but they now show considerable contractility, and gradually alter their form, until they become undistinguishable from true Amœbæ (Pl. 5, Fig. 18). Finally, according to Haeckel, these amœboid bodies, after living for a certain time in this condition, return to a state of rest, again contract into a spherical form, and secrete round themselves a structureless envelope.

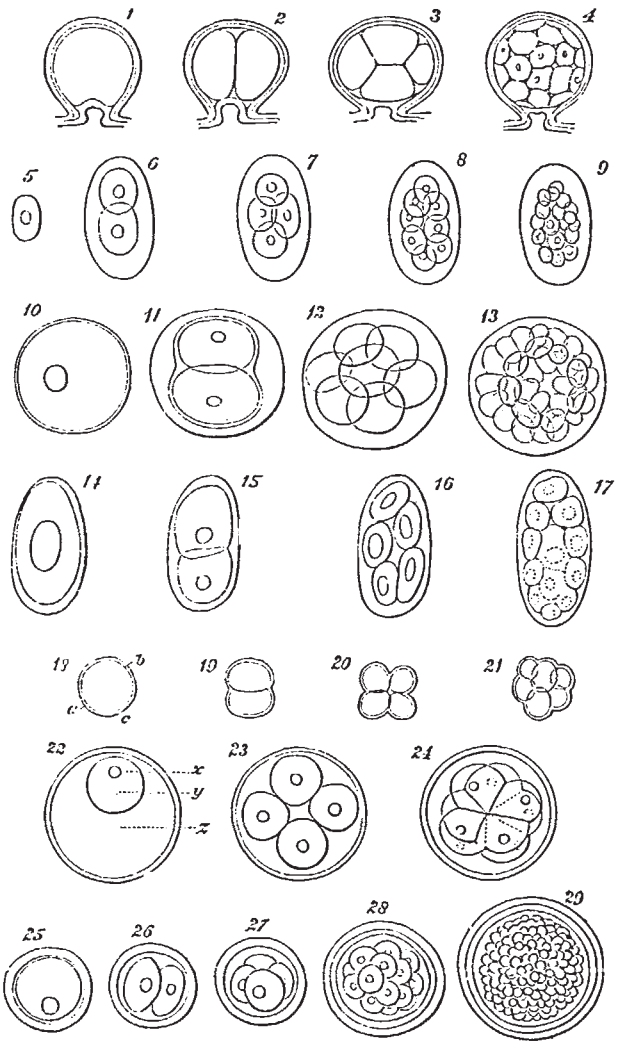

PLATE 6.

Plate 6.—Figs. 1—4, Yolk-segmentation in Laomedea; 5—9, in Filaria; 10—13, in Echinus; 14—17, in Lacinularia; 18—21, in Purpura; 22—24, Amphioxus; 25—29, Vertebrata.

It may be said, and said truly, that the difference between such beings as these and the Campodea, or Tardigrade, is immense. But if it be considered incredible that even during the long lapse of geological time such great changes should have taken place as are implied in the belief that there is any genetic connection between insects and these lower groups, let us consider what happens under our eyes in the development of each one of these little creatures, in the proverbially short space of their individual life.

I will take for instance the first stages, and for the sake of brevity only the first stages, of the life history of a Tardigrade.* As shown in Fig. 60, the egg is at first a round body, with a clear central cell—the germinal vesicle; it increases in size, and after a while the yolk and the germinal vesicle divide into two (Fig. 61), then again into four (Fig. 62), and so on, just as we have seen to be the case in Magosphœra. From the minute cells (Fig. 63) arising through this process of yolk-segmentation, the body of the Tardigrade is then built up.

It is true that among the Insecta generally, normal yolk-segmentation does not occur, though the first stages of development in Platygaster, as figured by Ganin (ante Figs.), closely resemble those of the Tardigrada.

Though I will not now attempt to point out the full bearing of these facts on the study of embryology generally, yet I cannot resist calling attention to the similarity of the development of Magosphœra with the first stages of development of other animals, because it appears to me to possess a significance, the importance of which it would be difficult to over-estimate.

Among the Zoophytes Prof. Allman thus describes† the process in Laomedea, as representing the Hydroids (Pl. 6, Fig. 1, represents the young egg):—"The first step observable in the segmentation-process is the cleavage of the yolk into two segments (Pl. 6, Fig. 2), immediately followed by the cleavage of these into other two, so that the vitellus is now composed of four cleavage spheres (Pl. 6, Fig. 3)." These spheres again divide (Pl. 6, Fig. 4) and subdivide, thus at length forming minute cells, of which, as in the previous cases, the body of the embryo is built up.

In Pl. 6, Figs. 5—9 represent the corresponding stages in the development of a small parasitic worm—the *Filaria mustelarum*—as given by Van Beneden.‡ The first process is that within the egg, which represents, so to say, the encysted condition of Magosphœra,; the yolk divides itself into two balls (Pl. 6, Fig. 6), then into four (Pl. 6, Fig. 7), eight, and so on, the cells thus constituted finally forming the young worm. I have myself observed the same stages in the eggs of the very remarkable and abnormal *Sphærularia bombi*.§

Among the Echinoderms M. Derbès thus describes the first stages (Pl. 6, Figs. 10—13) in the development of the egg of an Echinus (*Echinus esculentus*):—"Le jaune, commence à se segmenter, d'abord en deux, puis en quatre et ainsi de suite, chacune des nouvelles cellules se partageant à son tour en deux."‖ Sars has observed the same thing in the starfish.¶

* See, for instance, Kauffmann, Uber die Entwickelung und systematische stellung der Tardigraden. Zeits. f. Wiss. Zool. 1851, p. 220.

† Monograph of the Gymnoblastic or Tubularian Hydroids, by G. J. Allman. Ray. Soc. 1871, p. 86.

‡ V. Beneden, Mem. sur les Vers Intestinaux, 1858.

§ Natural History Review, 1861, p. 44.

‖ Derbès, Ann. des Sci. Nat. 1847, p. 90.

¶ Fauna Littoralis Norvegiæ, pl. viii.

In the Rotatoria, as shown by Huxley in Lacinularia,* and by Williamson in Melicerta,† the yolk is at first a single globular mass, the first changes which take place in it being as follows:—"The central nucleus becomes drawn out and subdivides into two, this division being followed by a corresponding segmentation of the yolk. The same process is repeated again and again, until at length the entire yolk is converted into a mass of minute cells." Among the Crustacea the total segmentation of the yolk occcurs among the Copepoda, the Rhizocephala, and Cirripedia. Sars has described the same process in one of the nudibranchiate mollusca ‡ (Tritonia), Muller in Entochocha,§ Haeckel in Ascidia,‖ Lacaze Duthiers in Dentalium.¶ Figures 18 to 21, Pl. 6, are taken from Koren and Danielssen's ** memoir on the development of *Purpura lapillus*.

Figs. 22-24 show the same stages in a fish (Amphioxus) as given by Haeckel, and it is unnecessary to point out the great similarity.

Lastly, figures 25 to 29, Pl. 6, are given by Dr. Allen Thomson,†† as illustrating the first stages in the development of the vertebrata.

I might have given many other examples, but the above are probably sufficient, and show that the processes which constitute the life-history of the lowest organised beings, very closely resemble the first stages in the development of more advanced groups; that, as Allen Thomson has truly observed,‡‡ "the occurrence of segmentation and the regularity of its phenomena are so constant that we may regard it as one of the best established series of facts in organic nature."

It is true that yolk segmentation is not universal in the animal kingdom; that there are great groups in which the yolk does not divide in this manner,—perhaps owing to some difference in its relation to the germinal vesicle, or perhaps because it has become one of these suppressed stages in embryological development, many instances of which might be given, not only in zoology, but, as I may state on the authority of Dr. Hooker, in botany also. But however this may be, it is surely not uninteresting, nor without significance, to find that changes which constitute the life-history of the lowest creatures, form the initial stages even of the highest.

Returning to the immediate subject of this work, I have pointed out that many beetles and other insects are derived from larvæ closely resembling Campodea, that other insects come from larvæ more or less like Lindia, and it has been shown over and over again that in many circumstances the embryo of the more specialised forms resembles the full-grown representatives of lower types. I conclude, therefore, that the Insecta generally are descended from ancestors resembling the existing genus Campodea, and that these again have arisen from others belonging to a type represented more or less closely by the existing genus Lindia.

Of course it may be argued that these facts have not really the significance which they seem to me to possess. It may be said that when Divine power created insects, they were created with these remarkable developmental processes. By such arguments the conclusions of geologists were long disputed. When God made the rocks, it was tersely said, he made the fossils in them. No one, I suppose, would now be found to maintain such a theory, and I believe the time will come when it will be generally admitted that the structure of the egg, and its developmental changes, teach us as truly the course of organic development in ancient times, as the contents of rocks teach us the past history of the earth itself.

JOHN LUBBOCK

* Trans. of the Microsc. Soc. of London, 1851.
† Quarterly Journal of Microsc. Science, 1853.
‡ Wiegmann's Archiv., 1840, p. 196.
§ Ueber die Erzeugung von Schnecken in Holothurier. Berlin, Bericht, 1851. Ann. Nat. Hist., 1852, v. ix. Muller's Archiv., 1852.
‖ Ann. des Sci. Nat. 1853, p. 89.
¶ Ann. des Sci. Nat, 1857, pl. vi.
** Naturliche, Schöpfungsgeschichte, pl. x.
†† Cyclopædia of Anatomy and Physiology. Art. Ovum, p. 4.
‡‡ Thomson, l.c. Article, Ovum p. 133.

NOTES

SIR CHARLES WHEATSTONE has been elected a Foreign Associate of the French Academy of Sciences in place of the late Baron Liebig.

MR. COLE's retirement from public service is now completed, and the Treasury have awarded him the full pension usually granted to officers who have completed fifty years of public service. Although Mr. Cole quits the South Kensington Museum, he will continue to assist in promoting the diffusion of Science and Art applied to productive industry as the Acting Commissioner for the estate purchased out of the surplus funds of the Exhibition of 1851. This estate at present comprehends the Horticultural Gardens, the buildings of the Annual International Exhibitions, and the Royal Albert Hall. Measures are in progress for forthwith commencing the National Training School for Music. A meeting of those interested in the Testimonial which it is proposed to present to Mr. Cole, will be held in Willis's Rooms to-morrow at 3 o'clock. Those who know best how much Mr. Cole has done for the encouragement and advance of Science, will, we are sure, be the most ready to take part in this well-deserved testimony to the value of his services to the public.

AFTER the alarming rumours that have recently found their way into the newspapers, it is a great relief to receive what appears to be really authentic news of the safety of Sir Samuel and Lady Baker. It appears, from the message received by the *Daily Telegraph*, that they arrived at Khartoum on the 29th of June. It is stated that the party had been as far south as a place called Mosindi, near the chief village of Kamrasi, the King of Unyoro, which would be in about 1°·45′ N. lat., and about 80 miles to the east of the shores of the Albert Nyanza. Here Sir Samuel is said to have been attacked by a chief named Kabriki, and, on his retreat, by a party of slave-hunters. He seems to have established another Egyptian station at a place called Fatiko, somewhere to the south of Gondokoro. The story about the Albert Nyanza and Lake Tanganyika being one, which forms part of the news published by the *Daily Telegraph*, is certainly very startling news, and must at present be received with great caution, though the *Telegraph* correspondent declares he received it direct from the lips of the Emancipator of Central Africa himself.

MR. AUBERON HERBERT'S Select Committee on the Wild Birds Protection Act has met three times, and examined a good many witnesses. It would not be fair to take the report, published in the *Field*, of what passed at those meetings as strictly correct, but if it be at all true, the doubt, before expressed in these pages (NATURE, May 1, 1873), as to any real good resulting from the inquiry, can hardly be otherwise than justified. The questions put by the chairman indicate, as far as we perceive, that he has a very hazy idea of the bearings of the whole subject, and no one of the other members appears to have sufficient knowledge of any part of it to follow home by cross-examination any of the evidence offered in reply. By many of the witnesses birds are regarded as divisible into two groups—the useful and the noxious—a simple classification which will be amusing to naturalists. Such witnesses also think that the destruction of the latter should be encouraged and the former protected—being quite innocent of the fact that no laws in the world will make most "useful" birds more numerous than they already are. It seems to us that the only way in which an inquiry of this kind could be satisfactorily conducted would be by a Royal Commission, in which the scientific element, so