of the *Turridæ*, from which we must at the same time remove the genus *Corydendrium*, which Allman had included in it on account of the uncertainty which still exists to its reproductive organs.

In regard to the habitat of this form, I may observe that my specimens were found in a very different condition from those of the first specimen described. Weismann had a colony which had been taken from a depth of 70 to 80 metres. On this account he refers to *Dendroclava Dohrnii* as a form living at great depths. My specimens on the contrary had been taken off the coasts of Nisida, and it is only necessary to glance at a bathymetric map of the Gulf of Pozzuoli to see that the island of Nisida is surrounded by waters of very inconsiderable depth.—*Bolletino Scientifico*, N. 3 e 4, Anno 1891.

On the Development of Bythinia tentaculata. By Dr. R. v. Erlanger, of the Heidelberg Zoological Institute.

Having been occupied for a long time with the embryology of Gastropods, I thought it desirable to test upon another Prosobranch the observations which I had made upon *Paludina vivipara*. For this purpose *Bythinia tentaculata* appeared to me to be most advantageous, since all the stages of development are to be had in any quantity, and the youngest are very suitable for sections on account of their relative size. Another circumstance strengthened me in my intention. *Bythinia* has already been the subject of a lengthy paper by P. Sarasin *, whose results were by no means to be reconciled with those which I had attained in the case of *Paludina*. The sequel will show that in almost all important points I have arrived at precisely opposite views to Sarasin, and that the development of *Bythinia* possesses a great similarity to that of *Paludina*.

After the expulsion of the directive vesicles the segmentation proceeds in the manner which is typical for the majority of Gastropods, and conforms closely to that of *Planorbis* and *Neritina*. Immediately after the division into two it becomes evident that the cells of the germ do not all divide simultaneously, but that the macromeres which are first formed gradually give rise to a large number of micromeres. I traced the segmentation as far as the stage with forty-eight cells; I did not succeed in following it further, on account of the excessive number of segments. By the time this stage is reached a segmentation-cavity of considerable size has been developed, which soon afterwards acquires its greatest dimensions. At the vegetative pole the four macromeres only are present, while the micromeres, which give rise to exclusively ectodermal elements, gradually diminish in size from the vegetative to the animal pole. The macromeres exhibit precisely the same arrangement as the corresponding cells in *Planorbis*. The anterior and posterior are in contact with one another, forming a sharply

* P. Sarasin, 'Entwicklungsgeschichte der *Bythinia tentaculata*.' Inaugural-Dissertation. Wiesbaden, 1882.

defined furrow between them, while the two lateral cells are separated from one another by the anterior and posterior ones. Thus the blastula already exhibits a bilaterally symmetrical structure.

The hindermost macromere may be termed the endo-mesoderm cell, since it divides into two cells, of which the one retains the position of the posterior macromere, while the other, moving in the longitudinal axis, passes more towards the animal pole. This cell then similarly divides into two, but in the direction of the longitudinal axis, and the two cells thus produced are the primitive mesoderm cells, which lie next one another on both sides of the longitudinal axis, dorsally to the posterior macromere.

After these processes have taken place the three other macromeres divide, but simultaneously with the fourth, which had superseded the endo-mesoderm cell, and furnish the endoderm cells of the wall of the archenteron. In the meantime the blastula flattens out dorso-ventrally, since the endoderm cells which have arisen from the macromeres, as well as the two primitive mesoderm cells, are surrounded by the ectoderm and pressed into the segmentation-cavity. With progressive flattening of the germ the archenteron is gradually formed by invagination of the endoderm, its walls being constituted by the progeny of the four macromeres. The flattening finally becomes so great that the segmentation-cavity is reduced to a cleft, while the blastopore forms an elongated oval which is situated in the longitudinal axis.

During this time the two primitive mesoderm cells, which on the invagination of the endoderm had come to lie at the hinder pole in the segmentation-cavity, have given rise to a mesodermic band on either side of the archenteron. Simultaneously with this the embryo has also lost its rounded form, and when seen from the ventral or dorsal surface appears as a spherical triangle with nearly equal transverse and longitudinal axes, and with the apex directed forwards and rounded angles.

At the next stage the blastopore forms a long slit, which occupies the whole length of the ventral side. The communication between the archenteron, which possesses a tolerably wide cavity, and the exterior persists at about the middle of the blastopore, while the edges of the blastopore elsewhere grow together. The mouth proceeds directly from the persisting communication between the blastopore and the exterior. The first traces of the velum now also appear in the shape of a double row of clear ciliated ectoderm cells, which form a girdle directed obliquely to the longitudinal axis, and which bisects the longitudinal axis in the dorsal median line and in the ventral median line passes in front of the anterior end of the blastopore. The mesoderm has become bilamellar and forms a saccule on each side on the right and left, which pass into one another at the hinder pole and gradually grow out forwards and dorsally. The cœlom lying between the two layers of the mesoderm is distinctly visible.

The archenteron soon changes its shape. It is broader in front, with a wider lumen, and narrows towards the hinder end, whereby its lumen becomes correspondingly smaller. In lateral view it is dorsally convex, ventrally concave. The shell-gland now appears upon the dorsal surface of the hinder end as a thickening of the ectoderm, and simultaneously the rudiments of the cerebral ganglia arise as lateral thickenings of the velar area. At this stage there further arises the glandular portion of the primitive kidney as a little heap of mesoderm cells. At the hinder end of the blastoporal groove a little pit is observable, which marks the spot at which subsequently the contracted end of the archenteron breaks through the ectoderm to form the anus.

The œsophagus arises by an invagination of the ectoderm at the spot where the mouth had originated from the blastopore, and exhibits in front of the mouth two large clear cells which belong to the velum. The velum itself is distinguished by the very large size of its cells, which show the concretions described by Sarasin, and are ciliated. It extends a very long way backwards.

Soon after this the foot is formed as a protuberance of the ectoderm on the ventral side behind the mouth. The œsophagus itself already exhibits the evagination of the radula pouch. Shell-gland and cerebral plates continue to increase in size, and the mesoderm grows round the archenteron more and more in a dorsal direction, while ventrally it gives rise to a considerable mass of cells, which is the rudiment of the pericardium.

The primitive kidney is brought into communication with the exterior by means of an ectodermal excretory duct lying beneath the hump-shaped lateral projections of the velum.

The embryo now grows more lengthwise, and its anterior end is distinctly marked off from the posterior, which bears the shell-gland, since it is separated from it by the foot. The kidney arises on the right side from a thickening of the pericardium; the latter has moved more towards the right and in a dorsal direction, owing to the torsion which now comes into play. The mantle-ridge appears somewhat later, and simultaneously there is formed in its vicinity a small invagination of the ectoderm, the rudiment of the excretory duct of the kidney.

In the rudiment of the pericardium, which was hitherto solid, a lumen arises, the pericardial cavity; the same thing happens in the kidney; the two lumina come into connexion with one another by a narrow opening, while the kidney itself opens by its excretory duct into the mantle-cavity, which has arisen through the outward growth of the edge of the mantle. The heart is formed as an invagination of the wall of the pericardium; it becomes constricted in the middle, and is thus divided into the auricle, which is situated in front, and the ventricle, which lies behind.

The ganglia arise in precisely the same way as in *Paludina* *, as separate thickenings of the ectoderm, which sever themselves from their place of origin, sink inwards, and then, and not before, come into connexion with one another by means of commissures and connectives. There is nothing to be seen of a continuous ingrowth of

* R. v. Erlanger, "Zur Entwicklung von *Paludina vivipara*," Zool. Anzeiger, no. 357 (1891).

ectoderm lying in the median longitudinal axis, from which, according to Sarasin, the pedal, intestinal, and visceral ganglia proceed, and which he homologizes with the ventral nerve-cord of the Annelids.

In opposition to Sarasin I must lay stress upon the following points. There is in *Bythinia* a separate mesoderm, which arises from the endoderm, and the development of which from the two primitive cells is traceable step by step. The archenteron proceeds from an invagination of the endoderm. The whole mid-gut, *i. e.* stomach and liver, as well as end-gut (if we can use the term at all as applied to mollusks), arises from the archenteron, which always exhibits a distinct lumen. The mouth proceeds directly from the blastopore, accompanied by an invagination of the ectoderm, which forms the œsophagus; consequently a complete closure of the blastopore does not take place. The anal opening corresponds to a small pit at the hinder end of the blastoporal groove. Primitive kidney and kidney, apart from their ectodermic excretory ducts, are of mesodermic origin; the same is true for the heart and pericardium. The ganglia arise completely separate from one another, and do not come into connexion until afterwards.—*Zoologischer Anzeiger*, xiv. Jahrg., 1891, no. 376, pp. 385–388.

On certain Reproductive Phenomena in Cirrhipedes. By M. A. Gruvel.

The history of the preliminary phenomena of fertilization in the Cirrhipedes is little known. Darwin, relying on the anatomical characters (length of the penis) and on the observation that the ova are not ripe at the same time as the spermatozoa, concluded that reciprocal fertilization must take place, but never actually witnessed it. I was fortunate enough, during my stay at the seaside *, to make a few interesting observations on this subject.

I had in a tank of the aquarium several specimens of *Balanus* (*B. tintinnabulum*) which had been living for some time and were adult; my attention was attracted by the very peculiar movements of one of them.

The movements of the cirri were accelerated, then all at once the latter stopped, opened behind, and from the midst of them there arose a sort of very mobile tentacle, which was moved to the right, to the left, backwards, and in every direction, as if seeking for something: this was the penis. Soon a contraction set in and emission took place; the penis then resumed its position between the cirri, which also resumed their ordinary movements, until the occurrence of a fresh series of similar phenomena.

My attention once directed to this point, I was not long in discovering analogous phenomena in *Lepas anatifera*.

Individuals of the latter species embrace one another to a certain extent with their cirri. It frequently happens that the fertilized

* These investigations were carried out at M. de Lacaze-Duthiers' laboratory of experimental zoology at Roscoff during the months of August and September, 1891.