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III.—Notes on some Turbellaria from Scottish Lochs. By C. H. Martin, B.A. (Magdalen College, Oxford). *Communicated by* Sir John Murray, K.C.B. (With Plates III., IV.)

(MS. received April 3, 1907. Read May 20, 1907.)

In this paper I wish to refer to some of the more interesting Turbellaria found during the months of July, August, and September 1905 at Ardeonaig on Loch Tay, and during August and the early part of September 1906 at Tarbet on Loch Lomond.

I also wish to describe in more detail a newly discovered Kalyptorhynch, and to put forward some observations on the origin of the nematocysts in some *Microstoma lineare.*

The opportunity of working on these forms occurred in connection with the work of the Scottish Lake Survey under Sir John Murray, to whom, for his unfailing kindness, I owe a very deep debt of gratitude.

Polycystis Goettei.

During the early summer of last year (1906) I found large numbers of small Proboscidea in a shallow pool on the Deri near Abergavenny, and later I found a few examples on the shores of Loch Lomond.

I had already completed my drawings and descriptions of this form when I found a full account of the animal by E. Bresslau in the *Zoologischer Anzeiger* for July 1906. As, however, there is as yet no account of this animal in English, and as my account differs from his in some important points, particularly as regards the water-vascular system, I have decided to publish it.

In those places in which it occurs, *Polycystis Goettei* is a very abundant form, swimming actively amongst water weeds, in association with *Prorhyncus stagnalis, Vortex truncatus,* and *Gyrator notops.*

Its food appears to consist mainly of copepods. In general appearance it closely resembles a small *Polycystis nægelii*: the body (Pl. III. fig. 1) is about 2 mm. long and more or less cylindrical, though the shape undergoes great changes, depending upon the extent of muscular contraction. In extreme cases the whole anterior end of the body can be invaginated so that the eyes appear to be near the posterior end.

At the anterior end there is a large protrusible proboscis with four long retractor muscles; behind this lies the brain, on the dorsal surface of which are placed the two eyes.

The mouth lies on the ventral surface, at about one-third of the length of the animal from the anterior end.

The pharynx rosulatus in young forms leads into a sac-like gut, which occupies most of the body, but in the sexually mature forms, as in *Gyrator notops*, the gut breaks down to form a loose packing around the gonads. In the form examined by Bresslau no such degeneration of the gut was found.

The common sexual aperture lies a little more than half way down the body, and near the posterior end is the aperture of a contractile bladder into which the paired water-vascular ducts open.

The proboscis, pharynx, gut, and brain do not offer any features of particular interest, but it is necessary to describe in some detail the gonads and water-vascular system, as in these organs I find that my account differs rather materially from that of Bresslau. The testes are more or less oval bodies lying dorsal to the uterus; they pass into short vasa deferentia, which unite and open into a common reservoir which lies close to the secrete reservoir, a little to the right and anteriorly of the common genital aperture (Pl. III. fig. 4).

The duct from the secrete reservoir passes through a short covered chitinous tube before joining the sperm duct, and opening into genital atrium (Pl. IV. figs. 1–2).

The female genital apparatus consists of paired ovaries (Pl. III. fig. 2) lying on either side of the genital aperture. The ovaries open into a duct which passes forward, receiving the opening of the uterus and the ductus seminalis, to the common genital aperture. I cannot find a distinct bursa seminalis in the position figured in Bresslau's diagram, in which also the entire male apparatus is placed on the animal's left side.

The cocoon (IV. 5) is a brown oval structure, concavo-convex in transverse section, and ending at one pole in a drop of viscid substance. Each cocoon contains a single embryo. The yolk glands are bilaterally arranged, irregularly branched structures, each gland consisting of two long anterior branches and two long and one short posterior branch, which unite about half way down the body into a common transverse duct opening near the base of the uterus.

The reserve stuff in the yolk gland appears to consist mainly of fat, which blackens readily in osmic preparations.

Apparently this substance undergoes some chemical change, as the cocoon does not appear to contain so much fat.

The water-vascular system (Pl. III. fig. 1) consists of two longitudinal trunks, which can be readily seen both in the living animal and in sections.

I know of no Turbellarian in which the main structure of the water-vascular system is so obvious. The two main ducts can be followed from the region of the eyes to the extreme posterior end, where they double forward upon themselves to open by means of two short transverse canals into the bladder.

The wall of the bladder, as can be readily seen in transverse sections, contains parallel bands of muscle fibre (Pl. III. fig. 3).

Bresslau states that the bladder is "nichts anders als eine einfache Epidermis einstülpung." And he therefore considers that it offers a marked contrast to the end-bladder of the Plagiostomidæ, which is formed by the union of the two ducts. It seems to me that the wall of the bladder is too well marked off from the epidermis (1) by the absence of rhabdites, (2) by the presence of muscle bands, for this view to be accepted, and it appears to me to mark off *Polycystis Goettei* very distinctly from all other Kalyptorhyncha.

The Scottish form appears to agree in all essential points with the *Polycystis Goettei* of Bresslau.

Whether, however, having regard:

(1) to the extremely aberrant condition of its water-vascular system,

(2) to the possible absence of a bursa seminalis,

it would not be better to place *Polycystis Goettei* in a special genus, seems to me to be still a moot question.

Microstoma lineare.

This form was found in all the Scottish lochs which I have personally examined.

The anatomy of the budding form has long been well known, and the only points to which I wish to refer in this note are—

(1) The nematocysts.

(2) The gonads.

It has long been known that the nematocysts of *Microstoma lineare* are very like those of Hydra; and Von Siebold, in his description of these organs, remarks that they are structures "welche denen der Hydra auf einen haar gleichen sollten."

Von Graff believed that the nematocysts of Microstoma differed from those of Hydra not only in their smaller size but in the possession of four instead of three barbs.

In the skin of Microstoma from the shores of the Scottish lochs in places where Hydra is abundant, I have found the three forms of nematocyst which are characteristic of Hydra. In some blind Microstoma from deep water where Hydra was absent there was no nematocyst.

This blind form without nematocysts was first described by Du Plessis in 1897; and later, Zacharias raised it to specific dignity under the name of *Microstoma inermis*. I do not believe that this species is a good one, for two reasons.

In the first place, in nearly all Turbellaria which inhabit both deep and shallow water one finds this degeneration of the eyes (e.g. *Automolos Morgiensis*) in the deep-water forms.

In the second place, the nematocysts of the Microstoma in littoral waters are derived from the Hydra on which it feeds, in much the same way in which Grosvenor found that the Æolids derive their nematocysts from their cœlenterate prey.

In transverse sections through a Microstoma which has recently fed upon Hydra, nematocysts are found in three places:—

(1) In the gut.
(2) Surrounded by mesenchyme cells in the space between the gut and the ectoderm.
(3) Under the ectoderm.

I hope to show in a further paper the mechanism by which this transference is accomplished; and further, that all true nematocysts with a thread capable of expulsion, found in Rhabdocoels, are obtained in a similar manner.

Gonads.

During the greater part of the summer Microstoma reproduces entirely by budding, and it is only in September that I have first found sexual forms on Loch Tay and Loch Lomond.

In both years male forms were common long before I could find any females. But in two cases, in sections of fully developed male individuals, I found the testes degenerating, and bodies which looked very like ova in the mid-ventral line. I hope to be able to get more material this year, and finally decide how far Microstoma can be described as protandrous.

Bothrioplana Bohemica.

This was first described by Braun in 1881, and it has usually been recognised that it occupies a more or less intermediate position between the Rhabdocoels and Triclads. Vedjovsky has also given a very full description of the anatomy of this form in the same paper.

Late in August 1906 I found a small pool near the hotel at Tarbet, Loch Lomond. This pool is of some interest, as it appears only to exist in very wet weather, and after a fortnight's fine weather at the beginning of September it was so dry that it was impossible to get any more material. The pool was about twenty yards long, with an average depth of about a foot, but the two ends of the pool were almost separated by a shallow. At one end of the pool large numbers of *Vortex truncatus* were found. At the other end large numbers of *Prorhyncus curvi-stylis* (Braun), *Opistoma Schulzeanum*, and *Bothrioplana Bohemica* (Vejdovsky) were found.

Opistoma Schulzeanum is one of the more rare Rhabdocoels, but its anatomy has recently been thoroughly described by Vejdovsky.

It may be interesting to note that, whilst Vejdovsky concluded from his observation that Opistoma did not live through the summer months, becoming sexually mature in the spring, sexual forms were abundant in Loch Lomond in August.

Prorhyncus curvi-stylis.

This animal was first found by M. Braun in a small ditch near Dorpat, and he has given a very careful description of its anatomy in the *Turbellaria Livlands*. It is readily distinguished from *Prorhyncus stagnalis* by the hooked copulatory organ and its size. The form found near Loch Lomond appeared to agree in all essentials with the form described by Braun, except for the absence of eyes in the Scotch form.

Automolos Morgiensis.

Automolos Morgiensis is one of the most common Turbellaria in the deeper waters of all the Scottish lochs that I have examined. Its cocoon, which I figure, is also fairly common (Pl. IV., 5). It occurs more rarely in shallow waters, but only in those places where the bottom is composed of a soft mud, *e.g.* twice in four feet of water, August 1907, in the estuary of a small stream, Tarbet, Loch Lomond. It was first discovered by G. du Plessis in the deep water of Lake Geneva, and for a long time doubt existed as to its true position.

Its discoverer placed it amongst the Alloiocoels, under the name of

Monotus Morgiensis, but Von Graff believed that its true position was amongst the Mesostomida, and therefore changed its name to *Otomesostoma Morgiensis.* The first thorough description of its anatomy was given by M. Braun, who recognised its true position, and gave it the name of *Automolos Morgiensis* in a paper upon the Turbellaria of Livland, published in 1884. In a quite recent paper in the *Zeitschrift für Wissenschaftliche Zoologie* for December 1906, Nils von Hofstein has published a somewhat lengthy paper upon this form, in which he endeavours to show (1) that the worm cannot be regarded as an Automolos, but must be placed in a separate genus amongst the Alloiocoela, for which he revives the old name Otomesostomum of Graff; and (2), a point of the utmost general importance, that all the ova are fertilised in the germarium long before they have reached maturity.

As regards the first point, the chief differences between Otomesostoma and Automolos are—

(1) In Otomesostoma the oviducts are short and transverse, whereas in Automolos the ovaries are anterior to the pharynx and long.

(2) There is no uterus in Otomesostoma.

Unfortunately, the anatomy of Automolos does not seem to be very well known, so that the question cannot at present be settled.

As regards the second point, the only proof Hofstein gives that the eggs are fertilised at such an early stage rests upon two drawings of sections of oocytes, in both of which darkly staining bodies lie near the nuclei.

These bodies, which I also find in my preparations, do present a certain superficial resemblance to spermatozoa, but I think they must be identical with the *vitellogen Schicht* or *dotter Kern* such as has been well figured by Bambecke in *Pholcus phalangioides.*

Gurwitch, in his *Morphologie und Biologie der Zelle* (Fischer: Jena, 1904) remarks that—

"Nach den übereinstimmenden Ergebnissen der neuerer Forscher besitzen die jungen Oocyten in ihrer sog. vitellogenen Schicht, einer sichelförmige Plasmaanhäufung welche das Idiozoma der oocyten umgibt, und Kappenförmig dem Keimbläschen anliegt, die eigentliche primäre Matrix der Dotterbildung."

As a matter of fact, this structure is best defined in the very young oocytes, at a later stage it appears to undergo a granular disintegration, and at the time when the egg is ready to enter the uterus nothing can be seen of it (Pl. IV. 3, 4).

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FIGURES.

Plate III.—*Polycystis Goetti.*

Fig. 1. General diagram outline. $\frac{1}{6}$ Zeiss + 2 oc.

Fig. 2. Ovaries opening into female atrium. 4 mm. + 6 comp. oc.

Fig. 3. Bladder of excretory system. Zeiss 2 mm. apo. + 6 comp. oc.

Fig. 4. Transverse section through middle region of the body. Reduced $\frac{1}{2}$. 4 mm. + 6 comp. oc.

Fig. 5. Transverse section through posterior region. Reduced $\frac{1}{2}$. 4 mm. + 6 comp. oc.

Plate IV.

Fig. 1. Transverse section through secrete reservoir and sperm reservoir. 2 mm. + 6 comp. oc. Reduced $\frac{1}{2}$.

Fig. 2. Following section to 6, showing secrete reservoir passing by chitinous tube into the ductus seminales. 2 mm. + 6 comp. oc. Reduced $\frac{1}{2}$.

Fig. 3. Early oocyte in the ovary of Monotus. 2 mm. + 6 oc.

Fig. 4. Late stage.

Fig. 5. Cocoon. A + 6 oc.

op. bl. opening of bladder.
bl. bladder.
coc. cocoon.
ect. ectoderm.
lat. tr. lateral trunk, water-vascular system.
ov. ovary.
ph. pharynx.
pr. proboscis.
sec. res. secrete reservoir.
sp. res. sperm reservoir.
sp. spermatozoa.
ut. uterus.
v. d. vas deferens.

(*Issued separately December* 24, 1907.)

MARTIN. Plate III.

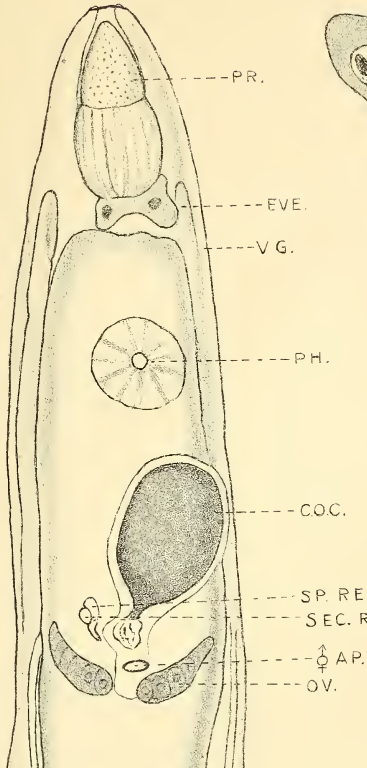


Fig. 4.

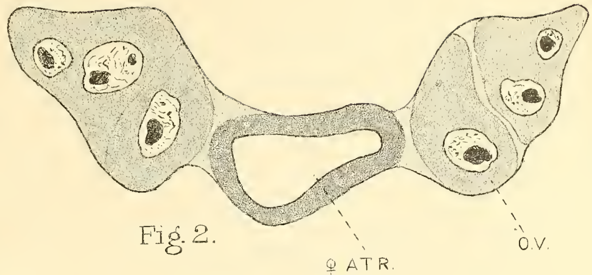
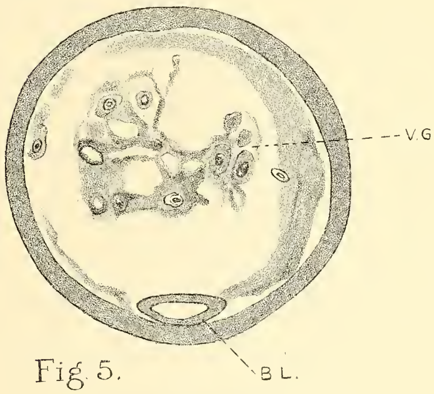


Fig. 2.



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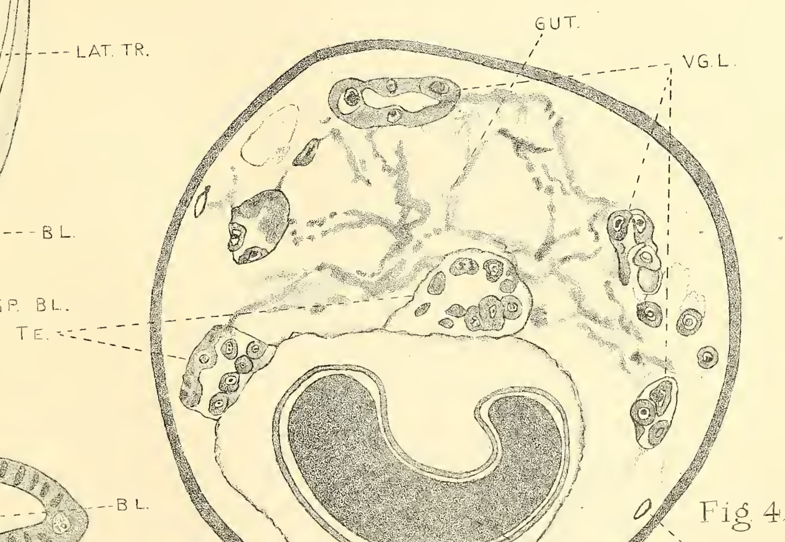

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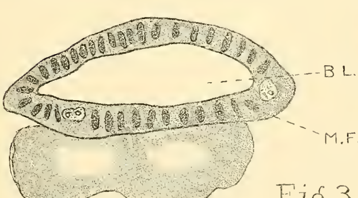


Fig. 3.

McFarlane & Erskine Lith Edinr.

MARTIN. Plate IV.

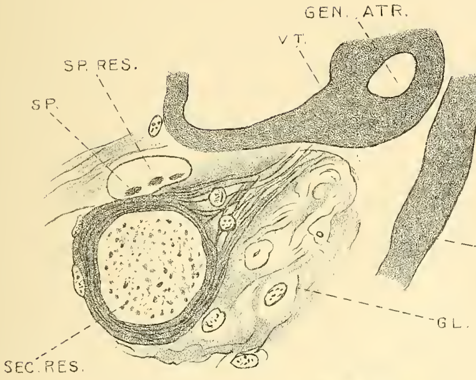
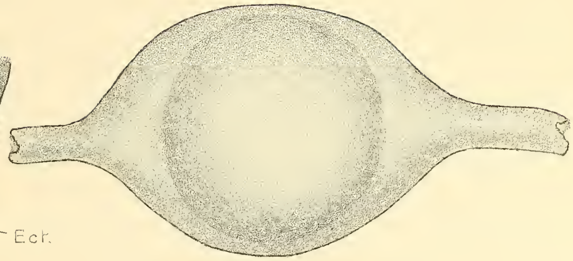


Fig. 1.



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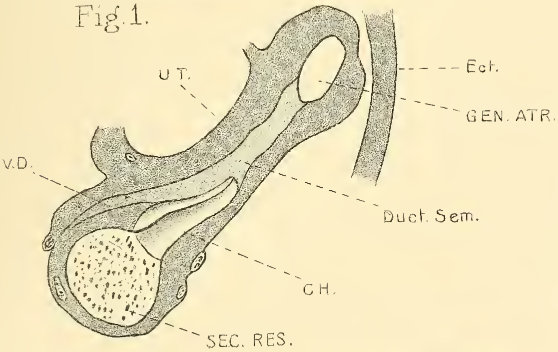

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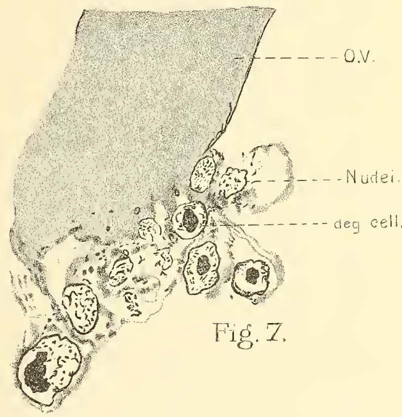

Fig. 7.

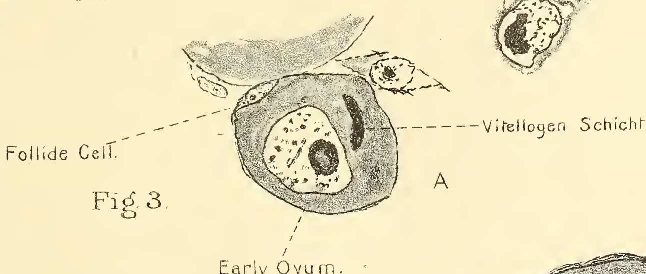

Fig. 3.

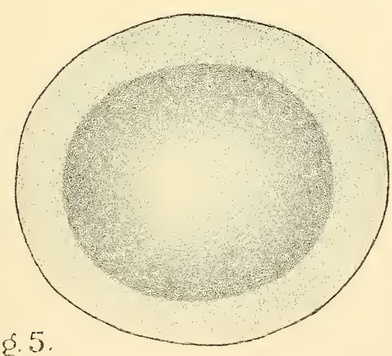

Fig. 5.

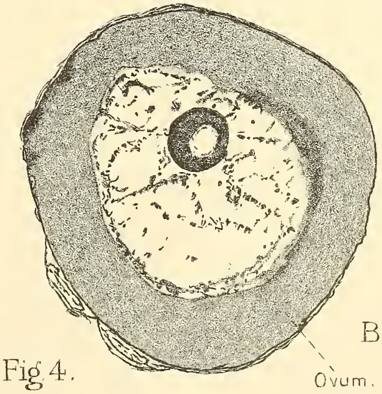

Fig. 4.

McFarlane & Erskine, Lith. Edin.