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SOME NOTES ON BRITISH FRESHWATER RHABDOCOELIDA—A GROUP OF TURBELLARIA.

By Henry Whitehead, B.Sc.

(*Read January 28th*, 1913.)

Plate 4.

The members of the group Rhabdocoelida are very similar as regards appearance, shape and movements to the Infusoria, though they are generally much larger and their complicated internal structure enables them to be distinguished at a glance. The Rhabdocoelida form a branch of the group *Turbellaria*, to which the larger Planarians found in fresh water also belong. The Turbellaria, in turn, together with the Liver-flukes and Tape-worms, are included in the phylum **Platyhelminthia** or Flat-worms.

The British marine Turbellaria have been monographed by Prof. Gamble (**12**), and our President has taken an active part in the study of the land Planarians of Australasia. The freshwater Turbellaria have apparently received but little attention in this country, though Prof. Gamble publishes a list of British species in the Cambridge Natural History (**14**).

As the larger freshwater Planaria (Tricladida) cannot be regarded as microscopic objects, and are therefore of no special interest to the Club, the writer proposes, in this paper, to deal only with the group Rhabdocoelida.

Von Graff has written two monographs on this group, and has devoted much time to valuable work on anatomical features; and it is chiefly from these sources that the information contained in this paper has been derived.

The writer does not propose dealing in detail with the anatomy, but rather to deal with the Rhabdocoels from a general point of view, emphasising matters of particular interest to the field naturalist.

The freshwater Rhabdocoels vary in size from 1/25th to half

an inch in length. They are generally found in ponds, lakes and ditches, and less frequently in running water. Like many other microscopic inhabitants of ponds, they appear in great abundance at certain seasons of the year and then suddenly disappear.

The body is more or less transparent, slightly flattened, and is provided with cilia. The Turbellaria are remarkable for peculiar secretions given off from the epidermis. These secretions are of two distinct kinds—one a mucous fluid, and the other consisting of very small solid bodies, or rhabdites, which, on coming in contact with the water, produce mucus. Several forms of rhabdites have been described (spindle-shaped, rod-shaped, egg-shaped and spherical). They are formed in special glandular cells which lie beneath the epidermis, and the rhabdites pass to the surface by means of minute ducts.

Another interesting feature is the presence, in certain species, of nematocysts similar to those found in Hydra.*

The Rhabdocoels are provided with a mouth, a pharynx and an unbranched, sac-like gut. The position of the mouth varies and affords a valuable generic character. It may lie at the extreme anterior or in a median position anywhere along the ventral surface as far down as two-thirds of the body length.

The excretory system consists of renal organs which are, in some cases, somewhat complicated in structure.

The nervous system is simple, and comprises a two-lobed brain and a pair of nerves running along the body close to the ventral surface. In some species the pigmented eyes are clearly defined, in others the eye pigment is scattered, and in some cases eyes are absent.

Some of the freshwater Rhabdocoels have at their anterior end pit-like depressions which contain cilia (Pl. 4, fig. 3, *cp*). The ciliated pits rest upon a group of ganglion cells which are connected with the brain. Similar structures are found in Nemertine worms, and some zoologists consider that this suggests affinity between the groups. Another interesting organ is the statocyst, which is present in some species. This consists of a cavity containing fluid, in which is suspended a highly

* Mr. Scourfield has recently called my attention to a paper by C. H. Martin (**20**) on this subject. The author shows conclusively that the nematocysts are derived from the prey upon which the Turbellarian feeds.

refractive particle of calcium carbonate—the otolith (or statolith). The statocysts serve as organs of equilibration.

Reproduction is, in most cases, sexual. The animals are hermaphrodite, but the male organs ripen first. The sexual organs are very complicated, and the details of their structure are of great value in classification. On this account it is often impossible to determine the species of immature individuals, and sometimes it is necessary to have specimens in both the male and the female stages before identification can be certain. Freshwater Turbellaria undergo no metamorphosis, and newly hatched individuals are similar to their parents in general appearance.

Asexual reproduction occurs only in the section Hysterophora. A chain of individuals is formed by the development of mouths, eyes, etc., at intervals along the body. Constriction of the body and gut then follow, and fresh individuals are produced by fission. The process is illustrated in Pl. 4, fig. 3. Some species which reproduce asexually throughout the year develop sexual organs in the autumn. These produce eggs which lie dormant through the winter.

Considerable interest has recently been aroused in certain green or yellow cells which are found in the bodies of some species of Turbellaria. The green cells contain chlorophyll and are able to decompose carbon dioxide in the presence of sunlight. Two marine species, *Convoluta roscoffiensis* and *C. paradoxa*, found on the coast of Brittany, have been the subjects of detailed study, and the results have been summarised by Prof. Keeble in a little book entitled *Plant-Animals*. The genus Convoluta belongs to a group of Turbellaria, the members of which have not, up to the present, been found in fresh water. The green cells or zoochlorellae, as they are termed, are now regarded as algae similar to Chlamydomonas. In the case of Convoluta it is certain that the presence of zoochlorellae is of benefit to the Turbellarian, and that the relationship is a true symbiosis.

Von Graff (**17**) mentions twenty-five species of freshwater Rhabdocoels in which green cells have been found. The freshwater species containing zoochlorellae have not been well studied, and some zoologists doubt whether there is mutual benefit in the association. This aspect of the subject will, however, be dealt with later.

The Rhabdocoelida live under various conditions, but generally

prefer still or gently flowing water to rapid streams. One species, *Prorhynchus stagnalis*, is sometimes found on moist earth. Many of the aquatic forms are free swimmers, and may be captured in the net in the same way as rotifers and water-fleas; others live in mud. In the latter case it is best to pour a little of the mud into a glass tank containing clear water, and to remove any Rhabdocoels by means of a pipette. They should be examined in a live box, and it will be found that a slight pressure is necessary to ensure making out their internal structure. They are very difficult to prepare in a satisfactory manner as permanent objects, and the writer has made numerous experiments with a view to narcotising them, but with little success. Eucaine, chloroform, ether and alcohol are of no use. The difficulty seems to lie in the fact that the rhabdites are discharged as soon as the animal is irritated, and these, of course, produce quantities of mucus. Moreover, the epidermal cells get destroyed during the process. The only satisfactory method of killing seems to be by means of some hardening reagent, like corrosive sublimate solution, which takes effect before the mucus and rhabdites can be discharged. The following well-known method is the best. The specimen is placed in a watch-glass with a little water, the bulk of which is withdrawn by a pipette. A drop of Lang's Fluid is then delivered from a pipette on the side of the watch-glass and is allowed to run over the animal. Death is almost instantaneous, and but little shrinkage takes place. Even with this method the writer has not yet succeeded in killing species of Mesostoma without disruption. After remaining in Lang's Fluid from ten to fifteen minutes, the specimens are removed to 45-per-cent. spirit. They are afterwards passed through alcohol of increasing strength, stained with borax-carmine and mounted in Canada balsam in the usual way.

Some of the Rhabdocoels appear to be entirely vegetarian in diet, and consume desmids, diatoms and unicellular algae. In fact, care is sometimes necessary to distinguish the food from the zoochlorellae. The latter, however, never occur in the gut. The majority of species take animal food, which consists of water-fleas, small worms, etc.

We may now consider a few typical species which have been taken by the writer in the neighbourhood of London.

Catenula lemnae (Ant. Dug.).

Occurs in ponds and lakes, and often appears suddenly in considerable numbers in collections of rain-water during the spring and summer, and disappears as rapidly as it comes. It is white and thread-like in appearance, consisting of a chain of 2—4 individuals (rarely more) and attaining a length of 5 mm. The body possesses a well-defined head lobe, which is marked off by a slight constriction and a ring of comparatively long cilia; a statocyst is present. The usual mode of reproduction is by fission, but sexual organs are developed when the pond or ditch begins to dry up.

Microstomum lineare (Müll.) (Pl. 4, fig. 3).

This species is very similar to the foregoing, but the colour is yellowish or greyish brown. It is usually found in the form of a chain of zooids of which there may be as many as 18. The colony attains a length of 8 mm. Each zooid develops a pair of red eyes, behind which may be seen the ciliated pits. The skin is thickly clad with cilia. No rhabdites are present, but nematocysts, similar in form to those of Hydra, are present (**20**). The figure shows the manner in which new individuals arise, and various stages in the formation of mouths may be seen. The gut is common to all the zooids in the chain, until fission takes place. The writer has seen desmids which had been swallowed for food pass along the common gut from one zooid to another. Sexual organs are sometimes produced, and the ripe eggs are oval in shape and orange or dark red in colour.

This species is fairly common in stagnant or slowly moving water. It has been found in thermal springs at a temperature of 130° F. and also in brackish water. It moves slowly on a surface, but is a graceful and swift swimmer.

Dalyellia viridis (G. Shaw) (Pl. 4, figs. 1 and 2).

Examples of this species attain a length of 5 mm., and are generally spinach-green in colour. The colour is due to the presence of algal cells which lie beneath the epidermis. The body is truncated in front, widens towards the middle and then tapers towards the tail. There are two bean-shaped eyes. There is a very distinct pharynx and the gut is sac-like.

Specimens of this interesting Rhabdocoel were taken in one of the ponds in Richmond Park, on the occasion of the Club's visit on April 13th, 1912. The following week the writer took specimens from a pond near Chigwell Row, Essex.

It was noticed that the animals had a number of eggs (in one instance 49 were counted) in the spongy body tissue, and individuals in this condition avoided the light. As far as could be ascertained, no eggs were deposited by the living animals, but, on death, the eggs were liberated on the decomposition of the body of the parent. So far none of these eggs have hatched.

Prof. Sekera (**16**) of Tabor, Bohemia, succeeded in keeping specimens alive for some time, and the following notes are taken from the account of his observations. Young specimens were taken in ponds in March, when ice was still floating on the water. The animals were colourless, but as soon as they approached maturity, and the sexual pore developed, it was noticed that a few algal cells (zoochlorellae) had entered the body cavity by this means. Streaks of green granules then began to spread from this region and extend beneath the cuticle over the whole body, until finally the animal became quite green. (I would remark, in parenthesis, that mature specimens show distinct lines or bands devoid of zoochlorellae.) Solid food in the form of diatoms, rotifers, etc., was ingested during this period. While rapid division of the algal cells was taking place, they formed spherical or ellipsoid clusters, each group being surrounded by a colourless membrane. The membrane finally disintegrated and the algal cells were dispersed in narrow irregular lines or bands. The mature zoochlorellae showed no signs of an enveloping membrane. The animals exhibited at this period a distinct tendency to crawl towards light (phototactic), but sank to the bottom of the vessel at night. During the third week eggs were formed in the body cavity. The worms at this stage began to avoid the light and spent the whole day at the bottom of the vessel or under vegetation. During the first week in May the animals died off rapidly, and with the decomposition of the body the eggs were liberated. The algal cells were set free and continued to live, and developed an investing membrane, then passed into a resting stage, probably awaiting an opportunity of invading the next generation of Dalyellia.

Prof. Sekera thinks that the alga is of little or no value to the

animal in the way of providing food, his reasons being that closely allied species, living under similar conditions, do not contain algae, and that solid food is ingested after the algal cells are fully developed. The writer hopes to investigate this question more fully, for Sekera's argument does not seem to be quite conclusive.

Sir J. G. Dalyell (**1**) wrote an account of this interesting species in 1814, and states that it sometimes occurs in large numbers, and then suddenly disappears. He found his specimens chiefly in the spring, but some were found in the autumn.

Mesostoma Spp. (Pl. 4, fig. 4).

Some of the species of Mesostoma produce two kinds of eggs—thin-shelled and thick-shelled. The thick-shelled eggs, which contain a large quantity of yolk, are produced in the late summer and lie dormant during the winter. The young hatched from these so-called "winter" eggs, when less than half the size of the parent commence to produce thin-shelled eggs with but little yolk. It is probable that these eggs are unfertilised; they are produced in great numbers and begin to hatch in April and May. The young hatched from these eggs attain full development and produce thick-shelled "winter" eggs, which have been fertilised (**14**).

There is some difference of opinion amongst observers as to the precise nature of the life-cycle in this genus. See von Graff (**17**). They vary in size from 3 to 15 mm. in length according to the species and condition. They live in clear, still or slowly flowing water and swim or creep over water-plants. Their food consists of entomostraca, small worms, etc., which are sometimes caught by means of slime threads.

Bothromesostoma personatum (Schm.).

Specimens of this species attain a length of about 7 mm. and are easily identified by two white patches which look like large eyes on each side of the "head." The rest of the body is either grey or black. The writer has taken specimens on the leaves of water-lilies and creeping on the surface film, at Staines and at the East London Waterworks. The genus Bothromesostoma is closely allied to Mesostoma, and like the latter produces both summer and winter eggs.

Gyratrix hermaphroditus Ehrbg. (Pl. 4, fig. 5).

This species appears to be widely distributed. It is about 2 mm. in length, is almost transparent and is a rapid and graceful swimmer. It can easily be recognised by the comparatively long stiletto at the posterior extremity. This weapon, although connected with the male copulatory apparatus, is furnished with a gland which probably secretes a poison of some kind and is used by the animal when attacking its prey. It has a well-marked proboscis, behind which are two eyes. The mouth and pharynx are situated near the middle. As a general rule, only one egg-capsule is present, and this produces one or two embryos.

The field is almost unworked as regards this country. Von Graff records 110 species of Rhabdocoelida from Germany. As far as the writer can ascertain, only 30 species have been recorded from the British Isles. It is hoped that this short account may arouse the interest of some of the members of the Quekett Microscopical Club in these interesting animals.

List of British Species.

In the following list the descriptions of the species will, unless otherwise stated, be found in *Die Süsswasserfauna Deutschlands*, Heft. 19. The initials H. W. after the localities denote that the species has been found by the author at those places :

Sub-order **RHABDOCOELA.**

Section Hysterophora.

Fam. CATENULIDAE.

Catenula lemnae Ant. Dug.

Near Cork (**14**).

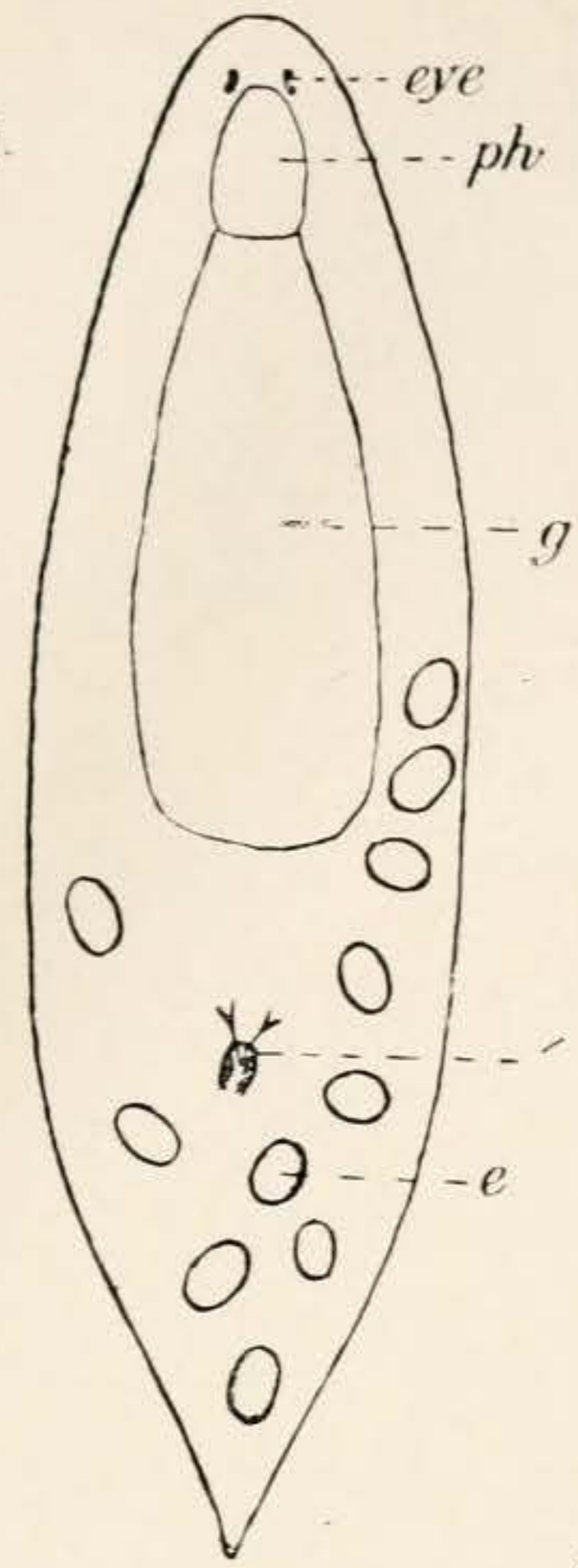
Stenostomum leucops (Ant. Dug.).

Common (**14**); Clare Is. (**24**); Staines (H. W.).

S. unicolor O. Schm.

Clare Is. (**24**).

1.



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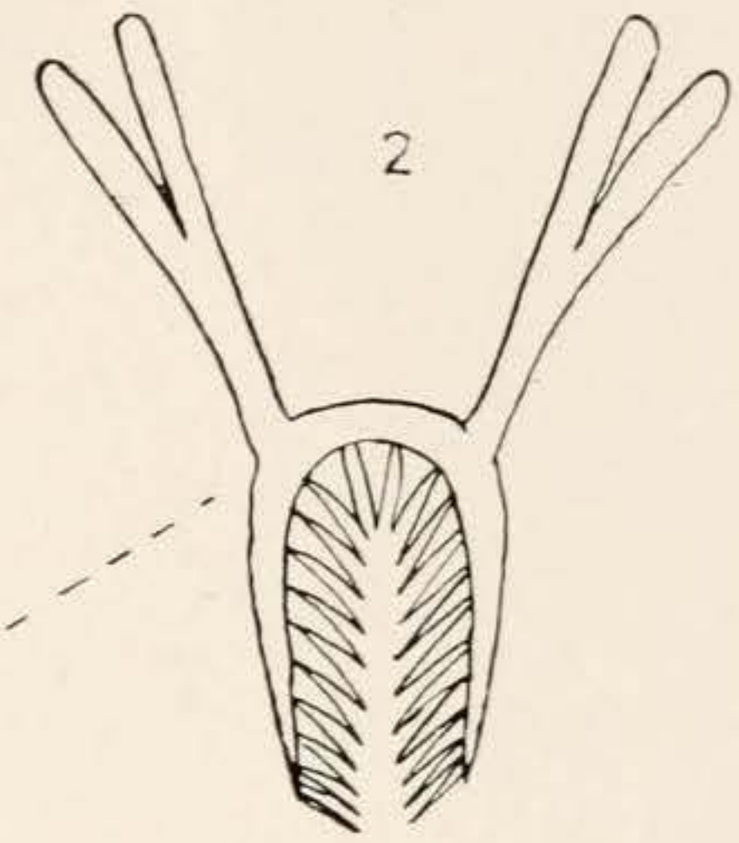

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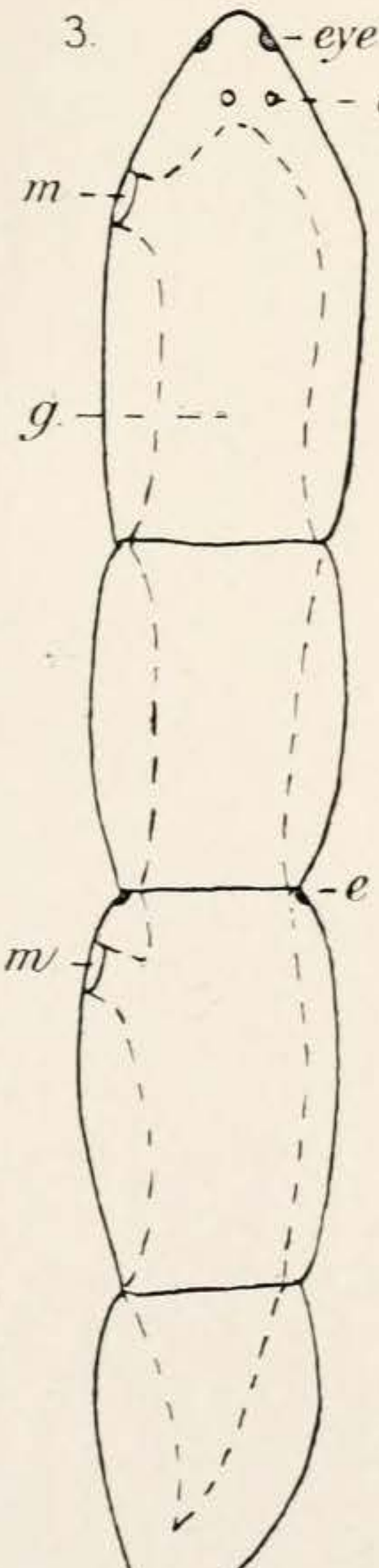

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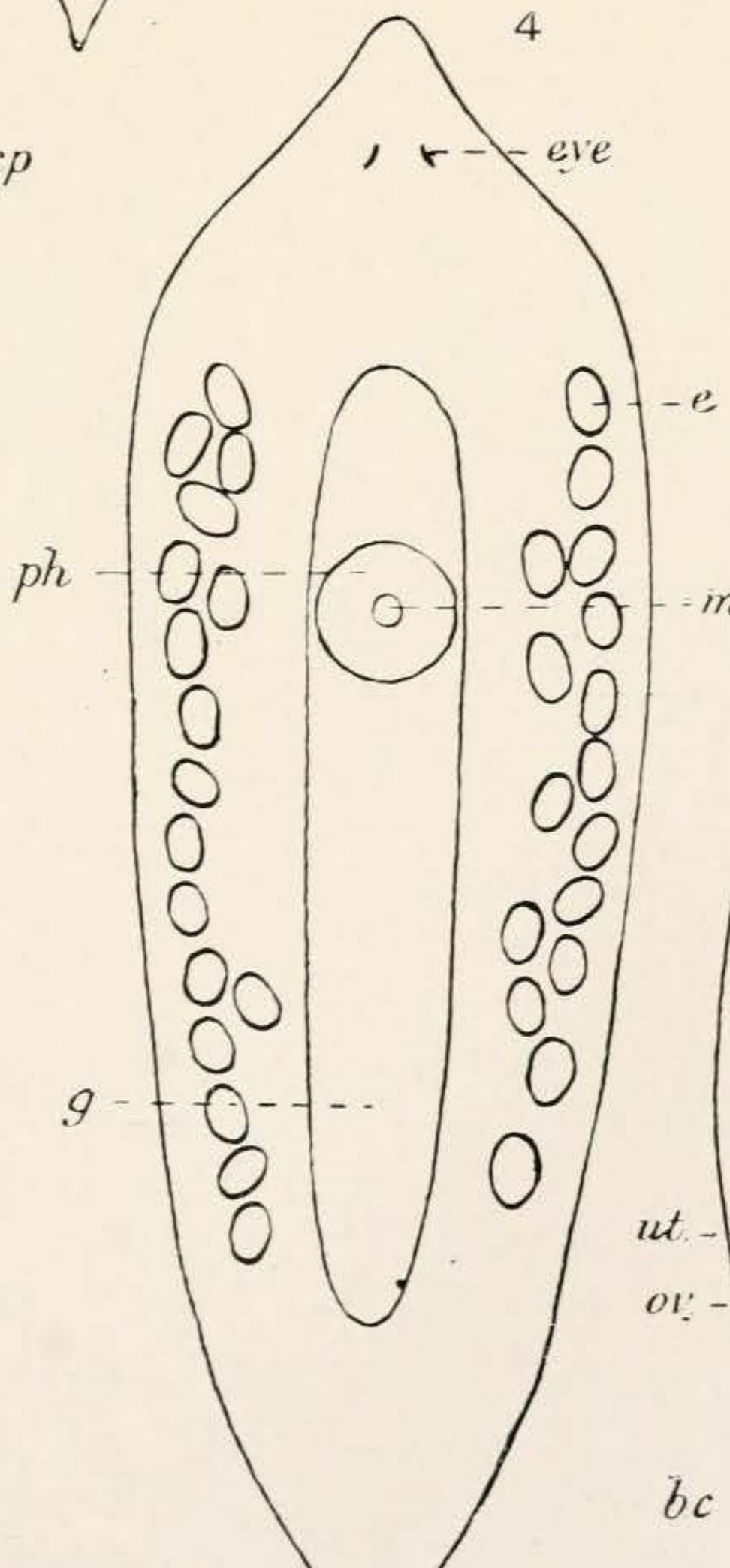

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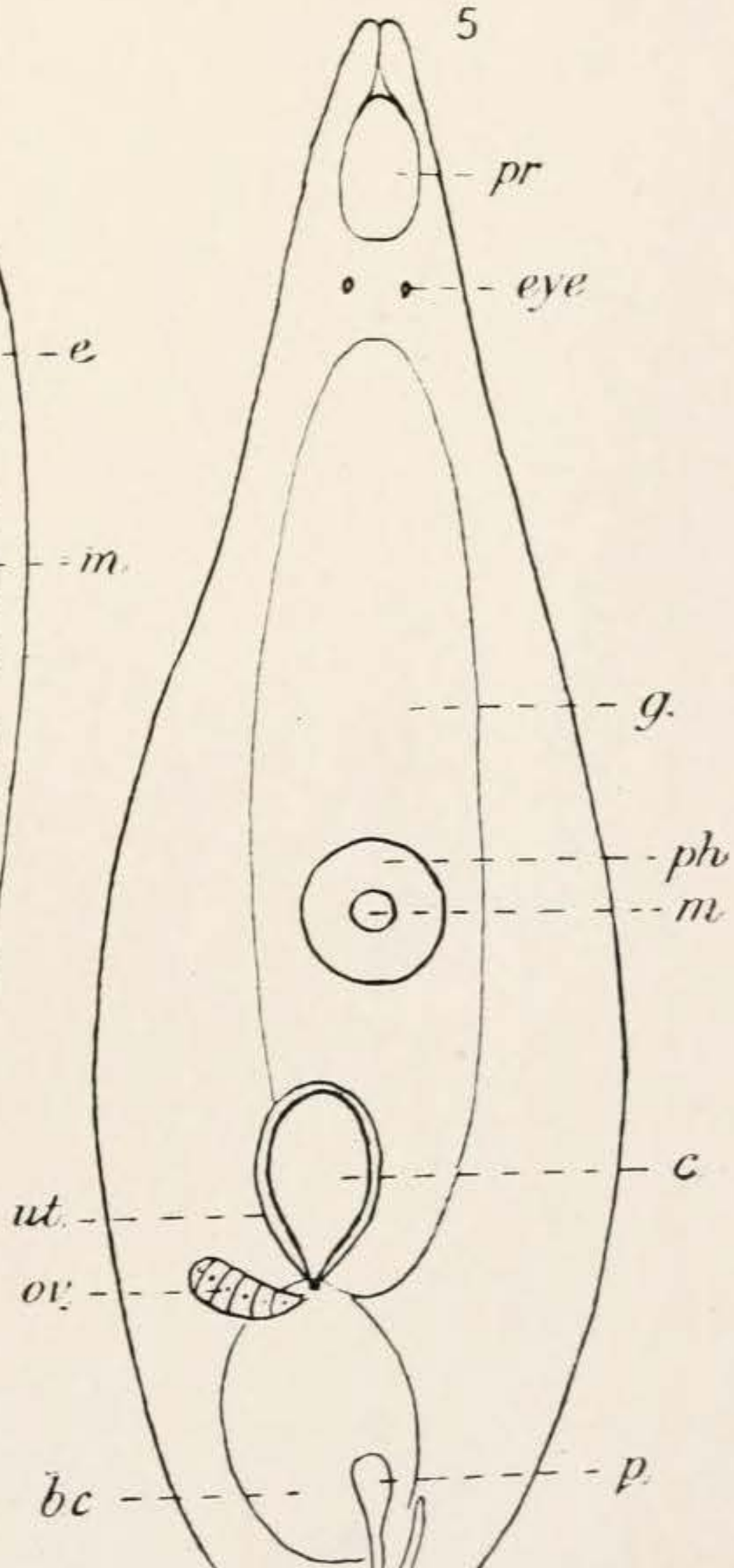

H.W del.

RHABDOCOELIDA.

FAM. MICROSTOMIDAE.

Microstomum lineare (Müll).

Fresh water (**14**): Chigwell: Higham's Park, (H. W.); "In all Scottish lochs" (**19**); near Dublin (**21**).

Macrostomum appendiculatum (O. Fabr.) (= *hystrix*, Oe).

Stagnant water (**14**); Clare Is. (salt water) (**24**).

FAM. PRORHYNCHIDAE.

Prorhynchus stagnalis M. Schultze.

In Devonshire rivers (**14**); L. Lomond (**19**); Fenton Tower, E. Scotland (**9**).

P. curvistylus M. Braun.

Near L. Lomond (**19**).

Section LECITHOPHORA.

FAM. DALYELLIIDAE.

Dalyellia diadema Hofsten (**18**).

Chigwell Row (H. W.). This species appears to have been recorded only once before, viz. in the Bernese Alps.

D. viridis (G. Shaw) (= *helluo* Müll).

Generally distributed (**14**); Richmond Park, Chigwell Row (H. W.); Edinburgh (**9**).

D. armigera (O. Schm.).

Millport (**14**).

D. Schmidtii (L. Graff).

Millport (**14**).

D. millportianus (L. Graff) (**9**).

Millport (**9**).

Jensenia agilis Fuhrm (= *serotina*, Dorner).

Richmond Park, Epping Forest (H. W.).

J. truncata (Abildg.).

Abundant in fresh water (**14**), L. Lomond (**19**).

Phaenocora (= *Derostomum*) **punctatum** Örst.

Theydon Bois (H. W.); Edinburgh (**9**).

Opistomum Schultzeanum Dies.

L. Lomond (**19**).

FAM. TYPHLOPLANIDAE.

Rhynchomesostoma rostratum (Müll).
Widely distributed (**14**); Millport, Edinburgh (**9**).

Typhloplana viridata (Abildg.) (= *Mesostoma viridatum* M. Sch.).
Manchester (**14**): Clare Is. (**24**).

Mesostoma productum (O. Schm.).
Cambridge (**14**).

M. lingua (Abbild.).
Cambridge (**14**).

M. Ehrenbergii (Focke).
Cambridge (**14**).

M. tetragonum O. F. M.
Cambridge (**14**).

M. Robertsonii L. Graff. (**9**).
Millport (**9**).

M. flavidum L. Graff. (**9**).
Millport (**9**).

Bothromesostoma personatum (O. Schm.).
Preston (**14**); Staines, E. Lon. Waterworks (H. W.).

FAM. POLYCYSTIDIDAE.

Polycystis Goettei Bresslau.
Nr. Abergavenny, L. Lomond (**19**).

FAM. GYRATRICIDAE.

Gyratrix hermaphroditus Ehrbg.
Common in fresh water (**14**); Chigwell Row (H. W.); St. Andrews (salt water) (**9**); Clare Is. (salt water) (**24**).

SUB-ORDER **ALLOEOCOELA.**

FAM. OTOPLANIDAE.

Otomesostoma auditivum (Pless.) (= *Monotus morgiensis* et *relictus* Du Plessis).
Deep waters of Scottish lochs (**19**).

FAM. BOTHRIOPLANIDAE.

Bothrioplana sp.?

Manchester (**14**).

Euporobothria bohemica (Vejd.).

Tarbet, L. Lomond (**19**).

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Description of Plate 4.

Fig. 1. *Dalyellia viridis*, entire, × 15.

„ 2. Chitinous copulatory organ of *D. viridis*, × 150.

„ 3. *Microstomum lineare*, entire, × 20.

„ 4. *Mesostoma* sp., entire with thin-shelled eggs, × 20.

„ 5. *Gyratrix hermaphroditus*, entire, × 45. *b c*, bursa copulatrix; *c*, cocoon; *c p*, ciliated pit; *e*, egg; *g*, gut; *m*, mouth; *o v*, ovary; *p*, poison-sac; *p h*, pharynx; *p r*, proboscis; *s t*, stiletto; *u t*, uterus.