

Studies on the Turbellaria.**Part III.—Didymorchis.**

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With Plate 14, and 1 Text-figure.

OF the many and varied inhabitants of the branchial cavities of Australasian crayfishes the Rhabdocoles are not the least remarkable. They are very minute colourless forms, which only occur in association with the crayfishes, and present certain adaptations to their special mode of life. They are able to adhere tenaciously by means of an apparatus having the function of a sucker to the filaments of the gills or to the walls of the branchial chamber, and are thus not liable to be swept out by the respiratory current or dislodged by the movements of the podobranchs; and, with cilia only developed ventrally, they glide along in close contact with the substratum, so that they can instantaneously anchor themselves when any movement takes place that might displace them.

One of these, which occurs on *Paranephrops neozelanicus* of New Zealand, I described some years ago (5) under the name of *Didymorchis paranephropis*. *Didymorchis* belongs to Graff's family *Dalyellidæ* (formerly *Derostomidæ*), and differs from the other genera of that family in the character of the excretory system and in the restriction of the cilia to the ventral surface.

In the two common crayfishes of Eastern Australia,

Astacopsis serratus and *Cheraps bicarinatus*, *Rhabdocœles* are constantly present. Of these there are, as far as I have been able to determine, only two species, one confined to each of the two crayfishes in question. They both belong to the *Dalyellidæ*, and resemble *Didymorchis* in many points; but the excretory system is constructed on entirely different lines. In this respect—the arrangement of the main trunks of the excretory system—the two Australian forms are at one, though they differ from one another in certain features of the reproductive apparatus. On the whole I think it better, instead of coining a new generic name or names, to regard them as a species of *Didymorchis*.¹

The species living in the branchial cavities of *Cheraps bicarinatus* I propose to name *D. cherapsis*. When the gills and branchiostegites of the crayfish are removed and placed in water in a glass vessel, a small number of the *Rhabdocœles* will always be found among the crowd of actively moving animals—chiefly *Craspedellæ*, together with a *Nematode*—which soon begin to become separated out from the gills. When among the gill-filaments the *Rhabdocœles* readily clamber from one to another by looping movements. On the surface of the glass, when undisturbed, they glide evenly along through the action of the cilia of the ventral surface; when disturbed by a touch or by an attempt to draw them into a pipette, they instantly attach themselves to the surface with considerable tenacity.

Didymorchis cherapsis (Pl. 14, fig. 1) is, like *D. paraneuropis*, a very small *Rhabdocœle*, not exceeding a millimetre in length. When gliding along freely it becomes relatively long and narrow, with the anterior end truncate and slightly more expanded than the rest, the posterior end narrower and slightly emarginate. The largest specimens are of a very light greenish-yellow colour: smaller specimens

¹ I have a note also on an allied form occurring in *A. australiensis* of Tasmania, but without details sufficient to determine its relationship to the others.

are quite colourless. There is a small pair of eyes of crescentic shape situated about one sixth of the total length from the anterior end, and separated from one another by an interval of about a half to a third of the total breadth. The mouth is some little distance—about one eighth to one sixth of the total length from the anterior end. The single reproductive aperture is a similar distance from the posterior end.

At the posterior end on the ventral surface is a sub-crescentic elevated area with the concavity forwards (Pl. 14, fig. 2). The surface of this is non-ciliated, but is dotted with numerous minute bright spots, which indicate the openings of the ducts of integumentary glands. This elevation appears to play the part of a sucker.

The epidermis (*ep.*), which varies somewhat in thickness in different parts, is ciliated only on a definitely limited area of the surface on the ventral side. In this respect, as well as in the other features of the integument, *D. cherapsis* resembles *D. paranephropis*. A yet more remarkable feature of this layer in *Didymorchis* is that it is entirely devoid both of cell-boundaries and of nuclei. This is a very exceptional condition. I do not know of any other instance of it except Plehn's genus *Sanguinicola*, which lives as an internal parasite in the blood-vascular system of Cyprinid fishes (6).

Within the epidermis is a basement-membrane which becomes very conspicuous in hæmatoxylin-stained sections (Pl. 14, figs. 3-5), owing to its affinity for the dye. Within this again are the muscular layers usual in *Rhabdocœles*—an external circular and an internal longitudinal. The former is very feebly developed; it is not shown in the figures of sections.

The openings of the ducts of the integumentary glands are confined mainly to two localities—the anterior and posterior extremities of the ventral surface. In the latter position in the middle line behind the testes, numerous ducts open close together on a small area, which is capable of being depressed into a deep pit, occupying the middle of the crescentic area

already referred to. In the terminal portions of the ducts where they pass between the testes, masses of the secretion collect ready to be discharged instantaneously. It is mainly this arrangement that enables the animal to adhere firmly to a surface in the manner already described. At the anterior end, where the adhesive power is much feebler, there is less concentration of the ducts and their apertures, but the latter are mainly concentrated on two areas at the sides of the mouth and in front of it.

The mouth leads into a narrow passage—the anterior part of the pharyngeal sac—opening into the pharynx behind. The latter is of Graff's "doliiform" type, and has the shape of a cylinder which is about twice as long as it is wide. The unicellular glands in the substance of its walls are very conspicuous in the living animal; the ducts of all of them, much convoluted in the ordinary retracted condition of the organ, straightened out in the protracted state, open round the anterior margin.

The pharynx is freely eversible, becoming protruded to as much as a third of its extent through the mouth, its thin, circular, anterior margin projecting beyond the anterior end of the body.

Posteriorly it opens directly into the intestine—an œsophagus not being differentiated. Around the opening are about six œsophageal glands, the secretion of which has the appearance of extremely minute spherules.

The intestine (Pl. 14, fig. 4) has no epithelium and no lumen. It is merely a vacuolated protoplasmic mass with irregularly distributed nuclei; numerous bright spherical granules or droplets, some of relatively large size, are embedded in it. In some series of sections the intestine is quite solid without any internal cavity. In others irregular spaces occur. Externally the intestinal syncytium is not definitely circumscribed, and no definite limit can be recognised between it and the general mesenchyme or parenchyma.

This syncytial condition of the intestine appears to be specially characteristic of the Dalyellidæ. When I found

such a condition occurring in *Anomalocœlus* (4), I was under the impression that it was a very exceptional one. But Hallez (3) describes exactly the same state of things in *Proderostoma*, and, in this case at least, it is clear enough that the syncytial condition is not a secondary one; there never is an epithelium at any stage in *Proderostoma*. In all probability the same holds good of the others; certainly there is no appearance of an epithelium in the youngest specimens of *Anomalocœlus* and *Didymorchis* examined.¹

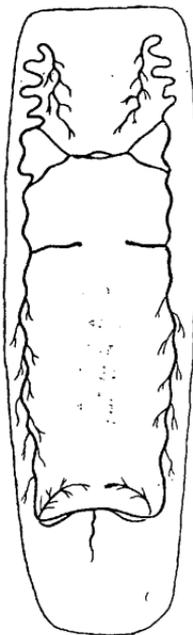
There is no doubt, however, that Hallez goes too far in concluding that the condition observed in *Proderostoma* is general among the *Rhabdocœles*. He says: "On voit que von Ihering a raison en ce sens que l'intestin des *Rhabdocœles* est chez l'embryon un organ massif et chez l'adulte un plasmode comme chez les *Acœles*. Une lumiere n'en existe pas moins chez l'adulte, mais celle est un simple vacuole du syncytium." In von Graff's 'Monographie' (1) there are a number of figures showing enteric epithelium and a definite enteric lumen in members of various families of *Rhabdocœles*. In fact, the only member of the group in which that distinguished author recognises a plasmodial condition is *Plicastomum bimaculatum* (loc. cit., p. 2126, also 2, p. 2132).

There are two excretory apertures, situated on the ventral surface towards the middle of the body and some distance behind the posterior end of the pharynx. Each of the apertures (Text-fig. 1), which are separated from one another by a considerable space, leads directly, without the intercalation of any excretory sac or vesicle, into a transverse main vessel

¹ It was partly on account of this feature, supposed to be exceptional, that I proposed that *Anomalocœlus* should be regarded as the type of a distinct family. Von Graff, however, states (2, p. 1993) that *Anomalocœlus* approximates so closely to *Phænocora* (*Derostoma*) as scarcely to demand a separate generic name. But he overlooks the fact that in the latter the testes are compact, as in the rest of the *Dalyellidæ*, while in the former they are of the diffuse type—a distinction which elsewhere he treats as an important one in his scheme of classification.

of considerable dimensions. This divides towards the margin of the body into anterior and posterior longitudinal trunks. The anterior runs forwards towards the anterior extremity and then bends back upon itself and breaks up into a number

TEXT-FIG. 1.



of branches in the anterior region of the body. From it as it runs forwards are given off internally two large branches, which, widely separated at their origin, converge and unite near the middle line on the ventral side below the middle of the pharynx to form a short, transverse commissural vessel having corresponding relations on the opposite side.

The posterior longitudinal vessel bends inwards towards the posterior extremity of the body, and, behind the genital aperture, passes into the posterior longitudinal vessel of the opposite side. It gives off, not far from the middle line, a large branch which runs outwards in close apposition with it for some distance, and then bends inwards and breaks up into branches in the reproductive region.

The above-described arrangement of the excretory vessels and their apertures differs completely from that which occurs in *D. paranephropis*, and appears to approximate more closely to that observable in *Phænocora stagnalis*, as described by Fuhrmann (see 2, p. 2147), than to that occurring in any other member of the Dalyelliidæ.

The reproductive apparatus (Pl. 14, fig. 1) is very similar to that of *D. paranephropis* with certain important points of difference. The genital aperture leads into a genital cloaca into which the free end of the penis projects on the left, while the female aperture is situated towards the right. The penis (Pl. 14, fig. 6) is a chitinous cylinder narrowing somewhat towards its free end, where it possesses an introvert armed with a number of fine spines. At its base is a rounded bulb into which numerous ducts of granule glands open, and from which is given off a short rounded ejaculatory sac. The granule glands are situated chiefly on the left side between the left testis and the intestine. With the bulb of the penis is connected by a narrow neck the large pyriform vesicula seminalis, into which the two vasa deferentia open. There are two compact, somewhat reniform testes situated in the posterior region of the body and coming very close to one another posteriorly.

The female aperture leads into a rounded chamber, the vagina. In the walls of this are situated two, or, in the largest specimens, three groups of chitinous teeth. Each group is supported on a muscular cushion. In each group there are six rows, the outermost row containing about ten teeth—the number in each row decreasing from the outer towards the inner rows. In large specimens the teeth are

more closely aggregated, and the division into rows becomes less definite.

The succeeding division of the female duct (ootype) is not definitely dilated; eggs have never been found in it, but there are a number of unicellular glands (shell-glands) around it. The anterior part of the female duct (oviduct) usually contains a small number of actively moving spermatozoa. It receives the two vitelline ducts and gives off in front, in about the middle line of the body, a rounded sac, the receptaculum, which varies greatly in size in different individuals, and usually contains a quantity of granular matter with embedded inert spermatozoa. The ovary on the right side of the body, is of the same type as that of *D. paranephropis*—compact, oval, containing only a small number of relatively large ova.

The vitelline glands are a pair of solid cylinders, which extend forward on each side to about the line of junction between the pharynx and the intestine. Posteriorly they converge, become narrowed into the form of ducts, and open together into the oviduct close to the mouth of the receptaculum and not far from the ovary.

The form which occurs in the spiny crayfish, and which I propose to call *D. astacopsidis*, resembles *D. cherapsis* in all the most essential features. It is usually more abruptly truncate at the ends; the posterior end being more or less emarginate. The eyes are wider apart. The pharynx is relatively shorter. The penis (Pl. 14, fig. 7) has a somewhat longer introvert with longer spines. The vagina is entirely devoid of teeth.

LITERATURE.

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EXPLANATION OF PLATE 14,

Illustrating Mr. W. A. Haswell's paper “Studies on the ‘Turbellaria.’”

LETTERING.

ap. Reproductive aperture. *bm.* Basement membrane. *e.* Eyes.
ep. Epidermis. *ex.* Excretory vessels. *i.* Intestine. *lm.* Longitudinal muscular layer. *n.* Fibrous mass of brain. *od.* Oviduct. *ov.* Ovary.
p. Penis. *ph.* Pharynx. *r.* Receptaculum. *t.* Teeth in vagina. *te.* Testes. *v.* Vitelline glands.

Fig. 1.—General view (semi-diagrammatic) of the organisation of *Didymorchis cherapsis*, magnified 140 times.

Fig. 2.—Ventral surface of posterior end with adhesive apparatus.

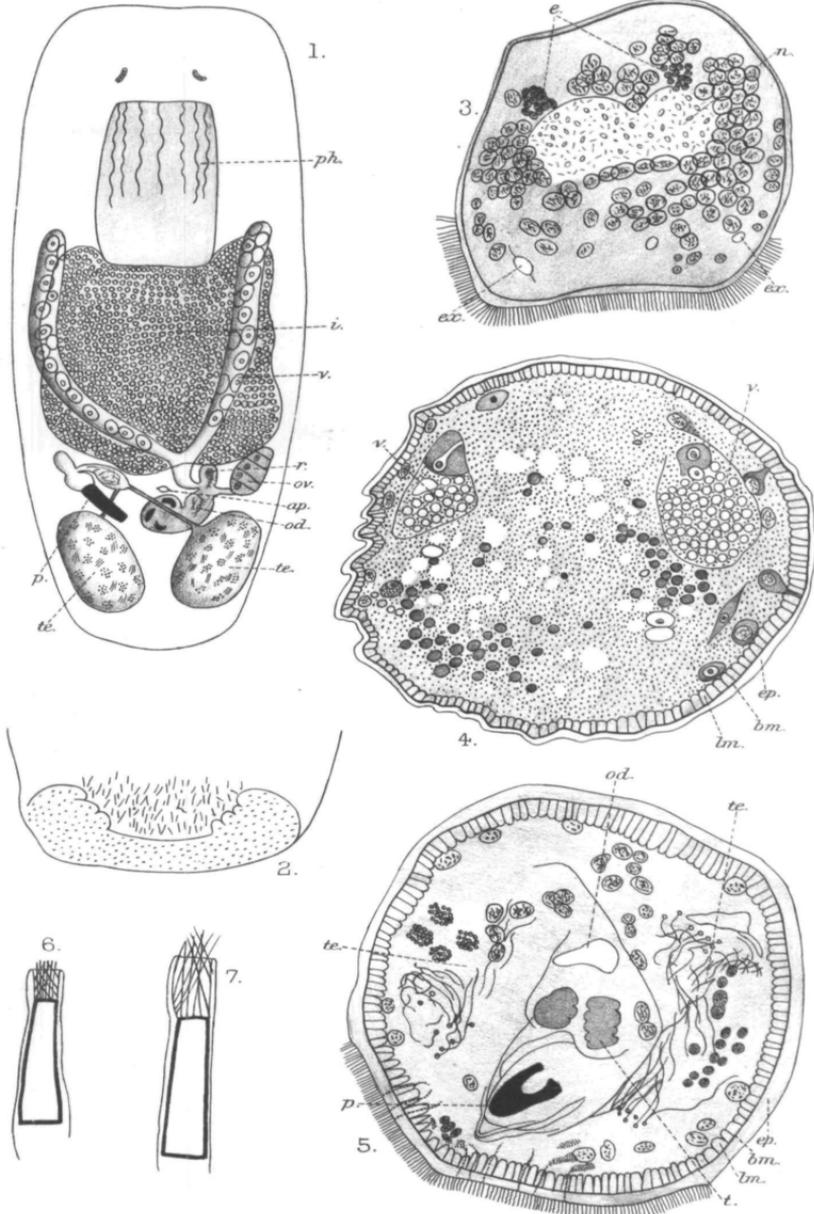
Fig. 3.—Transverse section passing through brain and eyes.

Fig. 4.—Transverse section through intestinal region, showing the absence of epithelium and of lumen. The cilia of the surface are not shown.

Fig. 5.—Transverse section a little behind the genital aperture.

Fig. 6.—Penis of *D. cherapsis*.

Fig. 7.—Penis of *D. astacopsidis*.



HASWELL.— DIDYMORCHIS.

Enth. Lith. London.