FRESHWATER TRICLADS FROM THE BASIN OF THE INLE LAKE.

By TOKIÖ KABURAKI, *Rigakushi, Science College, Imperial University, Tokyo.*

(Plate XXVII).

In the present paper a record is given of three new species of freshwater planarians from the basin of the Inlé Lake, Southern Shan States, Burma, which were collected by Dr. N. Annandale and Dr. F. H. Gravely of the Zoological Survey of India, in the latter part of February, 1917. The specimens were sent to Professor Oka of the Higher Normal School of Tokyo, who kindly gave them over to me for examination. To the gentlemen named I beg to express my thanks for the opportunity of studying these interesting planarians. I deem it my duty to mention my indebtedness to Professor Ijima for kind assistance in many respects.

Planaria burmaensis, n. sp.

Pl. XXVII, figs. 1, 4, 5.

This new species is represented by six individuals (W. $\frac{118}{1}$) in the collection. They were obtained from the middle of the Inlé Lake, Southern Shan States, from a muddy bottom in about 12 feet of water.

The head in the preserved state presents a triangular shape and merges behind in the trunk without being marked off by a neck-like narrowing. The trunk gradually widens backwards to the region of the genital end-organs and then begins to taper rather abruptly, to end with a point at the posterior body-end. The mature specimens measure 5—7 mm. in length and 1·5—2 mm. across the widest part of the body.

The ground colour of the dorsal surface is usually light drab. There exist no pigments. One of the individuals with well-developed genital organs presents on the dorsal side a light grayish-olive colour due to the gut contents, the positions of the pharynx and copulatory organs being marked by clear brownish colouration (fig. 1); the ventral surface is of a much lighter colour, except the genital end-organs which appear of a blackish colour.

The crescentic eyes exist at about the level of the tips of the lateral lappets; the distance between them is somewhat less than that of either eye from the tip of the lappet of the same side. Only in the grayish individual mentioned above the eye is surrounded by a colourless area. The eye consists of a pigment cup and of numerous retina cones, just as in *Pl. gonocephala*. The species is wholly destitute of colourless areas corresponding to the auricular sense organ.

The epidermis is somewhat thicker on the dorsal than on the ventral side. The complete absence of rhabdites in both the epidermis and

the parenchyma is of interest. In addition to the glands opening submarginally on the ventral surface there are some eosinophil glands which open here and there in scattered distribution all over the entire surface of the body.

The dermal musculature is well developed and consists as usual of circular, diagonal and longitudinal layers. Dorso-ventral fibres occur also in the usual manner.

The mouth is placed slightly in front of the commencement of the posterior third of the body. The pharynx is inserted a short distance in front of the middle of the body ; its length is nearly equal to one-sixth that of the body. The intestines are quite of the Triclad type. The anterior trunk extends to a point far in front of the brain and usually sends out 8 pairs of lateral branches, which are sometimes bifurcated and sometimes multifurcated. The posterior trunks are provided with 13—15 subdivided branches. So far as I have observed, Minot's glands are altogether absent in the intestinal epithelium. The food of the worm seems to consist of small organisms, either planktonic or littoral. Remains of a crustacean were found in the pharyngeal chamber and intestinal canal. Moreover, the latter was found to be filled with a dense coagulum.

Of the excretory canals I have been able to obtain no more insight than a few loops at some points in the dorso-lateral parts of the body.

The exact arrangement of the nervous system could not be ascertained, but it seemed to be quite similar to that of *Pl. gonocephala*. Each longitudinal nerve-trunk forms anteriorly a well-developed brain-mass, those of the two sides being connected by a number of strong commissures. From each brain-mass arise a few forwardly-directed sensory and numerous lateral nerves. Posteriorly the longitudinal trunks proceed, running nearly parallel to each other, to the tail-end of the body, and are connected together by fine transverse commissures. Lateral nerves are given off from the main trunks usually at points opposite to the union of the latter with transverse commissures. Marginal nerves could not be brought under observation.

The genital opening lies nearly midway between the mouth and the hind end of body. It leads into the narrow vestibulum, which receives in front the opening of the penis-sheath. Both the vestibulum and the penis-sheath are lined with a single epithelium resting upon a fine basement membrane, beneath which are found circular and longitudinal muscular layers. Eosinophil glands are found all round the vestibulum, into which they open. In one individual a compact mass of spermatozoa was observed in the penis-sheath, close to the tip of the penis.

Numerous testes occur, occupying a dorsal position in the body. They are arranged in two lateral zones beginning from the brain region and extending behind nearly to the posterior end of the body. As is well known, each testis is made up of sperm-mother cells and spermatozoa in all stages of development, surrounded by the tunica propria. Usually each testis gives rise, on its lower side, to a fine testicular canal or vas efferens. This can be made out only by a careful search. The vasa efferentia run down between gut diverticula, frequently uniting with

one another to form somewhat wider ducts, and then take a course directed towards either of the vasa deferentia, which are distinctly discernible in the pharyngeal region. The vasa deferentia, proceeding backward inside the longitudinal nerve cords on the ventral side, rise upward to enter the penis-bulb separately on the sides and finally open into the lumen of the penis or the ejaculatory duct (see figs. 4 and 5). The vas deferens, which is filled with spermatozoa, has the wall consisting of an epithelium and an outer layer of ring-muscle fibres best developed in the neighbourhood of the penis.

The penis consists as usual of two parts, *viz.*, the free, conical and massive intromittent part lying horizontally in the penis-sheath, and the bulbous basal part of strongly muscular nature. The latter part encloses a wide and smooth-walled cavity of a spheroidal shape, the seminal vesicle; posteriorly this is continuous with the ejaculatory duct, which opens into the penis-sheath at the under side of the tip of the penis. In its course the ejaculatory duct makes an obliquely anteriorly directed annular outbulging, much as in *Pl. gonocephala*; consequently there is formed in the lumen a small backwardly directed process surrounded by the said outbulging and which is axially traversed by the narrow anterior section of the ejaculatory duct. It is a short distance in front of the above process that the duct receives laterally the outer ends of the vasa deferentia. Imbedded in the parenchyma around the penis-bulb are numerous eosinophil penis-glands, the ducts of which enter the penis at the base and open into the ejaculatory duct behind the outbulging mentioned above.

The paired ovary is situated far behind the brain and between the fourth and fifth anterior lateral branches of the gut. It is of a nearly spherical shape.

The vitelline glands are represented by cellular cords with the cells arranged in one or more rows; they are very extensively distributed posteriorly from the region of the ovaries and in the interstices between gut diverticula, and stand at many points in connection with the oviduct.

The oviduct of each side starts from the antero-lateral aspect of the ovary as an ampullaceous passage filled with spermatozoa; this soon assumes the character of a narrow tube, which proceeds straight backwards just along the outside of the nerve-cord. In the region of the genital aperture, the oviduct rather abruptly bends mediad, at the same time rising slightly upward, soon to open into the vestibulum from behind near the outer end of the vaginal canal, without uniting with its fellow of the opposite side into a common duct. The oviduct shows a distinct lumen in its entire length. Its actual wall is formed by a homogeneous and ciliated layer which shows no nuclei;—apparently a part of an epithelium, of which the nucleus-containing parts are sunk into the surrounding parenchyma, as has been observed by several investigators to be the case in *Pl. gonocephala*, *Pl. polychroa*, *Dendrocoelum lacteum*, etc. Directly external to the layer mentioned are the two layers of internal circular and external longitudinal muscular fibres. An inversion in the relative position of these two muscular layers does not occur in the terminal parts of the oviduct, as it does in some species according

to v. Graff,[1] Stoppenbrink[2] and others. Outside the muscular layers there exists a cellular coating which probably represents the insunken parts of the lining epithelium. Processes from the cells are occasionally seen to extend to and to join the ciliated lining layer.

As already indicated, the oviduct receives the vitelline glands at several points of its course. The mode of the connection is quite similar to that described by Kennel,[3] Ijima,[4] v. Graff and others in *Pl. gonocephala*, *Pl. polychroa*, *Dendr. lacteum* and some land-planarians. It is effected by means of a pyriform or spherical giant cell, which usually contains an internal space filled with spermatozoa and probably communicating with the lumen of the oviduct. The cytoplasm of the cell is finely granular and exhibits but little affinity for haematoxylin; the nucleus is by far larger than those of surrounding tissues. In no case have I been able to demonstrate the polycellular club-shaped body which was described by Stoppenbrink in place of the single giant cell. In sections the cellular cords of the yolk-gland are seen to be attached to the surface of the giant cell, but exactly how the yolk-cells reach the oviduct lumen cannot be elucidated. As has been pointed out by previous authors, the giant cell in question is probably of a glandular nature. It may be that its secretion disperses into the parenchyma and acts as an attractive agent, which may cause the yolk-cells to collect at its position. Eventually the cell breaks up and disappears, and then the yolk-cells may be said to be in a position to make their way unhindered into the oviduct.

The receptaculum seminis (uterus) is a large sac-like organ occupying a position between the pharyngeal chamber and the penis. Its wall is an epithelium made up of large columnar cells of a glandular nature, resting on a delicate basement membrane, beneath which are layers of fine circular and longitudinal muscular fibres. In the specimens I have examined, the organ seems to have been in secretory activity, the cells containing some refringent globules besides being vacuolated. In one individual, the organ contained spermatozoa enveloped in a coagulum of the secretion, while in another it contained a well-formed spermatophore of an elongate ovoidal shape.

From the postero-superior end of the receptaculum arises the vaginal canal, which runs backward, passing dorsally to the left of the penis, and then dips below to open into the vestibulum. The vagina is internally lined with an epithelium made up of cylindrical cells resting on a fine basement membrane. Just external to this are found the internal longitudinal, the middle circular and the external longitudinal muscular layers in direct succession. Of these the circular layer is best developed, thickest in the middle parts of the course of the canal. Towards both ends of the canal, the muscular layers as a whole gradually grow thinner.

---

[1] v. Graff, L., 1899. *Monographie der Turbellarien.* II. *Tricladida terricola.*

[2] Stoppenbrink, F., 1905. "Der Einfluss herabgesetzter Ernährung auf den histologischen Bau der Süsswassertricladen." *Zeitschr. f. wiss. Zool.*, Bd. LXXIX.

[3] Kennel, J., 1879. "Die in Deutschland gefundenen Landplanarien, *Rhynchodemus terrestris* O. F. Müll. und *Geodesmus bilineatus* Metschn." *Arbeiten des zool.-zoot. Inst. zu Würzburg.*

[4] Ijima, I., 1884. "Untersuchungen über Bau und die Entwicklungsgeschichte der Süsswasser-Dendrocölen (Tricladen)." *Zeitschr. f. wiss. Zool.*, Bd. XL.

Outside them the canal is surrounded by a large number of cells, which seem to be of a glandular nature. Processes from these cells are sometimes observed to extend right to the internal epithelium. In one individual, I have found spermatozoa in considerable quantity in the lumen of the canal.

Planaria annandalei, n. sp.

Pl. XXVII, figs. 2, 6, 7.

This new species is based on a single specimen (W. $\frac{121}{1}$) which was collected about half a mile off Kyezagon, in the Inlé Lake, Southern Shan States, from a muddy bottom in about 7 feet of water.

The body-shape in the preserved condition is closely similar to that of *Pl. torva* and *polychroa* in the same state. The head is broadly rounded and merges into the trunk, from which it is indistinctly separated by a slight neck-like narrowing. From the region of the genital organs the sides of the trunk converge backward to the rounded posterior extremity. The specimen measures about 6 mm. in length and 1·5 mm. across in the broadest part of the body at the pharyngeal region.

The dorsal side of the specimen is of a buffy-brownish colour, which acquires a much darker tone in the median parts from behind the eyes to the posterior body-region. The ventral surface is of a much lighter colour than the dorsal side.

Two crescentic eyes, each surrounded by a small oval space without pigment, lie slightly in front of the line drawn across in the broadest part of the head; the distance between them is about equal to that between either of them and the lateral head margin of the same side.

The auricular sense organ of each side, visible as a slender colourless streak, extends posteriorly from the level of the eyes, exactly as in *Pl. polychroa.*

The epidermis is somewhat thinner on the dorsal surface than on the ventral or at the body-margin. It nowhere contains rhabdites except on the head near the anterior margin, where they are found in very small numbers, evidently situated between the epidermal cells. In the part of the body just indicated and immediately beneath the dermal musculature, there occur such rhabdites as are still contained in their mother cells. These are scattered in a sparse number in the parenchyma. There are some eosinophil glandular cells, situated in the parenchyma, opening to the exterior at various points of the entire body-surface, much as in the preceding species.

The mouth is situated at the end of the middle third of the body. In the specimen examined the pharynx is entirely missing, apparently having been lost by breaking through the dorsal body-wall before preservation. The unpaired anterior main trunk of the intestine extends to a point in front of the brain. It seemed to be provided with at least 8 pairs of lateral branches, while each of the posterior trunks gives off a larger number. Among the columnar cells of the intestinal epithelium Minot's glands are but rarely found.

The genital aperture lies slightly in front of the middle of the posterior third of the body. It leads directly into the simple penis-sheath

(fig. 6, *ps.*), much as in *Pl. polychroa.* A large number of eosinophil unicellular glands, occurring in a cluster around the genital aperture, discharge themselves into the atrial part of the sheath.

Numerous follicular testes are placed close together in the dorsal parts of the body, arranged in two longitudinal lateral zones which extend from the ovarian region to nearly the posterior end of the body.

The vasa deferentia, filled up with spermatozoa, can be clearly made out in the pharyngeal region. After running backward in the usual way, they rise obliquely upward to enter, each separately, the bulbous part of the penis at the upper lateral sides. After that they again slant down and finally open into the lumen of the penis or the ejaculatory duct. This is devoid of the annular outbulging which we have seen in the preceding form.

The penis consists of the hemispherical bulb and the conical and massive intromittent part which is horizontally disposed in the penis-sheath. The bulb contains a relatively narrow and smooth-walled seminal vesicle, which posteriorly narrows gradually into the ejaculatory duct. In its course the ejaculatory duct receives laterally the vasa deferentia and throughout its length the eosinophil penis-glands, which are profusely present in the body-parenchyma around the penis-bulb.

The ovaries are nearly spherical in shape and are present in a pair close behind the brain and probably between the first and second pairs of the lateral branches of the anterior gut-trunk.

The oviduct of either side leaves the ovary in the form of a funnel-like widening, which is filled with spermatozoa. For the rest of its length it is a narrow duct running just outside the longitudinal nerve-trunk; in the region of the genital opening it nears the median line, slightly rising at the same time, and finally opens into the vaginal canal from behind and at a point near the outer end of it. The vitelline glands extensively fill up the interspaces between gut diverticula. They are in connection with the oviduct at numerous points by means of a spherical or pyriform giant cell.

The receptaculum seminis is a nearly fusiform sac-like organ, situated dorsally in front of the penis. It is lined with an epithelium of elongate cylindrical or pyriform cells. The appearance of the cells varies much with the state of their secretory activity; the protoplasm is either entirely homogeneous or contains some globules, and at other times it is vacuolated. They rest upon a delicate basement-membrane, close to which is a feeble layer of muscular fibres. Some small glandular cells of a pyriform shape are found in close apposition to the wall of this organ in the posterior parts, as shown in fig. 7.

Of interest is the fact that the receptaculum seminis of this specimen contained a spermatophore, or rather the capsule of an empty spermatophore. Unlike that of *Pl. torva, gonocephala, striata* and of the preceding species, the spermatophore of the present species appears to be of a tubular form, irregularly twisted as it lies in the cavity of the receptaculum. The capsule is thin, homogeneous and apparently of an elastic nature; it stains deeply with eosin, agreeing in this respect with the eosinophil secretion of the penis-gland, and differing from the cyanophil secretion of the receptaculum seminis. The fact

manifestly stands in favour of the view (Schultze,[1] Woodworth,[2] Bergendal[3] and Weiss[4]) that the formation of the spermatophore takes place in the penis-lumen, and not in the receptaculum seminis. Still another point which lends probability to this view is the fact that in the present species the spermatophore is tubular in conformity with the general shape of the lumen of the penis.

The receptaculum seminis gives rise posteriorly to the vaginal canal, which runs above and somewhat to the left of the penis. It opens into the penis-sheath from above. The cylindrical epithelium of its wall rests on a delicate basement membrane, beneath which is a muscular coat consisting of an internal circular and a thinner external longitudinal layer. Further, the vagina is surrounded by a large number of pyriform cells, which appear to represent the unicellular glands seen in the preceding form in the same situation.

Planaria bilineata, n. sp.

Pl. XXVII, fig. 3.

This new species is represented again by a single specimen (W. $\frac{1\,2\,4}{1}$), taken on the lower surface of a stone in a small stream in Yawnghwe State above Fort Stedman, at an altitude of about 3,500 ft. above sea-level, Southern Shan States.

Externally the specimen looks very much like *Pl. gonocephala, subtentaculata, maculata, aborensis*, etc., so far as concerns the shape in the preserved condition. The head is somewhat markedly triangular, with a slight prominent lappet on either side. There thus exists behind the head a somewhat neck-like constriction. The trunk in the hind parts gradually tapers to the bluntly pointed posterior extremity, which in the present specimen bears a sign of regeneration in that it exhibits pigmentation in a somewhat less degree than the rest of the body-surface (fig. 3). The worm measures 8 mm. long by 2·5 mm. across in the broadest part of the body.

The colour of the dorsal surface is darkish olive-brown, with two longitudinal well-defined blackish bands running on either side of the median line from the eyes to the posterior end. These bands are narrower and much more distinctly defined than those sometimes observed in *Pl. gonocephala.* The ventral surface is as usual of a somewhat lighter colour than the dorsal.

The crescentic eyes, each situated at the inner edge of an oval colourless area, are situated about midway between the anterior extremity and the line connecting the apices of the lateral head lappets, and are separated from each other by a space about equal to the shortest

---

[1] Schultze, M., 1854. "Zoologische Skizzen." *Zeitschr. f. wiss. Zool.*, Bd. IV, pp. 186, 187.

[2] Woodworth, W. McM., 1891. "Contributions to the Morphology of the Turbellaria I. On the structure of *Phagocata gracilis* Leidy." *Bull. Mus. Comp. Zool. Harvard Coll.*, Vol. XXI, pp. 31, 32.

[3] Bergendal, D., 1892. "Einiges über den Uterus der Tricladen." *Festschr. z. 70 ten Geburtstag R. Leuckarts*, p. 318.

[4] Weiss, A., 1910. "Beiträge zur Kenntnis der australischen Turbellarien. I. Tricladen." *Zeitschr. f. wiss. Zool.*, Bd. XCIV, pp. 584-586.

distance of either eye from the lateral head-margin of the same side. Auricular sense organs are present on each side as very distinct, reniform, non-pigmented areas on the cephalic lappet, much as in *Pl. gonocephala.*

The epithelium is full of minute rhabdites. Those inclosed in the subcutaneous cells occur in wide distribution over various parts of the body.

The mouth is situated about between the third and the fourth quarter of the body. The insertion of the pharynx takes place slightly in front of the middle of the body, being somewhat shorter than one-third the body-length. The anterior gut-trunk extends as far forward as the eyes and gives off on either side approximately seven branching diverticula, while the posterior trunks are provided each with at least thirteen bifurcated or trifurcated diverticula. Minot's glands are found in abundance in the gut epithelium.

The nervous system seems to be in its main features similar to that of *Pl. burmaensis.* The sexual organs were not yet developed in the individual examined.