

FRESHWATER TRICLADS FROM THE BASIN OF THE INLE LAKE.

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(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 sub-marginally 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 Stoppenbrink² 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. gonoccephala*, *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 Süßwassertricliden." *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 (Tricliden)." *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 Kyezagou, 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 Bergendal³ and Weiss⁴) 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. $\frac{124}{1}$), taken on the lower surface of a stone in a small stream in Yawngnaw 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. 70ten 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.

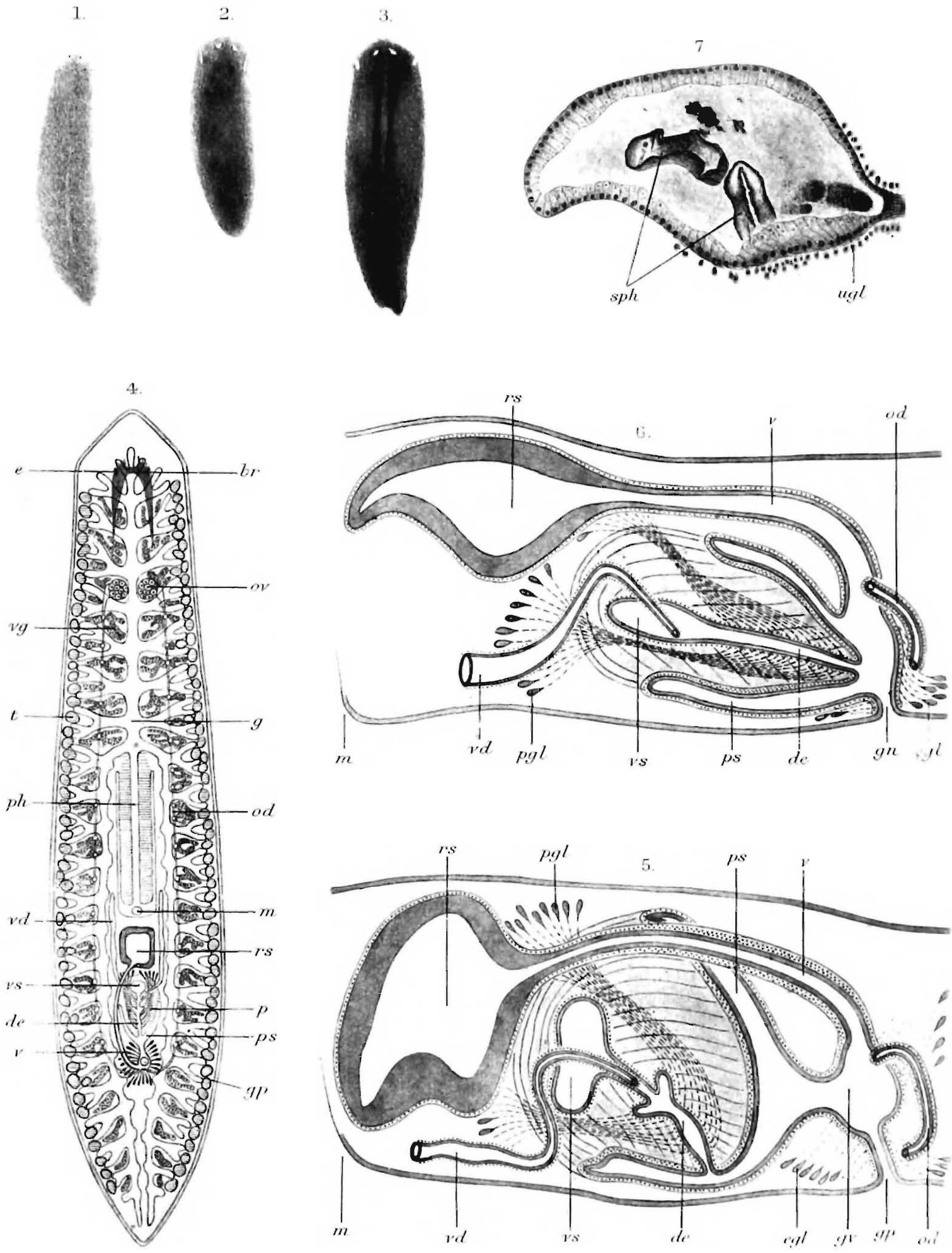
The nervous system seems to be in its main features similar to that of *Pl. burmaensis*. The sexual organs were not yet developed in the individual examined.

EXPLANATION OF PLATE XXVII.

- FIG. 1.—*Planaria burmaensis*, n. sp. in the preserved condition. $\times 6$.
 „ 2.—*Planaria annandalei*, n. sp. in the preserved condition. $\times 5.5$.
 „ 3.—*Planaria bilineata*, n. sp. in the preserved condition. $\times 5.5$.
 „ 4.—*Planaria burmaensis*, n. sp. Diagrammatic representation of the organization of an entire worm, as seen from the dorsal surface.
 „ 5.—The same. Diagram of sexual organs in sagittal section. $\times 90$.
 „ 6.—*Planaria annandalei*, n. sp. Diagram of sexual organs in sagittal section. $\times 100$.
 „ 7.—The same. Sagittal section through receptaculum seminis, containing fragments of spermatophore capsule. $\times 150$.

Explanation of lettering.

<i>br</i>	...	Brain.	<i>pgl</i>	...	Penis-gland.
<i>de</i>	...	Ductus ejaculatorius.	<i>ph</i>	...	Pharynx.
<i>e</i>	...	Eye.	<i>ps</i>	...	Penis-sheath.
<i>egl</i>	...	Eosinophil gland.	<i>rs</i>	...	Receptaculum seminis (uterus)
<i>g</i>	...	Gut.	<i>sph</i>	...	Spermatophore.
<i>gp</i>	...	Genital pore.	<i>t</i>	...	Testis.
<i>gv</i>	...	Genital vestibulum.	<i>ugl</i>	...	Unicellular uterine gland.
<i>m</i>	...	Mouth.	<i>v</i>	...	Vagina.
<i>od</i>	...	Oviduct.	<i>vd</i>	...	Vas deferens.
<i>ov</i>	...	Ovary.	<i>vg</i>	...	Vitelline gland.
<i>p</i>	...	Penis.	<i>vs</i>	...	Vesicula seminalis.



THE FAUNA OF THE INLE LAKE.

SUMMARY OF RESULTS.

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With Plate XXVI.

The object of this paper is to summarize what has been said in previous papers in this volume on the biology, the geographical relations and the origin of the fauna of the Inlé Lake.

In the time at our disposal in the Shan States Dr. Gravely and I were able to study only the macroscopic fauna and I must ignore one important element, namely the plancton, which I have purposely omitted from consideration. At the time of our visit to the lake, in early spring, floating organisms were extremely scarce and it is always necessary if the plancton of fresh water is to be examined in a satisfactory manner that collections should be made at all seasons. We know that many of the organisms are plastic and vary greatly with temperature and the like, and I am not at all sure that descriptions of stray samples of plancton are not liable to obscure rather than to elucidate the biology of a given body of water. In another direction we were able to do little—in the collection of aquatic reptiles, *Batrachia* and the more delicate insects, mainly because we were on the lake too soon after winter.

ZONES OF LIFE IN THE INLE LAKE.

Three zones of life can be distinguished in the Inlé Lake :—a Marginal Zone, an Intermediate Zone and a Central Region.

Marginal Zone.—This is a zone of varying width that encircles the lake. It owes its most peculiar features to the fact that it is covered with floating islands of dead and living plants in which the dead matter is undergoing a transformation into fen-peat. The process produces chemical changes in the water and also in both the chemical and the physical condition of the mud at the bottom, which is black, fairly coherent and often malodorous. Contamination of another kind is due to the villages built at the edge of the lake and on piles in the water. The floating islands provide abundant cover, with the floating plants on the channels between them, while the villages provide food for foul-feeding animals ; but the conditions prevalent in this zone are unfavourable to the more delicate forms of life and the environment is of the paludine rather than the lacustrine type. At the two ends of the lake, and to a less extent at certain places on the western shore, the ring of floating islands merges gradually into a great marsh, covered with a network of natural and artificial waterways and containing numerous small stagnant pools. This marsh is buried in gigantic reeds, which are burnt

down by the villagers in spring and explode with reports like pistol-shots, producing dense clouds of smoke. The floating islands are often reversed and cultivated or made to support pig-styes or even human habitations.

Intermediate Zone.—On the inner edge (*i.e.*, the edge nearer the centre of the lake) of the Marginal Zone the water, though doubtless less pure than that of the central parts, is clear, and the mud, though black, is less coherent and less malodorous. Submerged thickets of such plants as *Ceratophyllum*, *Hydrilla* and *Utricularia* flourish, those of *Ceratophyllum* being particularly luxuriant. This part of the lake may be conveniently considered as an Intermediate Zone, but its boundaries, whether inwards or outwards, are ill-defined.

Central Region.—In the open central parts of the lake the water is of the most perfect transparency, oxygenation of dead vegetable matter takes place rapidly and completely, and the bottom is composed of minute calcareous particles and fragments of dead plants mingled together to produce a peculiar greyish semi-liquid mud much less solid than good porridge. It has no foul odour. Mr. R. V. Briggs has provided the following analyses of dried mud and of water from this region :—

Water from Surface in Central Region.

Mud from Bottom of Central Region.

	Per litre.		Per cent.
Total solids	0.1710	Insoluble Silicious matter	0.98
Organic matter	0.0160	Alumina	1.30
Calcium	0.0222	Oxide of Iron	2.25
Magnesium	0.0279	Lime	45.31
Chlorine	0.0017	Magnesia	1.25
Sulphate (SO ₄)	0.0017	Potash	0.12
Silica	0.0010	Soda	0.46
Carbonic Acid (CO ₂)	0.1030	Moisture	3.10
	—	Carbonic Acid	33.15
Iron	Less	Phosphoric Acid	0.17
	than	Sulphuric Acid	0.41
	one	*Organic matter and combined	
	part in	water by difference	11.50
	5 mil-		—
	lion.		100.00
			—
		*Containing Nitrogen	.0619

A considerable part of the Central Region, from which, despite its shallowness, plants growing up out of the water or floating on the surface are practically absent, is filled almost to the surface with thickets of *Ceratophyllum*, but the bottom in many places is almost bare, with scattered plants of *Potamogeton* and *Hydrilla* or with clumps of Characeae, the growth of which seems to choke that of other plants. The Intha fishermen have the custom of protecting the houses occasionally built on poles in the Central Region in connection with fisheries or for other purposes, by floating breakwaters formed of strips cut off from the islands of the Marginal Zone, towed out and anchored by bamboo poles thrust through them into the bottom. These artificial floating islands flourish and produce in their immediate vicinity conditions similar in some respects to those prevalent in the Intermediate Zone, but they are not numerous and their influence is on the whole of small importance.

ANIMAL LIFE IN THE MARGINAL ZONE.

The most striking feature of the fauna of this zone is its wealth of insect life. Characteristic species occur among the fish and molluscs, but most of them are also found in marshes and pools and the fauna as a whole is paludine.

SPONGES.—*Ephydatia fluviatilis* var. *intha* is occasionally found and *Spongilla fragilis* var. *calcuttana* and *S. lacustris* var. *proliferens* occur.

ANNELIDS.—In mud at the edge of the lake we found two species of Oligochaeta, the Tubificid *Branchiura sowerbyi*, one of the few species with external gills, and the Megascolecid *Perionyx fulvus*, a form that possesses no obvious modification for an aquatic life. The specimens of *Branchiura* are of normal size with the gills long and as a rule numerous. A small almost colourless leech of the genus *Glossosiphonia* is common on the gastropod molluscs *Taia shanensis* and *Ampullaria winkleyi*, and we found specimens of a larger species of the same family on the tortoise *Cyclemys dhor shanensis*.

POLYZOA.—The Ctenostome *Hislopia lacustris* sometimes grows on Gastropod shells, but not so commonly or so luxuriantly as in other parts of the lake.

DECAPOD CRUSTACEA.—The little Atyid prawns *Caridina annandalei* and *C. weberi* occur, but *C. weberi*, which apparently enters the lake occasionally from small streams, is much less abundant than its congener. The crab *Potamon acanthicum* is fairly common among the roots of floating islands and *P. curtobates* probably wanders in occasionally from the rice-fields and marshes it usually inhabits.

INSECTS.—Both larval and adult aquatic insects are very abundant, but the latter are mainly surface-forms, the family best represented both in species and individuals being the Hydrometridae, which are attracted both by the shelter afforded by the islands and the floating plants on the waterways, and also by the abundance of food. As all members of the family are rapacious or feed on dead insects that have fallen into the water it is important for them to live in places where other insects are abundant, while their movements on the surface are greatly impeded by even small waves. The commonest species of Hydrometridae on the Inlé Lake are *Gerris fossarum* and *G. nepalensis*. Another family of Rhynchota, not surface forms, is well represented in the Corixidae, but Nepidae are comparatively scarce. Water-beetles of all families are also rather scarce. Dragon-fly larvae (Agrionidae and Aeschnidae) are abundant. Among Dipterous larvae we observed those of Culicidae (both Culicinae and Anophelinae,¹ both very scarce), Chironomidae and Stratiomyidae. Caddis-worms were not very common.

Speaking generally, therefore, the insects of this zone are just such as would be found in any Oriental marsh, though the number of apparently endemic species is large. No special modifications were observed.

MOLLUSCS.—The characteristic molluscs of this zone are *Planorbis exustus*, *Ampullaria winkleyi*, *Hydrobioides nassa typica*, *Hydrobioides nana* and *Taia shanensis*. All of these but the last, which has not

¹ *Anopheles barbirostris*, v. d. Wulp. I have to thank Dr. Bains Prashad for naming specimens of larvae.

been recorded from any other definite locality, are also found in swamps, pools and canals in the neighbourhood and have a wide distribution at any rate in Burma. *Hydrobioides nassa lacustris* occurs with the typical form in this zone only. Probably the pond form of *Limnaea andersoniana*, of which a dead shell was found floating on the surface, visits it occasionally, but the smaller Limnaeidae of other parts of the lake are scarce if not altogether absent. *Succinea indica* is found at the margin. We took no specimens of *Melania* or of any Pelecypod.

FISH.—Most or all of the fish of the Central Region of the lake wander as far as the Marginal Zone occasionally, but its characteristic species, which rarely or never visit the Central Region, are the eels *Amphipnous cuchia* and *Monopterus albus*, the cat-fish *Clarias batrachus* and the minute but brilliantly coloured Cyprinid *Microrasbora erythromicron*. With the exception of the last, these are mud-haunting species of wide geographical range that flourish in marshes, rice-fields, ditches, canals and slow streams. *M. erythromicron* is, however, a surface or mid-water fish that conceals itself under floating vegetation. It is only known from the Inlé Lake and from other parts of the Inlé basin, in which it is, to judge from its frequent occurrence in the dried whitebait sold in the Intha bazaars, by no means uncommon. A single specimen of the peculiar little eel *Chaudhuria caudata* was taken in this zone.

REPTILES.—The tortoise *Cyclemys dhor shanensis*, only known from the Inlé system, is not uncommon at the edge of the lake.

ANIMAL LIFE IN THE INTERMEDIATE ZONE.

There are few species confined to this zone, which is naturally a meeting-place for those of the Central Region and those of the Marginal Zone. Perhaps the most characteristic feature is the rich growth of sponges, mainly *Ephydatia fluviatilis* var. *intha*.

SPONGES.—The *Ephydatia* is very common on weeds and *Spongilla lacustris* var. *proliferens* occurs.

HYDROZOA.—Numerous specimens of *Hydra vulgaris* were found amidst a growth of *Hislopia* on a post in this region.

ANNELIDA.—Minute free-living Oligochaetes of the family Naididae are common among weeds and Polyzoa, but the only specimens collected were from the canals of *Ephydatia*. They represent three species of the genus *Chaetogaster*, one of which has recently been described from freshwater sponges in Japan, while another was originally found in the same organisms in Calcutta, the third being Palaearctic and often quasi-parasitic on *Limnaea*.

POLYZOA.—The house-posts of fishing-huts erected in this zone are covered with a growth of *Hislopia lacustris*, which also occurs very commonly on the shells of living molluscs of the genera *Hydrobioides* and *Txia*. We found, on the stem of a plant, a single colony of *H. malayensis*, an allied species described from a small lake in the Siamese Malay States and also common in the River Hughli at Calcutta.

DECAPOD CRUSTACEA.—Probably the only Decapod Crustacea that live in this zone are the same as those found in the Central Region, namely *Potamon acanthicum* and *Caridina annandalei*.

INSECTS.—Insects are much scarcer than in the Marginal Zone. Most if not all of the marginal species, however, make their way into it occasionally. Several Chironomid and free-living Trichopterous larvae were found in the canals of *Ephydatia*, together with one of the Neuropterous genus *Sisyra* (Hemerobiidae), a genus whose larva is always found in sponges.

MOLLUSCS.—The most characteristic molluscs of the zone is *Taia elitoralis*, which is not known elsewhere but is closely allied to the fossil *T. conica* from the Hsin-Dawng valley in the same district. It reaches a larger size than any other Gastropod of the lake except *Ampullaria*. *Hydrobioides nassa lacustris* grows larger here than in the Central Region. *Ampullaria winkleyi* is fairly common at some places, but *Planorbis exustus* does not come so far from the margin of the lake. The smaller Limnaeidae are perhaps more numerous in this zone than in any other; their shells are often a little darker in colour than in the Central Region.

FISH.—There is no fish peculiar to the Intermediate Zone, but the little Cyprinidae *Microrasbora rubescens* and *Sawbwa resplendens*, which are also common in the Central Region, perhaps breed in the former only, for it was only in this zone that we found the males in full breeding colour. *Barilius auropurpureus*, on the other hand, is neither so big nor so brightly coloured, though common enough, as in the Central Region. All weed-haunting species are abundant, e.g., the Shan Carp (*Cyprinus carpio intha*), *Cirrhina latia*, *Ophiocephalus* spp., *Mastacembelus* spp., etc.

ANIMAL LIFE IN THE CENTRAL REGION.

This is the only part of the lake in which the fauna can be said to be completely lacustrine. In it most of the peculiar species (excluding insects) occur in abundance and in many respects it is the most characteristic of the three regions. A curious feature is the complete absence of sponges, a fact for which no explanation is at present forthcoming. A similar lack is that of Phylactolaematous Polyzoa, but this is a feature of other parts of the lake also. The bottom fauna is perhaps richer than elsewhere, and it was only in the Central Region that we found Pelecypoda.

PLATYHELMINTHES.—Small Planaria of very normal appearance (*P. burmaensis* and *P. annandalei*) were dredged from the bottom. The most interesting feature about them is the complete or partial absence of rhabdites from their integument. The aberrant Trematode or Temnocephaloid *Caridinicola* is common in the gill-chamber of *Caridina annandalei*.

ANNELIDA.—The only Oligochaete we collected was *Branchiura sowerbyi*, which in the semi-liquid mud of this region attains an unusual size and has as a rule its gills less well developed than in the Marginal Zone, in which the water is much less thoroughly oxygenated. Great length is necessary for a cylindrical animal in the peculiar mud of the Central Region, if it would maintain a vertical position. A small red leech of the actively predaceous family Herpobdellidae is found occasion-

ally on the bottom and a *Glossosiphonia*, probably the same as that taken in the Marginal Zone, is not uncommon on *Taia intha*.

POLYZOA.—The only Polyzoan seen was *Hislopia lacustris*, colonies of which often cover living shells of *Taia* and *Hydrobioides* and grow on the exposed part of the valves of *Physunio*. This animal also grows over posts in the water. Its growth must be rapid, for it is known to cover a post in a few weeks.

DECAPOD CRUSTACEA.—*Caridina annandalei* is very abundant among weeds and we dredged several specimens of *Potamon acanthicum* from the bottom.

INSECTS.—Adult aquatic insects are scarce in this region. At places where artificial breakwaters have been made by anchoring strips of floating islands a few individuals of *Gerris fossarum* and *G. nepalensis* may occasionally be seen on the surface, in the shelter of the breakwaters. A *Micronecta* also occurs beneath floating masses of *Ceratophyllum*.

The number of insect larvae, on the other hand, is enormous, but rather in individuals than in species. At the season of our visit (the latter part of February and the beginning of March) vast swarms of small midges, caddis-flies and may-flies issued from the water every evening at dusk. They consisted mainly of three species, a small Chironomid of a genus I have been unable to identify, a small may-fly of the family Baetidae and a small caddis-fly of the family Leptoceridae. All three species are able to live, if they survive the attacks of the fish *Barilius auropurpureus* (which feeds extensively upon them) and other enemies, for several days. By day they conceal themselves; we found them in abundance between our books and in every possible corner. Fortunately none of them were blood-suckers. In spite of the prodigious abundance of the midge we were unable to identify its larva; possibly it is a red "blood-worm" very like that of many European species and common in mud at the bottom. The larva of the caddis-fly lives in great numbers among weeds in a little horn-shaped case of consolidated silk. Its feet are fringed with long hairs and it swims about vigorously by means of them. The Ephemerid larva is also found among weeds. It is a rather sluggish little animal of the type normal in its family. Other larvae found in this region are those of numerous species of dragon-flies, Agrionidae and Aeschnidae among weeds and Libellulidae on the bottom. The commonest species are the Agrionids *Ischnura* sp. and *Pseudagrion microcephalum*. The only other larva that we found at all common was that of the Chironomid *Polypedilum*. This larva constructs a case of silk to which it affixes living Protozoa (*Epistylis*), and lives among weeds, feeding on the Protozoa and other small animals. No burrowing larvae were observed except the red "blood-worms."

MOLLUSCS.—All the characteristic molluscs of the lake (except *Taia shanensis* and *T. elitoralis* and the paludine species of the Marginal Zone) are to be found in large numbers in this region. *Taia intha* and *Physunio ferrugineus* are apparently endemic in it, while the widely distributed *Melania tuberculata* and *Pisidium casertanum* were not found in any other part of the lake. *Taia intha*, *Hydrobioides nassa lacustris*

and *H. phycus* are much the most abundant species. *Amnicola alticola* is also very common, and *Physunio ferrugineus* fairly so. The smaller Limaeidae occur in small numbers among weeds.

FISH.—All the fish of the lake (except the mud-loving eels and cat-fish and *Microrasbora erythromicron*) probably enter this region, but *Barbus schanicus*, which is not a true lacustrine fish, avoids it habitually and we have no evidence as to the occurrence of *Lepidocephalus berdmorei*, which is little more than a stray immigrant in the lake. The most characteristic species is *Barilius auropurpureus*, which swims in large shoals just below the surface of the water. *Chaudhuria caudata* is found among weeds.

The fauna of the Central Region (i.e., the true lacustrine fauna) of the lake consist mainly, from a biological point of view, of two elements, viz., animals that live among weeds and bottom forms. Surface organisms of all kinds are, at any rate in early spring, very scarce and even *Barilius auropurpureus* descends to the bottom in the heat of the day.

The bottom fauna includes comparatively few burrowing forms, probably on account of the tenuity of the mud, which renders burrowing for any but very small and light or extremely elongate animals difficult. Among the few burrowers are *Physunio ferrugineus*, which works its way through the mud with the aid of a sharp projecting "wing" and is never entirely submerged, a very small form of *Pisidium casertanum*, the Oligochaete worm *Branchiura sowerbyi* (which is much longer than usual in this position and, like the Unionid, only buries the anterior part of its body) and small red Dipterous (Chironomid) larvae. *Melania tuberculata* crawls habitually on the bottom, on which, as well as among weeds, *Taia intha* and the species of *Hydrobioides* are also to be found. We dredged a few small Planarians of normal appearance and some flattened Libellulid dragon-fly nymphs, also mud-crawlers.

Life is rich among the weed-thickets of this region. Most of the fish conceal themselves and probably spawn among them. The small Limnaeidae so characteristic of the lake as a whole, *Caridina annandalei* and the larvae of Agrionid dragon-flies and of the Trichoptera and Ephemeroidea that swarm in the evening in a winged state find their home here. The peculiar larva of the midge *Polypedilum* in its case (which is also its larder) decorated with living Vorticellid Protozoa, also lives amidst the thickets of *Ceratophyllum*. A prolonged search would certainly reveal other interesting forms. A peculiarity of the weeds of this region is the total absence of sponges and polyzoa.

The house-posts of our dwelling in the middle of the lake had an interesting fauna, which it was possible to observe in almost ideal conditions. The house had been erected only a few weeks before our visit, but the surface of some of the posts on which it stood was almost completely covered with large colonies of *Hislopia lacustris*, the upper parts of which were perishing as the water sank. Considerable numbers of the mollusc *Taia intha* sat on the posts, sometimes without moving from day to day, and the two commonest species of *Hydrobioides* crawled on them more actively. The curious fish *Discognathus lamta* also

frequented them, clinging to them with its peculiar lip, gradually swimming up them, browsing on the way on *Hislopia* and algae.

GROUPS OF ANIMALS REPRESENTED.

Considered as a whole, the fauna of the lake is remarkably rich in fish and molluscs, both of which are abundant in species and individuals and include peculiar and apparently endemic forms. The Mollusca exhibit extraordinary plasticity and in several instances a very high degree of specialization in shell-form. The fish are almost equally remarkable. Included among them are several minute brilliantly coloured species and also the eel *Chaudhuria*, which is very small but not brilliantly coloured—a form so peculiar that a new family has had to be founded for its reception. A characteristic feature of most of the fish, doubtless correlated with the clearness of the water, is the large size of their eyes and the poor development of tactile organs such as barbels. The lower vertebrates, on the other hand, are poorly represented and in no way remarkable or highly specialized. Sponges are apparently absent altogether from the Central Region, though one species (*Ephydatia fluviatilis*) is common in the Intermediate Zone, while the Polyzoa are represented in the fauna only by the Ctenostomatous genus *Hislopia*, a species (*H. lacustris*) of which is common all over the lake. Notwithstanding a careful search, we were unable to find any Amphipod or Isopod Crustacea. Only two species of Decapoda penetrate as far as the Central Region, and the lower groups of Crustacea are apparently scarce throughout the lake. In the Marginal Zone numerous species of aquatic insects of the orders Odonata, Diptera, and Rhynchota occur, but beetles are scarce in all regions. In the Central Region the larvae of certain Diptera, Trichoptera and Ephemeridae swarm, but the number of species is limited. Dr. F. F. Laidlaw has kindly given me the following note on the Odonata in our collection:—

“The most interesting species in the collection is perhaps a small orange and black *Ischneura*, closely allied to *I. rufostigma*, Selys, from Bengal and Assam but quite distinct, and apparently new to science. A number of examples of the beautiful *Rhinocypha iridea*, Selys, hitherto recorded from Burma, form an addition to the Museum list of species; and *R. biforata*, Selys, is also represented. Specimens of a species of *Ceriagrion* present some difficulties in identification, they are possibly examples of my *C. olivaceum* recorded from the Abor country. The collection of larval forms is large and includes specimens belonging to species not represented amongst the adults; amongst others one that is possibly the larva of a *Disparoneura*. The adults, with the exception noted, are mostly to be referred to common and widely spread species. Possibly the season of the year was unsuitable for the obtaining of some species, but on the whole the collection of adults is not so rich as one would have expected from the variety of the larvae.”

Some of these dragon-flies breed in the lake, notably the *Ischneura*, while others (e.g., *Rhinocypha* spp.) are jungle forms only found in thickets on the hills. These latter probably breed in small streams.

GEOGRAPHICAL RELATIONS OF THE FAUNA.

The lower invertebrates of the lake and its connected waters throw little light on the geographical relations of the fauna, and the aquatic insects (none of which, of course, are completely aquatic in a literal sense) are still, with the exception of the Rhynchota and the Odonata, unknown. I will deal with the Rhynchota separately. Among the strictly aquatic forms we need consider only the Decapod Crustacea, the Mollusca and the fish. The facts about the geographical distribution of these groups will be found on pp. 37-38, pp. 81-82 and pp. 145-148. of this volume. They may be summarized as follows:—

- 33 genera are represented, of which 2 (fish) are endemic in the lake=*ca.* 6 per cent.
- 2 other genera (molluscs) are practically confined to the Shan Plateau, giving a total of four endemic Shan genera=*ca.* 12 per cent.
- 67 species and races have been found, of which 30 have been found only in the lake and connected waters, giving a percentage of *ca.* 45 per cent.
- 2 other species and two races are practically confined to the Shan Plateau, giving a total of endemic Shan forms of 34 =nearly 51 per cent.

The fauna is thus mainly a fauna endemic on the Shan Plateau, with a very large percentage of peculiar lake forms probably not existing outside the Inlé system. The only other elements that can be detected are (a) one consisting of widely distributed Oriental species, (b) one consisting of Indian forms found on both sides of the Bay of Bengal, (c) a very small Indo-Chinese element, represented by general affinities rather than common species, and perhaps faint traces of (d) an Eastern Palaearctic element. The true aquatic fauna of the Inlé system belongs, therefore, to that of the Indo-Burmese area, but represents a distinct off-shoot thereof. It will probably be found, when the upper waters of the Salween are investigated, that this offshoot is well established in the watershed of that river, in so far as it is not purely lacustrine.

A word may be said here about the aquatic Rhynchota. No less than 33 species, representing 20 genera, are known to occur in the Inlé system, and 13 (*ca.* 39 per cent.) are known only from that system. The rest are species widely distributed in India or the Oriental Region generally, with one Palaearctic species (*Gerris paludum*). No peculiar Indo-Chinese forms are found, and no endemic genera. The only genus not of very wide general distribution is *Perittopus*, which seems to be Malayan in origin but occurs in Assam as well as in Java, Malaya and Tenasserim. The number of endemic species is surprisingly large in view of the wide range of many aquatic bugs. The facts known about the Inlé representatives of this order, therefore, bear out what has been said as to the true aquatic fauna in the preceding paragraph. It is probable, however, that none of the Rhynchota are exclusively lacustrine.

ORIGIN OF THE FAUNA.

The aquatic and quasi-aquatic fauna of the Inlé district as a whole was separated from the common fauna of the Oriental Region at a remote but not extremely remote period. The fossil remains of the district are not sufficiently well known to cast much light on the precise period at which this occurred. The local fauna developed in circumstances that favoured plasticity but did not render peculiar adaptations to environment necessary. Primitive forms such as *Chaudhuria*¹ were able to survive side by side with highly modified forms such as *Sawbwa*, *Taia* and *Hydrobioides*. In still, deep lakes, with transparent water containing abundant salts of lime and other minerals, in a temperate climate free from extremes of cold or heat, with a heavy but not excessive rainfall, conditions were perhaps ideal for the rapid evolution and the preservation of peculiar forms, modified superficially but not changed in fundamental structure or adapted in direct correlation with their mode of life. On the one hand competition was less keen than in strictly tropical surroundings and physical barriers interfered with the immigration of alien forms; on the other there was nothing to check the momentum of eccentricity and small peculiarities were intensified rather than eliminated. The communities of different lakes developed slight racial or even specific peculiarities, but the fauna as a whole remained uniform over a large area. With the growth and deepening of the old lakes of the Shan Plateau this process continued, but the day of the great lakes was soon over. The lakes appeared and grew deep, changed their communications from time to time, and finally shrank and for the most part disappeared, owing to allied causes—the dissolving action of water, the re-deposition in solid form of the salts dissolved, and the formation of peat and of finely divided insoluble matter. The insoluble debris of the rocks eaten away by water accumulated in the form of red soil and masses of peat were heaped up as vegetable remains were transformed into this substance, until most of the basins were filled. At some places lakes dried up owing to their water eating through soluble barriers of hard limestone, at others new lakes were formed by the deposition of calcareous dams. The Inlé Lake, which was probably the largest of the system, has survived, shrunken in area and shallowed, but still a lake. In it the fauna of the old lakes has become as it were concentrated. This fauna has lost the power to resume the normal characters of a swamp-fauna, or perhaps in its isolated state there has been no reason why it should do so; it retains the peculiar features acquired in conditions quite other than those in which it now lives.

¹ Mr. R. H. Whitehouse, basing his view on a study of the structure of the tail, regards *Chaudhuria* as a highly specialized form. See p. 66 of this volume.

LIST OF THE FAUNA OF THE INLE LAKE SYSTEM.

Only species that have been identified at least generically are included. Under the heading "Marginal Fauna" notes are given on species found in ponds or marshes, but the fact is noted in each instance.

Name	General Distribution.	DISTRIBUTION IN LAKE SYSTEM.			
		Marginal zone.	Intermediate zone.	Central Region.	Running water..
PROTOZOA.					
<i>Epistylis flavicans</i> , Ehrenb. ...	Cosmopolitan ...	...	...	On larval case of <i>Polypedium</i> . On <i>Caridina</i> ...	...
<i>Cothurnia</i> sp. ...	Genus cosmopolitan ...	...	...		...
PORIFERA.					
<i>Spongilla lacustris</i> var. <i>proliferens</i> , Annd.	Species cosmopolitan. Var. in India and Burma.	Scarce ...	...	...	...
<i>Spongilla fragilis</i> var. <i>calcuttana</i> , Annd.	Species cosmopolitan. Var. in Gangetic delta.	Do. ...	...	...	...
<i>Ephydatia fluviatilis</i> var. <i>intha</i> , Annd.	Species cosmopolitan. Var. only known from the lake.	Do. ...	Abundant ...	...	...
TURBELLARIA.					
<i>Planaria burmaensis</i> , Kab. ...	Only known from the lake ...	...	...	Common ...	...
<i>Planaria annandalei</i> , Kab. ...	Only known from the lake ...	...	...	Scarce ...	...
<i>Planaria bilineata</i> , Kab. ...	Only known from the lake basin ...	...	...	...	In hill streamlet.
TEMNOCEPHALOIDEA.					
<i>Caridinicola</i> sp. ...	Genus known from India, Ceylon, China and Japan.	...	...	Common on <i>Caridina</i> .	...

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Name.	General Distribution.	DISTRIBUTION IN LAKE SYSTEM.			
		Marginal zone.	Intermediate zone.	Central Region.	Running water.
POLYZOA.					
<i>Hislopia lacustris</i> , Carter ...	India ; Burma ...	Scarce ...	Abundant ...	Abundant ...	...
<i>Hislopia malayensis</i> , Annd. ...	Peninsular Siam ; Gangetic delta ...	...	Scarce ...	...	...
OLIGOCHAETA.					
<i>Chaetogaster annandalei</i> , Steph. ...	Japan ...	...	In <i>Ephydatia</i> ...	...	...
<i>Chaetogaster limnaei</i> ?, v. Baer ...	Europe ; W. Himalayas ...	...	Do. ...	...	...
<i>Chaetogaster bengalensis</i> , Annd. ...	Gangetic delta ...	...	Do. ...	...	...
<i>Franchiura sowerbyi</i> , Bedd. ...	Probably endemic in Eastern Asia ; also found in Europe.	Common ...	...	Common ...	In stream from hot spring.
<i>Perionyx fulvus</i> , Steph. ...	Gangetic delta ...	Scarce ...	...	...	Common in Yawn-ghwe River.
CRUSTACEA.					
<i>Potamon</i> (<i>Potamon</i>) <i>brown-eanum</i> , Kemp. ...	Only known from the lake system ...	...	...	...	Common in streams.
<i>Potamon</i> (<i>Potamon</i>) <i>acanthicum</i> , Kemp. ...	Only known from the Shan States	Fairly common	...	Scarce ...	Do.
<i>Potamon</i> (<i>Potamon</i>) <i>curtobates</i> , Kemp. ...	Only known from the lake basin ...	Common in swamps.	...	...	...
<i>Palaemon naso</i> , Kemp. ...	Only known from the lake system ...	...	...	...	Abundant in river below lake.
<i>Palaemon</i> sp. ...	Probably identical with species from N. Shan States.	...	...	...	In warm spring.
<i>Palaemon hendersoni</i> , de Man ...	E. Himalayas ; hills of Assam and Upper Burma.	...	...	...	Fairly common.
<i>Caridina annandalei</i> , Kemp. ...	Tenasserim ...	Abundant ...	Abundant ...	Abundant ...	Less common.
<i>Caridina weberi</i> , de Man, var. ...	Species widely distributed in Malaysia and India.	Scarce ...	...	...	Common.

INSECTA.

Odonata.¹

<i>Pseudagrion microcephalum</i> (Ramb.)	Oriental Region	...	...	Larva abundant	Larva abundant	Larva abundant	...
<i>Ceriagrion olivaceum</i> ?, Laidlaw	Abor Hills, Assam	.	...	Larva perhaps from this zone.	...	...	...
<i>Ischnura</i> , sp. nov. ...	...		...	Larva abundant	Larva abundant	Larva abundant	...
<i>Rhinocypha iridea</i> , Selys.	Burra	...	...	...	...	...	Larvae probably in jungle streams.
<i>Rhinocypha biforata</i> , Selys.	Burma ; Malay Peninsula	...	...	...	...	...	Do.
Rhynchota.							
<i>Mesovelina vittigera</i> , ² Horv.	Syria, Egypt ; Oriental and Ethiopian Regions, New Guinea.	...	...	Common	...	...	...
<i>Velia Y-alba</i> , Paiva	Only known from the lake	...	...	A single specimen.	...	...	...
<i>Microvelia burmanica</i> , Paiva	Tenasserim	...	...	...	...	...	Common in small streams above lake.
<i>Microvelia diluta</i> , Dist.	Bengal	...	...	Small pool near Yawnghe.	...	...	...
<i>Peritopus breddini</i> , Kirk.	Java ; Malay Peninsula ; Tenasserim	...	...	...	...	...	Common in small streams.
<i>Gerris anadyomene</i> , Kirk.	Ceylon ; Philippines	...	...	Small pool	...	...	...
<i>Gerris nepalensis</i> , Dist.	Northern India ; Tenasserim	...	...	Common ; also in ponds.	...	...	...
<i>Gerris fossarum</i> (Fabr.)	Bengal ; Malay to Philippines and Australia.	...	...	Abundant	Abundant	Occasional	...
<i>Gerris nitida</i> (Mayr.)	India ; Burma and Ceylon	...	...	Scarce	...	...	...
<i>Gerris tristan</i> , Kirk.	India ; Burma and Ceylon	...	...	Do.	...	...	...
<i>Gerris paludum</i> , Fab.	Palearctic Region ; Upper Burma	...	...	Canal ; scarce	...	...	Small stream ; scarce.
<i>Gerris spinolae</i> , Leth. and Sev.	Oriental Region	...	...	Common	Common	Occasional	...
<i>Ptilomera laticaudata</i> (Hardw.)	Oriental Region	...	...	...	...	...	Common on jungle streams.
<i>Onychotrechus lyra</i> , Paiva	Only known from the lake system	...	...	...	...	...	On hill streams.
<i>Ventidius distant</i> , Paiva	Only known from the lake system	...	...	...	...	...	Do.

¹ Our collection from the Inlé Lake, which is now in the hands of Dr. F. F. Laidlaw, has not yet been completely worked out.² *Mesovelina mulsanti*, Buch. White. See Paiva, p. 20 in this volume, and Bergroth, *Philippine Journ. Sci.* XIII, p. 121 (1918)

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Name.	General Distribution.	DISTRIBUTION IN LAKE SYSTEM.			
		Marginal zone.	Intermediate zone.	Central Region.	Running water.
INSECTA—contd.					
Rhynchota—contd.					
<i>Metrocoris nigrofasciatus</i> , Dist. . .	Himalayas ; Burma ; Malaya ; Siam	Common on ponds	...	...	...
<i>Naboandelus signatus</i> , Dist. . .	Gangetic delta ...	Common in this zone.	...	...	...
<i>Rhagadotarsus kraepelini</i> , ¹ Bredd.	Oriental Region ...	Scarce ...	...	...	...
<i>Ranatra varipes</i> , Stal. ...	Widely distributed in Asia ...	From marsh ; scarce.	...	...	...
<i>Cercotmetus pilipes</i> (Dall.) ...	Bhutan ; E. Himalayas ...	From marsh ; scarce.	...	...	...
<i>Sphaerodema rusticum</i> (Fabr.) ...	India to Philippines ; China and Australia.	Common ...	...	...	...
<i>Enithares templetoni</i> (Kirby) ...	India ; Ceylon ; Peninsular Siam ...	...	...	...	Common in hill streams.
<i>Enithares intha</i> , Paiva ...	Only known from the lake ...	Scarce ...	...	...	...
<i>Anisops niveus</i> (Fab.) ...	Widely distributed in S. Asia ...	From muddy pool.	...	...	...
<i>Anisops sardea</i> (Herr.-Schaff.) ...	Widely distributed in S. Asia ...	From pool ...	...	...	...
<i>Nychia infuscata</i> , Paiva ...	Only known from the lake ...	Common ...	...	...	...
<i>Plea quinquenotata</i> , Paiva ...	Only known from the lake ...	Scarce ...	...	...	...
<i>Plea areolata</i> , Paiva ...	Only known from the lake system ...	...	...	...	One specimen from stream.
<i>Corixa septemlineata</i> , Paiva ...	Only known from the lake system ...	From pool ...	...	...	...
<i>Corixa unicolor</i> , Paiva ...	Only known from the lake system ...	Do. ...	...	...	...
<i>Micronecta substriata</i> , Paiva ...	Only known from the lake ...	Five specimens	...	...	...
<i>Micronecta soror</i> , Paiva ...	Only known from the lake ...	One specimen	...	...	...
<i>Micronecta fulva</i> , Paiva ...	Only known from the lake ...	Three specimens	...	...	...

DIPTERA.								
<i>Anopheles barbirostris</i> , v. d. W.	Widely distributed in S. E. Asia	...	Larva (scarce) in this zone.	...	...	...	...	...
<i>Polypedilum</i> sp.		...	...	...	...	Larvae not uncommon.	...	...
MOLLUSCA.								
Gastropoda.								
<i>Succinea indica</i> , Pfeiffer	Himalayas	...	At edge : common.	...	...	...	...	...
<i>Limnaea andersoniana</i> , Nevill	Yunnan ; Shan States	...	Occasional : one phase common in ponds.	...	...	...	One phase in streams.	...
<i>Limnaea shanensis</i> , Annd.	Only known from lake system	...	Scarce ; common in ponds.	...	...	...	...	...
<i>Limnaea mimetica</i> , Annd.	Only known from lake	...	...	Rather scarce	...	Scarce	...	...
<i>Planorbis exustus</i> , Desh.	Oriental Region	...	Common at edge.	...	...	...	...	...
<i>Planorbis velifer</i> , Annd.	Only known from lake	...	...	Not uncommon	...	Less abundant	...	...
<i>Planorbis trochoideus</i> , Benson	Gangetic delta	...	Scarce	Do.	...	Not uncommon	...	...
<i>Planorbis colathus</i> , Benson	Himalayas ; Ceylon ; Siam	...	Do.	Do.	...	Do.	...	...
<i>Planorbis caenosus</i> , Benson	N. India ; Ceylon	...	Do.	...	...	...	...	...
<i>Melania tuberculata</i> (Müller)	N. Africa ; Ethiopian and Oriental Regions, etc.	...	...	...	...	Common	...	Common in muddy streams.
<i>Melania terebra</i> , Benson		...	...	...	...	...	Do.	...
<i>Melania baccata elongata</i> (Gould)	Species in Shan States and Upper Burma. Var. only known from lake system.	...	In marshes	...	...	...	Do.	...
<i>Paludomus ornata</i> , Benson	Irrawadi and Brahmaputra	...	...	...	...	...	In runnel.	...
<i>Hydrobioides nassa</i> (Theobald)	Shan States	...	Common ; also in ponds and marshes.	...	...	...	...	...
<i>Hydrobioides nassa lacustris</i> , Annd.	Only known from lake	...	Fairly common	Common	...	Common	...	...
<i>Hydrobioides phycus</i> , Annd.	Only known from lake system	...	Common ; also in swamp.	Do.	...	Do.	...	...

¹ *Nacebus dux*, Dist. See Paiva, p. 26 in this volume, and Bergroth, *op. cit.* p. 122.

LIST OF THE FAUNA OF THE INLE LAKE SYSTEM—*contd.*

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Records of the Indian Museum.

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Name.	General Distribution.	DISTRIBUTION IN LAKE SYSTEM.			
		Marginal zone.	Intermediate zone.	Central Region.	Running water.
MOLLUSCA—contd.					
Gastropoda—contd.					
<i>Hydrobioides avarix</i> , Annd. ...	Tenasserim ...	...	...	...	In small stream of warm water.
<i>Hydrobioides nana</i> , Annd. ...	Only known from lake ...	Rather scarce	...	...	...
<i>Amnicola alticola</i> , Annd. ...	Only known from lake ...	Fairly common	Fairly common	Fairly common	...
<i>Vivipara lecythis</i> (Benson) ...	Assam ; Burma ; W. China ...	Very scarce	...	...	...
<i>Taia naticoides</i> (Theobald) ...	Shan States ; Upper Burma ...	Common in marshes.	...	...	In backwaters.
<i>Taia theobaldi</i> (Kobelt) ...	Shan States ; " Burma " ...	...	...	...	Common.
<i>Taia shanensis</i> (Kobelt) ...	S. Shan States ...	Common	...	...	...
<i>Taia elitoralis</i> , Annd. ...	Only known from lake ...	...	Rather scarce	...	...
<i>Taia intha</i> , Annd. ...	Only known from lake ...	...	...	Very abundant	...
<i>Ampullaria winkleyi</i> , Pilsbry ...	L. Burma ...	Common near edge.	Much scarcer	...	In stream from hot spring.
Pelecypoda.					
<i>Physunio micropteroides</i> , Annd....	Only known from Yawngnwe River	...	...	...	Common in mud.
<i>Physunio ferrugineus</i> , Annd. ...	Only known from lake ...	...	...	Common	...
<i>Corbicula noellingi</i> , v. Martens	Shan States ...	In ponds and marshes.	...	...	Common in sluggish streams.
<i>Pisidium casertanum</i> (Poli) ...	Europe ; Siberia ; Japan ...	...	...	Not uncommon	Scarce ; in back-water.
FISH.					
<i>Chaudhuria caudata</i> , Annd. ...	Genus only known from lake ...	Scarce	...	Scarce	...
<i>Amphipnous cuchia</i> (Ham. Buch.)	India ; Burma ; Malay Peninsula ...	Common	...	...	In sluggish streams.
<i>Monopterus albus</i> (Zuiew) ...	S. Asia east of Bay of Bengal ; N. China ; Japan.	Do.	...	...	Do.

<i>Clarias batrachus</i> (Linn.) ...	India to Philippines ...	Do. ...	...	...	Do. ...
<i>Lepidocephalus berdmorei</i> (Blyth)	Burma ...	Occasional ...	...	...	Common.
<i>Nemachilus botia</i> (Ham. Buch.)...	India ; Burma ...	...	...	...	In hill streams.
<i>Nemachilus brevis</i> , Boulenger ...	Only known from lake system ...	Abundant ...	Abundant ...	Abundant ...	In slow streams.
<i>Nemachilus brunneanus</i> , Annd.	Only known from Yawngnawe Valley	Do. ...	Do. ...	Do. ...	In slow and rapid streams.
<i>Discognathus lamta</i> (Ham. Buch.)	India ; Burma ...	Fairly common	Fairly common	Fairly common	In sluggish streams.
<i>Discognathus</i> ¹ sp. ...	Only known from He-Ho ...	...	...	...	Do.
<i>Cirrhitina latia</i> (Ham. Buch.) ...	India ; Burma ...	Abundant ...	Abundant ...	Abundant ...	...
<i>Barbus sarana caudimarginatus</i> , Blyth	Subsp., Upper Burma and Tenasserim ; species, India.	Do. ...	Less common	Less common	...
<i>Barbus dukai</i> , Day ...	E. Himalayas ; Burma ; Sumatra ...	...	...	...	In hill streams.
<i>Barbus tor</i> (Ham. Buch.) ...	Several local races in India ...	...	...	...	In streams and rivers.
<i>Barbus nigrovittatus</i> , Boulenger	Only known from Fort Stedman ...	...	...	...	? In streams.
<i>Barbus schanicus</i> , Boulenger ...	Only known from lake system ...	? Occasional ...	...	...	In larger streams.
<i>Barbus stoliczkanus</i> , Day ...	Burma ; ? India ...	...	...	...	In hill streams.
<i>Barbus stedmanensis</i> , Boulenger		...	...	...	...
<i>Cyprinus carpio intha</i> , Annd. ...	Southern Shan States ...	Abundant ...	Abundant ...	Abundant ...	...
<i>Saibwa resplendens</i> , Annd. ...	Genus only known from lake ...	Do. ...	Do. ...	Do. ...	...
<i>Microrasbora rubescens</i> , Annd. ...	Only known from lake system, also in ponds.	Do. ...	Do. ...	Do. ...	...
<i>Microrasbora erythromicron</i> , Annd.	Only known from lake system ...	Rather scarce ; common in rice-fields.	...	...	...
<i>Barilius auropurpureus</i> , Annd. ...	Only known from Yawngnawe Valley	Abundant ...	Abundant ...	Abundant ...	In sluggish streams.
<i>Barilius ornatus</i> , Sauvage ...	Menam River ...	...	...	...	? Rivers.
<i>Notopterus notopterus</i> (Pallas) ...	India ; Burma ; Siam ; Malaysia ...	Abundant ...	Abundant ...	Scarcer ...	In sluggish streams.
<i>Mastacembelus oatesii</i> , Boulenger	Only known from lake system ...	Common ...	Common ...	Common ...	Do.
<i>Mastacembalus caudiocellatus</i> , Boulenger	Only known from lake system ...	Do. ...	Do. ...	Do. ...	Do.
<i>Ophiocephalus striatus</i> , Bloch. ...	India ; Burma ...	Do. ...	Do. ...	Do. ...	...
<i>Ophiocephalus gachua</i> , ² Ham. Buch.	Persia ; India ; Burma ; Malaysia, etc.	?	?	?	?

¹ The examination of a large number of specimens of *Discognathus* since my paper on the Inlé fish was written has removed all doubts as to this form being an undescribed species. I will describe it shortly in the *Records of the Indian Museum*, vol. XVI.

² Possibly the form I have called *O. harcourt-butleri* is the same as that identified by Boulenger as *O. gachua* (*Ann. Mag. Nat. Hist.* (6) XII, p. 198).

LIST OF THE FAUNA OF THE INLE LAKE SYSTEM—concl'd.

Name.	General Distribution.	DISTRIBUTION IN LAKE SYSTEM.			
		Marginal zone.	Intermediate zone.	Central Region.	Running water.
FISH—cont'd.					
<i>Ophiocephalus harcourt-butleri</i> , Annd.	Only known from lake system ...	Abundant ...	Abundant ...	Abundant ...	In sluggish streams.
<i>Ophiocephalus siamensis</i> , Günther	Menam River ...	?	?	?	?
<i>Danio aequipinnatus</i> (McCl.) ...		In rice-fields ...	...	...	...
BATRACHIA.					
<i>Rana kuhlii</i> , D. and B. ...	Tropical and Sub-Tropical Asia east of Bay of Bengal.	...	...	...	Larvae in hill streams.
<i>Rana limnocharis</i> , Wiegman. ...	Plains of S. Asia ; N. China ; Japan	Probably common.	...	...	...
<i>Bufo melanostictus</i> , Schneid. ...	Oriental Region ...	...	...	...	Larvae in hill streams.
<i>Megalophrys montana</i> , Kuhl. ...	Siam ; Malay Peninsula and Archipelago.	...	...	...	Do.
REPTILIA.					
<i>Cyclemys dhor shanensis</i> , Annd....	Species, Assam to Malay Archipelago; sub-species only known from lake system.	Not uncommon	...	...	At edge of sluggish streams.
<i>Trionyx</i> sp. ...	?	?	?	?	...

EXPLANATION OF PLATE XXVI.

VIEWS IN THE THREE ZONES OF LIFE IN THE INLE LAKE.

- FIG. 1.—Floating gardens in the Marginal Zone, showing crops of spring onions, tomatoes and cucumbers, the last on trellises.
- FIG. 2.—View in the Intermediate Zone, showing floating islands in their natural condition in the background and sub-aquatic thickets of *Ceratophyllum* rising to the surface in the foreground.
- FIG. 3.—A fishing-hut built on piles in the Central Region and surrounded by a floating breakwater anchored by means of poles stuck through it into the bottom of the lake.



3



2



1

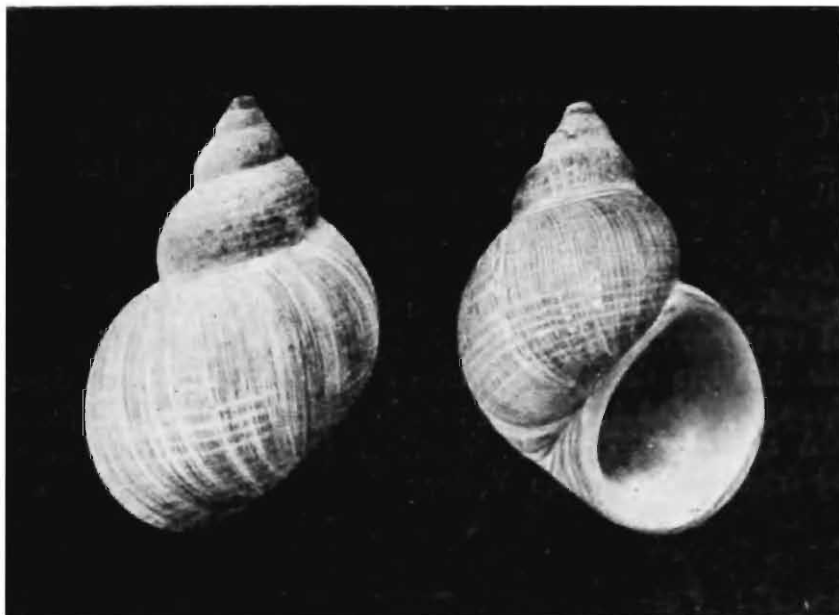
A NEW SPECIES OF *TAIA* FROM THE CHINDWIN VALLEY, UPPER BURMA.

By N. ANNANDALE, D.Ss., F.A.S.B., Director,
Zoological Survey of India.

The shell described here has no direct connection with the Inlé Lake, but it will, I think, be convenient to include a description of it in the volume in which the genus is discussed at length (see pp. 123—125). The original specimens reached me, through the Geological Survey of India, from Mr. A. P. Morris some time after my account of the Inlé molluscs was in print.

Taia incisa, sp. nov.

The shell is thick, moderately small and sharply conical; it was evidently marked when fresh with two broad brown or purple spiral bands, but the epidermis has entirely disappeared from all the specimens examined and they have assumed a chalky whiteness. The



Photographs of type-specimen of *Taia incisa*. (2).

Red powder has been dusted on the surface of the shell in order to show up the sculpture in the photographs.

suture is oblique and deeply impressed; the whorls are swollen and distinct, $5\frac{1}{2}$ in number. The spire is short and decreases rapidly towards the apex; it is less than half the length of the body-whorl however measured. The mouth of the shell is large, oblique and prominent oval or slightly ovoid in shape, with the outer lip slightly expanded outwards and forwards. The columellar callus is expanded and thickened

in the usual way, entirely concealing the umbilicus and in continuity with the outer lip; it is deeply grooved and plicated longitudinally and does not extend so far over the surface of the shell as in some species. The characteristic longitudinal striae are well developed but rather fine; the spiral sculpture consists entirely of incised lines, which are often slightly diverted where they are crossed by the stronger longitudinal striae. On the apex of the shell, which is perhaps worn in all the specimens examined, the spiral lines are obscure, but they are distinct and numerous on the last three whorls. On each of these whorls two or three of them are particularly deep on the upper surface just outside the suture. On the body-whorl the lines are obsolete or obsolescent on the central region but exceptionally strong on the upper part of the lowest third; at the base of the whorl they are well-marked but not so broad or so deep.

Measurement of shells (in millimetres).

					Type.		
Length	...	...	...	...	32	26	22
Breadth	...	...	...	...	20	18	15
Length of aperture	...	...	...	...	16	13	12
Breadth of aperture	...	...	...	...	11	9.5	8.5

Type specimen.—M. $\frac{11377}{2}$, Zool. Survey of India (*Ind. Mus.*).

Locality, etc.—A large number of dead shells were collected by Mr. A. P. Morris in obsolete mud-volcanoes at Kin-U north of Shwebo in the Chindwin Valley. They seem to have accumulated in the pools of the mud-volcanoes when the latter became inactive and are probably subfossil. With them were found several shells of *Vivipara viridis* (Reeve) and *Ampullaria winkleyi*, Pilsbry and one of *Bithynia goniomphalos* (Morelet).

The shell of *T. incisa* differs from that of all the species previously assigned to the genus in having only $5\frac{1}{2}$ whorls and in its incised spiral sculpture, but has the characteristic columellar callus well developed. It is perhaps related to *Vivipara chalanguensis* (Deshayes) from Cambodia. A species of *Taia*, *T. noetlingi* (Kobelt), has already been recorded from the Chindwin Valley.