XXIII. NOTES FROM THE BENGAL FISHERIES LABORATORY.

No. 5. PARASITES OF INDIAN FISHES, WITH A NOTE ON CARCINOMA IN THE CLIMBING PERCH.

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(Plates X-XIV.)

CONTENTS.

Introduction.

With the exception of the first part, describing a carcinoma in the climbing-perch, the following paper deals with a variety of parasites of Indian fishes. All the material was collected in the latter half of the year 1917 and the early part of the year 1918, except the Trematoda described.

I. ON THE OCCURRENCE OF COLLOID CARCINOMA ON THE BODY OF THE CLIMBING-PERCH (*ANABAS SCANDENS*, DALD.).

Plate X.

1. *Introduction.*—During April, 1917 investigations relating to the breeding habits of various fishes were made by the Department, in certain *beels* in the Khulna district, Bengal. On May 4th, 1917 a number of young specimens (about 70) of the climbing-perch (*Anabas scandens*, Dald.) roughly 1 cm. long were collected from a *beel* and brought to Calcutta. These were kept in an aquarium. No care whatever was taken of them. Between May 4th and the beginning of October the water in which the fish were placed was only changed once. The specimens were not fed except on five or six occasions when the office attendant casually threw in a handful or so of parched paddy (*khai*). By the beginning of October only twenty fish remained, the rest having died and been eaten by the survivors. They had then grown to a length of 14 centimetres. About the beginning of August, it was noticed that two of the fish had developed conspicuous outgrowths on various parts

of the body. On October 10th three fish were found to be affected. These were preserved. The present account deals with the nature and structure of the outgrowths noted above. Observations on the remaining 17 fishes, which are still living under the same conditions (April 1st), are being continued.

2. *Technique.*—The outgrowths were cut off from one of the living fish and preserved in corrosive acetic solution. This fish, along with the two others, was preserved in 90 per cent. alcohol. One of the outgrowths was teased out and permanently mounted in dilute glycerine. Sections of the tumour were also cut with a Minot's microtome by the ordinary paraffin method. These were stained with Heidenhain's iron haematoxylin followed by eosin.

3. *Appearance and occurrence.*—The outgrowths are remarkable in having a mulberry-shaped appearance. They are much divided, nodular masses (fig. 4) attached to the body of the fish by very short stalks. They vary considerably in appearance and occur in various situations. In one fish two masses were present on the left side, one attached a little above the operculum and the second about half an inch in front of the first (fig. 1). A very small one was developing below the eye, whilst a fourth was present on the mid-ventral line in the region of the throat.

In the second specimen (fig. 2) a large outgrowth had developed above the right eye. A similar but very much smaller one was present over the left eye. A third was to be seen on the right side, about half an inch behind the eye. A small outgrowth was hanging pendant from the upper jaw on the right side ; another from the lateral edge of the operculum on the right side. A small one was also present on the fin-rays of the ventral fin.

In the third fish (fig. 3) the main outgrowth was on the tip of the snout. A smaller one was attached to the ventral edge of the operculum, on the ventral side, near the throat. Another was situated a little in front of the pelvic fins, whilst still another large outgrowth was to be seen on the base of one of the spines of the dorsal fin. Another small one was also present on the upper margin of the caudal fin.

4. *Structure.*—The tumours are undoubtedly infiltrating epithelial neoplasms, or malignant epitheliomas, designated as Carcinomas by Orth. They are of an alveolo-tubular type, the greater proportion of these being solid. On teasing out a portion of the tumour it is seen to consist of large polygonal cells filled up almost entirely with large numbers of small glistening drops of colloid substance. The nuclei of these cells could not be distinguished in the glycerine mounts. They were, however, seen in the stained sections. The greater portion of the carcinoma is of a regular formation. The epithelium is closely packed, but very extensively vacuolated. Here and there, particularly where the outgrowths arise from the external surface, we find that the alveoli have coalesced to form large tubular cavities. These tubular cavities are lined by epithelium which also is vacuolated. Around the vacuoles, colloid material can be seen as deeply staining granules filling up the rest of the epithelial cells. The core of these wart-like outgrowths consists of connective tissue ; pigment corpuscles are present both in the connective tissue and in the epithelial cells.

5. *General considerations.*—A summary of the history of this disease amongst fishes, and the literature relating thereto, has already been given by one of us (2) and need not therefore be recapitulated. These tumours do not occur in fishes living under natural conditions. They only arise when fish are placed under artificial surroundings, such as occur in aquariums and hatcheries. These artificial conditions react on the fish in such a way that anomalous tissue, of thyroid nature, arises, either as a single tumour (as in trout), or a series of tumours (as in the climbing-perch). It is impossible to say whether these tumours are derived directly from the cells of the thyroid gland or not. A specific organism is suspected, but as yet no such organism has been isolated.

The tumours from the climbing-perch described above differ in certain respects from similar tumours described by other writers from other species of fish.

The colloid carcinomas recorded up to the present are rounded structures with smooth surfaces. Ours, as we have pointed out, may present the appearance of a series of closely approximated nodules, attached to each other, and to the body of the fish, by a short stalk. In other cases the surface of the tumour is rugose and the nodular appearance is less distinct. Quite young tumours are flattish or mushroom shaped.

The colloid carcinoma described by one of us (2) from a trout caught in the Punjab was enclosed in a tough fibrous capsule or cyst. The ones described from the climbing-perch are not encapsuled but merely covered with epithelium. It is clear, therefore, that the tumours may either be encapsuled or not, in accordance probably with their point of origin. Gaylord and Marsh (1) in discussing anomalous deposits of thyroid nature in fishes state that : " as the thyroid is a somewhat diffuse organ one might expect to find instances of remotely placed deposits. We are therefore surprised to find the sharp delimitation to the region already described which appears to exist in our wild specimens, with one marked exception, *i.e.*, the jugular pit to which reference has already been made. It has been assumed by some writers that aberrant thyroid deposits in some region might be frequently expected. This has been due to the development of tumour nodules in regions beyond the normal and usual seat of distribution, such as the lower mouth parts and gill arch region. The only outlying tumours of this sort which may be inferred with certainty to arise from original deposits of thyroid are the so-called pit-tumours."

The observations made on the tumors found in the climbing-perch show that thyroid deposits may occur anywhere in the fish, as internal or external growths. It is, however, impossible to decide at present whether such thyroid deposits are original or secondary.

It will be obvious that in the climbing-perch, the tumors being disposed as masses of tissue over the surface of the body, it is not impossible in some cases for the fish to remove them by rubbing the affected part against a solid substance. The tumors are, however, somewhat firmly attached. Whether removal in this manner would invariably result in spontaneous recovery may be doubted, since the tumours in question have a deep-seated origin.

Literature cited—

1. Gaylord, H. R. and Marsh, M. C.—*Carcinoma of the Thyroid in the Salmonoid fishes.* Institute for the study of Malignant diseases. Serial No. 99. Washington, 1914.
2. Southwell, T.—Notes from Bengal Fisheries Laboratory. Indian Museum, No. 2. On some Indian parasites of fish with a note on Carcinoma in Trout. *Rec. Ind. Mus.*, Vol. XI, Part IV, No. 16, August, Calcutta, 1915.

II. ON SOME INDIAN MYXOSPORIDIA.

Plate XI.

Except for a short note on a species of *Myxobolus* by one of us (9) practically nothing is known about the Indian Myxosporidia. Whilst working out the collections made by the Bengal Fisheries Department during the last few months we found three new species of the genus *Myxobolus*, Bütschli. Two of the species are unicapsulate forms, whilst the third is bicapsulate. A short note on another Myxosporidian of the genus *Sphaerospora*, Thélohan, in the collection of the Zoological Survey of India, is also included here.

Myxobolus rohitae, sp. nov.

This interesting parasite was found infesting the gills of *Labeo rohita* (Ham. Buch.). The fishes in question were caught in the Turag river at Mirpur, district Dacca, on the 2nd of June, 1917. A second lot of specimens was obtained on the 22nd of January, 1918. Unfortunately no observations were made on the living material, but well preserved specimens of the gills have enabled us to make a fairly complete study of the parasite. The infection was of a very heavy nature, involving all the gills of the fish in question, and, as will be seen from fig. 1, the cysts were scattered all over the surface of each of the gills. In one case 53 such cysts were counted on one surface of a single gill. The infection was equally severe over the rest of the gills of both the right and left sides.

Serial sections of the cyst, 3 to 4 μ thick, were cut by the ordinary paraffin method, and stained with Giemsa's solution, or Heidenhain's iron haematoxylin, followed by eosin. Besides sections, cysts were dissected and the spores thus removed were examined unstained, and also stained with Giemsa's solution. The sections of the cysts were found to be quite satisfactory and showed all the necessary stages.

The cyst (fig. 1).—The cysts preserved in spirit are of a creamy-yellow colour, measuring 3·1—3·8 mm. long and 0·8 —1·2 mm. broad. They lie with the long axis of the cyst parallel to the gill-filaments. The cyst varies in shape from oval to cylindrical. The ends are rounded while the surface attached to the gill-filaments is flattened. The infected gill-filaments were in no way specially enlarged or different from the other gill-filaments.

The wall of the cyst is formed of a vertically striated portion showing no nuclei. This part takes up the cytoplasmic eosin-stain only. It is covered externally by an epithelium two to three layers thick. Internal to the vertically striated portion of the cyst there is the endoplasmic layer. The layer shows a coarse granular structure; the nuclei, which lie scattered in the cytoplasm, are either round or elongated, and measure 3 to 5 μ in length. No cell limits could, however, be discovered.

In all the cysts examined, spore formation had already proceeded to an advanced stage, and it was clear that the whole of the cavity in the middle of the cyst was occupied by mature spores, whilst the pan-sporoblasts and the immature spores were lying round the periphery. In many cases these pan-sporoblasts were seen lying amongst the nuclei of the endoplasm.

Formation of the spores.—In the endoplasm two sorts of nuclei are to be seen, *viz.*, the vegetative and the generative. The latter always occur in rounded cells, which have been variously designated as "sphères primitives" by Thélohan, "pan-sporoblasts" by Gurley, and "Propagation Zellen" by Keysselitz. They are, as has been described above, of a rounded shape, with a marginally situated nucleus (figs. 2-4). These cells vary in size from 6 to 11 μ, and, in the nucleus, a distinct caryosom can easily be distinguished. The pan-sporoblasts were in all cases seen to divide mitotically into two (figs. 5-9). In this particular the present species differs from *Myxobolus toyamai*, Kudo, where the pan-sporoblasts divide into two or three daughter cells. In the division of the pan-sporoblasts, the chromatin was seen first to form a coiled thread, which later on splits up by mitosis into two parts, one for each of the daughter cells. The next stage that occurs is one in which two cells are united together (fig. 10). These cells are the micro- and macro-gametes, a fact which is evident from the size of the cells. No separate micro- or macro-gametes were found. The next stage in the union of these two cells is the formation of a sinuous chromation thread in the nucleus of the macro-gamete (fig. 12). The nuclear membrane of the micro-gamete was next seen to disappear. At the same time the nucleus of the macro-gamete showed a chromatin thread, and in the next stage two chromatin spiral threads were to be seen, lying in the cytoplasms of the micro- and macro-gametes respectively. Each of these chromatin threads splits up into two, and four nuclei, two large and two small, are formed in the united cystoplasmic substance of the micro- and macro-gametes (figs. 13-17). In our preparations the next stage seen is a pan-sporoblast cell with five fully formed nuclei, surrounded by definitely marked cystoplasmic areas, and a large chromatin mass lying free (fig. 18). In the final stage ten fully formed nuclei can be distinguished in the mother pan-sporoblast, besides two nuclei for the pan-sporoblast mother cell, and reduction nuclear chromatin particles lying free in the cystoplasm of the mother cell. Intermediate stages are also present. The pan-sporoblast next divides into two daughter cells or sporoblasts, each with five nuclei; two of these unite later on to form the nucleus of the sporoplasm portion of the spore, the one which is seen lying close to a vacuole forms the nucleus for the polar capsule and the other two

are for the spore membrane. Thus the transformation into the adult spore is brought about (figs. 24-25).

Structure of the spore.—A fully formed spore is an elongated pear-shaped body, rounded at the posterior extremity and acutely pointed anteriorly (fig. 26). It is symmetrical bilaterally, but not antero-posteriorly. The size of the spore varies from 30 to 32 μ in length, and from 7 to 8 μ in breadth. The spore-wall is formed of two valves; the point of junction of these valves is distinctly thickened, and can be seen, in a side view, as a slightly raised ridge. The ridge lies parallel to the long axis of the spore. Only one polar capsule is present in each spore. It is of a large size, 22 to 23 μ in length, and has the same shape as the parent spore. In the polar capsule a much coiled thread can be easily seen, as also the opening of the duct for the extrusion of the thread or polar filament at the anterior pointed extremity of the capsule and the spore (fig. 27). The length of the polar filament, in the spores measured, varied from 92 to 97 μ. The nucleus of the capsulogenous cell is seen lying at the periphery of the polar capsule, on one side, near the posterior extremity, as an elongated body. In the protoplasm of the spore itself an iodinophilous vacuole, 3·6 μ in diameter, is present. Lying just posterior to it is the nucleus of the spore. A few granules of chromatin were also seen lying scattered in the protoplasm.

Systematic position.—From the preceding description it will be clear that our form is a Myxosporidian. Following Labbe's classification it falls in the Family Myxobolidae, and the genus *Myxobolus*, Bűtschli, in having bilateral symmetry and a bi-valve shell, with the valve junction plane parallel to the long axis of the spore, and further in having an iodinophilous vacuole in the protoplasm of the spore, and a single polar capsule at the anterior end.

The species of this genus are grouped under two heads, *viz.*, one with a single and the other with two polar capsules. So far, only five unicapsulate species of the genus *Myxobolus* have been recorded. These are :—

M. piriformis, Thélohan.
M. unicapsulatus, Gurley.
M. fuhrmanni, Auerbach.
M. oculi-leucisci, Trojan.
M. toyamai, Kudo.

Our form, like *M. piriformis* and *M. toyamai*, occurs on the branchiae, and differs in this respect from the other three unicapsulate forms. Compared with all the previously described unicapsulate forms our species is a very large one. The size of the cyst, the spore, and the polar capsule is much larger than in any of the other forms, and these are the characters on which the classification is chiefly based. The shape of the spore slightly resembles that of *M. toyamai*, though the anterior extremity of the spore, instead of being attenuated, is sharply pointed. Calabash-shaped spores, recorded from *M. toyamai*, are not present in our species. For these reasons we consider the present form to be a new one, and have called it *Myxobolus rohitae* after the name of the host.

Habitat.—The gills of *Labeo rohita* (Ham. Buch).

Turag river, Mirpur, Dacca district, Bengal, June, 1917. Numerous cysts.

Type specimens in the collection of the Zoological Survey of India (Indian Museum), Calcutta, numbered P $\frac{48}{1}$.

Myxobolus seni, sp. nov.

Cyst (Fig. 28.).—Elongated, ellipsoidal, varying in length from 4·7 mm. to 5·4 mm. by 2·9 to 3·7 mm. in breadth. Whitish with black scattered granules on the surface.

Spore (Figs. 29-31.).—Body oval, much wider behind than in front and pointed at the anterior end. The size of the spore varies from 13·2 μ—13·6 μ in length and 10·1 μ—10·3 μ in breadth. The spore wall is formed of two valves, the point of junction of these valves is slightly thickened as seen in a side view. There is a single polar capsule about 4 μ long; in it there is a much coiled polar filament, which in one case measured as much as 43 μ in length. Iodinophilous vacuole measuring 2·3 μ is also to be seen.

Habitat.—On the median and caudal fins of *Labeo rohita* (Ham. Buch.) Mirpur, Dacca, 22nd January 1918.

Type specimens in the collection of the Zoological Survey of India, Calcutta, numbered P $\frac{53}{1}$.

Remarks.—This species differs very remarkably from the other species described in this paper as *M. rohitae*, in the spores being of a much smaller size, while the cyst is much larger. It differs from all previously described unicapsulate forms in the shape and size of the cyst, the spore and polar capsules.

Myxobolus nodularis, sp. nov.

Cyst (Figs. 32 and 33.).—Rounded or slightly elongated, varying in length from 3·5—3·8 mm. and 2·3—2·8 mm. in breadth. Creamy yellow in colour, in one case appearing blackish owing to the large number of black granules scattered in its surface.

Spore (Figs. 34-36.).—Ovoidal. The size of a spore is 9 μ by 7·2 μ. The spore wall is formed of two valves, and the junction of the valves is very thick, as is seen in a lateral view of the spore. There are two capsules of equal size, measuring 3·4 μ in length. The polar filament in each of the capsules is very much coiled. In a spore in which the filaments were extruded, they measured 18·3 μ in length.

Habitat.—In the muscles of *Rasbora daniconius* (Ham. Buch.) occurring in two fishes on the sides, and in another as a globular cyst near the anus. Mirpur, Dacca, 7th June 1917.

Type specimens in the collection of the Zoological Survey of India, numbered P $\frac{52}{1}$.

Sphaerospora sp.

We would here record the occurrence of a species of *Sphaerospora*, Thélohan, from Burma. The poor condition of the material did not allow of a complete account of its structure, but the bicapsulate, rounded structure of its spores places it undoubtedly in the genus

Sphaerospora, Thélohan. The cysts occurred in very large numbers, one under each scale. They were found on a specimen of *Barilius barna* (Ham. Buch.) collected in June 1915, by J. Coggin Brown, Esq., of the Geological Survey of India, from the vicinity of the Ruby Mines, Burma.

Literature cited—

1. Auerbach, M.—Bemerkungen uber Myxosporidien. *Zool. Anz.* 34. Leipzig, 1909.
2. ,, Studien uber die *Myxosporidien* der Norwegischen Seefische, und ihre Verbreitung. *Zool. Jahr., Syst.* 24. Jena, 1912.
3. Cohn Ludwig.—Uber die *Myxosporidien* von *Esox lucius* und *Perca fluviatilis*. *Zool. Jahrb., Anat. Abth.*, Vol. IX. Jena, 1896.
4. Gurley, R. R.—On the classification of the *Myxosporidia*, a group of Parasites infesting fish. *Bull. U. S. Fish Commission*, Vol. XI. Washington, 1891.
5. Keysselitz, G.—Die Entwicklung von *Myxobolus pfeifferi*, Thél. *Arch. f. Protistenk.*, XI. Jena, 1908.
6. Kudo, R.—Contributions to the study of Parasitic Protozoa II. *Myxobolus toyamai*, n. sp., a new *Myxosporidian* parasite, in *Cyprinus carpio*, Lin. *Journal of Parasitology*, Vol. II, No. 4. Urbana, Illinois, U. S. A., June, 1917.
7. Labbe, A.—*Sporozoa*. In "Das Tierreich." Berlin, 1899.
8. Minchin.—*Treatise on Zoology*, edited by E. Ray Lankester. *Protozoa*, Part I. London, 1903.
9. Southwell, T.—Notes from the Bengal Fisheries Laboratory, Indian Museum. "On some Indian Parasites of Fish with a note on Carcinoma in Trout." *Rec. Ind. Mus.*, Vol. XI. Calcutta, 1915.
10. Trojan, E.—Ein *Myxobolus* im Auge von *Leuciscus rutilus*. *Zool. Anz.* 34. Leipzig, 1909.

III. SOME FISH TREMATODES.

(Plate XII.)

We here describe a new species of the genus *Clinostomum*, Leidy. A small collection of encysted larval Trematodes is also described.

(*a*) **Clinostomum piscidium,** sp. nov.

Introduction.—The specimens dealt with in this communication were first collected from the mesentery of *Trichogaster fasciatus*, on April 16, 1915, at Khulna, Bengal. Since then specimens have been obtained from the mesentery of *Nandus nandus* [1] (May 1917),

[1] *Nandus marmoratus* of the "*Fauna of British India.*"

from the same place. On the latter occasion it was found that they were quite common in *T. fasciatus* as well. The specimens were found to be moving freely on the mesentery and were not encysted.

They are flat semi-oval worms (fig. 1), varying in size from 2·8 mm.—5·2 mm. in length by 1·4 mm.—1·8 mm. in breadth. The body is compressed, with a small circular sucker (*s.i.*) at the anterior end, and a much larger spherical sucker-like acetabulum (*s.ii.*) behind the anterior one. The mouth-opening lies within the anterior sucker. There is no pharynx. The alimentary canal is forked, the intestinal caecae (*Int.*) reaching the posterior extremity. These intestinal caecae shew short lateral projections on both sides. The excretory pore (*E. O.*) is situated at the extreme posterior end, connected with a triangular excretory vesicle (*E. v.*), which lies behind the genital organs. The gonads lie in the middle third of the body. The testes (T) are roughly pyriform structures with the margins slightly indented, the anterior testis is much larger than the posterior one. From the end of each of the testis the tubular vas deferns (*v. d.*) leads to the base of the large cirrus sac (*c. s.*) situated alongside the anterior testis; the two vasa deferentia here unite to form the slightly swollen vesicula seminalis, which is only the beginning of the much coiled tube lying in the cirrus-sac; the end portion of this tube—the ejaculatory duct—leads into the genital atrium (*G. a.*). The ovary (*ov.*) is an ovoidal structure, with entire margins, lying in between the two testes. From the ovary a thin tubular oviduct after making several loops in the space between the two testes, and receiving a duct from the yolk receptacle, is continued in a straight upward course outside the anterior testis, and then curves inwards to open into the uterus. The uterus (*ut.*) which is a large structure lying in the middle line, and extending anteriorly up to the lower margin of the posterior sucker (*s. ii.*), is constricted posteriorly to open into the genital atrium. The genital atrium (*G. a.*) lies near the anterior edge of the cirrus-sac receiving in its cavity the openings of both the male and the female ducts. The genital pore (*G. P.*), or the opening of the genital atrium, lies in the middle line about the middle of the animal.

The vitelline glands (*v*) lie scattered on the two limbs of the intestine. The vitelline duct (*Vt. d.*) comes from the yolk glands and is seen to be formed of a number of fine branches, the ducts from the two sides meet in the middle to form a sac-like yolk receptacle, which as stated above opens into the oviduct.

A nerve collar (*N. C.*), with two nerves running posteriorly from it, can be seen surrounding the alimentary canal, just before forking takes place.

The hermaphrodite nature of the worm, the two suckers, the position of the acetabulum, the situation of the ovary between the two testes (which are non-digitate), the genital pore being situated posterior to the acetabulum, and the intestine having short lateral projections, place the worm undoubtedly in the genus *Clinostomum*, Leidy (4). The present species, however, differs from all previously described species, and we therefore name it *Clinostomum piscidium*, sp. nov.

Habitat.—The mesentery of *Trichogaster fasciatus*, Bl. Schn., also found on the mesentery of *Nandus nandus* (Cuv. and Val.), Khulna, district Khulna, Bengal, April 1915, and May 1917. Numerous specimens ; types in the collection of the Zoological Survey of India (Indian Museum), No. W $\frac{5}{1}\frac{8}{8}$.

Literature cited—

1. Braun, M.—Vermes, A. Trematodes ; Bronn's *Thierreichs*, Bd. IV. Leipzig, 1892-93.
2. ,, Die Arten der Gattung *Clinostomum* Leidy. *Zool. Jahrb., Abth. f. Syst.*, Bd. XIV, Heft I. Jena, 1900.
3. Faust, E. E.—Notes on the Cercaria of the Bitter Root Valley, Montana. *Journal of Parasitology*, Vol. III. Urbana, Illinois, March, 1917.
4. Leidy, J.—A synopsis of Entozoa, etc. *Proc. Acad. Nat. Sci. Philadelphia*, 1856.
5. Looss, A.—Beitr. zur. Kenntn. der. Trematoden. *Z. wiss. Zool.*, Vol. 41. Leipzig, 1885.
6. Lühe, M.—*Die Susswasserfauna Deutschlands* I. Trematodes. Jena, 1909.
7. Osborn, H. L.—On the structure of *Clinostomum marginatum* a trematode parasite of the frog, bass and heron. *Journ Morph.* XXIII, 1912.
8. Pratt, H. S.—Synopsis of North American Invertebrates, XII. The Trematodes, Part II. The Aspidocotylea and the Malacocotylea, or Digenetic forms. *American Naturalist*, Vol. XXXVI, No. 431, Boston, November 1902, and No. 452, December 1902.

(*b*) On a small collection of encysted larval Trematodes of some Indian fishes.

This is a record of the occurrence of encysted cercaria, of five different types, found in various situations in some of the commoner Indian fishes. As the sexual organs were not developed, and as the whole classification of the adult Trematodes is based on the disposition of the generative organs, we are unable to identify them further than to say that they belong to the family Distomidae. The larval characters on which the classification of the redia has been attempted by Lühe (3) and by Lebour (2) do not help in further elucidating the situation of these forms. The classification, according to Lühe, all depends on the different forms assumed by the tails. Lebour's classification depends, on the other hand, on whether the cercariae develop in sporocysts or in redia. As will be clear both these classifications are extremely artificial and are not, in most cases, of much assistance in identification, particularly of encysted forms ; in such cases the tail of the cercaria is dropped before encystment and the adult characters have not as yet developed. At the same time we know nothing as to whether the cercaria were developed in sporocysts or in redia.

In all our forms we can distinguish the anterior sucker, and an acetabulum lying near the anterior end on the ventral surface. The alimentary canal is bifurcate and ends blindly, posteriorly. No spines are present. In one of the forms an excretory vesicle is to be seen. From these characters it is obvious that all the forms belong to the Distomidae. We append herewith a table showing the fish-hosts, the size of the parasites, and the situation where found.

Host.	Organ where encysted.	Size.	Locality.
Saccobranchus fossilis, Bloch.	Lateral muscles .	0·5 mm. by 0·17 mm. (Fig. 2).	Beel Kola, Khulna, Khulna district, 17th April, 1915.
Ophiocephalus marulius, Ham. Buch.	Wall of intestine .	1·2 mm. by 0·3 mm. (Figs. 3 and 3*a*).	Do.
Ophiocephalus striatus, Bloch.	Lateral muscles .	4·1 mm. by 1·7 mm. (Fig. 4).	Do.
Do. . .	Do. . .	6·2 mm. by 3·6 mm. (Fig. 5).	Do.
Trichogaster fasciatus, Bl. Schn.	Do. . .	1·3 mm. by 0·6 mm. (Fig. 6).	Khulna market, Khulna district, 16th April, 1915.

Literature cited—

1. Cort, W. W.—Some North American larval Trematodes. *Illinois Biological Monographs*, Vol. I, No. 4. Urbana, Illinois, U. S. A., 1915.
2. Lebour, M. V.—A review of the British Marine Cercariae. *Parasitology*. Cambridge, 1912.
3. Lühe, M.—*Die Susswasserfauna Deutschlands.* (I) Trematodes. Jena, 1909.

IV. NOTE ON *DISCOCEPHALUM PILEATUM*, LINTON.

Our specimens of this tapeworm were collected from *Carcharinus gangeticus*, Müll. and Henle, collected in the Pusser river, Khulna, on October 21st, 1917.

We had 7 specimens.

Length 17 cms.

Number of proglottides in a specimen, counted—100.

Length of neck—5·2 mm.

Last proglottid—

Length—5·2 mm.

Breadth—2·1 mm.

The specimens differed from Linton's in the following particulars :—

1. Size.
2. Absence of orange coloured bands.

3. Size and shape of the proglottides.
4. Colour being pure white.
5. Genital pores being irregularly alternate.
6. Uterine cavities being absent.

V. TWO NEW SPECIES OF PARASITIC COPEPODS.

Ergasilus bengalensis, sp. nov.

(Plate XIII.)

Female (Fig. 1).—Head and first thoracic segment completely fused, with no indication of the line of union. The resulting cephalothorax is more or less elliptical, a little arched dorsally, and about twice as long as broad. No rostrum. First three free thoracic segments less than half the width of the carapace. The third, fourth and fifth thoracic segments regularly diminishing in length and breadth ; all three however are distinct. Genital segment barrel-shaped, with the sides evenly rounded, slightly longer than broad and about one and a half times the breadth of the fifth thoracic segment. Abdomen three-jointed and a little more than half the length of the genital segment. First segment longer than the second, which is slightly smaller than the third. The first segment is also longer than the third. Anal laminae rhomboidal, much longer than the last abdominal joint, each tipped with two setae, the inner seta nearly twice the length of the outer one. Egg sacs cigar-shaped, smaller than the animal in length, and one-fourth the breadth of the carapace with the six longitudinal rows of eggs. About 120 eggs in each sac.

First atennae (fig. 2) six-jointed ; joints of unequal length and width, last three segments setose, terminal joint with four setae. Second antennae (fig. 3) four-jointed, first joint roughly triangular, with the base attached to the ventral surface of the carapace. The second joint is attached to the anterior upper surface of the first joint, a little below the apex ; it is more than twice as long as the first, and the third joint is attached to its chisel-shaped distal extremity. The third joint is slightly smaller than the second, and considerably narrower. The terminal fourth joint has the form of a curved claw.

Mouth parts (Fig. 4).—Labrum (*La*) large, not reaching the base of the first maxillae. Mandibles (*md.*) with the cutting edge curved upwards and forwards, and with a group of spines at their inner edge ; mandibular palps large, triangular, densely covered with setae. Basal portion of the first maxillae (*mx. i.*) is an oval papilla with two large spines, of which the inner one is longer than the outer. The second maxillae (*mx. ii.*) have a broad base with a much smaller distal end, this end bearing a tuft of bristles on its anterior margin only. Labrum (*Lb.*) flap-like, with the ends running to the curved portion of the second maxillae.

First four pairs of swimming legs (figs. 5-8) biramose, all the rami three-jointed, except the exopod of the fourth pair, which has two joints. Fifth pair much reduced, knob-like, with a single spine. Basal joint of all quite broad.

The arrangement of the spines on the first four pairs is as follows :—

First exopod	...	...	...	1—0	0—2	1—4
„ endopod	...	...	...	0—0	0—2	1—5
Second exopod	...	...	...	1—0	0—2	11—5
„ endopod	...	...	...	0—2	0—2	1—3
Third exopod	...	...	...	1—0	0—2	11—5
„ endopod	...	...	...	0—2	0—4	1—4
Fourth exopod	...	...	...	0—0	111—4	
„ endopod	...	...	...	0—2	0—2	1—3

Colour of specimens preserved in spirit milky-white, with minute black pigment spots scattered on the dorsal surface of the carapace.

	mm.
Length	1·22
Length of carapace	0·71
Breadth of carapace	0·39
Length of egg-strings	1·09
Breadth of egg-strings	0·14

From the gills of *Wallago attu* (Bl. Schn.), Mirpur, district Dacca, Bengal, 3rd June, 1917.

Many specimens. Types in the collection of the Zoological Survey of India, numbered $^{9}\frac{7}{1}\frac{7}{0}{}^{4}$.

No males were obtained.

Ergasilus hamiltoni, sp. nov.

(Plate XIV.)

Female (Fig. 1).—Cephalothorax a little more than half the entire length and one and a half times as long as broad. First thoracic segment distinctly separated from the head by a groove. Head transversely elliptical, with evenly rounded anterior margin. First thoracic segment three times longer and a little wider than the head, quadrilateral in outline, with acutely rounded corners. Second, third, fourth and fifth thoracic segments diminishing regularly in length but about the same width. Sixth, or the genital segment, thrice as wide as the fifth thoracic ; barrel-shaped, with rounded sides.

Abdomen three-jointed, the segments diminishing regularly in length and width, the terminal one deeply notched in the middle. Anal laminae more or less squarish, smaller in width than the last abdominal segment, and tipped with two setae, the inner of which is three times the length of the outer. Egg sacs two-thirds the length of the entire body, ellipsoidal ; eggs large, arranged in five longitudinal rows, 60-65 in each sac.

First antennae (fig. 2) six-jointed, joints diminishing regularly in length and breadth ; all segments setose. The second antennae (fig. 3) are attached to the ventral surface just posterior to the bases of the first pair. They are four-jointed, first or basal joint large and swollen, the second joint one and a half time as long as the first, third joint

curved and half the length of the second, the fourth or terminal joint has the usual claw-like appearance.

Mouth parts (Fig. 4).—Labrum (*La*) extensively fused with the head, distinguishable only as a curved line reaching the bases of the mandibular palps. Mandibles (*Md*) with a short and broad basal joint, neck long and narrow, the cutting blade much longer than broad, and armed along the inner margin only. The mandibular palps elongated, with seta on the upper surface only. Basal portion of the first maxillae (*mx. i*) reduced to a circular papilla only, with two stout setae arising from the centre. The second maxillae (*mx. ii*) have a broad basal portion, while the distal portion (which is curved along its outer margin) appears as a second segment, articulating with the basal portion; this distal portion bears setae on its upper free surface. Labium (*Lb*) small, flap-like, and triangular in outline.

First four pairs of swimming legs (figs. 5—8) biramose, all the rami three-jointed, except the exopod of the fourth pair, which has two joints. The fifth pair reduced to an elongated process only. The arrangement of spines on the first four pairs is as follows :—

First exopod	0—0	0—1	11—5
„ endopod	0—1	0—1	11—4
Second exopod	0—0	0—2	11—3
„ endopod	0—1	0—1	11—4
Third exopod	0—1	0—1	11—4
„ endopod	0—1	0—1	11—4
Fourth exopod	0—0	11—4	
„ endopod	0—1	0—2	11—4

Colour of specimens preserved in spirit creamy yellow, with a large number of black pigment spots scattered on the dorsal surface of the animal. Eyes blackish, trilobate, in the middle of the head.

	mm.
Length	0·8
Length of egg-strings	0·52
Breadth of egg-strings	0·17

From the gills of the *Anabas scandens* (Daldorf). Gosaba, Sunderbans, Bengal, 11th December 1917.

Three specimens. Types in the collection of the Zoological Survey of India, numbered $\frac{9848}{10}$. This species is named in honour of Sir Daniel Hamilton of Gosaba, in recognition of the help given by him in the work of the Fisheries Department.

Literature cited—

1. Basett-Smith, P. W.—Some new or rare Parasitic Copepoda found on fish in the Indo-tropical region. *Ann. Mag. Nat. Hist.* (7), Vol. 2, 1898.

2. „ A systematic Description of Parasitic Copepods found on fishes, with an enumeration of the known species. *Proc. Zool. Soc. London*, 1899.

3. Gerstaeeker, A. D.—Brönn's *Thierreich*, Bd. V, abth. 2. *Gliederfussler.* Lieferung, 11—16. Leipzig u. Heidelberg, 1870-1871.
4. Sars, G. O.—An account of the *Crustacea of Norway.* Vol. 4. Copepoda Calanoida, Bergen, 1901-03.
5. Scott, T. and Scott, A.—The *British Parasitic Copepoda.* Copepoda parasitic on Fishes. Vols. 1 and 2, Ray Society, London, 1913.
6. Wilson, C. B.—North American Parasitic Copepods belonging to the family Ergasilidae. *Proc. U. S. National Mus.*, Vol. 39, Washington, 1911.

EXPLANATION OF PLATE X.

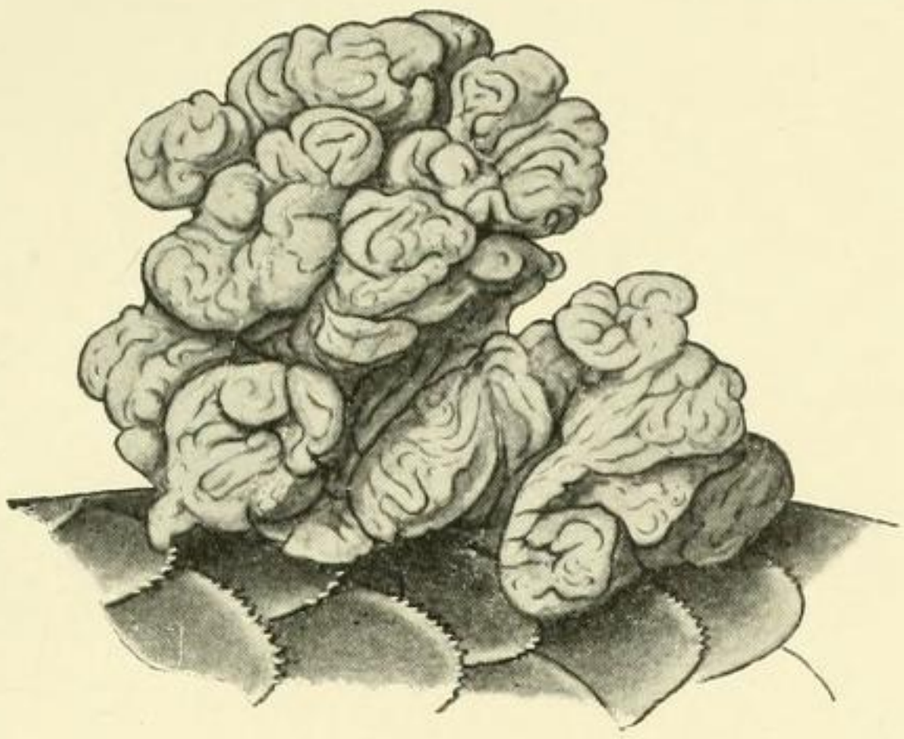
FIG. 1.—Photograph of side view of *Anabas scandens* with Carcinoma.

„ 2.—Photograph of the second specimen.

„ 3.—Photograph of the third specimen.

„ 4.—Enlarged view of the warty Carcinoma, ×4.

„ 5.—T. section of the Carcinoma, outgrowth.



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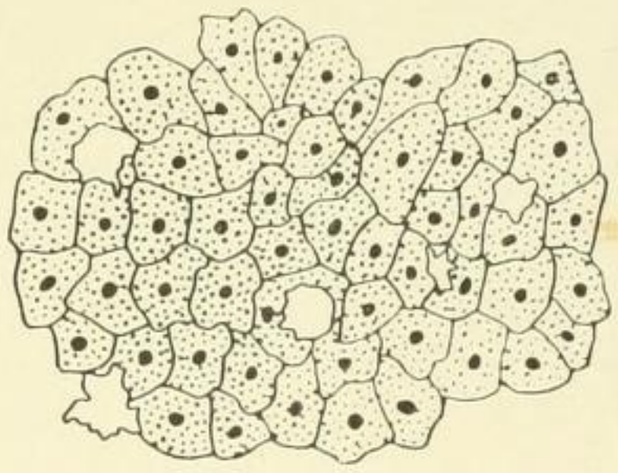

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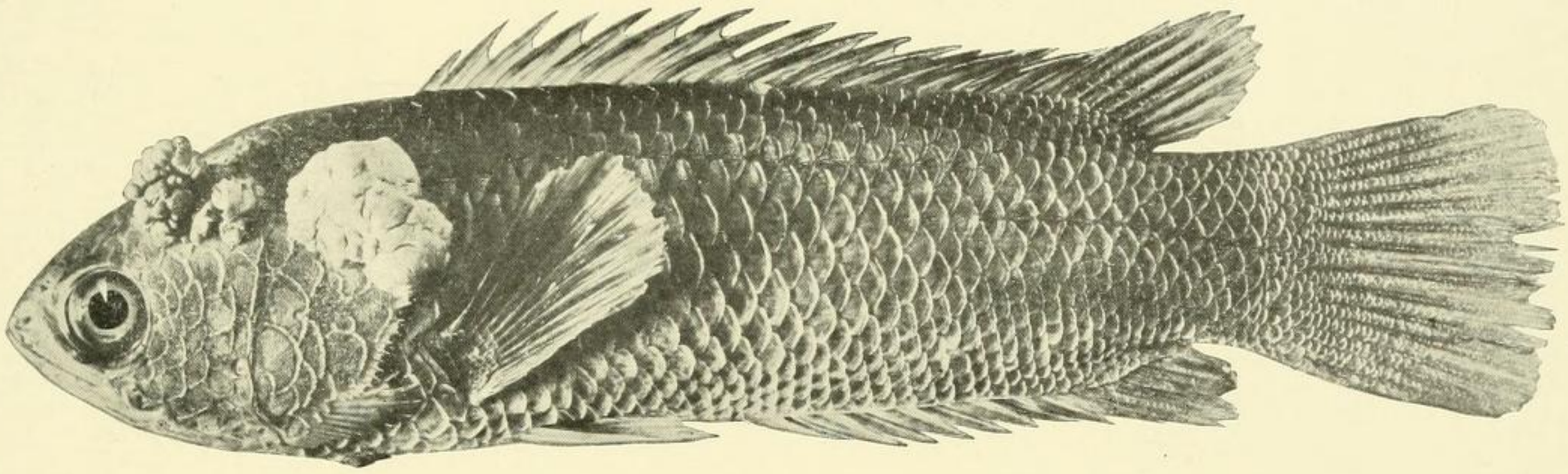

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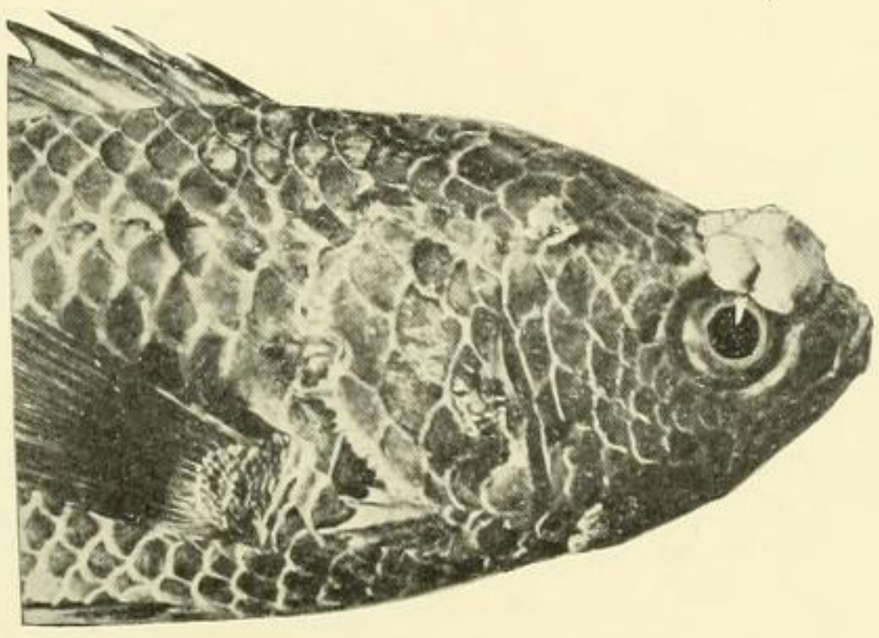

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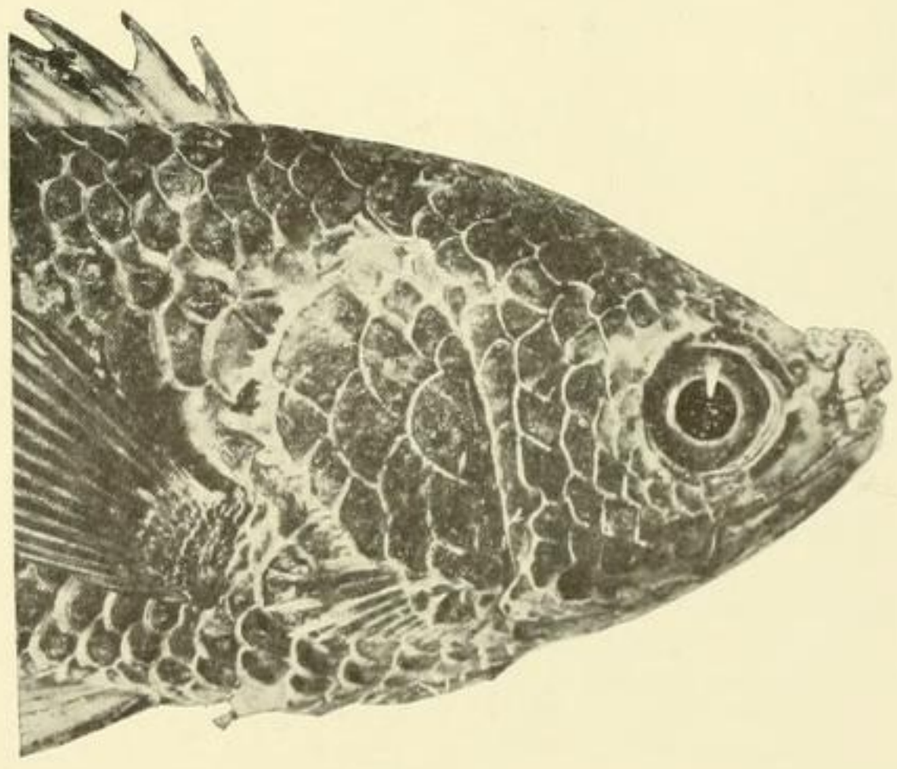


3

CARCINOMA OF CLIMBING PERCH.

S. C. Mondul, phot.

Photo.-engraved & printed at the Offices of the Survey of India, Calcutta, 1918.

EXPLANATION OF PLATE XI.

FIG. 1.—Gill of *Labeo rohita* with cysts of *Myxobolus rohitae* on the filaments.

„ 2-4.—Propagative cells of *M. rohitae.*

„ 5-9.—Division of propagative cells.

„ 10 and 11.—Union of a micro- and macro-gametes.

„ 12-20.—Division of the micro- and macro-gametes, and the formation of the pan-sporoblast.

„ 21-22.—Division of the pan-sporoblast into two sporoblast.

„ 23-25.—Young spores in development.

„ 26.—Mature spore showing the structure.

„ 27.—Spore with the polar filament extruded.

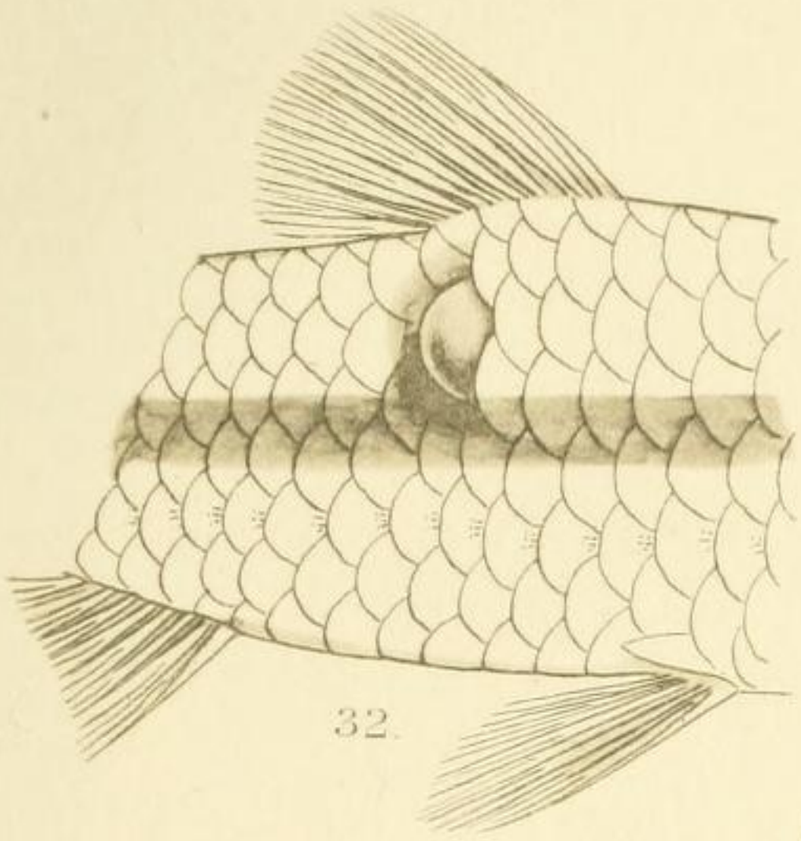
„ 28.—A portion of the caudal fin of *Labeo rohita* with a cyst of *Myxobolus seni.*

„ 29-31.—Mature spores of *M. seni.*

„ 32-33.—Side views of two specimens of *Rasbora daniconius* showing cysts of *Myxobolus nodularis.*

„ 34-36.—Mature spores of *M. nodularis.*

PLATE XI.



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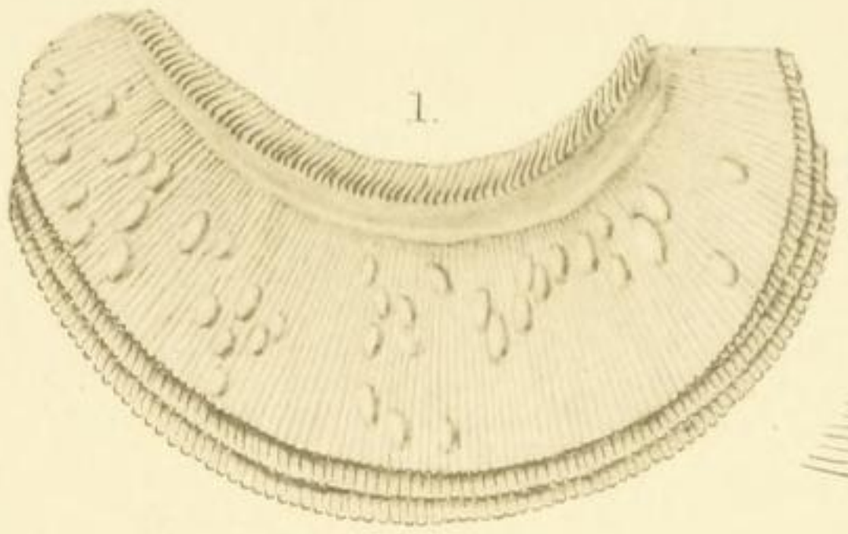

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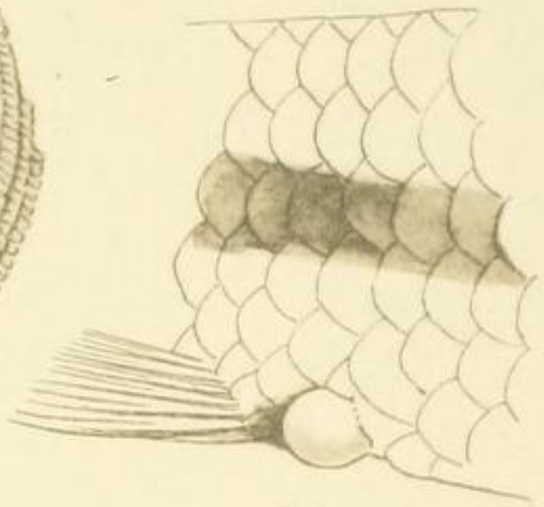

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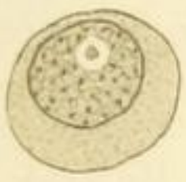

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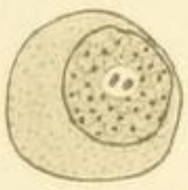

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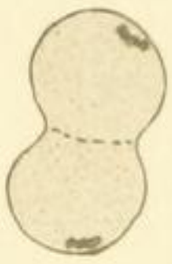

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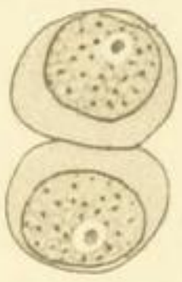

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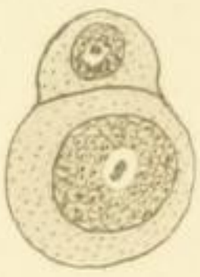

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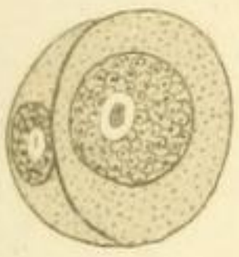

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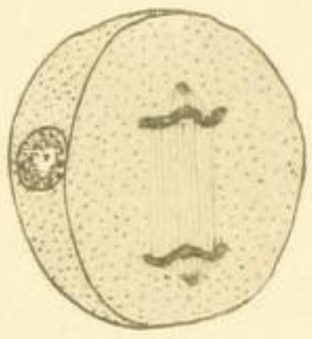

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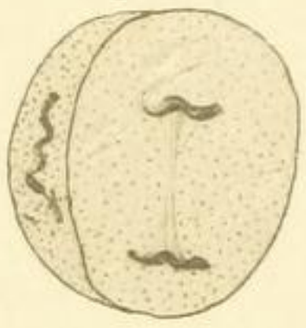

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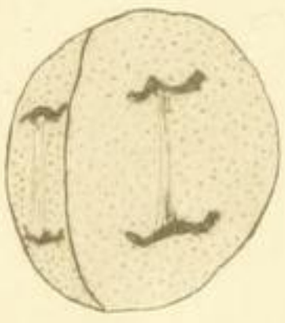

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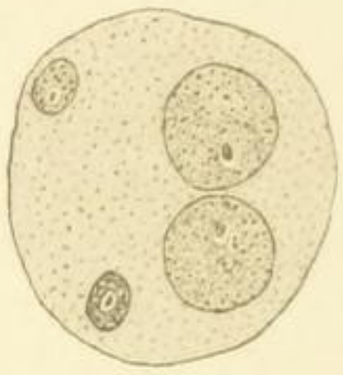

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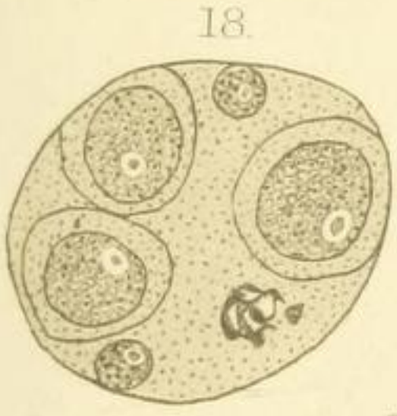

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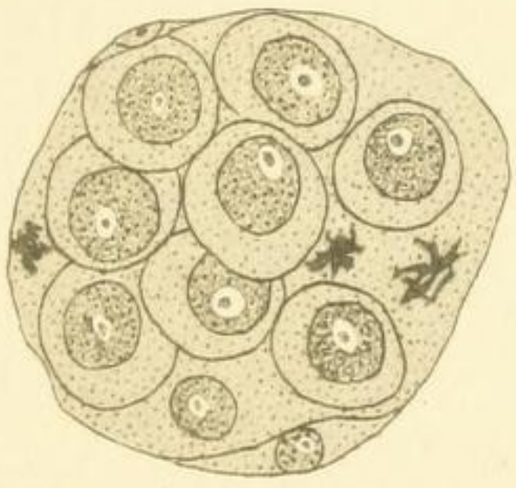

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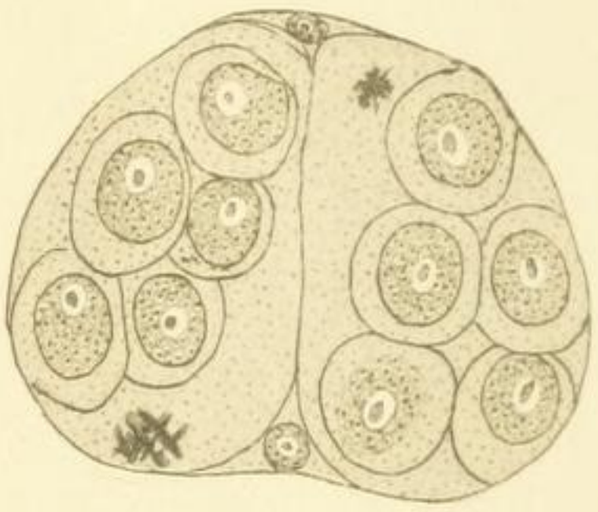

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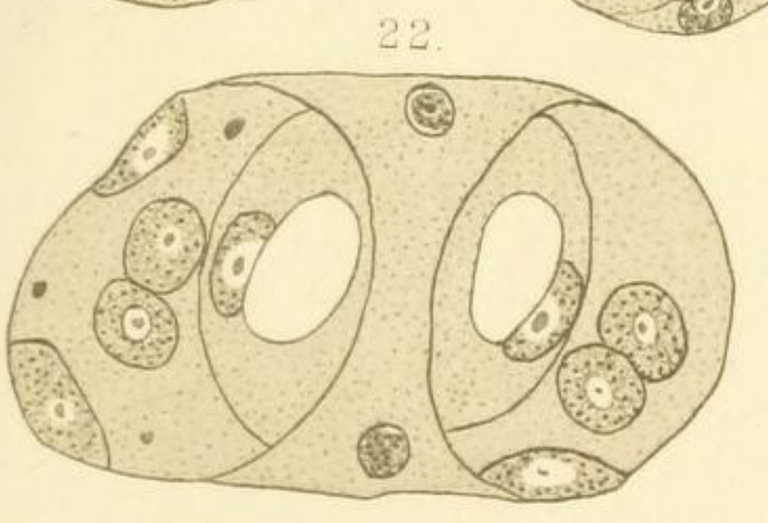

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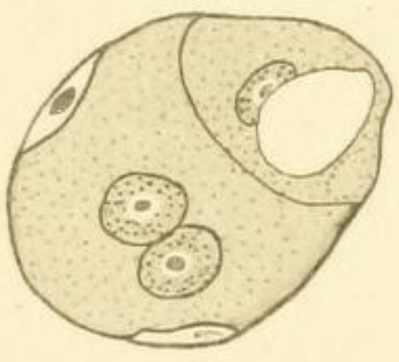

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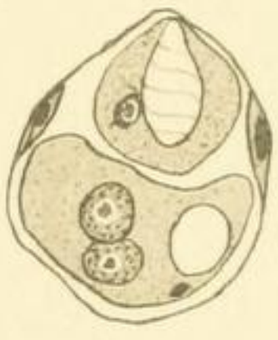

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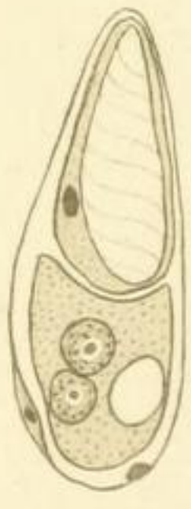

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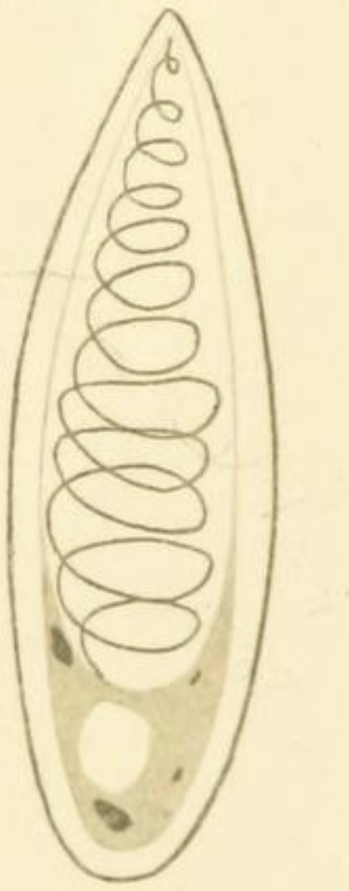

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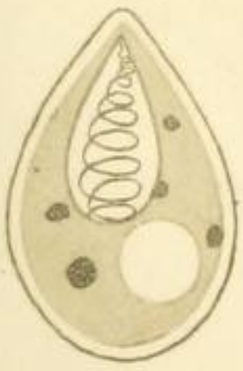

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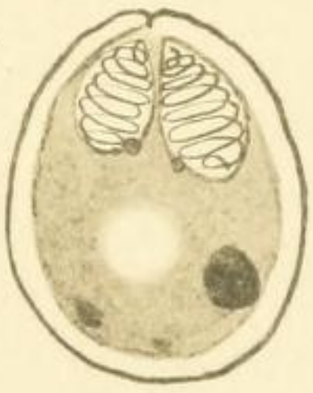

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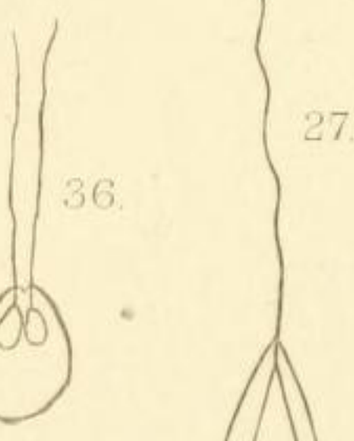

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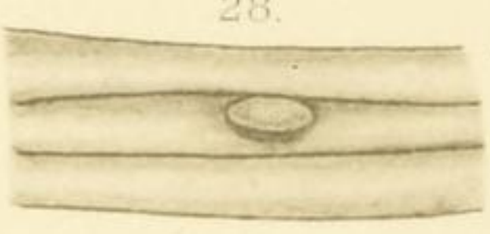


28.

B. Prashad & A.C. Chowdhary, del.

Photogravure—Survey of India Offices, Calcutta, 1918.

INDIAN MYXOSPORIDIA.

EXPLANATION OF PLATE XII.

FIG. 1.—*Clinostomum piscidium.* Entire worm showing the anatomy.

„ 2.—Cercaria from the lateral muscles of *Saccobranchus fossilis.*

„ 3.—A cyst containing a Cercaria from the wall of the intestine of *Ophiocephalus marulius.*

„ 3(*a*).—Another specimen of the same while still enclosed in the wall of the intestine.

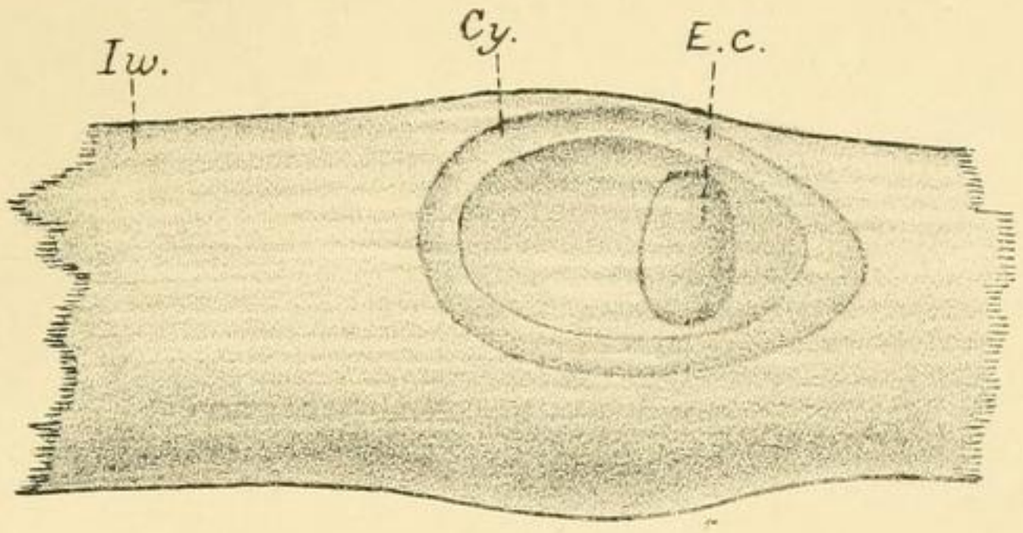
„ 4.—Cercaria from the lateral muscles of *Ophiocephalus striatus.*

„ 5.—Cercaria from the lateral muscles of *Ophiocephalus striatus.*

„ 6.—Cercaria from the lateral muscles of *Trichogaster fasciatus.*

EXPLANATION OF LETTERING.

C. S. Cirrus Sac. Cy. Cyst. E. C. Encysted cercaria. E. O. Excretory opening. E. V. Excretory vesicle. G. A. Genital atrium. I. W. Intestinal wall. Int. Intestine. N. C. Nerve collar. G. P. Genital pore. Ov. Ovary. O. d. Oviduct. S(i) Anterior sucker. S(ii) Posterior sucker or Acetabulum. T. Testis. Ut. Uterus. V. Vitelline gland. V. d. vas deferens.



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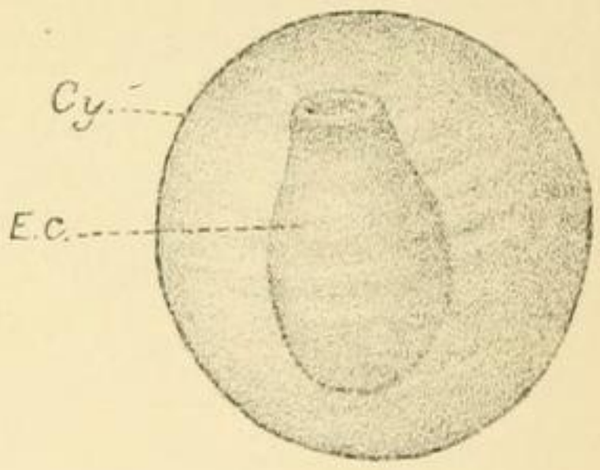

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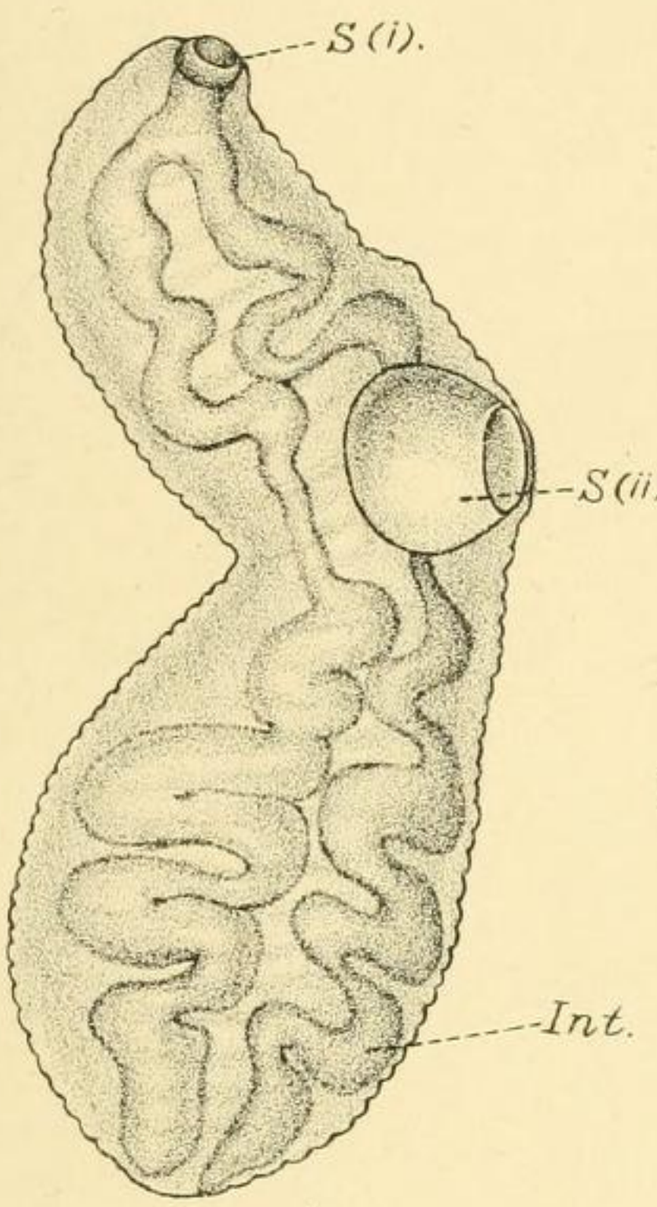

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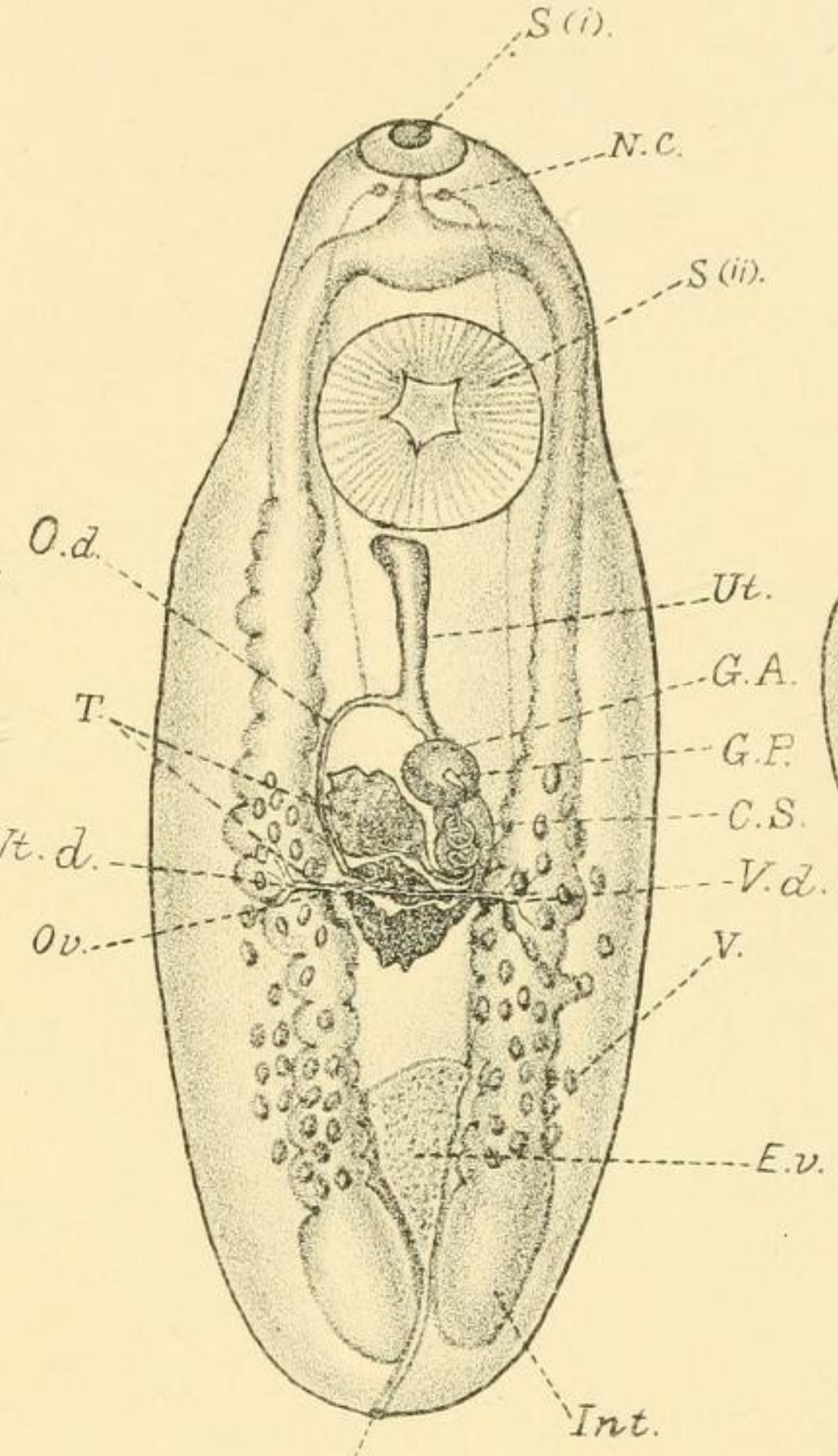

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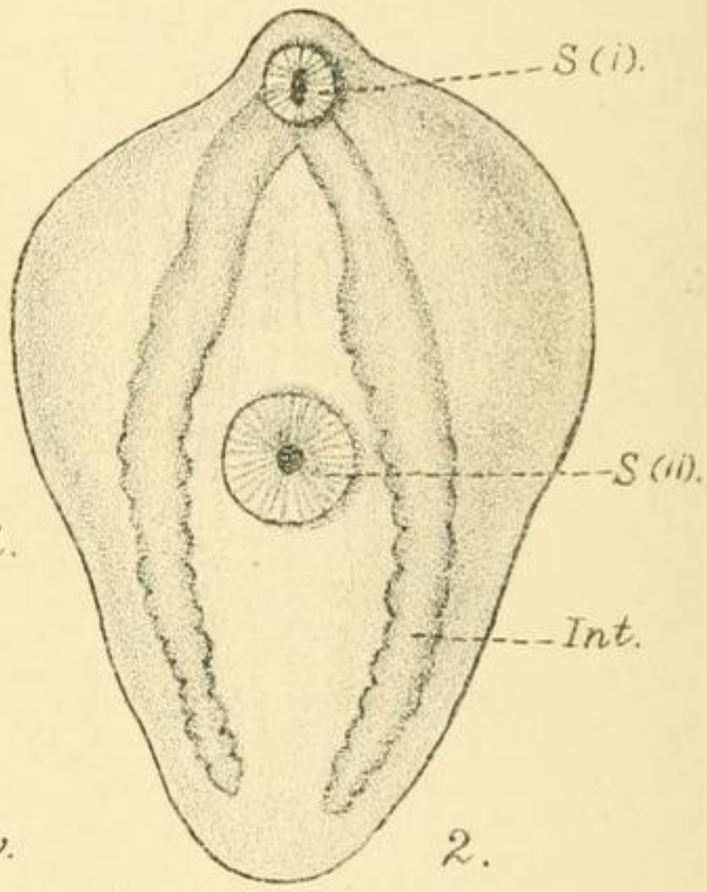

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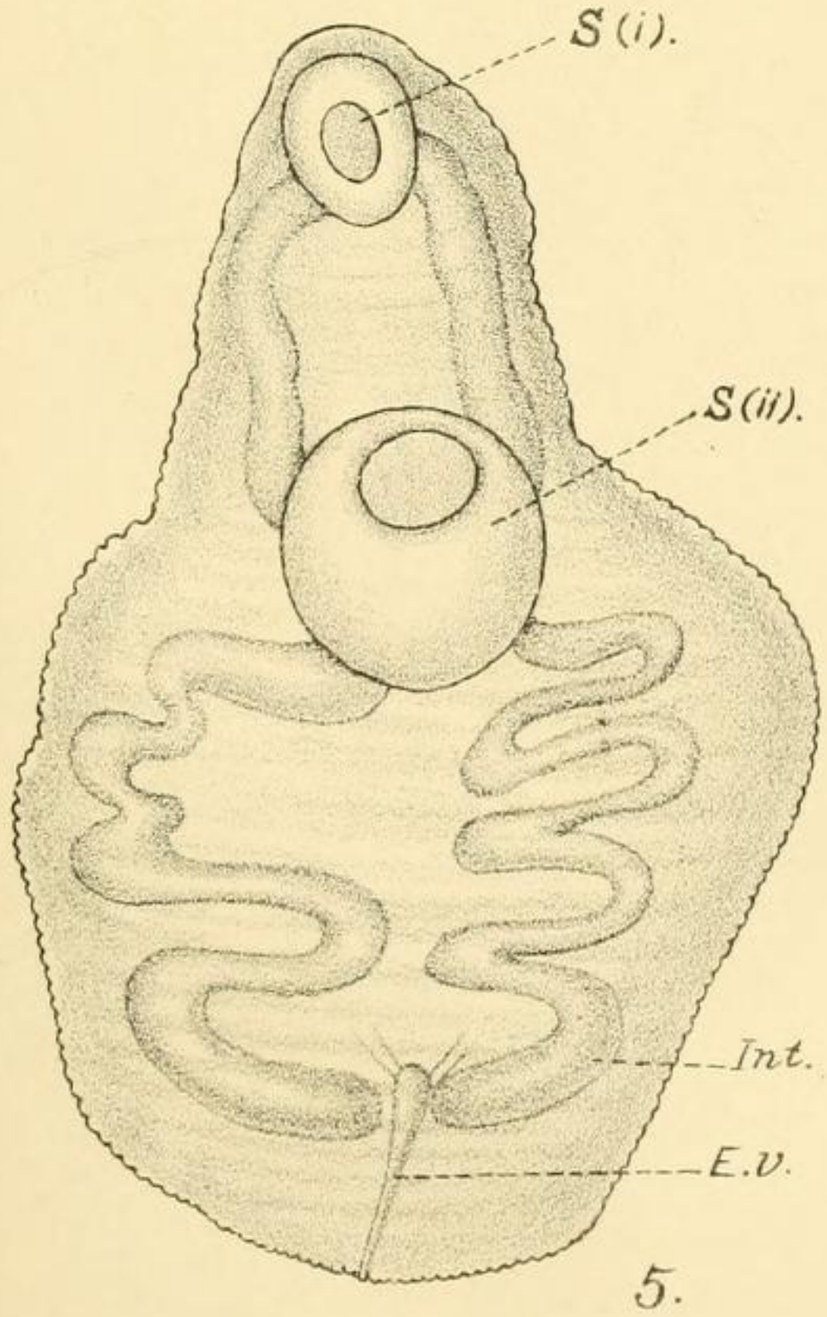

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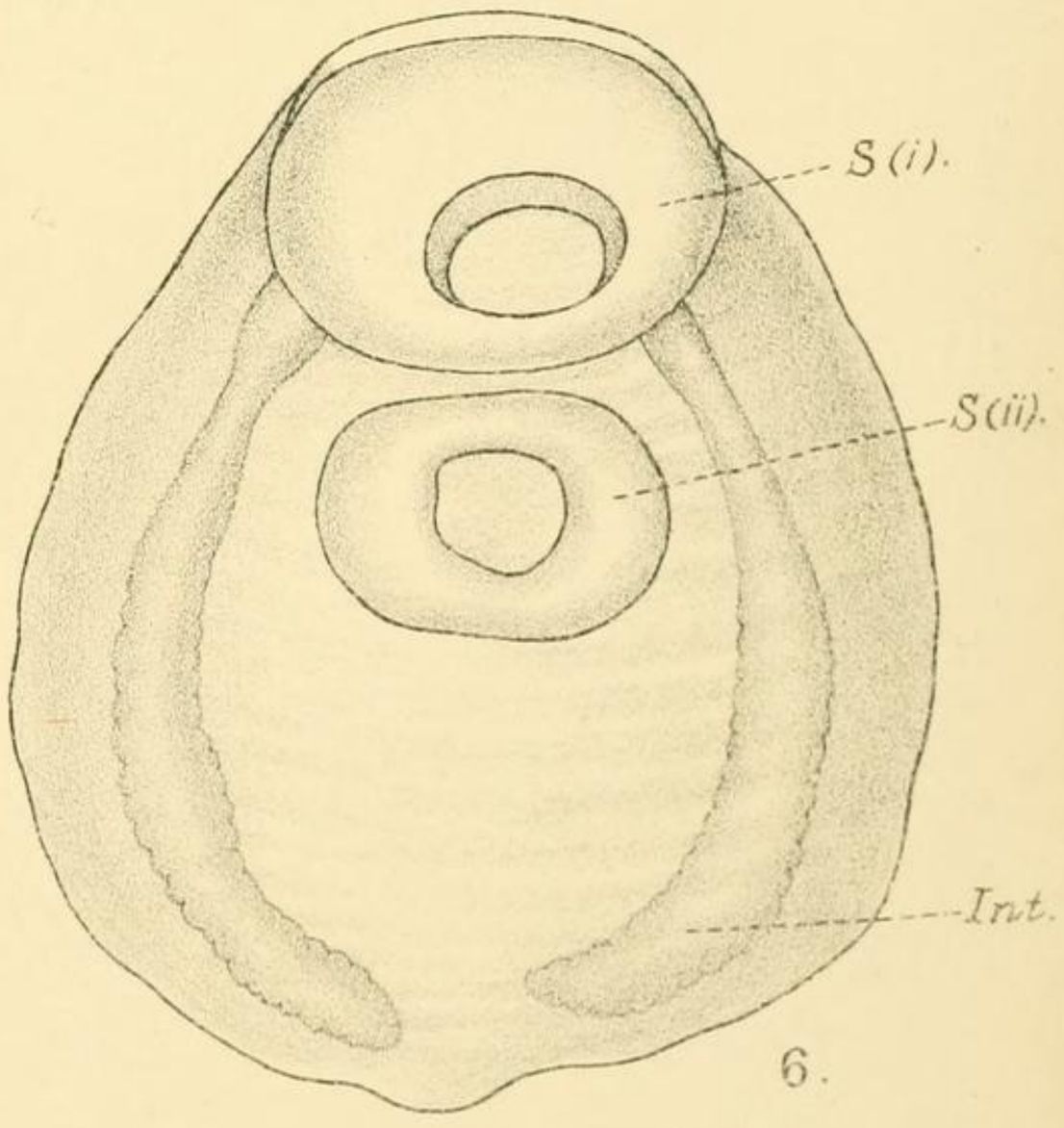


6.

B.P. del.

A. Chowdhary lith.

SOME FISH TREMATODES.

EXPLANATION OF PLATE XIII.

All the figures are of *Ergasilus bengalensis*.

Fig. 1.—Dorsal view of the entire female animal.

„ 2.—First antenna.

„ 3.—Second antenna.

„ 4.—Mouth parts, ×1250.

„ 5.—First swimming leg.

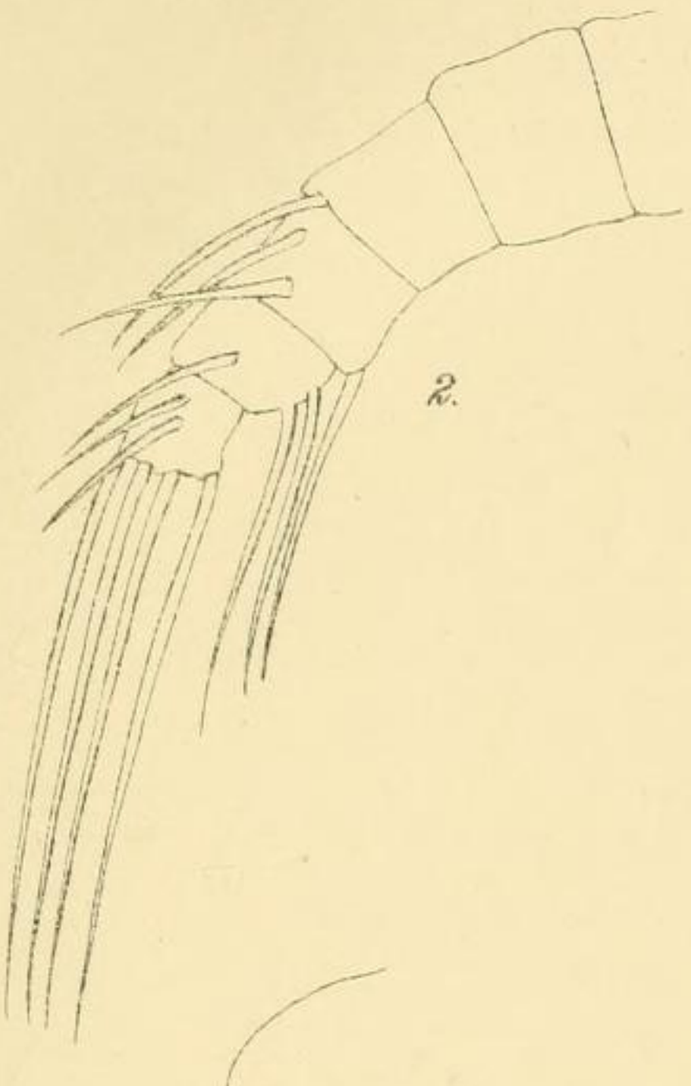
„ 6.—Second swimming leg.

„ 7.—Third swimming leg.

„ 8.—Fourth swimming leg.

Explanation of lettering.

a. i.—a. iii. First to third abdominal. segments. A. l. anal lamina. an. i. an. ii. First and second antennae. E. S. Egg sacs. G. s. Genital segment. La. Labrum. Lb. Labium. Md. Mandible. M. p. Mandibular palp. Mx. i., mx. ii. First and second maxillae. T. 2—T. 5. Second to fifth free thoracic segments.



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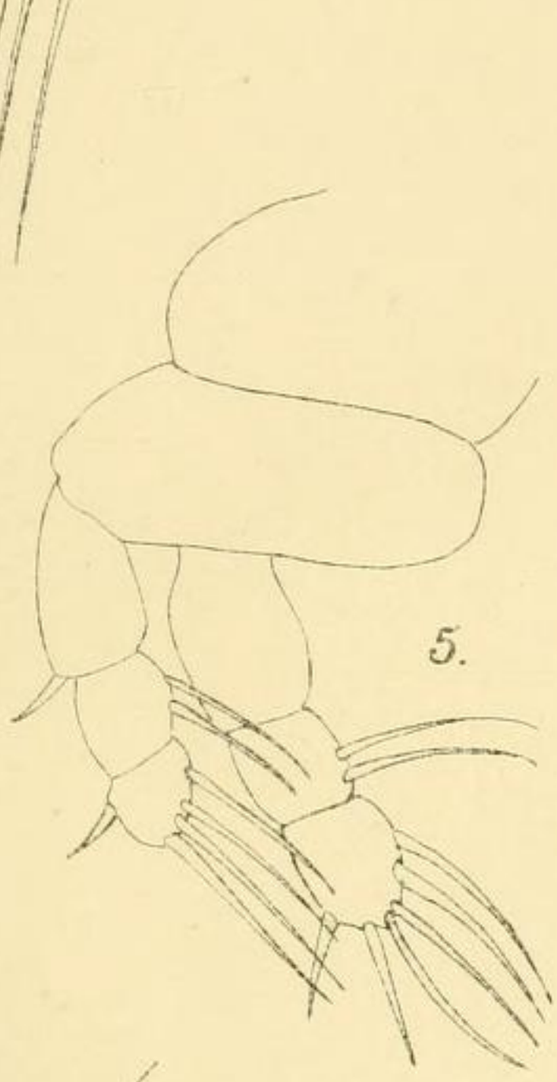

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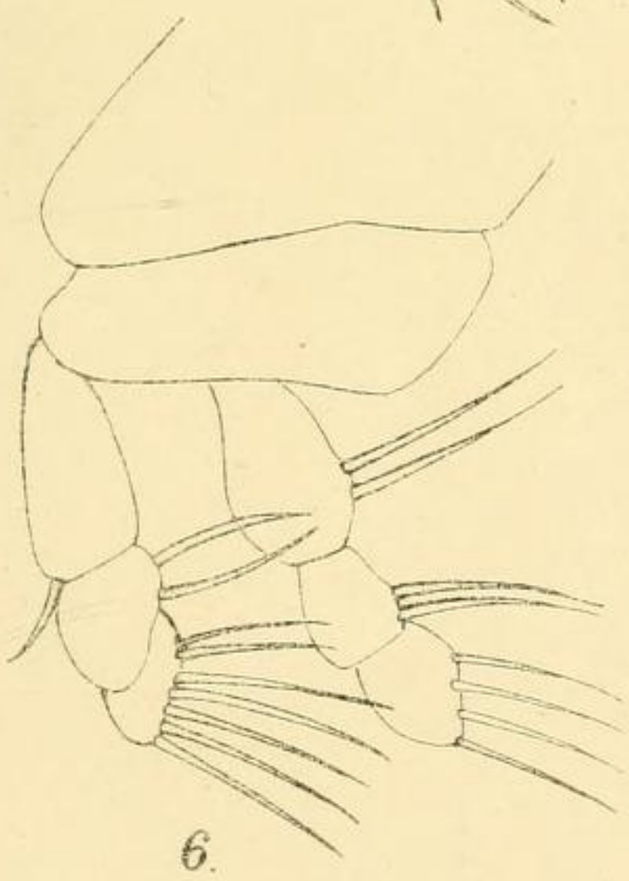

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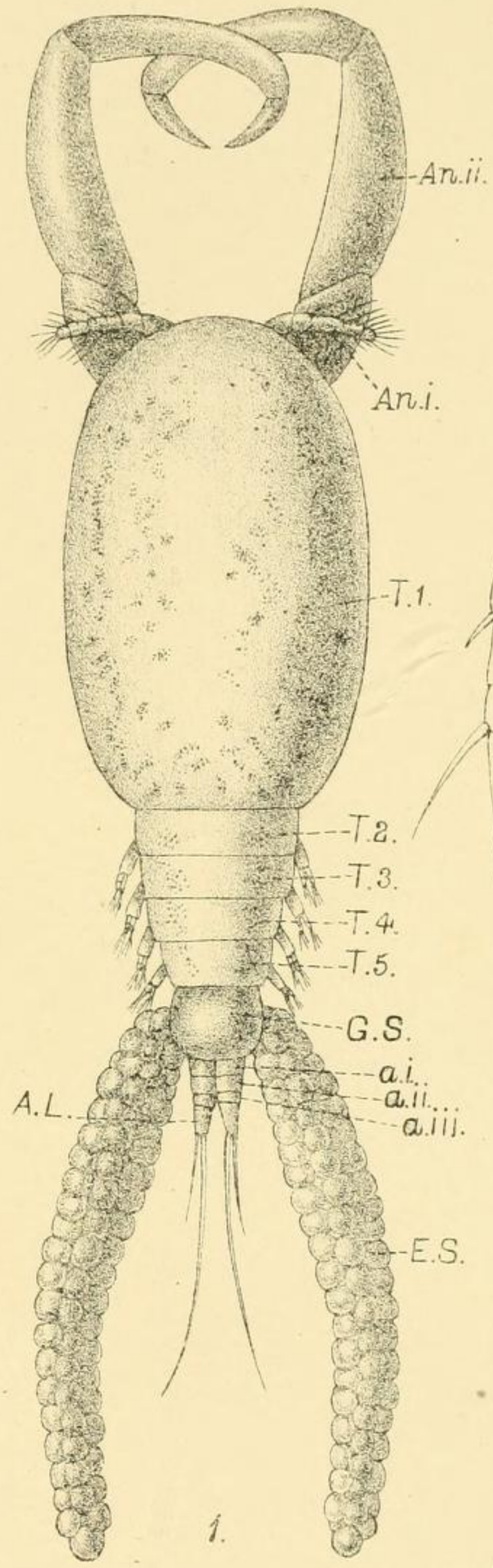

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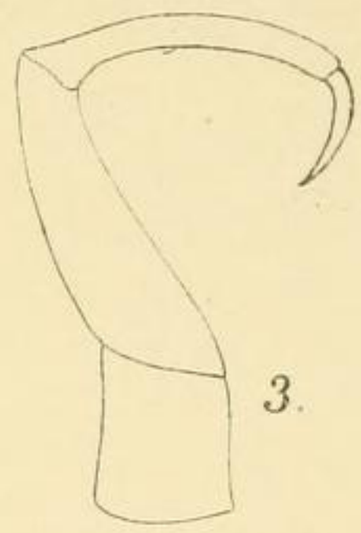

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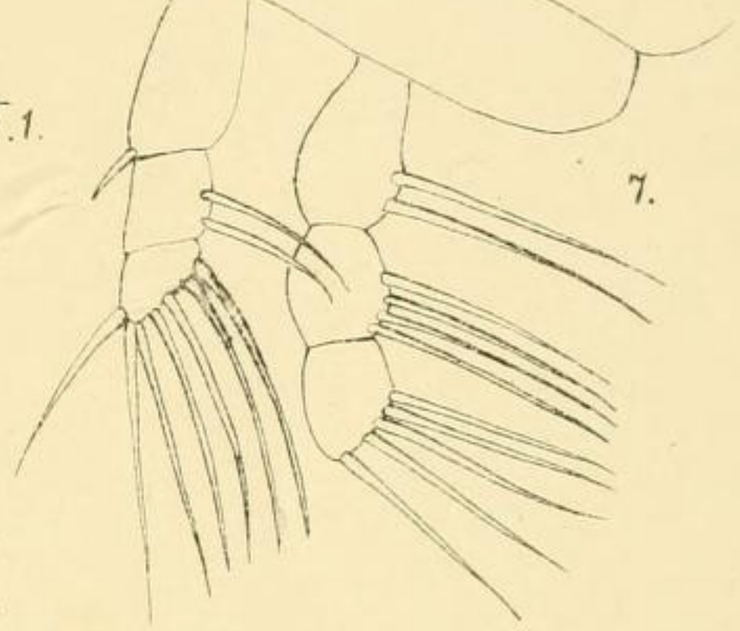

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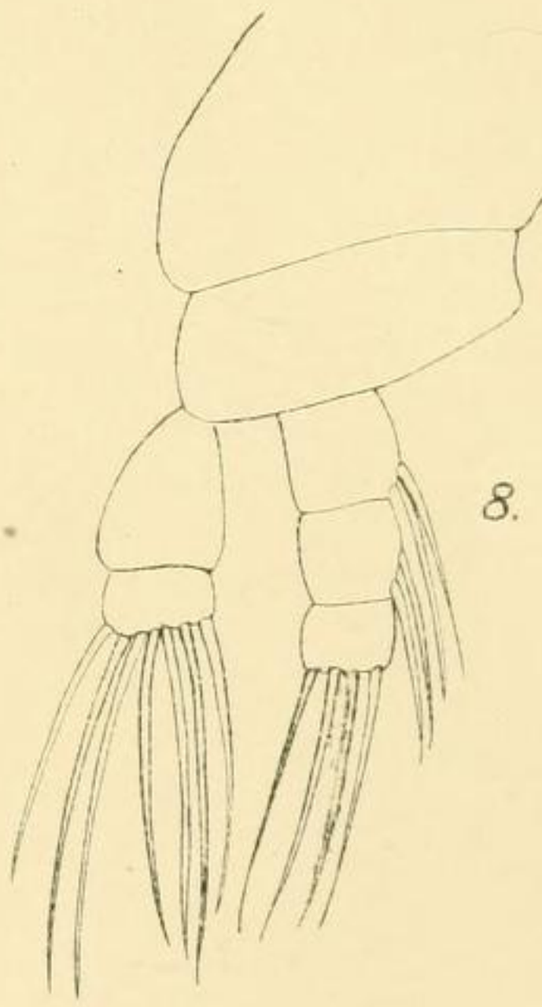


8.

4.

B.P. del.

D. Bagchi lith.

ERGASILUS BENGALENSIS.

EXPLANATION OF PLATE XIV.

All the figures are of *Ergasilus hamiltoni*; reference lettering same as in plate XIII.

FIG. 1.—Dorsal view of the entire female animal.

,, 2.—First antenna.

,, 3.—Second antenna.

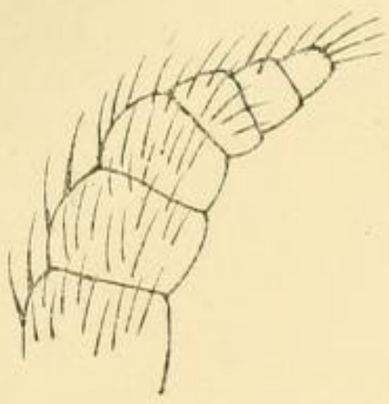
,, 4.—Mouth parts, ×1250.

,, 5.—First swimming leg.

,, 6.—Second swimming leg.

,, 7.—Third swimming leg.

,, 8.—Fourth swimming leg.



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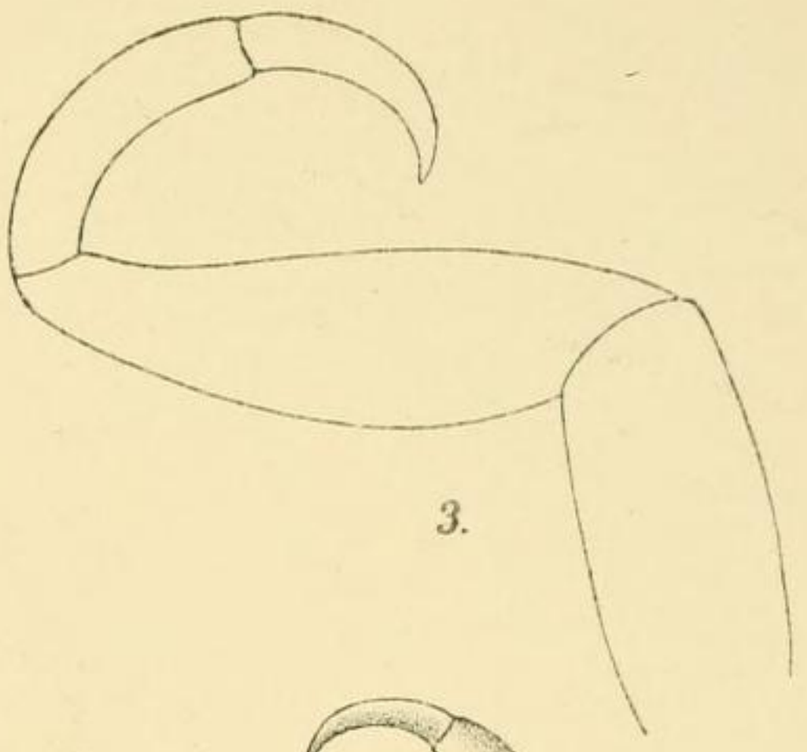

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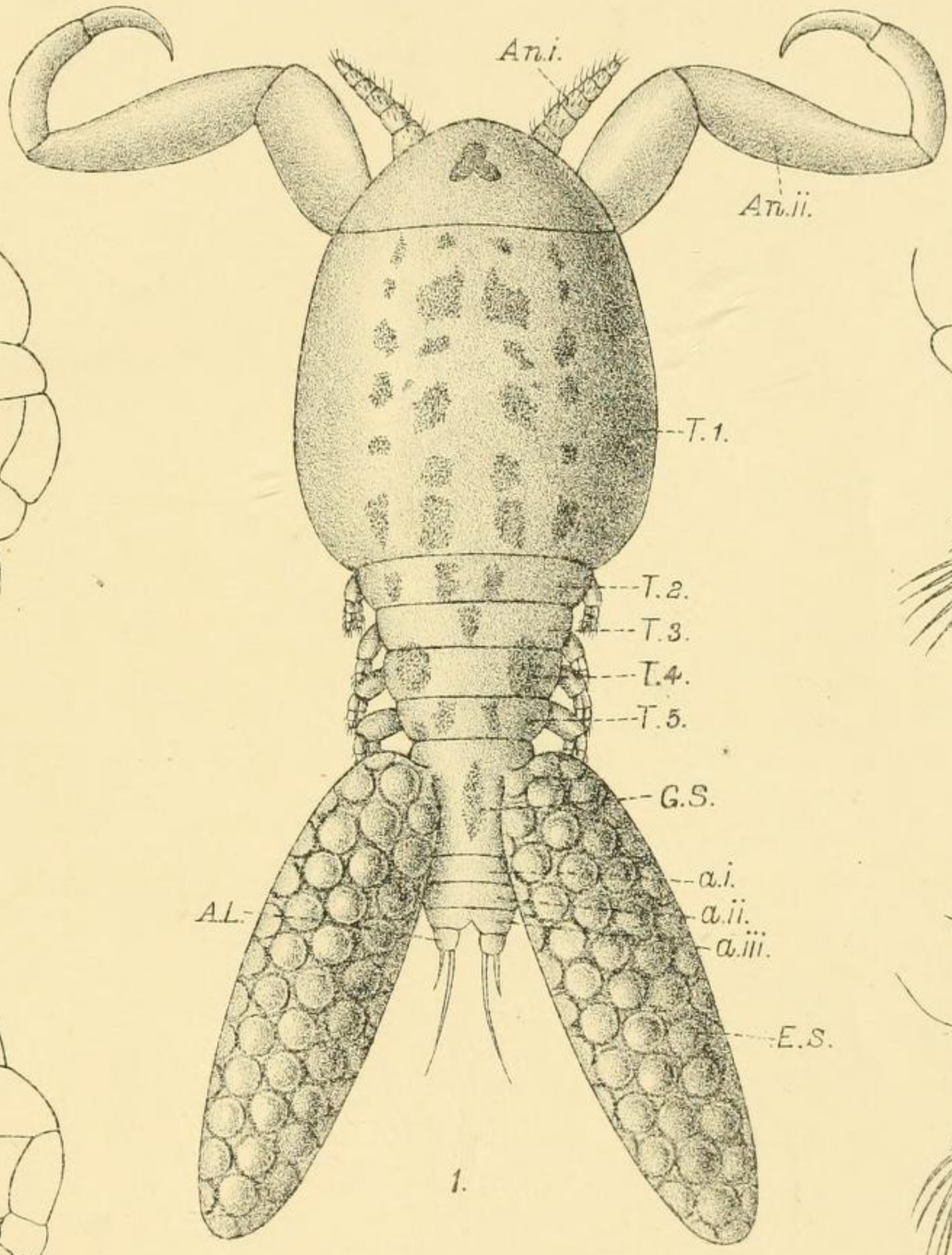

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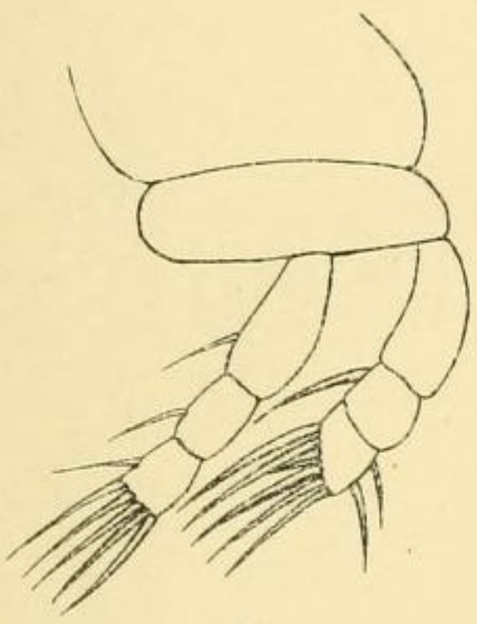

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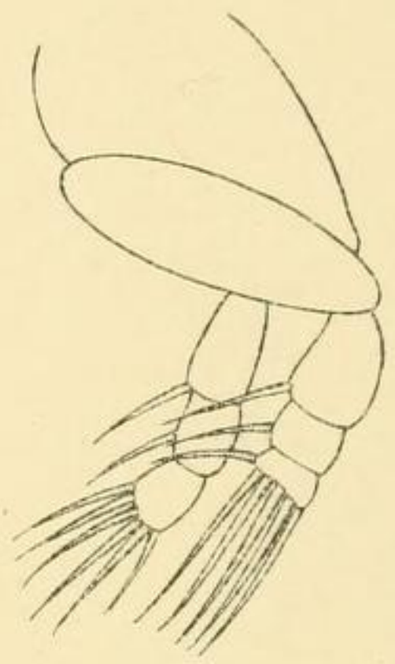

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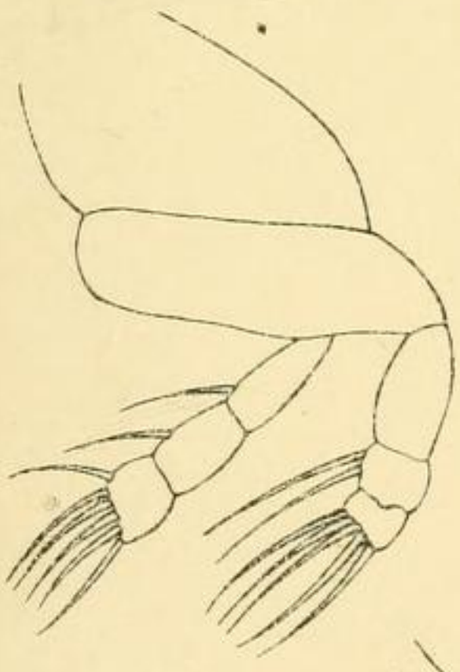

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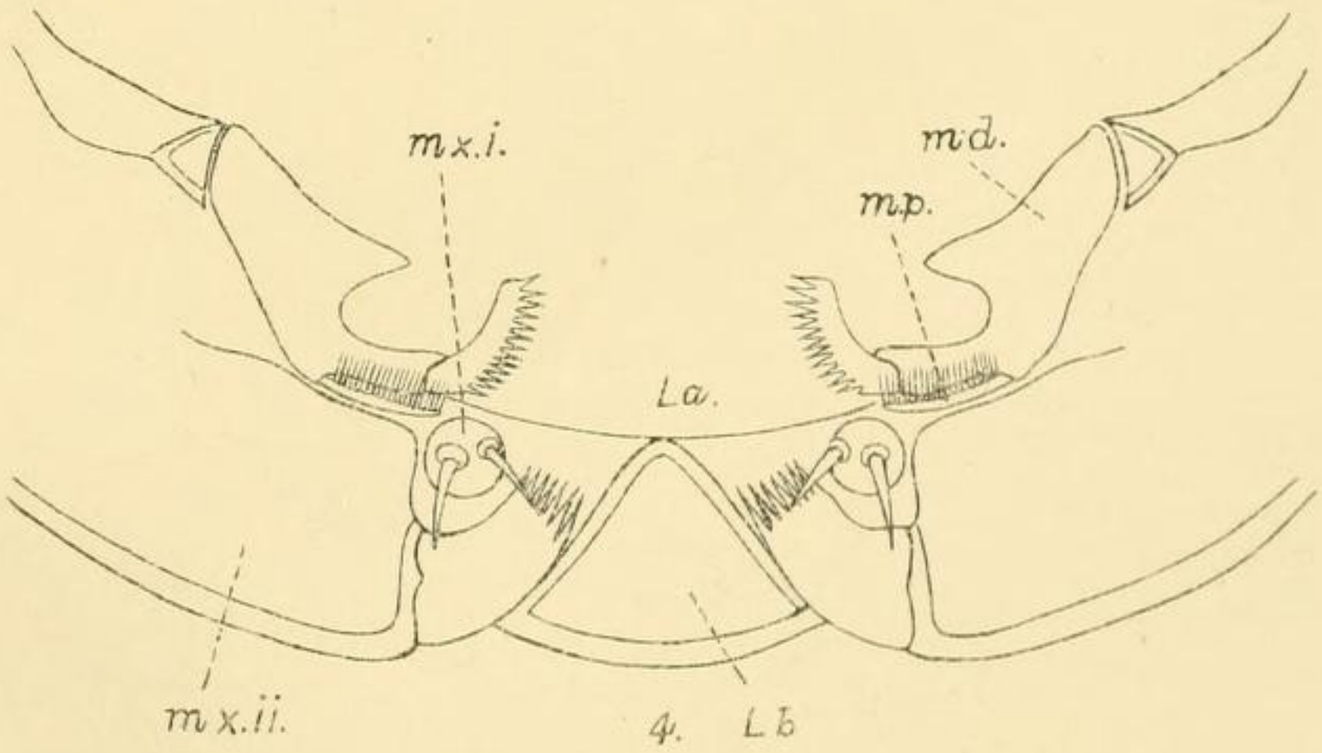

4.

B. P. del. S. C. Mondul lith.

ERGASILUS HAMILTONI.