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The Structure and Development of the Sessile Ctenophore *Lyrocteis imperatoris* KOMAI

By

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With Plates I-III

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Contents

Introduction

This spring I had the privilege of examining some specimens of a remarkable sessile ctenophore which had been discovered by the members of, and kept at the Biological Laboratory in the Imperial Palace. The specimens were accompanied by careful field notes and beautiful color sketches from life by Mr. HIROO SANADA, an assistant in the Laboratory. Mere casual examination of the specimens and sketches enabled me to ascertain that they represented a new and very remarkable platyctenid type. Subsequent studies have elucidated the greater part of its structure. Moreover, because of the viviparous nature of the animal, its developmental stages have been traced for the most part. Thus I was able to give an outline of my findings at the meeting of the Committee of the Pacific Oceanography of the National Research Council held on May 24 th. The name, *Lyrocteis imperatoris*, n. g., n. sp., was then proposed for the animal. Also a short paper entitled " A New Remarkable Sessile Ctenophore " was kindly communicated by DR. N. YATSU to the June Meeting of the Imperial Academy, and published in the Proceedings of the Academy (vol. 17, no. 6, pp. 216-220).

The specimens, two perfect and five fragmentary, were obtained in January, 1941, at a depth of 70 m., 3 km. off Enosima in Sagami Bay. Subsequently, in July, three more were secured by the members of the same laboratory in the same locality, and one of the specimens, together with the field notes prepared by Mr. SANADA, was sent to me for examination. Quite recently, on November 13, two fragmentary specimens apparently of one and the same individual were obtained, and they were brought back to Tokyo on the following day during my stay there. All these specimens have become the material of the present report. My findings on the preserved material have greatly been supplemented by the observations on the fresh specimens by the members of the Laboratory. Mr. SANADA's notes and sketches especially were quite helpful in understanding the observed facts. But for them, the present study would have been far more incomplete, particularly because of the great difficulty in preserving such a fragile animal in good condition. It is thus my duty to express here my hearty thanks to Dr. HIROTARO HATTORI, biologist in the service of the Laboratory, who offered me the opportunity of studying this most interesting animal, and also my indebtedness to Mr. SANADA for his very valuable informations on the fresh material.

Historical

Although it is true that *Lyrocteis* was discovered only recently, there is good evidence to show that it had been collected and observed by a Japanese zoologist many years previously. In Dobutugaku-Zassi (Zoological Magazine) vol. 8, no. 49, pp. 307-309 issued in August 1896, we find a short note in Japanese by a T. N. (evidently the late Mr. TOKICHI NISHIKAWA, the inventor of the famous cultured pearl) entitled, " A Curious Animal ", which deals with a specimen of a strange-looking animal caught with a long line at a spot in the Sagami Sea at some distance from the place where the present material was discovered. The article of which the translation may be found on p. 31, is accompanied by fairly good sketches of the specimen which are reproduced on p. 32. These accounts and sketches show quite definitely that the ' curious animal ' was no other than another specimen of the present ctenophore.

But since the real nature of the animal was unknown to the writer of the article, as well as to its readers, it had remained enigmatic for nearly half a century. I noticed the resemblance of the problematical animal to *Tjalfiella,* while I was studying *Coeloplana* more than twenty years ago, and I suspected that it might have been an unknown platyctenid. Since the original specimen was lost, however, and no further specimen had since been obtained, I had no means of proving my assumption. When the specimens and sketches of the newly discovered sessile ctenophore were shown to me, I immediately remembered the 'curious animal'. It soon became quite clear that it had been another specimen of the ctenophore collected 45 years ago. At any rate, it is certainly a striking fact that such a remarkable animal has remained unknown for so long, notwithstanding that the locality is where the zoological surveys have been carried out more thoroughly than anywhere else in the Japanese seas.

Next, it may be convenient for the reader to review briefly our knowledge of the other forms belonging to the group Platyctenida.

The forms belonging to this order are characterized by having more or less flattened bodies, often beautifully colored, and commonly lacking comb-plates in the adult stage. The pharynx is clearly sectioned into two portions, of which the outer is extended to become a creeping sole, or an adhering organ. The gastro-vascular canals are complexly branched, and anastomose in many cases. The gonads develop in the wall of the canals representing the meridional canals. They, especially the testes, form compact masses, and the testes are provided with seminal ducts. The larva is a typical cydippid and always has distinct comb-plates.

The order includes, apart from the present *Lyrocteis, Coeloplana, Ctenoplana,** *Tjalfiella* and *Gastra. Coeloplana* (Fig. 26 A) was discovered first and is perhaps the best known of all these forms, especially because its development has been thoroughly worked out (KOWALEVSKY 1880, ABBOTT 1902, 1907, KOMAI 1920 a, 1922 and KREMPF 1920 a & b, 1921). The animal has an extremely thin, flattened, oblong and beautifully colored body, with a rather well-developed sense-organ at the center and two pinnate tentacles on the longer body axis. The gastro-vascular system is profusely branched and forms a network penetrating the whole body tissue. The female gonads develop on the walls of the canals representing the meridional canals of ordinary ctenophores; the male gonads form a few compact masses situated on the wall of the same canals, and they are each provided with a duct leading to the dorsal side of the body. A series of blind sacs which function as seminal receptacles are found on the ovarian tract. The eggs are laid through the mouth aperture, and develop under the mother animal.

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* DAWYDOFF (1936) divides this genus into *Ctenoplana* and *Planoctena.* The distinction, however, is based on rather slight differences in the tentacle sheath and polar plate. So, for the present purpose, both will be included in *Ctenoplana.*

The larva is a typical ctenophore, with distinct comb-plates; the external portion of its pharynx is extensile and acts as a creeping sole. This genus is represented by more than a dozen species known from various spots of the Indo-Pacific.

Ctenoplana (KOROTNEFF 1886, WILLEY 1896, DAWYDOFF 1936, KOMAI 1922) differs from *Coeloplana* in having short but distinct ribs and in being able to perform both swimming and creeping movements. The gastro-vascular system forms a network. The ovary is unknown, but the testes seem to develop as some compact masses with ducts. The genus is represented by some ten species of rather dubious distinction, described from the seas of the Dutch and French East Indies as well as of Japan.

Tjalfiella (Fig. 26 C) is known merely through MORTENSEN's works (1910, 1912). It was obtained only once from deep waters off West Greenland, and was found attached to the pennatulid *Umbellula lindahlii.* It is apparently a sessile form with very limited power of locomotion if any. It is shaped somewhat like an ascidian, consisting of a middle part elongate in the transverse axis and a chimney-like elevation on either end of the axis. The tentacle is unbranched, and projects from the tip of the process where its sheath opens. The comb-plates are entirely missing; the gastro-vascular canals form a branching system, but no network. The ovary and testis develop in the wall of each of the much shortened meridional canals, together making a compact mass. The animal is viviparous. The embryo is a typical ctenophore provided with long combs.

Gastra (*Gastrodes*) lastly, (KOROTNEFF 1888, HEIDER 1893, KOMAI 1920 b, 1922, DAWYDOFF 1937) is a tiny parasite found in the mantle of various species of *Salpa*, measuring only 3 mm. in diameter in the most advanced stage known. In this stage the animal is shaped like an inverted saucer or bowl, while the younger ones are entirely disc-like. The ventral side of the animal is homologous with the inner wall of the pharynx of ordinary ctenophores. The parasite is provided with rather long ribs and a pair of rudimentary tentacles. The testis is unknown; the ova are dispersed in the wall of the ventral side, quite unlike the ova of other ctenophores. The meridional canals are broad sacs. Thus the animal has distinct larval features, especially in its rudimentary tentacles and sac-like canals, and it is possible that it undergoes further development after leaving the host. On the whole, *Gastra* differs from the other members of platyctenids in several respects, but its flattened body resulting from the opening out of the pharynx seems to justify its ranking in this group.

Material

The material consists of eleven individuals, five perfect or nearly perfect, and six fragmentary, which were all collected at a depth of 70 m., 3 km. off Enosima in Sagami Bay. The place, locally called Hiramon, is noted for tai-fish (*Pagrosomus*) fishing. The bottom is mud and dispersed with rocks. These are apparently covered with crinoids and gorgonids, for pieces of these forms often come up entangled in the fishing implements. The specimens were dredged by the party from the Biological Laboratory in the Imperial Palace on five occasions, January 15 th and 18 th, July 13 th and 14 th, and November 13, 1941. Two specimens were obtained in the same haul on January 15 th, and five, also in the same haul, on January 18 th, mixed with pieces of sponges, hydroids, gorgonids and nudibranchs, in addition to a quantity of mud. On July 13 th two specimens and one on the 14 th, were secured in the same haul, together with many pieces of gorgonid colonies. It is noteworthy that more than one individual, at one time even as many as five, of different colors entered the same haul. This fact strongly suggests the gregarious habit of the animal.

The living specimens obtained in

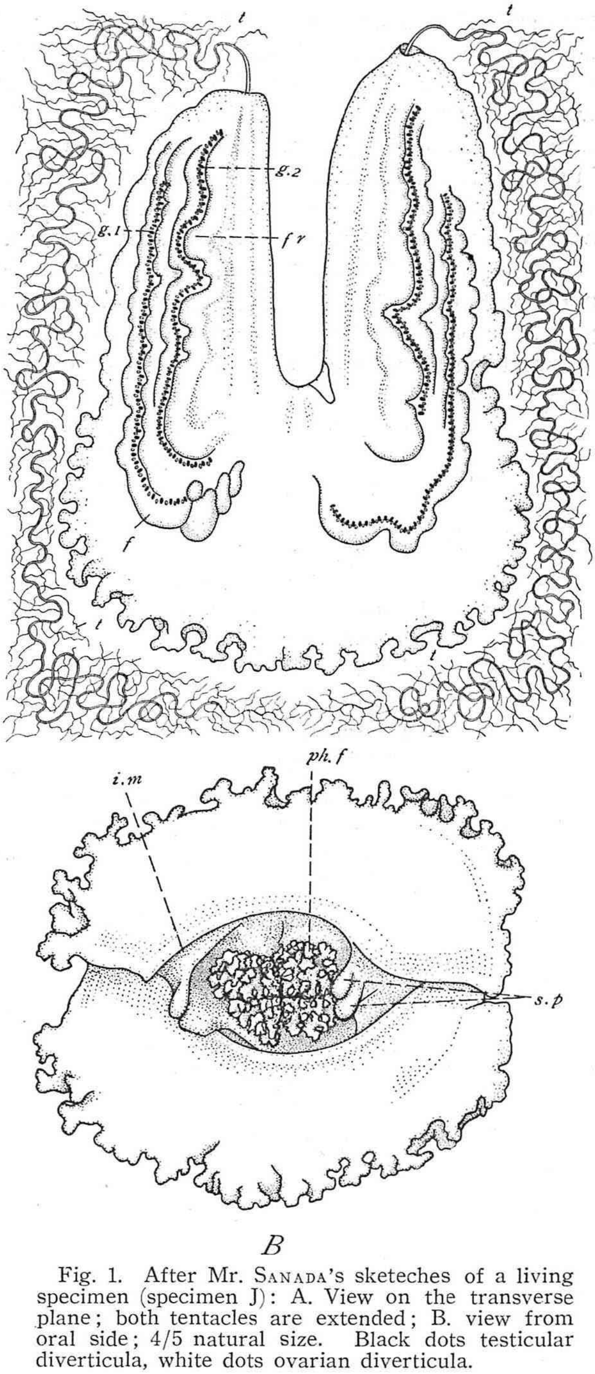

Fig. 1. After Mr. SANADA's sketeches of a living specimen (specimen J): A. View on the transverse plane; both tentacles are extended; B. view from oral side; 4/5 natural size. Black dots testicular diverticula, white dots ovarian diverticula.

January and July were observed by the members of the party, and careful field notes and beautiful color sketches reproduced on Plates I and II were taken by Mr. SANADA. The specimens secured on November 13 were kindly brought back by DR. HATTORI on the following day to Tokyo where I was staying then. This gave me a chance to examine the animal in the living state. The greater part of the descriptions of the living material which follow, however, are based on these notes and sketches, as well as on personal communications by Dr. HATTORI, Dr. T. SATO and Mr. SANADA.

The body of the animal is lyre-shaped, consiting of a saddle-shaped main part or trunk, and an arm-like process on either side. The whole periphery of the body is encircled by a deep furrow. A pinnate tentacle of great length protrudes from the tip of each arm (Fig. 1 and Plate I).

Specimen Collected on	Ground color*	Margin of trunk	Color bands along genital tracts	Figure on Plate
A (perfect) Jan. 15, '41	Picric yellow	Light picric yellow	Orange buff	——
B (fragmentary) Jan. 18, '41	,, ,,	,, ,, ,,	,, ,,	Plate II, fig. 4
C (nearly perfect) Jan. 15, '41	Ventian pink scattered with rather large, oblong, carmine tubercles	Seafown green	Apricot buff	,, fig. 1
D (fragmentary) Jan. 18. '41	Venetian pink scattered with carmine tubercles of various sizes	,, ,,	,, ,,	——
E (,,) ,, ,, ,,	Venetian pink scattered with small, oblong tubercles of carmine or English-red	,, ,,	,, ,,	Plate II, fig. 3
F (,,) ,, ,, ,,	Venetian pink scattered with small, rod-shaped carmine tubercles	,, ,,	,, ,,	,, fig. 2
G (,,) ,, ,, ,,	Milky white	,, ,,	,, ,,	,, fig. 5
H (nearly perfect) July 13, '41	Venetian pink scattered with light vinaceous rufous, rod-shaped tubercles	——	——	——
I (fragmentary) ,, ,, ,,	Milky white with a very light yellowish hue, scatterd with vinaceous rufous spots	——	——	——
J (nearly perfect) July 14, '41	Mustard yellow, without spot	——	——	Plate I,
K (fragmentary) Nov. 13, '41	Mustard yellow, scattered with rather large oblong tubercles	——	——	——

* The color nomenclature is according to RIDGEWAY: Color standards and Nomenclature.

The body is very soft and fragile, but it is firm enough to enable the collector to scoop it in his hands.

The speciemens produced a quantity of mucus from the epithelium of the furrow, which became resin-like in water, exactly like the mucus of some polyclads. All the specimens were translucent and beautifully colored, showing high individual variation as shown in the table.

Size: Mr. SANADA's measurements of Specimens H, I, J, and my measurement of specimen K, are as follows (in cm.):—

Specimen	Total length from tip of arm to margin of trunk	Arm length	Trunk length	Trunk width	Arm thickness	Trunk thickness
H	11.5	6.3	5.2	9.0	3 0	4.0
I	——			8.0		
J	10.8	{5.0, 5.7 (unequal)	5.1	8.0	2.5	3.5
K	12.0					

His sketches of other specimens drawn in natural sizes show the following measurements:

Specimen	Total length	Arm length	Trunk length	Trunk length	Arm width
A	13.5	6.5	6.8	11.7	4.0
B			5.0		3.8
C	13.8	6.8	7.0	6 0(half)	4.2
D	13.3	6.7	6.6	5.8(half)	4 0

Thus it is evident that *Lyrocteis* is much larger than any of the known platyctenid.

The animal, when put in a vessel, lay flat on the bottom on one side of its body, or obliquely on the edge of the skirt, without showing any movement except for the gentle retraction and protraction of the tentacles. When the edges of the skirt were open to examine the interior of the marginal furrow, they remained for some time in that state. It is probable that the edges serve the animal the purpose of attachment, as shown in Mr. NISHIKAWA's notes and sketch reproduced on page 32, while the tentacles and arm furrows are used for capturing the prey and for transfering it to the mouth respectively. The prey are apparently small crustaceans, since half-digested remains of some of them were found in the mucus discharged from the mouth part of specimen J. *Tjalfiella* (MORTENSEN, 1912) and *Coeloplana* (KOMAI, 1922) as well as ordinary ctenophores are known to take similar kinds of food.

Some of the materials were fixed with acetic-sublimate solution (70 parts saturated aqueous sublimate solution +30 parts 95% alcohol +1.5 parts glacial acetic acid); others in BOUIN's mixture. The former fixative gave a much better result than the latter. The material, however, shrank by fixation to certain degree: for instance, specimen A became 10.7 cm. long, 5.6 cm. wide and 1 cm. thick by fixation with acetic-sublimate.

External appearances

As mentioned above, the body of the animal is lyre-shaped, consist-

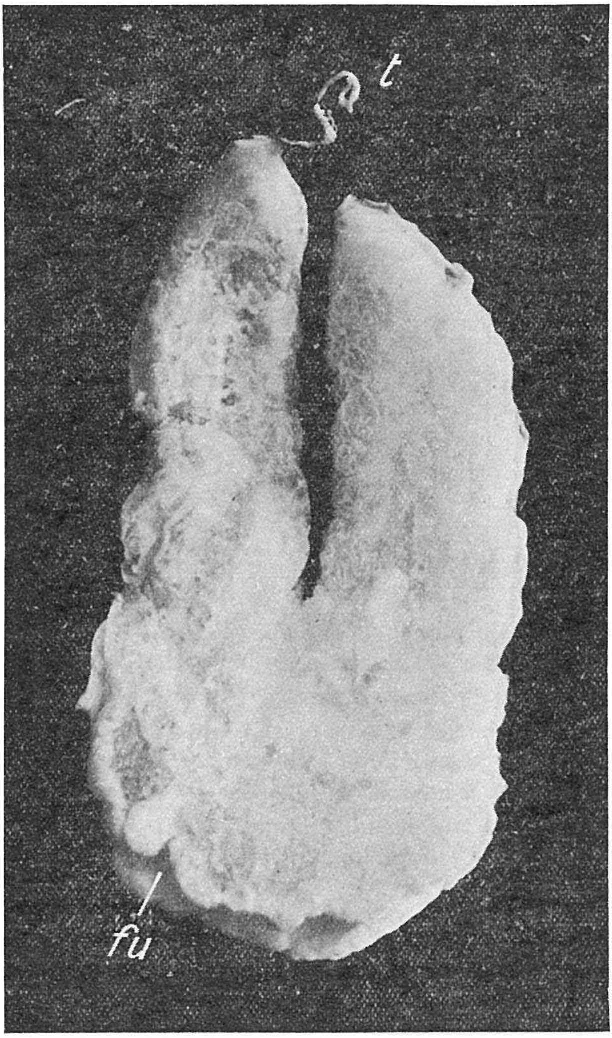

Fig. 2. Photograph of a preserved specimen (Specimen A); natural size.

ing of a saddle-shaped main part or trunk and two arm-like processes of slightly unequal lengths one on either side. This shape is due to the extension of the oral aperture of the original cydippid-like form, along the transverse axis to such a degree that both ends come up to a level much above that of the sense-organ. Thus the deep furrow (Figs. 2 and 3, *fu*) which encircles the whole body is homologous with the outer portion of the pharynx of a cydippid; consequently its inside wall corresponds with the creeping sole of *Coeloplana*.

The furrow is deepest in the middle part of the trunk, at which point it is nearly half the height of the latter, while it is one-third to two-fifths of the width of the arm. When viewed on the tentacular plane, the inner margin of the arm is nearly parallel to the main axis of the body and the outer margin is slightly convex, while the margin of the trunk, which may be called 'skirt', is broadly rounded. The whole periphery of the body, including the arm and trunk, is considerably frilled; this is especially the case with the part forming the hem of the skirt as shown in Plate I. The arm bears four longitudinal fringes on either surface, which run nearly parallel to the outer margin (Figs. 1 and 3, *fr*). Of these fringes, the outermost and innermost ones are longer than the rest, and their oral ends curve onto the part of the trunk and are broken into a series of branched papillae. It is evident that the fringes are homologous with the dorsal papillae found in many species of *Coeloplana*, and they function as respiratory organs.

In the interspaces between the first and second fringes and those between the third and fourth are found a series of closely juxtaposed, more or less pyriform bodies (Figs. 1 and 3). These are the gonads consisting of tests (*te*) and ovaries (*ov*). The former, however, appear more clearly, especially in the preserved material, because of the whitish sperm masses they contain. The gonads develop on the wall of the diverticula of the meridional canals, so that they mark the tracts of these canals. These are in the form of an inverted parabola, the portion most strongly curved being between the trunk and the arm. The testes and ovaries develop in the diverticula formed on the different sides of the canal, the testes on the interradial side and the ovaries on the perradial. To each ovary are attached one or two brood chambers (*b. c.*), each of which contains a developing embryo.

A pinnate tentacle (*t*) projects from the tip of the arm where the opening of its sheath is found. In the living specimen the tentacles were extended to a great length probably not less than 60 cm., and the whole structure was piled up on the bottom of the vessel like a conspicuous mass of vermiform bodies, according to Mr. SANADA's statement. In the preserved specimens only a small part of the tip of the tentacle projects from the opening of the sheath. The remaining part is retracted to the sheath which runs parallel to the inner margin of the arm, and may be seen through the body wall as a yellowish tract. The basal part of the tentacle

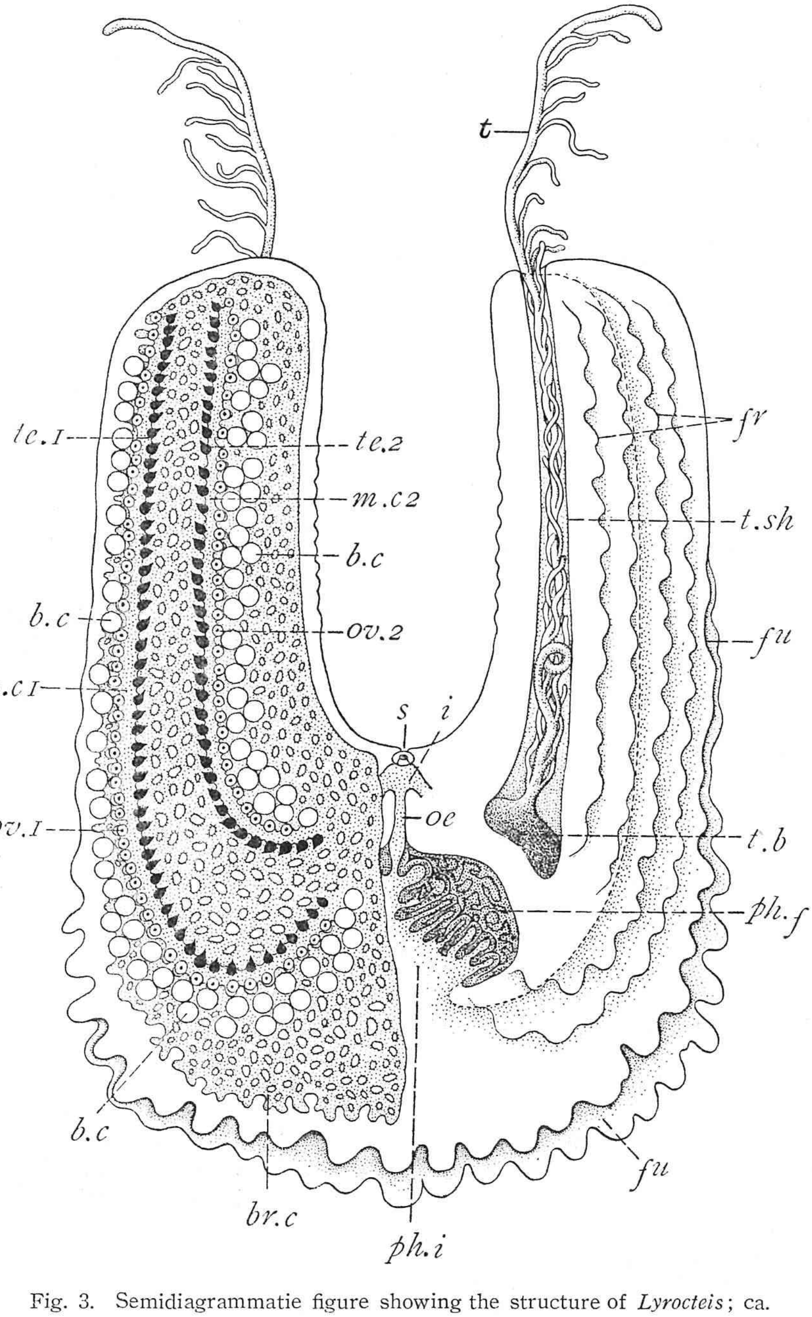

Fig. 3. Semidiagrammatie figure showing the structure of *Lyrocteis*; ca. natural size. The canal system, gonads and brood chambers are shown on the left side, the tentacular apparatus and pharyngeal folds on the right.

is found in the region between the arm and the trunk, bulging out on the surface like a tubercle in some specimens.

The lowest point of the saddle-shaped curvature of the trunk is the site of the aboral sense-organ (Fig. 3, *s*). When I wrote my preliminary report, I had been unable to confirm the presence of the organ. Mr. SANADA, however, noticed a small whitish dot at this spot (Pl. II, fig. 6), which he assumed to be the sense-organ in one of the specimens obtained in July. Subsequently, I discovered the sense-organ in sections, and its presence has since become undisputed.

The whole tissue of the body is penetrated by the fine network of gastro-vascular canals (Fig. 3, *br. c*, Fig. 8). This gives the surface a rather corrugated appearance which is enhanced by the presence of developing embryos underneath the part adjacent to the meridional canals. The skirt has ripple-like markings as shown in Pls. I and II.

Epidermis

The epidermis of *Lyrocteis* (Fig. 4. A) has the same structure as that of *Coeloplana*. It consists of gland cells and interstitial cells. The former are of two kinds, the clear (*c. g*) and the granular (*g. g*). The interstitial cells (*i. c*) are largely restricted to the deepest layer of the epidermis. Of the gland cells, the clear ones are more numerous than the granular, and are characterized by their homogeneous and basophilous contents. They vary considerably in size and appearance, a fact which is due, at least in some measure, to the difference in the stage of secretion. When filled with secretion, they appear quite swollen and clearer than in any other stage; after secretion they become more shrunken and opaque. The granular cells contain strongly eosinophilous secretory granules which vary in size to some extent. This kind of cell rarely appears swollen.

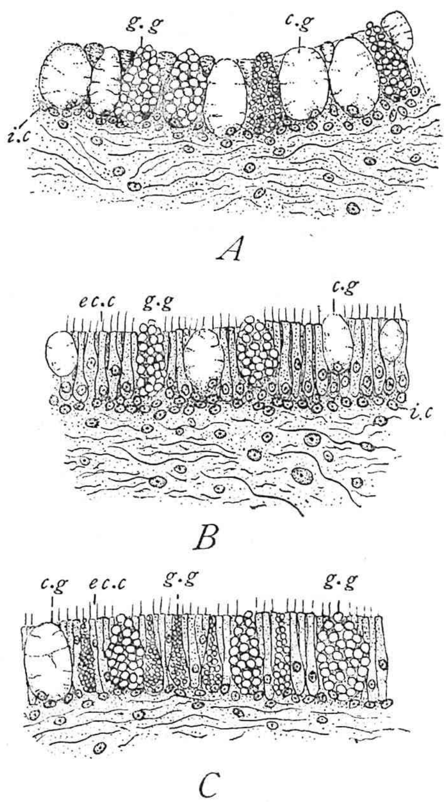

Fig. 4. A. epidermis; B. epithelium of marginal furrow; C. epithelium of pharynx. ×500.

The thickness of the epidermis is considerably varied in different parts of the body, but without being accompanied by any differentiation in structure. Only the fringes on the arms have a very thin epidermis which is almost entirely lacking in the gland cells (Fig. 9, B).

Sense-organ

The sense-organ is situated at the lowest point of the saddle-like curvature on the aboral side of the trunk (Fig. 3, *s*). Mr. SANADA's sketch of this region in the living specimen shows a whitish spot surrounded by four symmetrically disposed elevations (Pl. II, fig. 6). In section the sense-organ appears as shown in Fig. 5. It is situated at the bottom of a deep pit resulting from the shrinkage of the neighboring region. The organ is a spherical capsule whose wall is made up of tall, columnar, ciliated cells. The entrance to the capsule is closed by a bundle of long cilia which appear to be cemented together by a strongly eosinophilous substance (*do*). This ciliary bundle represents the dome of the sensory capsule found in ordinary ctenophores. The cells bearing the cilia are characterized by their clear eosinophilous cytoplasm and by their nuclei situated near the apical end of each cell. In the other regions the wall of the organ is constructed with slender cells whose nuclei are arranged in 4 or 5 layers mostly in the basal region of the wall. The cells bear short cilia. Only the cells situated

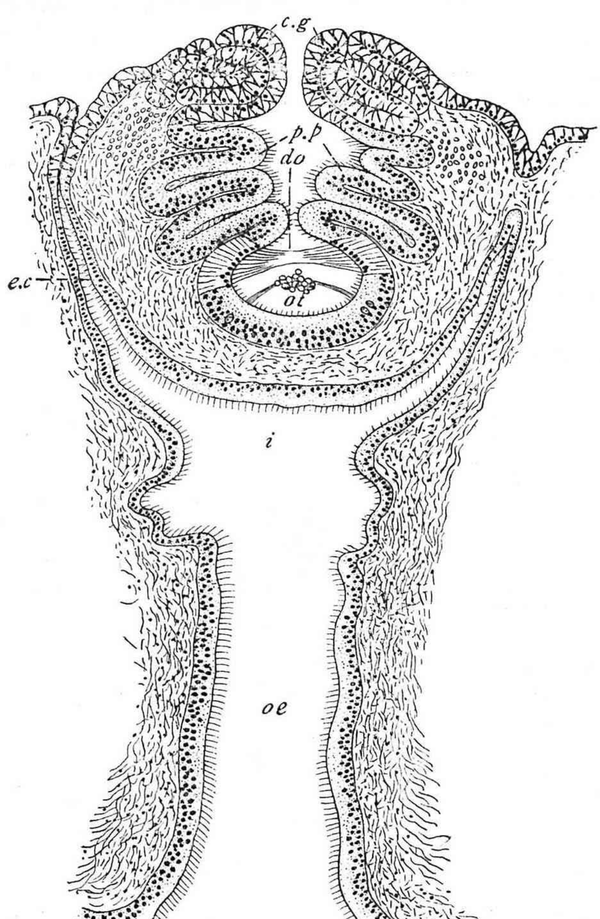

Fig. 5. Semidiagrammatic figure showing sense-organ, infundibulum and oesophagus. ×100.

near the periphery of the bottom of the capsule have very long cilia which are fused into the balancers of the otolith. The otolith (*ot*) is an aggregate of small concretions as in ordinary ctenophores.

The part of the epidermis immediately outside the sensory capsule is markedly folded, and consists of ciliated cells. This part is obviously the polar plate (*p. p*). Although the shape of the plate remains to be ascertained in a living material, the organ is perhaps a rather complicated structure like that found in the embryo of this form as well as in *Ctenoplana* and some *Coeloplana* species.

The part of the epidermis directly adjacent to the polar plate has quite a number of basophilous gland cells (*c. g*) without any intermixture of eosinophilous cells.

In short, the sense-organ is very similar to that found in *Coeloplana* and *Ctenoplana*, as well as to those in ordinary ctenophores.

Tentacular apparatus

The tentacles are the most conspicuous organs in the living specimen, as stated above. They are well-developed, and were seen extended to a length many times as long as the body. In the preserved specimens, however, they are entirely concealed in the sheath except for the apical end projected from the tip of the arm in some specimens. From the opening found here, the sheath runs nearly parallel to the inner margin of the arm

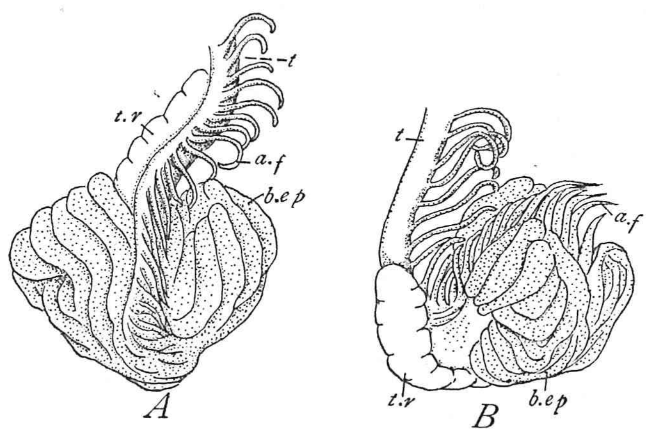

Fig. 6. Total views of tentacle base cut out of the surrounding tissues: A. view from outside, B. side view. ×8.

as far as the region between the arm and the trunk (Fig. 3, *t. sh*). The bottom of the sheath is occupied by the tentacle base which is the formative zone of the tentacle. This part is at an oblique angle to the main axis of the body (*t. b*), and consists of the tentacle root lying in the middle and the base epithelium situated on either side of it. Fig. 6 shows the whole tentacle base dissected out of the surrounding tissues. The tentacle root (*t. r*) is relatively flat and narrow, being elongated in the transverse plane; it is continuous with the tentacle stem near its aboral end.

The tentacle root is the mother tissue of the muscle fibers of the tentacle and its accessory filements. Its basal margin is roughly semicircular in the sections across its length (Pl. III, fig. 1, *t. r*). The margin is, however, much complicated by a number of invaginations and evaginations. The tentacle root consists of embryonic muscle fibers which form the core of the tentacle and its accessory filaments. The fibers of the tentacle arise from the whole periphery of the root, while those of the accessory filaments develop in the part near the oral end of the root. Those in the youngest stage stain vividly in hematoxylin, while the older fibers are much eosinophilous.

The root tapers toward both the aboral and oral directions. In these terminal parts the paired nature of the tentacle root is more apparent than in the middle part, since there the root is divided by a distinct median gelatinous septum into two symmetrical halves (Pl. III, fig. 2, *t. r*). At the oral end, the root is broken into numerous embryonic tissue blocks which are the rudiments of the accessory filaments. The filaments which arise in this region are arranged into one longitudinal row at regular intervals on the outer side of the tentacle stem (Fig. 6, *a. f.*).

Both the tentacle stem and the accessory filaments present nothing other than mentioned in my *Coeloplana* paper. The core of the stem is made up of longitudinal muscle fibers for the most part with a small quantity of gelatinous tissue inserted among them. The latter contains very small nuclei, while the fibers are devoid of them. The whole structure is divided into two lateral halves by a septal band of gelatinous tissue which is continuous with the median septum of the tentacle root mentioned above.

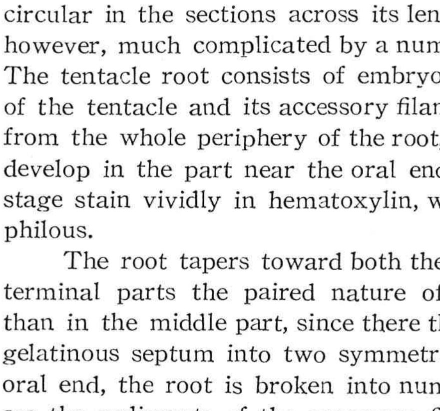

Fig. 7. Cross-section of accessory filament. ×500.

The structure of the accessory filament is shown in Fig. 7. It is made up of muscle fibers and gelatinous tissues arranged alternately. The precise mode of arrangement of these two kinds of tissues may be seen in the figure.

The base epithelium is continuous with the lining of the tentacle sheath. It is, however, highly arched, and extremely folded. The branches of the tentacular canal accompany all these folds on the ventral side. The formative zones of the epithelium exist in the margins and furrows of these folds where the tissue is very thin, compact and highly cyanophilous. From these zones the differentiating process advances posteromedially, the epithelium gradually growing thicker, more diffuse and more yellowish toward the median and posterior directions (Pl. III, fig. 2). Coming near the oral end of the base, the whole tissue is completely differentiated into colloblasts which are attached to the cores of the accessory filaments formed in the same region.

Gastro-vascular system

As mentioned above, the whole margin of the peripheral furrow of *Lyrocteis* is homologous with the margin of the oral aperture of ordinary ctenophores, and the inside of the furrow of the former corresponds with the cavity of the outer portion of the pharynx of the latter. The epithelium of the furrow is constructed with ciliated cells and some gland cells of both kinds occurring rather sparsely (Fig. 4, B). At the bottom of the furrow, around the main axis of the body, is a large opening elongate along the transverse axis (Fig. 1, B, *i. m*). This is the entrance to the inner portion of the pharynx, and may be called the inner mouth. It is guarded by two papilliform processes occurring on either corner (*s. p*). These are probably the organs of tactile or gustatory sense which guard against improper food stuff entering the inner pharynx. As far as I know, such an organ has never been described in other ctenophores.

The inner portion of the pharynx is of a depressed form, and provided with conspicuous folds on the ceiling. The folds, the homologue of the pharyngeal folds of ordinary ctenophores, are divided into four groups by a cross furrow whose arms lie on the two planes of symmetry of the body (Fig. 1, B, *ph. f*). The epithelium of the folds contain quite a number of gland cells (Fig. 4, C). The granular cells (*g. g*) especially stand out very pronouncedly in the section stained with eosin. In this staining capacity, these cells greatly exceeds those found in the epidermis; it is likely that the secretion has a chemical composition different from that of the epidermal granular cells. The mucous substance produced in large quantities by the living specimens was obviouslv the secretion of these gland cells.

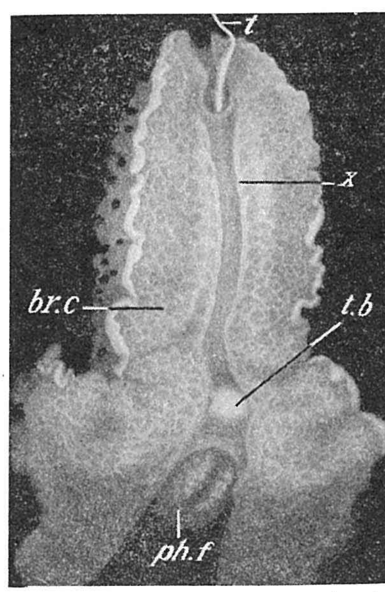

Fig. 8. Mr. SANADA's sketch of the canal system on the wall of the marginal furrow. 2/3 natural size.

At the bottom of one of the arms of the cross-furrow dividing the pharyngeal folds—that occurring in the sagittal plane—is a slit leading aborally into the oesophagus. The oesophagus (Fig. 5, *oe*) is a short and narrow passage, very much compressed in the sagittal plane; the wall is rather thick and composed exclusively of tall ciliated cells. The oesophagus communicates aborally with the infundibulum (*i*) which lies directly under the sense-organ and is shaped as suggested by its name. It is lined with a ciliated epithelium of about the same nature as that of the oesophagus, though somewhat thinner and more diffusely ciliated.

The infundibulum issues, from each of its sagittal corners, a narrow canal in the aboral direction which opens to the exterior at a point close to the sensory capsule on the sagittal plane. This is the excretory canal (*e. c*). As in *Coeloplana* and other platyctenids, there is no infundibular canal, the excretory canals starting directly from the infundibulum.

The infundibulum is the source of the whole internal canal system of *Lyrocteis* much as in other ctenophores. The mode of the branching of the main portions of the system, however, has not been thoroughly worked out. But apparently it is essentially identical with that found in *Coeloplana* and in the cydippids. The tracts of the meridional canals (Fig. 3, *m. c*) are indicated by the series of genital diverticula, as mentioned above. The peripheral part of the tentacular canal is divided into many branches (Pl. III, fig. 1, *t. c*), in exact accordance with the folding of the tentacular base epithelium, a branch of the former underlying every fold of the latter and apparently nourishing it.

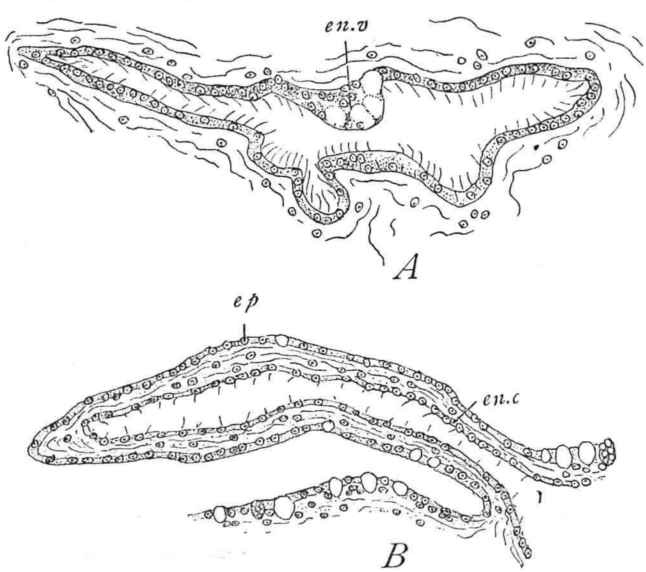

Fig. 9. A. Cross-section of meridional canal; B. cross-section of dorsal fringe. ×300.

The meridionals canals send out numerous side branches throughout their course, as shown in Fig. 3. Many of these branches are short, and develop gonads; these may be called the genital diverticula. The rest undergo further branching many times, and the branchlets profusely anastomose among themselves (*br. c*), so that the whole mesogloeal tissue is honeycombed by the network of these branchlets. The meridional canals further communicate with the above mentioned internal cavity of the superficial fringes.

In the furrow of the arm is a distinct longitudinal canal on either side of the tentacle sheath (Fig. 8 *x*); this is probably a branch of the tentacular canal. The canal issues many anastomosing branchlets (*br. c*) on the wall of the furrow.

The meridional canals (Fig. 9, A) are lined with a rather thin ciliated epithelium on all sides, except for the small median portion on the external side provided with relatively large vacuolated cells. Thus the canals are somewhat different in construction from the same canals found in *Coeloplana*, which have a tall and pallisade epithelium along the whole dorsal side. This is probably due to the fact that in *Lyrocteis* the canals serve only as passages of the fluid circulating in the canal system, whereas in *Coeloplana* they develop gonads on the dorsal wall. The genital diverticula are lined with tall and bulky cells almost on all sides. The wall on the ventral side, however, is sometimes thin and ciliated.

The tentacular canals and their branches have a large and vacuolated epithelium on the side underlying the tentacle base. The anastomosing branchlets have large cells mostly on the external side (Fig. 10, A), but sometimes on the internal side (B). The vacuolated cells very often contain food particles (*f*), which fact shows that the digestion of food is carried out principally intracellularly, as in other ctenophores.

The so-called rosette (*ro*, Fig. 11), the character-

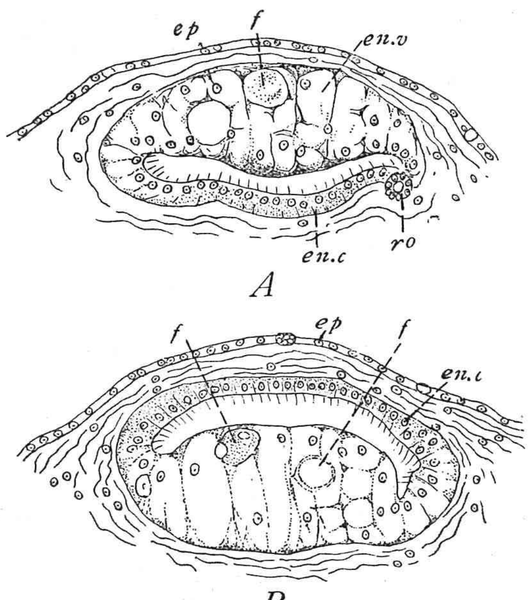

Fig. 10. Cross-section of peripheral canals: A. one with vacuolated wall on the out side; B. one with vacuolated wall on the inside. ×300.

istic cell aggregate occurring in the ctenophoran endoderm, is found in great numbers. It is exactly identical in structure with that of other ctenophores. Its peculiar structure makes it quite certain that it has some special function. The classical view of homologizing it with flame cells or the nephrostomal cell-aggregate is certainly highly suggestive.

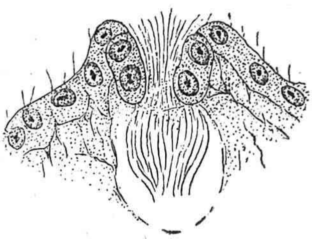

Fig. 11. Rosette. ×1000.

Mesogloeal tissue

The mesogloeal tissue has in the subepidermal region a quantity of pigment cells of two kinds. One contains brown and yellowish pigment granules which give the animal the characteristic coloration. The other is composed of minute spherules and appears milky by reflected light. The translucency of the living tissue is obviously due to the presence of this element. This cell is more irregular in shape than the ordiary pigment cell. The mesogloea further contains a quantity of fibers, in addition to a number of isolated cells (Figs. 5 and 14, *ms*). The fibers are of various lengths and thicknesses. But judging from the fact that the living animal had very limited power of movement or contraction, few of them apparently are muscular. Many of the fibers around the sense-organ, however, are probably muscular. Similarly, some muscular fibers must be contained in the tissues constructing the hem of the marginal furrow.

Gonads

Both the sperm and ova develop in the diverticula of the meridional canal, the sperm in those on the interradial side (Fig. 3, *te. 1, 2*) and the ova in those on the perradial side (*ov. 1, 2*). There are great many such diverticula for each meridional canal. Although the exact numbers are difficult to give, there are apparently more than hundred testicular diverticula for each subpharyngeal canal and more than fifty for each subtentacular canal. The ovarian diverticula may be about as many as, or somewhat fewer than, the testicular diverticula.

Testis

As shown in Fig. 12, the testes (*te*) are tuberculiform, and provided each with a short and narrow stalk (*st*) which unites them with the meridional canal. They are strongly compressed by mutual pressure so that they have rather flattened proximal and distal sides, and the external side under the epidermis is also flattened. Each testis is carved by several furrows. Many of these converge to the stalk, giving the testis a lobed appearance. The distal half of the external side is often marked with a transverse furrow which divides it into two subequal portions. Some-where near the center of this side is a tiny process which is the seminal duct (*s. d*). Some tests have two such ducts.

Section (Fig. 13) shows that the testicular diverticulum has a tall and vacuolated epithelium on nearly all sides, except on a small portion of the inner side near the stalk. The sperm cells are arranged in distinct aggregates between which are dispersed the nuclei of interstitial non-sexual cells (*i. c*). In the testes which contain elements in various developmental stages, the youngest element is found in the region around the stalk, and the cells grow gradually older with distance from the stalk. The mature

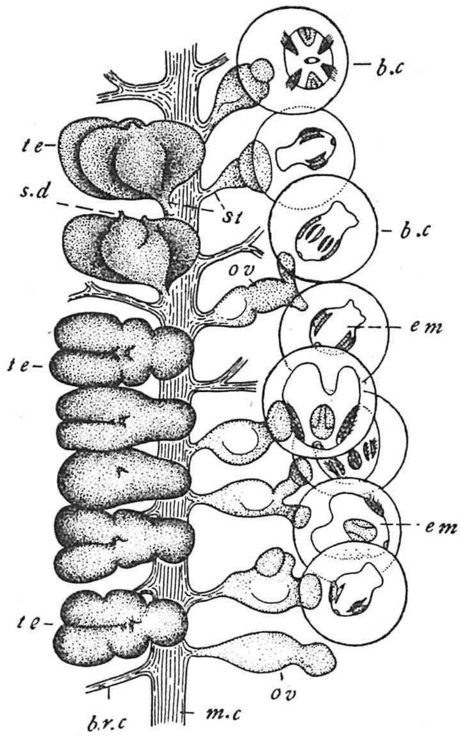

Fig. 12. A part of genital tracts cut out of surrounding tissues: meridional canal (*m. c.*) in the middle, testes (*te.*) on the left side, and ovaries (*o. v.*) and brood chambers (*b. c.*) on the right. ×8.

spermatozoa occur in the region on the opposite side of the stalk, at the base of the seminal duct (*s. d.*).

The seminal duct (Figs. 13, 14, *s. d*) is formed by low ciliated cells and has a relatively large lumen. The wall is continous with the epidermis on one side and with the testicular membrane on the other. The lumen

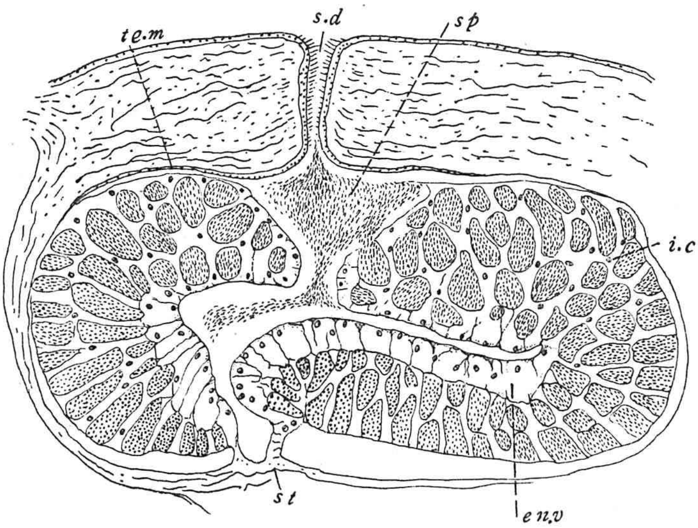

Fig. 13. Longitudial section of testis. ×100.

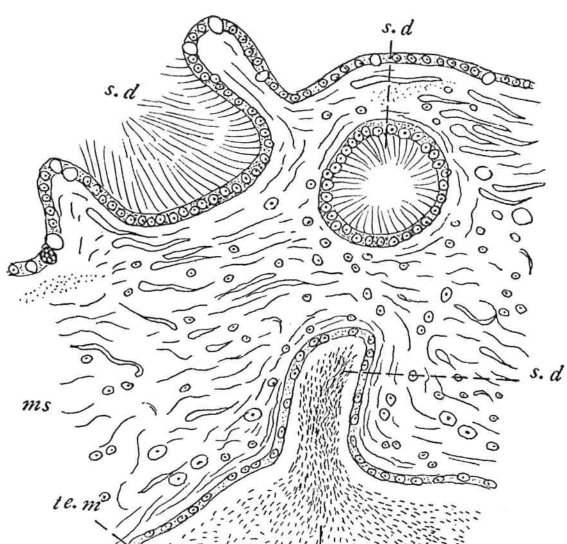

Fig. 14. Seminal duct and testicular menbrane. ×400.

grows gradually wider toward the opening which forms, on the general surface of the epidermis, a funnel-shaped depression encircled by strongly ciliated cells.

The testis is covered completely by a membrane (*te. m*), which is comparatively thick and shows nuclei at short intervals in the region at the base of the duct. It becomes thinner with distance from the duct, being reduced to an almost structureless membrane in most parts around the testis. The nearly mature testes have between the membrane and sperm-cell aggregates a wide vacancy which apparently develops by the differentiation of the sperm. The lumen of the stalk of the testis is narrow, and surrounded by a thin ciliated epithelium like that of the meridional canal.

Ovary

The ovarian diverticula (Fig. 12, *ov*) each consists of a narrow and short stalk and a rather wide main portion, so that they appear something like flower buds. Each ovary (Fig. 15) is clothed with a thick epithelium on all sides. The formative zone of the ova occurs in the vicinity of the stalk, the larger ova being found in the terminal parts of the ovarian diverticulum. The developing ovum becomes constricted away from the general surface of the ovary, and protrudes into the lumen of the diverticulum. It is completely encircled by the ovarian epithelium which becomes

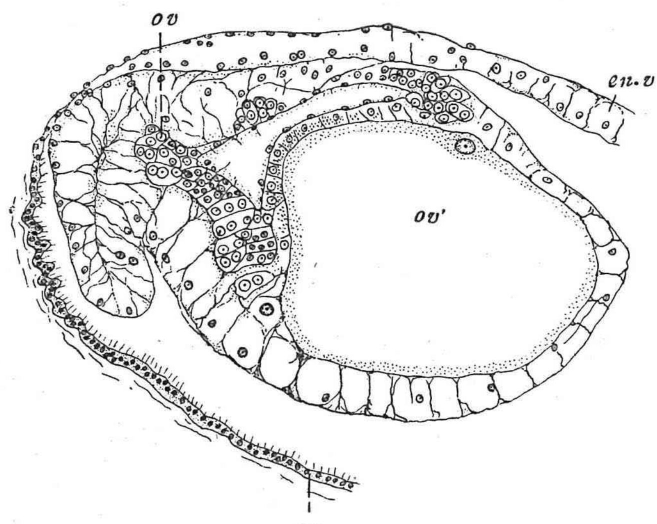

Fig. 15. Vertical section of ovary. *ov'* neary full-grown ovum. ×100.

thinner by the pressure of the developing ovum. The full-grown ovum (*ov'*) has exactly the same structure as that of *Coeloplana* and other ctenophores. It consists of a distinct exoplasm of granular appearance and an endoplasm presenting an alveolar structure. It measures 0.4—0.5 mm, in diameter, which size is about the same as that of the egg of *Beroë cucumis* and decidedly larger than that of the egg of *Coeloplana bocki* (0.25 mm).

No structure recalling the seminal receptacle in *Coeloplana* is present. How and when the ovum is fertilized is unknown. I have met with cases where some sperms are scattered in the ovarian tissue, or in the endoderm enclosing the tissue. It is thus probable that fertilization takes place in the ovary by the sperm that comes through the canal system.

Development

The development of the fertilized ova proceeds in the brood chamber (Fig. 12, *b. c*). The chamber is apparently formed by the expansion of the terminal end of the ovarian diverticulum, so that its lumen directly communicates with that of the diverticulum. The branched diverticulm often has more than one brood chamber one for each branch. The corrugated appearance of the body surface in this ctenophore is partly due to the presence of many of these chambers directly underneath.

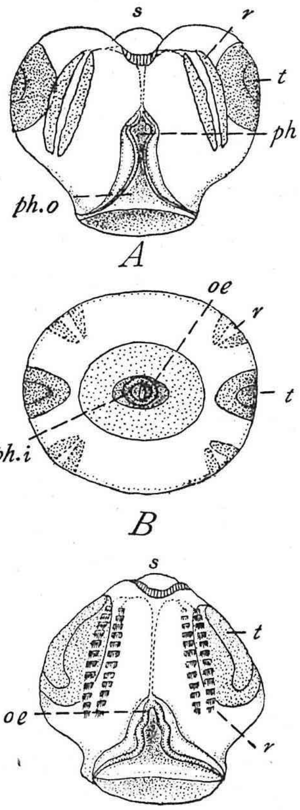

Fig. 16. Youngest embryo observed (Stage 1): A. view on transverse plane. B. oral view. C. slightly older stage. ×30.

The developing ovum is encircled by an extremely thin membrane with a wide space between. The membrane appears almost structureless, but it has flattened nuclei here and there, and it seems certain that it develops from the endoderm that clothes the ovarian ovum.

The embryos in the brood chambers of living specimens were recognized very clearly from the surface; they were rotating actively. The preserved specimens examined all contain a number of developing embryos in various stages. Even stages as young as cleavage or gastrulation could be identified. These, however, are not preserved satisfactorily so as to allow minute studies. But there is no reason to suspect that they are in any way different from the corresponding stages in the development of other ctenophores.

The youngest stage observed tolerably well (Stage 1) is shown in Fig. 16. The body is ovoid with the transverse axis slightly longer than the sagittal axis. The ribs have not been formed as yet, but their rudiments (*r*) may be recognized as four pairs of longitudinal tracts of minute granules. The rudiment of the tentacle base (*t*) appears to surface view as an oblong area situated at either end of the transverse axis; the area consists of an oval central region and a marginal region of uniform breadth. Section (Fig. 17) shows that the rudiment is a wedge-shaped depression on the epidermis, the apex of the wedge corresponding with the central region and the base with the marginal region. The apex is formed by tall cells arranged in a single layer (*t. r*), while the other parts are composed of polygonal cells piled up in 5 or 6 layers (*b. ep*).

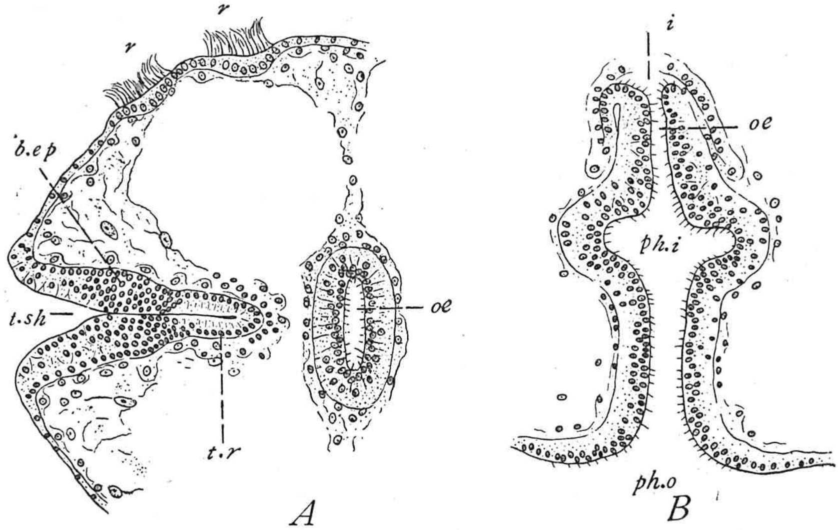

Fig. 17. Sections showing the structure of the stage in fig. 16, C; A. section across oesophagus, B. longitudinal section of oesophgus and pharynx ×150.

Obviously, the former develops into the tentacle root and the latter becomes the base epithelium. The oral aperture is oblong, its longer diameter coinciding with the transverse axis; the region around the mouth somewhat protrudes. The pharynx is barely half as long as the main axis of the body, its inner portion (Fig. 16. *ph. i*) presenting a nearly circular optical cross-section. The oesophagus (*oe*) has been differentiated from the pharynx as a short apical outgrowth, and its cavity communicates with the central endodermal cavity. The wall of both the pharynx and oesophagus is constructed of ciliated cells, with nuclei arranged in 4 or 5 layers. The rudiment of the aboral sense-organ (*s*) also has been formed. The endoderm forms four spacious sacs around the central cavity.

A slightly more advanced stage (Stage 2) (Fig. 18), has the ribs (*r*) which are rather long and each consists of 12 or 13 comb-plates bearing very short swimming cilia. The tentacle base is more elongated longitudinally than before, and the first rudiment of the tentacle appears as a small knob (B *t*). The polar plates (*p. p.*) of the sense-organ are differentiated as a pair of erect semilunar processes placed one on either sagittal side of the organ. The gape of the mouth enlarges. The pharynx is sectioned into an inner *(ph. i)* and an outer portion *(ph. o)*, though rather vaguely as yet. The two portions are compressed in different directions, the inner being wider in the sagittal direction and the outer in the transverse direction.

In the next stage (Stage 3) (Fig. 19) the cilia of the comb-plates become more elongated, and the gape of the mouth still more enlarged.

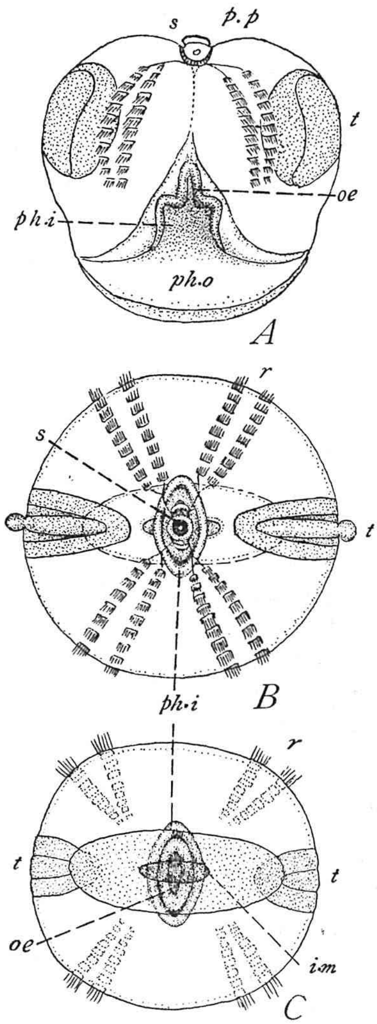

Fig. 18. Stage-2 embryo: A. view on transverse plane; B. aboral view; C. oral view ×40.

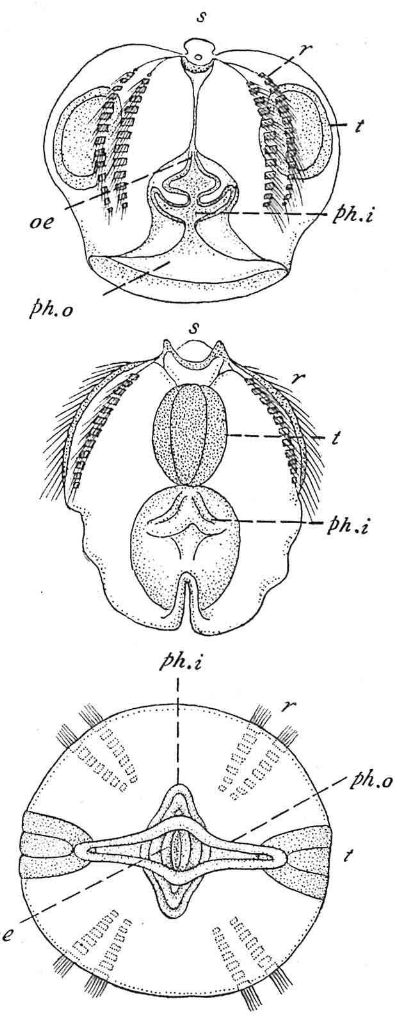

Fig. 19. Stage-3 embryo: A. view on transverse plane; B. view on sagittal plane; C. aboral view. ×40.

The wall of the inner portion of the pharynx is distinctly folded. The configuration of the pharynx in this stage may be seen in the diagrammatic figures (Fig. 20) showing the cross-sections of the organ at various levels.

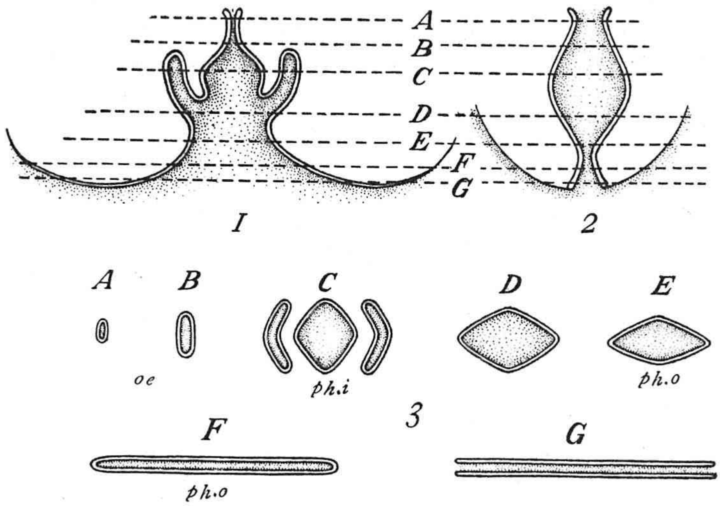

Fig. 20. Diagrammatic figures showing the configuration of pharynx in stage-3 embryo; 1. view on transverse plane; 2. view on sagittal plane; 3. cross-sections of pharynx in different levels designated in 1 and 2.

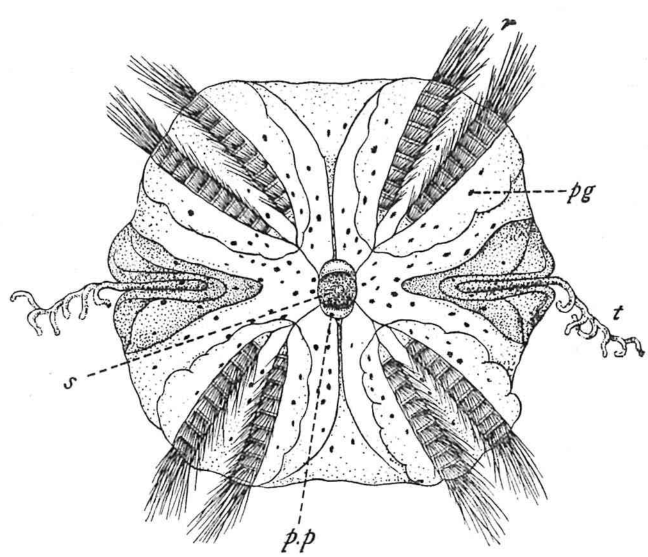

Fig. 21. A living stage-3 embryo showing pigment cells (*pg*) in the aboral region. ×50.

The living embryo of this stage has a few pigment cells scattered in the aboral regions as well as in the parts around the mouth (Fig. 21). This stage roughly corresponds with the hatching stage in *Coeloplana.*

With further development (Stage 4) (Fig. 22), the cilia of the comb become more elongated and each pair of ribs sunken somewhat below the general surface of the body. The gape of the mouth now occupies nearly half of the circumference of the embryo viewed on the transverse plane. The folding of the inner portion of the pharynx increases. The tentacles acquire a few branches.

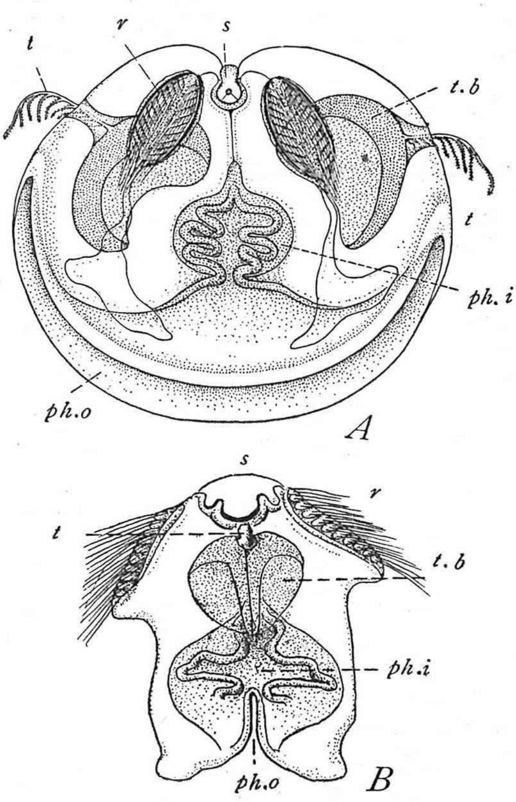

Fig. 22. Stage-4 embryo: A. view on transverse plane, B. view on sagittal plane. ×40.

Throught these changes described above, the embryo grows in size. The gastrula and the youngest embryo are both about 0.5 mm. in diameter; in the last stage described it is more than 1.0mm. and in the next stage 1.5 mm. or more. Such a growth obviously correlates with the viviparous habit of this animal. MORTENSEN (1912) recognizes similar growth in the embryo of *Tjalfiella* which is also viviparous.

The oldest embryo ready to hatch out (Stage 5) is shown in Figs. 23 and 24, Pl. II, fig. 5 and Pl. III, figs. 3 and 4. The living embryo taken out of the brood chamber creeps on the sole of the pharyngeal wall in which attitude it appears hat shaped. The pigment cells are found in greater quantity than in the preceding stage, being especially abundant in the aboral regions, on the tentacle sheaths, as well as on the skirt. The opaque pigment cells are also formed as shown in Pl. II, fig. 5.

This stage is preserved better than the younger stages, so that it allows even relatively minute histological studies. On the whole, it has all characteristic features of a ctenophore, except for the still juvenile states of the canal system and mesogloeal tissue and the lack of gonads.

The rib pair is concealed in a deep pocket-like depression. The outer margin of the polar plate is divided into about five digitiform processes (Figs. 24 and 25, *p. p*). The tentacles are of essentially the same structure as those of the adult. The outline of the inner portion of the pharynx appears roughly rectangular from the oral or aboral side (Pl. III, fig. 4) the longer diameter coinciding with the transverse axis. The wall is complexly folded, and if followed on section, it describes a meandering course,

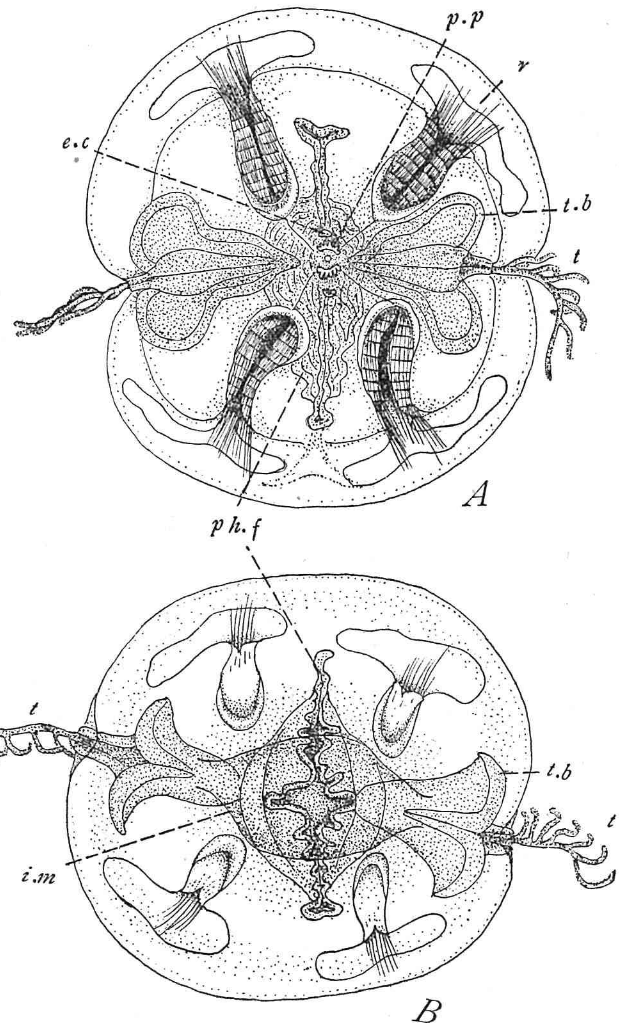

Fig. 23. Stage-5 (the oldest) embryo; with extended outer portion of pharynx: A. aboral view; B. oral view. ×40.

of which Fig. 24 and Pl. III, fig. 4 will give a general idea. The external part of the wall comprises a large number of gland cells, particularly the eosinophilous granular ones, while the internal part adjacent to the oesophagus is largely constructed of ciliated cells.

The peripheral endodermal cavity is still essentially in the state of broad sacs, except for some branch canalicules that have been differentiated. The distinction between the vacuolated and ciliated parts of the endoderm, however, is already clear, especially in the region underlying the tentacle base. There are even rosettes, though these are still few in number. The mesogloeal tissue is very diffuse compared with that of the adult, having few fibrous elements.

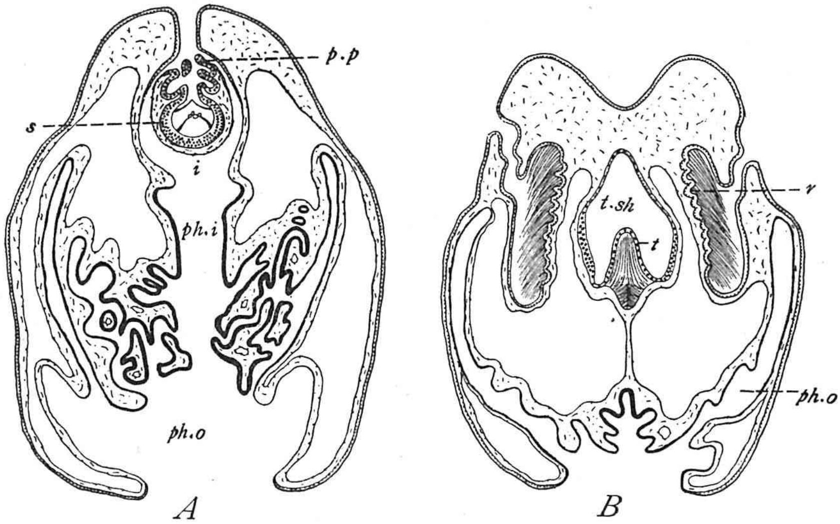

Fig. 24. Sections of a stage-5 embryo: A. section on sagittal plane; B. section on a plane parallel to sagittal plane including two ribs and tentacle base. ×40.

The embryos escape from the mother animal by piercing its tissue, leaving many small holes behind on the body surface.

As no specimen of the young stage after the liberation was available, the changes undergone during this period remain to be elucidated. But the following presumption is probably not far from the truth. The larva will swim about with its ribs for some time, then sink on the bottom. The combs will be lost, and the body will change gradually into the definitive lyre-shape. This will be brought about chiefly by the extension of the mouth along the transverse axis and the bending of the axis into U-shape, which brings the corners of the mouth high above the level of the sense-organ to include the opening of the tentacle sheath. Thus the original mouth will become the marginal furrow whose middle part serves as an attachment to a foreign body, while the more distal parts are used to transport food to the inner mouth. Meanwhile, the endodermal sacs will develop into the complicated canal system, and the gonads appear in the diverticula of the meridional canals. The mesogloeal tissue will become more compact by the development of fibrous elements.

Systematic position

Thus *Lyrocteis* obviously rsesembles both *Coeloplana* and *Tjalfiella*. It is more like *Tjalfiella* in its general shape, but in the organization of the body it is closer to *Coeloplana*. The pinnate tentacles, the digitiform processes of the polar plates, the well-developed meridional canals, the anastomosing peripheral canals and the compact testes provided with a seminal duct are common features of *Lyrocteis* and *Coeloplana* which distinguish them from *Tjalfiella* (Fig. 26).

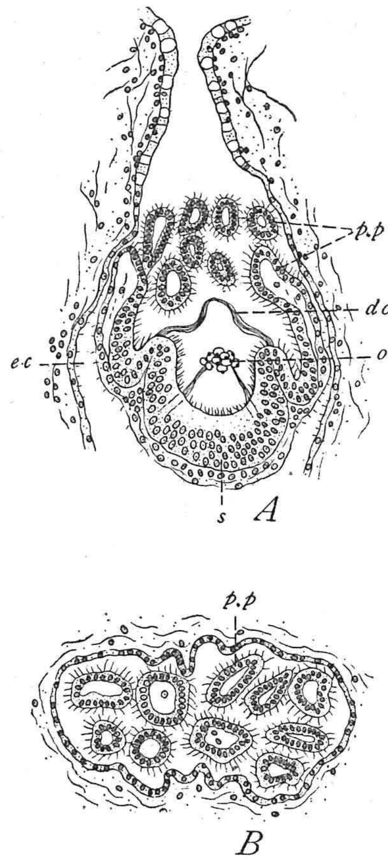

Fig. 25. Sections of aboral sense-organ of stage-5 embryo: A. section on sagittal plane; B. horizontal section of the processes of polar plates. ×250.

But *Lyrocteis*, when compared with *Coeloplana*, is much larger in size and considerably different in shape. The characteristic lyre-shape, as stated above, is due to the great extension of the oral aperture along the transverse axis and the bending of the axis into U-shape. One of the *Coeloplana*-species, *C. sophiae*, described by DAWYDOFF (1938), has a distinct furrow along the transverse axis between the inner mouth and the tentacle sheath on the creeping sole. This furrow reminds us highly of the marginal furrow in *Lyrocteis*. The meridional canals are sterile in *Lyrocteis* unlike in *Coeloplana*, and gonads develop in the diverticula of the canals. The seminal receptaces, of which *Coeloplana* has many along each ovarian tract, are entirely missing in *Lyrocteis*. Thus it is certain that *Lyrocteis* shows the closest affinity to *Coeloplana*, but at the same time has distinctive features which are probably sufficient to make it a representative of a new family *Lyroctenidae*.

A diagnosis of the genus *Lyrocteis* may be set forth as follows:–

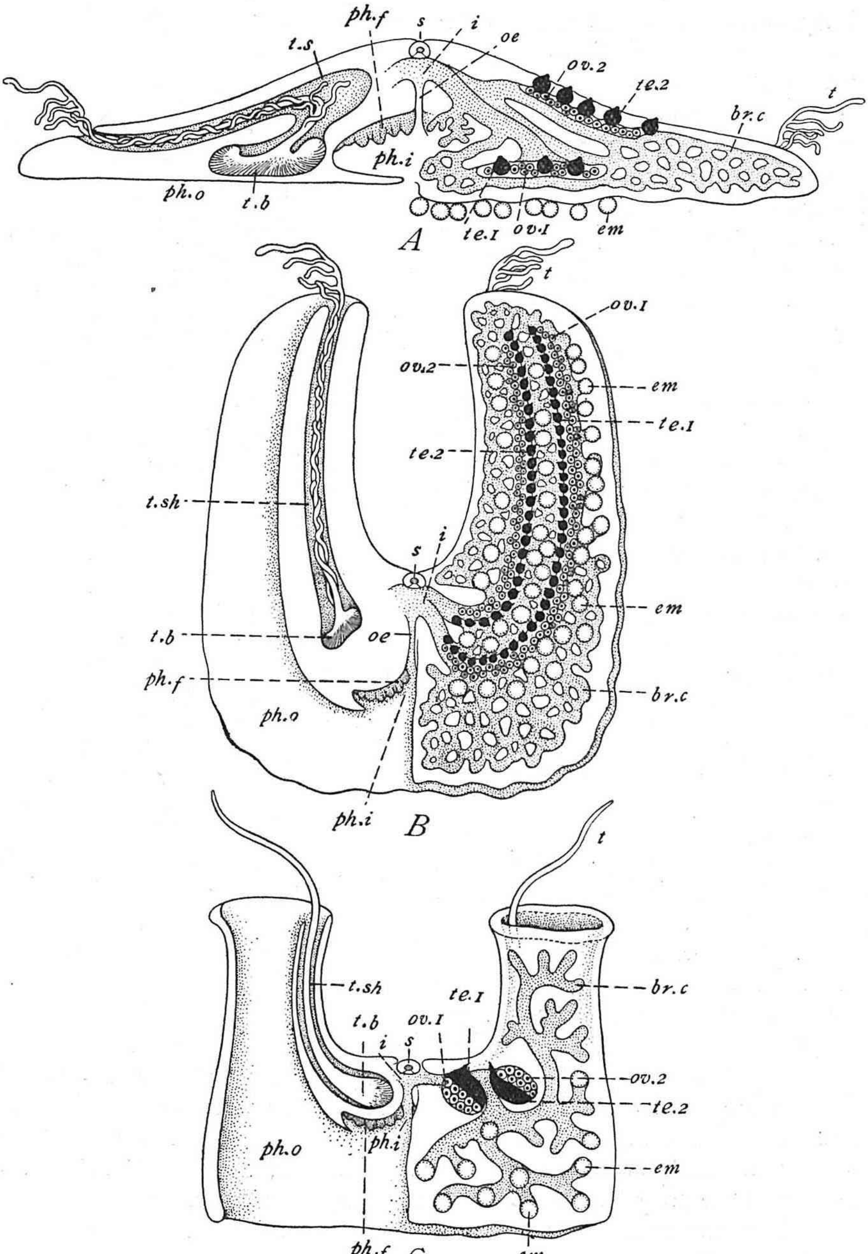

Fig. 26. Diagrammatic figures showing the structures of *Coeloplana* (A), *Lyrocteis* (B) and *Tjalfiella* (C), with tentacles and pharynx in the left half, and canal systems, gonads and embryos in the right.

Sessile, size enormous for a platyctenid, body lyre-shaped, strongly compressed, and circumscribed by a deep marginal furrow—the homologue of mouth aperture; beautifully colored; comb-plates absent, tentacle pinnate, and its sheath opens in the marginal furrow at the tip of arm-like process; meridional canals well developed, peripheral canals form network; gonads develop in numerous diverticula of meridional canals, each testis provided with a duct opening to the exterior; viviparous, cydippid embryo develops in the brood chamber formed at the end of ovarian diverticulum.

Remarks

As stated above, Mr. NISHIKAWA's notes on, and sketches of the 'curious animal' published in the August 1896 Number of Dobutugaku-Zassi undoubtedly refer to another specimen of this sessile ctenophore caught 45 years ago in the same Sagami Bay. The sketches are reproduced in Fig. 27. The translation of the full text follows, while the correct interpretations of the accounts are given in the foot-notes. "A Curious Animal" "In the following paragraphs I shall briefly describe a curious animal which was caught with a dabo (long) line by the collecting yacht 'Golden Hind'[1] on the fifth of this month in Sagami Sea at the spot Nagamori-line×Mera 2 line.[2] Everybody on board was impressed by its peculiarity. The animal had a translucent and soft body, very sluggish, flattened, rectangular, and was provided with a large posterior indentation by which the part of the body was divided into two large parallel processes.[3] It measured 15 cm. long, 7.2 cm. wide and 2.5 cm. thick; the processes occupied nearly two-thirds of the length. In the middle of the front side occurs a mouth opening[4] which is surrounded by four groups of oral papillae.[5] On each side of the latter is found a lip-like process, of which the one on the left side is vaguely divided into two.[6] On the outer side of the process is a wide furrow which runs along the peripheral margin of the process to its extermity.[7] A small opening occurs at the distal end of the furrow.[8] When the animal was alive, the margins of the furrow were tightly closed together and the furrow could be seen only by opening the margins by force. The dorsal and ventral margins of the furrow on the front side are very large and have extremely wavy edges.

"Both the dorsal and ventral surfaces[9] are scattered with numerous

1. The collecting yacht owned by Mr ALAN OWSTON.
2. A place 35 km. south-east from the spot where the present material was obtained.
3. The arms.
4. Inner mouth.
5. Pharyngeal folds.
6. Sensory papillae.
7. Marginal furrow.
8. The opening of the tentacle sheath.
9. There is no such distinction.

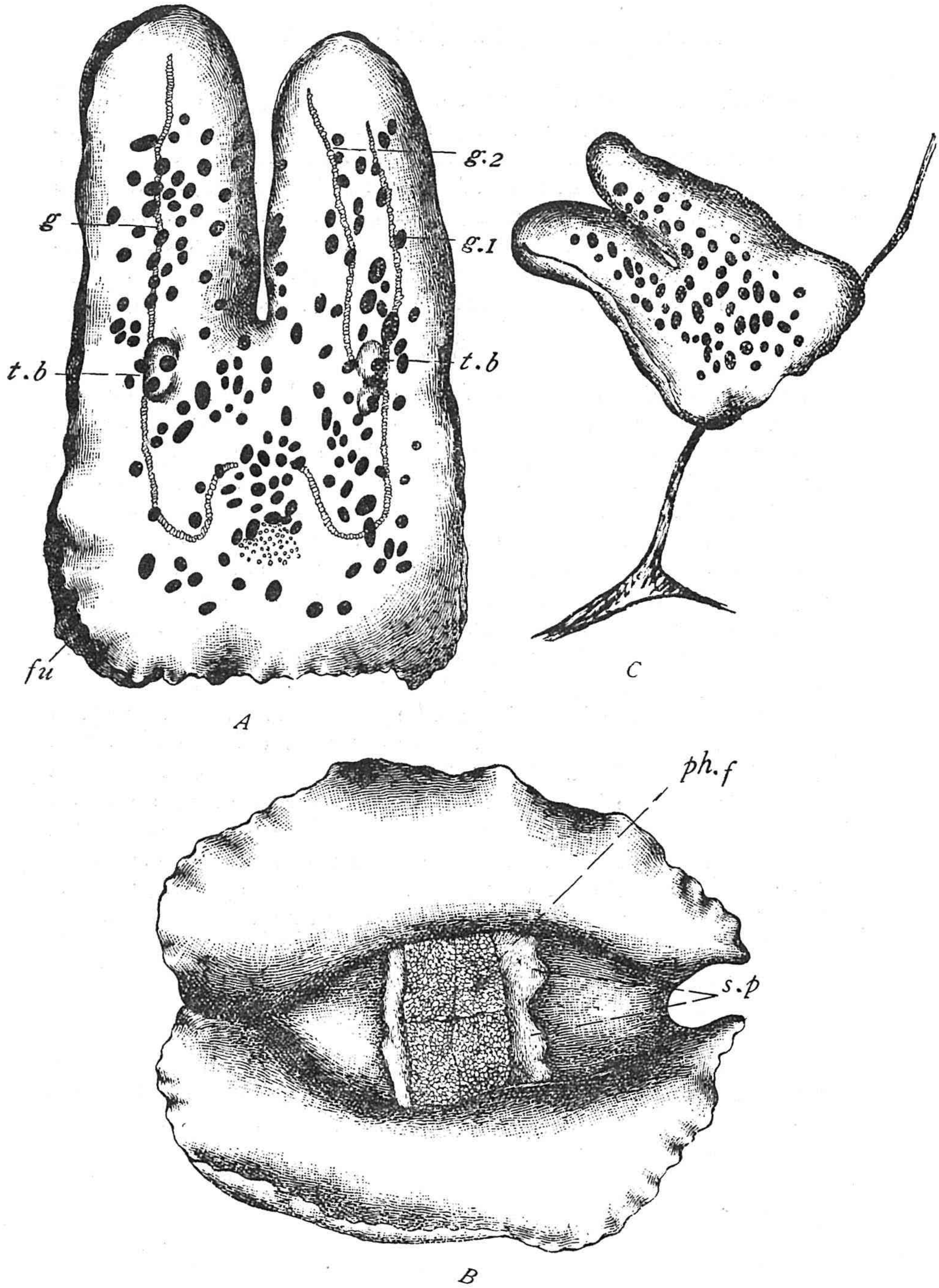

Fig. 27. Reproduction of Mr. NISHIKAWA's figures of the specimen of *Lyrocteis* obtained in 1896: A. total view; B. view of oral regions exposed by opening vental furrow; C. sketch of the specimen while attached to a gorgonid (?), A. B. natural size, C. somewhat reduced. Legends my own.

dark-brown patches, round or oblong and of various sizes, of which the largest ones measure 6 mm. On both the dorsal and ventral surfaces, lines consisting of a series of whitish masses show through; there are two such lines on the left side and one on the right. They are presumably the gonoducts.[10] Near the center on the dorsal surface occur flat processes, one on the right side and two on the left.[11] Besides, there is an aggregate of minute granules at the anterior end of the median line which distinguishes this as the dorsal side.

"When this animal was caught with the dabo line, it was firmly attached to the stem of a gorgonid by its anterior processes, only to be detached after nearly an hour. There was much discussion about the nature of the animal among the members on board. Some maintained it was an ascidian, others took it to be a nudibranch, still others wondered if it did not belong to the Holothuroidea; there was even a joke that it represented a new subkingdom! We had few books for consultation on board the yacht, and we were unable to carry out any detailed study of the specimen. When the animal was detached from the substratum, however, the ascidian theory vanished, and the nudibranch theory became prevalent. But, since the animal had neither gill (if the oral papillae were not the gill) nor anus, it is very difficult to decide to which family of the Nudibranchiata the animal should be referred".

It should be pointed out that the above description gives valuable information on the presumably natural habit of the animal—that the specimen was firmly attached to the stalk of a gorgonid by the edges of the ventral furrow. Fig. 27 C also clearly illustrates this posture of the specimen. Another point worth mentioning is that the specimen had a coloration different from any of the newly caught individuals. Although it apparently belonged to the type having color patches or tubercles, these were dark-brown, while the recent specimens all had crimson tubercles.

Summary

1. *Lyrocteis imperatoris* KOMAI is a new sessile ctenophore recently discovered from a depth of 70 m. in Sagami Sea. It is lyre-shaped, and very large for a platyctenid. The living specimens are illustrated in Pls. VII and VIII, and the structure is shown diagrammatically in Fig. 3.

2. The external margin of the body is encircled by a deep furrow whose cavity is homologous with the outer portion of the pharynx. The inner portion of the pharynx has an excessively folded wall, which comprises quite a number of gland cells.

3. The sense-organ is situated at the lowest point of the saddle-shaped curvature of the trunk; its structure is shown in Fig. 5. It is of the

10. Series of gonads.
11. The retracted tentacles.

type characteristic to the ctenophore. The polar plate is of a complex shape.

4. The tentacles are pinnate and well-developed; the tentacle sheath lies parallel to the margin of the arm-like process and has the opening in the marginal furrow at the tip of the arm. The structure of the tentacle is described in detail.

5. The configuration of the main part of the canal system is essentially the same as in the cydippid. The meridional canals are well developed. The peripheral canal branches anastomose among themselves. The endodermal wall is differentiated into thin ciliated and thick vacuolated parts. The meridional canals are lined all over with a ciliated endoderm unlike other ctenophores. Rosettes are found in large numbers in the ciliated parts of the wall of the canals.

6. Both testes and ovaries develop in the serial diverticula of meridional canals, the testes in those on the interradial side, and the ovaries in those on the perradial side. There are many of both. The testes are tuberculiform each provided with a seminal duct. The ovarian diverticula are shaped somewhat like flower buds (Fig. 12). The internal structures of both testes and ovaries are identical with those of ordinary ctenophores.

7. The embryo develops in the brood chamber formed at the distal extremity of the ovarian diverticulum. The successive developmental stages are described. An especially noteworthy fact is that, with development, the oral aperture is enlarged considerably in the transverse direction to occupy nearly half of the entire circumference of the body in the advanced stage of the embryo. Meanwhile the wall of the inner portion of the pharynx becomes complexly folded.

8. The systematic position of *Lyrocteis* is discussed. The genus is situated between *Coeloplana* and *Tjalfiella*, but has a closer affinity to the former than to the latter. The diagnosis of the genus is given.

9. Reference is made to the old record of the capture of a specimen of this animal in Dobutugaku-Zassi (Zoological Magazine). The original sketches are reproduced in Fig. 27, the translation of the full text is given in pp. 31–33.

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List of abbreviations used in textfigures and Plate IX

a. f . . . . . accessory filaments of tentacle.
a. f' . . . . . embryonic accessory filaments.
b. c . . . . . brood chamber.
b. ep . . . . . base epithelium.
br. c . . . . . branching canalicules.
c. g . . . . . clear gland-cell.
co . . . . . colloblast.
do . . . . . dome of sensory capsule.
e. c . . . . . excretory canal.
ec. c . . . . . ciliated cell in ectoderm.
em . . . . . developing embryo in brood chamber.
en. c . . . . . ciliated cell in endoderm.
en. v . . . . . vacuolated cell in endoderm.
ep . . . . . epidermis.
f . . . . . food particle in endodermal cell.
fr . . . . . fringe on arm.
fu . . . . . marginal furrow.
g . . . . . genital tract.
g. 1 . . . . . genital tract along subpharyngeal canal.
g. 2 . . . . . genital tract along subtentacular canal.
g. g . . . . . granular gland cell.
i . . . . . infundibulum.
i. m . . . . . inner mouth.
ms . . . . . mesogloeal tissue.

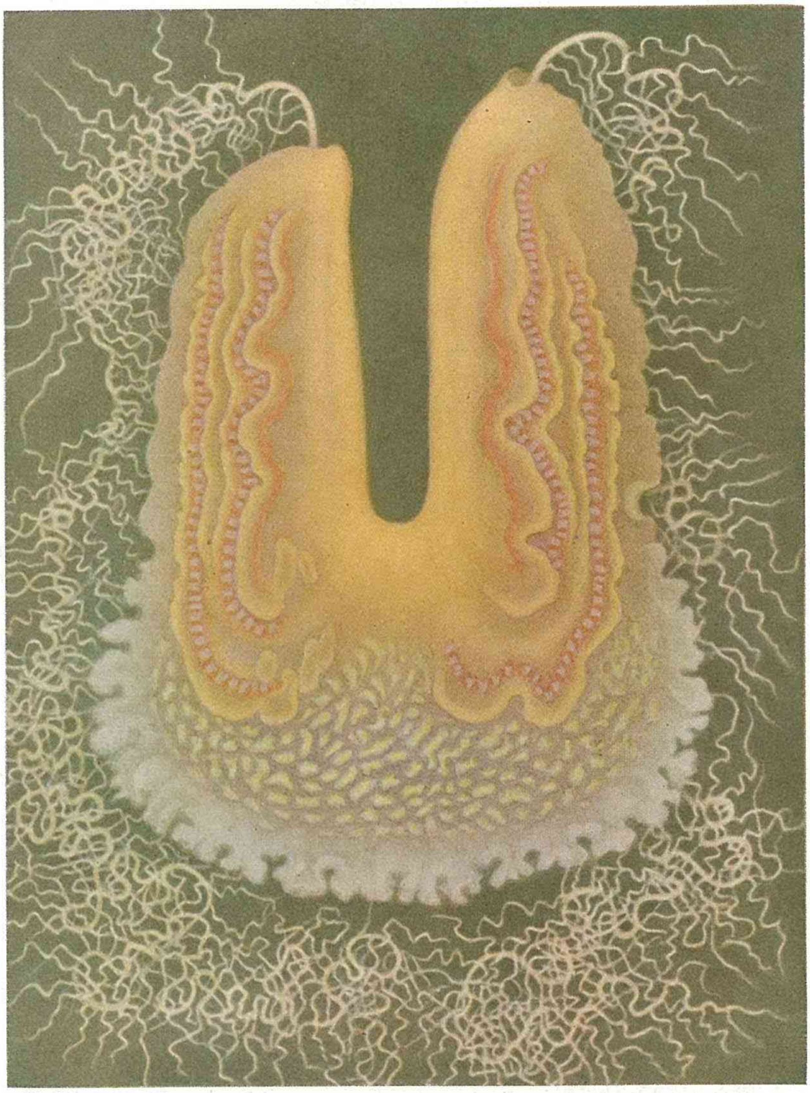
oe	oesophagus.
ot	otolith.
ov	ovary.
ov. 1	ovarian tract along subpharyngeal canal.
ov. 2	ovarian tract along subtentacular canal.
pg.	pigment cell.
ph. f	pharyngeal folds.
ph. i	inner portion of pharynx.
ph. o	outer portion of pharynx.
p. p	polar plate.
r	rib.
ro	rosette.
s	sensory capsule.
s. d	seminal duct.
sp	sperm mass.
s. p	sensory papilla.
st	stalk of testis or ovary.
t	tentacle.
t. b	tentacle base.
t. c	tentacular canal.
te	testis.
te. 1	testicular tract along subpharyngeal canal.
te. 2	testicular tract along subtentacular canal.
te. m	testicular membrane.
t. r	tentacle root.
t. sh	tentacle sheath.

Explanation of Plates I—III

Plate I. A perfect living specimen (Specimen J) with both tentacles protruded: drawn by Mr. H. SANADA. ×I.

Plate II. fig. 1. Half of Specimen C. ×1.
fig. 2. A part of skirt of Specimen F. ×1.
fig. 3. A part of skirt of Specimen E. ×1.
fig. 4. A part of skirt of Specimen B. ×1.
fig. 5. A part of skirt of Specimen G. ×1.
fig. 6. Region of aboral sense-organ of Specimen J. ×15.
fig. 7. An oldest-stage embryo taken out of brood chamber in creeping attitude, view from aboral pole. ×50.
(figs. 1–4. drawn by Mr. H. SANADA, fig. 5. drawn by Mr. Y. MAKINO from theauthor's sketch)

Plate III. Microphotos. ×30.
figs. 1 and 2. Sections across tenacle base of adult:
fig. 1. at the level of tentacle stem, showing to the tentacle root and stem; fig. 2. at the level near the oral end the tentacle root, showing the folded base epithelium.
figs. 3 and 4. Horizontal sections of oldest-stage embryo: figs. 3. at the level of sense-organ, fig. 4. at the level of pharyngeal folds.



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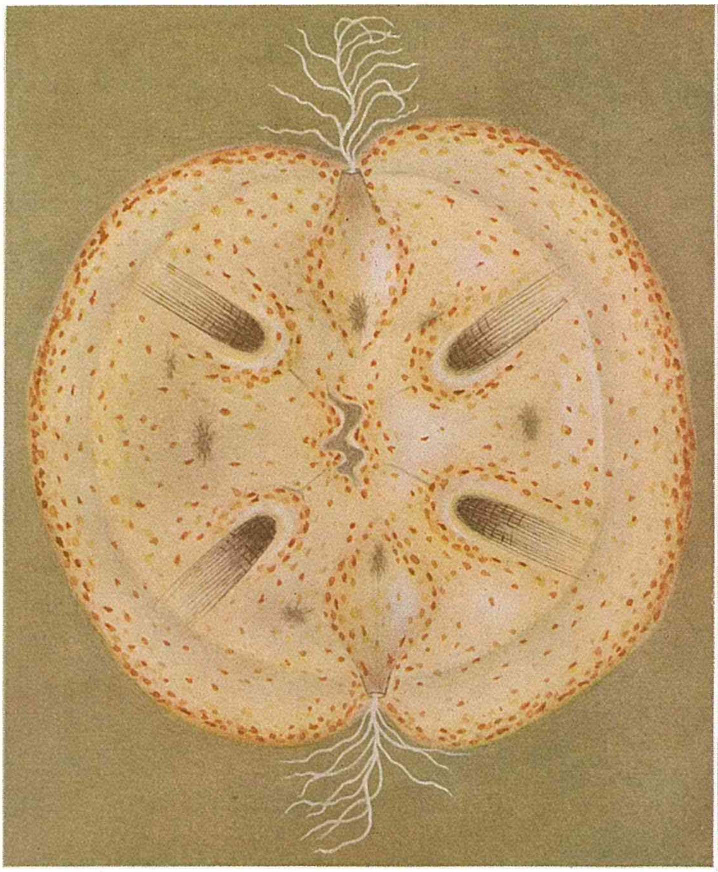

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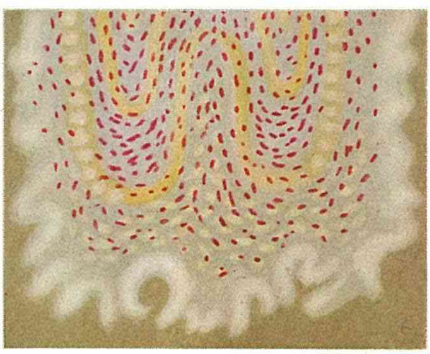

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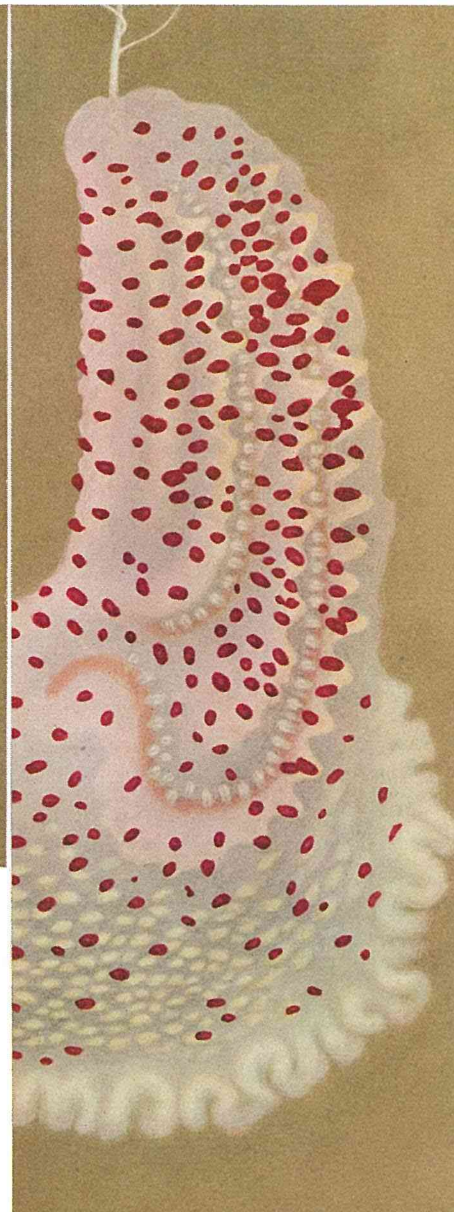

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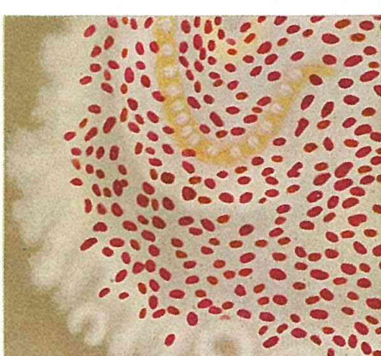

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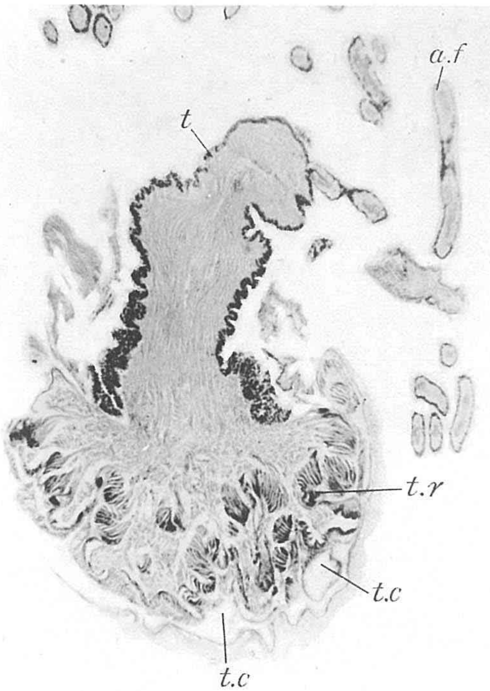
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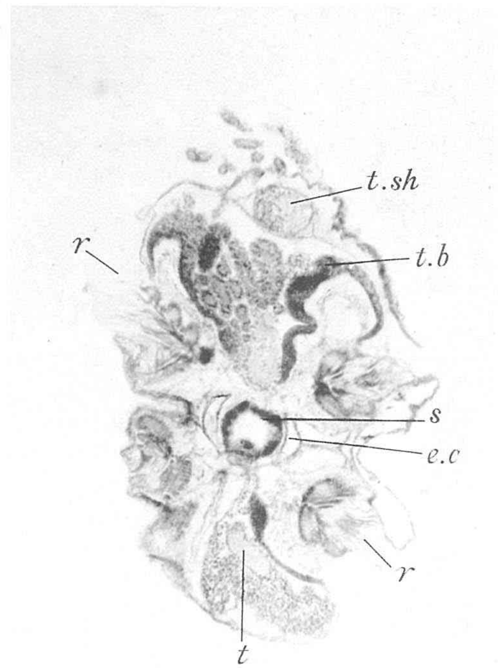
t.c

1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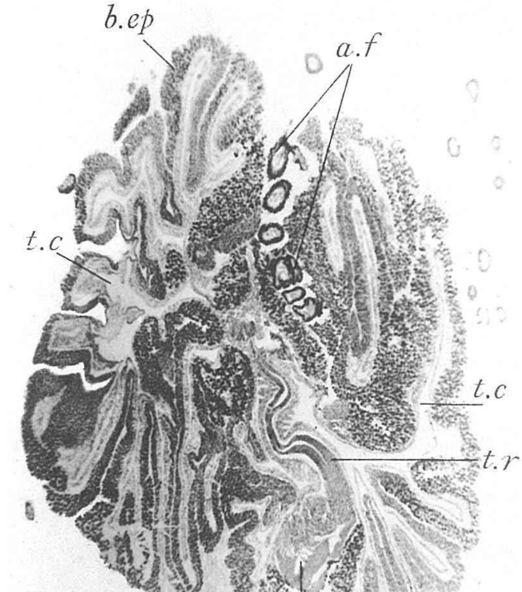
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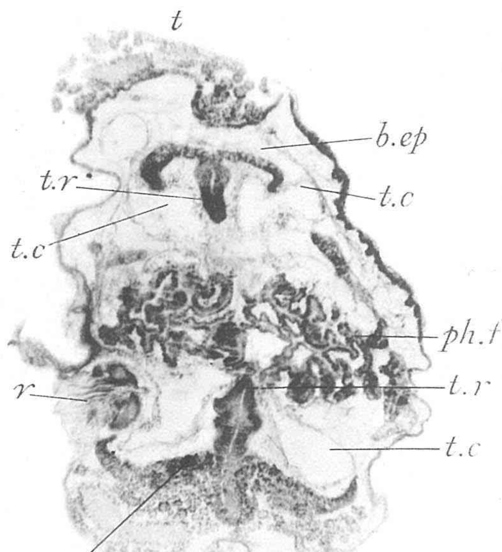
2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