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ZOOLOGICAL RESULTS OF A TOUR IN THE FAR EAST.

POLYZOA ENTOPROCTA AND CTENOSTOMATA.

*By* N. ANNANDALE, *D.Sc., F.A.S.B.*

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# ZOOLOGICAL RESULTS OF A TOUR IN THE FAR EAST.

## POLYZOA ENTOPROCTA AND CTENOSTOMATA.

(Plate I; plate II, figs. I, 1a.)

By N. ANNANDALE, D.Sc., F.A.S.B. (*Zoological Survey of India*).

The Polyzoa discussed or described in this paper are all from fresh or brackish water. The majority are from the Talé Sap in the north-eastern part of the Malay Peninsula, but a few come from the Tai-Hu in the Kiangsu Province of China. I have also included notes on one Indian form. The following species are to be considered:—

### ENTOPROCTA.

*Chitaspis athleticus*, gen. et sp. nov., from the Talé Sap.

### CTENOSTOMATA.

*Alcyonidium mytili*, Dalyell, from Indian estuaries, etc.

*Triticella pedicellata* (Alder), from the Talé Sap.

*Bowerbankia caudata*, Hincks, from the Talé Sap and Perak.

*Paludicella elongata*, Leidy, from the Tai-Hu.

*Paludicella pentagonalis*, sp. nov., from the Talé Sap.

*Victorella bengalensis*, Annandale, from the Talé Sap.

*Hislopia cambodgiensis* (Jullien), from the Tai-Hu.

*Hislopia malayensis*, sp. nov., from Jalor in the Malay Peninsula.

It will be as well to defer consideration of the biology and distribution of these species until I have been able to deal systematically with the Phylactolaemata and Cheilostomata collected on my tour. All that need be said here is that while the species of *Paludicella* and *Hislopia* are from fresh water, the others on the list are from brackish water.

### ENTOPROCTA.

The only species of Entoproctous Polyzoan represented in my collection was found in brackish water in the Talé Sap on the Gulf of Siam. It represents an undescribed species and genus of the family Urnatellidae.

I take this opportunity to state that my identification<sup>1</sup> of a species of *Barentsia* from the Mutlah R. in the Gangetic delta as *B. discreta* (Busk) was incorrect. The

<sup>1</sup> Annandale, *Rec. Ind. Mus.* VII, p. 205 (1912).

specimens represent *B. gracilis*<sup>1</sup> (Sars), as is apparent from Harmer's detailed description and figures.

#### Family URNATELLIDAE.

1915. Annandale, *Mem. Ind. Mus.* V, p. 127.

In the paper cited I discussed the limits of this family, which I restricted provisionally to the genera *Urnatella*, Leidy and *Loxosomatoides*, Annandale. The discovery of a new genus that is evidently allied closely to the latter but yet has certain affinities with *Myosoma*, Robertson, makes it at any rate probable that *Myosoma* should also be included. The following key shows the more striking differences between these genera:—

- I. Stalk segmented, each segment heavily chitinized and capable of functioning as a resting bud .. .. . *Urnatella*.
- II. Stalk not segmented.
  - A. Aboral surface of both stalk and capitulum bearing scattered chitinous spines; no chitinous shield on capitulum. Muscles of stalk entering capitulum .. .. . *Myosoma*.
  - B. A chitinous shield, sometimes spiniferous, on aboral surface of capitulum only.
    - 1. Muscles of stalk nearly straight, completely surrounding it, not entering capitulum .. .. . *Loxosomatoides*.
    - 2. Muscles of stalk directed downwards and outwards from the capitulum, confined to oral and lateral surfaces of the stalk, meeting in the lower part of the capitulum with well-defined oblique capitular muscle-bands at an angle .. *Chitaspis* (nov.)

With the exception of *Myosoma*,<sup>2</sup> the species of these genera have been found only in fresh or brackish water. *Urnatella* is fluviatile and is only known from the neighbourhood of Philadelphia, U.S.A. Two species of *Loxosomatoides*<sup>3</sup> occur in lagoons and deltaic tracts on the east coast of India, while the new genus *Chitaspis* is represented by a species from a lagoon connected with the Gulf of Siam. *Myosoma* was described from a species found in the sea on the Pacific Coast of North America.

#### *Chitaspis*, gen. nov.

This genus consists of Urnatellidae with unsegmented stalks and capitular shields like those of *Loxosomatoides*. The muscles of the stalk, however, emerge from the capitulum; they are directed outwards and downwards and are confined

<sup>1</sup> See Harmer, *Siboga-Exp.*, mon. XXVIIIa, p. 27 (1915).

<sup>2</sup> Robertson, *Proc. California Acad. Sci. (Zool.)* II (3), p. 324 (1900).

<sup>3</sup> Annandale, *Rec. Ind. Mus.* II, p. 14 (1908) and *Mem. Ind. Mus.* V, p. 128 (1915).

to the oral and lateral surfaces of the stalk; within the capitulum they meet at an angle with a pair of well-defined oblique muscular bands on each side.

TYPE-SPECIES.—*Chitaspis athleticus*, sp. nov., from the Talé Sap, Gulf of Siam.

Closely allied as is the type-species to *Loxosomatoides*, the arrangement of its musculature is so conspicuously different that a new genus is necessary for its reception. In this point it is different from all other Entoprocta as yet known. In *Myosoma* the muscles of the stalk emerge from the capitulum in much the same way, but the oblique body-muscles are much less highly differentiated.<sup>1</sup> In the resting buds of *Urnatella*<sup>2</sup> and *Loxosomatoides*<sup>3</sup> oblique strands of muscles occur, but no such structures have been detected in the normal capitulum. The body-muscles described by Ehlers<sup>4</sup> in *Barentsia* (*Ascopodaria*) are by no means highly specialized and the stalk-muscles do not enter the capitulum. The *Loxosomatidae* are so different in other respects that no confusion is possible and discussion as to resemblances and differences in the musculature is unnecessary here.

### *Chitaspis athleticus*, sp. nov.

(Pl. I, fig. 1.)

*Colony.* In the type-specimens the colony consists of a segmented, entirely adherent stolon that branches sparingly on the surface of a stone and gives rise at considerable intervals to single upright polyps. Polypiferous and non-polypiferous segments alternate with some regularity, the latter being by far the longer of the two. The lateral branches are given off, as a rule singly, from polypiferous segments of the stolon. The stolon is flattened below and evenly arched above; it varies somewhat in diameter, but does not exceed 0.082 mm. Both stolon and polyps are covered with a rather thick chitinous investment which varies somewhat in thickness, but is not more than 0.0041 mm. thick; on the aboral surface of the polyps this ectocyst is modified to form the aboral shield characteristic of the genus and of *Loxosomatoides*.

*Polyp.* Each polyp consists of a short stalk bearing a relatively large capitulum. The stalk is rarely if ever longer than, and as a rule rather shorter than, the capitulum. It is relatively very stout and does not taper much above; there is no defined swelling at its base. The capitulum is rather broadly oval as seen from in front or behind; it is not much compressed. Large capitula are about 0.374 mm. high and 0.272 mm. broad. The diameter of the stalk may be as much as 0.17 mm. at the base.

The normal number of tentacles is 18.

The aboral shield varies considerably in extent but never encroaches on the oral surface. When fully developed it covers the whole of the aboral surface, and has well-defined limits. It never bears spines but is ornamented with a minute network of fine ridges that encloses polygonal depressions of somewhat variable size and outline but never more than 0.051 mm. in greatest diameter. The ridges are slightly

<sup>1</sup> Robertson, *Proc. California Acad. Sci.* (Zool.) II (3), p. 324, pl. xvi, figs. 1-12 (1900).

<sup>2</sup> Davenport, *Bull. Mus. Comp. Zool. Harvard* XXIV, p. 24, pl. vi, fig. 57 (1893).

<sup>3</sup> Annandale, *Mem. Ind. Mus.* V, p. 130, fig. 2 (1915).

<sup>4</sup> Ehlers, *Abh. Kong. Gesells. Wiss. Göttingen* (Math.-Naturw. Kl.) XXXVI, p. 64, pl. iii, figs. 40, 43 (1890).

elevated at the nodes of the reticulation. The whole structure is very thin; in opaque specimens it has a pale golden colour, which contrasts well with the translucent white of the soft parts, though a yellowish tinge is given to the whole organism by the ectocyst. In specimens mounted in Canada balsam it is difficult to see details of the structure of the shield because of its transparency.

The oral surface of the capitulum and the whole surface of the stalk is quite smooth.

The general anatomy, both in the stalk and in the capitulum, closely resembles that of *Loxosomatoides*, except in respect to the musculature. Some polyps in my specimens possess unripe gonads in the form of a broad transverse band interrupted before and behind and lying in the upper half of the capitulum.

*Musculature.* The spinctor of the orifice consists of a considerable number (at least 6) of circular strands. The strands that lie externally are more or less inter-

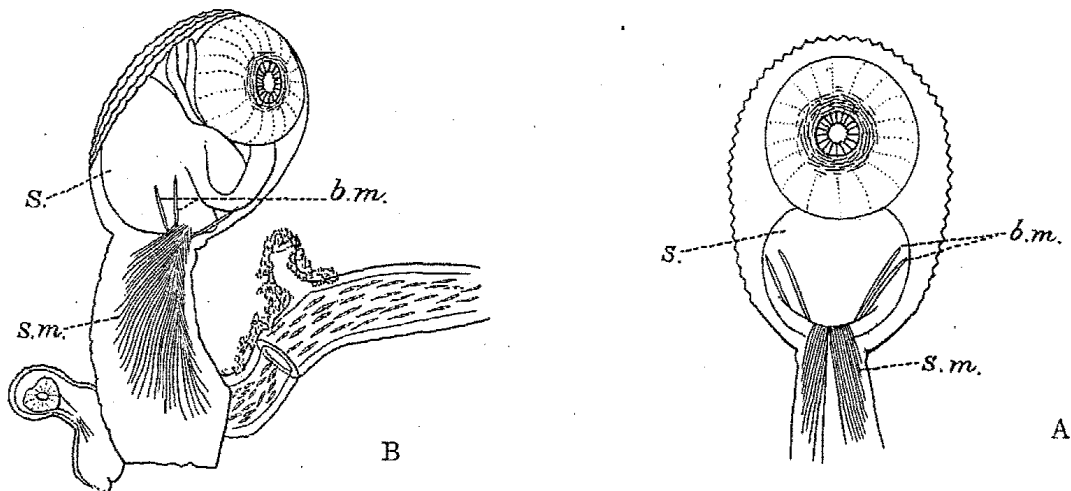


FIG. 1.—*Chitaspis athleticus*, gen. et sp. nov.,  $\times 62$ .

A. Oral view of a polypide. B. Oblique lateral view of another polypide with a bud and part of the stolon.

b.m. = capitular muscles. s. = stomach. s.m. = stalk muscles.

rupted. The muscles of the lophophore apparently resemble those of *Loxosomatoides* and there is a well-marked retractor running along the centre of each tentacle.

The body-muscles lie mainly in the body-wall. Possibly the outer strand (see fig. 1) is entirely superficial, but the inner strand certainly bends inwards above and its upper end is probably attached to the outer wall of the stomach.

The muscles of the stalk are directed outwards and downwards from the capitulum on the oral surface. They usually form two somewhat divergent groups arranged symmetrically, but this is more clearly the case in some polyps than in others. The lower end of the muscle is situated distinctly above the base of the stalk. I have not been able to detect any trace of muscle-fibres on the aboral face of the stalk or in the rhizome.

*Type-specimen.* No. 7157/7 Z E.V., Ind. Mus. (Zool. Survey of India): in alcohol.  
*Locality, etc.* The island of Koh Yaw, outer part of the Talé Sap (Great Lake)

on the Gulf of Siam; at the edge of the lake in water of very variable salinity but having a specific gravity (corrected to a standard temperature of 15°C) of 1.00625 at the time when the specimens were taken. The type-specimen was attached to a stone that had been built into a sea-wall. It was accompanied by colonies of *Bowerbankia caudata* and of the Cheilostomes *Membranipora hippopus* and *M. bengalensis*.

## ECTOPROCTA.

### Order Gymnolaemata.

#### Suborder Ctenostomata.

Harmer's recent account of the Ctenostomata of the 'Siboga' Expedition<sup>1</sup> has done much to elucidate the internal relationships of this very difficult group, and although I have not been able to accept all his conclusions on the families of fresh and brackish water (which naturally do not come fully into view in the consideration of the results of a naval expedition) I must here express my indebtedness to this admirable work, which has done for the seas of the Malay Archipelago almost as much as Hincks' *British Marine Polyzoa* did for those of Great Britain. In saying this I do not of course mean to infer that the Polyzoa of that vast area in the East are as well known as those of British seas were even in Hincks' time; but there is now a solid foundation on which further study can be based.

The suborder is well represented among the Polyzoa of fresh and brackish water in eastern lakes and ponds, but until recently our knowledge of the anatomy of critical genera has been very scanty, mainly owing to the fact that a number of the more important forms, though easily preserved in formalin or alcohol, collapse and become valueless if transferred to oil of cloves or cedar. It is thus very difficult to examine stained specimens under a high power of the microscope, without the aid of which I find it impossible to ascertain details with certainty. Harmer (*op. cit.*, p. 41) gives elaborate directions, based on the methods put forward by Rousselet, for the mounting of specimens in formalin for microscopic examination, but specimens so prepared, though often both beautiful and useful, cannot be satisfactorily used under really powerful objectives. Moreover, the methods are so elaborate, tedious and costly that it is difficult to mount a sufficiently large number of preparations in the case of variable forms. I find it necessary, in the case of species like those of *Victorella* and *Bowerbankia*, to examine not several but many preparations and to search in all for details that cannot be seen unless the organisms are stained and rendered transparent, and also, if not flattened, at any rate rendered as flat as may be possible without distortion. For this purpose a simple modification of Rousselet and Harmer's technique is sufficient, though I cannot say if it is permanent; the preparations will last, in a tropical climate, at least for two or even three years, and possibly for longer.

I place the specimens to be mounted, after staining with borax carmine and cleaning in acid alcohol, in a 50% solution of glycerine in 70% alcohol and leave

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<sup>1</sup> *Siboga-Expeditie*. Monograph XXVIIIa. *The Polyzoa of the Siboga Expedition*. Pt. I. *Entoprocta, Ctenostomata and Cyclostomata* (Leiden, 1915).

them exposed in a shallow dish for 24 hours. They are then transferred to a drop of pure glycerine on a slide, and, if there is any danger of crushing, fragments of a broken cover-slip are arranged round the drop. A complete cover-slip of relatively large size is cleaned and a square or circle of rather thick Canada balsam solution painted round it to the requisite thickness. It is then dropped from a pair of forceps over the glycerine on the slide, the painted side of course being downwards. The glycerine and the balsam are pressed together without mixing.

It is always as well at the same time to attempt to mount some specimens in Canada balsam after clearing them in the ordinary way. Ninety per cent or more of such attempts will, in the case of the more delicate tubular species, result in failure; but the few zoecia that do not collapse will prove particularly valuable. I am of course presuming that abundant material is available, and this is usually the case if the investigator be also the collector.

In the species of *Hislopia* and *Paludicella* (*i.e.* in the most abundant of the true freshwater Ctenostomata) there is as a rule no difficulty in clearing preparations with oil of cloves, the ectocyst being relatively thick and at the same time more permeable to oils.

To understand the Ctenostomata and their classification it is necessary above all things to study the general anatomy of the polypide and in particular of that part of the alimentary canal that lies between the mouth and the stomach. Some confusion exists in the terminology of this system, more particularly in reference to the terms "oesophagus" and "gizzard." The former has been applied in two entirely different senses, while the latter has been used indifferently in a morphological and in a physiological sense.

It is in the Division Alcyonellea or Carnosa that the simplest and probably the most primitive condition is to be found.

In *Alcyonidium* the mouth opens into a comparatively short funnel-shaped "oesophagus." The walls of this organ are very thick above and become gradually thinner towards its base, which is defined by a circular valve, the so-called "cardia" or, as I prefer to call it, the oesophageal valve. When this valve is open the lumen of the oesophagus is practically continuous with that of the stomach, at any rate when the polypide is expanded. The region that intervenes between the valve and the stomach proper or "pylorus" takes the form of a rather stout tube, the walls of which do not differ in essential histological characters from those of the latter. There are apparently no circular muscles in the wall of this region, which may be known as the cardiac region.

In the Stolonifera the structure of this part of the alimentary canal seems to be essentially the same as in the Alcyonellea, but in the Paludicellea a progressive differentiation is found in the different families. In the Paludicellidae (fig. 2, A) the only marked changes that occur are that the oesophagus is greatly lengthened and more or less distinctly differentiated into an external thick-walled funnel shaped "pharynx" and a thin-walled oesophagus proper, and that scattered circular muscle-fibres appear in the wall of the cardiac region.



In the Victorellidae (fig. 2, B) this region is much more highly specialized and consists of three parts. Immediately below the valve there is a comparatively large oval chamber without muscle-fibres, but lined internally with a fine layer of horny substance. Below this there is a short muscular tube, the external wall of which is composed of close-set circular fibres, and finally a relatively long thick-walled glandular tube connects the muscular region with the pylorus.

In the Hislopiidae (fig. 2, C) still further specialization occurs. Three parts can again be distinguished, but their arrangement and structure are very different from

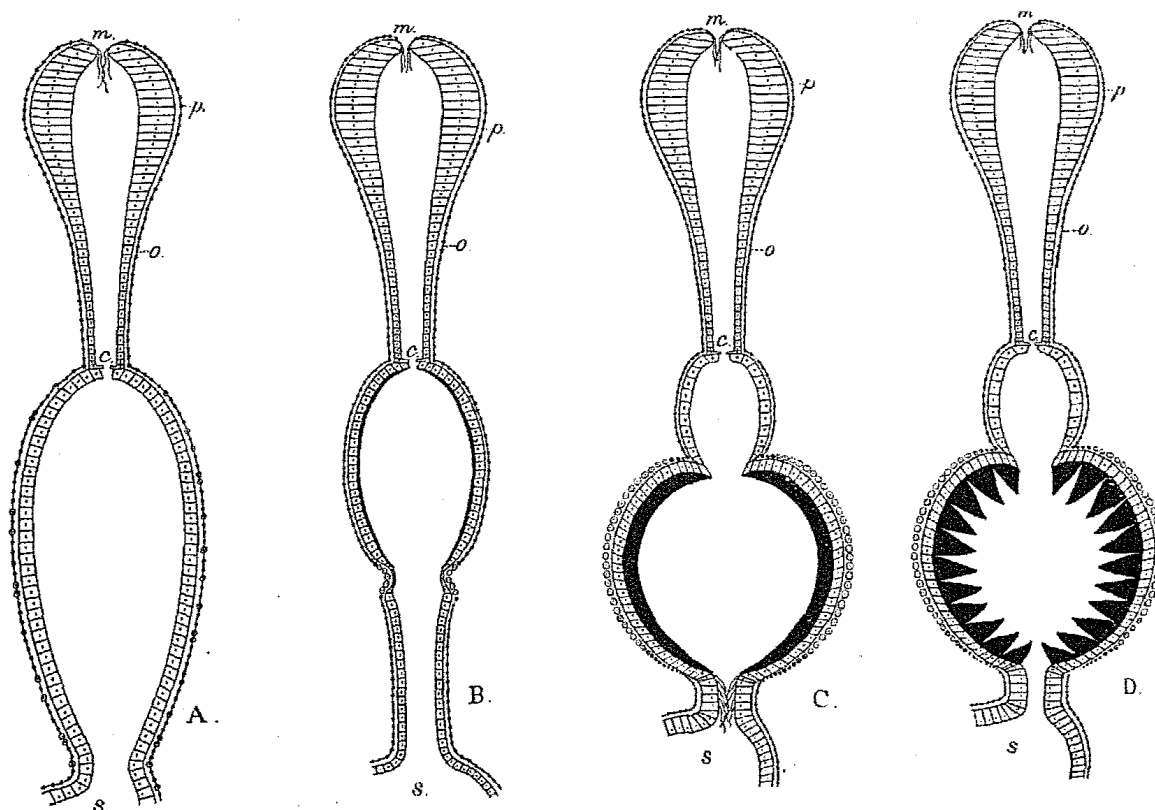


FIG. 2.—Diagram of the oesophageal and cardiac regions of the alimentary canal in certain families of Ctenostomata.

A.—Paludicellidae. B.—Victorellidae. C.—Hislopiidae. D.—Vesiculariidae.

*c.* = oesophageal valve. *m.* = mouth. *o.* = oesophagus proper. *p.* = pharynx. *s.* = stomach.

Cilia are represented by depending sinuous lines, circular muscles by minute circles with a dot in the centre of each, and horny structures in solid black.

the corresponding parts in *Victorella*. The outermost part, immediately below the valve, is a conical thick-walled but non-muscular "proventriculus." This opens directly into a spherical chamber of large size in which the outer wall is composed of very stout circular muscle-fibres, while the lining consists of a thick layer of horny substance that has in longitudinal section the appearance of a sharp ridge. The inner surface of this horny lining is perfectly smooth. In preserved specimens the spherical chamber has the appearance of opening directly into the pylorus, but if the living animal be examined in an expanded condition, it will be seen that a narrow ring intervenes, bearing very long and powerful cilia. It is this ring that I regard as a

third part of the cardiac region. In the Vesicularina, or at any rate in *Bowerbankia* (fig. 2, D), the general structure resembles that found in *Hislopia*, except that the horny lining of the spherical chamber is broken up into a number of sharp teeth<sup>1</sup> and that there are no cilia on the narrow ring that separates the spherical chamber from the pylorus.

Thus, in three families, belonging to two different divisions of the suborder, we find a chamber lined with chitin in the cardiac region of the alimentary canal. In the Hislopiidae and the Vesiculariidae this chamber occupies the same position and is probably homologous, though, as we shall see in a moment, it is not analogous. In the Victorellidae it differs both in position and in function and seems to be homologous rather with the proventriculus of the other families than with their spherical chamber. If this be so, the spherical chamber of these forms is homologous with the narrow muscular part in *Victorella*. In *Bowerbankia* the function of the chamber with the horny teeth is that of a true gizzard. It crushes the food. In *Hislopia* the function is rather that of a store-chamber; the chitinous lining has very little crushing power and its function is merely to maintain the spherical form of the chamber in a position of rest, without preventing a change of shape and consequent diminution of the lumen in muscular contraction.<sup>2</sup> In *Victorella* the function of the horny region seems to that of retaining hard particles of irregular shape which might injure the delicate walls of the stomach, the natural food consisting of diatoms with a smooth surface.<sup>3</sup>

In this summary description I have taken the oesophageal valve as a fixed point, as seems to be justified by a comparative study of the alimentary canal in different groups of Ctenostomata; but the term oesophagus has been applied in *Alcyonidium* by others not only to that region to which I have confined it, but also to the whole of the alimentary canal between the mouth and the stomach proper. The term "gizzard" is applicable, in a physiological sense, only to forms like *Bowerbankia* and *Cryptozoon*, and it is perhaps best not to use it either for the homologous, but not analogous, structure in *Bowerbankia*, or for the superficially similar, but neither homologous nor analogous, structure in *Victorella*.

#### Division *ALCYONELLEA*.

Harmer<sup>4</sup> in his recent report on the Ctenostomata of the 'Siboga' has revived Gray's name *Carnosa* (1841) for this division, on the ground that Ehrenberg's name *Halcyonellea* (1839) included *Phylactolaemata* as well as Ctenostomata.

#### Family *ALCYONIDIIDAE*.

#### Genus *Alcyonidium*, Lamx.

1915. *Alcyonidium*, Harmer, *op. cit.*, p. 36.

<sup>1</sup> In the anomalous genus *Cryptozoon*, Dendy, which perhaps belongs to this division, the horny layer takes the form of a pair of stout quadrangular masses. See Dendy, *Proc. Roy. Soc. Victoria* (n.s.), I, pp. 1-12, pls. iii (1889).

<sup>2</sup> Annandale, *Faun. Brit. Ind., Freshw. Sponges, etc.*, pp. 200-202 (1911).

<sup>3</sup> *Id.*, *ibid.*, p. 197.

<sup>4</sup> *Siboga-Exp.*, mon. XXVIIIa, p. 35 (1915).

*Alcyonidium mytili*, Dalyell.

(Pl. I, fig. 2.)

1848. *Alcyonidium mytili*, Dalyell, *Rare and Remark. Anim. Scotland* II, p. 36, pl. xi, figs. 1-4.  
 1906. *Alcyonidium mytili*, Silberman, *Arch. f. Naturg.*, Jahr. 72, I, p. 265, pls. xix, xx.  
 1915. *Alcyonidium mytili*, Annandale, *Mem. Ind. Mus.* V, p. 127.  
 1915. *Alcyonidium polyoum*, Harmer, *op. cit.*, p. 37, pl. iii, fig. 1.

Harmer says, on the synonymy of this species: "It is probable that *Sarcochitum polyoum*, Hassall, 1841, is the form assumed by old colonies of *A. mytili*." But mere probability (which in this case is by no means strengthened by an examination of Indian specimens) is a poor excuse for discarding well-known specific names in favour of others much less well known.

I did not take *A. mytili* on my recent tour, but as I have fairly abundant material from India it will be well to give in this paper a description of Oriental specimens from brackish water.

My specimens are on the shells of Gastropod molluscs (*Purpura* or *Thais carinifera* and *Potamides fluviatilis*) from the Chilka Lake and on the skin of a sea-snake (*Enhydrina valakadien*) from the estuary of the R. Hughli. In both cases the colony is extremely thin and transparent and when living was barely visible to the naked eye. In our survey of the Chilka Lake we saw no thickened examples, though we found the extremely inconspicuous films of the typical *A. mytili* not uncommonly. On shells the outlines of the colonies are obscured by the irregularity of the surface of attachment, but on the sea snake, to which a large number of colonies were attached, they were almost exactly circular. None were more than 2 cm. in diameter. It is probable, however, that these latter colonies were young. The zooecia and polypides agree with Harmer's figure, except that, at any rate in the central part of the colony, the zooecia are much more variable in size and shape, some being very much smaller than others. I figure a single polypide (pl. i, fig. 2) for comparison with that of other species discussed in this paper.

In living specimens from the Chilka Lake I found the number of tentacles to be 12 or 14, but in polypides dissected out from a colony from the Gangetic delta it is certainly 16, as Silberman found to be the case in European specimens.

Division *STOLONIFERA*.

Family *TRITICELLIDAE*.

Genus *Triticella*, Dalyell.

1915. *Triticella*, Harmer, *op. cit.*, p. 90.

Harmer may be consulted for other references. Several, if not all, of the species are probably cosmopolitan, but only two records from Indo-Pacific seas have hitherto been published, *viz.* Harmer's (*loc. cit.*) of *T. boeckii*, Sars from Algoa Bay and my own of *T. koreni*, Sars from Japan (*Rec. Ind. Mus.* VII, p. 124).

*Triticella pedicellata* (Alder).

(Pl. I, fig. 3.)

1857. *Farella pedicellata*, Alder, *Quart. Journ. Micr. Sci.* V, p. 24, pl. xiv, figs. 1-3.1880. *Triticella pedicellata*, Hincks, *Brit. Mar. Polyzoa*, p. 547, pl. lxxx, figs. 1-3.1893. *Triticella pedicellata*, Duerden, *Proc. Roy. Irish Acad.* (3) III, p. 133, pl. v, figs. 3, 5.

I found my colonies of this species on the tail of a sea-snake (*Enhydris hardwickii*) and on the carapace of *Limulus moluccanus*, taken in both cases in fishing-nets off Singgora near the mouth of the Talé Sap in January, 1916. The water had at the time a specific gravity (corrected) of 1.0085. In both cases the colonies accompanied and partly grew over those of the Cheilostome *Membranipora hippopus*.

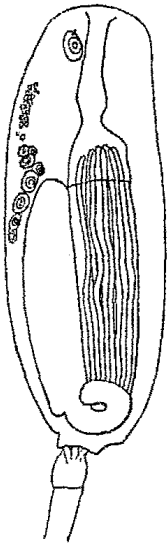


FIG. 3.—*Triticella pedicellata*, × 90.

My specimens agree closely in most respects with Duerden's description and figures of Irish examples. The rhizome (pl. i, fig. 3) is in an intermediate condition, forming neither a simple branching structure nor a flat plate but having a modified cruciform arrangement. Pairs of opposed lateral branches are given off at irregular intervals and at the meeting place of the four arms thus formed small polygonal flattened plates are budded off from the lateral branches and the main stem in the same plane. It is from these plates that the upright stalks of the zooecia arise. This formation is not mentioned by Duerden, but is shown in his plate (fig. 5). The only point in which I find any actual discrepancy is in the form of the base of the zooecium and in the manner of its attachment to the stalk (see text-figure 3), but the stalk is so delicate that it is liable to be distorted; in many of my specimens it has much the same appearance as in Duerden's fig. 3. My figure was drawn from a particularly well-preserved zooecium.

So far as I am aware, *T. pedicellata* has not hitherto been recorded from tropical waters, but only from the North Sea and the west of Ireland, where it occurs on shells in moderately deep water. As it was found in the Talé Sap attached to marine animals possessing considerable power of progression, we may suppose that it is not a permanent inhabitant of the lake, but enters brackish water occasionally.

Division VESICULARINA.

Family VESICULARIIDAE.

Genus *Bowerbankia*, Farre.*Bowerbankia caudata*, Hincks.

(Pl. I, figs. 10, 11).

1880. *Bowerbankia caudata* and *B. gracillima*, Hincks, *Brit. Mar. Polyzoa*, pp. 521, 525, pl. lxxv, figs. 6-8.1908. *Bowerbankia caudata* race *bengalensis*, Annandale, *Rec. Ind. Mus.* II, p. 13.

1911. *Bowerbankia caudata* subsp. *bengalensis*, *id.*, *Faun. Brit. Ind., Freshw. Sponges, etc.*, p. 189.

1915. *Bowerbankia caudata*, *id.*, *Mem. Ind. Mus. V*, p. 126.

I have already discussed this form so often that it may seem superfluous to return to it again, but it is clear from Harmer's remarks in his report on the 'Siboga' Polyzoa that a detailed description is still called for on my part. Harmer refers to my figure of the zoecium, but I never published one.

In the form I call *Bowerbankia caudata* the colony consists of zooecia arising singly, in pairs or in groups on both sides of a reptant rhizome that branches more or less freely both in a cruciform and in a dichotomous manner. The rhizome may occasionally be free for a considerable part of its length, but is usually adherent and

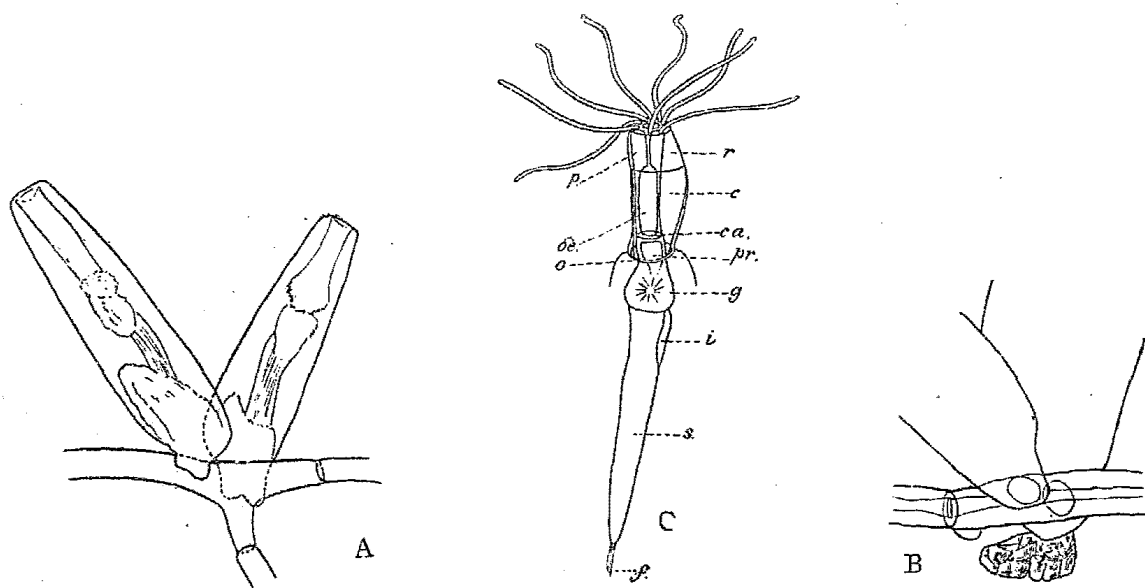


FIG. 4.—*Bowerbankia caudata*.

A.—Two polypides with apparently bifid bases,  $\times 45$ . B.—Lower part of two other polypides in one of which the base has become attached to a fragment of stone,  $\times 45$ . C.—Fully expanded polypide,  $\times 45$ .

*c.* = collar. *ca.* = oesophageal valve. *f.* = funiculus. *g.* = gizzard. *i.* = intestine. *o.* = orifice of zoecium. *oe.* = oesophagus. *p.* = pharynx. *pr.* = proventriculus. *r.* = rectum. *s.* = stomach.

never gives rise to upright branches. The zooecia are invariably attached to the side of the rhizome, with the interior of which they communicate by means of a circular or oval aperture of relatively large size in their own wall and in that of the rhizome. Vertical partitions, each perforated by a single pore, occur at intervals in the rhizome. In the younger parts of the colony the normal arrangement seems to be that two zooecia arise approximately opposite one another; a partition occurs in the rhizome close to the pair of zooecia in the direction nearest to the centre of the colony, and another at some distance away, near another pair of zooecia, in the opposite direction; but this arrangement is liable to all kinds of irregularities and practically disappears in congested parts of the colony, where, for considerable distances, the zooecia are closely packed together on one or both sides of the rhizome and partitions are absent or scattered irregularly. There is never any trace of a spiral arrangement of the zooecia.

Lateral branches are usually given off in the neighbourhood of groups of zooecia, but the tips of these branches divide dichotomously in front of the last zooecium (pl. i, fig. 10).

The size of individual zooecia varies greatly both in the same colony and in colonies from different localities or growing under different conditions. If the organism is threatened by the deposition of mud in its interstices, as often happens if it is attached to the roots of reeds in muddy estuarine waters, some zooecia are often of very great length without attaining more than normal girth. The following table gives, in millimetres, the length and greatest transverse diameter in the longest zooecium discoverable in four colonies from different localities, the first two of which are situated on different sides of the Malay Peninsula, while the two latter are in the Gangetic delta:—

	<i>Port Weld.</i>	<i>Talé Sap.</i>	<i>Calcutta.</i>	<i>Port Canning.</i>
Length .. ..	1·78	1·02	2·55	0·775
Breadth .. ..	0·204	0·119	0·255	0·119

The zooecia are always more or less spindle-shaped, tapering both above and at the base, which is usually prolonged below the point of attachment to the rhizome in the form of a pointed process or "tail." If this tail comes in contact with a hard object it is often expanded into a funnel-like body, concave at the tip, which attaches itself to the object. Its position is sometimes a little eccentric so that it is situated at one side of rather than in the middle line of the main body of the zooecium, the base of which then grows out into a lateral pocket, thus giving the whole structure a bifid appearance (text-fig. 4, A); but the tail never forms a branching radicle. The distal region of the zooecium is subcircular in cross-section. Its ectocyst is faintly and minutely striated transversely, but the striae are often obsolete. The tint of the ectocyst varies greatly; often it is colourless but sometimes it is stained with yellow or brown. It is always transparent.

In both arrangement and number the parietal muscles vary considerably. Sometimes they are practically confined to the upper part of the zooecia, while in some zooecia they extend almost to the base (*cf.* figs. 10 and 10a, pl. i).

There are always 8 tentacles, which are armed with a sensory bristle at the base, with several horizontal hairs on the outer margin and a bunch of finer hairs at the tip. The alimentary canal resembles that of other species. The diameter of the gizzard varies with the size of the zooecium (*cf.* pl. i, figs. 10, 10a and 11).

*B. caudata*, therefore, differs from the form described by Waters<sup>1</sup> and by Harmer<sup>2</sup> as *B. imbricata* in the following characters:—

(1) The zooecia are more slender and less cylindrical; their base never forms a binding radicle.

(2) They are joined to the rhizome by a distinctly lateral communication and never exhibit any approach to a spiral arrangement.

<sup>1</sup> *Journ. Lin. Soc.* XXXI, p. 248, pl. xxv, figs 6-10 (1910).

<sup>2</sup> *Siboga-Exp.*, mon. XXVIIIa, p. 70, pl. vii, figs. 15, 16 (1915).

(3) The rhizome, although it is not always adherent, never gives rise to vertical branches.

(4) The number of tentacles is always eight.

I find these characters constant in a large series of specimens from Bengal, Madras, Perak and the Talé Sap.

In eastern waters *B. caudata* is characteristic of estuarine tracts in which the water has a lower salinity than that of the open sea. I found the species abundant at Koh Yaw in water of a specific gravity (corrected) of from 1.004 to 1.0085. It occurred (often with *Victorella bengalensis*) on sticks and stones. I also took a specimen on a worm-eaten fragment of a wooden pier at Port Weld on the coast of Perak. This place is situated up a creek, some distance from the open sea (Straits of Malacca), but the water is probably almost if not quite as salt as that of the Straits.

#### Division PALUDICELLEA.

1911. Palludicellina, Annandale, *Faun. Brit. Ind., Freshw. Sponges, etc.*, p. 186.

1915. Paludicellea, Harmer, *Siboga-Exp.*, mon. XXVIIIa, p. 43.

Harmer (*loc. cit.*) includes in this division the following families: Paludicellidae, Victorellidae, Arachnidiidae and Nolellidae (= *Cylindroeciidae*, *auct.*); whereas I have hitherto included only the Paludicellidae, Victorellidae and Hislopiidae—the last a freshwater family referred to by Harmer only in a foot-note. He supports his views as to the inclusion of certain marine genera with abundant evidence and clears up several anatomical points hitherto obscure, in particular by means of his excellent figures. These show that there is practically no difference in the general structure of the polypide between *Cylindroecium* and *Victorella*. In fig. 19 of his plate iv, for example, it is quite clear that the polypide of *Cylindroecium* (or *Nolella*) *papuensis* possesses a cardiac store-chamber and a well-defined single funiculus. Indeed, now that this evidence on anatomy is available, the grounds on which the family *Cylindroeciidae* is separated from the family *Victorellidae* become rather flimsy.

It is somewhat otherwise with the *Arachnidiidae*, in which Harmer follows Loppens<sup>1</sup> in placing the freshwater genus *Arachnoidea*, Moore. His figure of the polypide of *Arachnidium irregulare* (*op. cit.*, pl. iii, fig. 6) shows quite clearly that there is neither a proventriculus, nor a spherical chamber, nor a funiculus. This, of course, does not rule *Arachnidium* out of the division—the alimentary canal is merely in a simple and probably primitive condition; but it does prove that *Arachnoidea* is by no means closely related to *Arachnidium*. *Arachnoidea* I would still retain in the family *Hislopiidae* on anatomical grounds, for although its anatomy is still imperfectly known, it certainly possesses a spherical chamber closely resembling that of *Hislopia*. This structure is not clearly indicated either in Moore's original sketch<sup>2</sup> or in Rousset's more elaborate figure,<sup>3</sup> but I have seen it without a doubt in specimens mounted by the latter author and in *Hislopia* the horny lining of the gizzard remains

<sup>1</sup> *Ann. Biol. lacust.* III, p. 150 (1908).

<sup>2</sup> *The Tanganyika Problem*, p. 296, fig. (1903).

<sup>3</sup> *Proc. Zool. Soc. London* 1907 I), pl. xiv, figs. 5, 6.

as a fairly conspicuous object even in very badly preserved specimens. There is some reason, therefore, to doubt whether Harmer's marine species *Arachnoidea protecta* (*op. cit.*, p. 50, pl. iii, figs. 7-11) is really co-generic, notwithstanding the very close external resemblances, with *A. ray-lankesteri* from Lake Tanganyika.

I would, therefore, arrange the families of the Division Paludicellea as follows, basing their classification on the structure of the polypide as well as the form of the zooecium:—

- I. Alimentary canal of simple structure, cardiac limb of stomach undifferentiated.
  - A. Zooecia broad, flattened, adherent, with the orifice situated on a tubercle or short upright tubule; no funiculus. . . . . ARACHNIDIIDAE.
  - B. Zooecia relatively narrow, either entirely vertical or bearing a comparatively long, vertical orificial tubule; two funiculi . . . . . PALUDICELLIDAE.
- II. Alimentary canal more highly specialized in the cardiac region.
  - A. Cardiac region of the alimentary canal with an antechamber (always?) lined with chitin; no proventriculus; adult zooecia vertical and tubular; a single funiculus.
    - 1. Base of zooecia swollen or slipper-shaped . . . . . VICTORELLIDAE.
    - 2. Base of zooecium sharply constricted off from the false rhizomes by which it is connected with other zooecia . . . . . CYLINDROECIIDAE.
  - B. Cardiac region of alimentary canal with a proventriculus and a spherical chamber lined with thick chitin; no funiculus.
    - Zooecia flattened and adherent, with or without a high orificial tubule . . . . . HISLOPIIDAE.

#### Family PALUDICELLIDAE.

#### Genus *Paludicella*, Gervais.

1887. *Paludicella*, Kraepelin, *Deutsch. Süßwasserbryozoen* I, p. 96.

1913. *Paludicella*, Harmer, *Proc. Zool. Soc. London* III, p. 441.

1914. *Paludicella*, Braem, *Arch. f. Hydrobiol.* IX, p. 456.

Recent authors have recognized a single species in this genus, namely *Paludicella articulata* (Ehrenberg) = *P. ehrenbergii*, v. Beneden. I have here, however, to revive a second usually relegated to the synonymy of that species and to describe a third—the latter a very distinct form. A fourth species, or what I believe to be a fourth species, occurs in Japan and will shortly be described by Prof. A. Oka.

The genus is probably cosmopolitan but has not yet been found in India, unless



we accept Carter's somewhat inconclusive record.<sup>1</sup> Personally I am of the opinion that this record refers to a species of *Victorella*.

*Paludicella elongata*, Leidy.

(Pl. I, fig. 4.)

1852. *Paludicella elongata*, Leidy, *Proc. Acad. Nat. Sci. Philadelphia* V, p. 321, pl. —, figs. 1, 2.

Specimens in my collection from China agree precisely with Leidy's figures, which, however, show only the outlines of zooecia. The species differs from *P. articulata* in the following characters:—

1. The ectocyst is colourless and very thin, liable to collapse in spirit.
2. The proximal part of the zooecia is much elongated and attenuated, while the distal part, as viewed in profile, is not much deeper than the proximal; the orificial tubule is relatively short.
3. Young buds reach the full length of an adult zooecium and assume a somewhat clavate form before the orifice is developed.
4. The whole of the alimentary canal is stouter than in the common European form, the stomach in particular being much larger; when fully developed, the pyloric part has a broadly elliptical form.

The last of these differences I consider the most important. It becomes very clear if fig. 4 on pl. i be compared with the figures already published by Allman,<sup>2</sup> Kraepelin,<sup>3</sup> Hancock<sup>4</sup> or myself.<sup>5</sup> In young polypides the stomach is more slender than in those that are fully adult and the main or pyloric portion is slightly contracted in the middle and somewhat pointed at the free extremity, but even in such polypides the organ is relatively more bulky than in European specimens.

The only examples of *P. elongata* I have seen were growing, with the Hydroid *Cordylophora lacustris*, on the roots of a willow, on shells of *Modiola lacustris* attached to them in large numbers, and on living shells of a Unionid mollusc (*Anodonta woodiana*). In these specimens there is no trace of vertical branches, but in the colonies on roots many of the zooecia are free and floated loosely in the water. In December none of the zooecia contained mature gonads, though immature testis and ovary were found in one. They occupied the same position as in *P. articulata*. A single free resting-bud was observed. It was flattened and polygonal and had a thinner shell than is usual in *P. articulata*.

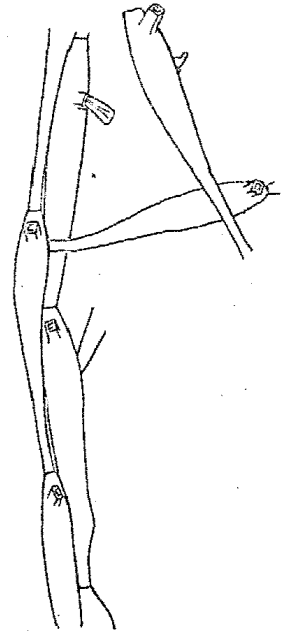


FIG. 5.—*Paludicella elongata*.  
Part of a colony, × 16.

<sup>1</sup> *Ann. Mag. Nat. Hist.* III (3), p. 333 (1859).

<sup>2</sup> *Mon. Fresh-Water Polyzoa*, pl. x (1856).

<sup>3</sup> *Deutsch. Süßwasserbryozoen* I, pl. iii, fig. 104 (1887).

<sup>4</sup> *Ann. Nat. Hist.* V (2), pl. iv (1850).

<sup>5</sup> *Rec. Ind. Mus.* VI, pl. xii, fig. 1 (1911).

*Localities.*—The species was originally described, with *Urnatella gracilis*, from the Delaware and Schuylkill rivers near Philadelphia, U.S.A. My specimens were taken in a few feet of water at the mouth of the Moo-Too creek and in the north-west corner of the Tai-Hu (Great Lake) in the Kiangsu Province of China: December, 1915.

*Paludicella pentagonalis*, sp. nov.

(Pl. I, fig. 5.)

The type-specimen of this peculiar little Polyzoon was attached to a piece of stick and was rather deeply buried in crevices between the ridges on the bark. It consisted of a single small colony apparently in a degenerate condition, and only a few of its zooecia and polypides are at all well preserved. I found it impossible, moreover, to gain more than a very general idea of the structure of the organism *in situ* and only succeeded in extracting and mounting two consecutive zooecia—evidently the two oldest zooecia in the colony—in such a condition as to illustrate their natural relationship one to another. Fortunately these two zooecia, and the polypides they contain, are well preserved, fully mature and in one case about to produce a resting

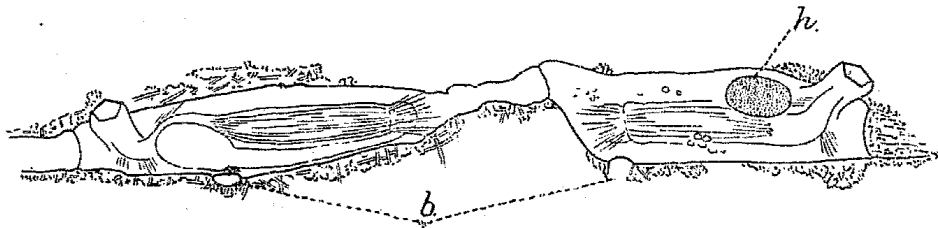


FIG. 6.—*Paludicella pentagonalis*, sp. nov., × 35.

Part of the type-colony seen in oblique lateral view.

*b.* = base of lateral bud. *h.* = resting bud.

bud. Their peculiarities are so well marked that I do not hesitate to accept them as the type of a new species.

*Colony.* The colony as observed consisted of a linear series of zooecia without lateral branches, but it is evident that lateral branches must have existed at some period in the history of the organism as the bases of the lateral buds can still be detected in mounted zooecia. Not more than half a dozen zooecia in all were present. The colony seems to have arisen from an embryo or bud that gave rise to two zooecia that were orientated in opposite directions (fig. 6).

*Zooecia.* The ectocyst of the zooecia is perfectly colourless and hyaline except on the orificial tubules, on which it is yellowish and considerably thickened. The zooecia are variable in shape and proportions but always flattened, relatively broad and more or less produced and narrowed proximally. They do not exceed 1.2 mm. in length.

The orifice is distinctly pentagonal. The orificial tubule is relatively long and subcircular in cross-section below the orifice. Its ectocyst sometimes exhibits a tendency to flake in such a way as to produce slender irregular processes that stand up

vertically above the orifice when the polypide is retracted. Fig. 5a, pl. i, shows the structure of the orifice so far as it can be made out in the material at my disposal.

*Polypide.* The polypide has the structure normal in the genus, but is remarkable for the great length of the slender-walled oesophagus and for the broadly pear-shaped outline of the stomach, which occupies a relatively larger part of the space available in the zooecium. The tentacles are long and slender and probably number 16. The intestine is bulky. Funiculi cannot be seen in my specimen and I have not been able to detect the collar precisely.

*Musculature.* All the muscle-fibres are remarkably stout, especially those of the retractor muscles. The parietal muscles are short and entirely lateral in position. They are variable in number and arrangement. The "pyramidal" muscles connected with the orifice are attached to the retractile part of the ectocyst very low down and are arranged in three groups, two anterior (distal) and one posterior (proximal).

*Gonads.* One of my mounted zooecia contains a ripe testis. It consists of rather discrete groups of cells situated on the floor of the zooecium proximad of the stomach and some distance from the proximal end of the zooecium (pl. i, fig. 5).

*Buds.* The position of the primary lateral buds seems to be variable; sometimes they are situated much nearer the proximal end of the zooecium than is usual in *P. ehrenbergi* or *P. elongata*.

In one zooecium a young resting-bud occurs in the distal part of the zooecium. It consists of a broadly oval mass of rounded cells densely packed with food-granules. The upper surface is smoothly rounded, but below the outline seems to be irregular. A thin chitinous investment has already been deposited round it. The length is 0.1477 mm. and the greatest transverse diameter 0.102 mm. The polypide in this zooecium is not markedly degenerate.

*Type.* No. 7194/7 Z. E. V. in the register of the Indian Museum (Zool. Survey of India): mounted in Canada balsam on a slide.

*Locality.* Lampam, at the edge of Patalung R. near its entry into the Talé Sap, Singgora Province, Peninsular Siam: January, 1916: in permanently fresh water.

The most striking feature of this new species is its pentagonal orifice, in which it resembles *Potsiella erecta*, Leidy. From that species, however, it differs entirely in the form of the zooecium, and, so far as can be seen at present, there is no reason for separating it from the genus *Paludicella*.

## Family VICTORELLIDAE.

### Genus *Victorella*, Kent.

1911. *Victorella*, Annandale, *Rec. Ind. Mus.* IV, p. 193.

1915. *Victorella*, Harmer, 'Siboga'-Exp., mon. XXVIIIa, p. 44.

Most species of the genus are found habitually in brackish water on or near the coast, but the genus has been recorded from Lake Tanganyika in Central Africa, the Birket-el-Qûrun in Egypt and Issyk-kul in Central Asia. Loppens found the common European form (*V. pavidata*, Kent) in marine oyster-beds on the coast of Belgium and

Harmer (*op. cit.*, p. 45) has ascribed to the genus a marine species (*V. sibogae*) from a depth of 0 and 32 metres in the Malay Archipelago.

All brackish-water species as yet examined have eight tentacles, but *V. sibogae* has probably more than twenty. Its generic position seems to me doubtful.

The genus is evidently cosmopolitan in distribution, but has not as yet been found in America. Definite records now exist from northern Europe, Egypt, Central Africa, Central Asia and India; a specimen was recently taken in the Main Island of Japan by Dr. A. Oka and myself.

### *Victorella bengalensis*, Annandale.

(Pl. I, figs. 6, 7.)

1907. *Victorella pavida*, Annandale (*nec* Kent), *Rec. Ind. Mus.* I, p. 200, figs. 1-4.  
 1908. *Victorella bengalensis*, *id.*, *Rec. Ind. Mus.* II, p. 12, fig. 1.  
 1911. *Victorella bengalensis*, *id.*, *Faun. Brit. Ind., Freshw. Sponges, etc.*, pp. 191, 192, fig. 37 a-f; p. 170, fig. 31.  
 1911. *Victorella continentalis*, Braem, *Trans. Soc. Nat. St. Pétersb.* LXII, p. 30, figs. 18-21.  
 1911. *Victorella bengalensis*, Annandale, *Rec. Ind. Mus.* VI, p. 197, pl. xiii, figs. 3, 7, 8.  
 1911. *Victorella symbiotica*, *id.* (? *nec* Rousselet), *ibid.*, p. 197, pl. xiii, fig. 6.  
 1915. *Victorella bengalensis*, *id.*, *Mem. Ind. Mus.* V, p. 125.

This species was abundant on sticks in the Talé Sap off Koh Yaw in January, 1916, in water that varied in specific gravity (corrected) from 1.00625 to 1.008. I can see no specific difference between specimens from India and Siam and others from the salt-lake Birket-el-Qûrun in Egypt. The latter seem to me to agree well enough with Rousselet's figure of *V. symbiotica* from L. Tanganyika, but Braem, who has examined examples from both African localities, states that there is a difference (which he refrains from describing) in the alimentary canal between the true *V. symbiotica* and

the Egyptian form. As I have not examined specimens from Tanganyika and as Rousselet does not discuss or figure the anatomy in detail, I can express no opinion on this point, but must content myself with reproducing a drawing of the alimentary canal of *V. bengalensis* (pl. i, fig. 7).

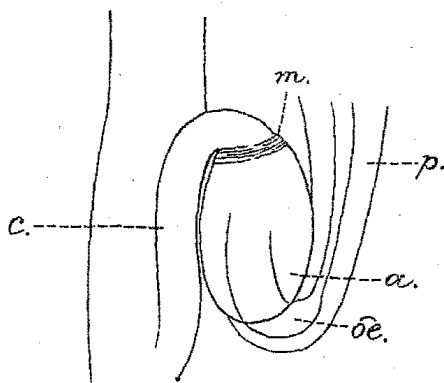


FIG. 7.—*Victorella bengalensis*.

Central region of the alimentary canal of a retracted polypide in lateral view (slightly diagrammatic).

a. = oval chamber with horny lining. c. = thick walled glandular tube. m. = circular muscle. oe. = oesophagus. p. = pharynx.

ecia. My Siamese examples on the other hand are particularly well developed in all

*V. bengalensis*, as I have pointed out elsewhere, is a very variable form; some colonies have larger zooecia and a thicker ectocyst than others, while environment appears to exert a direct effect on the growth and appearance of the colony. With the thickness of the zooecia the development of the parietal muscles is to some extent correlated. Specimens from Birket-el-Qûrun have very small and delicate zooecia.

cases; the length and greatest diameter of the largest zooecia are 2.55 and 0.272 mm. In a colony from the neighbourhood of Calcutta the largest zooecia are, however, only 1.615 long by 0.221 in diameter, while in one from Port Canning, some 30 miles distant, the measurements are 0.935 and 0.153. These differences appear to be considerable if individual colonies are compared, but they disappear completely in a long series of specimens.

In all my Siamese specimens the ectocyst is rather thick and has a slight yellowish tinge. The parietal muscles, though well developed in some zooecia, are not invariably stronger or more numerous than in specimens from India or Egypt. In some Siamese zooecia, however, they extend further up the zooecia than is usual in Indian examples.

#### Family HISLOPIIDAE.

1911. Hislopiidae, Annandale, *Faun. Brit. Ind., Freshw. Sponges*, etc., p. 199.

1911. Hislopiidae, *id.*, *Rec. Ind. Mus.* VI, p. 199.

#### Genus *Hislopia*, Carter.

I have now been able to examine ample material of all the forms hitherto described in this genus with the exception of *H. placoides* (Korotneff), and on my recent tour was fortunate in discovering a new species which, owing to the transparency of its ectocyst, the study of the anatomy was peculiarly easy. The following key to the species may, therefore, be of some value:—

- I. Orifice armed with four very long spines . . . . . *H. placoides*.
- II. Orifice unarmed or bearing four short spines.
  - A. Zooecia in uncongested parts of the colony almost circular, slightly truncated proximally and distally. Ectocyst yellowish, orifice quadrate or subquadrate, usually with four short spines . . . *H. moniliformis*.
  - B. Zooecia in uncongested parts of colony oval or ovoid.
    - i. Ectocyst perfectly hyaline and colourless; terminal zooecia assuming a fan-like outline before becoming oval; no orificial spines. . . . . *H. malayensis*.
    - ii. Ectocyst yellowish; terminal zooecia not passing through a fan-shaped stage.
      - a. Zooecia (at any rate in peripheral parts of the colony) constricted and produced at the proximal end; the margins not noticeably thickened; orifice as a rule without spines . . . *H. cambodgiensis*.
      - b. Zooecia not or very rarely pedunculate; their margins thickened and chitinized; four short orificial spines frequently present . . . *H. lacustris*.

All these species are closely related and in order to identify specimens satisfactorily it is necessary to examine the peripheral parts of the colony; the older zooecia, which of course occur towards the centre, are often distorted owing to congestion.

The genus *Hislopia* occurs over a great part of Asia. *H. placoides* is only known from Lake Baikal and *H. moniliformis* (originally described in my volume in the "Fauna" as a variety of *H. lacustris*) from ponds at Calcutta. *H. lacustris* is widely distributed in northern India and Burma and *H. cambodgiensis* in Indo-China, Siam and China; while the new species *H. malayensis* has been found as yet only in a small lake in the Siamese province of Patani in the north-east of the Malay Peninsula. I have recently observed what I take to be remains of a species of *Hislopia* on shells of the genus *Aetheria* from tropical Africa, probably from the Upper Nile; but these cannot be identified specifically.

### *Hislopia cambodgiensis* (Jullien).

(Pl. I, fig. 8.)

1880. *Norodonia cambodgiensis* and *H. sinensis*, Jullien, *Bull. Soc. zool. France* V, pp. 77-79, figs.

I found in Chinese specimens, attached (like the types) to shells of freshwater molluscs, that the two forms described by Jullien in the paper cited passed insensibly one into the other, his *cambodgiensis* representing in fact merely older colonies, or the central congested part of old colonies, of his *sinensis*. I can find no difference between these forms and *H. lacustris*, the type-species of *Hislopia*, that would justify generic separation. Indeed, I have long hesitated whether to regard the differences that do exist as specific or as merely racial. In the collection of the Indian Museum there are specimens of *H. lacustris* on the shells of Unionidae and Viviparidae from *jhils* (swamps or shallow lakes) in northern Bengal the central or oldest zooecia of which agree almost exactly with those of the same kind in colonies from China. Moreover, the form of the orifice and the development of spines in connection with it are extremely variable characters in both the Indian and the Chinese forms. But while in the former the young zooecia are rarely if ever pedunculate, in the latter they are invariably so, thus having a very characteristic appearance (see pl. i, fig. 8). Other less important differences are the following:—

1. The colony of *H. lacustris* invariably forms, when fully developed, owing to profuse lateral budding, a solid pavement or layer, whereas in *H. cambodgiensis* lateral buds are produced much less sparingly, so that the colony consists of visibly radiating and separate branches.
2. In *H. lacustris* (and also in *H. moniliformis*) the margin of the zooecia is thickened and chitinized, whereas in *H. cambodgiensis* this is not at all or very indistinctly the case.
3. In *H. lacustris* some at any rate of the zooecia in each colony possess four well-developed but short spines at the four corners of the quadrate orifice, whereas in *H. cambodgiensis* the orifice is usually subcircular and spines are only occasionally developed in connection with it.

4. The chitinous lining of the gizzard is usually rather thicker in *H. cambodgiensis* than in *H. lacustris* and the thin-walled oesophagus perhaps rather longer.
5. In *H. cambodgiensis* the parietal muscles are, at any rate in the older zooecia, more powerful, consisting of more numerous and thicker muscle-fibres.

Jullien's description of *Norodonia* was apparently based on dried specimens, in which the central part of the roof of the zooecia, especially if they be young, as a rule collapses, giving a somewhat false idea of the natural appearance. The ectocyst becomes considerably thicker and darker in old zooecia than in young ones.

The orifice in this species is as a rule rather small and the orificial tubercle very low. The former is in most cases surrounded by an incomplete circular or subcircular horny ring, which is interrupted posteriorly. Occasional zooecia may be found in the older parts of colonies in which the ring is complete and subquadrate. More rarely it bears spines at its four corners, but one or more of the spines is usually abortive and I have not seen a case in which four well-developed spines were present.

Zooecia developing in the depressions between ridges on the epidermis of Unionid shells are frequently assymmetrical, as in the branch figured on pl. i.

The number and the arrangement of the parietal muscles are very variable, as is apparently the case in all species of the genus. The fibres seem to become stouter and more numerous as the ectocyst thickens with age. These muscles do not run parallel to the walls of the ectocyst as in *Paludicella*, *Victorella*, *Bowerbankia* and other more or less tubular forms, but directly from the floor to the roof at some distance from the sides of the zooecium, as in flattened forms such as *Alcyonidium*. In some cases they form a rather dense mass on either side of the polypide, but in young zooecia they are always very difficult to detect.

*Localities, etc.* Jullien found the two forms here regarded as synonymous on Lamellibranch shells from an island in the Mekong River on the borders of Siam and Cambodia, from the interior of Cambodia and from the neighbourhood of Canton and the province of Ngan-Honi in China. My own examples of the species are on shells from the south-east corner of the Tai-Hu (Great Lake) in the Kiangsu Province of China. They were taken in the channel west of the island of Tong-Dong-Ding and in the Moo-Too creek, on a muddy bottom in from 6 to 10 feet of water, in December, 1916.

All specimens as yet found have been on the shells of molluscs; my own were on those of *Anodonta woodiana* (Lea) the animals in which were alive.

### *Hislopia malayensis*, sp. nov.

(Pl. I, fig. 9; pl. II, figs. 1, 1a.)

The species may be distinguished by the following diagnostic characters.

The *colony* is entirely adherent and of a more or less circular form, consisting of numerous primary branches that radiate from a common centre and give rise occasionally at an acute angle to lateral branches in the typical cruciform manner.

Adult *zooecia* are flattened, oval or ovoid and not or but very slightly pedunculate. Young terminal *zooecia* arise in the form of slender, pointed, flattened cylinders, which reach almost their full length and then expand fan-wise at the tip until they take the form of a comparatively long and narrow peduncle supporting a triangular or pentagonal head. The whole structure then gradually expands from in front backwards until the adult oval or ovoid outline is assumed. The ectocyst is hyaline and colourless except round the orifice; the margins of the *zooecium* are not thickened but are surrounded by a narrow rim of flat membrane. The orificial tubercle is low. The orifice is surrounded on three sides by a brownish chitinous rim, which does not bear spines, though it is usually quadrate or subquadrate, and is broadly interrupted posteriorly or proximally.

I can find no definite diagnostic characters in the polypide or musculature. Both are admirably displayed in stained and mounted specimens (pl. i, fig. 9).

*Type-specimens.* No. 7152/7 Z.E.V., Ind. Mus. (Zool. Survey of India); in alcohol.

*Locality, etc.* Small lake at the base of a limestone hill (Bukit Jalor) in the inland state of Jalor or Yäla in the Siamese province of Patani in the eastern part of the Malay Peninsula. The specimens, which were taken in the first week of February, 1916, were growing on a dead palm-leaf that had fallen into the water. Specimens were also taken by Mr. H. C. Robinson and myself at the same place in 1901. They met with an accident that caused them to dry up and I identified them provisionally as *H. lacustris*.

The colony is as a rule less congested than in *H. lacustris* and *H. cambodgiensis*, if more luxuriant in its growth than *H. moniliformis*. This is mainly because lateral branches are sparingly, but not very sparingly, produced. The successive forms assumed by the young terminal *zooecia* are most characteristic. In the other species I have seen the buds often attain a considerable length as flattened cylinders, but seem to assume the adult form gradually. Even in *H. cambodgiensis*, in which adult *zooecia* are normally pedunculate, I cannot find any state comparable to those marked c, d and e on fig. 1a, pl. ii.

The parietal muscles are fully developed in this species and vary greatly in number of fibres and in arrangement. In the *zooecium* figured on pl. i they consist of a number of imperfectly grouped or solitary fibres scattered chiefly on the outer side of the polypide.

In specimens preserved in alcohol the roof of the *zooecium* usually collapses to some extent and consequently these muscles are somewhat distorted or displaced.

The homologues of the pyramidal muscles of the orificial tubule in such genera as *Paludicella* consist of separate fibres grouped in a somewhat indefinite manner on each side of the orifice. It is not uncommon for them to be, as in the figure, markedly assymetrical.

The polypide, as I have already stated, agrees closely with that of *H. lacustris*, the general structure of which is discussed and figured in the "Fauna." There is considerable variation in the proportions of the different parts of the alimentary



canal. This is due partly to the different states of contraction in which different polypides are killed and partly to changes induced by growth and other physiological conditions.

There are apparently about 16 tentacles. In contracted specimens I cannot see the collar.

The star-shaped aperture by means of which a zooecium communicates with its parent and daughter zooecia are clearly defined and easily seen in this species (fig. 8A). There is no trace of a funiculus in connection with them. They are always surrounded by wandering cells, which may sometimes be seen actually over the aperture. The rays of the star-like aperture frequently bifurcate so as to produce a

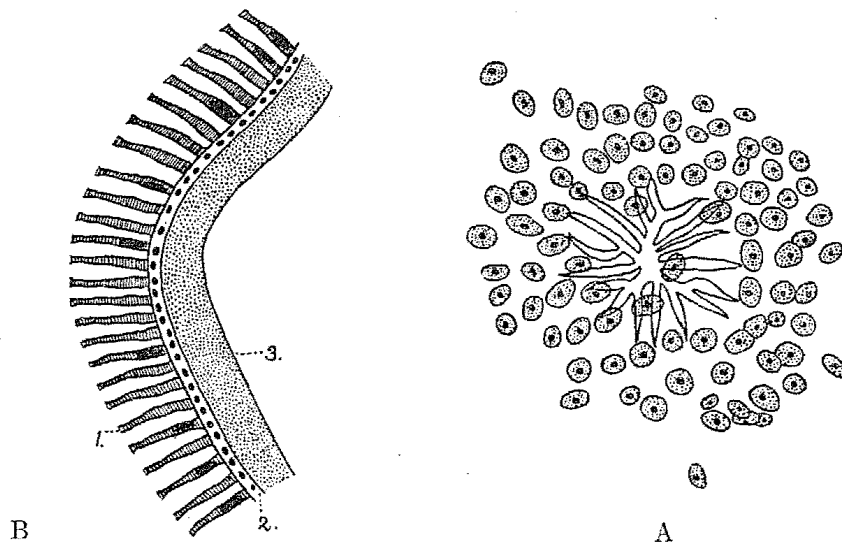


FIG. 8.—*Histopia malayensis*, sp. nov.

A.—Orifice between two zooecia as seen from within distal zooecium, showing wandering cells ( $\times 542$ ). B.—Optical section of wall of circular chamber ( $\times 542$ ).

1 = circular muscle-fibre 2 = internal cellular layer. 3 = horny lining of chamber.

somewhat complicated figure. At the points at which buds are given off or a daughter zooecium is attached to its parent, the flat marginal membrane is interrupted and a short peduncle is developed to form the actual linking structure. When adjacent zooecia not originally connected are pressed together by the growth of the colony, as in the preparation figured on plate i, fig. 9, the membrane of the older or more vigorous zooecium often grows over the membrane or over a part of the roof of the younger or less vigorous.

The ovaries are scattered round the periphery of the zooecial chamber and each produces several ova. The testes probably occur similarly but are not developed in the preparations I have examined. It is possible that the colonies are unisexual.

EXPLANATION OF PLATE I.

CHITASPIS ATHLETICUS, gen. et sp. nov.

- FIG. 1.—Lateral view of a part of the type-specimen, showing two polypiferous and parts or the whole of three non-polypiferous segments. One of the polyps has lost its capitulum.  $\times 46.5$ .

ALCYONIDIUM MYTILI, Dalyell.

- FIG. 2.—Retracted polypide from a specimen on a shell of *Potamides fluviatilis* from the Chilka Lake in Orissa.  $\times ca. 84$ .

TRITICELLA PEDICELLATA (Alder).

- FIG. 3.—Part of the rhizome of a specimen from the tail of the sea-snake *Enhydris hardwickii* from the Talé Sap, Peninsular Siam.  $\times 101$ .  
The stalks of the zooecia have been cut off near the base and have probably been somewhat compressed in the process.

PALUDICELLA ELONGATA, Leidy.

- FIG. 4.—Right lateral view of a zooecium from the roots of a willow tree at the edge of the Moo-Too creek, Tai-Hu, Kiangsu Province, China. (Stained with borax carmine).  $\times ca. 35$ .

PALUDICELLA PENTAGONALIS, sp. nov.

- FIG. 5.—Left lateral view (slightly oblique) of a zooecium of the type-specimen. (Stained with borax carmine).  $\times 67.5$ .  
,, 5a.—Orifice and adjacent parts of another zooecia from the same colony. (Stained with borax carmine).  $\times ca. 79$ .

VICTORELLA BENGALENSIS, Annandale.

- FIG. 6.—A group of zooecia from a colony growing on a stick in the Talé Sap, Peninsular Siam. (Stained with borax carmine).  $\times ca. 34$ .  
,, 7.—Polypide (partly expanded) from colony from Port Canning, Gangetic delta. a = Cardiac antechamber. c = Cardiac limb of stomach. ca = Oesophageal valve. f = Funiculus. i = Intestine. m = Cardiac muscle. oe = Oesophagus proper. p = Pharynx. r = Rectum. s = Pyloric limb of stomach. t = Tentacles.

HISLOPIA CAMBODGIENSIS (Jullien).

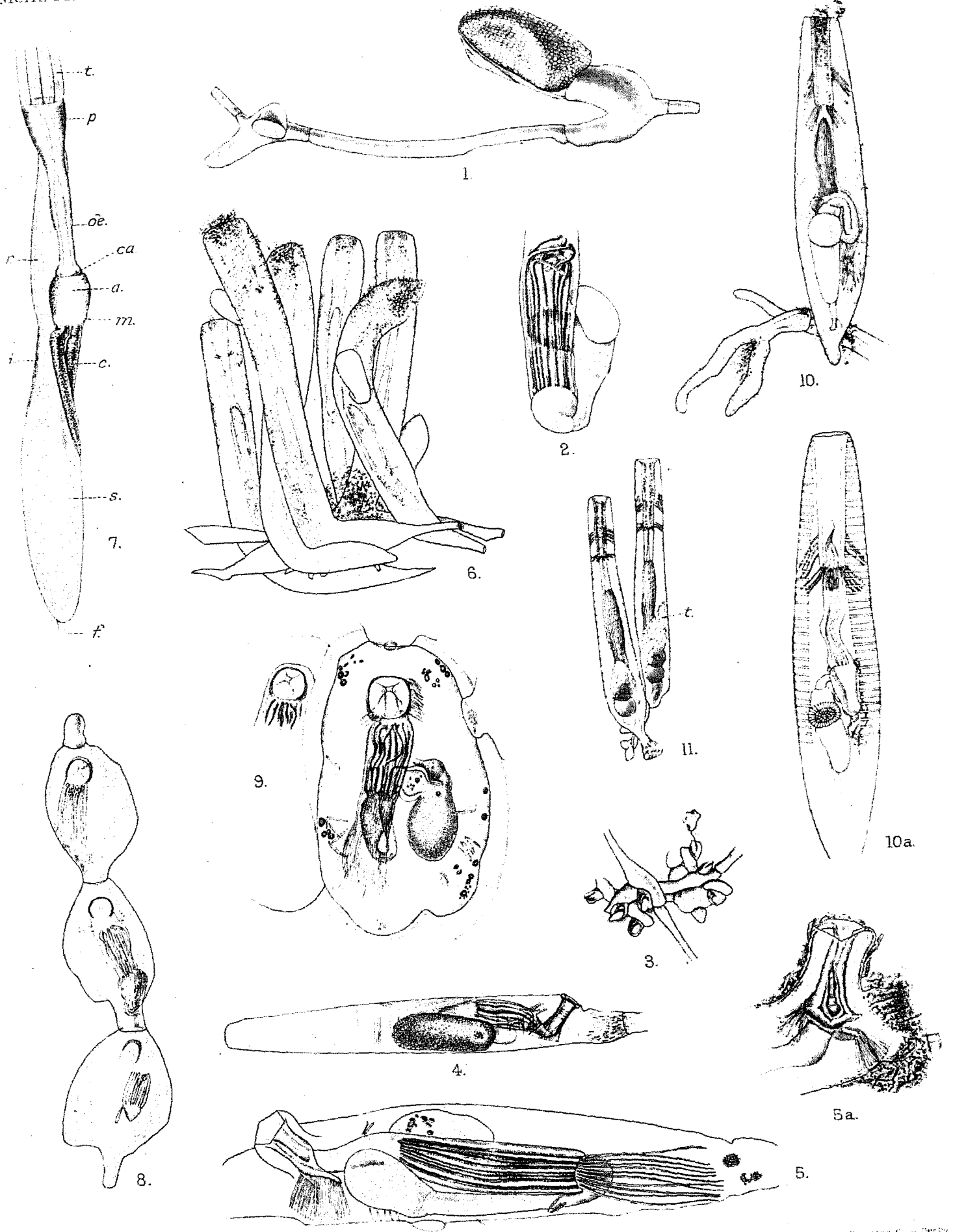
- FIG. 8.—Terminal part of a branch of a specimen growing on a living shell of *Anodonta* from the south-east part of the Tai-Hu, Kiangsu Province, China.  $\times 22.5$ .

HISLOPIA MALAYENSIS, sp. nov.

- FIG. 9.—Zooecium from type-specimen. (Stained with borax carmine).  $\times ca. 34$ .

BOWERBANKIA CAUDATA, Hincks.

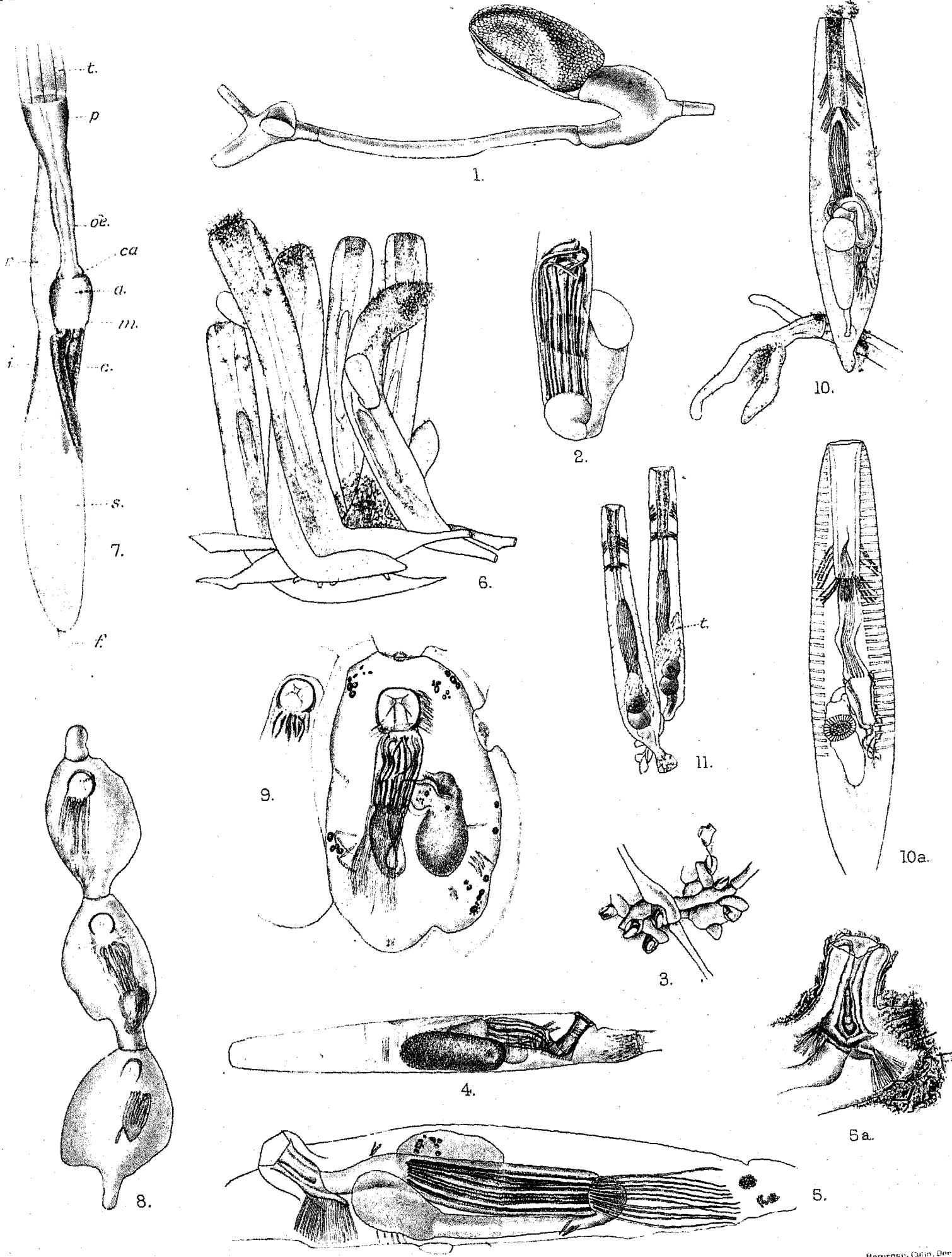
- FIG. 10.—Terminal zooecium of a colony from Port Weld, west coast of the Malay Peninsula.  $\times ca. 34$ .  
,, 10a.—Another zooecium from the same colony, showing parietal muscles, etc. (Stained with borax carmine).  $\times ca. 34$ .  
,, 11.—Two zooecia from a colony from the Talé Sap, Peninsular Siam, showing the expansion of the "tail" to form an organ of adhesion in one zooecium and its almost complete absence in another.  $\times ca. 34$ .  
t = Testes.



D. N. Bagchi, del.

ENTOPROCTA AND CTENOSTOMATA.

Hemlock, Calcutta, India



D. N. Bagechi, del.

ENTOPROCTA AND CTENOSTOMATA.

Berkeley, Calif., Dec.

EXPLANATION OF PLATE II.

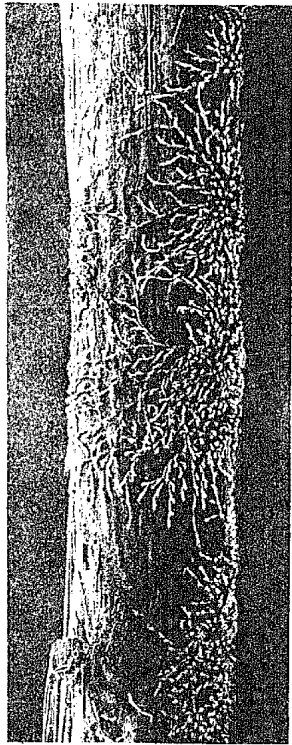
Photographs of Polyzoa and Sponges from Fresh and Brackish Water in the Malay Peninsula.

*HISLOPIA MALAYENSIS*, sp. nov.

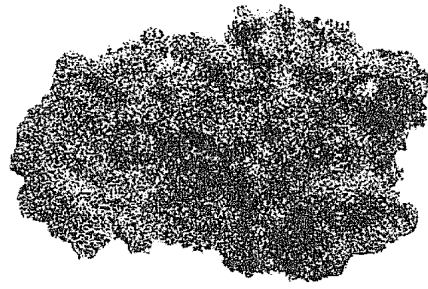
FIG. 1.—Type-specimen (nat. size).

„ 1a.—Part of the same enlarged. a, b, c, d, e = young zooecia in different stages of development.

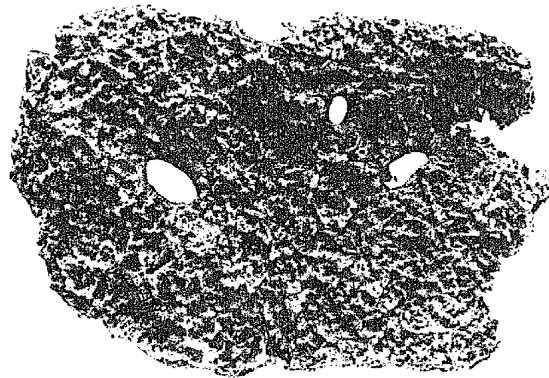
(The other figures in this plate will be explained in subsequent reports).



2.



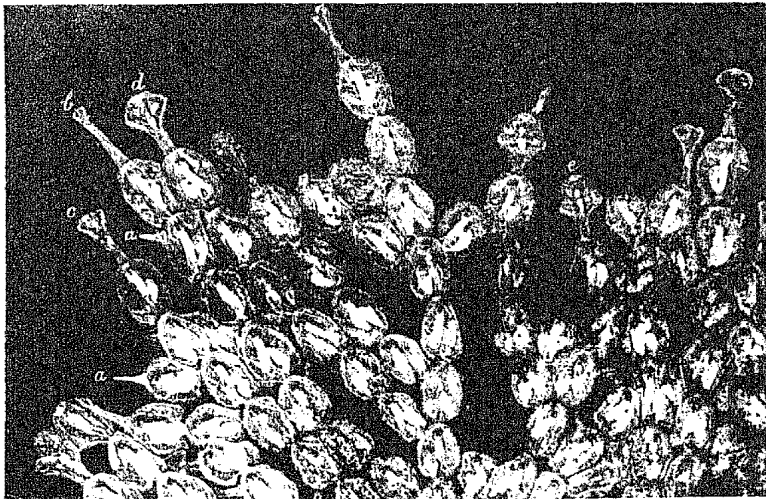
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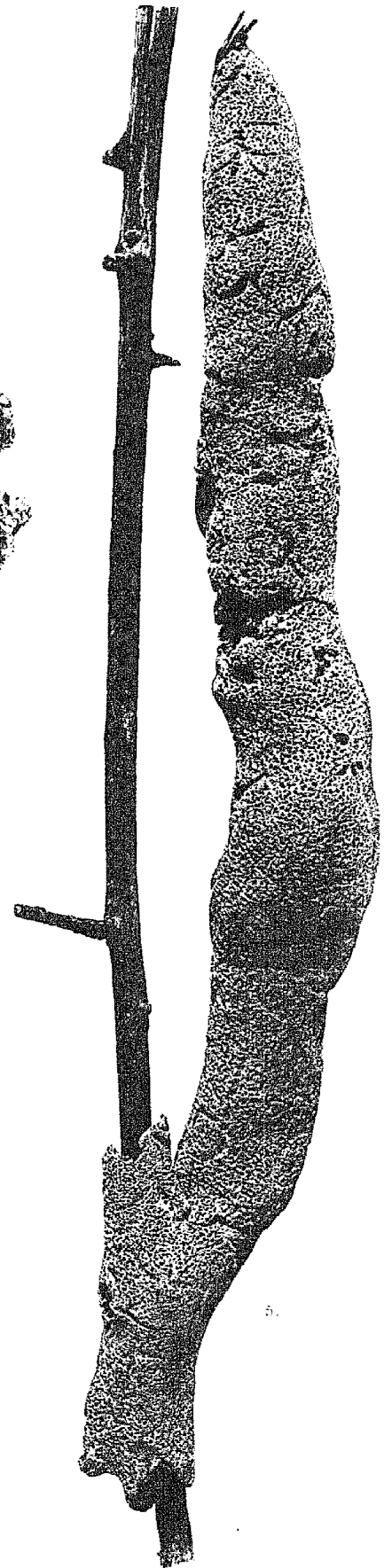
3.



4.



1a



5.

Photo. by D. Bagchi.

Fig. 5. *Spongia*, *Spongia* (Hutchinson) *Spongia*.