

## REPORT UPON THE TUNICATA IN THE COLLECTION OF THE INDIAN MUSEUM.

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(Plates I—V.)

The collection of Tunicata may, for the sake of convenience, be divided into three groups: (1) simple Ascidians, (2) compound Ascidians, and (3) pelagic Tunicata including the Ascidiæ Salpaeformes, the Thaliacea, and the Larvacea. The present report contains a detailed account of the first and third groups; the compound Ascidians, of which there are only a few specimens, will be worked up along with those from other sources and will be described and figured afterwards in a separate paper.

The collection generally was in a fairly good state of preservation, but some of the specimens, especially the pelagic forms, were rather in a poor condition, making in a few cases the identification extremely difficult. Among the simple Ascidians I found two specimens of which the test alone was preserved, so that it was impossible to determine with certainty to what form they belonged.

The group of simple Ascidians consists of seventeen species arranged in nine genera. Ten of the species seem to be new to science, and for one of these it was found necessary to form a new genus. The other group—the pelagic Tunicata—contains only one species of *Pyrosoma* and five species of *Salpa*, all of which are well known cosmopolitan forms, and a specimen of a very large Appendicularian, apparently belonging to the genus *Megalocercus*. The number of species recorded in this paper is, accordingly, twenty-four in all.

This collection, though a small one, is especially interesting on account of its containing five well-preserved specimens of an extremely aberrant simple Ascidian, very probably belonging to the genus *Hexacrobylus*, Sluiter. As is well known, this genus was formed by Sluiter for a curious deep-sea Ascidian dredged during the Siboga Expedition, which in external appearance was so unlike ordinary Ascidians that neither Weber nor Sluiter was able to guess its true nature until they cut open the only specimen. The description published in the Reports of the Siboga Expedition, based upon the examination of the unique specimen, could naturally not be quite satisfactory, and yet it has remained the only record of the genus. Under such circumstances the five specimens contained in the collection, though representing a different species, were extraordinarily valuable, and I paid special attention

to the internal anatomy of the animal. One specimen was carefully dissected and two others, removed from the test, were stained with borax carmine and cut into sections. Pl. III, fig. 2, is a reconstruction from such sections and represents, satisfactorily I hope, the relations of the internal organs of this very curious Ascidian.

The new genus *Monobotryllus* is interesting inasmuch as it represents a connecting link between the two families, the Styelidae and the Polystyelidae. Although itself a simple Ascidian, it is most closely allied, not to any of the simple forms, but to some members of holosomatous compound Ascidians. In the shape and position of the branchial sac and alimentary canal it very much resembles the genus *Botryllus* or *Botrylloides*, while in the arrangement of the gonads, which are hermaphrodite polycarps, it is so exactly like the genus *Michaelsenia* among the Polystyelidae that nobody would hesitate placing it in that genus, were the individuals found imbedded in a common test. This furnishes another instance showing that the division of the Ascidians into simple and compound forms is simply a matter of convenience.

The occurrence of a representative of the genus *Megalocercus* in the Indian Seas is of much interest zoo-geographically. This genus has hitherto been known only from three specimens procured from a considerable depth (600 and 900 meters) near Ischia and Capri in the Mediterranean.

Two specimens of simple Ascidians, belonging to widely different species, *Polycarpa annandalei*, n. sp., and *Ascidia willeyi*, n. sp., harboured each in the branchial sac a pair of macrurous crustaceans, which, judging from their size, must have entered the body of the host as larvae and grown up there to maturity. Although a number of crustaceans may frequently be found in the branchial sac or atrial cavity of Ascidians they are almost always amphipods or copepods; commensal macrurans living in pairs, as those found in the interior of the siliceous sponge *Euplectella*, have, so far as I am aware, never been recorded from Ascidians.

Before proceeding to the description of the species I wish to express my cordial thanks to Dr. N. Annandale, Superintendent of the Indian Museum, Calcutta, for having given me the opportunity of studying a material including so many interesting forms.

## ASCIDIAE SIMPLICES.

### Fam. MOLGULIDAE.

This family is represented in the collection by three species. Two of these belong to the genus *Molgula* (*Caesira*) and, though both of them are new to science, do not exhibit any striking characters. The third is a very remarkable form apparently belonging to the genus *Hexacrobylus*, Sluiter, which has hitherto been considered as the type of a separate order, the Aspiraculata, on account of the total absence of stigmata in the branchial sac. After a careful study of the internal anatomy, however, I came to the conclusion that it is more natural and convenient to place it, notwithstanding its most aberrant characters, in the family Molgulidae. A preliminary note on this animal giving the reasons for regarding it as a highly modified

Molgulid was published in "*Zoologischer Anzeiger*", Vol. XLIII, No. 1, in November 1913.<sup>1</sup>

**Molgula simulans**, n. sp.

(Pl. II, figs. 1 and 2.)

*External Appearance.*—The body is ovate, broad and rounded at the anterior end and somewhat tapering towards the posterior, the long axis being directed antero-posteriorly. It is compressed laterally, evidently in consequence of preservation. The apertures are sessile, not conspicuous; they are situated at the dorsal and ventral edges of the anterior end, the distance between them being about one-fifth of the longitudinal circumference of the body. The animal is not attached.

The surface of the body is regular and even, and is pretty smooth. There are, however, a large number of small papilla-like processes, corresponding no doubt to the delicate hairs of other Molgulids, scattered all over the surface. These are usually short and almost conical, but in some places they are longer and may even be branched. On account of the adhering mud particles they appear as minute opaque dots on the surface of the otherwise transparent test. Here and there foraminiferan shells and broken sponge spicules are found attached to the external surface of the body. The colour of the animal preserved in alcohol is a light transparent grey.

The dimensions of the three specimens are as follows:—

Specimen.	Entire animal.	Internal body.
No. 1	10 mm. × 7 mm.	4 mm. × 5 mm.
No. 2	8 mm. × 5 mm.	3 mm. × 3.5 mm.
No. 3	7.5 mm. × 5 mm.	3 mm. × 3 mm.

The *Test* is thin, soft, gelatinous, and quite transparent. Between the papilla-like processes, which are mostly opaque, the outer surface of the test is entirely naked, allowing the mantle and the viscera to be seen distinctly from the outside. There are no blood vessels traversing the substance of the test.

Owing to the contraction of the mantle the internal body taken out of the test is considerably smaller than the entire animal (see the dimensions given above). There is a large space between the test and the mantle all over, the latter being separated from the test except round the apertures; in the posterior half of the body this space is especially large so that here the test is hollow inside. The internal body is, consequently, broader than it is long, *i.e.* its greater diameter lies dorso-ventrally. It is oval or almost spherical with the short siphons projecting from the dorsal and ventral edges of the broad anterior end (Pl. II, fig. 1). The branchial siphon is pointed anteriorly and somewhat ventrally, and is distinctly six-lobed; the atrial is directed anteriorly and is four-lobed. The lobes are triangular and pointed.

The *Mantle* is thin, almost membranous, and transparent. The musculature is only feebly developed, the bands being fine and distant, with the interstices filled up

<sup>1</sup> Dr. R. Hartmeyer, of Berlin, who is at present engaged in drawing up a complete list of the Ascidiaceans for "*Das Tierreich*", has told me in a letter that he will in that work relinquish the Order Asciparaculata and place the genus *Hexacrobylus* in the family Molgulidae.

with gelatinous connective tissue. The muscular bands either radiate from the bases of the branchial and atrial siphons, or run parallel with their lower edges, so that they generally cross one another at right angles and form a more or less regular network with large rectangular meshes. Posteriorly the work is more irregular. The siphons are short, but the sphincters are tolerably well developed.

The *Tentacles* are much branched and not numerous. There are about seven large ones and, alternating with these, about the same number of much smaller ones. In the interspaces between these branched tentacles a number of minute, unbranched, almost papilla-like, rudimentary tentacles are found, arranged in a row. The mode of branching of the larger tentacles is rather irregular and the terminal twigs end bluntly, as is usual in other Molgulids (Pl. II, fig. 2).

The *Branchial Sac* is tolerably well developed and has seven distinct folds upon each side; those next the endostyle are rather slighter than the others. These folds, however, do not include the stigmatic part of the branchial sac, but are formed entirely of a number of internal longitudinal bars united by short transverse vessels, and thus form an open network with rectangular meshes. Usually eight to ten internal longitudinal bars form a fold, while there is none in the space between two folds. Narrow horizontal membranes are seen running transversely from fold to fold at the same levels as the transverse vessels. The stigmata form large flat infundibula arranged regularly in longitudinal and transverse rows, each infundibulum being composed of a single spiral with six to eight turns. The longitudinal rows of infundibula coincide in position with the folds in the interior of the branchial sac, but as the infundibula are extremely shallow, they hardly project into the folds. The boundary lines between the transverse rows of infundibula correspond in position with the transverse vessels on the folds. The arrangement of the infundibula is therefore much the same as that found in the genus *Eugyra*. The peripharyngeal ridge is conspicuous by being strongly undulated.

The *Dorsal Tubercle* is very simple, the opening being a short straight slit with slightly raised lips, situated longitudinally in the centre of a rather small peritubercular area.

The *Dorsal Lamina* is a plain broad membrane with no ribs and no teeth.

The *Alimentary Canal* forms a long narrow loop upon the left side. The oesophageal aperture is situated rather backward in the branchial sac, near the dorsal edge of the body. The oesophagus is short, narrow, and cylindrical, and opens into the wider end of the small pyriform stomach. There are no hepatic folds, and the posterior end of the stomach is not sharply bounded from the intestine. The intestine runs posteriorly and ventrally for some distance, then turns round abruptly, and returns closely pressed against the anterior wall of its first part, so that no open loop is formed, and finally runs anteriorly along the dorsal edge of the branchial sac past the oesophageal aperture and opens just opposite the lower edge of the atrial siphon. The anal opening is entire and smooth. The greater part of the alimentary canal is firmly attached to the inner surface of the mantle and is clearly visible from the external surface.

*The Gonads* are paired; that on the left side is placed anteriorly to the intestinal loop, close to the place of bending of the latter, while the other one is situated in the centre of the right side; both are attached to the inner surface of the mantle. They are roundish oval in shape, with the peripheral part divided into a number of small lobes. The ducts of the genital glands, as well as the renal organ, could not be satisfactorily made out.

*Locality.*—Station 277, 5° 48' 15" N., 80° 56' E.; depth 859-880 fathoms; bottom green mud and sand; January 10th, 1901. Three specimens.

This interesting little species looks externally very much like *Eugyra*. The large infundibula arranged regularly in longitudinal and transverse rows and showing clearly through the transparent test strongly reminds one of those of *Eugyra*, so that at first glance one is greatly tempted to refer the animal to that genus. On cutting it open, however, it becomes at once clear that we have here, not *Eugyra*, but a member of the genus *Molgula*, which is characterized by the branchial sac being disposed in well marked folds. There are, indeed, some species of *Molgula* already known, such as *M. eugyroides*, Traustedt (16) from the West Indies and the two species, *M. sordida* and *M. crinita*, Sluiter (13) from the Malay Archipelago, which have the branchial sac with large infundibula arranged regularly like that of *Eugyra*, but the present species is quite distinct from all of them. It differs from *M. eugyroides*, whose "gjellesaekken minder i en paafaldend Grad om Eugyra-Slaegtens", in having seven folds instead of six upon each side of the branchial sac, and also in having eight to ten internal longitudinal bars on each fold instead of three or four. The other two species, which have both seven folds on each side, can readily be distinguished from the present species by the unusual number of the lobes at the branchial and atrial apertures, *M. sordida* having seven lobes at the branchial and none at the atrial, while *M. crinita* has both apertures four-lobed.

Of the three specimens one was tolerably well preserved, though somewhat contracted; and the above description refers mainly to this specimen. The remaining two had the whole internal body so strongly contracted that it was impossible to study the internal anatomy satisfactorily.

### *Molgula birmanica*, n. sp.

(Pl. I, figs. 1—2; pl. II, figs. 3—7.)

*External Appearance.*—The body is roughly speaking egg-shaped, with the longer axis directed dorso-ventrally. The anterior surface is usually sunk in, so as to form a shallow elliptical depression, at the bottom of which the short siphons are placed (Pl. I, fig. 1). The posterior end is broad and rounded. The dorsal and ventral edges are both strongly convex, but the ventral is more so than the dorsal, the former corresponding with the pointed end of the egg. The animal is not attached, lying at the bottom either singly or gathered into groups of several individuals.

The apertures are borne on short siphons, and are not distant. The siphons form knob-like prominences and are distinctly visible even when they are fully

retracted. The number of lobes at the apertures, which is as usual six for the branchial and four for the atrial, is always discernible, though very faintly, from the outside.

The surface is entirely covered with a layer of fine sand attached to the hair-like processes of the test. The sandy coating is partly continued on the siphons, thus rendering them incapable of being completely retracted. The colour of the sand is dark greenish grey.

*Size*: length of the body (dorso-ventral) 28 mm., breadth of the body (antero-posterior) 21 mm., distance between the apertures 7 mm.

The *Test* is thin (less than 0.2 mm. in thickness), membranous but rather tough, and is quite transparent. It bears fine, branched, hair-like processes all over the outer surface, to which sand is attached in such quantity as to form a solid coating of uniform thickness (about 0.5 mm). On sections it is clearly seen that the sand grains are also attached to the outer surface of the test itself, but are never imbedded in the substance of the test. The length of the hair-like processes does not exceed 1 mm.

The internal body taken out of the test has nearly the same form as the entire animal (Pl. II; figs. 3 and 4), the test being in close contact with the mantle all over. The test can, however, be separated with ease except at the tips of the siphons where it is firmly attached to the mantle. The siphons, though short, are prominent, and the lobes at the branchial and atrial apertures are very distinctly seen. Most of the internal organs, particularly the gonads, the intestine, and the endostyle show through the mantle. The internal body is of a pale brownish-grey colour with a slight tinge of greenish-yellow.

The *Mantle* is thin, membranous, and for the most part transparent. The musculature is not strong; in the anterior part of the body stout longitudinal bands radiating from the bases of the siphons are conspicuous, but in the posterior half there are scarcely any muscle bands visible to the naked eye. Examined under a low power, however, we find minute spindle-shaped muscle bands, so characteristic of the Molgulidae, scattered over the whole extent of the mantle. They are very minute and run in all directions, not forming a continuous layer. In the anterior part of the body they lie mostly in a transverse direction so as to cut the conspicuous longitudinal bands at right angles. Ring muscle fibres are well developed on the siphons, especially at their base, and form powerful sphincters.

The *Tentacles* are compound, and much branched; there are about seven large and seven small ones placed alternately. The larger tentacles show ramifications repeated to the fifth order. The stem is pyramidal and curved so as to have the convex side looking posteriorly. The fine terminal twigs end rather bluntly, with the epithelial lining somewhat thicker at the tip than elsewhere.

The *Branchial Sac* is moderately strong, with seven distinct but narrow folds on each side. There are usually three or four internal longitudinal bars upon each fold, and none in the space between two folds. The transverse vessels are very irregular; they originate at the base of the folds and soon divide and anastomose to form a network in the meshes of which the infundibula are placed. Narrow, delicate mem-

branes springing from the branches of the transverse vessels run in all directions over the space between the folds. The stigmata are very irregular in shape, being short and almost straight or even oval in some places, while in others they are long and wavy or curved in spirals. These spirals are quite irregular both in size and in position, the larger ones form conical infundibula, but the smaller ones are perfectly flat (Pl. II, fig. 6). The endostyle is long, but rather narrow.

The *Dorsal Tubercle* is elliptical or kidney-shaped with the greatest length antero-posterior; both horns are coiled inwards and form simple spirals of nearly equal size; the aperture is at the left side. It occupies the centre of a flat triangular peritubercular area (Pl. II, fig. 7).

The *Dorsal Lamina* is narrow and very thick; it looks like a stout internal longitudinal bar, and there are no ribs and no marginal teeth.

The *Alimentary Canal* forms a long curved closed loop on the left side. The oesophageal aperture is on the dorsal side of the branchial sac at the posterior extremity of the dorsal lamina, and the oesophagus curves posteriorly to open into the oblong stomach situated at the dorsal edge of the posterior end. The wall of the stomach is thick, and its outer surface is rough from the presence of a number of small rounded projections.

The *Gonads* are present on both sides of the body. The gland on the left side lies dorsally to the place of abrupt bending of the intestine, while the opposite gland occupies the centre of the right side. They are irregular in shape, being composed of minute follicles, and there is no apparent distinction between the ovarial and testicular portions of the gland. A common genital duct is seen springing from the middle of the inner side and running for a short distance towards the base of the atrial siphon.

The *Excretory Organ* is a long, slightly curved, sausage-shaped sac, situated posteriorly to the genital gland of the right side. A small number of irregularly shaped brownish concretions are found floating in the sac.

*Locality*.—Byickhwaaw Bay, Lower Burma, "Investigator", 1911. About a dozen specimens.

This species is very closely allied to *M. martensi*, Traustedt, a species collected by the "Gazelle" in Mermaid Strait in North-West Australia. In the external appearance, the shape of the body, and the configuration of the intestinal loop, the two species are almost identical, and, besides, they are both from the Indian Ocean. There are, however, certain differences in the internal anatomy which necessitate the specific separation of these two forms. In *M. birmanica* the dorsal tubercle is elongated antero-posteriorly with both horns coiled inwards, whereas in *M. martensi* it is broad and S-shaped with one of the horns bent outwards and the other inwards—"Fomreorganet stort, bredere end langt, S-formigt, det tilhøire liggende Horn udad—det tilventre liggende indad krummet." Then, the latter species has usually six internal longitudinal bars on one side of the fold, the stigmata are mostly straight, and the anus has "3 store Lappen in Randen", all of which characters do not apply to our species. They are also different in size, *M. martensi* being much the larger of the two.

**Hexacrobylus indicus, Oka.**

(Pl. I, fig. 3; pl. II, figs. 8-13; pl. III, figs. 1 and 2.)

*Hexacrobylus indicus*, Oka, A., Zur Kenntnis der zwei aberranten Ascidiengattungen, *Dicopia*, Sluiter und *Hexacrobylus*, Sluiter. *Zool. Anz.* Bd XLIII, No. 1, 1913.

*External Appearance.*—The body is ovate in shape, and is slightly compressed laterally (Pl. I, fig. 3, and pl. II, fig. 8). The anterior or upper end is broad and rounded, the posterior or lower is somewhat narrower and slightly pointed. The dorsal and ventral edges are equally convex. The branchial aperture is situated a little above the middle of the ventral edge, and is very large and conspicuous. The atrial aperture is placed in the middle of the anterior surface, *i.e.* at the summit of the body, looking anteriorly; it is very small and insignificant. The animal is not attached, having its lower end simply imbedded in sand or mud of the bottom.

The configuration of the branchial aperture is very peculiar. It is a wide transverse slit, more or less gaping in all the specimens, and guarded by what seems at first glance to be thick projecting warty lips. In reality the opening is surrounded by six pinnately branched processes arranged in such a manner that two of them stand on the anterior border and the remaining four on the posterior border of the aperture. They are not all of one size, those on the anterior border being the largest, while the median ones on the posterior border are slightly smaller than the lateral ones (Pl. II, fig. 9). In consequence of preservation in alcohol they are all strongly contracted and bent inwards, and the stem exhibits a series of transverse furrows corresponding to the intervals between the lateral branches, of which there are five to seven on each side. These branches are again ramified (Pl. II, figs. 10 and 11). Judging from the development of muscular fibres in their interior it is highly probable that these processes could be expanded during life, like the tentacles of Alcyonarians, to serve as an organ for collecting food.

The external surface is covered all over with delicate woolly hairs. These generally are rather short, but at the lower end of the body, which seems to have been buried in mud or sand, they are much longer. Sand grains and foraminiferan shells are seen here and there adhering to these hairs. The colour of the animal is a light brownish-grey, owing to fine mud particles on the outer surface. Held against the light, the body is found to be semi-transparent. The six tentacle-like processes of the branchial aperture are almost destitute of hairs and are much darker.

The dimensions of the five specimens are as follows:—

Specimen.	Length (antero-posterior).	Breadth (dorso-ventral).	Thickness.
No. 1	34 mm.	23 mm.	20 mm.
No. 2	28 mm.	20 mm.	15 mm.
No. 3	25 mm.	18 mm.	14 mm.
No. 4	20 mm.	15 mm.	10 mm.
No. 5	19 mm.	15 mm.	12 mm.

The *Test* is composed of two layers, an outer and an inner. The outer layer, which is formed mainly of the basal parts of the delicate hair-like processes, is very

thin all over and can be peeled off as a fine, moderately tough membrane. The hairs are outgrowths of this layer and are seen to spring densely from the surface in an oblique direction. Each hair is nearly of the same thickness throughout and is never branched; the surface is rugged and is covered with fine mud particles. The inner layer or the test proper is soft, cartilaginous, almost colourless and transparent. Its thickness varies considerably in different parts, so that the internal body, taken out of the test, has quite a different shape compared with the entire animal (Pl. II, fig. 12). It is thickest in the region lying between the branchial and atrial apertures where it is nearly 5 mm. thick, while at the opposite end of the body it is less than 0.5 mm. thick. The inner surface is even and smooth, and is of the same colour as the substance of the test proper. A thin continuation of the test extends for some distance inwards from the branchial aperture.

The internal body has a very peculiar shape. It consists of a globular trunk from the anterior end of which two large siphons are projecting. One of these, the atrial, exhibits no striking character, being simply a long, conical, slightly curved tube directed anteriorly and ending in a small four-lobed aperture, but the other, the branchial, is modified in a most extraordinary manner, and its shape is quite unique among the whole group of the Ascidiacea. Roughly speaking, it may be compared with a very short but wide tube bent in a curve, with one end compressed so as to represent a bilabiate mouth, and the wall on the convex side puffed out in the form of a hemispherical dome. The branchial aperture is directed ventrally, the rounded dome-like surface looks anteriorly, and the whole structure is placed at the ventral edge of the anterior end of the trunk. The branchial siphon is nearly as large as the trunk itself, and as there is a slight constriction looking like a neck between the trunk and the siphon, one is reminded of a bird's head with a disproportionately wide mouth. Strangely enough, there is nothing in the external appearance of the animal suggestive of this peculiar configuration of the internal body.

The *Mantle* is very thin and transparent in the trunk region, and scarcely any muscle bands are visible in this part of the body. On the siphons, on the contrary, both the connective tissue and the muscular bands constituting the mantle are well developed. There are strong muscle bands forming the rim of the branchial aperture, and a number of concentric annular bands are seen running parallel with the former. The longitudinal muscle bands are also numerous; they all start at the margin of the aperture, and run on the inner side of the transverse bands, cutting them at right angles so as to form a regular network with rectangular meshes. On the anterior surface of the body the longitudinal bands disappear gradually, being lost in the connective tissue, but on the ventral side they all terminate rather abruptly in a line marking the posterior boundary of the branchial siphon. Each of the tentacle-like lobes surrounding the branchial aperture is provided with a bundle of strong muscle fibres which fill up the axial portion of the stem. On reaching the base of the process just inside the rim of the branchial aperture, these fibres diverge and are either mixed up with the longitudinal and transverse bands of the branchial siphon proper or are gradually lost in the connective tissue (Pl. III, fig. 1).

The musculature of the atrial siphon is simple and regular, being composed of longitudinal and transverse bands cutting one another at right angles so as to form a very regular network.

The *Tentacles* are entirely absent. There is not even a trace of these organs, whose much branched and dendritic form is so characteristic of the family Molgulidae.

The *Branchial Sac* is in a totally reduced condition. There is, it is true, a more or less widened part of the alimentary canal in front of the narrow oesophagus, but this region exhibits nothing characteristic of a Tunicate pharynx. The walls are not perforated, and there are no stigmata, no endostyle, and no dorsal lamina, if we do not count as such a slight longitudinal ridge immediately below the opening of the dorsal tubercle. Besides, there is no demarcation between this part and the oesophagus proper. The inner surface is perfectly smooth, and the lining epithelium seems not to be ciliated. A network of fine blood spaces traversing the wall probably subserves the respiratory function. The boundary between the internal wall of the branchial siphon and the pharyngeal portion of the oesophagus is very distinct, since the former is lined with a thin layer of test, whereas the latter has of course the epithelium naked.

The *Dorsal Tubercle* is situated on the dorsal wall of the pharyngeal region just below its anterior boundary. It is a simple round pit with scarcely raised lips, connected by a short canal with the subneural gland lying immediately underneath the nerve ganglion. The latter is oval-shaped and is placed at the anterior end of the trunk between the bases of the branchial and atrial siphons. It gives off six nerve trunks, one to each of the tentacle-like lobes of the branchial aperture.

The *Alimentary Canal* consists, as usual, of oesophagus, stomach, and intestine, and forms a loop twisted somewhat in the shape of the figure 8. The oesophagus, which is fairly long but rather narrow, is directed posteriorly and dorsally and opens into the anterior end of the stomach. The stomach is of an elongated oval form, and lies obliquely in the hindermost region of the trunk with its hind end looking ventrally and a little towards the left. The wall of the stomach is smooth both inside and outside. The intestine, immediately after leaving the stomach, turns dorsally and, running along the inner surface of the mantle of the left side, reaches the dorsal edge of the body and then turns anteriorly to open into the cloacal cavity at the base of the atrial siphon. The anus is somewhat bilabiate with entire margins. A rounded pouch-like liver is present, attached to the hind part of the stomach. It is a large organ, hollow inside, crenated externally, and placed in the centre of the trunk, occupying the space between the stomach and the renal organ.

The *Gonads* are symmetrically developed on both sides of the body. The ovaries and the testes are separate, and each gland is provided with its own duct. The testes, of which there is one on each side, are attached to the inner surface of the mantle about half way between the anterior and posterior end of the trunk, and rather nearer the ventral than the dorsal edge. Each testis is roughly oval in outline, and is composed of a large number of branched seminiferous tubules. The vas deferens is extremely short and opens directly into the lateral region of the peribranchial cavity.

The ovaries, of which we find likewise one on each side, are elongated tubular organs placed for the greater part horizontally in the same level with the testes and in direct contact with the dorsal part of these organs. Each ovary is bent almost at a right angle near its distal end, so that the terminal portion assumes a vertical position. This part is pointed anteriorly and is directly continuous with the oviduct. The latter is short and wide and opens with a large gaping aperture into the cloacal cavity at the base of the atrial siphon. The axial portion of the ovary is taken up by a spacious canal directly continuous with the oviduct, while the ova are found imbedded in, or bulging out of, the thickness of the wall.

The *Excretory Organ* is globular in shape, and is situated just inside the mantle on the ventral median line of the trunk. It is a large, completely closed, sac-like organ with thin transparent membranous walls, in which a comparatively large dark brown spherical concretion is seen floating.

*Locality.*—South of Ceylon, at Station 278; 6° 52' N., 81° 11' E.; depth 1912 fathoms, bottom green mud and sand, January 11, 1901. Five specimens.

The genus *Hexacrobylus*, undoubtedly the most extraordinary member of the Order Ascidiacea, has hitherto been known to science in only one species, namely, *H. psammatodes*, Sluiter (13, 14). A single specimen of this form was collected during the Siboga-Expedition at Station 211 (5° 40' 7" S., 140° 45' 5" E.) from a depth of 1158 meters, and a detailed account of its external appearance and its internal anatomy, so far as could be ascertained from the unique specimen, was given by Sluiter in 1905 in the Report of that Expedition. As the present species differs markedly from this form in some essential points of structure, it will be interesting to go over the more important organs and examine the differences and resemblances which they exhibit in these two forms.

In regard to the external form, the difference between the two species appears to be considerable. In *H. psammatodes* the body is provided at the anterior end with a distinct collar, sharply bounded from the trunk proper and a little narrower than the latter. The trunk proper is cylindrical in shape and bears a small tail-like atrial siphon at the posterior end. Thus, in this species, the branchial and atrial apertures lie at the anterior and posterior extremities of the body, whereas in the new species here described the branchial aperture is on the ventral edge and the atrial on the anterior surface, so that the two apertures are separated only by a fraction of the longitudinal circumference of the body. However, this difference might be more apparent than real, since the condition met with in *H. psammatodes* would also be produced in *H. indicus* if the atrial aperture were shifted dorsally until it came to lie opposite the branchial, and the denominations of parts were changed accordingly. The condition of the external surface and the colour of the animal seem to be essentially the same in both forms.

In *H. psammatodes* the test is very thin, especially on the ventral side, but on the tentacle-like lobes of the branchial aperture it is thicker and brittle on account of foreign bodies imbedded in its substance. In *H. indicus*, on the contrary, the test is rather thick all over, and is elastic and never brittle. The delicate hair-like

processes of the test are in *H. psammátodes* least numerous on the ventral side, while in our species these processes are best developed at the posterior end, evidently corresponding to the ventral side of the Malayan species.

The musculature of the mantle exhibits, roughly speaking, the same type of arrangement in both species. There are but few muscle bands on the trunk proper, while on the siphons they are pretty well developed. The strongest muscle bands are found in both species along the margin of the branchial aperture and inside the tentacle-like lobes surrounding it.

The tentacles show a very striking difference in the two species. In *H. psammátodes* there are more than a hundred tentacles having the form of short finger-like filaments. As stated above, our species has no tentacles at all.

The branchial sac, which is the most characteristic feature of the genus, exhibits a wonderful conformity in the two species. In both forms it is narrow, and its walls are perfectly intact, there being no stigmata perforating them. Between the pharyngeal portion of the alimentary canal and the oesophagus there is no visible constriction, so that these two regions cannot be sharply defined.

The course of the alimentary canal is very different in the two species. In *H. psammátodes* it is very short and wide, and runs almost in a straight line to the anus at the hind end of the trunk, there being no stomach and no intestinal loop, a condition not found in any other known Ascidian. The liver, which is a conspicuous organ in our species, was not observed in *H. psammátodes*.

The gonads show partly a close agreement and partly a remarkable discrepancy in the two species. Both have the testes and ovaries developed one on each side, and the gonoducts are all separate. The testis is roughly oval in outline, while the ovary is elongated and bent in knee-like fashion. But in *H. psammátodes* each genital gland is provided with a large bladder-like sac with thin membranous walls, and differs in this respect markedly from the gonads of all other Ascidians. In the present species nothing comparable to these sacs could be observed.

The excretory organ is not mentioned in Sluiter's description of his species. In *H. indicus*, on the other hand, there is a large globular renal sac containing brown concretions, exactly like that of a typical *Molgula*.

As seen from the above comparison, the two species, while agreeing in many important points of structure, still exhibit so great a difference that it would seem almost necessary to regard them as the types of two different genera. When we consider, however, that they agree in a most striking manner just in those points which separate them so widely from all other Ascidians, and further that only a single specimen of *H. psammátodes* could be examined, which of course made the investigation of the internal anatomy somewhat difficult, it is thought best, at least for the present, to unite the two forms under one generic title and amend the diagnosis of the genus *Hexacrobylus* accordingly. Under these considerations I have decided to name our species *Hexacrobylus indicus*.

The only other simple Ascidian hitherto known which shows any close affinity to the genus *Hexacrobylus* is the curious deep-sea form *Oligotrema psammites*, collec-

ted by Dr. Willey off Lifu, New Britain, and described by Prof. Bourne in the "Quarterly Journal of Microscopical Science" in 1903 (1). In external appearance this species looks very much like an Alcyonarian zooid having six pinnately branched tentacles surrounding the mouth-opening at the anterior end of the body. In regard to internal anatomy it agrees with *Hexacrobylus indicus* far better than *H. psamatodes*. The intestine forms a loop, with distinct oesophagus, stomach, and intestine, and there is a globular renal sac lying on the ventral side of the stomach. The chief point of difference, which renders the generic separation of the two forms necessary, is found in the structure of the branchial sac. This organ is likewise much reduced in *Oligotrema*, being nothing more than the widened anterior portion of the alimentary canal, but its walls are perforated by a number of rudimentary stigmata.

#### Fam. CYNTHIIDAE.

This family is represented in the collection by four species: *Cynthia lanka*, Herdman; *C. sluiteri*, n. sp.; *Rhabdocynthia ceylonica*, Herdman; and *Microcosmus manaarensis*, Herdman. Three of these were collected for the first time by Herdman on the coast of Ceylon, and were described in his "Report on the Pearl Oyster Fisheries", 1906 (7). The remaining one, which is new to science, shows a close affinity to *C. spinosa*, Sluiter (15), from the Gulf of Tadjourah on the eastern coast of Africa. It is curious to find that out of the four species two are entirely covered by a thick coating of sand, which is rather exceptional in this family.

#### *Cynthia lanka*, Herdman.

(Pl. I, fig. 4.)

*Cynthia lanka*, Herdman, *Report on the Pearl Oyster Fisheries of the Gulf Manaar. On the Tunicata*, 1906.

*Localities*.—(1) Palk Strait, 12 fathoms. One specimen. (2) Mergui. One specimen. (3) Laccadive Sea, at Station 246, 11° 14' 30" N., 74° 57' 15" E.; depth 68-148 fathoms; bottom sand and stones; October 15th, 1897. Two specimens.

In one of the specimens the ridge joining the apertures on the anterior end is well marked, and the configuration of the apertures is exactly like those shown in Herdman's figures. In the remaining three the ridge is only very faintly represented and the apertures are simply cross-shaped as in the majority of *Cynthia*. The sandy coating of the test is in one specimen, from Palk Strait, rather thick (about 3 mm.), while in the others it is "not thick", as given in the original description of the species. The branchial and atrial siphons are of nearly the same length, and the minute spines lining the branchial siphon are yellowish-green with beautiful metallic lustre. The zigzag arrangement of the oviduct connecting the gonads is very conspicuous except in the specimen from Mergui, which also differs somewhat in the course of the intestinal loop reaching higher up than in the other specimens. Otherwise the internal anatomy agrees pretty well with the accounts given by Herdman. The dimensions of the four specimens are 30 mm. × 26 mm., 24 mm. × 18 mm., 23 mm. × 17 mm., and 20 mm. × 15 mm. respectively.

*Cynthia sluiteri*, n. sp.

(Pl. I, fig. 5; pl. III, figs. 3 and 4.)

*External Appearance.*—The body is roundish ovoid in shape, and is not compressed laterally. The branchial aperture is at the anterior end, and the atrial about one-third down the dorsal edge; they are both cross slit, and are borne each on a very short, truncated, conical projection. The animal is attached by the ventral edge and near the ventral half of the left side.

The surface in the exposed part of the test is regular and even, but very rough from the presence of small pointed scales all over. On the lips of the apertures these suddenly increase in size and form large branched spines. The latter, however, are not numerous, being arranged in a single irregular row round the aperture. The attached surface of the test is provided with numerous short but branched root-like processes to which a few shell fragments and sand grains are seen attached. Along the boundary line between the free and attached parts of the surface, the test is slightly raised, so as to form a very low ridge running in a circle.

The scales covering the greater part of the test are roundish in outline, slightly elevated, and are each provided with a small pointed spine at or near the anterior border (Pl. III, fig. 4). The base of this spine is surrounded at some distance by a number of much smaller prickles arranged in a circle. The larger spines found on the lips of the aperture consist each of a straight stem, tapering towards the tip, from which a number of lateral prickles spring at three or four different levels (Pl. III, fig. 3). Some of these spines are 1.5 mm. long and are surrounded at the base by a circle of curved pointed prickles. There are, besides, smaller spines which look like intermediate stages between the larger spines and the ordinary scales shown in the figure.

The colour of the body is a dull greyish-yellow. The tips of the spines and prickles are dark brown. The body measures 25 mm. in length and 19 mm. in diameter at the broadest part.

The *Test* is leathery, not thick (0.5 mm); the inner surface is of nearly the same colour as the outside.

The *Mantle* is not very thick, but muscular. The musculature consists of two layers, an outer layer of fine transverse fibres and an inner layer of much stronger longitudinal bands. On the siphons the external fine transverse fibres are wanting; but there is a deeper layer of annular muscle bands which form powerful sphincters at their bases.

The *Tentacles* are compound, but not bushy, the branches being rather distant and short; they are about twenty in number, five of them being much larger than the rest. They are of several sizes and there is no regularity in their arrangement.

The *Branchial Sac* has nine broad folds upon each side. There are about thirteen to fifteen internal longitudinal bars on the fold, and only three to four in the interspace. Every fourth transverse vessel is much wider than the intermediate ones, which are all of one size. The meshes are elongated transversely and contain each six or seven stigmata.

The *Dorsal Tubercle* is roundish in outline; the funnel is horseshoe-shaped with the horns turned spirally inwards.

The *Dorsal Lamina* is represented by a series of slender languets.

The *Alimentary Canal* forms a wide loop as is usual in the genus *Cynthia*. The anus has its margin entire.

The *Gonads* are hermaphrodite glands developed one upon each side of the body. Each gland has the shape of a curved cylinder with smooth surface, and opens into the peribranchial cavity at the base of the atrial siphon. The openings of the glands are separate, but lie very close to each other.

*Locality*.—Muscat, 5 fathoms. One specimen.

This species is closely allied to *C. spinosa*, Sluiter (15), from the Gulf of Tadjourah, East Africa, which is also covered all over with peculiarly shaped spiny scales. These scales, however, though apparently belonging to the same type, are different in shape in the two species. In *C. spinosa* they are characterized by bearing along the margin five to seven curved spines, 0.25 mm. long, with their points turned towards the central spine, which is erect, straight, and 0.5 mm. long. As will be seen at once by comparing our figures (Pl. II, fig. 8c. Sluiter, *l.c.*, and Pl. III, fig. 4 of this paper) the difference in the shape of these scales is fairly striking. The larger spines surrounding the aperture, on the other hand, are quite similar in both species.

In internal structure the two species agree tolerably well, but slight differences are found in the number of tentacles, the number of internal longitudinal bars on the fold and the arrangement of transverse vessels, and in the form of the gonads. Thus, in *C. spinosa* the tentacles are only sixteen in number instead of twenty, and they are all of the same size. The number of the internal longitudinal bars on a fold is ten in *C. spinosa*, but thirteen to fifteen in *C. sluiteri*. Again, in *C. spinosa* the transverse vessels are placed large and small alternately, whereas in *C. sluiteri* every fourth transverse vessel is distinctly wider than the intermediate ones. The hermaphrodite glands of *C. spinosa* are lobed, and not entire as those of *C. sluiteri*. In other respects the two species agree almost perfectly.

### *Rhabdocynthia ceylonica*, Herdman.

(Pl. I, figs. 8-11.)

*Rhabdocynthia ceylonica*, Herdman, *Report on the Pearl Oyster Fisheries of the Gulf of Manaar. On the Tunicata*, 1906.

*Localities*.—(1) Station 152; 11½ miles S. 83° W. of Colombo Lt., depth 26½ fathoms; bottom sand, shell and coral; December 12th, 1893. One specimen. (2) Andamans. One specimen. (3) West coast of Andamans. Four specimens. (4) Coast of Cheduba, 20-30 fathoms; August 29th, 1877 (coll. *Armstrong*). One specimen. (5) Nicobars (coll. *Armstrong*). One specimen. (6) East of the Terribles, 15 fathoms. Two specimens.

This species appears to be rather common in the northern part of the Indian

Ocean, as the collection contains specimens from no less than six different localities. They vary somewhat externally, but in internal structure they agree pretty well with Herdman's original description and figures of this species. The largest specimen, from the Andamans, measures 38 mm.  $\times$  21 mm.  $\times$  16 mm., and is considerably larger than those from the Gulf of Manaar. The next largest, also from the Andamans, is 26 mm. long and 21 mm. wide. The remaining specimens are all less than 20 mm. in length.

Four of the specimens, from the west coast of the Andamans, have the siphons very prominent and the body covered with clear pale yellow sand and small shell fragments, and thus look very like the type specimens figured by Herdman (*l.c.* Pl. III, figs. 1, 2, 3, and 4). In another specimen, the largest one, the anterior surface of the body is sunk in, undoubtedly in consequence of preservation, and the siphons, which are less prominent than in others, are placed at the bottom of this concavity. Besides, this specimen is characterized by the well-developed condition of the dorsal tubercle which recalls that of *Rh. pallida*. The rest of the specimens, except two mentioned below, have the siphons more or less contracted, but conspicuous on account of their nakedness.

The two specimens referred to above are those from East of the Terribles. They differ somewhat both externally and in internal structure, and might as well be regarded as a distinct variety. The body is nearly globular, and the siphons are very short with the apertures scarcely discernible, being thinly covered with sand all over. The test is soft, leathery, and transparent. Internally they agree in most respects with the typical form, but differ somewhat markedly in the structure of the branchial sac. There are seven folds on each side as usual; the internal longitudinal bars are, however, much broader and look like so many longitudinal membranes, projecting into the lumen of the branchial sac. I counted four to six such membranes on a fold and about two in the interspace. The meshes are broader than long and contain six or seven stigmata each.

### **Microcosmus manaarensis, Herdman.**

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

*Microcosmus manaarensis*, Herdman, *Report on the Pearl Oyster Fisheries of the Gulf of Manaar. On the Tunicata*, 1906.

*Locality*.—Madras coast, 20 fathoms. Twelve specimens.

I have referred these specimens to this species notwithstanding certain differences in the structure of the branchial sac, because they agree quite well in all other respects with the original description. They are nearly spherical and form a rough mass of sand, foraminifera, and shell fragments, stiff but brittle, with two short siphons projecting, and having the posterior end thickly covered and prolonged into root-like sandy wisps. The apertures are distant and looking away from each other, they are both cross slit. The crust of sand covering the test is 3 to 7 mm. thick, and some of the branched root-like processes are more than 20 mm. in length.

The tentacles are much branched, there are six to eight large and six to eight smaller placed alternately, with some very small intermediate ones. The dorsal tubercle is small, cordate in outline, with the opening anterior and both horns turned in. The dorsal lamina is a plain membrane.

The branchial sac has six folds on each side, but there are on each fold about twelve internal longitudinal bars instead of five, and only one in the interspace instead of three. In this respect the specimens are sharply distinguished from the type of the species, but otherwise they agree quite well, so that it seems inadvisable to separate them specifically on the strength of this single character. Possibly the species may have a very wide range of individual or local variation in the arrangement of the internal longitudinal bars. The arrangement of the transverse vessels is also somewhat different; in the type specimens there are seven narrower transverse vessels between each pair of very much wider, while in our specimens they are of three different sizes placed alternately after the scheme 1, 3, 2, 3, 1... The meshes in the interspace between the folds are elongated and contain about nine stigmata each. Most of the meshes are crossed by a narrow horizontal membrane.

As Herdman has already pointed out, this species is very closely allied to *Microcosmus gleba*, Traustedt, from the Pacific. The differences are, in fact, rather slight, being confined to some details of the branchial sac, and it seems doubtful whether the two forms should be regarded as specifically distinct or not. I have preferred, however, to leave the question to those investigators who have the opportunity of comparing the original specimens of both forms. It is, by the way, also questionable if the Island of Banca where *Microcosmus gleba* was found should be included in "Stille Hav", as given in Traustedt's paper and quoted by Herdman.

#### Fam. STYELIDAE.

This family is represented in the collection by three species of *Polycarpa*, one of which is new to science, and a minute solitary form for which it was found necessary to form a new genus. The latter is especially interesting, as it exhibits a combination of characters which is intermediate between the Styelidae from among the simple Ascidiaceans on one hand and the Polystyelidae from among the compound Ascidiaceans on the other.

#### *Polycarpa cryptocarpa*, Sluiter.

(Pl. I, fig. 13.)

*Polycarpa cryptocarpa*, Sluiter, Über einige einfache Ascidien von der Insel Billiton. *Natuurk. Tijdschr. Ned. Ind.* D. XLV, 1885.

*Localities*.—(1) Madras coast, 20 fathoms. Five specimens. (2) Off C Negrais, Burma, at Station 384; 16° 0' N., 93° 37' E.; depth 40 fathoms; bottom coral; February 22nd, 1909. One specimen.

The specimens agree quite well with the original description by Sluiter except in certain details of internal structure. The tentacles are not all of one size as in the type specimens, but are of three different sizes placed alternately after the

schema 1, 3, 2, 3, 1. . . There are about seventeen tentacles of the first order. The dorsal tubercle is of the usual form and not broken up in a number of small openings as in Sluiter's specimens. The branchial sac is dark brown and has four large folds on each side, but there are ten to twelve internal longitudinal bars upon a fold and four or five in the interspace, while in the original description the number of longitudinal bars in the interspace is given as about eight. The transverse vessels are of two sizes, there being three smaller ones between each pair of the larger. These are, however, all points of minor importance subject to individual variation and do not affect in any degree the identification of this exceedingly well characterized species.

The specimens from the Madras coast are about 50 mm. long and 35 mm. broad, and much compressed laterally; at the posterior end the test is provided with a number of branched root-like processes for attachment. The specimen from Station 384 is somewhat smaller and is of a lighter brown colour.

### *Polycarpa glebosa*, Sluiter.

*Styela glebosa*, Sluiter, Die Tunicaten der Siboga-Expedition. IAbt. Die Sozialen und Holoformen Ascidien. *Siboga-Exped.* Bd. LVIA, 1904.

*Locality*.—Andamans. One specimen.

It is with much hesitation that I refer this specimen to Sluiter's species from Pulu Sebangkatan, Borneo Bank. As will be seen below, there are many points in internal structure in which it does not quite agree with the description of *Styela glebosa*, but as the points in which they agree appear to outweigh the differences I have thought it better to regard, at least temporarily, the two forms as identical, rather than to increase the number of species of this already bulky genus on the strength of a single doubtful specimen.

The body is erect, oval in shape, 27 mm. in length and 18 mm. in breadth, and is not compressed laterally. The branchial aperture is at the anterior end, and the atrial is about one-third of the way down the dorsal edge; they are both cross slit, inconspicuous, there being no prominent siphons. The surface is irregularly creased all over, and is of a pale greyish yellow colour, with reddish brown patches on both sides of the dorsal half. There are some branched root-like processes of the test, especially along the ventral edge and on the ventral half of the left side, to which foraminiferan shells and fragments of algae are found adhering.

The test is not thick, but tough and leathery; it is white on the inside and in section. The mantle is rather thick, soft and gelatinous, with the musculature only feebly developed. The siphons are very slight even in the mantle.

The tentacles are simple, filiform; there are eight larger and eight smaller, placed alternately, with some quite small intermediate ones here and there.

The branchial sac has four very narrow folds on each side; the most dorsally situated pair is very slight. The fold has about ten internal longitudinal bars and there are two to three in each interspace. The transverse vessels are of three sizes

arranged thus: 1, 3, 2, 3, 1. . . The meshes are broader than long and contain each about seven stigmata.

The dorsal tubercle is broadly crescentic in shape, placed transversely with the concavity turned forwards.

The dorsal lamina is a narrow plain membrane.

The alimentary canal forms a short close loop with a distinct stomach. The intestine is rather wide, and the wall of the stomach is ridged longitudinally. The anus has a finely toothed margin.

The gonads consist of about a dozen roundish polycarps on each side, all embedded in the thickness of the wall.

The most important point of difference between the present specimen and the description of *Styela glebosa* by Sluiter is in the shape of the dorsal tubercle which is a transverse slit with irregularly indented lips in the type specimens. Another point of difference is that in our specimen the "ziemlich regelmässig verbreitete runde Pünktchen" on the outside of the mantle are not found. There are also differences in the number of tentacles and of the internal longitudinal bars on the folds of the branchial sac, but they are not considerable.

### *Polycarpa annandalei*, n. sp.

(Pl. I, fig. 12; pl. III, figs. 5-9.)

*External Appearance.*—The body is somewhat quadrate in shape, with the apertures on two equal projections at the dorsal and ventral edges of the anterior end, giving the latter a cleft appearance (Pl. I, fig. 12). The siphons are bent towards the ventral and dorsal sides respectively. The surface is corrugated and encrusted with sand grains and shell fragments all over, and is of a yellowish-brown colour on account of the sand. It is 33 mm. long, 23 mm. broad, and 19 mm. thick, and the apertures are 38 mm. distant from each other. The apertures are both cross slit.

The *Test* is thin, hard, and stiff, and is whitish with pearly lustre on the inside. In section it is seen that the sand grains are embedded in, as well as attached to, the test. Some of the sand grains even project inwards forming little prominences on the inner surface of the test.

The *Mantle* is exceedingly thin and colourless, and contains an irregular network of fine muscle fibres.

The *Tentacles* are of three sizes; there are about twelve large, twelve smaller, and a number of still smaller ones arranged regularly, though not throughout, after the scheme 1, 3, 2, 3, 1. . . They are finger-like in shape, with the tips rather blunt (Pl. III, fig. 5).

The *Branchial Sac* has four narrow folds upon each side. There are seven to fourteen internal longitudinal bars on a fold and five to nine in the interspace. The transverse vessels are of two sizes, for the most part placed large and small alternately, but in some places every fourth vessel is larger than the intermediate ones. The meshes are nearly square and contain three to four stigmata each (Pl. III,

fig. 6). In one of the specimens the number of internal longitudinal bars on the folds and in the interspaces is as follows:—

End. 8 (7), 6 (9), 5 (14), 7 (9), 9 D.L.

The *Dorsal Tubercle* is a cordate horse-shoe, with the opening anterior and the horns bent inwards at the tip (Pl. III, fig. 8).

The *Dorsal Lamina* is very narrow but rather thick, somewhat resembling a stout longitudinal bar.

The *Alimentary Canal* forms a simple small open loop on the left side of the branchial sac. The stomach is distinct, oblong in shape, and longitudinally folded; the intestine is both thin and short for an animal of this size (Pl. III, fig. 7). The margin of the anal opening is entire.

The *Gonads* are present in the form of numerous elongated polycarps attached to the outer surface of the branchial sac. There are about twenty placed along the fourth fold on each side, and about fourteen forming a row just below the anterior margin of the branchial sac. Each polycarp consists of a central ovarian portion surrounded by a peripheral layer of fine testicular follicles (Pl. III, fig. 9).

*Locality*.—Madras coast, 20 fathoms. Two specimens.

The specimens show externally so striking a resemblance to *Polycarpa manaaensis*, Herdman, from the Gulf of Manaar, Ceylon, that at the first glance I had almost no doubt as to their identity. On cutting them open, however, many points of difference in internal structure were found, which necessitated the formation of a new species for the present form. Thus, the mantle, which is very thin and colourless in our species, is thick, opaque, and ruddy brown in *P. manaaensis*. The dorsal tubercle is a widely open horse-shoe with the horns not turned in in that species, whereas it is almost closed in our specimens. The shape of the stomach also is not the same in the two species. But perhaps the most important point of difference in the internal anatomy is the situation of the polycarps, which in Herdman's species are rounded and embedded in the thick mantle.

A pair of a macrurous Crustacean was found living as commensals in the branchial sac of one of the specimens.

### **Monobotryllus violaceus, n. g. and n. sp.**

(Pl. III, figs. 10 and 11; pl. IV, figs. 1-3).

*External Appearance*.—The body of this curious little species is ovoid in outline, much depressed, and attached by the whole of the under surface. Along the periphery the test is drawn out to form a thin layer with irregularly indented margins. The upper surface is convex and bears the branchial and atrial apertures on the longer diameter, placed rather distant from each other. The apertures are both simple round holes, not lobed, with somewhat raised lips. The surface is entirely naked and smooth and is of a pale greenish-violet colour with a little silky lustre. The size of the largest specimen is about 4 mm. in length and 2.5 mm. in breadth.

The *Test* is thin, but tough and leathery; on the under surface it is exceedingly

thin and colourless. In the marginal zone it is traversed by numerous blood vessels with terminal knobs like those of *Botryllus*.

The *Mantle* is very thin all over, with no specially developed musculature. It is quite transparent, allowing all internal viscera to show through distinctly.

The *Tentacles* are simple, filiform, with pointed tips. They are twenty in number, and of two sizes, placed large and small alternately.

The *Branchial Sac* is well developed and occupies a large portion of the internal cavity. It is not folded, but bears a number (fifteen or more) of internal longitudinal bars on both sides. The stigmata are broad and short, sometimes oval in shape, and are arranged more or less regularly in transverse rows on both sides of the endostyle; in other places their arrangement is quite irregular. The transverse vessels, where they are present, are only slightly larger than the interstigmatic vessels, and are all of one size. The endostyle is long but narrow.

The *Dorsal Tubercle* is elongated longitudinally and placed between the posterior arms of the peripharyngeal ridge; its opening is a short simple longitudinal slit. The nerve ganglion is seen lying immediately behind the dorsal tubercle.

The *Dorsal Lamina* is a very narrow plain membrane.

The *Alimentary Canal* is very much like that of *Botryllus*. It forms a simple loop consisting of oesophagus, stomach, and intestine, and is placed under the posterior portion of the branchial sac, mostly on the left side of the median line. The oesophagus is very short and bent ventrally to open into the stomach. The stomach is oval-shaped with its walls folded longitudinally. It is provided with a small curved blind sac. The intestine is bent in the shape of the letter S, and has its posterior half surrounded by a ramifying gland whose duct opens into the blind sac of the stomach. The margin of the anal opening is entire.

The *Gonads* consist of a number of small polycarps projecting from the walls of the peribranchial cavity. They are arranged in two rows, one on each side of the endostyle. Each polycarp is rounded in shape and is made up of two parts, the ovarian lying nearer the endostyle and the testicular occupying the outer half.

*Locality*.—Puri, Orissa. "Golden Crown". About fifty large and small specimens attached to a fragment of oyster-shell.

This species is especially interesting as it exhibits a close resemblance to certain compound Ascidiæ, such as the Botryllidæ and the Polystyelidæ. The shape of the body, the structure of the branchial sac and the alimentary canal, and the condition of the reproductive organs are all so strikingly similar to the corresponding parts in members of the above named families that the only thing wanting for placing it in one of these families is the common investing mass. At first I considered the possibility of the reproduction by budding and carefully examined some of the specimens, but was unable to find any trace of the occurrence of this mode of propagation. Besides, compound Ascidiæ are, so far as I know, never solitary, and even in a minute colony containing a single full grown ascidiozoid there are always one or two large and some smaller buds imbedded in the common test. That the test is traversed by blood vessels with enlarged terminal bulbs like those of

*Botryllus* is not in itself suggestive of the occurrence of budding, since exactly the same condition is also met with in certain species of simple Ascidians, e.g. *Ascidia lurida*, Möll., *Ascidiella expansa*, Kiaer, *Ascidiella minuta*, Kiaer, etc. which certainly do not propagate by gemmation.

As this species cannot be included in any of the known genera of the Ascidiæ Simplices, it was found necessary to form a new genus for its reception. This genus, which I propose to name *Monobotryllus* in reference to its great resemblance to *Botryllus*, may be diagnosed as follows:—

**Monobotryllus, nov. gen.**

*Test* leathery, both apertures not lobed.

*Tentacles* simple, filiform.

*Branchial sac* without folds, with numerous internal longitudinal bars.

*Alimentary canal* lying alongside the branchial sac; stomach longitudinally folded, with a small blind sac.

*Reproductive organs* consisting of a number of hermaphrodite polycarps arranged in two rows, one on each side of the endostyle; each polycarp made up of an ovarial and testicular part joined together to form a rounded mass.

As to the systematic position of this genus it is quite obvious that its nearest allies are those forms among the Polystyelidae which have no folds in the branchial sac, e.g. *Goodsiria* and *Chorizocormus*; but as it is a solitary form I have thought it more convenient to place it in the family Styelidae alongside the genus *Polycarpa*. In the structure and arrangement of the polycarps it comes very near Michaelsen's *Monandrocarpa*, which is known only from a solitary individual but which the author is inclined to regard as the young stage of a colony. The presence of a small curved blind sac attached to the posterior end of the stomach seems to point to a close affinity to the Polystyelidae, whose members are invariably provided with such an appendage, while on the other hand the simple unlobed condition of the branchial and atrial apertures would rather suggest a near relationship to the Botryllidae.

Fam. ASCIDIIDAE.

This family is represented in the collection by five species, which, with the exception of a single doubtful form, are all new to science. They all belong to the genus *Ascidia*. The doubtful form could not be identified with certainty, as the internal body had been removed from the test, the latter alone being preserved.

***Ascidia canaliculata*, Heller (?).**

(Pl. IV, fig. 4).

*Ascidia canaliculata*, Heller, Beiträge zur näheren Kenntnis der Tunicaten. *Sitzungsber. Akad. Wiss. Wien.* Bd. LXXVII, 1878.

*Locality*.—The Andamans. One specimen (the test only).

It is from the external appearance alone that I refer this specimen with much doubt to Heller's *Ascidia canaliculata*, originally described from the Cape of Good

Hope. So far as the shape and condition of the test is concerned, especially in the presence of longitudinal grooves on the outer surface of the siphons, it agrees pretty well; but the number of lobes at the branchial and atrial apertures is different, being in our specimen seven and five instead of the usual eight and six respectively. As there is only one specimen in the collection it is impossible to decide whether this is an abnormal condition or a constant specific character. In the latter case it should of course be considered as a distinct species and be given a new specific name.

The body is ovate in shape, with anterior end narrower and pointed and the posterior broader and rounded; it is somewhat compressed laterally, and is attached by the whole of the left side. The apertures are borne on large prominent siphons, the sides of which are channelled by well marked straight grooves running down longitudinally from between the lobes. The branchial siphon is anterior, terminal, and is directed anteriorly; it is not curved and the aperture has seven lobes. The atrial is situated about one-third the way down the dorsal edge, it is nearly as large as the branchial, and is directed anteriorly and somewhat dorsally; the aperture is only five-lobed. The surface is a little roughish, otherwise it is smooth and regular, and is quite naked. The colour is a light yellowish-grey. The test is cartilaginous and semi-transparent; it is not thick, the thickness varying from 0.5 mm. on the left side to nearly 1 mm. on the siphons. Size of the body: 43 mm. long and 22 mm. broad.

Sluiter (11) described two specimens of this species from the island Billiton; strangely enough they had both only seven longitudinal grooves on the branchial siphon, the same as our specimen, and not eight as in the type described by Heller. The atrial siphon, however, seems to have had the usual number of lobes and grooves, as Sluiter makes no mention of abnormalities about them.

What makes me more inclined to believe that the test described above belongs to this species, is the presence in another bottle, also containing Ascidiens from the Andamans, of a specimen of *Ascidia*, devoid of test, which agrees tolerably well with the description given by Sluiter. It is rather small, being only 25 mm. long and 7 mm. broad at the widest part, so that it is of course questionable whether it belonged to the same individual as the test. I insert here a brief account of this specimen in order to show how far it agrees with the internal body of *A. canaliculata* as described by Sluiter. As Heller gave no detailed account of the internal organs it is impossible to compare our specimen with the original type of the species.

The mantle is thin and delicate on the left side; on the right it has well developed muscle bands running perpendicularly to the margin and ending abruptly at a short distance from it so as to form a sort of boundary zone surrounding the remaining part of the mantle. The siphons are strongly muscular.

The tentacles are simple, filiform, and numerous; they are not all of one size and are arranged irregularly.

The branchial sac is rather delicate, and slightly plicated longitudinally. The internal longitudinal bars are numerous but very thin, and bear at the points of crossing

with the transverse vessels short curved papillae with rounded tips. Intermediate papillae do not occur. The meshes are longer than broad, and contain about four stigmata each. Owing to the contracted state of the specimen the form of the dorsal tubercle could not be ascertained.

The alimentary canal forms a double loop with only a little space in the first loop. The stomach is globular, with irregularly raised walls, and is sharply bounded from the intestine. The intestine is rather thick throughout, except the rectum which is very short and narrowed. The gonads are not well developed; they lie in the first intestinal loop and seem, partly at least, to extend over the outer surface of the intestine.

The locality is East Island, Andamans (coll. *Dr. A. R. Anderson*), 1898.

In the same bottle with this there is a specimen of a simple Ascidian entirely covered with shell fragments. As nothing but the test is preserved it is impossible to determine to what genus and species it belongs, but judging from the shape and condition of the test I am inclined to believe that it is *Styela lapidosa*, Herdman, first described from Ceylon.

#### *Ascidia irregularis*, n. sp.

(Pl. IV, figs. 5-10.)

*External Appearance.*—The body is roughly oval in outline and a little flattened laterally. It is attached by the entire left side. Encircling the area of attachment the test sends out a thin layer extending over the substratum in the form of an irregular skirt. The siphons are both prominent and tube-like; the branchial is situated at a little distance from the anterior end, and is pointed anteriorly and to the right; its aperture is surrounded by seven lobes, two of which are much smaller than the rest. The atrial siphon is placed about half way from the anterior to the posterior end, and is pointed posteriorly and to the right; its aperture is only five-lobed. The surface is naked and shows small pointed protuberances all over, which causes a very rugged appearance (Pl. IV, fig. 5). The colour is a hyaline pale yellow. In size the animal is 29 mm. long, 20 mm. broad, and 8 mm. thick.

The *Test* is thin, cartilaginous, transparent, and of a pale yellow colour. On the left side, by which the animal is attached, it is very thin and shows the internal viscera most clearly.

The *Mantle* is very delicate on the left side, where no muscle fibres are visible. On the right side the musculature is pretty well developed and forms a continuous layer of obliquely running fibres (Pl. IV, figs. 6 and 7).

The *Tentacles* are simple, filiform, with tapering ends; they are about sixteen in number and are all of one size.

The *Branchial Sac* is delicate, and is not plicated longitudinally. The transverse vessels are all of one size. The internal longitudinal bars are moderately strong and bear at the angles of the meshes, as well as in the middle of each segment, short conical papillae with bluntly pointed ends (Pl. IV, fig. 10). The papillae are all of the same form, but those at the angles of the meshes are somewhat larger than the

intermediate ones. The meshes are much longer antero-posteriorly than transversely and contain each three long narrow stigmata.

The *Dorsal Tubercle* is cordate in shape, and is placed antero-posteriorly, with the opening at the anterior end, slightly to the left of the median line. The horns are both turned inwards (Pl. IV, fig. 9).

The *Dorsal Lamina* is a simple membrane with no ribs and no teeth. It is rather broad.

The *Alimentary Canal* forms a double loop on the left side of the branchial sac (Pl. IV, fig. 8). It consists of a very short oesophagus and a large intestine bent in the form of the letter S, of which the first loop is almost closed. There is no distinct stomach. The anus is bilabiate.

The *Gonads* are inconspicuous. No compact ovaries are present, but a large number of eggs, some very small and some larger, are found imbedded in the mantle on its inner surface over the intestinal loop. The largest eggs measure about 0.3 mm. in diameter.

*Locality*.—Laccadive Sea, at Station 245, 12° 40' 28" N., 74° 2' 45" E.; depth 449-465 fathoms, bottom green mud; October 14th, 1898.

This species belongs to that group of *Ascidia* which is characterized by the presence of asperities on the outer surface of the test, but differs from all of them hitherto known in one or other of the distinctive characters, either in the number of tentacles, or the condition of the dorsal lamina, or the number and arrangement of the internal longitudinal bars in the branchial sac. At first I took it to be *A. donnani*, Herdman, recorded from the Gulf of Manaar, Ceylon; but the latter has fifty to sixty tentacles, a strongly ribbed dorsal lamina, and about half a dozen stigmata in each mesh of the branchial sac, and can by no means be identified with our species in spite of their resemblance in the external form.

### *Ascidia hyalina*, n. sp.

(Pl. I, fig. 14; pl. IV, figs. 11 and 12; pl. V, fig. 1.)

*External Appearance*.—The body is irregularly ovate in outline, and is much flattened laterally (Pl. IV, fig. 11). The apertures are both sessile, inconspicuous; they are both in the anterior part of the body and are not far distant from each other. The surface is naked and smooth. The colour is a pale transparent grey. The animal appears to have been attached by the left side to branches of a bryozoan colony. The size of the body is 20 mm. in length and 14 mm. in breadth.

The *Test* is thin, soft, and gelatinous; it is almost colourless and quite transparent.

The *Mantle* is delicate and transparent, with the musculature very feebly developed. In some places, especially near the atrial aperture, blood vessels with minute branches are very distinctly visible.

The *Tentacles* are simple, filiform, and not numerous.

The *Branchial Sac* is rather delicate. The transverse vessels are of three different sizes, three of the smallest ones occurring between those of the larger sizes

which alternate more or less regularly. The meshes are almost square and contain each five or six stigmata (Pl. V, fig. 1). Short, rounded knob-like papillae are found at the angles of the meshes. There are no intermediate papillae.

The *Dorsal Tubercle* is horseshoe-shaped, simple, with both horns bent near the tip to the right (Pl. IV, fig. 12).

The *Dorsal Lamina* is a simple narrow membrane, with no ribs and no teeth.

The *Alimentary Canal* forms a simple loop on the left side of the branchial sac in the posterior half of the body (Pl. IV, fig. 11). It consists of a short narrow oesophagus, an oval stomach, and a rather wide intestine bent in the form of the letter S. The stomach is smooth-walled, and the anal opening is smooth-edged.

The *Gonads* form an elongated hermaphrodite gland placed inside the intestinal loop. From it a duct is seen to proceed along the first part of the intestine and the stomach, and then along the terminal portion of the intestine to open a little below the anus.

*Locality*.—E.N.E. of Prepara Id., Bay of Bengal, at Station 61, 14° 54' 30" N., 93° 51' E.; depth 41 fathoms; bottom sand, shell, and coral; November 30th, 1889. One specimen.

This species resembles in external appearance some of those *Ascidiae* already known which have thin transparent tests, but differs from all of them in the details of internal structure. It appears to be most closely allied to *Ascidia aperta*, Sluiter (13), obtained during the Siboga-Expedition, but the form and condition of the genital glands as well as the course of the genital duct are quite different. The form of the intestinal loop, too, is very unlike in the two species.

### *Ascidia willeyi*, n. sp.

(Pl. V, figs. 2-5.)

*External Appearance*.—The body is longish oval in shape, and is somewhat flattened obliquely (Pl. V, fig. 2). It is attached by the greater part of the left side and partly by the posterior end, and the edge of the base is in places expanded into a thin spreading margin. The apertures are both on the upper (right) side; the branchial is anterior and subterminal; the atrial is about half way down and at some distance from the dorsal edge. They are almost sessile, and the lobes, of which there are eight at the branchial and six at the atrial as usual, are very distinct.

The surface is even, smooth, and naked. The colour is a pale horny tint. The size of the body: 35 mm. in length and 20 mm. in breadth.

The *Test* is cartilaginous and transparent; it is very thin on the left side, but is much thicker on the right. Fine blood vessels are seen everywhere traversing the test.

The *Mantle* is thin and transparent. The musculature is only feebly developed, consisting on the right side of an irregular network of delicate fibres running in all directions, while on the left side there are scarcely any muscle fibres so that the internal viscera are very clearly visible (Pl. V, fig. 3). Even around the apertures the musculature is very weak.

The *Tentacles* are simple and filiform, and about sixty in number. They are of various sizes, some very long, and are arranged apparently without any regularity.

The *Branchial Sac* extends to the base of the mantle and is not longitudinally plicated. The transverse vessels are all narrow. The internal longitudinal bars are very numerous and bear pointed conical papillae at the angles of the meshes. There are no intermediate papillae. The meshes are elongated antero-posteriorly and each contain two stigmata (Pl. V, fig. 4). Parastigmatic vessels are not present.

The *Dorsal Tubercle* is horseshoe-shaped, broader than long, with the aperture directed forwards.

The *Dorsal Lamina* is a rather broad membrane, showing ribs which are continued beyond the margin of the lamina as long tentacle-like filaments (Pl. V, fig. 5).

The *Alimentary Canal* forms a close loop on the left side of the posterior half of the body. The stomach is ovate, smooth-walled, and is not sharply bounded from the intestine. The anal aperture is not toothed.

The *Gonads* are placed in the narrow space between the first and second loop of the intestine, as well as over its branchial surface. The testicular follicles are seen to be connected by delicate ducts with the vas deferens. The oviduct is distended by a large number of spherical ova and is quite conspicuous; it runs along the terminal portion of the intestine.

*Locality*.—Off Cape Negrais, Burma, at Station 387, 15° 25' N., 93° 45' E.; depth 40-49 fathoms; bottom sand and coral; November 16th, 1909.

This specimen presents in external appearance much resemblance to *Ascidia depressiuscula*, Heller, with which it also shows certain affinities in internal structure. The shape and colour of the body, the mode of attachment and the condition of the test are much the same; and in the number of tentacles, the shape and size of the alimentary canal, and the position of the gonads our specimen agrees pretty well with the description of that species given by Herdman in his report on the Tunicata of the Gulf of Manaar. But the number of stigmata in each mesh of the branchial sac is in *A. depressiuscula* five or six instead of two, and the dorsal lamina is a plain membrane with slight ribs and small marginal denticulations, differing in a marked degree from what is found in our specimen.

### *Ascidia andamanensis*, n. sp.

(Pl. V, figs. 6-9.)

*External Appearance*.—The body is longish oval, much depressed laterally, and is attached by the whole of the left side (Pl. V, fig. 6). The branchial aperture is anterior, terminal, and appears to be sessile; the atrial, on the other hand, is placed on a prominent cylindrical siphon springing from the dorsal edge about half way from the anterior to the posterior end. The apertures are eight-lobed and six-lobed respectively, as usual. The surface is quite naked and smooth except for a few slight longitudinal creases and is of a pale yellowish-grey colour. The size of the body is about 32 mm. in length and 16 mm. across the wider posterior part of the body; the length of the atrial siphon is 6 mm.

The *Test* is rather thick. It is cartilaginous and semi-transparent, allowing the internal body to be seen more or less clearly from outside.

The *Mantle* is very thin and transparent, with the musculature only very feebly developed (Pl. V, fig. 7). Even on the siphons the muscular bands are not strong.

The *Tentacles* are simple, filiform, and more than thirty in number. They are not all of one size and are not arranged with any regularity.

The *Branchial Sac* is well developed and has very numerous internal longitudinal bars. The transverse vessels are nearly all of the same size. The meshes are much longer antero-posteriorly than transversely and contain mostly only two stigmata each (Pl. V, fig. 9). Very short wart-like papillae are found at the angles of the meshes. No intermediate papillae are present.

The *Dorsal Tubercle* is horseshoe-shaped, simple, with both horns turned inwards. It is placed in the posterior corner of a triangular peritubercular area just in front of the origin of the dorsal lamina.

The *Dorsal Lamina* is a simple broad membrane. It has no teeth and no ribs, and has the free margin undulated sideways (Pl. V, fig. 8).

The *Alimentary Canal* forms a double loop on the left side of the branchial sac in the posterior third of the body. There is no sharp boundary between the stomach and the intestine and the anal aperture is smooth-edged.

The *Gonads* form an oval mass of testicular and ovarian follicles filling up the space between the first and second loop of the intestine. The oviduct and the vas deferens are separate, both running parallel with the rectum.

*Locality*.—Andamans. One specimen.

This species differs more or less distinctly from all the other known species of *Ascidia* which have about two stigmata in each mesh of the branchial sac. It differs from *A. diplozoon*, Sluiter, *A. longisiphoniata*, Kiaer, and *A. longistriata*, Hartmeyer, in having the dorsal lamina plain, and from *A. tricuspis*, Sluiter, in having the branchial papillae rounded and not provided with lateral processes. In the structure of the branchial sac this species agrees pretty well with *A. reptans*, Heller, from which, however, it differs markedly in several important characters. Perhaps its nearest ally is *A. nodosa* described by Sluiter from the Bay of Batavia, but in this species the tentacles are all of one size, the dorsal lamina is narrow, and the mantle is muscular.

#### Fam. CLAVELINIDAE.

This interesting family, characterized by the possession of the faculty of reproduction by budding, is represented in the collection by the following single species.

#### *Podoclavella fecunda*, Sluiter (?).

(Pl. V, figs. 10-12.)

*Podoclavella fecunda*, Sluiter, Die Tunicaten der Siboga-Expedition. I Abt. Die Sozialen und Holosomen Ascidien. *Siboga-Exped.* Bd. LVIa, 1904.

*Locality*.—Coral Islands, Andamans. Five specimens.

It is with much doubt that I refer these specimens to the above named species,

first recorded from Banda. They are much contracted, and it was difficult to make out their internal structure. The external appearance, however, and the greater part of what could be examined internally agree pretty well with the description given by Sluiter. The slight differences which occur here and there may be regarded as coming within the limits of individual variation. I insert here a brief account of one of the specimens which was least contracted.

The body is cylindrical in shape, about 15 mm. long and 5 mm. across, with the posterior end tapering into a short stalk. The branchial aperture is anterior and terminal, the atrial is placed a little backwards on the dorsal median line; the two are borne on short conical projections, and are not lobed. The surface is of a grey colour, and is wrinkled transversely in consequence of preservation. The test is thin, soft, and transparent. The branchial sac is regularly built but rather small; there are broad horizontal membranes running along the transverse vessels and the stigmata are long and narrow. Internal longitudinal bars are entirely absent. The dorsal tubercle and dorsal lamina are just like the figures given by Sluiter. The intestine forms a distinct abdomen; the stomach is large, oval and smooth-walled. The gonads are situated in the intestinal loop and are visible on both sides, and the duct is seen running parallel with the terminal portion of the intestine. Four tadpoles were found in the atrial cavity.

### PELAGIC FORMS.

Of the three different groups comprised in the Pelagic Tunicata each is represented by a single family in the collection,—the Ascidiæ Salpaeformes by the family Pyrosomatidae, the Thaliacea by the family Salpidae, and the Larvacea by the family Appendiculariidae.

#### Fam. PYROSOMATIDÆ.

The collection contains numerous specimens of *Pyrosoma*, but they are mostly in such a bad state of preservation that it is almost impossible to determine to what species they belong. It is even difficult to count how many colonies there are, as the specimens are nearly all very incomplete fragments, some being not more than one-tenth of a colony. The only species which I could identify with some degree of certainty is the following.

#### *Pyrosoma spinosum*, Herdman.

*Pyrosoma spinosum*, Herdman, Report on the Tunicata, Part III. *Report of the Scientific Results of the Voyage of H.M.S. "Challenger,"* Vol. XXVII, 1888.

*Localities.* (1) Laccadive Sea, at Station 275, 8° 27' N., 75° 35' E.; depth of net 731-771 fathoms; bottom green mud. One colony, 80 mm. long and 15 mm. across. (2) 20° 17' 30" N., 88° 50' E. Two imperfect colonies. (3) No locality given, 1300 fathoms. Two imperfect colonies.

Specimens of *Pyrosoma* from the following localities could not be identified on account of their bad state of preservation:—

(1) Andaman Sea, at Station 235,  $14^{\circ} 13' N.$ ,  $93^{\circ} 40' E.$ ; depth of net 370-419 fathoms; bottom grey mud; April 8th, 1898. Two broken colonies and four fragments. (2) Andaman Sea, at Station 236,  $13^{\circ} 59' N.$ ,  $93^{\circ} E.$ ; depth of net 172-303 fathoms; April 11th, 1898. One fragment. (3) Laccadive Sea, at Station 371,  $12^{\circ} 18' 46'' N.$ ,  $74^{\circ} 5' 29'' E.$ ; depth of net 450-580 fathoms; bottom green mud, sand, and globigerina ooze; December 3rd, 1906. Ten larger and many smaller fragments. (4) Bay of Bengal, 1300 fathoms. Four larger and four smaller fragments. (5) Andamans. One small fragment.

#### Fam. SALPIDAE.

This family is represented in the collection by five species of the genus *Salpa*, all well known to science.

#### *Salpa costata-tilesii*, Quoy et Gaimard (Cuvier).

*Thetys vagina*, Tilesius, *Jahrb. Naturg.* Vol. I, 1802.

*Salpa tilesii*, Cuvier, *Ann. du Mus.* tome IV, 1804.

*Salpa costata*, Quoy et Gaimard, *Freycinet, Voyage*, 1824.

*Localities*.—(1) Station 152,  $11\frac{1}{2}$  miles S.  $83^{\circ} W.$  of Colombo Lt.; depth of net  $26\frac{1}{2}$  fathoms; bottom sand, shells, coral; December 12th, 1893. One specimen. (2) Bay of Bengal, at Station 162,  $13^{\circ} 51' 12'' N.$ ,  $80^{\circ} 28' 12'' E.$ ; depth of net 145-250 fathoms; January 30th, 1894. One specimen. (3) Arabian Sea, at Station 358,  $15^{\circ} 55' 30'' N.$ ,  $52^{\circ} 38' 30'' E.$ ; depth of net 585 fathoms; bottom green mud and sand; December 18th, 1905. Four specimens.

The specimen from Station 152 is imperfect, nothing but the test being preserved.

#### *Salpa hexagona*, Quoy et Gaimard.

*Salpa hexagona*, Quoy et Gaimard, *Freycinet, Voyage*, 1824.

*Localities*.—(1) Bay of Bengal, at Station 166,  $13^{\circ} 34' 55'' N.$ ,  $80^{\circ} 32' 12'' E.$ ; depth of net 133 fathoms; bottom brown mud; February 8th, 1894. Two specimens. (2) Bay of Bengal, at Station 323,  $16^{\circ} 25' N.$ ,  $93^{\circ} 43' 30'' E.$ ; depth of net 463 fathoms; bottom green mud; December 21st, 1903. One specimen. (3) Off Port Blair, 244 fathoms. One specimen. (4) 57 miles SE by E of Ross Island, Andamans, 165 fathoms. Three specimens. (5) Andaman Sea. Three specimens.

#### *Salpa cordiformis-zonaria*, Quoy et Gaimard (Pallas).

*Holothurium zonarium*, Pallas, *Spicil. Zool.*, fasc. X, 1774.

*Salpa cordiformis*, Quoy et Gaimard, *Ann. des Sci. nat.* tome X, 1827.

*Localities*.—(1) Arabian Sea, at Station 135,  $15^{\circ} 29' N.$ ,  $72^{\circ} 41' E.$ ; depth of net 559 fathoms; bottom green mud; May 4th, 1892. One specimen. (2) Lat.  $5^{\circ} 56' N.$ , Long.  $91^{\circ} 05' E.$ ; 1590 fathoms. Two specimens. (3) Off Port Blair, 244 fathoms. One specimen. (4) Bay of Bengal,  $20^{\circ} 18' N.$ ,  $90^{\circ} 50' E.$ , 65 fathoms. Nine specimens. (5) Andaman Sea. One specimen.

**Salpa cylindrica**, Cuvier.

*Salpa cylindrica*, Cuvier, *Ann. du Mus.* tome IV, 1804.

*Locality*.—Andaman Sea. Numerous specimens.

**Salpa scutigera-confoederata**, Cuvier (Forskål).

*Salpa confoederata*, Forskål, *Descrip Anim.*, 1775.

*Salpa scutigera*, Cuvier, *Ann. du Mus.* tome IV, 1804.

*Localities*.—(1) Laccadive Sea, at Station 319, 12° 2' N., 73° 46' E.; depth of net 1154 fathoms; bottom green mud, globigerina ooze; November 7th, 1903. (2) Gulf of Oman, at Station 342, 24° 46' 15" N., 57° 15' E.; depth of net 745 fathoms; bottom soft green mud; October 19th, 1904. Four specimens. (3) Off Cinque Id., Andamans, surface. One specimen. (4) Andaman Sea. Two specimens.

## Fam. APPENDICULARIIDAE.

Of this family the collection contains only a single specimen, but this specimen is highly interesting on account of its being unusually large and having voluminous spiracular passages which occupy nearly the middle third of the trunk. Very probably it belongs to the rare genus *Megalocercus*, Chun.

**Megalocercus** sp.

This very interesting specimen is unfortunately in a somewhat shrivelled condition, so that it was impossible to make out the internal structure satisfactorily. So far, however, as could be ascertained without injuring the unique specimen, it presents no character, except its slightly smaller size, particularly contradictory to the description of *Megalocercus abyssorum* given by Chun (2). Whether it belongs to that species or not, it is of course difficult to say, but it appears to me very probable that it belongs to the same genus.

The body including the tail is about 15.5 mm. long. The trunk alone is nearly 5 mm. long and 3 mm. across at the widest part; it is elongated oval in shape, with the greatest width at the middle of the length and gradually narrowing towards both extremities. The anterior end is truncated and is occupied by the transversely elongated oral aperture, while the posterior end is rounded and a little compressed laterally. The anterior two-thirds are taken up mainly by the large pharynx and are comparatively transparent, but the posterior third is filled up with the gonads and is quite opaque. The endostyle is rather long and narrow, and runs along the ventral median line of the pharyngeal cavity; it is somewhat widened at the anterior end where it joins the peripharyngeal band. The peripharyngeal band runs transversely in its ventral half parallel to the margin of the oral aperture, but in its dorsal half its course is more oblique, enclosing a triangular space on the roof of the pharyngeal cavity. The spiracula are very large; they form two large cavities symmetrically placed one on each side of the median line in the middle third of the trunk. It is these cavities that make this region the widest part of the trunk. The spiracular openings are about 1 mm. in diameter, and seem to have been circular in

life. The spiracular cavities are mostly lined with ordinary flat cells, the ciliated epithelium being present only at certain places inside the external openings. The tail is 13 mm. long and 3 mm. wide; the median muscular portion measures 2 mm. in breadth and is thus wider than half the breadth of the tail. The colour of the specimen preserved in alcohol is dirty greyish-yellow.

There is in the same bottle a detached tail of another individual; it is about 10 mm. long and 3 mm. across. It is somewhat darker in colour, being a little brownish, but otherwise differs in no respect from the tail of the uninjured specimen described above.

The genus *Megalocercus* contained hitherto only a single species, *M. abyssorum*, known from three specimens collected by Chun near Capri and Ischia from a depth of six to nine hundred meters. They are 18, 22, and 30 mm. in length respectively.

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