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

By ASAJIRO OKA, *Ph.D.*, Tokyo.

(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 Ascidiæ 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 Ascidians for " *Das Tierreich* ", has told me in a letter that he will in that work relinquish the Order *Aspiraculata* 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. psammotodes* 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. psammotodes* 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. psammotodes* 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. psammotodes*.

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. psammotodes* 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. psammotodes* 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. psammatoedes*. 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 Ascidiens on one hand and the Polystyelidae from among the compound Ascidiens 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. I Abt. Die Sozialen und Holo-somen 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 ovarial 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 ovarial 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 Ascidiæ, 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 Simplicis, 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 Michaelson'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. ASCIDIIDAË.

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 (II) 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 Ascidiæ 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. IAbt. Die Sozialen und Holosomen Ascidien. *Siboga-Exped* Bd. LVIIa, 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. PYROSOMATIDAE.

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° 13' N., 93° 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° 59' N., 93° E.; depth of net 172-303 fathoms; April 11th, 1898. One fragment. (3) Laccadive Sea, at Station 371, 12° 18' 46" N., 74° 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, 11½ miles S. 83° W. of Colombo Lt.; depth of net 26½ fathoms; bottom sand, shells, coral; December 12th, 1893. One specimen. (2) Bay of Bengal, at Station 162, 13° 51' 12" N., 80° 28' 12" E.; depth of net 145-250 fathoms; January 30th, 1894. One specimen. (3) Arabian Sea, at Station 358, 15° 55' 30" N., 52° 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° 34' 55" N., 80° 32' 12" E.; depth of net 133 fathoms; bottom brown mud; February 8th, 1894. Two specimens. (2) Bay of Bengal, at Station 323, 16° 25' N., 93° 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° 29' N., 72° 41' E.; depth of net 559 fathoms; bottom green mud; May 4th, 1892. One specimen. (2) Lat. 5° 56' N., Long. 91° 05' E.; 1590 fathoms. Two specimens. (3) Off Port Blair, 244 fathoms. One specimen. (4) Bay of Bengal, 20° 18' N., 90° 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.

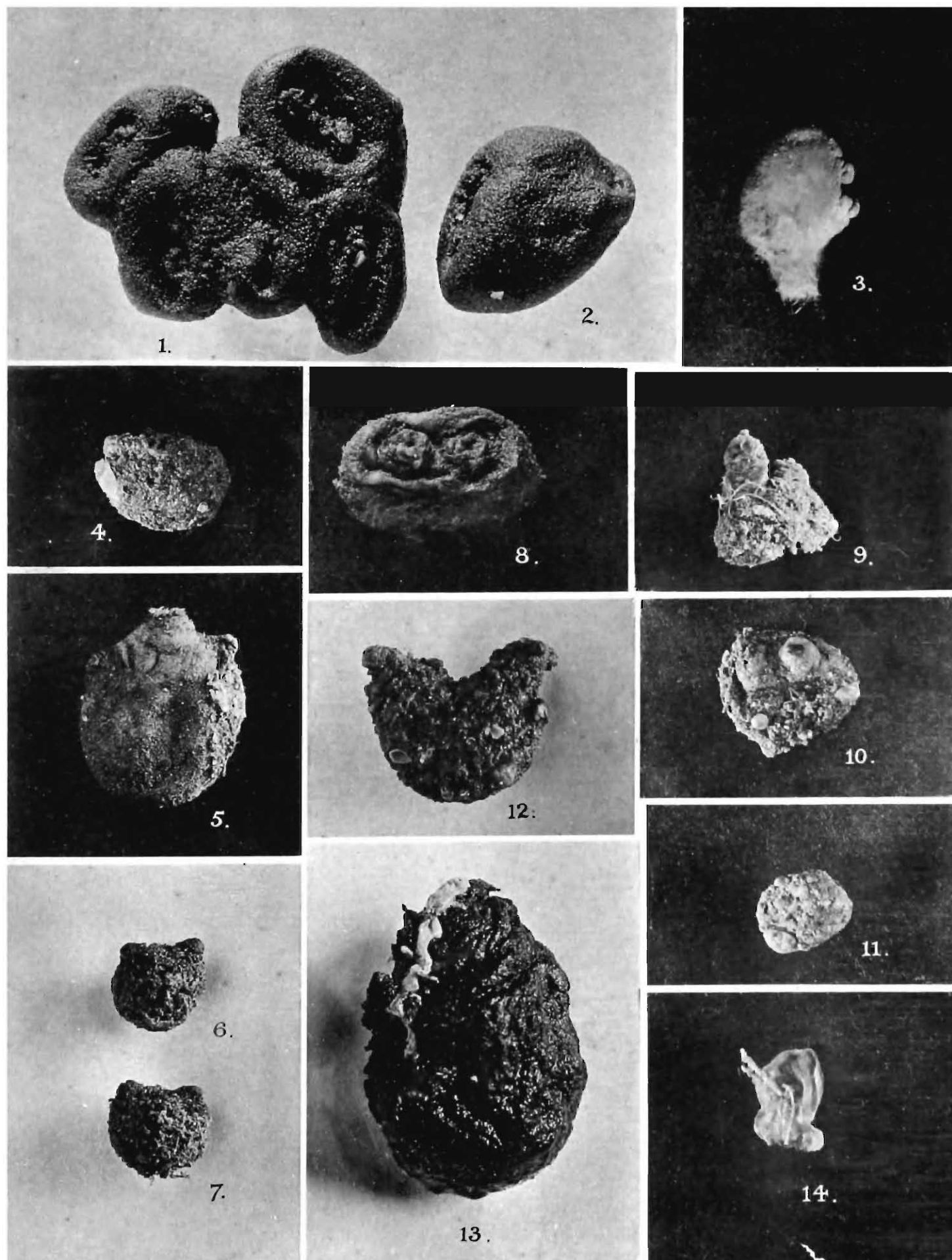
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-

EXPLANATION OF PLATE I.

- FIGS. 1 and 2. *Molgula birmanica*, n. sp. About natural size.  
FIG. 3.—*Hexacrobylus indicus*, Oka, from right side. About natural size.  
,, 4.—*Cynthia lanka*, Herdman. Nat. size.  
,, 5.—*Cynthia sluiteri*, n. sp., from left side. Nat. size.  
FIGS. 6 and 7. *Microcosmus manaarensis*, Herdman. Nat. size.  
,, 8—11. *Rhabdocynthia ceylonica*, Herdman. Nat. size.  
FIG. 12.—*Polycarpa annandalei*, n. sp. Nat. size.  
,, 13.—*Polycarpa cryptocarpa*, Sluiter. Nat. size.  
,, 14.—*Ascidia hyalina*, n. sp. Nat. size.



Bennett, Colla, 1915

INDIAN TUNICATES.

## EXPLANATION OF PLATE II.

- FIG. 1.—*Molgula simulans*, n. sp., with test removed, seen from left side,  $\times 5$ .  
 „ 2. „ „ tentacle,  $\times 100$ .  
 FIG. 3. „ *birmanica*, n. sp., with test removed, seen from left side.  
           „ „ Nat. size.  
 „ 4. „ „ seen from right side. Nat. size.  
 „ 5. „ „ part of branchial sac,  $\times 10$ .  
 „ 6. „ „ part of branchial sac, showing the stigmata,  
           „ „  $\times 40$ .  
 „ 7. „ „ dorsal tubercle and dorsal lamina,  $\times 40$ .  
 FIG. 8.—*Hexacrobylus indicus*, entire animal, front view. Nat. size.  
 „ 9. „ „ branchial aperture, front view,  $\times 3$ .  
 „ 10. „ „ one of the tentacle-like lobes of the branchial  
           „ „ aperture seen from outside,  $\times 10$ .  
 „ 11. „ „ seen from inside,  $\times 10$ .  
 „ 12. „ „ with test removed. Nat. size.  
 „ 13. „ „ atrial siphon,  $\times 5$ .



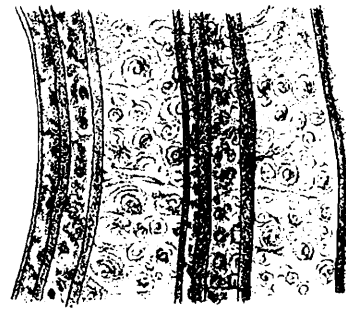
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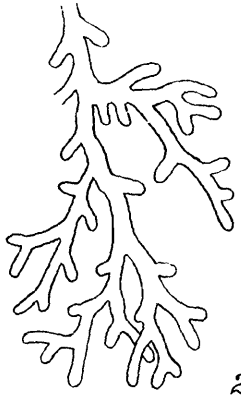
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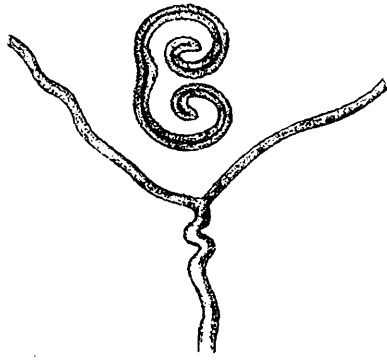
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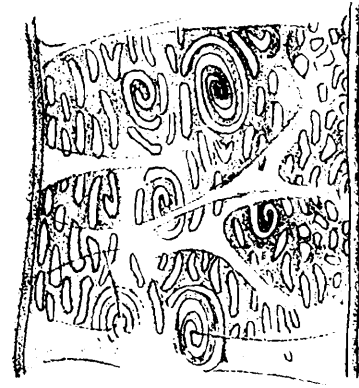
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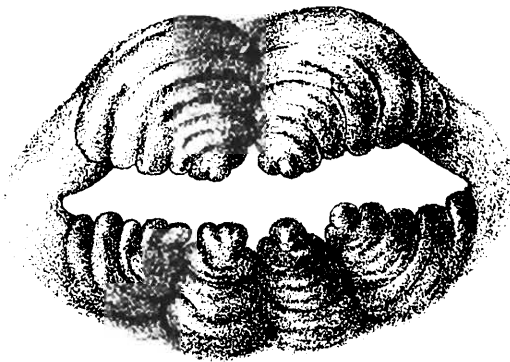
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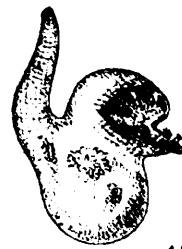
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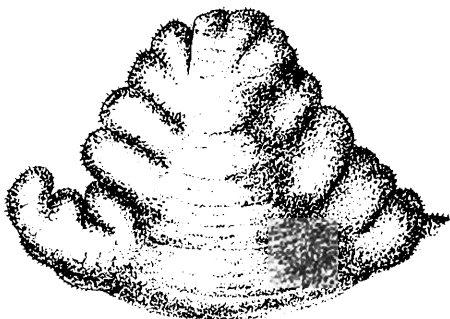
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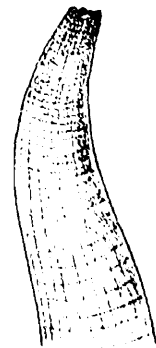
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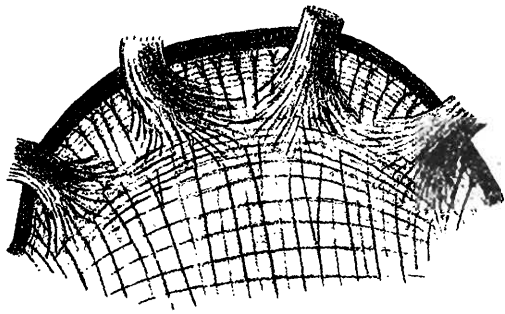
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A. Chowdhary, lith.

INDIAN TUNICATES

EXPLANATION OF PLATE III.

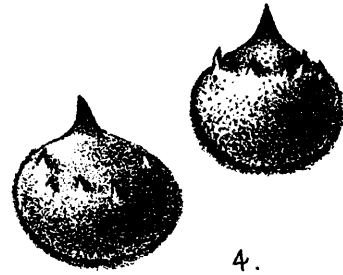
- FIG. 1.—*Hexacrobylus indicus*, lower lip of the branchial aperture, with test removed.  $\times 5$ . Only the proximal portions of the axial muscles of the tentacle-like lobes are shown.
- „ 2. „ „ Reconstruction figure from serial sections showing the internal anatomy of the animal.
- FIG. 3.—*Cynthia sluiteri*, n. sp., a spine from the tip of branchial siphon,  $\times 40$ .
- „ 4. „ „ two scales from the external surface of test,  $\times 40$ .
- FIG. 5.—*Polycarpa annandalei*, n. sp., tentacles,  $\times 20$ .
- „ 6. „ „ part of branchial sac,  $\times 40$ .
- „ 7. „ „ alimentary canal. Nat. size.
- „ 8. „ „ dorsal tubercle and part of dorsal lamina,  $\times 20$ .
- „ 9. „ „ one of the polycarps,  $\times 20$ .
- FIG. 10.—*Monobotryllus violaceus*, n. g. and n. sp., entire animal. Nat. size.
- „ 11. „ „ „ entire animal,  $\times 20$ .



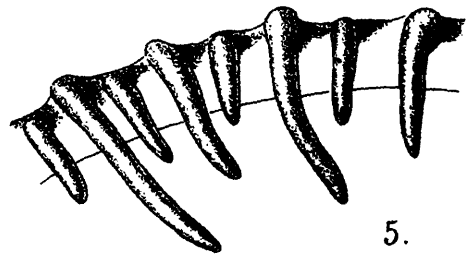
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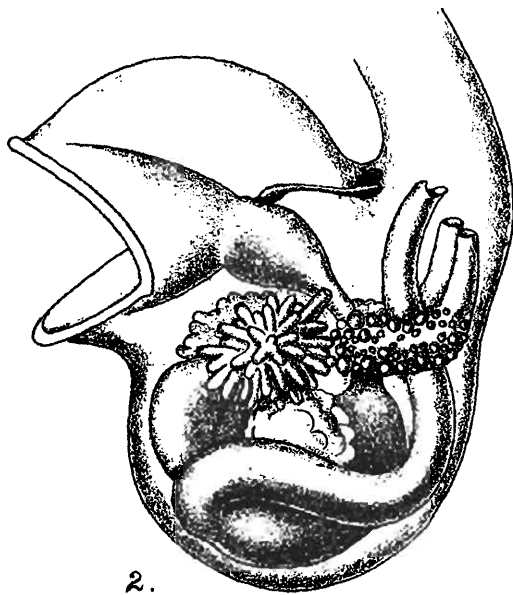
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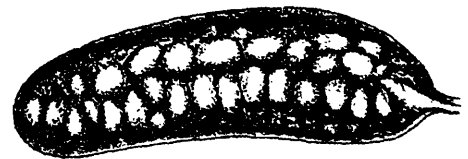
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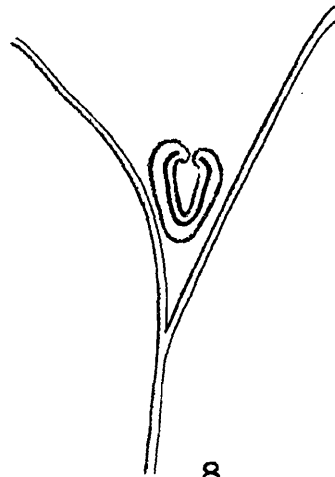
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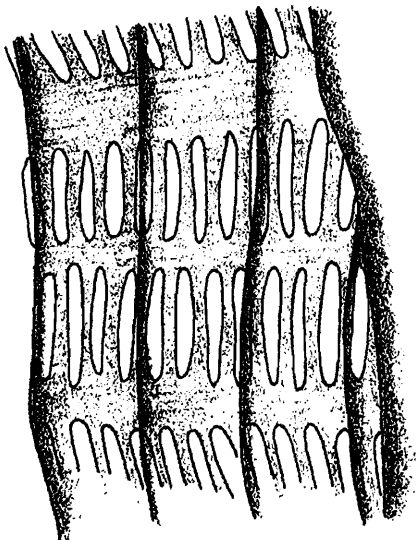
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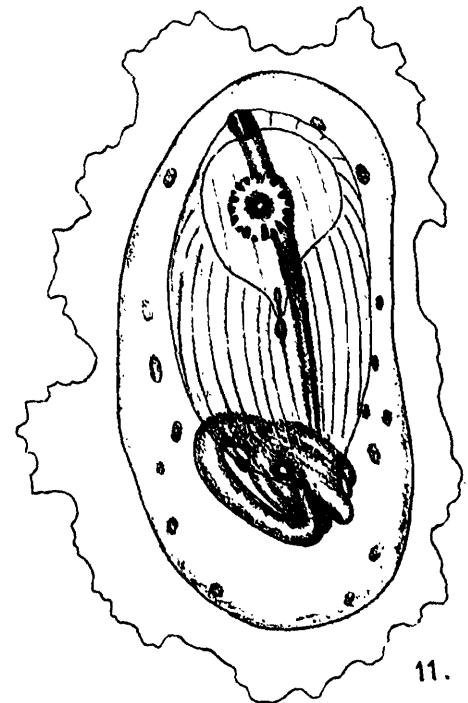
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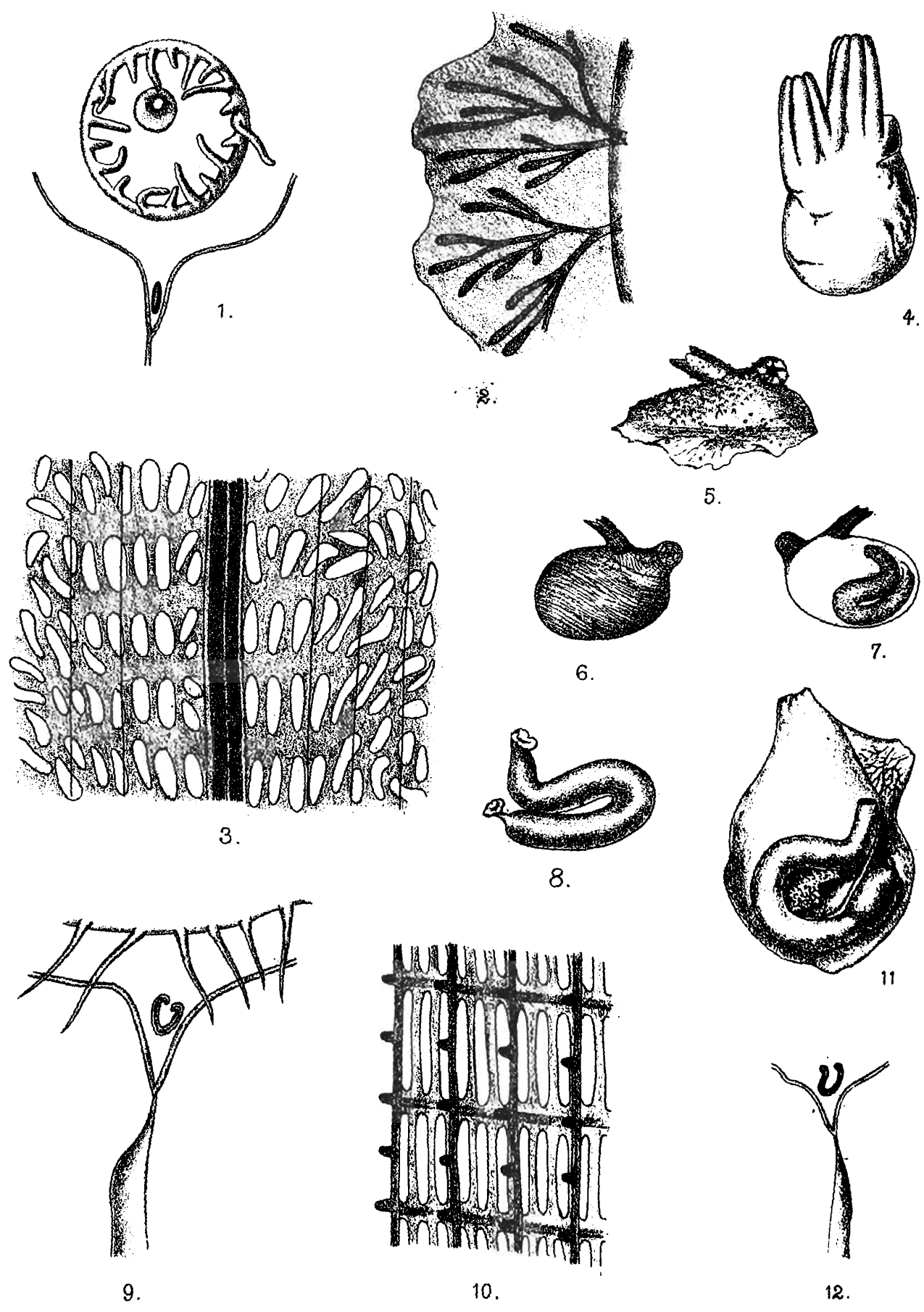
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A. Chowdhary, lith.

INDIAN TUNICATES

### EXPLANATION OF PLATE IV

- FIG. 1.—*Monobotryllus violaceus*, tentacular circulet, dorsal tubercle, and part of peripharyngeal band,  $\times 50$ .
- „ 2. „ „ marginal zone of test, showing knob-like terminations of blood vessels,  $\times 50$ .
- „ 3. „ „ part of branchial sac,  $\times 50$ .
- FIG. 4.—*Ascidia canaliculata*, Heller (?), test. Nat. size.
- FIG. 5. „ *irregularis*, n. sp., entire animal, from right side. Nat. size.
- „ 6. „ „ with test removed, seen from right side. Nat. size.
- „ 7. „ „ seen from left side. Nat. size.
- „ 8. „ „ alimentary canal,  $\times 2$ .
- „ 9. „ „ tentacles; dorsal tubercle, and dorsal lamina,  $\times 10$ .
- „ 10. „ „ part of branchial sac,  $\times 40$ .
- FIG. 11. „ *hyalina*, n. sp., entire animal, from left side,  $\times 3$ .
- „ 12. „ „ dorsal tubercle and dorsal lamina,  $\times 40$ .

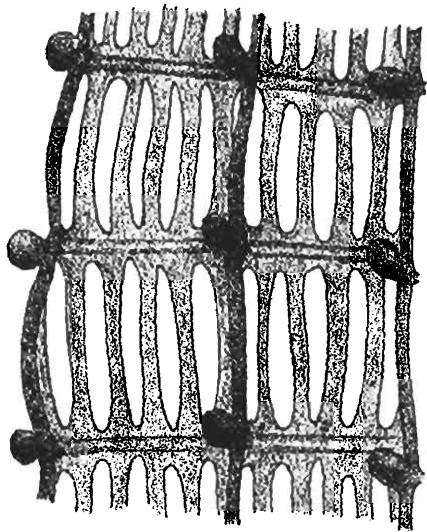


A. Chowdhary, lith.

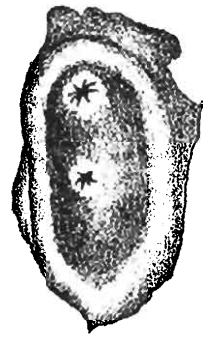
INDIAN TUNICATES

### EXPLANATION OF PLATE V

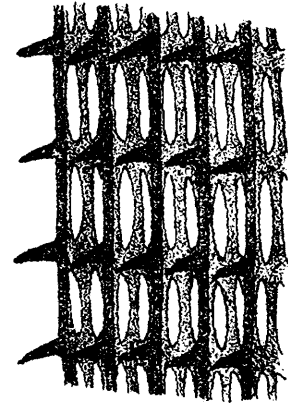
- FIG. 1.—*Ascidia hyalina*, part of branchial sac, × 40.
- FIG. 2.     ,,     *willeyi*, n. sp., entire animal, front view. Nat. size.
- ,,     3.     ,,     ,,     with test removed, seen from left side. Nat. size.
- ,,     4.     ,,     ,,     part of branchial sac, × 40.
- ,,     5.     ,,     ,,     dorsal tubercle and dorsal lamina, × 40.
- FIG. 6.     ,,     *andamanensis*, n. sp., entire animal from right side. Nat. size.
- ,,     7.     ,,     ,,     with test removed, seen from left side. Nat. size.
- ,,     8.     ,,     ,,     tentacles, dorsal tubercle, and dorsal lamina, × 40.
- ,,     9.     ,,     ,,     part of branchial sac, × 40.
- FIG. 10.—*Podoclavella fecunda*, Sluiter (?), two individuals. Nat. size.
- ,,     11.     ,,     ,,     with test removed, × 3.
- ,,     12.     ,,     ,,     part of branchial sac, × 40.



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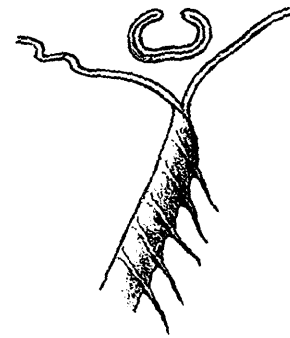
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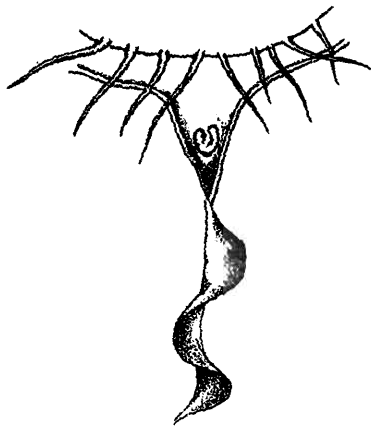
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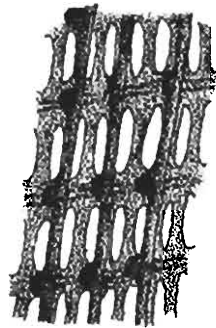
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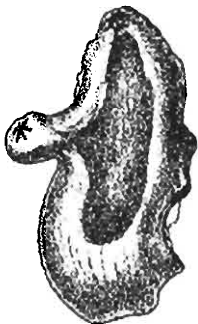
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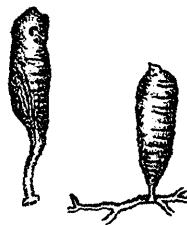
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12.

A. Chowdhary, lith.

INDIAN TUNICATES.

# ON SOME INDIAN OLIGOCHAETA, MAINLY FROM SOUTHERN INDIA AND CEYLON.

By J STEPHENSON, M.B., D.Sc., Lt.-Col., I.M.S., Professor of Zoology,  
Government College, Lahore.

(Plates VI—IX).

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### SYSTEMATIC PART.

#### Family Enchytraeidae.

##### Genus *Enchytraeus*.

*Enchytraeus barkudensis*, Steph. 45

##### Genus *Fridericia*.

*Fridericia carmichaeli*, sp. nov. 47

#### Family Moniligastridae.

##### Genus *Drawida*.

*Drawida ghatensis*, Mich. 49

*Drawida brunnea*, sp. nov. 51

*Drawida parambikulamana*, sp. nov. 53

*Drawida chalakudiana*, sp. nov. 54

##### Genus *Moniligaster*.

*Moniligaster deshayesi*, E. Perr. 57

*Moniligaster deshayesi*, var. *gravelyi*, var. nov. 59

#### Family Megascolecidae.

##### Sub-family Megascolecinae.

##### Genus *Plutellus*.

*Plutellus* sp. 61

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## INTRODUCTION

The following paper deals principally with two collections of Oligochaeta from the southern extremity of the Indian region,—one made by Mr. Kemp in Ceylon in December, 1913, and one by Mr. Gravely in Cochin State in September, 1914. I have added to the account of these collections descriptions or notes of a few worms that have recently come into my hands from other sources;—two species from Bombay kindly sent me by Mr. N. Kinnear of the Bombay Natural History Society, of which one is already known and one belongs to a new genus; one found near Simla by my pupil L. Bains Parshad, M.Sc., Research Student of the Panjab University; an Enchytraeid from Darjiling District belonging to Lord Carmichael's Zoological collection in the Indian Museum; and one or two species collected by Dr. Annandale at Ennur near Madras; the occurrence of the common *Pheretima posthuma* at Allahabad, whence it was sent me by Dr. Woodland, is also worth recording because of its bearing on our knowledge of the Indian earthworm fauna in general.

To take the last point first. In a recent paper (22) I wrote:—" Though the United Provinces (the upper Gangetic plain) is one of the best investigated regions in India in the matter of terrestrial Oligochaeta, *Pheretima posthuma* has hitherto been found nowhere within its limits; though it is on the one hand the commonest worm of the Punjab, and on the other has been recorded by Michaelsen from no fewer than ten places in Bengal." Indeed the genus *Pheretima* appeared to be absent or practically absent from the region intervening between Bengal and the Punjab. On receiving a copy of the paper containing these remarks, Dr. Woodland immediately sent me some worms belonging to the species commonly used for dissection in Allahabad, asking if they were not *P. posthuma*,—which they were. *Pheretima posthuma* being a well-known peregrine form, the occurrence is of no particular importance from a zoogeographical point of view: but it is interesting as showing that we are still far from a complete acquaintance with the distribution of Indian earthworms, and that any conclusions based on the absence of any forms from this or that region are liable to be upset at any time. It is probably true that, as Michaelsen wrote (9) in 1909, " We may now be sure as regards the principal characters of this interesting fauna and are justified in drawing conclusions as to its distribution and as to the geological history on which this distribution depends"; but notwithstanding the fact that considerable collections have been worked over since that date, it would seem that India is so large and diversified that all that has been done is really not much more than the taking of a few samples here and there.

From the point of view of the Oligochaete system, the most interesting result of the investigation of the present material is the discovery of two new genera, one from

Bombay and one from Cochin State. The former, which I have named *Erythraeodrilus*, stands in a somewhat isolated position as a branch from the base of the Octochaetine stock; its nearest relative and probably its immediate ancestor would seem to be *Howascolex*, which occurs in Madagascar. The other, *Comarodrilus*, takes its place as a well-marked genus of the subfamily Megascolecinae, and is related to other South Indian genera such as *Woodwardia* and *Megascolides*.

The next most striking feature is the large number of new species which have come to hand. Thus of 37 definitely named forms no fewer than 25 (20 species and 5 varieties) are new; moreover, even of the specimens which I have referred to some previously described species, a number are characterized by peculiarities which seemed worth recording. In the genus *Drawida* three out of four forms are new, in *Megascolides* all three, and in *Megascolex* twelve out of sixteen. With regard to the latter especially, the impression left after working over these collections is that in South India and Ceylon the genus has recently undergone a notable blossoming forth, with the production of a large number of forms and intermediate forms, and that in consequence it is extremely difficult to separate species from varieties, and varieties from examples of individual variability. The (Indian) range of *Megascolex* is of very limited extent, yet the number of species is extraordinarily large; and still every collector, wherever he chooses to explore, brings back numerous novelties. So Michaelsen (14):—"Trotzdem schon mehrfach Oligochätenausbeuten von Travancore zur Bearbeitung gelangten—ich erinnere an die Arbeiten Fedarbs, Michaelsens und Cognettis, scheint die Oligochätenfauna dieses Distriktes doch noch bei weitem nicht erschöpfend erforscht zu sein. Dafür spricht die verhältnismässig grosse Zahl (fünf) neuer Formen in dieser zwölf verschiedene Formen enthaltenden jüngsten Ausbeute. Wir dürfen hieraus den Schluss ziehen, dass die Oligochätenfauna Travancores, sowie des südlichsten Vorderindiens überhaupt, eine besonders reiche ist." And the same author found the difficulty to which I have also referred (*cf. post.* under *Megascolex sextus*) since he continues:—"Leider wurde die Untersuchung dieser Ausbeute dadurch erschwert, dass gerade die neuen Arten und Varietäten nur durch je ein einziges Exemplar vertreten sind." It is interesting to compare the above with what I have previously said regarding Ceylon (20). The earthworm fauna of the extreme South of the Indian region contrasts strangely with that of the North, where there are no endemic species, and those that do occur are well defined and fixed in character.

The addition of a *Fridericia* to the small list of Indian Enchytraeids deserves mention in passing.

From the zoogeographical point of view no considerable addition to the general scheme of our knowledge is to be recorded. The significance of *Erythraeodrilus* and of its relationship to *Howascolex* can scarcely be discussed at present, and must be deferred till more is known concerning the earthworms of Western India. Indeed, this is the portion of India which is most in need of exploration; a glance through the table given by Michaelsen (12) shows that with the exception of a few localities on the West Coast which may more properly be reckoned to the South Indian region, the only places in Western India which figure in the earthworm records are Thanā near

Bombay, Poona, and ' Sind ',—each once. Since then I have received a few specimens from Baroda (22), as well as those from Bombay recorded below. It is probably from this region that we may look for the greatest advance in our knowledge in the future.

The finding of the first terrestrial species of *Pontodrilus* is noteworthy. With the exception of the lacustrine *P. lacustris* (Benham) (described originally as a *Plutellus*,—perhaps its generic affinities are not yet entirely free from doubt, cf. 4 and 11), all the previous species of *Pontodrilus* are littoral; it is therefore startling to find a representative of the genus living in crevices of quartz many miles from the shore. The ancestral *Pontodrilus* was no doubt terrestrial; and it is interesting to speculate on the possibility of *P. agnesae* as representing that ancestor,—at least in so far as it has retained the terrestrial habit,—and of Ceylon as the original home of the genus; reaching the shore, and being enabled to adapt themselves to a littoral mode of life, its descendants, on this supposition, would have been carried in well-known ways widely over the tropical regions of the globe, becoming differentiated into the various species which now exist.

In favour of this, first, is the fact that species of *Plutellus*, from which *Pontodrilus* is descended, are endemic in Ceylon. Secondly, the disposition of the seminal vesicles in *Pontodrilus agnesae* (in ix and xii) is peculiar; those organs in other species of *Pontodrilus* are in general in xi and xii (in *P. lacustris* in ix and xi). In *Plutellus*, the direct ancestor of *Pontodrilus*, the seminal vesicles vary in position, but the commonest position, which is also perhaps primitive for the Megascolecinae in general, is in segments ix and xii, as in the present species.<sup>1</sup> It is possible therefore that *P. agnesae* retains a primitive character in the disposition of its seminal vesicles.

On the other hand *P. agnesae* shows no trace of a gizzard. Now not only has *Plutellus* a gizzard, but certain forms or species of *Pontodrilus* are also said to possess a rudimentary gizzard (though in others it is quite absent). In this feature therefore the present species appears to be among those that have departed more widely from the parent genus.

The question is not at present soluble. It is of course just possible that, while the littoral species of *Pontodrilus* may have descended from a Ceylon ancestor represented for us to-day by *P. agnesae*, and, one step further back, from a Ceylon *Plutellus*, *Pontodrilus lacustris* on the other hand may have originated independently from an Australian *Plutellus*. We are familiar with such parallel developments in the Megascolecidae; such characters as the perichaetine arrangement of the setae, the micro-nephridial condition, the rudimentary gizzard, have arisen at various times in the history of the family and on various branches of the tree; so too, according to the arguments used in discussing the position of *Erythraeodrilus* (*v. post.*), we have in the past history of that genus a course of evolution somewhat similar to that which, occurring on another branch of the tree, has resulted in *Eutyphoeus*.

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<sup>1</sup> Of the 35 species in which the distribution of the seminal vesicles is mentioned in Michaelsen's *Oligochaeta* (*Tierreich*, 1900), they are in ix and xii in 18; the next commonest condition is that where they occur in xii only (8 species); other conditions are represented only by three, two, or one species.

In addition to the above remarks there are a few points of more or less general interest to students of the Oligochaeta, which have recently,—in part during the preparation of the present paper,—suggested themselves to me for brief discussion; though I cannot pretend that the species described in the main part of the paper offer more than a convenient peg on which to hang my remarks.

#### THE PHARYNX IN THE ENCHYTRAEIDAE.

The usual condition in which what is sometimes called the 'pharynx' of Enchytraeids presents itself in sections is that of a flat raised plate of high columnar epithelium, with very definite edges, on the dorsal wall of the alimentary tube immediately behind the buccal cavity; this is shown, for example, for *Enchytraeus barkudensis* in fig. 1 of the original description of the worm (23). This plate is sometimes described as 'suckerlike',—at least it has been so by myself,—with, certainly, a suspicion that it might be everted from the mouth aperture and applied to the substratum for the purpose of adhesion after the manner of an actual sucker.

Fig. 1 shows that such eversion may take place; a number of specimens of *E. barkudensis* (belonging to a previous capture from the Chilka Lake) appear to have everted the pharynx at the moment of fixation. A similar phenomenon is recorded by Baylis (1) for a species which he describes as *Enchytraeus carcinophilus*.

But whether the plate when everted can act as a sucker, for adhesion, possibly for help in progression, seems to me more doubtful. The muscular fibres (*m. ph.*, fig. 1) attached to the epithelial plate might be supposed by contraction to withdraw the centre of the plate, and so, as for example in a sucker of *Sepia*, to produce a vacuum between the centre of the plate and the substratum; but the firm margin, capable of maintaining a close apposition, is wanting, and the high columnar epithelium seems an unsuitable sort of covering for such an organ.

The use of the everted pharynx as a means of adhesion and progression in *Aulophorus tonkinensis* (belonging to the Naididae) is well established (Annandale *apud* Michaelsen, 9; Stephenson, 18); but under 'pharynx' is here included the whole circumference of the alimentary tube ("the pharynx is large and wide"),—hence the meaning of the word is different from that in which it is used above in connection with the Enchytraeidae.

It is possible that the plate might be the central plug of the sucker, the margin being formed by the surrounding structures,—prostomium and everted portion of buccal cavity, *cf.* fig. 1). But I would suggest rather that the plate is sensory in function, and may be extruded for the purpose of exploration, or possibly also for picking up minute food particles by adhesion.

Another condition of the pharynx is shown in fig. 3; the pharynx is here retracted so as to appear as a thickwalled hollow hemisphere opening forwards into the buccal cavity. The figure is actually drawn from a specimen of *Fridericia carmichaeli*; but the same condition, only in a more exaggerated form (narrower cavity, the upper and lower walls being almost in apposition; narrower mouth projecting forwards into buccal cavity) was found in specimens of *Enchytraeus barkudensis* also.

The condition is therefore to be regarded, wherever found, as temporary only; the specimen from which Southern has illustrated the pharynx in his account of *Grania maricola* is in this condition (16).

#### ON THE OCCURRENCE OF SETAE IN THE BODY-CAVITY IN ENCHYTRAEIDS.

In the description below of *Fridericia carmichaeli*, reference is made to aggregations of setae and setal fragments in segments vii—ix, surrounded by masses of coelomic corpuscles. These were present in all the specimens examined, and are therefore, it would seem, not accidental but a regular character of the worm. The condition is represented in fig. 4. The masses of setae and corpuscles occupy the hinder and upper parts of the segments, the posterior septum of the segment often forming a sort of pocket, more markedly bulged backwards than in the specimen selected for illustration. The setae are in the actual specimens much more conspicuous than appears from the figure, where they are not distinguished by differential shading from the masses in which they are embedded; in reality they stand out by their brightness very markedly; the small circles in segment viii in the figure are setae or fragments cut transversely.

The fragments are of all sizes and thicknesses, from fully developed and normally shaped setae downwards. Some are miniature setae of the ordinary shape; some are spicule or needle-like, mere straight rods, often much thinner than ordinary setae, and perhaps longer too; some are stout and blunt, some stout and sharp; some are hooked at the end, others not. Along with the setae there also occur in the mass numbers of black granules. In places the masses appear to be limited by a membrane formed of flat cells—presumably the modified coelomic corpuscles of the surface of the mass.

The above appearances brought to my mind a curious condition I found on a previous occasion in a specimen of *Enchytraeus harurami*, which I did not describe in my account of the worm (22), but which may perhaps find mention here. Dorsally situated under the body-wall, to which it was adherent, was a large sac containing much granular matter (apparently disintegrating cells), one large normally shaped seta, a number of normally shaped but smaller setae, and many incomplete setae—minute fragments only. The capsule or enclosing membrane of this tumour,—for this seemed the best word to apply to it,—may have been, as I was inclined to regard it at the time, the distended setal sac itself; or as in the case of *Fridericia carmichaeli* the mass may have consisted essentially of coelomic corpuscles, and the sac wall may have been produced by the modification of an outer layer of the corpuscles. But a difference between the two cases is that in the *Enchytraeus*, so far as I know, the appearance was confined to a single specimen.

Another case which may possibly be comparable in some degree with the above is that of *Grania maricola*<sup>1</sup> described by Southern (16). Here “in addition to the

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<sup>1</sup> Michaelsen (15) considers this form to belong to the genus *Michaelsena*; for convenience however I here retain the author's name for it.

normally formed functional setae, almost every specimen shows large numbers of setae of various sizes scattered about in the body-wall. These setae usually occur in parallel bunches, but may be scattered about quite irregularly. They lie in the inner layer of the body-wall parallel to the surface, and do not pierce the epidermis. In shape they resemble the functional setae." The author considers that "in order to explain the observed phenomena it is therefore necessary to suppose that the seta-producing tissue has undergone a process of proliferation and spread from the region of the normal setae over the inner surface of the body-wall. This tissue appears to be in a state of unstable equilibrium in this species." It will be observed that the supernumerary setae are not said to be in the body cavity or surrounded by coelomic corpuscles, but in the inner layer of the body-wall.

Finally, it is well known that in the Lumbricidae small brown grains, of about the size of a small pin's head, may often be found in the coelom; these when broken up are seen to consist of brown granular matter derived from broken-down discoloured amoebocytes, in which are embedded discarded setae and nematode worms (Johnson, 6). I have found such grains, one of which on examination contained an entire seta, in a species of *Perionyx*, a Megascolecid.

The above cases may not all be comparable together. In some at least, the abnormally situated setae or fragments are apparently in process of being got rid of, —in other words eaten away by the surrounding cells.

The black particles in the corpuscular masses in *Fridericia carmichaeli* recall chloragogen pigment, and so too the brown granular matter in the grains found in the coelom of Lumbricidae, etc. It seems possible that the coelomic corpuscles, dissolving the substance of the setae, separate out the matter again in the form of the brown or black granules, and that this is perhaps ultimately got rid of by the nephridia; or, of course, the effect of embedding the setae may merely be to render them harmless.

As to whether the setae are in all cases, at first, normal setae, I should say not; it might be possible to suppose that the variously shaped fragments in *Fridericia carmichaeli* had been derived from normal setae by gradual solution under the influence of the corpuscles; but the long straight needles present a difficulty; and the smaller setae of *Grania maricola* appear to have been laid down originally of smaller size than the ordinary functional setae.

The chitinous cuticle of Arthropods and Annelids, besides being important or indispensable to its possessors in the rôle of an external protective covering, is nevertheless suspected to be, in part, an excretion; and if so the same must be said of the similar material which composes the setae. It would seem possible from the above, that this may be formed, on occasion, as rods or spicules purely in the way of excretion. These purely "excretory setae" are perhaps sometimes never got rid of, and remain to the end of life (as possibly in *Grania maricola*); in other cases, possibly, they may in turn be attacked, metamorphosed into substances that can be more easily disposed of, and finally eliminated through the usual channels.

ON THE SPERM-SACS IN THE GENUS *ENCHYTRAEUS*.

In a recent paper (23) I wrote of the sperm-sacs in this genus, "The sacs do not include the funnels of the vasa deferentia"; and since they are, in the stages at which I have examined them, completely closed, it is not obvious how the spermatozoa escape. A specimen of *Enchytraeus barkudensis* perhaps explains this (*v. inf.*); the wall of the sac was apparently wanting in part,—hence it would seem that at a certain stage the sperm-sac disintegrates or ruptures, possibly under pressure from within. Indeed, unless we assume an active penetration of the sac wall by the ripe spermatozoa there would seem to be no other means of exit. I do not, however, think we are at present entitled to exclude the active penetration of the sac; a re-examination of my specimens of *E. harurami* has also shown, in one case at least, a small break in continuity of the wall of a sac;—but on the one hand it is possible that slight damage of the kind might occur during section-cutting, and on the other the appearances do, in one or two places, suggest the penetration of the sac-wall by mature spermatozoa.

The question now arises,—Are sperm-sacs present throughout the genus *Enchytraeus*? In the published descriptions of a number of species they are said to be present<sup>1</sup>, in others they are not mentioned, while in some they are definitely said to be absent (as in *E. indicus*, 19, and compare 22, p. 322). In the latter class I am sure (as regards the specimens I myself examined) I may place *E. dubius* and *E. nodosus*, described some time ago by me from the Clyde (17). But is it possible that after rupturing, the wall of the sperm-sac entirely disintegrates, so that in the later stages not even the remains of sacs are visible? On this supposition the species in which the sacs are absent or are not noted may have been described from specimens in a late stage of maturity; it may be noted that I have never seen a clitellum in *E. barkudensis*, and in *E. harurami*, which also possesses testis-sacs, the clitellum, though distinguishable, was not conspicuous. It is, however, scarcely possible that the specimens of *E. dubius*, without testis-sacs, belonged to a late stage (*cf.* text-fig. 2 and fig. 12, pl. ii of the original description, both showing large testes,—hence an early rather than a late stage).

It may perhaps be necessary ultimately to remove *E. dubius* from the genus (I included it, as the name implies, somewhat doubtfully); or the present genus may have to be split up into two, one comprising those species which have and the other those which have not sperm-sacs. But a number of already described forms may have to be re-investigated before this can be done.

I may refer briefly to the condition in *E. carcinophilus* recently described by Baylis (1). The sperm-sacs appear to be of the nature of those described for *E. barkudensis*, etc.; but the testes are said to be in segment x on septum 10/11, *i.e.* outside the sperm-sacs,—it would be impossible so to describe them if they were within the sacs. This appears to me to be an unlikely position; apart from the analogy of *E. harurami* and *E. barkudensis*, to mention only forms with which I am myself acquainted, there

<sup>1</sup> So recently Stirrup (24), for *Enchytraeus albidus*.

is the apparent impossibility of the sexual cells getting *into* the testis-sac, where they are to undergo ripening; for whatever may be said as to the possibility of their getting *out*, when ripe, in order to enter the funnel, they are at least not motile when, in their early stages, before they even form the well-known morula-like masses, they are detached from the testis.<sup>1</sup>

#### ON THE USE OF THE TERM "IRIDESCENT FUNNELS."

On dissecting many of the ordinary Indian earthworms, what appear to be the funnels of the male deferent apparatus are often conspicuous by their glistening or iridescent appearance; and we find that words like metallic, glittering, iridescent, glancing, glänzend, have frequently been used in descriptions.

What I wish briefly to draw attention to, is the fact that the funnels themselves are not iridescent, but that this appearance is due to the ripe spermatozoa in their neighbourhood. The spermatozoa when fully formed constitute wisps or bundles of innumerable extremely fine threads lying parallel to each other, and the iridescence is a consequence of the parallel arrangement. The phenomenon is the same as that seen in the well-known 'diffraction grating'; in the same way the separated cuticle of a worm is iridescent, in consequence of the parallel striae of which it is composed.

While ripe spermatozoa, which have assumed the parallel arrangement, are thus iridescent in mass, sperm morulae and the various developmental stages of the spermatozoa are not. Since the spermatozoa take on the parallel arrangement before their discharge by the sperm-ducts, a quantity of matter in the testis segments (or in the testis-sacs, if these are present) will often be found to be iridescent; and if the ripe spermatozoa cluster round the funnel, this will be concealed by an iridescent investing layer.

As confirmatory, it may be recalled that in the Megascolecidae the spermathecal diverticula (which act as the storehouse for spermatozoa received from another worm) are frequently of the same glancing appearance. In some cases the flocculent mass of sperm morulae, etc. in a testis segment passes gradually into the iridescent material, without there being any definite separation between the two (I observed this in *Megascolex polytheca* var. *zonatus*). In *Drawida ghatensis* a fragment of what might have been described as a large iridescent funnel, when broken off and teased, was found to consist entirely of spermatozoa (the 'Samentrichter' in Michaelsen's figure of this species,—fig. 2,—is I think obviously merely bundles of spermatozoa). Finally, I have cut sections of the 'iridescent funnels' of *Pheretima hawayana*, after detaching as much of the surrounding matter from them as possible, and found, as was to be expected, that the actual funnels were largely overlaid by a layer of spermatozoa arranged

<sup>1</sup> If I might venture a further word of criticism, I would briefly advert on the non-correspondence of text and figures in the account of this worm. The segments occupied by the clitellum (xi—xiii) are said to be devoid of setae; but setae are shown on xi in fig. 1 and on xiii in fig. 8. The clitellum itself in fig. 8 seems only to extend over xii-1/2 xiii. The outline of the brain is said to be very slightly concave behind; but figs. 1 and 4 show it as slightly or markedly convex. It is hardly likely that the writer has prepared text and figures from different species; is the species variable in these points? It would have added to the value of the description if (supposing this to be the case) it had been so stated.

parallel to each other, with their axes at right angles to the epithelial surface of the funnel.

It is quite allowable, I think, to take the presence of the iridescent material, at any rate when adherent, as an indication of the presence of an underlying funnel; though probably no inference as to the actual size of the funnel can be drawn from that of the iridescent mass, and such a phrase as 'large iridescent funnels' (which I have no doubt used myself on occasions) is scarcely admissible.

Family ENCHYTRAEIDAE.

Genus ENCHYTRAEUS.

*Enchytraeus barkudensis*, Stephenson.

(Plate VI, figs. 1-2.)

Ennur backwater, Sta. 3. Two batches, one of four and one of three specimens, both obtained during January, 1915 (*N. Annandale*).

This species was recently described (23) from the Chilka Lake, and it is perhaps not surprising to find it again in a somewhat similar habitat further south. There are, however, a number of differences, some of which are interesting and have a bearing on the general anatomy of the Enchytraeidae; these are referred to below. The three chief diagnostic marks of the species however, which I gave in my former paper (number and distribution of setae, rudimentary salivary glands, and sperm-sacs enclosing testes) characterize the present specimens; as additional points of agreement may be mentioned the characters of the penial bulb and perhaps the thickening of septa 7/8-9/10.

In the first batch the specimens were 6 mm. or less in length, and comprised 46-48 segments; in the second they were 8-10 mm., and of 64-67 segments. No clitellum was seen even in those specimens which were fully sexual.

The *pharynx* was found in one of two conditions. Either it presented a dorsally situated sucker-like plate (the condition usually met with in Enchytraeids), sharply defined, of a very tall narrow epithelium; or it resembled the form of pharynx found in *Fridericia carmichaeli* (*v. inf.*),—a hemispherical thick-walled caecum with convexity backwards, the narrow lumen in this case appearing as a slit between the dorsal and ventral walls of the caecum, the oesophagus beginning ventral and anterior to its narrow mouth. For a third condition (extrusion outside the mouth) found in some later specimens from the Chilka Lake, and remarks thereon, see the Introductory section.

In both the caecal and the sucker-like condition of the pharynx a stout band or bands of muscular fibres were seen passing downwards and backwards from the pharynx to the ventral body wall, in addition to the numerous bands, universal in the Oligochaeta, which pass upwards and backwards to the dorsal parietes (*cf. Fridericia carmichaeli, inf.*). With this band the anterior prolongation of the septal glands towards the pharynx (supposed ductules of the septal gland-cells) unite.

The oesophagus certainly passes into the intestine without sudden change, as noted in the previous description; but this seems to take place in segment xi or xiii

(instead of further back in xv, xvi, or xvii). The dorsal vessel also seems to begin variously in xii, xiii, or xxii; there appears to be no doubt about the last observation, and, since the previous account of the worm gives the origin of the vessel as xv, xvi, or xvii, we may conclude that this character also shows a large degree of variation.

There are four well-marked lateral *vascular commissures* in the anterior region; the first, running very obliquely downwards and forwards, ends ventrally at a level between the setae of segments ii and iii; the second, less oblique, ends between the setae of iii and iv; the third, almost vertical, ends behind the setae of iv; the last, behind the setae of v; they seem therefore to belong to segments ii—v. The *ventral vessel* is formed by the union of two trunks from the anterior end of the animal; this union takes place just behind the level of the setae of segment iv; the first two commissures therefore join the trunks before their union, the last two join the ventral vessel.

The form of the nephridia is illustrated in fig. 2*a* and *b*. The interest here again lies in the variability of characters which are commonly taken to be of specific value; and it may be noted that in this case the variability exists within the same specimen. Fig. 2*a* represents the nephridium of segment ix; it is thin, elongated, continued behind without sharp demarcation into the duct; fig. 2*b*, from a nephridium behind the genital segments, is pyramidal, with a relatively narrow duct which leads off from the ventral and posterior angle with an arched course downwards and backwards to the surface (the arching was considerably more marked in another case). The figures were drawn from an entire specimen in cedar oil; the facts were also confirmed by a subsequent examination of longitudinal sections.

The *sperm-sacs* and *testes* present the same features as the previous specimens from the Chilka Lake; but in one of the specimens which was sectioned the wall of the sac appeared to be wanting in its posterior part, and there also seemed to be a gap at one place on the antero-dorsal part of its extent. The contained sperm-morulae were nevertheless not scattered through the adjacent segments, but remained compacted together in a definite mass within the sac. Ripe spermatozoa were seen in clusters round the mouth of the funnel. The sac-wall is an extremely delicate structure, and it is of course possible that the apparent rents in its continuity are due to damage during section-cutting; I have, however, no reason to think that this is really so,—and of course a disintegration of the sac is the easiest way of explaining how the male products reach the funnel.

The *penial bulb* is a small approximately spherical cluster of cells surrounded by a membranous capsule; it might be called rudimentary. The cells of which it is composed have no very distinctive characters; muscular strands pass upwards, as usual. The penial lumen is chitin-lined; the bulk of the bulb, and the terminal portion of the vas deferens lie to its inner side. The male aperture can be seen on the surface as a semicircular slit, in the position of the (absent) ventral setae of xii.

What I think must be regarded as a rudimentary *female funnel* and *oviduct* were discovered in longitudinal sections. A few nuclei are seen on a slight backward pouching of the ventral portion of septum 12/13 in one of the series; and from this

situation a cord of cells leads downwards, apparently losing itself in or on the body-wall.

To the previous description of the *spermathecal apparatus* it may be added that there are no glands found round the end of the duct, which opens in 4/5 just below the level of the lateral setae.

### Genus FRIDERICIA.

#### *Fridericia carmichaeli*, sp. nov.

(Plate VI, figs. 3-5.)

Rungneet Tea estate, 4000—5000 ft., Darjiling District ; ii-iii, 1914. Thirteen specimens.

The average *length* was about 15 mm., *breadth* 4 mm. ; 64 *segments* were counted in one of the specimens.

The *prostomium* is rounded, more or less semicircular in shape. The first six segments are relatively short.

The *setae* are of the '*Enchytraeus* type' The lateral bundles contain each two setae ; and this was also the case in the ventral bundles of four out of five worms examined carefully for their setal characters. In the fifth specimen, however, the number of setae was mostly three per ventral bundle in front of the clitellum and two per bundle behind it ; bundles of replacing setae, three or two, were also seen. Both ventral and lateral bundles are absent in segment xii.

A *head-pore* is present, and also *dorsal pores* from segment vi onwards.

The *clitellum* is only slightly marked ; it covers segments xii—xiii. The *male apertures* are situated on bluntly conical papillae on segment xii at the sites of the missing ventral setae.

The internal anatomy was elucidated principally by means of sections.

The *coelomic corpuscles* are large, oval, and granular, with a very distinct nucleus. There are definite aggregates of these corpuscles dorsally in segments vii, viii and ix (fig. 4), surrounding numbers of setal fragments ; these are not chance collections, since they occur in the same situations in all four of the sectioned specimens ; they are further referred to on p. 41, General Part.

The epithelial lining of the *buccal cavity* is approximately cubical, and is thrown into folds both dorsally and ventrally, especially ventrally (fig. 3, *buc. cav.*). The dorsal wall of the *pharynx* is not in these specimens marked by the flat sucker-like elevation, composed of tall columnar cells, which is commonly seen in sections of *Enchytraeids* ; the pharynx may be described as a hemisphere with its convexity directed backwards, with thick wall composed of an elongated columnar epithelium, and a lumen opening anteriorly into the buccal cavity (fig. 3, *ph*) but the condition is probably temporary, as explained in the General Part *ant.* ; the oesophagus begins from the floor of the buccal cavity in front of the pharynx. The pharyngeal musculature forms a layer behind the hemispherical projection ; especially noticeable is a sheet, well marked on each side of the oesophagus, at the anterior limit of segment iv which passes downwards and backwards to the ventral body-wall (fig. 3, *m.*). Further remarks on the pharynx of *Enchytraeids* will be found on p. 40.

The *salivary glands* are small; they originate from the junction of pharynx and oesophagus as diverticula which are prolonged backwards each as a solid club-shaped mass of cells (fig. 3, *sal.*), the posterior end being rather broader than the stalk, and appearing to be somewhat curled inwards behind the pharynx towards the middle line. These structures are limited behind by the sheet of muscle-fibres passing downwards and backwards from the pharynx. In their club-like form and small extent of the lumen they resemble the structures described in *Enchytraeus barkudensis* (23).

*Septal glands* are present in segments iv, v and vi; they are bulky, filling the segments at the sides of the oesophagus; those in v and vi have forwardly extending ventral lobes in addition.

*Chloragogen cells* begin in v, and are numerous in vi and behind. The *oesophagus* passes into the *intestine* without the appearance of any marked difference between these two portions of the canal.

The *chyle cells* which are a character of the genus extend in this species through segments xiv—xviii. In these segments they form a considerable portion of the alimentary epithelium, indeed in a number of sections apparently the whole, though usually other more cubical cells are present along with them. The chyle cells are elongated columnar cells, their peculiarity, as is well known, being the possession of a central canal which opens into the lumen of the gut. In the present species the canal is straight for the greater part of its length, but at the basal end of the cell it is often bent to a right angle or curved into a semicircle; the portion of the canal near its mouth seems to be ciliated, but only that portion. The free surfaces of the cells are ciliated; the nucleus, containing a central karyosome, is situated at about half the height of the cell or a little lower. The lumen of the canal within the cell is bordered by a zone of hyaline non-granular protoplasm, and beyond this again is a zone of deeply-staining (with iron haematoxylin) granular particles. The cells are not in close apposition throughout their length; there appear to be considerable intervals between them; the intestinal blood-sinus bathes their basal ends.

The *dorsal vessel* can be traced backwards in sections as far, at least, as segment xv; in the posterior part of ix, just in front of its passage through the septum, a number of cells are aggregated inside its lumen, but these are not definite enough to be called a cardiac body. A sinus-like space containing blood can be traced in the intestinal wall as far forwards as segment vi.

The *nephridia* begin from segment vii. The anteseptal portion is of relatively considerable size, perhaps a third as long as the postseptal, and the tube undergoes some windings in the anteseptal portion before piercing the septum. The duct appears to leave the lower surface at the posterior end. The determination of the characters of the nephridia in preserved material is not always satisfactory.

The *cerebral ganglion* is rounded behind, concave anteriorly; it is a little longer than broad, and lies above the buccal cavity, in front of the hemispherical pharynx. The *ventral nerve cord* shows a giant fibre dorsal in position.

The *testes* were doubtfully identified ventrally in segment xi. The *funnel* begins anteriorly as a collar of cubical cells; the main bulk of the funnel, which succeeds the

collar, appears as a large spongy mass, in which it is mostly impossible to discern cell boundaries; each funnel is larger in section than the alimentary tube, the space between which and the lateral body-wall it entirely fills out. The lumen is small, excentric, nearer the inner side of the funnel; the cells of which the mass is composed appear, so far as they can be distinguished at all, not to radiate directly outwards from the lumen to the periphery, but to be disposed in a spiral manner.

*Sperm morulae* are free in large numbers in xi; septum 10/11 is much bulged forwards, so that segment x is almost non-existent as a cavity in the mature animal (cf. fig. 4.) The *vas deferens* is an extremely fine much coiled tube situated in the ventral portion of xii; the amount of coiling is illustrated by the fact that it may be cut about 16 times in a single section.

The *penial body* (fig. 5) is a small compact ovoid structure, with a muscular or fibrous capsule; strong strands pass dorsally and laterally to the body-wall. The mass lies to the inner side of the penial lumen, which latter extends upwards and outwards beyond the point where it is joined by the *vas deferens*. The cells of the bulb do not extend on to the body-wall; but I am unable to give more precise details of its structure since the condition of the specimens scarcely permits of refined histological study.

The *ovaries* and detached ova are present in segment xii; funnel and oviducts were not distinguished.

The *spermathecae* have the usual situation. The *ampullae* are ovoid in shape, situated dorsally somewhat above the level of the oesophagus, with which their lower ends are continuous; though the cells of the one organ are continued into those of the other I did not make out an actual continuity of the lumina of the two. The epithelium of the ampullary wall consists of columnar cells of variable height, but mostly considerably elongated, with granular protoplasm and basally situated nucleus; owing to the height of the cells the cavity is relatively small. At the upper end where the duct takes origin the walls are thinner and the elongated granular cells have disappeared. The commencement of the duct is invaginated into the cavity of the ampulla; its first portion continues the direction of the ampulla obliquely upwards towards the dorsal body-wall; it then bends downwards and outwards to open on the lateral surface in about the mid-lateral line of the body. There are no gland cells round the aperture.

#### Family MONILIGASTRIDAE.

#### Genus DRAWIDA.

#### *Drawida ghatensis*, Mchlsn.

(Plate VII, fig. 6.)

Kavalai, 1300-3000 ft., Cochin State; 24-27-ix-1914 (*F. H. Gravely*). Two specimens.

Forest tramway, mile 10-14, alt. 0-300 ft.; Cochin State; 28-29-ix-1914 (*F. H. Gravely*) Two specimens.

This species has recently been described by Michaelsen (12); it will therefore suffice to draw attention to a few differences between his specimens and mine, and to mention a few additional facts of structure.

*External characters*—Length of largest specimen 195 mm., diameter 7 mm. Dorsally the colour is a slaty grey, with a pink tinge posteriorly, ventrally a lighter grey; the lateral region in the anterior portion of the animal appears thickened, the intersegmental furrows being deeper as they cross this lateral region than above or below it; this lateral region is in tint the lightest portion of the body.

Segments 183—186; posterior end tapers rapidly, the segments being very small. The prostomium is small and zygalobous.

With the higher powers of the dissecting binocular rings of minute papillae, light in colour, are seen on the anterior or on most of the segments of the body. These papillae resemble those caused by extremely numerous and minute perichaetine setae, and are possibly of the nature of sense organs.

I could not in all cases be certain as to the segment on which the setae begin. In one specimen the ventral bundles began in ii, the lateral apparently in iv; in another both bundles began from iii, and in a third from iv, though lateral setae were doubtfully present in iii.

A few of the setae were examined microscopically. A seta from segment viii is shown in fig. 6; its length is 52 mm., breadth at nodulus .041 mm.; the basal portion is seen to be very stout, the free end being curved and pointed. The distal fifth or thereabouts shows a number of very fine sculpturings; under the oil immersion lens these appear to be angular, with point directed backwards (basalwards); they are possibly spines, though they cannot be seen to project from the sides of the shaft. A second seta from the same segment was considerably thicker at the nodulus (.054 mm.). A seta from a few segments further back showed the thickening of the base in a more exaggerated form; but this curious deformation was not present in a seta taken some distance behind the genital region. The sculpturing appears to be constant. It should be added that probably all the setae examined were of the nature of reserve setae, which had not yet come to project freely on the surface.

There was no clitellum in any of the specimens, notwithstanding that dissection showed them to be sexually mature.

The nephridiopores in the anterior part of the body are in the line *cd*; in the middle and posterior regions they are mostly lateral, in *cd*, but occasionally ventral, in *ab*.

*Internal anatomy*.—Septum 4/5 is distinct and somewhat thickened. Septa 10/11 and 11/12 are fused in such a manner as to form a ring-like ovarian chamber above the alimentary canal.

The gizzards vary; the most posterior is the largest, and the anterior ones are successively smaller. It is really scarcely correct to speak of separate gizzards; there are only slight segmental constrictions in a continuous hard muscular tube. One might reckon six gizzards, in xvi to xxi, in the specimen first dissected, though the anterior one or two were weaker than the rest; the oesophagus was still firmer than normal and somewhat thickened in xv. In a second, six were counted, in xiv to xix, the first being less firm than the rest. In a third, belonging to the second batch of specimens, there were four only, in xix to xxii, though the oesophagus was still rather firm in xviii.

The diverticula of septum 9/10, which pass backwards as elongated sacs, and in which the male genital products are formed, reached as far as segment xii, xiv, or xv. After crossing segment x each sac passes dorsal to the gut underneath the ovarian chamber representing segment xi, previously described. The sac is quite free, and does not fuse with the floor of the chamber; the ovarian chamber can be cut through in the middle line and lifted up quite clear of the subjacent structures. On opening the posterior swollen end of the sac I did not discover a testicular vesicle,—*i.e.* a second, closed sac within the bag-like diverticulum of 9/10; the testis and developing genital products appeared to me to lie free in the cavity of the diverticulum itself.

The prostate (male atrium) is an ovoid mass, with its long axis antero-posterior, conspicuous on the body-wall, taking up the length of segment x; it is joined by the vas deferens on its anterior face. The ovaries are crescentic fringes on the anterior wall of the ovarian chamber (segment xi), lying alongside and underneath the arch of the nephridium.

The shape of the spermathecal atrium varies. It may project upwards, papilla-like, from the ventral body-wall; or it may appear as an ovoid structure, with its long axis antero-posterior, sessile on the body-wall; in these cases the duct joins the atrium not on its upper surface but at the middle of its height. Or it may be embedded in a recess in the body-wall,—easily defined and isolated but not projecting, its surface being flush with the inner surface of the parietes.

*Remarks.*—*Drawida ghatensis* is thus a variable species. After dissecting the first example, I thought it would be necessary to erect a separate variety for it, on the ground, principally, of differences in the gizzards and spermathecal atrium. In no case where these features were examined, do they correspond with the condition described by Michaelsen; but neither do they agree among themselves. A comparison of the original description of the species with the above notes will show a few other differences, though none of much importance.

### **Drawida brunnea, sp. nov.**

Parambikulam, 1700-3200 ft., Cochin State; 16—24-ix-1914 (*F. H. Gravelly*). A single specimen.

Length 40 mm.; maximum breadth 5 mm. A short, relatively very broad, dorso-ventrally flattened worm, perhaps much contracted antero-posteriorly as all the segments are very short. The colour is a very dark brown, almost black, dorsally, and very slightly lighter ventrally. Segments 120. Prostomium not recognizable.

Dorsal pores apparently absent. The setae are very small and very closely paired; they are difficult to detect in the anterior part of the body, and I could not distinguish them at all in segment ii. Setae *cd* are in the lateral line of the body: and since the mid-ventral interval is rather less than the ventro-lateral, *aa*  $< 1/6$  circumference, *bc*  $> 1/6$  circumference.

The male apertures are in furrow 10/11; they are bordered by prominent lips, which are swellings of the margins of the furrow. They are situated midway between *b* and *c*, or rather nearer to *c*.

There was no clitellum, and no other genital apertures were visible. From an

examination of the base of the female funnel in the dissection, the female aperture would appear to be between *b* and *c*, probably near *b*.

*Internal anatomy.*—Septa 5/6—8/9 are somewhat thickened.

There are three gizzards in segments xiii—xv; the anterior one is, however, less firm than the other two.

The last heart is in ix.

The testis-sacs are large, massive, projecting on both sides of septum 9/10, not constricted by the septum; the part in x is larger than that in ix. On opening the sac the testis is seen, after clearing out the contents, as a small bushy structure. The vas deferens is a fine tube which leaves the posterior side of the sac and presents numerous closely packed coils. The prostate is an opaque-white ovoid body in x; it has a short moderately thick stalk, a smooth surface but without muscular shimmer, and is joined by the vas deferens on its inner side.

The ovarian chamber is formed by the fusion of septa 10/11 and 11/12. It was opened into while opening the specimen, which seems to show that the roof of the chamber is at the dorsal parietes. The chamber encircles the gut dorsally and laterally, and in the present case was full of ova.

The ovary is a considerable fringe-like band on the anterior wall of the ovarian chamber. The funnel is on the posterior wall, in the lateral region; it extends upwards, however, lateral to the gut by a greatly drawn-out dorsal lip which reaches to not very far from the mid-dorsal line; the base of the funnel is ventro-lateral, on the body-wall.

The ovisac, originating dorsally from the posterior wall of the ovarian chamber, is tubular, elongated, and contained within segment xii. It passes laterally round the alimentary tube, and tapers towards its lower end.

The ampulla of the spermatheca is situated dorsally in viii, on the posterior face of septum 7/8; it is ovoid in shape, and the duct leads off from its lower and outer end. The duct coils considerably, some coils lying on the septum while others are free in segment viii; it then pierces the septum ventrally and immediately joins the atrium, which is wholly in vii. The atrium is a mammillary projection, sessile on the parietes in the line of the lateral setae (or rather in the longitudinally running interruption of the muscular layer of the body-wall which marks this line); it is joined by the duct at its base.

*Remarks.*—The species which, perhaps, the present form most resembles is *D. travancorensis*, Mich. (12). It is indeed just possible that the two are identical, since Michaelsen's specimens were in a bad condition of preservation, and the present account is based on a single specimen; and future opportunities may bring to light specimens which bridge over the differences. The size, proportions, and shape of the present specimen seem however to distinguish it; I should be inclined to put the colour as characteristic,—unfortunately the condition of Michaelsen's specimens did not allow him to state the colour. The shape of the egg-sacs, of the spermathecal atria, perhaps also of the prostates and of the male apertures, may be valid distinguishing marks between the two.

**Drawida parambikulamana, sp. nov.**

Parambikulam, 1700-3200 ft. Cochin State; 16-24-ix-1914 (*F. H. Gravely*). A single specimen.

*External characters*.—Length 84 mm., diameter  $3\frac{1}{2}$  mm., colour a bluish grey, darker on dorsal, lighter on ventral surface and laterally. The body-wall in the lateral region on each side appears rather thickened (*cf. D. ghatensis, ant.*) The situation of the ventral setal bundles is marked on each side by a dark line extending the whole length of the ventral surface (due probably to the interruption along this line of the continuity of the longitudinal muscular coat); there is a similar dark line in the situation of the lateral bundles in the posterior half of the body, though this lateral dark line is less marked than the ventral.

Segments 140. Prostomium indistinguishable.

The setae are small and closely paired;  $aa=bc$ ;  $dd$  is approximately equal to half the circumference of the body,—perhaps a little more, but not as much as  $\frac{4}{7}$ . The lateral bundles are situated a little below the middle in height of the thickened lateral region of each segment. The setae are less closely paired in the anterior region of the body, where (segment vii)  $aa=5ab$ , while further back  $aa=7ab$ .

A considerable number of nephridiopores are lateral in position, a few however ventral.

No clitellum was distinguishable.

The male apertures are on minute papillae in furrow 10/11 outside the line  $b$ , but nearer  $b$  than  $c$ . The female apertures were perhaps represented by a pair of minute pale spots in furrow 11/12, in the line  $b$ . The spermathecal apertures are in 7/8, small, and their centre in the line  $c$ .

*Internal anatomy*.—Septum 4/5 is perhaps represented by a sheet of a muscle directed rather backwards from its insertion round the alimentary canal towards the body-wall, which it joins a little in front of the level of furrow 5/6; being thus concave backwards it may not be homologous with a septum, the septa being usually in the anterior part of the body concave forwards. Septum 5/6 is attached to the body-wall rather behind the level of the corresponding groove; it and subsequent septa up to 8/9 are considerably thickened; the rest are thin.

There are three gizzards, in segments xiii—xv, that in xiii being smaller than the other two. The last heart is in ix.

The testis-sacs are on septum 9/10, projecting backwards into segment x, and only slightly (right side) or not at all (left side) forwards into ix. A sac was opened, but the contents were so intimately adherent to the wall that testis and funnel could not be recognized; part of the adherent mass itself was presumably testis.

In segment ix, ventral to the level of attachment of the testis-sac, and sessile on the anterior face of the septum 9/10, is a white mass with a delicately mammillated surface. On teasing out and examining microscopically this proves to be the extremely fine and tightly coiled vas deferens. The tube has in this part of its course a diameter of .04 mm.; it is broader and easily visible under the dissecting binocular in its terminal portion, before it joins the prostate. In this specimen the duct was full

of spermatozoa, and had while still *in situ* a rather glancing opalescent appearance.

The prostate is an ovoid sac-like mass of considerable size, attached by a broad base to the body-wall. It is rather flattened laterally, and its lower part is yellower and apparently more muscular. A flocculent substance (? glandular cells) can be scraped off its surface by needles; the surface is however in the natural condition smooth. A small central cavity can be demonstrated by cutting across with scissors. The vas deferens joins it on its anterior margin.

Segment xi is short antero-posteriorly; septa 10/11 and 11/12 are fused immediately above and at the sides of the alimentary canal, and thus form the floor of an ovarian chamber. The roof of the chamber is at the dorsal parietes, where the two septa mentioned are close together though separate. The ovarian chamber (=segment xi) is thus opened in the ordinary dissection. The ovaries are seen as narrow fringes lateral and dorso-lateral to the intestine on the anterior wall of the chamber; the funnels were not identified.

The egg-sacs, diverticula of septum 11/12, are small, tubular, wider at the mouth and narrower at their hinder end, which is turned forwards. They are entirely contained within segment xii.

The spermathecal ampullae are broadly oval sacs of considerable size in segment viii, on the anterior wall of the segment, one on each side dorsal to the gut and almost touching each other in the middle line. The duct is narrow, coils considerably in viii, and pierces septum 7/8 to join the atrium at the base of the latter. The atrium is of moderate size, teat-like, with a cavity (as seen when examined microscopically after clearing with acetic acid) of simple form.

*Remarks.*—With the exception of *D. parva* (Bourne) no species of the genus seems closely to approach the present one. A comparison with *D. parva* is difficult, because on the one hand Bourne's description (5) presents the extreme of brevity and baldness, and on the other I have only a single specimen of the present form, and there is thus no indication of the amount of variability which may be expected to occur. I separate the two partly on the ground of differences in the testis-sac, prostates, and, probably, colour; but perhaps more on the ground of the bodily proportions; Bourne's specimen, though but little shorter than mine (75 as against 84 mm.) is only slightly over one-third the thickness (Bourne gives the circumference of his worm as 4.25 mm., which corresponds to a diameter of  $1\frac{1}{3}$  mm.; the coloured drawing, however, which represents the living worm of natural size, shows it as  $2\frac{1}{2}$  mm. diameter; the colour during life might, from the plate, be described as light brown with a pinkish tinge due to blood vessels).

### *Drawida chalakudiana*, sp. nov.

(Plate VII, fig. 7.)

Chalakudi, Cochin State; 14—30-ix-1914 (*F. H. Gravely*). Three specimens, of which one, the largest, bears sexual marks.

*External characters.*—Length 41 mm., diameter  $1\frac{1}{2}$  mm.; colour bluish grey, dark on the dorsal, light on the ventral surface. Segments 135.

Prostomium prolobous,—an oval lobe filling up the circle of the anterior margin of the first segment.

The setae are paired, but not very closely in the anterior region; in the segments near the male aperture  $aa=3\frac{1}{2}ab$ , further back  $aa=6ab$ . The other relations may be given as  $aa=bc$ ,  $dd$ =half circumference. The setae begin on segment ii.

No clitellum is distinguishable. The sexual apertures also were distinguished only doubtfully, though the specimen was quite mature; they all were extremely minute, the male pores apparently in  $b$ , the female as whitish spots in  $a$ , the spermathecal apertures in  $c$ , in the usual furrows.

Genital markings were present as follows (fig. 7):—On segments x and xi, bisected by furrow 10/11, is a transversely oval area, which extends antero-posteriorly from the setae of x to those of xi, and laterally on each side to a point outside the line  $b$ . Thus in lateral extent it comprehends the whole ventral surface; while antero-posteriorly it is more than the equivalent of a segment, since the ventral setae of x are in front of, and those of xi very considerably behind, the middle of the length of their respective segments. The margin of the area ( $b$ ) is white, the interior ( $c$ ) darker. Within the dark region, medially situated on the posterior half of x, is a semicircular raised patch ( $e$ ) with its base lying at furrow 10/11; the furrow is here slightly curved with its convexity backwards, and this portion of the furrow is deepened as compared with the portions in proximity to the lateral margins of the raised semicircle, which are shallow ( $d$ ).

A slightly thickened lighter oval area, also transversely elongated, is present on segments vii and viii, bisected by furrow 7/8; it is however less well marked and less extensive than that on x xi.

*Internal anatomy*.—Septum 5/6 is moderately, septa 6/7—8/9 are considerably strengthened.

The gizzards are three, in segments xiii—xv; this region might be described as a fortified part of the oesophagus; it is not very hard, there is not much constriction at the septa, and the septa are not displaced at all.

The last heart is in ix.

The nephridia arch round the gut on each side, each nephridium being adherent to the posterior face of a septum. The nephridiopores are (? always) in the line of the lateral setae.

The testis-sacs are large, suspended by septum 9/10 and slightly constricted by it. The portion of the sac which projects forwards into ix is larger (considerably larger on the left side) than that which projects backwards into x. After opening one of the testis-sacs and clearing out the detachable flocculent matter, a quantity still remained intimately adherent to the sac-wall as a sort of fur; this perhaps indicates that the testis is a diffuse proliferation of the wall. The site of the funnel was perhaps indicated by a small iridescent mass on the floor of the sac in the neighbourhood of the septal attachment, where the vas deferens could also be seen arising. The vas deferens undergoes a number of windings on both sides of the septum; it enters the prostate on its anterior face at about the middle of its height.

The prostate is large, and presents itself as a rectangular block beneath and rather to the outer side of the hinder half of the testis-sac; it takes up the whole length of the segment, and is somewhat constricted where it is attached to the parietes,—or it might be described in other words as sessile on the body-wall by a somewhat narrowed base. It is soft in texture; no muscular lower portion or duct is distinguishable.

The ovarian chamber is of a less specialized form than in a number of other species of the genus. On opening the specimen the appearances in this region did not suggest the presence of a chamber at all, and septa 10/11 and 11/12 appeared to have the usual disposition (*i.e.* that usual in other families). On closer examination, however, 11/12 appeared to pass forwards above and close to the gut to be united with 10/11, thus forming the floor for an ovarian chamber, which has as its roof the dorsal body-wall, where the septa are not approximated at all. I believe I passed a needle forwards, from segment xii underneath the chamber and dorsal to the alimentary tube, so that its point appeared in x, without penetrating a septum: but the whole worm is very small.

The space,—segment xi, ovarian chamber,—was filled dorsally and laterally to the alimentary canal by a block of soft white substance, which on microscopic examination proved to be ovary,—not ova which had been shed. The block is divided in the mid-dorsal line and each half is attached ventrally in the segment. The ovaries are thus particularly massive.

The ovarian sacs extend backwards from septum 11/12 as far as segment xvi; they are of an elongated tubular shape, constricted at the septa and narrowing gradually towards the posterior end.

The funnels, on the anterior face of 11/12, may be described as each consisting of a couple of much thickened rounded folds, parallel and almost close together, and hence forming the borders of a groove; at their upper end, near the mouth of the ovisac, these folds unite in a bluntly pointed freely projecting tip. The folds and the contained groove, passing ventralwards, reach the floor of the segment just posterior to the attachment of the ovary.

The spermathecal ampulla is spherical, attached to the posterior surface of septum 7/8 dorso-lateral to the oesophagus; the duct is thin, and is coiled in the lower part of segment viii. The atrium, in vii, is relatively fairly large, and is a conspicuous structure in its segment; it is of simple shape,—a stumpy cylindrical sac-like structure projecting upwards. The junction of the duct was not seen,—possibly it is situated in the body-wall. So far as could be seen from inside, the atrium was situated in or about the line *ab*,—near the middle line immediately adjacent to the oesophagus.

*Remarks.*—This would appear to be one of the more primitive species of the genus. As primitive characters may be mentioned the slight differentiation of the gizzard region of the alimentary tube and non-displacement of septa in this tract; the condition of the ovarian chamber; the well-marked prostomium (in the species which I have had the opportunity of examining, both in connection with the present collection and previously, it is very common for the prostomium to be either small or quite invisible);

and, perhaps, the fact that the setae begin, as normally, in ii, and are certainly not so relatively small and very closely paired as in a number of species of the genus.

### Genus MONILIGASTER.

#### *Moniligaster deshayesi*, E. Perrier.

Parambikulam, 1700–3200 ft., Cochin State; 16–24-ix-1914 (*F. H. Gravelly*). Two specimens, one without clitellum.

*External characters*—Length 150 mm., breadth 6.5 mm.; colour a medium olive ventrally, considerably darker dorsally with a bluish tinge. Segments about 184.

Prostomium not distinct; slight lateral thickened regions in each segment (*cf.* some species of *Drawida*, *ant.*) No dorsal pores.

Setae minute, closely paired;  $aa=bc$ ;  $dd$  estimated at slightly more than half circumference, so that  $d$  is just below the lateral line of the body.

The sensory papillae, if they are such, described in the next variety (*var. gravellyi*) were scarcely visible and irregularly distributed in the first specimen examined: they were more regular and more marked in the second.

Clitellum x—xiii=4, not well marked, distinguished by a rather lighter colour and a yellowish tinge.

Male apertures small, in groove 10/11, outside  $b$ , but nearer  $b$  than  $c$ . Female apertures indistinct, in groove 11/12 in  $b$ . Spermathecal apertures minute, in groove 7/8, just below  $c$ .

The nephridiopores may be in line either with the ventral or the lateral setal bundles, but there is no regular alternation.

*Internal anatomy*.—Amongst the numerous muscular sheets and strands which pass from the anterior portion of the alimentary canal to the parietes, those which represent septa are to be distinguished by their relation to the nephridia; since the rule throughout the body is that the nephridia lie against the posterior face of a septum. The first nephridium is that of segment iv, and the sheet of tissue on the posterior face of which it lies will be septum 3/4. Taking the nephridia as guides, it is found that septa 4/5 and 5/6 are fused at their peripheral attachment, so that segment v is not necessarily opened in the usual procedure for displaying the interior of the worm. On opening the chamber representing segment v the nephridia of the segment are seen, as well as a section of the dorsal vessel, and a pair of small lateral vessels; the attachment of the conjoined septa 4/5 and 5/6 to the parietes is at the level of groove 5/6. Septa 6/7—8/9 are much thickened.

The gizzards are four in number, in xv—xviii; the oesophageal wall is however muscular in xiv, so that an additional rudimentary gizzard might also be enumerated.

The last heart is in ix. The hearts are not attached to the posterior septum of the segment, as is perhaps generally the case in the Oligochaeta, but are free in the cavity of the segment.

The nephridia, attached to the posterior face of the septa, arch over the alimentary tube so as almost to meet each other in the middle line dorsal to the gut.

The testis-sac is in segment x,—large, rectangular, attached to the posterior face of septum 9/10. On opening and emptying one of the sacs, the testis is perhaps seen to be represented by a small bushy projection on the ventral wall; there was also seen on the ventral wall of the delicate and transparent sac an oval ring-like opaque thickening, perhaps representing the margin of the funnel; the vas deferens leads off from the anterior end of the ring, near which the testis is also situated. Curiously, in the second specimen examined, the right testis-sac was not contained in x at all, but in xii. Its empty neck passed beneath the ovarian chamber, and expanded in xii to a rectangular bag filled with genital products. The condition here therefore somewhat resembles that in *Drawida ghatensis*. A number of coils of the vas deferens also accompanied the testis-sac in xii.

The vas deferens is a very long and much looped tube; the loops are long, straight, the two limbs running closely side by side; there are two bunches of such loops, one projecting forwards from septum 9/10 into ix, another on the posterior face of the septum, ventral to the testis-sac, projecting into x. The first part of the vas is thinner than the rest.

The prostates are very large, sausage-shaped, extending back dorsal to the alimentary canal as far as septum 14/15; but this does not represent their full length, since 14/15 is so much bulged back by them that it comes to lie at the same level as 16/17 dorsal to the gut. The prostates are rather bent to one side at their hinder ends; they are of a pearly white colour, thus differing from the egg-sacs, testis-sacs and spermathecal ampullae, which are (in the preserved specimen) yellowish. The vas deferens in its terminal portion runs backwards on the surface of the prostate, opening into the latter some little distance from its hinder end. The terminal (anterior, ectal) part of the prostate is narrower than the rest, more shining and more like a duct: it is rather twisted, and appears finally to become rather broader again as it enters the body-wall.

The ovarian chamber, situated dorsally and laterally to the alimentary tube, is morphologically the eleventh segment. The ovaries are contained within it, as a pair of fringes on the anterior wall of the chamber, arching dorsalwards over the gut so as to approach each other near the middle line. The funnel is seen as folds on the posterior wall which pass downwards to the ventro-lateral portion of the chamber.

The ovarian chamber is quite free from the alimentary tube, and a needle can easily be passed between them.

The ovisacs are large, lying alongside and of equal extent with the prostates; anteriorly they open by a narrow neck into the ovarian chamber.

The spermathecal ampulla is broadly ovoid, situated on the posterior surface of septum 7/8, to which it is attached underneath the arch of the nephridium. The duct leaves the lower end of the ampulla, forms a number of coils in segment viii, and pierces septum 7/8 ventrally, close to its attachment to the parietes; it then has a considerable course in vii passing finally between the two lobes of the atrial appendage to join the inner (internal) end of the stalk of the mass at the point where it bifurcates (*v. inf.*).

The glandular mass in connection with the ectal end of the spermathecal apparatus is of large size, situated in vii, bifid, each half compact and rounded, with a yellowish mammillated surface; one half lies higher in the segment, the other ventrally to this, the whole bound down to the ventral body-wall and to the septum (7/8) by loose areolar tissue. The stalk (atrium) is relatively narrow, and bifurcates, one branch going to each half of the mass. Neither the stalk nor its two branches are in any sense sacs; the appearance is that of two ducts proceeding one from each half of the mammillated glandular mass, which unite to form a common duct; this common duct is less than half as long as the glandular part and nowhere dilated.

In the second specimen the division of the glandular mass into two lobes was not obvious; a division could however be made by means of needles, though not without some slight damage to the substance of the gland. But I am quite certain that the idea of trying to separate the mass into two parts would never have occurred to any one who had no previous knowledge of the species. The duct from the spermathecal ampulla entered the lower surface of the mass.

*Remarks.*—This species is especially interesting as being the first of the family Moniligastridae to be described (E. Perrier, in 1872, from Ceylon). The type specimen (the only one of the species then known) was re-examined about 1909 by Michaelsen (9), who corrected some errors in the original description. Michaelsen himself became possessed of other specimens in 1910 (12), and made a few remarks on them, especially throwing doubt on the alleged locality of the type. In 1913 he also received from Travancore (14) a badly preserved specimen of a new variety (var. *minor*).

The present is therefore the fourth occasion on which specimens of this historic species have come to hand. Since it is possible that the present specimens also differ sufficiently from the type to constitute a variety (in the prostomium, setal relations, position of nephridiopores, and perhaps the form of the atrial glands of the spermathecal apparatus), though I do not at present name them as such, I have given an account of them at some length.

Var. **gravelyi**, var. nov.

Trichur, 0-300 ft., Cochin State; 1-4-x-1914 (*F. H. Gravely*). A single specimen.

*External characters.*—Length 130 mm., diameter 5 mm.; colour on dorsal surface an even, beautiful bluish grey, on ventral surface a lighter tint of the same, the lateral surfaces different from and sharply marked off from both, of a still lighter drab colour; these lateral regions appear thickened, and the intersegmental grooves are deeper here than dorsally or ventrally (*cf.* some spp. of *Drawida*, *ant.*). Segments 139.

Prostomium absent (or invisible). No dorsal pores.

The setae are minute and very closely paired; *aa* and *bc* appear to be, in general, approximately equal. The lateral couples are a little below the middle of the height of the lateral lighter-coloured regions (*v. sup.*) in the anterior part of the body, about the middle of their height in the middle, and slightly above in the posterior part of body.

In the first 10 or 11 segments are a number of small whitish spots, arranged as a ring in each segment, each spot slightly raised. These rings at first sight simulate

rings of minute perichaetine setae; in the most anterior segments of all they are smaller than in the rest of the segments in which they occur. They may possibly represent sensory papillae (*cf. Drawida ghatensis, ant.*).

No clitellum was distinguishable.

The male pores appear as slits in furrow 10/11, marked only by a slight thickening and whitening of the intersegmental furrow at the junction of the lateral and ventral areas of the body-wall, *i.e.* between *b* and *c*. No other apertures or genital marks were visible.

The nephridiopores are some in the line *ab*, others in *cd*; but there is no regular alternation.

*Internal anatomy.*—The anterior septa have the exact relations described in the case of the preceding form; septa 5/6—8/9 are much thickened.

The gizzards are four in number, in segments xv—xviii; they are spherical or somewhat flattened antero-posteriorly, are all about the same size, and are preceded by a firm portion of the oesophagus in xiv.

The testis-sacs are ovoid, attached to septum 9/10, projecting backwards into segment x but not forwards into ix. The vas deferens consists of large bunches of loops, in both ix and x, which are prominent and look at first sight like a bushy gland, an ovary for example. The loops are all attached to the septum, or to the base of the testis-sac where it joins the septum, and cannot be seen to communicate with one another at their attached ends. The vas emerges from the tangle near the body-wall in x, passes back to the prostate to which it applies itself near its ectal end, ascends along the inner face of the prostate, bound down to the latter by connective tissue, and enters the substance of the prostate at its posterior (ental) end.

The prostate, attached to the body-wall in the situation of 10/11, is narrow at its origin, rather twisted, firm and indistinctly shiny,—hence probably muscular. The organ passes back as far as segment xiii, becoming much broader, and with its fellow entirely covering the dorsal aspect of the gut. Segment xiii is bulged both forwards and backwards by the swollen and curved posterior ends of the glands, these posterior ends, as said above, being joined by the vasa deferentia. The glands are of an opaque white colour, their surface is marked out by shallow depressions into slightly marked lobes, but is otherwise smooth. The organs are bulky, and with the gizzards are the most conspicuous objects on opening the worm.

Though the male apparatus and, as will be seen, the spermathecal apparatus were quite fully developed, I could find but little trace of the female organs. Ovaries and egg-sacs were absent; there appears to be an ovarian chamber, as in the previous species and in *Drawida*; rudiments of the female funnels were identified, though somewhat doubtfully.

The spermathecal ampulla is in segment viii, attached, as usual, to the posterior face of 7/8 and overarched by the nephridium; it is of ovoid shape, and is continued into a narrow duct, the coils of which project backwards into segment viii. The duct penetrates septum 7/8 near the body-wall, and, having become more transparent and difficult to follow, it joins the atrial gland on its upper border. The atrial

glands are a pair of structures in segment vii, one on each side, in shape an elongated and rather flattened ovoid, and lying obliquely in the segment so that the anterior end is more external; in the natural condition this position is probably represented by saying that the glands are flattened between the cone-like septa 6/7 and 7/8. The gland is bound to the parietes by a quantity of connective tissue; there is no trace of its being bifid; its surface is however mammillated, or composed of a number of small slightly projecting lobules. The duct is given off from the under portion of the gland; it is short, moderately stout, and opens apparently ventro-laterally on the surface,—at a rough guess, as seen from inside, about one-third of the circumference from its fellow of the opposite side.

*Remarks.*—When I first examined this form I had no doubt that it was a distinct species, since the large atrial gland of the spermathecal apparatus was a single undivided structure on each side; in the other species of the genus these glands are double on each side. But the dissection of the other specimens of the genus contained in the present collection has rendered necessary a revision of my first impression; as has already been seen, in one of the specimens which I refer to *M. deshayesi*, the double character of the glands was obvious, and each portion had its own stalk leading to the common atrium; in the other specimen the double nature of the glands was much less apparent, and could only be demonstrated at the cost of some damage to the glandular mass. Since therefore the division into two of the organ seems to vary in its completeness, the purely single character of the gland in the present specimen is of less importance; and since there are no other considerable differences between the two forms, it seems best to be content with establishing a variety for the present example.

#### Subfamily MEGASCOLECINAE.

##### Genus PLUTELLUS.

Parambikulam, 1700–3200 ft., Cochin State; 16–24-ix-1914 (*F. H. Gravelly*). A single specimen, but unfortunately immature, wanting spermathecal and seminal vesicles; the species is therefore indeterminable.

##### Genus PONTODRILUS.

##### *Pontodrilus bermudensis*, Bedd. f. *ephippiger* (Rosa).

Ennur backwater, Madras; 18-i-1915 and 21-i-1915 (*N. Annandale*). Several batches, taken on separate occasions.

##### *Pontodrilus agnesae*, sp. nov.

Horton Plains, Ceylon, 7000 ft.; in crevices of quartz. Dec., 1913 (*S. W. Kemp*). Three specimens, none complete; two of them represent the anterior end, one the posterior.

Elk Plains, Nuwara Eliya, Ceylon, 6200 ft., Dec., 1913 (*S. W. Kemp*). One complete though damaged specimen; one fragment incomplete at both ends.

*External characters.*—Length 65 mm., diameter (average) 1 mm.; colour dark brown. Segments 116.

Prostomium prolobous, but the groove marking off the prostomium is slight, so that the condition is almost zygalobous.

The setae are paired;  $aa=2ab$ ,  $bc=1\frac{1}{2}ab=cd$ ; the setae  $d$  are dorso-lateral, and  $dd$  = about  $3cd$ , and is approximately one-third of the circumference. In the anterior part of the body  $dd$  is rather greater. Setae  $a$  and  $b$  are absent on xviii.

The clitellum is a little lighter in colour than the rest of the body, and extends from  $\frac{1}{2}$  xiii to  $\frac{1}{2}$  xvii or over the whole of xvii=4 or  $4\frac{1}{2}$ . The mid-ventral region has here the form of a longitudinal groove.

The male apertures are on small papillae on segment xviii, between the positions of setae  $a$  and  $b$  which are absent here. The female apertures were not seen; in sections they were found to be paired, opening at the level of the setae of xiv. The spermathecal apertures are minute, in furrows  $7/8$  and  $8/9$ , in the line  $b$ . There were no other genital marks.

*Internal anatomy.*—The internal structure was elucidated by sectioning one and dissecting another specimen.

Septa  $4/5$ ,  $5/6$  and  $6/7$  are all thin,  $7/8$  and  $8/9$  are slightly thickened,  $9/10$ — $11/12$  are moderately thick, and finally  $12/13$  is also slightly thickened.

The pharyngeal glands appear, as usual, as deeply staining masses in sections; in iv the cells are mingled with the muscular bundles on the dorsum of the pharynx; and the mass extends backwards as far as vii. The oesophagus is straight throughout its length; it is dilated in v, but its wall is not thickened. There is no gizzard, nor any calcareous glands.

No heart was seen posterior to segment xii.

The excretory system is meganephric; the nephridia begin in xii (sections) or xiii (dissected specimen).

Testes and spermatozoa are free in x and xi. A funnel is present in xi; none were identified in x.

The vesiculae seminales are two pairs, in ix and xii, depending forwards and backwards from septa  $9/10$  and  $11/12$  respectively.

The prostates are tubular: but the condition is liable to be mistaken at first sight, both in sections and in dissection, for the compact branched form. The gland is moderate in size, and confined to segment xviii. The coils of the tube are closely pressed together, and both in sections and in the dissection resemble lobes of a *Pheretima*-prostate; but by careful manipulation the coils can be loosened from each other. The terminal portion of the duct is at first thin-walled and winding; near its ending in the body-wall it becomes stouter and more muscular.

The ovaries and funnels are in segment xiii; the oviducts pass back into xiv and open, separately from each other, at the middle of the length of the segment.

The spermathecal ampullae are ovoid or subspherical in shape; in sections they reach upwards to the dorsal body-wall. The duct is stout, narrowing towards its termination, and about half as long as the ampulla, from which it is not sharply demarcated. There is a single diverticulum, given off from the middle of the length of the duct; in shape it is elongated, spindle or club-shaped, and reaches upwards by the side of the ampulla to about half the height of the latter.

*Remarks.*—The above account (except the measurements and enumeration of seg-

ments) is the result of the examination of the Horton Plains specimens. The specimen from Elk Plains, examined later, showed a few differences. The prostomium was small; its character was difficult to ascertain,—I thought at first it was zygalobous but afterwards concluded that it was  $\frac{1}{3}$  epilobous. The clitellum extended only slightly into xvii, *i.e.*—rather over  $3\frac{1}{2}$ . The setal relations seemed to vary, perhaps in consequence of the uneven contraction of the surfaces in different parts of the worm;  $aa=1\frac{1}{2}-2ab=bc=cd$  approximately. The nephridia began in xii on one side, xiii on the other. The duct of the spermathecal apparatus was relatively longer and thinner, the diverticulum smaller and attached nearer the ectal end of the duct. The prostates were destroyed by the injury to the specimen.

### Genus MEGASCOLIDES.

#### *Megascolides hastatus*, sp. nov.

(Plate VII, fig. 9.)

Parambikulam, 1700–3200 ft., Cochin State; 16–24-xi-1915 (*F. H. Gravely*). Seven specimens.

*External characters*.—The specimens are of various sizes; some of the smaller ones show the porophores as well as the larger,—*e.g.* they are present in a specimen 55 mm. long and  $1\frac{1}{4}$  mm. in maximum diameter.

The largest specimen measures 175 mm. in length, and has a maximum diameter of  $2\frac{1}{2}$  mm. Colour grey, with a slaty tinge in places. The body is rather flattened in the anterior portion behind the genital region, and posteriorly is cylindrical. Segments 216.

The prostomium is small or invisible; where it was best seen it was epilobous  $\frac{1}{2}$ , and bent downwards into the buccal cavity.

The dorsal pores begin from furrow 10/11.

The clitellum extends apparently over  $\frac{1}{2}$  xiv—xvii= $3\frac{1}{2}$ , but is not well marked; in one specimen it was only distinguished by being of a browner colour.

The setae are paired. In front of the clitellum  $aa=2\frac{1}{2}-3ab$ ,  $bc=1\frac{1}{2}-2ab$ ,  $cd=1\frac{1}{4}-1\frac{1}{2}ab$ ; behind the clitellum  $aa=3ab$ ,  $bc=2ab$ ,  $cd=1\frac{1}{2}ab$ ; near the posterior end  $aa=2ab$ ,  $bc=cd=1\frac{1}{2}ab$ ; the pairing of the lateral setae is thus not very close, the interlateral setal distance being about half as much again as the ventro-lateral. The mid-dorsal interval (*dd*) is equal to half the circumference. The setae of the first twenty segments are smaller than those behind.

The male apertures are on small circular papillae on segment xviii, between the lines of setae *a* and *b*.

The female apertures are probably represented by minute white spots on xiv near the middle line, between and just in front of the level of setae *a*.

The spermathecal apertures are small, in furrows 7/8 and 8/9, in line with setae *a*. There are no other genital marks.

*Internal anatomy*.—Septum 4/5 is apparently present, thin and delicate, as is 5/6; 6/7 is slightly, 7/8—11/12 are moderately thickened, and 12/13 again is slightly thickened.

The gizzard is well-developed, barrel-shaped, in vi; in front of the gizzard the oesophagus is soft, dark and bulky. There are no calcareous glands; the oesophagus is dark, vascular and rather bulged in xiii—xvi. The intestine begins in xix.

The last heart is in xiii.

Micronephridia are present as large tufts at the sides of the oesophagus and gizzard, and throughout the anterior part of the body they appear as a single bush-like bunch laterally on each side in each segment, each bunch attached apparently to the body-wall by a single narrow stalk; there are none elsewhere on the body-wall, and there are no meganephridia. In the posterior segments the micronephridial tuft is still present; and in addition there is a relatively large (meganephridial) loop, intimately connected at its lower end with the tuft, which is here ventral in the segment; the loop extends dorsalwards on the body-wall nearly to the mid-dorsal line.

Testes and funnels are free in segment xi, none are present in x (confirmed on a second specimen). The seminal vesicles are one pair only, attached to the anterior wall of segment xii; they are small and grape-like.

The prostate, in the specimen first dissected, was an elongated straight, narrow and somewhat flattened ("tongue-shaped") structure with smooth borders and tapering hinder end; the duct was short, cylindrical and slightly glancing; the glandular portion extended back to segment xxi. The prostate of the second specimen however was coiled. One of the glands of the first specimen was examined microscopically; the edge of the gland, under magnification, was seen to be cut up here and there by fine incisures. Transverse sections showed a minute, more or less central, lumen, round which the cells have an epithelial arrangement; and also numerous small ducts of similar structure in the substance of the gland, which unite with the central channel; the main mass of the gland consisted of a compact tissue in which cell outlines were not visible under ordinary magnifications, but the specimen was not in good condition for histological details.

The spermathecae lie in segments viii and ix; they are of simple form. The ampulla, in the specimen in which they appeared to be best developed, was elongated and cylindrical but bent once or twice on itself. A duct can hardly be described; a single diverticulum rises from the base of the ampulla close to where it joins the body-wall; it also is cylindrical, is about two-thirds as long as the ampulla when the latter is straightened out, and about two-thirds as thick also.

Penial setae (fig. 9) are contained in a sac which, situated to the inner side of the prostate, extends back as far as segment xxii. In length they are 3—3.5 mm., in diameter (at middle of shaft) .016 mm. They are almost straight for the greater part of their length, slightly bowed distally, and the terminal seventh is sinuous. The tip is excavated crescentically; the lateral margins of the extreme end are stouter than the central portion, which latter therefore forms a sort of web. Numerous fine sculpturings are present from near the tip to some little distance beyond the sinuous portion of the shaft; these are triangular with the point forwards; they do not seem to be spines, since they do not stand off from the side of the seta on focussing the margin; they need the oil immersion lens to be well seen.

*Remarks.*—This species is interesting, since it seems to show stages in the transition from the meganephric to the micronephric condition, and from the tubular to the branched prostate.

The micronephridia are here not scattered over the septa or body-wall, but arise as a single tuft from the ventral end of the meganephridia in the posterior part of the body, as if constituting a branched proliferation of the originally single nephridium.<sup>1</sup> Anteriorly the main portion of the nephridium has disappeared, leaving only the branching tuft. The micronephridial condition has been evolved more than once within the family Megascolecidae, and possibly therefore in different ways on different occasions. The above may represent one mode of origin; further evolution along this line might consist in the dissolution of the tuft and the scattering of the individual branches on the body-wall. The genus *Trinephrus* may represent another mode; here three such tufts may have appeared before the disappearances of the main portion of the original nephridium.

It is interesting to note that a number of micronephridial genera of the Megascolecidae (*e.g.* *Notoscolex*, *Megascolex*, *Pheretima*, *Lampito*, other species of *Megascolides* (21), as well as *Eutyphoeus* of the subfamily Octochaetinae) regularly present the tufted condition, and the attachment by a narrow stalk, in one or more of the anterior segments; these tufts, just behind the pharynx, in segments v and vi or thereabouts, are conspicuous in the ordinary dissection of the worms. Comparison with the tufted condition which exists in the present species would suggest that these “pharyngeal tufts” also are proliferations from the ventral end of a now vanished meganephridium, though the diffused micronephridia on the septa and body-wall may quite possibly have originated otherwise.

With regard to the prostates, these must be designated as tubular. At the same time the slight indentation of the margin, and the presence of branches of the main tube in the interior of the gland, seem to show a passage towards the lobed or branched condition of *Notoscolex*, *Megascolex*, *Pheretima*, etc. If Michaelsen is right in supposing that the branched prostate has arisen only once in the history of the Megascolecidae, the present form would presumably be placed somewhere near the main line of descent of the above genera.

### ***Megascolides duodecimalis*, sp. nov.**

(Plate VII, figs. 10-11.)

Parambikulam, 1700-3200 ft., Cochin State; 16-24.xi.1914 (*F. H. Gravely*). A single specimen.

*External characters.*—Length 160 mm., diameter 5 mm.; colour a dirty grey, somewhat mottled, lighter at the anterior end. Segments *ca.* 317; segments v and vi biannular, most or all of the subsequent ones triannular; vii, viii, ix indistinctly quadriannular dorsally.

Prostomium invisible.

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<sup>1</sup> Michaelsen however (9, pp. 200, 202) would derive such tufts from the aggregation of originally scattered micronephric villi.

First dorsal pore in groove 11/12.

The setae are paired,—the ventral setae very closely in the anterior part of the body; they are small, especially towards the front end, and the ventral setae are not recognizable in a number of segments in front of vii; lateral setae are apparently present throughout, but they also are difficult of recognition in front of vii. In the anterior region  $aa=ca. 10ab$ ;  $bc$  is about  $\frac{2}{3}aa$  and  $cd$  about  $\frac{1}{3}aa$ , *i.e.* the setae of the lateral couple are separated by an interval three times as great as that between the setae of the ventral couple. Behind the clitellum  $aa=8ab$ , in the middle of the body  $aa=6ab$ , *i.e.* the pairing of the ventral setae is not so close. The setae  $d$  are below the lateral line of the body;  $dd=\frac{4}{7}$  of the circumference.

The clitellum is slightly marked, and apparently extends over xiv-xvii=4. The ventral surface is here slightly flatter and smoother.

The male pores are on xviii; the ventral surface of the segment between the situation of the apertures appears as a rectangular depression. The porophores occupy the lateral walls of the depression, and so face inwards (strictly inwards and ventralwards); they are relatively small projections situated in  $ab$ .

The female apertures are minute, paired, on xiv, in front of the line of the setae, near each other and considerably internal to  $a$ .

The spermathecal apertures are small, in grooves 7/8 and 8/9, in line with  $a$  or  $ab$ .

*Internal anatomy.*—Septum 5/6 is slightly, 6/7—11/12 considerably thickened; 12/13 is somewhat and 13/14 slightly thickened.

The gizzard is large, globular, in segment v. I at first placed it in vi, but my attention was arrested by a baggy membrane around its posterior end; this proved to be the hinder portion of septum 5/6; the septum is closely adherent to the surface of the gizzard, but can be separated by careful dissection.

Calcareous glands are present in segments x—xiii. They are well set off, being attached to the oesophagus by a narrower portion or pedicle; they are flattened antero-posteriorly between the successive septa; their margins are rounded, and semi-circular in outline. Vascular channels radiate on anterior and posterior surfaces in a fan-like manner towards the periphery of the gland. In segment xi the seminal vesicle extends as a lobed fringe all round the margin of the gland.

The intestine begins in xvi.

The last heart is in xii.

The anterior part of the body presents micronephridia, which are situated mainly on the septa, and so appear in the dissection as a ring round the alimentary canal at the site of each septum; there are the usual large tufts behind the pharynx, in between the anterior septa. Towards the posterior end of the animal, besides a number of micronephridia which on dissecting in the usual way remain on the septa around the gut, there are distinguishable (i) a very regular longitudinal chain of micronephridia on the body-wall, between setae  $a$  and  $b$  of each segment; these might be said to be of moderate size,—large for micronephridia, though very minute for meganephridia; they are visible without difficulty by the naked eye; (ii) a similar but less regular series, with a similar relation to setae  $cd$ ; these are about of the same size

as the preceding; some segments appear to want them, and the line of the series is not as straight; (iii) other scattered nephridia, also of the same size, further out on the body-wall, not in line with each other, and not present in every segment.

Testes could not be distinguished. Funnels however were distinguished, free in x and xi, as a minute gleam posteriorly by the side of the nerve cord in each segment (the left side only was examined, since the specimen is single).

The vesiculae seminales are small, in xi and xii. In xi, as already said, the vesicle appears as a lobed fringe round the margin of the calcareous gland; its connection with the anterior septum could not be made out,—possibly the genital products travel by the side of the alimentary canal; on the other hand it was adherent, in places at least, to the posterior septum. The seminal vesicles in both segments are dorsal, and those of opposite sides are fused over the gut, so that a single structure in each segment results; they are much cut up into small lobes, and so present a racemose appearance.

The prostates, situated in segments xviii and xix, are tubular. At their beginning (ental end) in xix they are rather coiled; the terminal portion forms a short and narrow duct. At a distance equal to about one-fourth of its length from its ectal end, the prostate is bound down to the body-wall by the sac of the penial setae which here crosses over it.

Ovary and funnel, the latter very small, were identified in xiii.

The spermathecae (fig. 10) are elongated and finger-like, with a dilated basal portion; this basal portion is smoother than the rest, which appears slightly crenulated, or rather, perhaps, marked by a number of indistinct transverse striations, due possibly to the folding of the inner surface of the wall. The finger-shaped portion is double as long as the dilated base, and may be bent on itself (three out of the four). A small spherical diverticulum arises from the basal dilatation where it joins the body-wall; in breadth it is only equal to a fourth or a third of the base to which it is attached. It contained a small glistening mass;—the specimen had therefore undergone copulation.

Penial setae (fig. 11) are present, in length .82 mm., in breadth  $14\mu$ . The shaft is straight for the most part, curving slightly towards the free end, the tip tapering, bluntly pointed and curved slightly in the opposite direction. A few minute pointed projections, the points directed towards the base of the seta, are irregularly scattered near the free end.

*Remarks.*—In spite of the indistinctness of the clitellum, apparent absence of testes, and small size of vesiculae seminales, the specimen appears to be mature;—penial setae are present, as are ovary and ovarian funnel, and as noted above copulation had occurred. The appearances are possibly to be explained by the opposite supposition,—that the period of most active functioning, of the male organs at least, is over.

The condition of the nephridial system in the hinder part of the body is somewhat reminiscent of *Trinephrus*,—a genus which has not so far been found in India.

**Megascolides pilatus**, sp. nov.

(Plate VII, fig. 12.)

Parambikulam, 1700—3200 ft., Cochin State; 16—24-ix-1914 (*F. H. Gravely*). A single specimen, incomplete posteriorly.

*External characters*.—Length 123 mm.; diameter 4 mm.; colour grey, mottled bluish or slaty in places, anterior end lighter, not pigmented. Probably the mottling, here and elsewhere, which occurs in rather badly preserved specimens, is due to the earth in the alimentary tube appearing through the thinned walls. Segments not counted; viii is biannular, and a number of succeeding segments triannular,—perhaps originally all, but the present specimen is much softened.

Prostomium not distinguishable.

First dorsal pore in groove 11/12.

The setae are paired; but anteriorly the lateral setae almost or quite lose the paired character, the interlateral being equal to the ventro-lateral setal interval. Thus near the anterior end  $aa=2ab$ ;  $bc$  is only slightly greater than  $cd$ , which in turn is slightly greater than  $ab$ ; in front of the male pores  $aa=3-4ab$ ,  $bc=2-3ab=2cd$ ; behind the male pores the setae are very small,  $aa=6-7ab$ ,  $bc=3ab=2cd$ .

The clitellum was not distinguishable.

The male apertures are situated on small porophores on segment xviii in the line  $ab$ . An oval thickened area, slightly marked, takes up the whole of the ventral surface of xviii, extending laterally almost to the line of setae  $c$ , and posteriorly encroaching slightly on to the anterior part of xix. The level of the male apertures is slightly behind the middle of the length of segment xviii, so that the thickened area is symmetrical with regard to the male apertures.

The female apertures, with difficulty distinguishable, are apparently just in front of the level of the setae of xiv, on the anterior part of the second of the three annuli of the segment; they are paired, and their positions divide the interval  $aa$  into three equal parts, so that  $a \text{ ♀} = \text{♀} \text{ ♀} = \text{♀} a$ .

The spermathecal apertures are represented by minute papillae in grooves 7/8 and 8/9, in the line  $a$ .

*Internal anatomy*.—The whole of the internal organs were much softened. Septum 5/6 is thin, septa 6/7—12/13 probably originally considerably thickened, 13/14 less so, 14/15 perhaps slightly so, the rest thin.

The gizzard is large and spherical, in v. Calcareous glands are present, four pairs in segments x—xiii; they are rather bean-shaped, flattened antero-posteriorly, and embrace the sides of the oesophagus, to which they are attached only at their ventral ends. The attachment takes place by a narrow stalk which joins the oesophagus where it comes through the anterior septum of the segment. The hearts are applied to the outer convex edges of the glands.

The intestine begins in xvi.

The last heart is in xiii.

Micronephridia are present as considerable tufts by the side of the alimentary tube in certain of the anterior segments; elsewhere they are numerous and small,

and situated on the septa, so that in dissection they appear as a ring round the intestine at the position of each septum. The posterior end of the specimen (not the posterior end of the animal, which was lost) showed micronephridia only; a regular row of small tufts occupied the line *ab*, and these constituted the ventralmost tufts in each segment; the rest, irregularly arranged, are seated mostly on the parietes, a certain number however being connected with the septa.

Testes and funnels are small, and free in segments x and xi. The seminal vesicles are small, in xi and xii, on the anterior wall of the segment. They consist each of a double row of grape-like lobes; in other words, the attachment of each vesicle to the septum is linear, and on each side of this axis is a row of grape-like lobes; the whole is flattened against the septum.

The prostates are tubular, small and narrow, consisting of a few windings only. Each begins in xix; the terminal portion, in xviii, is straighter, slightly shiny, and runs inwards to the male aperture; though it must be called the duct, it is not narrower than the rest, and does not differ much in appearance.

The ovary was identified in xiii, but not the funnel.

The spermathecae are two pairs; they are quite small, near the middle line, are simple cylindrical or finger-like sacs,—perhaps very slightly wider at their inner end. There is no diverticulum or duct.

The penial setae (fig. 12) are in length from end to end neglecting any curves, 57 mm., and in thickness  $21\mu$ . The shaft is curved in various degrees. The free end is bayonet-shaped, the tip flattened and markedly hollowed, the edge apparently semicircular, thin and sharp. A few small irregularities or indentations may be seen on one or both margins near the distal end.

### Genus **COMARODRILUS**, gen. nov.

#### **Comarodrillus gravelyi**, sp. nov.

(Plate VII, fig. 13.)

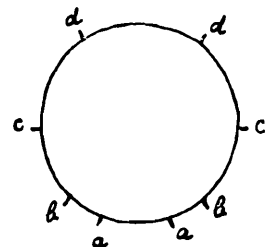
Trichur, 0-300 ft., Cochin State; 1-4-x-1914 (*F. H. Gravely*). A single specimen.

*External characters*.—Length 92 mm.; diameter (average) 1 mm., max. 1.25 mm., a long thin worm, constricted at the clitellum. Colour grey, no notable difference between dorsal and ventral surfaces, clitellum light brown. Segments 135.

Prostomium indistinguishable.

First dorsal pore in groove 6/7.

The ventral setae are arranged in pairs, but not the lateral setae. In front of the clitellum *aa* = approximately *zab*, while *c* is about and *d* much above the lateral line of the body;  $bc = 2-2\frac{1}{4} ab$ , and *cd* is greater than *bc*; the interdorsal distance is a little greater than the interlateral ( $dd > cd$ .) In the middle and posterior parts of the body the setae *d* are much closer together, indeed not far from the mid-dorsal line, and *dd* is obviously less than *cd*.



TEXT-FIG. 1. — *Comarodrillus gravelyi*; ideal transverse section, to show setal distribution in pre-clitellar region.

The clitellum covers segments xiv-xvii=4; in sections it is seen to encroach on xiii.

The male apertures are on small conical papillae which abut on each other in the mid-ventral line in segment xviii; the apertures are thus fairly close together.

The female pore or pores were not seen.

The spermathecal apertures appear as minute whitish rings, mid-ventrally in grooves 7/8 and 8/9.

A genital area (fig. 13) is constituted on segment xviii by a couple of semicircular depressions, with well-defined margins, one anterior and one posterior to the male papillae. The bases of the semicircles are at the margins of the porophores, and hence face each other. The porophores take up the middle third of the length of xviii, and the two depressions the anterior and posterior thirds respectively, extending, the anterior one to the border of the clitellum, and the posterior slightly onto xix.

*Internal anatomy.*—The internal anatomy was investigated by a series of longitudinal sections of the first twenty-five segments.

Septum 4/5 is present, but very thin; 5/6 and 6/7 are somewhat thickened, 7/8-9/10 considerably so; 10/11 is somewhat thickened, and 11/12 slightly.

The usual 'pharyngeal glands', deeply staining, are present in segments iv and v, projecting back over the oesophagus.

The gizzard, in v, is, at least in some degree, rudimentary; it is a very muscular portion of the oesophagus, with marked cuticular lining; this is bent on itself, and seems to have lost the usual form of a gizzard.

The wall of the oesophagus is folded, and the blood sinus extends into the folds in segments vii and viii and all the segments x—xvi; there are no proper calcareous glands.

The anterior part of the body presents the micronephridial condition; they can be recognized in all segments from ii to xii, on the body-wall, on strands of connective or muscular tissue, and on the septa by the side of the alimentary canal. But behind segment xii the micronephridia cease, and are replaced from xii onwards by meganephridia of relatively large size. The portion of the specimen which had not been used for sectioning was dissected to confirm the latter condition; only meganephridia were found, of considerable size for the size of the animal; occasionally nephridia are absent from one or both sides of a segment.

Testes were not identified, but funnels are seen free in segments x and xi; these segments also contain spermatozoa and sperm morulae. The vesiculae seminales are lobed, in segments xi and xii, attached to the posterior face of septa 10/11 and 11/12. I was unable to trace the vas deferens or to see its junction with the prostatic duct.

The prostate is confined to segment xviii, the anterior septum of which is somewhat bulged forwards by it; it forms a compact glandular mass (not a twisted cylindrical or tubular structure). The duct is strongly muscular, with a small central lumen; its first portion (after emerging from the gland) is contorted, and may be cut four times in a single section; its terminal portion is straight, and enters the conical porophore to terminate on the surface near the middle line.

The ovaries are in xiii; the oviducts and pore or pores were not seen.

The spermathecae are single in each of the segments viii and ix. The ampulla of each is ovoid with the longer axis transverse, or perhaps spherical; the sections being longitudinal, a calculation from the number of sections in which the spermatheca appears and the thickness of each section gives .5 mm. as the breadth, while direct measurement gives .4 mm. as the height of the ampulla. The duct is thick, in length equal to the ampulla; in one case the duct makes a considerable bend, in the other it is straighter and so shorter. The ducts are placed on opposite sides of the nerve cord, the anterior on the left, the posterior on the right; each passes underneath the cord to end in the mid-ventral line. A small diverticulum is given off from the duct near its junction with the body-wall.

There are no penial setae.

*Remarks.*—The combination of lumbricine setae, rudimentary gizzard, coexistence of mega- and micronephridia (with a characteristic distribution), 'Pheretima-prostate', and unpaired spermathecae gives *Comarodrilus* a somewhat isolated position in the subfamily; and apparently the genus is without any very near relations.

The single series of spermathecae immediately recalls *Fletcherodrilus*, an Australian genus; but the coexistence of micro- with the meganephridia in the present form, and the compact, not tubular, prostate, divide the two genera rather widely. In these two characters *Fletcherodrilus* shows the more primitive, *Comarodrilus* the derived condition; *Fletcherodrilus* however cannot be the ancestor of *Comarodrilus*, since in the former the male pores also have fused in the middle line, while they are separate in the latter.

The present worm recalls *Pontodrilus* in the limitation of the meganephridia to the segments xiii onwards, and in the reduction of the gizzard. It would, however, seem to be impossible to derive *Comarodrilus* from *Pontodrilus*; nephridia have disappeared altogether from the anterior region of the latter, and according to current views of evolution they can hardly,—whether of the same or of a different type,—reappear in a descendant. There can of course, in view of the unpaired spermathecae and compact prostate of the present genus, be no question of deriving *Pontodrilus* from *Comarodrilus*.

On the whole it seems to me that *Woodwardia* must be taken as the connecting link between this form and the rest of the subfamily. *Woodwardia* inhabits Australia, Tasmania, Java, Burma (one species) and Ceylon (one species); it is characterized by a lumbricine arrangement of setae, presence of a gizzard, 'Pheretima-prostate', meganephridia only, and, of course, the usual double series of spermathecae. In those points in which it differs from *Comarodrilus*, therefore, it shows the primitive, *Comarodrilus* the derived condition; in other words, *Comarodrilus* may be supposed to have arisen from *Woodwardia* by the substitution of micro- for meganephridia in the anterior part of the body, the reduction of the spermathecae to a single series, and some degree of degeneration of the gizzard. *Megascolides* is less suitable as a starting point, since the nephridial system is already in that genus more broken up than it is in *Comarodrilus*.

It is interesting to note, in the present form, the considerable separation of the setae of the lateral bundles, and their shifting dorsalwards,—especially the remarkably high position, near the mid-dorsal line, of the setae *d*. This may perhaps represent a first step towards the perichaetine arrangement.

Finally I may perhaps add that the single series of spermathecae presented itself to me as being possibly related to the long thin conformation of the worm,—until I looked up the dimensions of the only species of *Fletcherodrilus* (the other genus with unpaired spermathecae), and found that this has a diameter of 6—10 mm! It is true that *Fletcherodrilus* is also longer than the present form, but in nothing like the same proportion.

### Genus PERIONYX.

In addition to two new species described at length below, examples of the genus, unfortunately indeterminable as regards the species, came to hand from the Rungneet tea estate, 4500-5000 ft., Darjiling district; Horton Plains, 7000 ft., Ceylon, in water at the base of a cardamom flower a few inches from the ground (this possibly *P. excavatus*, E. Perr.); and Kavalai, 1300-3000 ft., Cochin State.

#### *Perionyx bainii*, sp. nov.

(Plate VII, fig. 14; pl. VIII, fig. 15.)

Simla, 1½ miles below Sanjauli; 7-viii-1914 (*Baini Parshad*). Two sexually mature specimens.

*External characters*.—Dimensions of the larger, 50 mm. in length, 2½ mm. diameter; of the smaller 23 mm. and max. diameter 2 mm. Colour dark bluish purple dorsally, grey ventrally. Segments 94.

Prostomium epilobous ½, the posterior 'tongue' delimited by a transverse groove behind.

The dorsal pores' conspicuous, begin from groove 4/5.

The setal ring is closed ventrally in the post-clitellar portion of the body; in front of and on the clitellum the ring may or may not be broken. There is a definite though small dorsal break in the ring; in front of the clitellum  $zz=2yz$ , behind =  $1\frac{1}{2}yz$ . The numbers of setae counted were vii/52, xiii/ca. 55, xx/56.

The clitellum extends over the 5 segments xiii-xvii; setae are present, but the furrows are almost obliterated.

The male pores (fig. 14, ♂) are on segment xviii, near the middle line, and appear as transverse cracks, each bounded at the outer end by a small tag-like papilla (*t*) (the 'tags' very slight in the second specimen). In front of and behind each aperture, near the anterior and posterior borders of the segment respectively, is a slightly curved groove, the concavity facing the male aperture; each groove is deepest laterally, shallower towards the middle line. In the second specimen the grooves of opposite sides are continuous across the middle line in front of and behind the male pores, and the whole region constitutes an oval genital field. A number of small fissures mark the surface in the vicinity of the apertures; some join the margins of

the apertures. No setae are present between the male pores; the distance included between the centres of the apertures is about  $\frac{1}{10}$  of the circumference.

The female aperture is single, median, on xiv, midway between the line of the setae and the anterior border of the segment.

The spermathecal apertures are in grooves  $\frac{7}{8}$  and  $\frac{8}{9}$ , surrounded by slightly whiter areas. They are considerably further apart than the male apertures,—about  $\frac{1}{3}$  or  $\frac{1}{6}$  of the circumference.

*Internal anatomy.*—The first distinctly recognizable septum is  $\frac{6}{7}$ , though  $\frac{5}{6}$  appears to be slightly developed. None are thickened.

There is a smooth rounded dilatation of the alimentary tube in segment vi, but its walls are soft, and it is therefore not to be reckoned as a gizzard. There are no calcareous glands; but the oesophagus is bulged in segments x—xiii, and the bulgings are marked by a transverse striation due to vascular channels. The intestine begins in xvi.

The last heart is in xii.

The excretory system is meganephric; the nephridia are all in the same line.

The testes are free in x and xi and have the form of finger-like lobes: the funnels, in the same segments, are of relatively considerable size, folded, and not (in the specimen dissected) iridescent.

The seminal vesicles, in segments xi and xii, arise from the anterior septa of their segments. Those in xi almost meet over the alimentary canal, those in xii actually meet and fuse.

The prostates, of the '*Pheretima*' type, form a compact mass in xviii, not overstepping the boundaries of the segment, but causing the septa to bulge somewhat both in front and behind. The duct is almost straight, is moderately stout and short, and has a transverse direction from the middle of the gland to its termination.

Ovaries and ovarian funnels, both of considerable size, occupy the usual position.

The spermathecae are two pairs, large, and situated in segments viii and ix; the anterior pair, in the specimen examined, were larger than the posterior. The ampulla is a regular ovoid in shape; the duct is stout (in the posterior pair almost as thick as the ampulla), and about equal in length to the ampulla, from which it is marked off by a constriction. There is no diverticulum.

Penial setae (fig. 15) are present, in length 1 mm., and in breadth, at the middle of the shaft,  $20\mu$ ; they form a considerable group, of six or more on each side. The shaft is straight except for a slight curve towards the distal end; this end shows a very slight bulbous swelling immediately proximal to the extreme tip, which is bluntly pointed. There are about eight rings of spines around the free end; the individual spines are of moderately large size.

*Remarks.*—The present species appears to come nearest to *P. koboensis* Stephenson (21), from which it is distinguished by the more anterior position of the first dorsal pore, the greater extent of the clitellum, the closer approximation of the spermathecal apertures, the presence of two instead of three pairs of vesiculae seminales,

and other minor characters such as the complete absence of a gizzard and the much smaller number of rings of spines on the penial setae.

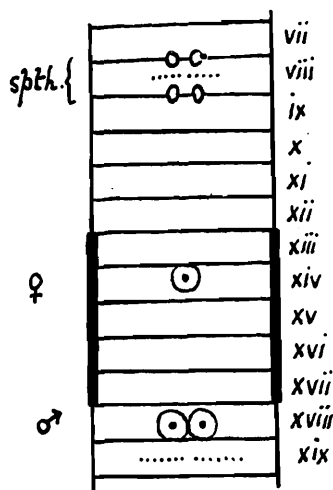
### *Perionyx millardi*, sp. nov.

Malabar Hill, Bombay; 1914 (*W. S. Millard*). Three specimens, in bad condition, much softened.

*External Characters*.—Length 60-75 mm., diameter 2 mm.; colour a deep purple dorsally, brown ventrally, with a fairly sharp demarcation between the two colours. Segments 126.

Prostomium epilobous  $\frac{1}{2}$ — $\frac{2}{3}$ , the lateral grooves converging behind, but the tongue included between them not closed behind by a transverse groove.

Dorsal pores begin from 4/5 or 5/6.



TEXT-FIG. 2. — *Perionyx millardi*; diagram of genital region, a few setae shown on segments viii and xix to indicate the relative position of the neighbouring apertures.

The female aperture is single, in a considerable round pale patch on xiv.

The setae are in rings, the rings being broken in the mid-dorsal and mid-ventral lines, though the gaps are small,—largest ventrally in the preclitellar region, where  $aa=2ab$  or perhaps rather more. The setae were very difficult to count, owing to the small size of the worm, and to its dark colour forming a background against which the setae were almost or quite invisible; in segment vi there are about 40, and the same in xxi.

The clitellum embraces segments xiii—xvii=5.

The male apertures are on xviii, on small papillae, close to the middle line; they are small round pores, not slit-like.

The spermathecal apertures, in grooves 7/8 and 8/9, are fairly conspicuous round apertures, very near the middle line,—about as near each other as the male pores, and in line with the second seta (seta *b*).

The female aperture is single, in a considerable round pale patch on xiv.

The spermathecal apertures, in grooves 7/8 and 8/9, are fairly conspicuous round apertures, very near the middle line,—about as near each other as the male pores, and in line with the second seta (seta *b*).

*Internal anatomy*.—It is impossible to give any details of the septa.

There is a trace of a gizzard, apparently, in segment vi; shining longitudinal muscular bundles were seen in the softened walls of the oesophagus. The intestine begins behind the prostates.

The last heart is in xiii.

The meganephridia are all in the same line.

Male funnels were identified in x and xi; seminal vesicles are present in xi and xii. The prostates are compact masses of moderate size, taking up the whole of segment xviii; the duct runs transversely inwards.

The female organs have the usual position.

The spermathecae, in viii and ix, are of considerable size; the ampulla is of an irregular ovoid shape, the duct is short and narrow, and there are no diverticula.

Penial setae are present, in length 65 mm., and  $18\mu$  in diameter. The curve towards the free end and the slightly bulbous swelling close to the bluntly pointed tip

are an almost exact counterpart of the appearances in the foregoing species. The number of circles of spines is perhaps rather greater (9-10), and the spines themselves are apparently a little smaller and more numerous; but the similarity of the setae in the two species is very striking.

*Remarks.*—This species happened to present itself for dissection almost immediately after the foregoing; and I was naturally much struck by the great similarity of the penial setae. I was tempted to unite them in the same species, notwithstanding the wide distance between their respective habitats; and it may possibly still be true that they should be considered as varieties only of a single species. A more extended knowledge of Indian earthworms, which may result in the discovery of intermediate forms, may decide the matter. I made a complete dissection of two specimens and in addition examined the external characters of a third of the present batch, with the result that the differences between this form and the last may be said to consist in the much closer approximation of the spermathecal apertures in the present form, the position of the last heart in xiii instead of xii, the short narrow spermathecal duct, and the simple form of the male apertures.

### Genus **LAMPITO**.

#### **Lampito mauritii**, Kinberg.

Ennur, Madras, under bricks on sandy soil in garden; 20-1-1915 (*N. Annandale*). One large and five small specimens.

### Genus **MEGASCOLEX**.

#### **Megascolex nureliyensis**, Mich.

Horton Plains, 7000 ft., Ceylon; dug from earth; Dec., 1913 (*S. W. Kemp*). Three specimens.  
Same locality, under stones and logs; same date and collector. A single specimen

A full description need not be given; but the following points may be of interest for comparison with the original description of the species.

The mid-dorsal setal interval is irregular,— $zz=2-3yz$ , and the intersetal distances are also irregular. Ventrally there is a difference in the setal relations between the preclitellar and postclitellar regions; in the former  $aa$  is slightly greater than  $ab$ ,—up to  $1\frac{1}{2}ab$ ; behind the clitellum it is considerably greater,— $aa=2-3ab$ . I could not confirm the details of the original description regarding the diminution of intersetal intervals and size of setae on passing outwards from the middle line; but the enlargement of the ventral setae on a number of anterior segments appears to be a character worth mentioning; those of iii or iv to viii or ix are enlarged, while those of x may be noticeably small.

The clitellum may be absent in fully sexual specimens; in any case it seems to be indefinite in extent,—perhaps xiii-xvii=5, and marked only by a more pronounced purple colour on the dorsal surface.

The gizzard is in vi (in two specimens dissected).

Testis-sacs enclose not only the testes and funnels, but the alimentary canal and hearts also, in segments x and xi. On opening the worm, a thin membrane is

seen, stretching as a second roof over these segments; the organs only come into view after tearing through the membrane and liberating a large amount of flocculent matter.

The seminal vesicles vary in their distribution. In one of the dissected specimens there were four pairs, in segments xi-xiv; those in xi were contained within the testis-sac; those in xii were the largest; in xiii and xiv they were small. In the other they were found in xii only. The vesicles are attached to the anterior septum of the segment, and are of a somewhat pyriform shape, the lower end being the broader. The tapering upper end curves inwards towards the middle line; their surface is finely mammillated all over, or mammillated in the upper, smooth in the broader lower portion.

The prostates extend back to the posterior septum of segment xxiii, or in the second specimen to xxv. They lie on the intestine and almost or quite conceal it from view.

The penial setae were 1.6—2 mm. in length. I could not see any reason for supposing that the concave margin of the curved distal end of the seta was sharp rather than, as usual, rounded.

*Remarks.*—This species must, according to the finding of these specimens, be removed from the small number of species which have the gizzard in segment vii (Michaelsen, 12).

### *Megascolex singhalensis*, Mich.

Horton Plains, 7000 ft., Ceylon; under stones and logs. Dec., 1913 (*S. W. Kemp*). A single specimen.

A few notes will be sufficient, for comparison with the original description.

Prostomium epilobous  $\frac{4}{5}$ , almost tanylobous, the tongue not delimited posteriorly by a transverse groove.

Dorsal pores are present, the first in groove 5/6.

The dorsal break in the setal rings is irregular; in front of the clitellum  $zz$  is about equal to  $3yz$ ; behind, about  $2yz$ . Ventrally, in front of the clitellum the break is small, practically absent anteriorly, increasing just in front of the clitellum so that here  $aa = 1\frac{1}{3}ab$ ; behind the clitellum  $aa = 2ab$  very regularly. The setae of segments iv-viii are very large, those of ix and x smaller but still larger than those of succeeding segments. In the segments behind the clitellum only,  $ab$  is greater than the succeeding intersetal intervals, but the difference is not great. I did not notice any progressive diminution in the size of the setae on passing lateralwards from the mid-ventral line. The numbers counted were:—vi/39, xii/ca. 40, xix/ca. 46, more posteriorly ca. 50.

There were a pair of genital papillae, small and whitish, in the situation of furrow 18/19, a little outside of and just posterior to the porophores.

The gizzard was in segment vi, partly at least, and probably wholly; but I could not be sure that the very delicate septum 6/7 was not attached round the gizzard itself; in this case the gizzard would be partly in vii.

The testis-sacs are exactly similar to those described in the preceding species.

The penial setae, of the form described by Michaelsen, are here considerably shorter than in his specimens,—measured across the curve they are just under 3 mm.

*Remarks.*—With regard to the position of the gizzard (said in the original description to be in vii) Michaelsen (12) has already suspected that it might prove to be in vi.

**Megascolex escherichi**, Mich. var. **papillifer**, var. nov.

(Plate VIII, fig. 16.)

Horton Plains, Ceylon, 7000 ft.; under stones and logs; Dec., 1913 (*S. W. Kemp*). Numerous specimens.

Same locality, date and collector; in jungle paths. Four specimens.

This interesting species has recently been described by Michaelsen (12). There can, I think, be no doubt about the specific identification of the present specimens; but the presence of genital papillae, and especially the coexistence of “megane-phridia” along with micronephridia, give them a peculiar interest. I append a description of the external characters, together with a few remarks on points in the internal anatomy.

*External characters.*—Length 55 mm., max. diameter 3 mm.; colour dorsally a brownish purple, deepest anteriorly, but of varying depth in different specimens, grey ventrally; position of setal ring marked by a white line. Body slightly flattened dorso-ventrally. Segments 121.

Prostomium epilobous  $\frac{1}{2}$ , the dorsal process (tongue) cut off or not by a transverse groove behind; segment i divided ventrally by a longitudinal cleft.

First dorsal pore in  $\frac{5}{6}$ ; none seen anterior to  $\frac{11}{12}$  in another specimen.

The setal ring presents a mid-dorsal break,— $zz=2-2\frac{1}{2}yz$ . Ventrally the ring is almost closed,  $aa=1\frac{1}{2}ab$ . The numbers counted were:—v/36, xiii/40, xix/40, more posteriorly 44.

Clitellum xiv—xvii=4, distinguishable only by being of a redder tinge.

The male pores are small, close together on xviii, in the middle of an oval slightly raised whitish patch (fig. 16) which encroaches forwards on xvii, but not always backwards on xix. The surface of the patch may be marked by one or more of the following grooves:—a transverse, near its anterior border, a similar groove near its posterior border, and a median longitudinal joining the two former.

Female apertures as in the original description.

Spermathecal apertures minute, quite close to the middle line, in  $\frac{6}{7}$ ,  $\frac{7}{8}$  and  $\frac{8}{9}$ .

A genital papilla may or may not be present in groove  $\frac{19}{20}$ ; or occasionally two, in  $\frac{19}{20}$  and  $\frac{20}{21}$ . The papillae are small, transversely oval, whitish, and situated rather to one side of the middle line, never mid-ventrally. Of twenty-four specimens examined, there were no papillae in 5 (of these perhaps two were not fully mature), there was one on the left side in 9, one on the right in 9, two both on the right (*v. fig. 16*) in one.

*Internal characters.*—The gizzard is partly in segment vi, septum  $\frac{6}{7}$  being attached round its anterior part, behind its anterior third. The gizzard appeared to me rather soft, but not in any degree rudimentary.

There are considerable tufts of micronephridia by the side of the alimentary tube in segments v-ix; and micronephridia are thinly scattered over the body-wall throughout. The remarkable feature is the presence, in addition, of a large nephridium on each side from segment xvii backwards; these have however no connection with the septa. On opening the specimen and pinning out in the usual way they appear as wavy or curled tubes, emerging on each side from under the intestine, and extending outwards on the body-wall for a distance equal to half the diameter of the intestine or less. Their ventral ends are as a matter of fact only just covered by the intestine in this position, as may be seen by drawing the intestine slightly to one side. Towards the posterior end of the body these nephridia are smaller though still easily visible to the naked eye; they may here be absent on one or both sides, or there may be more than one minute tuft.

The anterior male organs are proandric, with testis-sac and a single pair of seminal vesicles, as described by Michaelsen.

In the first batch of specimens, the spermathecal diverticulum was longer than in the original account of the species, finger-shaped and of equal thickness throughout, not stalked. In the second, while the shape of the diverticulum was more like that of the type form of the species, main duct and diverticulum were attached quite separately to the body-wall.

The spines of the penial setae are more numerous than in the original (6-7 rings), and do not stand off so much from the shaft; the truncated distal end is narrower.

*Remarks.*—Here again the dissection shows that the gizzard is at least not wholly in segment vii; the small number of forms which (constantly at any rate) possess this peculiarity is thus still further diminished.

It may be noted that the spermathecal apertures are not here fused in the middle line, as in the original.

### ***Megascolex campester*, sp. nov.**

(Plate VIII, figs. 17-18.)

Horton Plains, Ceylon, 7000 ft.; in jungle paths; Dec., 1913 (*S. W. Kemp*.) Three specimens.

*External characters.*—Length 60-74 mm., maximum diameter 4 mm.; colour dark slate, only slightly lighter on ventral surface and over first few segments. Segments 139.

Prostomium epilobous  $\frac{1}{2}$ — $\frac{2}{3}$ , the posterior process delimited behind by a transverse groove.

Dorsal pores begin in groove 5/6, and are present on the clitellum.

The setal rings are situated on a whiter line round each segment. Ventrally the ring is closed, or almost so; dorsally there is a short interval, so that  $zz=2yz$ . The intersetal distances are rather greater dorsally than elsewhere, and are narrowest laterally. The numbers counted were:—v/46, ix/ca. 50, xiii/48, xix/50, and in the middle of the body ca. 47.

The clitellum extends over segments xiii—xvii=5. It is purple in colour, in one

specimen mottled with lighter spots; indeed this colour difference is the only means of distinguishing it.

The male pores are on segment xviii; they are small, each in the middle of a whitish oval depressed area, the two areas being united across the middle line by a tract of whiter colour than the regions in front and behind. In front of and behind each aperture is a slight groove. The pores are distant from each other  $\frac{1}{5}$ — $\frac{1}{6}$  of the circumference, and lie in line with setae *f*, or *fg*.

The female pores were perhaps rather doubtfully recognized as a couple of minute pale spots close to the middle line in segment xiv, in the line of the setae.

The spermathecal apertures are three pairs, inconspicuous, marked also by a slight whitening of the posterior border of the intersegmental grooves 6/7, 7/8 and 8/9; they are in line with seta *g*.

In one of the three specimens there were a pair of small, oval, whitish and scarcely raised flat genital papillae, internal and posterior to the male apertures, in groove 18/19; in the other two specimens these were represented only as slightly lighter patches.

*Internal anatomy*.—The first septum is  $\frac{4}{5}$ , from which backwards the series is complete. None are notably thickened.

The gizzard is large, firm, barrel-shaped, in vii.

The oesophagus is dilated in x on the right side only, and in xi, xii, xiii on both sides; the swellings are not set off from the alimentary canal, but have a striated appearance, due to a series of transversely arranged lamellae.

The intestine begins in xiv.

The last heart is in xiii.

The nephridial system here again shows a combination of mega- and micronephridia. The micronephridia are very numerous and minute, on the inner surface of the whole body-wall; at the anterior end they are very noticeable on the dorsal wall of the pharynx and buccal cavity around the cerebral ganglion.

Commencing from segment xx there are larger nephridia also; but in calling these meganephridia I do not wish to imply that they are necessarily different in kind from the smaller micronephridia. These larger nephridia are not, at first, present in all segments or always on both sides of the same segment; the series becomes more regular further back. At the posterior end there is a difference; the number of the small micronephridia is still large, but the larger nephridia, much more opaque, and obviously of far greater calibre, standing out distinctly on opening the worm and easily visible to the naked eye, are more numerous. There are usually two on each side in each segment and sometimes three; each is a small coil of a few turns or loops, without any connection with a septum.

Testes and iridescent funnels are present in segments x and xi, enclosed in testis-sacs. The sacs of one side communicate with those of the other underneath the alimentary canal; and the anterior sac of each side with the two anterior seminal vesicles, the posterior with the two posterior.

The seminal vesicles are four pairs, in segments ix, x, xi and xii. Those in ix

are attached to the posterior wall of the segment, those in the other three segments to the anterior walls. All are of moderate size, situated laterally in the segment, and not nearly meeting over the alimentary canal; the edges are produced into a number of small rounded lobules.

The prostates are flattened lobed structures, which do not constrict the alimentary tube at all; they occupy segments xviii-xix or xviii-xx. The duct, relatively stout, almost straight, shining, and of equal diameter throughout, leaves the gland in segment xix and runs forwards and inwards.

The ovaries are large and branching, in xiii.

The spermathecae (fig. 17) are three pairs. The ampulla varies in form; it may perhaps be described as roughly pear-shaped, with narrow end internal, and broader end at its junction with the duct. The duct is also pear-shaped, but in the reverse direction, so that the broad ends of ampulla and duct join each other, and are separated by a marked constriction. The duct is more regular in shape than the ampulla; it is as long and, at its broad end, about as wide as the latter, but it becomes much narrower at its ectal end. A small diverticulum arises from the outer side of the duct, not far from its junction with the ampulla; the diverticulum is stalked, and dilated at its free end, in which a few chambers can be indistinctly seen. A number of micronephridia invest the broad portion of the duct.

The penial setae (fig. 18) are in maximum length 1.7 mm., in breadth at the middle of the shaft .02 mm.; the shaft is almost straight, with a slight curve distally; it does not become notably slenderer till close to the tip. Owing to the curve of the shaft, the setae are always seen on the slide from one of two aspects; the appearances on focussing up and down, however, indicate that the tip is flattened in one plane, and ends in two projecting points with an incisure between. There are a few,—perhaps half a dozen,—irregular rings of fine sculpturings near the free end, which are not resolvable into distinct spines under the oil immersion lens.

*Remarks.*—This species seems to be closely related to *M. brachycylus* (Schmarda), from which however it differs in colour, in the greater interval between the male pores and spermathecal pores, in the distribution of the copulatory areas, in the shape of the penial setae and the characters of the spermathecal duct. The peculiar nephridial condition also would, I think, certainly have been mentioned by previous investigators if it were present in *M. brachycylus*; but in view of what has been found in *M. escherichi* var. *papillifer* (v. ant.) this by itself would not necessitate a separation.

Michaelsen (12) suspects that *M. brachycylus* may prove to have the gizzard in segment vi, not vii as stated. In this, a near relative, however, the gizzard was in segment vii.

### **Megascolex bifoveatus, Stephenson.**

Horton Plains, Ceylon, 7000 ft.; in jungle paths; Dec., 1913 (S. W. Kemp). Two complete sexual specimens, with some fragments.

Same locality; under stones and logs; same date and collector. Seven specimens, mostly fully mature.

This species was recently described by me (20) from Pattipola, Ceylon. I give below an account of the external features of the present specimens, which differ somewhat from those of the type, together with a few additional notes on the internal anatomy.

*External characters*.—Length 48-80 mm., maximum breadth  $2-2\frac{1}{2}$  mm.; colour grey with a purplish tinge on the anterior half of the dorsal surface, and a purple mid-dorsal line, clitellum browner. Segments 100—126.

Prostomium epilobous  $\frac{1}{2}$ ; 'tongue' cut off behind by a transverse groove.

First dorsal pore in groove  $\frac{4}{5}$ .

The setae are arranged in fairly regular longitudinal rows. The ventral break in the continuity of the rings diminishes backwards: in front of the clitellum  $aa = 2-2\frac{1}{2}ab$ ; in middle of body  $= 1\frac{1}{2}ab$ ; towards the posterior end the ring is closed. Dorsally, in the anterior and middle regions  $zz = 1\frac{1}{2}-2yz$ , posteriorly the interval is small and irregular. The setae are small and difficult to count:—v and vi/ca. 34, ix/38, xii/38, in middle of body 36 or 38.

Clitellum as in previous description, xiv—xvi=3; in one specimen extended over posterior two thirds of xiii also.

The male apertures, in xviii, on whitish round papillae, the bases of which take up the greater part of the length of the segment. Their position corresponds to line *c*; there are no setae between the apertures.

The female apertures are in a transversely extended whitish area on xiv, probably paired and in front of setae *a*,—though they could not be made out distinctly.

The spermathecal apertures, in  $\frac{7}{8}$ ,  $\frac{8}{9}$ , have their centres in *e*.

While in the second batch of specimens the genital markings appear as pits (as in the type, whence the specific name), in the first batch they were not depressed, though on the other hand scarcely elevated. They were here a pair of oval, almost circular, patches, flat, darker in colour in their centre, situated in  $\frac{19}{20}$  rather internal to the line of the male apertures,—their centre being just outside *b*, and their whole transverse extent from *a* to between *c* and *d*.

*Internal anatomy*.—The first septum is  $\frac{4}{5}$ ; thereafter all are present;  $\frac{12}{13}$  and apparently a variable number in front of and behind this are slightly to moderately thickened.

In segment vii is the gizzard, which does not take up the whole of the interval between the septa. In the anterior part of vii the alimentary canal is dilated, soft and transparent; in the posterior half its character suddenly changes, and it becomes a gizzard, though a somewhat rudimentary one,—short and cylindrical, ending abruptly in a thickened ring at the posterior limit of the segment, and bulging back septum  $\frac{7}{8}$  considerably. The gizzard is not, as usual, obvious on first opening the animal, but is seen only on looking for it by displacing segment  $\frac{7}{8}$ .

Here again the nephridial system is of considerable interest. Micronephridia are few or absent on the inner surface of the body-wall in front of the clitellum; they are thickly present on the ventral half of the body-wall in the clitellar segments, and are also numerous behind the clitellum. In addition, in specimens of each of the two

batches there were present behind the clitellum larger nephridia. These were most closely examined in a specimen of the first batch; they were present, one on each side of most if not all segments, as a wavy or twisted tube in the lateral region, and in relative size about as large as those described (*v. ant.*) for *M. escherichi* var. *papillifer*. At the posterior end of the animal there were, easily visible to the naked eye, two or three nephridia on each side of each segment, sometimes attached, sometimes not, to the anterior septum; with the dissecting binocular a larger number of minute micronephridia, previously invisible, came into view.

Since these larger nephridia were not mentioned in my original account of the worm, I asked for and obtained, through the kindness of Dr. Annandale, permission to re-examine the type of the species. The actual type specimen is mutilated posteriorly; there are no larger nephridia in the anterior part of the body, where it had been opened in the previous dissection; but on opening the specimen at its hinder end (probably corresponding to a place rather behind the middle of a complete worm) some of the nephridia (*i.e.* micronephridia) in each segment were found to be larger than the rest:—not one only, and the difference in size was in some cases relatively considerable.

The second specimen of the original batch, hitherto undissected, was also opened in its posterior portion for nearly half its length. Where this dissection begins, there is one larger nephridium on each side per segment (sometimes only on one side); these are considerably larger than the rest, and consist of a number of coils, in marked contrast to the micronephridia which consist of single tiny loops;—still they are not more than half as large, relatively to the other structures, as those of *M. escherichi* var. *papillifer*. Passing backwards, they very soon become smaller, and in the posterior third of the body increase in number, there being frequently two on each side. At the posterior end they are quite small, though still very obviously distinguishable from the numerous minute nephridia among which they lie.

The remaining organs present no considerable differences from the original description.

*Remarks.*—It may be taken as established that the present species is one of the few belonging to the genus *Megascolex* which have the gizzard in segment vii; furthermore, it is actually in the posterior part of vii, thus approaching in this respect more nearly to the condition in *Pheretima* than, perhaps, any other species of the genus. There are however no testis-sacs.

It is interesting to compare the condition of the nephridia in the several specimens with those in the preceding species. It does however not seem possible here to distinguish a "meganephric" variety.

I append a brief note on a specimen, found along with the example of *M. nureli-yensis*, which represents perhaps a mere abnormality, but possibly a distinct variety:—Length 64 mm, diameter  $2\frac{1}{2}$  mm. Epilobous  $\frac{1}{2}$ , tongue not cut off behind. First dorsal pore in  $5/6$ . Male apertures on small, slightly elevated whitish papillae, with their centres a little external to line *c*; spermathecal apertures with their centres in *fg*, if not in *g*. The two pits however constitute the chief difference; they

are in 18/19 instead of 19/20,—oval depressions with whitish margins, their centre just internal to *b*, the whole pit extending from *c* to *a* or a very little further inwards.

The gizzard takes up the posterior three-quarters of segment vii, and vii being a segment of considerable length the gizzard is thus of some size, certainly larger than in the former specimens; it is cylindrical, rather soft, but harder in its hinder than in its front part. The micronephridia are fairly numerous in front of the clitellum: behind the clitellum there can often be distinguished larger tufts, but these are not regularly present in each segment, are not visible to the naked eye and have to be searched for under the binocular; they would certainly not have been remarked in an ordinary dissection. The shape of the spermathecal ampulla was irregular in some cases, and in one case the diverticulum was bifid; the short stout duct is fairly well marked off from the ampulla. Penial setae as before.

### **Megascolex hortonensis**, sp. nov.

(Plate VIII, figs. 19-20.)

Horton Plains, 7000 ft., Ceylon; under stones and logs; Dec., 1913 (*S. W. Kemp*). A single specimen, injured near the anterior end.

*External characters*.—Length 72 mm., maximum diameter 3 mm.; colour light grey throughout. Segments 141.

Prostomium prolobous.

Dorsal pores begin from groove 8/9 or in front of this (the injury obscures this region).

The setal rings are broken dorsally and ventrally;  $zz=2yz$ , but as the setae are not very numerous the interval is actually of fair extent; ventrally  $aa=2\frac{1}{2}ab$ . The setae are larger in the anterior part of the body in front of segment viii, and are also somewhat enlarged again at the hinder end. They are arranged in fairly regular lines, especially *a*, *b* and *c*, but not in pairs;  $ab=2\frac{1}{2}bc$ . The numbers are iv/20, v/20, vii/22, xiii/22, behind clitellum 24, and in the posterior part of the body 28.

The clitellum extends over segments xiv-xvi = 3. It is smooth, of the same colour as the rest of the body, with very slight indications of the intersegmental grooves; the setae are just visible in places, but dorsal pores are absent. It is delimited at both ends by a very definite constriction.

The male genital area (fig. 19) is an almost rectangular thickened patch, taking up the ventral surface of xvii, xviii and  $\frac{1}{2}$ xix. In this area are distinguishable—(*a*) a pair of conical pointed penis-like projections (*pen.*), somewhat compressed antero-posteriorly, near the lateral border of xviii, and slightly behind the middle of the length of the segment; (*b*) a pair of circular depressions (*pit*), one on each side of the middle line, on the anterior part of xviii, internal to and slightly in front of the pores, near each other, and connected together by a transverse crack; (*c*) a pair of flat oval areas (*pap.*) at the postero-lateral corners of the rectangle, scarcely raised above and yet sufficiently well marked off from the rest of the field. No setae are visible on the male area. The penes are about  $\frac{1}{3}$  of the circumference apart.

The female aperture is single on xiv, appearing as a small depression about the middle of the length of the segment.

The spermathecal apertures are one pair, in furrow 8/9; they are fairly widely separated, perhaps about  $\frac{1}{3}$  circumference (the injury to the specimen prevents an exact computation).

A thickened genital area includes nearly all the ventral surface of segment viii. This area is limited anteriorly by the furrow 7/8; its lateral limits are also definite; but posteriorly, where it extends on to the anterior part of ix, its hinder margin is not well defined. The spermathecal apertures are near the lateral limits of this area. A pair of slightly darker oval, almost circular, patches, in the posterior half of viii, are included in this area; the patches are not raised above the general surface; the outer border of each is in line with the spermathecal aperture.

*Internal anatomy.*—I am unable to state whether any septa exist in front of 6/7; from this level backwards all are present, and all as far as about 13/14 are slightly thickened.

The subspherical gizzard is in vi. The intestine begins in xix. No calcareous glands were seen.

The last heart is in xiii.

The excretory system is micronephridial.

Large transversely elongated funnels are present in x and xi. The seminal vesicles, in xi and xii, are lobulated, and those of a pair meet dorsally over the alimentary canal.

The prostates, of moderate size, are flattened and compact in appearance, and occupy xvii and xviii. The duct is shining, moderately stout, almost straight, and of equal diameter throughout.

Ovaries and funnels are present in xiii.

The spermathecae (fig. 20) are a single pair. The ampulla is of an elongated ovoid shape; the duct is short and relatively wide,  $-\frac{1}{3}-\frac{1}{4}$  as wide as the ampulla; the single diverticulum is finger-like and about as broad as the duct, from which it arises near its termination at the body-wall; in length the diverticulum is two-fifths of the conjoined ampulla and duct.

There are no penial setae.

*Remarks.*—The present species appears to be related to *M. willeyi* (Michaelsen, 10, 12); from which however it is distinguished by the setae, the number and form of the spermathecae, the character of the genital areas, and the absence of penial setae.

### **Megascolex kempii, sp. nov.**

(Plate VIII, fig. 21.)

Horton Plains, 7000 ft., Ceylon; under stones and logs; Dec., 1913 (*S. W. Kemp*). A single specimen.

*External characters.*—Length 44 mm., diameter 2 mm.; colour grey, clitellum rather lighter than the rest. Segments 115.

Prostomium prolobous. Dorsal surface flattened, with a slight groove along the middle in the middle and posterior thirds.

The dorsal pores begin from groove 6/7, and are present on the clitellum.

The setal rings are broken dorsally and ventrally,  $aa=2ab$ ,  $zz=2yz$ . The setae are in regular longitudinal lines, but are not grouped in pairs;  $ab=bc$ . The ventral setae are larger in the anterior part of the body, and at the posterior end they are again larger than in the middle. In front of the clitellum the setae are 12 per segment, *i.e.* 6 on each side (on some of the most anterior segments apparently only 4 or 5 on each side), behind the clitellum the ring consists of 16.

The clitellum extends over  $xiv-\frac{1}{3}xvii=3\frac{1}{3}$ . It is smooth, without setae, distinctly limited at each end.

The male pores are on xviii, on relatively large conical papillae, in line with *b*, and distant from each other rather more than  $\frac{1}{4}$  of the circumference.

The female pore is a minute pit, single, on xiv.

The spermathecal apertures are inconspicuous, in groove 8/9, in line with *b*.

A genital area is present on segment xii, a transversely oval, mesially situated, relatively large flat papilla; its general colour is whitish, its central portion darker. It is defined sharply behind by groove 12/13; it extends slightly at its rather indefinite anterior margin on to xi, obliterating the mid-ventral portion of groove 11/12. Its transverse diameter is about twice its longitudinal; it extends laterally as far as the line *b*; setae *a* are prominent on it.

*Internal anatomy*.—Septum 4/5 is doubtfully present; 5/6 is very thin. No septa are markedly thickened, though all from 6/7 as far as the prostates appear somewhat thicker than those behind; but degrees of thickness, when slight, are not easy to estimate in such a small worm.

The gizzard is in vi, well developed, barrel-shaped. No calcareous glands were seen.

The last heart is in xiii.

Large tufts of micronephridia are present at the sides of the alimentary canal in front of the gizzard; and behind the clitellum there are regular transverse rows in each segment.

Testes and funnels are free in x and xi. Seminal vesicles are present in xi and xii, on the anterior wall of the segment; those in xi are small, and consist of a few rounded lobules; those in xii are larger grape-like masses, which nearly meet above the oesophagus in the middle line.

The prostates are conspicuous rectangular masses, only slightly incised into lobes; they cause a considerable constriction of the intestine; they occupy segment xviii, and by bulging back septum 18/19 appear to extend through xix also. The duct is short, relatively narrow, almost straight, shining, and of equal diameter throughout.

The female organs are normal in position.

The spermathecae (fig. 21) are one pair, lying in segment ix. The ampulla is much elongated, fusiform in shape; the duct is very short and narrow. A single diverticulum is given off from the base of the ampulla; it is finger-shaped, two-thirds to three-quarters as long and half as wide as the ampulla.

There are no penial setae.

**Megascolex varians**, Mchlsn. var. **insolitus**, var. nov.

(Plate VIII, figs. 22-23.)

Horton Plains, 7000 ft., Ceylon; under stones and logs; Dec., 1913 (*S. W. Kemp*). Six specimens, all mature.

*External characters.*—The size varies; two of the specimens are considerably larger than the rest. Length up to 70 mm., maximum diameter 3 mm.; colour light grey, both dorsally and ventrally. Segments III.

Prostomium prolobous. Dorsal pores begin from 6/7; they are just visible on the clitellum.

The rings of setae are broken dorsally and ventrally; dorsally in front of the clitellum  $zz=2-2\frac{1}{2}yz$ , behind  $=3-3\frac{1}{2}yz$ ; ventrally, in front of the clitellum  $aa=2\frac{1}{2}ab$ , behind  $=3ab$  and more posteriorly  $=4ab$ . The setae of segments ii-vii are enlarged. The lines of setae *a* and *b* are very regular, and setae *a* and *b* are larger than the others of the same segment. As to the intersetal intervals,  $ab=bc > cd, de$ , etc.; the intervals after the first few are more irregular.

The clitellum, extending over xiv—xvii=4, is smooth, and marked off by constrictions at each end.

The male apertures, on xviii, are small, round, and situated on slight papillae which are partly surrounded by grooves in front and behind. They are distant from each other about  $\frac{1}{5}$  of the circumference, and are situated in line with setae *b*. There is no wall external to the apertures.

The female pore is single, but in a very anomalous position,—on segment xv, instead of on xiv as is the universal rule throughout the Megascolecidae. The aperture is rather in front of the line of the setae, in a slightly depressed darker area. The anomalous position was found in all six specimens.

The spermathecal apertures are a single pair, in groove 8/9, in line with *b* and distant from each other one quarter of the circumference.

The only constant genital papilla is one on segment xii; this is oval, its long axis transverse; it presents on its rather flat surface a darker coloured oval ring; it takes up the whole length of the segment from 11/12 to 12/13, and is not quite symmetrical about the middle line (rather to the right in the type specimen, with its centre in *a*). In one of the specimens an additional papilla of the same kind is present on segment xx, in this case in the middle line, extending from beyond the line of seta *a* on one side to a corresponding point on the other; in another specimen, along with the papilla on xii one is present on xiii, but on the opposite side.

*Internal anatomy.*—The anterior septa are very thin, and apparently incomplete; thus 5/6, the first, seemed to be wanting on the right side, and 6/7 was perhaps partly wanting on the right side also; in another specimen these two septa were not noted at all. Septum 7/8 is quite thin; 8/9, close behind the former, is slightly thickened; 9/10 is considerably thickened. From this, which is the stoutest of the septa, the thickness diminishes progressively, but so slightly that even at the level of the prostates the septa are in some degree stouter than those behind.

The gizzard is large, stoutly barrel-shaped; septum 5/6 appears to be inserted on to it, so that it would be partly in v and partly in vi; but the extreme tenuity of the anterior septa renders an exact determination difficult.

There are no definite calcareous glands; but paired ovoid swellings of the oesophagus, not marked off from the main tube, are present in segments xiv—xvi and, less marked, in xvii; these show transverse vascular striations on their surface. The intestine begins in xviii.

The last heart is in xiii.

The excretory system is micronephridial. There is a large tuft on each side of the posterior part of the pharyngeal mass, but none on the body-wall in the region of the gizzard or in front; from this point they are few till the clitellum is reached. In the clitellar region they are thickly set, and behind this they form a transverse line in each segment behind the anterior septum.

The testes and iridescent funnels are free in x and xi. The vesiculae seminales, in xi and xii, are attached to septa 10/11 and 11/12, and are racemose in form, consisting of a number of small globular or ovoid lobules.

The prostates are lobulated, rather small, confined to xviii or extending into xix; the duct is narrow, almost straight, and transverse in direction.

The ovaries are large, flattened and plate-like, in xiii; the funnels are in the same segment. The oviducts pierce septum 13/14, converge underneath the nerve cord, and, meeting, enter the body-wall just in front of the line of attachment 14/15,—practically in that line.

The spermathecal apparatus (fig. 22) varies, even on the two sides of the same specimen. The ampulla is large, somewhat ovoid, and delimited from the duct by a slight constriction; the duct, which may either be fully as long as, or considerably shorter than the ampulla, is stout, and narrowest at its outer (ectal) end. The diverticulum, arising from the duct near its junction with the body-wall, is long,—longer than ampulla and duct together, cylindrical and bent on itself; in width it is about equal to the duct.

The penial setal sacs are remarkable for their enormous length; they stretch back to be attached in segment xxvi. The setae themselves (fig. 23) are 5 mm. long, and  $27\mu$  in thickness near the tip. They are nearly straight, the free end slightly expanded, transversely cut across, and thinned in the middle, so that the condition is that of a web stretching between the two limbs of a fork. A number of spines, of fair size, project somewhat from the distalmost portion of the shaft; the spines have no regular arrangement.

*Remarks.*—The only case of the female pore or pores opening on segment xv, according to Beddard, is that of *Libyodrilus* (Geoscolecidae) (2, p. 102), where however dissection “shows that the septum dividing the fourteenth and fifteenth segments lies behind the point of opening of the ducts,” and the abnormal position of the external opening is due to non-correspondence of septa and external grooves (3).

The propriety of the specific name is illustrated by a comparison of the above

account with previous descriptions. Like *M. varians* var. *simplex*, the present form has only one pair of spermathecae.

I may add here that I am now of opinion that my *M. annandalei* (20) is to be identified with the var. *simplex* of the present species; in view of the range of variation in this species the differences I formerly described are not sufficient to entitle the single specimen I had at my command to separate recognition.

### **Megascolex sextus**, Stephenson.

(Plate VIII, fig. 24.)

Pattipola, 6200 ft., Ceylon; under rotten wood, etc. Nov.-Dec., 1913 (S. W. Kemp). A single specimen.

The species was recently described by me (20) from a single specimen, also obtained at Pattipola. I was at first inclined to separate the present specimen as a distinct variety, on the ground of differences in the genital markings, penial setae, and certain minor points. But since this is only the second specimen of the species that has come to hand, we have as yet no knowledge of the amount of variation that occurs; the present collections have shown me, however, that the limits of variation in the Ceylon and S. Indian species of *Megascolex* are wide, and it is at least probable that the comparatively slight differences between the present and the former specimen will be bridged in the future.

The following notes of the present specimen are given for comparison with the previous description.

Number of setae 50/v, 50/ix, 52/xii, 46/xix, and in the middle of the body 46.

A pair of genital papillae are present in groove 18/19; these are small, almost circular; eye-like, and in line with but smaller than the papillae of the male pores.

The first distinguishable septum is 6/7; none are noticeably thickened. The gizzard, barrel-shaped and comparatively soft, is as previously found, in vii. The intestine begins in xv.

The micronephridia are in two rows per segment, one in front of and the other behind the line of the setae.

A dorsal connection of the testis-sacs of the two sides was not made out; but they approach each other over the gut near the middle line.

The spermathecae, in vii and viii, open (as in the original) in 6/7 and 7/8; the diverticulum here arises from the middle of the length of the duct.

The penial setae (fig. 24) are 1 mm. long, and 15 broad at the middle of their length. The shaft is straight in its proximal two-thirds; in its distal third it has a wavy outline, of two successive gentle curves. The tip is curved through a quadrant, and sharply pointed. About .08 mm. from the point a slight swelling marks the situation of a ring of tooth-like sculpturings, which however do not stand off as spines from the surface; a little proximal to this is a second swelling or irregularity on the shaft, with more rudimentary sculpturings; and there may, further along, be a sign of a third.

*Remarks.*—The species belongs to the small group in which the gizzard is undoubt-

edly in segment vii, and which also possess testis-sacs. The possession of two pairs of spermathecae opening in 6/7 and 7/8 is noteworthy.

**Megascolex polytheca**, sp. nov.

(Plate VIII, fig. 25.)

Kavalai, 1300—3000 ft., Cochin State; 24—27-ix-1914 (*F. H. Gravelly*). Two specimens.

*External characters*.—Length 160—250 mm., maximum diameter  $3\frac{1}{2}$  mm.; colour a uniform grey except at the anterior end, which is darker with a purplish tinge. The anterior part of the body as far as segment xi is stout, firm and cylindrical; but the anterior half of the animal behind the genital segments is rather depressed, with a mid-dorsal groove. Segments (of the shorter specimen) 264; the setae on v—xi are implanted on raised circular bands,—especially so in the middle segments of this series, which have thus an indistinctly triannulated appearance.

Prostomium proepilobous in one specimen; in the other epilobous  $\frac{1}{2}$ , with the hinder end of the 'tongue' open, but an indication of a transverse groove at the front end of the tongue.

Dorsal pores begin in groove 4/5.

The setal rings are almost closed dorsally; in front of the genital region  $zz = 1\frac{1}{2}yz$  on the average; behind,  $zz = 1\frac{1}{4}yz$  or the ring may be quite closed. Ventrally the interval is larger; in front of the genital region  $aa = 3ab$ , behind the male apertures  $= 4ab$ , or further back as much as  $5ab$ ;  $ab > bc$ . Setae *a* and *b* are in regular longitudinal lines, and are larger than the other setae; *c*, *d*, and *e* may also be arranged in fairly regular lines behind the genital region. The setae of the preclitellar region are smaller and more numerous than those behind; the numbers counted were 54/ix-53/xiii, ca. 46/xix, and 46—48 more posteriorly.

No clitellum was distinguishable.

The male apertures, in xviii, are situated on circular white papillae which take up nearly the whole length of the segment; the pores themselves are in *bc*.

Female apertures were not distinguished.

The spermathecal apertures, in grooves 7/8 and 8/9, are numerous. On separating the lips of the groove a row of white points, 6—9 in number on each side, are seen; these begin internally between the lines *b* and *c*, the intervals between the successive points are rather greater than the intersetal intervals. Each white dot corresponds to a spermatheca, is of an opaque glistening appearance, and is surrounded by a small darker area. The actual numbers in each row were 6, 8, 8 and 9.

*Internal anatomy*.—The shorter specimen was dissected, as being possibly more mature. Septum 4/5 seems to be represented, though very delicate; 5/6 and 6/7 are slightly thickened, 7/8—11/12 considerably so (7/8—9/10 most of all), and the following one or two are slightly thickened.

The barrel-shaped gizzard is in segment v. There are no calcareous glands; the oesophagus is dilated, deep yellow, and vascular in xii, and there are similar but rather smaller swellings in xiii and xiv; all are marked by large transversely directed

bloodvessels. The intestine begins in xix, after the alimentary tube has escaped from the compression of the prostates.

The last heart is in xiii.

The excretory system is micronephridial.

The testes were not identified; funnels were present, free in x and xi. The seminal vesicles, attached to the anterior walls of xi and xii, are cut up into small ovoid lobules like bunches of grapes.

The prostates, in xviii, are of moderate size, and cause the septa 17/18 and 18/19 to bulge forwards and backwards respectively; they consist of a number of small lobes closely compacted together. The duct is short, shining, stout, and even further widened near its termination.

The ovaries are of comparatively large size, composed of parallel finger-like lobes, and break up at their free ends into moniliform strings of ova.

The spermathecae (fig. 25) are small and numerous, and correspond to the white dots seen externally. Each is a club-shaped organ, with a long stalk, and the internal end dilated to a greater or less degree; they are disposed more or less parallel to each other in a closely set row, their dilated inner ends directed backwards. The length varies,—up to 1 mm.; the breadth at the wider end is about .2 mm. Examined in glycerine, the wall is seen to be moderately thick, the greater part of its thickness due apparently to a tall columnar epithelium (*ep.*); in the ectal portion (duct) the lumen is narrow, a chink only; the bulbous portion contains a transparent mass (*x*) which nearly fills it, leaving a space (*cav.*) at the inner end.

There are no penial setae.

Var. *zonatus*, var. nov.

(Plate IX, fig. 26.)

Parambikulam, 1700—3200 ft., Cochin State; 16—24-ix-1914 (*F. H. Gravelly*). A single specimen.

*External characters.*—Length 110 mm., diameter 2.75 mm.; colour a medium grey, with darker mid-dorsal groove over greater part of length; clitellum rather browner. Segments 145.

Prostomium epilobous  $\frac{1}{2}$ , the longitudinal grooves bounding the 'tongue' converging behind, but the 'tongue' not cut off posteriorly by a transverse groove. No appearance of secondary annulation in the anterior segments.

First dorsal pore in groove 5/6.

The dorsal and ventral interruptions in the setal rings differ a little from the type form; thus dorsally in front of the clitellum  $zz = 2\frac{1}{2} - 1\frac{1}{2}yz$ , diminishing backwards, while behind the clitellum  $zz = 2 - 1\frac{1}{2}yz$ , ultimately diminishing so that near the posterior end the ring is closed. Ventrally, in front  $aa = 2\frac{1}{2} - 3ab$ , behind the clitellum  $= 3\frac{1}{2} ab$ , and the same towards the posterior end. The setae of the pregenital region are on the whole smaller than the rest; *a* and *b* are not larger than the other setae, and are not in regular lines; *ab* is not regularly greater than *bc*. The numbers (counted on the two sides) were:—22 + 23/ix, 21 + 24/xiii, 18 + 21/xix, and further back 14 + 21, 20 + 18,

The clitellum extends from xiv to nearly the hinder end of xvii, and thus includes nearly 4 segments; it is well delimited in front and behind, rather narrower than the neighbouring segments, smooth, and shows setae and dorsal pores.

The male pores are on small whitish papillae on xviii in line with setae *b*; the surface between the apertures is depressed.

The female pore is single, mid-ventral in xiv, just in front of the line of the setae.

The spermathecal apertures are similar in appearance to those of the type form; in number they are 4 or 5 on each side of each groove (7/8 and 8/9); they begin in *ab* or *b*, and are continued outwards at intervals corresponding about to the intersetal distances.

*Internal anatomy.*—This agrees closely, on the whole, with that of the type form. The prostatic duct has a somewhat wavy course; its terminal portion is notably broader.

The spermathecae (fig. 26) are 4, 5, or 6 on each side in each of the two segments. Here an ampulla can be distinguished from a duct in each; the ampulla is ovoid, the duct is cylindrical, rather longer than and about half as wide as the ampulla. In most cases there is also a diverticulum, from the terminal portion of the duct, in form slightly club-shaped, glistening, and in length from half as long to nearly as long as the duct; the cavity of the diverticulum is simple. The diverticulum may be wanting; this happens in the outermost spermathecae of three of the four rows (in the row of six the outer two spermathecae lack a diverticulum).

There are no penial setae.

*Remarks.*—Though not uncommon in the Glossoscolecidae, the possession of numerous spermathecae in a single segment is rare in the Megascolecidae,—indeed is apparently found only in a few species of *Pheretima*.

The more important differences between the type form and the variety are the following:—in the former, setae *a* and *b* are larger than the rest, and the setal interval *ab* is greater,—characters which are not found in the variety; the number of setae is greater in the type form; the variety has a clitellum, the type form not; the number of spermathecae is smaller in the variety, an ampulla and duct are differentiated, and a diverticulum is usually present.

### **Megascolex kavalaianus, sp. nov.**

(Plate IX, fig. 27.)

Kavalai, 1300–3000 ft., Cochin State; 24–27-ix-1914 (*F. H. Gravely*). A single mature specimen.

*External characters.*—Length 57 mm., maximum diameter 1.5 mm.; colour pinkish grey, the anterior end purplish, clitellum grey without the pink tinge. Segments 94.

Prostomium epilobous  $\frac{1}{2}$ , small, folded downwards into the mouth aperture.

First dorsal pore in groove 5/6.

The dorsal break in the setal ring is small,  $-zz=2yz$ ; ventrally  $aa=4ab$  in front of the clitellum,  $=3ab$  behind, and further back  $3\frac{1}{2}ab$ . The setae are often small and difficult to see. The numbers counted were 40/ix, 38/xii, ca. 32/xix, and in the middle of the body approximately 28, but the number is not constant.

The clitellum extends over  $\frac{1}{2}$ xiii— $\frac{3}{4}$ xvii =  $4\frac{1}{4}$ ; it is well delimited in front and behind, is slightly swollen, shows the dorsal pores, and setae are just visible on it.

The male apertures appear as minute white dots each in the centre of a circular slightly raised area. These areas touch each other in the middle line, and take up the greater part, about two-thirds, of the length of segment xviii; they are white with a darker centre. The pores are in the transverse line of the setae, in a position corresponding to seta *b*; the areas are void of setae.

The female aperture is single, a minute dot in a small shallow depression in the line of the setae of xiv.

The spermathecal apertures are minute, in grooves  $7/8$  and  $8/9$ , near the middle line, approximately in *b*.

There were no other genital markings.

*Internal anatomy.*—The first septum is  $4/5$ ; none are noticeably thickened.

The gizzard is barrel-shaped, of considerable size but soft, in segment vi. The oesophagus is bulged in xv, xvi and xvii, with transverse vascular striations; on opening this portion, small folds are seen projecting into the lumen. The intestine begins in xix, behind the prostate.

The excretory system is micronephridial; the nephridia are relatively few and scattered,—most numerous on the body-wall in the clitellar segments.

The last hearts are in xiv; these are smaller than those in xiii.

Testes and funnels are present in x and xi (testes not identified in the latter segment). Vesiculae seminales are attached to the posterior surface of septa 10/11 and 11/12; they are racemose in form and each meets its fellow above the oesophagus.

The prostates are confined to xviii; they are cut up into lobes which are tightly compacted together. The duct runs straight inwards to open near the middle line; its first part is narrow, the rest stout; it has the usual shining appearance.

The ovaries are large, with moniliform branches. Ovisacs are present in xiv, on the anterior septum, each containing six to twelve eggs. I satisfied myself that these were not a second, abnormal pair of ovaries; they are sessile on the septum, and all the contained ova appear to be of full size.

The spermathecae (fig. 27) are two pairs, in viii and ix. The ampulla is of a flattened ovoid shape. The duct is well marked off from the ampulla, is moderately wide, and about  $\frac{1}{3}$ — $\frac{1}{2}$  the length of the ampulla. The diverticulum is given off from the termination of the duct; it is a long and narrow glistening tube with a slightly dilated inner end; it is longer than the ampulla, and when laid alongside it may reach beyond the ampulla for a distance equal to the length of the ampulla itself, but its length varies.

There are no penial setae.

*Remarks.*—The presence of an additional pair of hearts beyond what is usual and the existence of egg-sacs, are peculiarities which mark out the present species as occupying an isolated position in the genus.

**Megascolex phaseolus**, sp. nov.

(Plate IX, figs. 28-29.)

Parambikulam, 1700-3000 ft., Cochin State; 16-24-ix-1914 (*F. H. Gravely*). Three specimens, two incomplete posteriorly.

*External characters*.—Length 180 mm., maximum diameter 3 mm.; colour grey, with a bluish tinge in parts; clitellum olive. Segments 270.

Prostomium small, bent downwards into the opening of the mouth, proepilobous or epilobous  $\frac{1}{3}$ .

Dorsal pores begin from groove 5/6.

The setal rings are broken dorsally and ventrally. In the preclitellar region dorsally the setae were difficult to see; immediately behind the clitellum  $zz = 3yz$ , further back  $= 2yz$ , in the middle and hinder parts of the body  $= 1\frac{1}{2}yz$ . Ventrally the interval is small in front of the clitellum,  $-aa = 2ab$  or less; behind the clitellum and in the middle of the body  $aa = 4ab$ , and posteriorly rather less, about  $3ab$ . The setae are closer together ventrally than dorsally and laterally, and in front of the clitellum those on the dorsal and lateral surfaces of the body are arranged in pairs, the pairs separated by a considerable interval. The numbers counted were:—34/v, 35/ix, 36 (16+20)/xii, 38/xix, and 26—28 in the middle of the body. The intersetal intervals in the middle of the body are very irregular.

The clitellum extends over xiv—xvii = 4; it is smooth, and limited by constrictions in front and behind; setae are not visible, but there is an indication of dorsal pores.

The male genital field (fig. 28) is characterized by a kidney-shaped elevation (*b*) placed transversely across segment xviii, with its concavity directed backwards; this elevation is surrounded by a groove or valley, around which again is a more or less elliptical raised ring (*w*), with a cleft behind in the middle line, *i.e.* behind the 'hilus' of the kidney-shaped elevation; the 'ring' is narrower in front than behind. The whole area as described above takes up the length of segment xviii, and may slightly encroach on xvii; laterally it includes the whole of the ventral surface.

The male apertures appear as oblique slits, or it may be little more than points, on the ring-like elevation, near the median cleft in the latter, and behind the concavity in the margin of the kidney-shaped cushion. From the apertures a groove may lead forwards and outwards, on one or both sides, crossing the valley between ring and included cushion, and ending on the latter.

The female pore is single, just in front of the line of setae of segment xiv.

The spermathecal apertures, in 7/8 and 8/9, are minute and close to the middle line, in *a* or between *a* and *b*.

In one specimen only there was present on the anterior part of segment xix a median papilla (*p*, fig. 28), the posterior border of which was semicircular, and caused the line of setae to bend backwards; the anterior border, situated at groove 18/19, was flatter.

*Internal anatomy*.—Septum 4/5 is present but very thin; 5/6 is also thin, 6/7—13/14 are all somewhat thickened.

The gizzard is well developed, ovoid, situated in segment v. There are no calcareous glands. The intestine begins in xix, behind the prostates.

The last heart is in xiii.

There are numerous small micronephridia.

Testes were not identified; from the presence of iridescent masses in x and xi, they and the funnels are doubtless contained in these segments. The vesiculae seminales, comparatively small, racemose in form, depend from septa 10/11 and 11/12 into segments xi and xii.

The prostates, in xviii, are relatively small; they form somewhat flattened masses, roughly circular in outline, and are much cut up into small lobes tightly compacted together. The duct is relatively stout, shining, almost straight, its terminal portion slightly widened.

The female organs have the usual position.

The spermathecae (fig. 29) are two pairs, in segments viii and ix. The ampulla is elongated and cylindrical, and passes without sharp demarcation into the duct, which is as long as the ampulla. The diverticulum, given off from the duct where it enters the body-wall, is elongated and club-shaped; and lying alongside the duct, it reaches as far as the base of the ampulla.

There are no penial setae.

### *Megascolex filiciseta*, sp. nov.

(Plate IX, figs. 30-31.)

Parambikulam, 1700—3000 ft., Cochin State; 16—24-ix-1914 (*F. H. Gravely*). Three specimens.

*External characters*.—Length 63-70 mm., diameter 2-3 mm.; colour dorsally bluish grey behind, purplish in front, a purplish tinge also at the extreme posterior end, ventrally a slaty grey; a fine dark mid-dorsal stripe, better marked posteriorly. Segments 118.

Prostomium epilobous  $\frac{1}{4}$ , dorsal process delimited behind by a transverse groove, the process itself marked by a median groove.

The first dorsal pore is in groove 5/6.

The setal rings are broken dorsally;  $zz = 2yz$ ,—a little less ( $1\frac{1}{2}yz$ ) in the most anterior segments, a little more ( $3yz$ ) for some distance behind the genital region. Ventrally the ring is closed in the anterior segments as far back as xi; the interval soon becomes and remains of moderate extent,— $aa = 2\frac{1}{2}ab$ ;  $a$  seems as a rule smaller than the other setae, and  $ab$  on the average less than  $bc$ . The setae are not arranged in regular longitudinal lines. The numbers are 33/v, 41/ix, 18 + 19/xii, 20 + 22/xix, and in the middle of the body 36 or 38.

The clitellum extends perhaps over xiv—xvi = 3; it was only marked by the presence of a little flocculent mucus between the cuticle and the epidermis.

The male apertures are inconspicuous, on very small porophores, on segment xviii, between the lines  $a$  and  $b$ . The regular circle of setae begins outside the porophores with seta  $c$ .

The female aperture or apertures were not seen.

The spermathecal apertures are minute and close to the middle line, in grooves 7/8 and 8/9.

*Internal anatomy*.—Septum 5/6, the first, is extremely delicate, 6/7 is also delicate, 7/8 slightly and 8/9—11/12 moderately thickened, 12/13 and 13/14 again slightly thickened.

The gizzard, well developed and barrel-shaped, is in segment vi; it is preceded by a dark, soft-walled, dilated and crop-like portion of the oesophagus. There are no calcareous glands. The intestine begins in xv.

The last heart is in xiii.

The excretory system is micronephridial; but its peculiarities merit a short description. In each segment the nephridia,—one might almost say the nephridium,—appear on either side as a bushy tuft attached by a narrow base, as numerous twigs springing from a common stem, or sometimes radiating from a common centre. The tufts of successive segments form a regular longitudinal series; there is no connection with the septa. The tufts begin in front just behind the pharynx, where they are large structures lying at the sides of the oesophagus, between the successive cone-shaped septa. Some distance behind the clitellum it may be possible to distinguish a dorsally (laterally as the parts lie in the dissection) directed loop which is rather larger than the rest; towards the posterior end this loop gains an increased prominence, but it still has no attachment to the septum; no funnel could be seen microscopically in tufts from either anterior or posterior regions, but I can scarcely regard this observation as conclusive.

Testes and funnels are free in x and xi; seminal vesicles, small, lobed and flattened, in ix and xii, on the posterior and anterior walls of these segments respectively.

The prostates are small, flattened, confined to xviii, the margin lobed; the duct was not visible as a separate structure.

The ovaries are in the usual situation.

The spermathecae are small, and probably not fully developed; they are situated close by the side of the nerve cord in segments viii and ix; the ampulla is ovoid, and no duct is distinguishable; the diverticulum, half as long as the main pouch, arises with the latter from a common base on the parietes.

The penial setae (figs. 30, 31) are characteristic. They are 1.3 mm. in length as measured along the base of the arc, and  $22\mu$  in diameter. The shaft is bent to form a bow and it tapers towards the distal end, the tip being slightly recurved. On each side of the tip is a row of straight stout teeth, arranged like the pinnae of a fern; the longer of the teeth are fully  $20\mu$  long and 5— $6\mu$  in breadth. The number of teeth on each side is from 8 to 16; the smallest number was found in a seta in which the tip was free from the sac (fig. 30), the largest in a very young seta, where only this portion had been formed (fig. 31).

*Remarks*.—The specimens were probably not fully mature, and the description of the spermathecae, and perhaps the prostate, may prove to be defective. The curious penial setae, which will permit recognition of the species, and the interesting nephri-

dial condition, determined me to give the above description. The condition of the nephridia may be compared with that in *Megascolides hastatus*.

***Megascolex cochinensis*, sp. nov.**

(Plate IX, figs. 32-33.)

Forest tramway, mile 10-14, alt. 0-300 ft., Cochin State; 28-29-ix-1914 (*F. H. Gravely*). Two specimens.

*External characters*.—Length 175-220 mm., diameter 4 mm.; colour an equable light grey, nonpigmented. Segments 224.

Prostomium epilobous  $\frac{1}{3}$ — $\frac{1}{2}$ , the 'tongue' being cut off behind.

The dorsal pores begin in groove 5/6.

The setal rings are broken; dorsally  $zz = 2yz$ , ventrally  $aa = 2ab$  or rather more in front of the clitellum, and  $= 3ab$  behind it. The setae are closer together ventrally; the intersetal intervals are not very regular, so that the setae are not arranged in longitudinal series. The numbers counted were 41/v, 54/ix, 57/xii, 48/xix, and in the middle of the body 36 and 38.

The clitellum, extending over xiv— $\frac{2}{3}$ xvii ( $= 3\frac{2}{3}$ ), is smooth; setal rings and dorsal pores are present on it.

The male pores (fig. 32) on segment xviii, are elongated wavy slits, obliquely disposed, their posterior ends nearer the middle line than their anterior. These slits are situated each on a white oval elevation, the long axis of each elevation being oblique and corresponding with the slit, so that the hinder ends of the elevations approach one another, or almost touch in the middle line. Around and between these oval papillae the surface is depressed and darker; and surrounding the whole is a well defined wall, the 'moat' between papilla and wall being deepest anteriorly (fig. 32). The centres of the male apertures are about  $\frac{1}{2}$  of the circumference distant from each other.

The female aperture is indicated by an oval patch with its long axis transverse, whitish in colour, mid-ventrally situated in the line of the setae of xiv; its lateral extent is from  $a$  to  $a$  or slightly more.

The spermathecal apertures are transverse slits with distinct anterior and posterior lips, in 7/8 and 8/9, in line with  $a$ ; each is surrounded by a small area rather darker in colour than the surroundings.

*Internal anatomy*.—Septa 4/5 and 5/6 are thin, 6/7—11/12 moderately and 12/13—13/14 slightly thickened.

The gizzard, in v, is large and barrel-shaped. There are no calcareous glands, but the oesophagus is swollen and vascular in xii, xiii and xiv. The intestine begins in xix.

The last heart is in xiii.

The excretory system is micronephridial. There are the usual tufts, here very large, by the side of the oesophagus behind the pharynx, and similar tufts are continued backwards between the successive cone-like septa for some distance behind the gizzard. In the clitellar region the nephridia appear as bushy tufts, about six in

number, in a transverse row on each side in each segment (xv, xvi, xvii). There are no nephridia on the parietes in front of the clitellum; behind, however, they are very numerous and very small, and form a transverse band (not a single line of nephridia) between the row of setae and the anterior septum of the segment.

Testes and funnels are free in x and xi. The seminal vesicles, moderately large masses resembling bunches of grapes, are in xi and xii, attached to the anterior septum.

The prostates are limited to xviii, and consist of a mass of small roundish lobules closely packed together into a solid-looking mass. The muscular duct, wider at its termination than at its beginning, passes straight inwards.

Ovaries, with moniliform branches, and funnels are present in xiii. An additional pair of small ovaries but no funnels were seen in xiv.

The spermathecae (fig. 33) are two pairs, in viii and ix. The ampulla is ovoid in shape; the duct is as long as the ampulla and less than half as wide. The diverticulum, arising from the termination of the duct, is club-shaped; in length it reaches to about the middle of the length of the ampulla, *i.e.* is nearly  $\frac{3}{4}$  as long as duct and ampulla together; its cavity is simple.

There are no penial setae.

*Remarks.*—The present species has no marked peculiarities, except the form of the male genital field; it is difficult therefore to assign it to any definite position within the genus, but it may perhaps be allied to *M insignis* Mchln. (12).

### **Megascolex konkanensis**, Fedarb var. **longus**, var. nov.

(Plate IX, figs. 34-35.)

Parambikulam, 1700-3200 ft., Cochin State; 16—24-ix-1914 (*F. H. Gravely*). Two specimens, with perhaps a posterior fragment of another.

*External characters.*—Length 345-570 mm., maximum diameter 3 mm. in one, 4 mm. the other. They are thus extraordinarily long and (relatively) thin worms. The anterior end does not taper, but appears as if suddenly cut off; the front portion of the body is flattened, but behind the first third it becomes cylindrical, and much narrower (about 2 mm. only). Colour grey, with in parts a bluish or slaty mottling. Segments of longer specimen, estimated, after counting the anterior third, 550; of the shorter, estimated, after counting the anterior half, 400.

Prostomium bent downwards within the buccal cavity; proepilobous, with in addition two short longitudinal grooves continued backwards a little distance on the dorsal surface of the first segment.

First dorsal pore in furrow  $\frac{5}{6}$ .

The setal ring is broken dorsally, in front of the clitellum, so that  $zz = 3yz$  approximately, but the ratio varies, not so much on account of the width of  $zz$  as of that of  $yz$ , which is irregular. Behind the clitellum the break is absolutely and relatively less, so that  $zz = 1\frac{1}{2}yz$ ; further back the ring is closed dorsally. Ventrally, in front of the clitellum  $aa = 2ab$ ; behind,  $aa = 3\frac{1}{2}ab$  ( $3ab$  to  $4ab$  at various parts).

The setae in front of the clitellum are mostly very small; the ventral setae of xii—xvii are enlarged, and the interval *ab* is greater than *bc* ( $= 1\frac{1}{2}bc$ ). This relation between *ab* and *bc* is continued backwards for a considerable distance; there is no constant difference between *bc*, *cd*, *de*, etc. The numbers counted were:—16 + 16/v, 16 + 17/xii, 15 + 15/xv, 16 + 16/xix, behind the clitellar region 14 + 16, and 18 + 19; at the end of the first third of the body 30, and in three segments near the posterior end of the body 28, 29 and 30.

The male apertures, on segment xviii, are situated apparently (the actual pores being unrecognizable) on a pair of transversely oval papillae, placed towards the lateral parts of the segment, with their centres in or not far from the line of setae *d*. These papillae are connected across the middle line, the whole having the outline of an elongated dumbbell, and being surrounded by a darker area of corresponding shape.

The female aperture is minute, single, on xiv, in the line of the setae.

The spermathecal apertures are small, in 7/8 and 8/9, in line with setae *d*, or between *d* and *e*.

In one of the two specimens there was a curious shifting back of all the genital apertures; the female to xvi, the male to xx, the spermathecal to grooves 9/10 and 10/11; and the latter were in line with *b* or *bc*.

*Internal anatomy.*—The gizzard is in v.

The prostates (fig. 34) are small, confined to xviii; the septa are not bulged at all. The whole has a bushy appearance, since the gland is divided up into a large number of lobules, of various shapes from spherical to finger-shaped. The duct passes straight inwards; it is soft, slightly glistening, thin in its first and bulged in its terminal portion.

The ampulla of the spermathecal apparatus (fig. 35) is a rather elongated oval. The duct is half as wide, and one and a half times as long as the ampulla. The diverticulum, full of glistening spermatozoa, and given off from the termination of the duct at the body-wall, is small, club-shaped, and half or less than half as long as the duct, alongside which it lies.

*Remarks.*—Michaelsen has recently (12) redescribed this species, having had at his disposal more than 100 specimens belonging to 16 captures from 14 localities. Out of this number the longest specimen measured 415 mm. and consisted of about 370 segments; these figures may therefore probably be taken to represent pretty nearly the extreme limits reached by that particular form. Consequently, when one out of two specimens here described exceeds the previous maximum length by nearly two-fifths, there is ground for supposing that we are dealing with a different variety, one of the distinguishing marks of which is a greater size. Other distinctions are to be found in the single female aperture (though this was originally stated by Fedarb for her specimens), shape of spermatheca, and smaller size of prostate; as well as, perhaps, the absence of a clitellum (though copulation had occurred, as evidenced by the glistening mass of spermatozoa in the spermathecal diverticulum), the differing details of the male genital field, and larger number of setae in the hinder region.

Genus **PHERETIMA**.***Pheretima heterochaeta*** (Mchlsn.).

Simla,  $1\frac{1}{2}$  miles below Sanjauli; 7-viii-1914 (*Buini Parshad*). Two specimens.

Horton Plains, 7000 ft., Ceylon; dug from earth; Dec., 1913 (*S. W. Kemp*). Three specimens.

Pattipola, 6200 ft., Ceylon; under rotten wood, etc. Nov.-Dec., 1913 (*S. W. Kemp*). Two specimens.

Cherrapunji, Assam, 4400 ft.; 2-8-x-1914 (*S. W. Kemp*). Four specimens.

***Pheretima posthuma*** (L. Vaill.).

Allahabad; Dec., 1914. A few specimens sent by Dr. Woodland; said to be common in the neighbourhood.

This species is referred to in the introduction.

***Pheretima lignicola***, Stephenson.

Malabar Hill, Bombay; 30-x-1914 (*W. S. Millard*). Five specimens, soft and in bad condition.

This species was previously described by me (21) from the Abor country. The correspondence between the present specimens and the previous description is close; since however I had then only a single specimen at my disposal, which was necessarily handled with care, I subjoin here a few additional notes.

*External characters*.—Length 165 mm., diameter  $6\frac{1}{2}$  mm.; colour a dark brownish purple dorsally, but pure brown after stripping off the iridescent cuticle; brown ventrally; clitellum lighter brown. Segments 130.

Male apertures large, pit-like, on xviii, distant from each other  $\frac{2}{7}$  of the circumference. The margins of the pits are whitish, swollen and puckered, and much less well defined on the inner side.

Female aperture single, small, in a transversely oval, dark, moderately shallow but conspicuous pit, on xiv about the middle of its length.

The small spermathecal apertures, surrounded by whitish lips, are approximately in line with *f*.

The numbers of setae counted were 33/v, 45/ix, 56/xii, 64/xix.

*Internal anatomy*.—Septum 4/5 is definitely present, and slightly thickened. Septum 10/11 is attached to the parietes at the level of the setae of xi; 11/12, 12/13 and 13/14 are also all attached behind the level of the corresponding intersegmental grooves.

The intestine here begins in xvi, and the diverticula originate in xxvii; these latter are simple, finger-shaped, and extend forwards through xxvi and xxv.

I am able to give a better account of the anterior male organs than in the first description. The testes and funnels are enclosed in sacs, those of segment x being small; funnels, but not testes, were distinguished within them; they are situated on the anterior face of septum 10/11, and probably communicate with each other across the middle line below the alimentary canal. The sacs in segment xi were larger, separated by the alimentary canal between them, and contained both testes and funnels, as well as the anterior seminal vesicles, which depend backwards from septum

10/11; the testis-sacs in xi extend over the whole length of the segment, from 10/11 to 11/12, and do not communicate with each other either above or below the gut.

The spermathecal ampulla is rather heart-shaped, the duct leading off from the broad end. The duct is fusiform, narrower at its two ends and swelling gently in its middle portion; it is  $\frac{1}{2}$ — $\frac{2}{3}$  as long as the ampulla. The narrow tubular diverticulum, arising from near the termination of the duct, is nearly as long as duct and ampulla combined; it may be twisted; it is broader and rather mammillated towards its free, and narrower and smoother towards its attached end.

There are no penial setae.

### Subfamily OCTOCHAETINAE.

Genus **ERYTHRAEODRILUS**, gen. nov.

**Erythraeodrilus kinneari**, sp. nov.

(Plate VII, fig. 8.)

Castle Rock, Bombay; 17-x 1913 (*S. H. Prater*). Three specimens.

*External characters*.—The specimens were much softened; one had apparently autotomized itself, and another almost so. Length 120 mm, maximum diameter  $3\frac{1}{2}$  mm.; colour brown, with an iridescent appearance due to the cuticle,—rather darker in the anterior part of the body, and the ventral surface slightly lighter than the dorsal. Segments  $90 + 22 = 112$ .

Prostomium apparently prolobous.

The first dorsal pore is in groove  $3/4$ ; pores are absent on the clitellum.

The setae are in rings; they are small, and there are no notable differences in size or in the intersetal intervals; they are present on the clitellum. The mid-dorsal and mid-ventral intervals are about the same in both anterior and posterior parts of the body,— $aa = 1\frac{1}{2}ab$  throughout, and  $zz = 2-3yz$ . The numbers of setae were vi/46, ix/53 approx.; xiv/43, xix/40.

The clitellum covers  $\frac{1}{2}xiii - \frac{2}{3}xvi = 3\frac{1}{8}$ ; it is darker in colour than the rest of the animal.

The male apertures are on segment xvii, behind the setal ring, and fairly near each other, in about the line of setae *cd*; this is equivalent to an interval of about  $\frac{1}{7}$  circumference. In the specimens first examined, the pores, on small whitish papillae, were situated at the postero-lateral angles of a rectangular glandular area which took up the whole length of xvii; in the other two specimens the glandular area was not visible, though in one there was an elevation between the two papillae.

The female aperture is single, mid-ventral, on xiv, in a small whitish oval area between the line of setae and the anterior border of the segment.

The manner of opening of the spermathecae will be described later.

Genital markings vary in the several specimens. In one there are on segment xviii a pair of small rounded papillae, situated posteriorly in the segment between

the setal ring and groove 18/19; the centres of these papillae are very slightly internal to a line drawn through the centres of the papillae of the male pores. These papillae were not present in the other two specimens; but in one of these there were seen a couple of oval patches with a whitish circumference and dark centre, situated near the posterior border of segment vii,—each small, with its centre in line with seta *e*; as well as a single eye-like marking in groove 16/17 just internal to the line of the male papilla of the right side.

*Internal anatomy*.—The septa are all very thin and transparent,—a condition which is no doubt due partly to the bad state of preservation; still it seems safe to say that none are notably thickened. The series of septa is complete from 4/5 onwards.

The gizzard is an ovoid mass in vi. The calcareous glands are four pairs, set off from the oesophagus, in segments x—xiii, the glands in x and xi are smaller than the others. Each gland receives its blood from a very distinct branch of a supraoesophageal trunk. The intestine begins in xv or xvi.

The last heart is in xii; the dorsal vessel can be followed forwards on to the pharynx, but no regular series of lateral commissural vessels can be distinguished in front of viii.

The nephridial system consists of both mega- and micronephridia. The meganephridia begin in xx or xxi, and are continued backwards to near the posterior end of the body; they are of large size, extending, in the dissection, from underneath the margin of the intestine outwards and dorsalwards almost to the mid-dorsal line; they consist of three parallel, more or less winding, limbs. The condition of the specimens is unsuitable for histological work, and I was unsuccessful in obtaining a preparation of the funnel, which however appears to be situated on the anterior side of the septum behind which the nephridium lies; the tube itself is differentiated into broad and narrow, nonciliated and, apparently, ciliated portions. The micronephridia extend throughout the body, they are especially numerous (as is often the case) on the inner surface of the body-wall in the clitellar segments, and occur (again a common condition) in the form of large conspicuous tufts on each side of the hinder end of the pharynx in segments iv and v.

The testes, along with large much folded iridescent funnels, are contained within testis-sacs, in segments x and xi. The vesiculae seminales are three pairs, in ix, x, and xii; those in ix and x depend forwards from the posterior wall of their segments, and are large and lobed; those in xii depend backwards from septum 11/12, are of moderate size, and not cut up into lobes. Thus segment x contains both testis-sacs and seminal vesicles, xi testis-sacs only; in this latter segment the sacs extend towards the dorsal surface, and contain also the hearts.

The prostates are tubular; the terminal portion forming the duct is thinner and more transparent than the coils of the gland itself, and ends in segment xvii. On the left side of the specimen examined the gland extended back to xxi, on the right it first passed forwards from the duct into xvi, and ended behind in xix. The vas deferens cannot be distinctly followed in its course on the body-wall; but it appears in segment xvii to be situated to the outer side of the prostatic duct, and I would

suggest that it probably curves round behind the latter to end on its posterior or perhaps its inner side.

Ovaries and funnels were identified in xiii.

The chief peculiarity of these specimens is the condition of the spermathecae (fig. 8). There is on each side a cluster of spermathecae, of two sizes, larger and smaller, which open either in common or near each other on the eighth segment.

To take first the larger spermathecae. These are four in number, two on each side, and appear to represent the original two pairs. They are large, and either regularly or irregularly pear-shaped; in the latter case the irregularity is due to indentations and the consequent production of a lobed outline. The narrow end, narrowing still further, becomes the duct, which is thus not demarcated from the ampulla. The diverticula form two considerable clusters at the base of the ampulla; these clusters leave one face of the ampulla (or duct) largely free, but cover the other face.

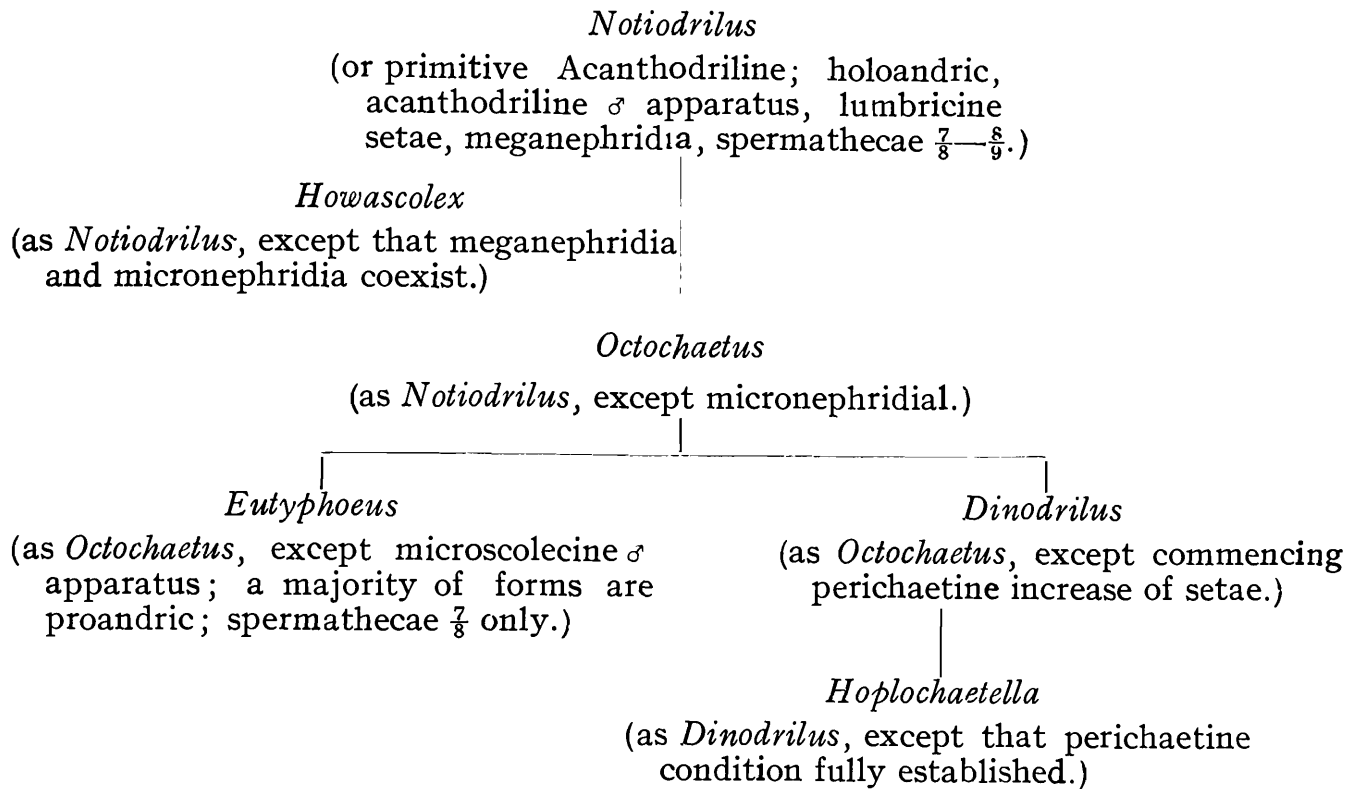
As to their external openings:—the anterior spermatheca of each side becomes attached to the body-wall between segments vii and viii, and the posterior at or in front of the posterior boundary of viii; but by gently scraping the body-wall the duct of the anterior can be traced backwards, and that of the posterior forwards, so that the two approach and almost meet at the level of the setae of viii, and not far from the middle line. Moreover the condition of the worm is such that the external ends of the ducts can be seen from the ventral surface through the softened walls, and though (in the dissected specimen) the actual opening cannot be distinguished with certainty, from the situation of the converging ducts as seen from the outside it must be about in a position corresponding to seta *d*.

The smaller associated sacs are either two (left) or three (right side) in number. They are narrow, apparently tubular, finger-like structures, of varying length, the longest about half as long as one of the larger spermathecae. The surface is slightly mammillated; they converge to their attachment on the body-wall between the ends of the larger spermathecae.

It has already been said that no definite external aperture could be seen in the dissected specimen. In another example however a roundish marking, with a whitish circumference and darker interior, was visible on both sides in the line of the setal ring of segment viii, slightly external in position to the genital marking previously described as situated posteriorly in vii; on the left side a small similar marking could be made out internal to the first. These marks perhaps represent the position of the spermathecal aperture or apertures, though the latter are themselves not visible.

No penial setae were discovered.

*Remarks.*—The position of the genus is not determinable without some little difficulty. Since it has obvious relations to the Octochaetinae, it will be helpful to note in the following form the chief distinguishing characters of the genera of the subfamily and their relations to the ancestral Acanthodrilinae.



Now if it were allowable to derive the mixed mega- and micronephridial condition of *Erythraeodrilus* from a pure micronephridial, it would be easy to suppose *Erythraeodrilus* a descendant of *Hoplochaetella*; the evolution would be, in some respects, parallel to that which has given rise to *Eutyphoeus* from *Octochaetus*. *Eutyphoeus* has undergone the microscolecine reduction of the posterior portion of the male genital apparatus; *i.e.* of the original two pairs of prostatic glands with openings on xvii and xix, those of xix have disappeared, and the ending of the vas deferens, originally on xviii and so between the prostatic pores, has approached or fused with the remaining prostatic aperture, that of xvii. Along with this in *Eutyphoeus* there goes the reduction of the spermathecae to one pair instead of two, and the disappearance, in the majority of cases, of the posterior pair of testes (proandric condition).

The same changes appear to be in progress in *Erythraeodrilus*; the microscolecine reduction has taken place, but it has not as yet been followed by the disappearance of the posterior pair of testes; in the spermathecal apparatus there is a tendency to the reduction in the number of apertures, even if this has not actually been attained. It is interesting to note the way in which the reduction of spermathecae is being brought about,—those of the same side have approached and met at their external ends in the middle of segment viii. In *Eutyphoeus* (if this genus has really had a parallel evolution) we may suppose that after fusion of the apertures, fusion of the spermathecae themselves followed; and that then the point of opening of the single organ moved forwards to groove 7/8, the situation of the anterior of the original two pairs of apertures.

<sup>1</sup> I use the generic name *Notiodrilus* in the sense in which it was used, for example, by Michaelsen in his "Geographische Verbreitung der Oligochäten."

But there are difficulties in supposing that the micronephridial condition, itself derived from the meganephridial, can retrace its history; and it seems better therefore to derive *Erythraeodrilus* from a situation on the line of descent anterior to the point of appearance of micronephridia, *i.e.* from some place between *Notiodrilus* and *Octochaetus*.

*Howascolex* (Michaelsen, 7, *cf.* also remarks of the same author, 12 and 13) here suggests itself as a possible point of departure. I have placed it, in imitation of Michaelsen (8), at the side of the basal stem in the preceding scheme. *Howascolex* already presents the mixed mega- and micronephridial condition found in *Erythraeodrilus*, and the latter could be derived from it by (a) the microscolecine reduction, which as we have seen takes place in the younger branch represented by *Eutyphoeus*, and (b) an increase in the number of setae, such as also occurs in the *Hoplochaetella* branch. If geographical considerations (*Howascolex* has only been found in Madagascar) stand in the way of this, then the only remaining possibility would be a derivation from the original Acanthodriline itself,—which scarcely make things easier.

Assuming provisionally therefore that *Erythraeodrilus* is a descendant of *Howascolex*, there remains the question whether it is to be reckoned to the Acanthodrilinae or Octochaetinae (there is at present no known indigenous Acanthodriline in India).

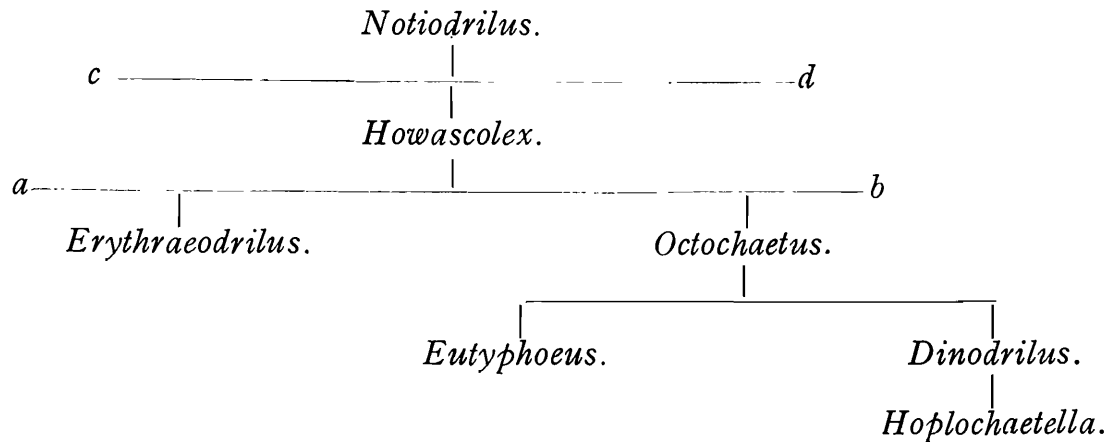
*Howascolex* is placed (with some reserve) by Michaelsen in the Acanthodrilinae, and is considered as possibly but by no means certainly in the line of descent from *Notiodrilus* to *Octochaetus*, *i.e.* the ancestral line of the Octochaetinae (8, 12, 13).

If *Howascolex* is judged not to be in the direct line, its descendant *Erythraeodrilus* obviously cannot be included in the Octochaetinae. Even if *Howascolex* is a direct ancestor, *Erythraeodrilus* cannot be so included unless *Howascolex* is included also, for this would offend by making the Octochaetinae diphyletic (*cf.* table *inf.* If the Octochaetinae are to begin below the line *ab*, then to reckon *Erythraeodrilus* to them would deprive them of genetic unity). So long as *Howascolex* is placed in the Acanthodrilinae therefore, *Erythraeodrilus* must also go to the Acanthodrilinae, or must constitute a separate subfamily.

The very wide difference between *Erythraeodrilus* and the rest of the Acanthodrilinae, and the inconvenience of instituting a subfamily for a single species, render both these solutions of the problem undesirable. I think the best way of dealing with it is to consider *Howascolex* as already, in virtue of its micronephridia, an Octochaetine, and as the direct progenitor of *Octochaetus*. There will then be no difficulty in placing *Erythraeodrilus* as an Octochaetine also,—as a twig which arises independently from the base of the subfamily.

I may add that morphologically there is no reason why *Howascolex* should not be in the direct line between *Notiodrilus* and *Octochaetus*; the only essential difference between *Howascolex* and *Octochaetus* is the coexistence of meganephridia with the micronephridia in *Howascolex*,—a difference which has not always been considered as necessitating even a generic separation. I presume that the reason why Michaelsen hesitates to consider *Octochaetus* as the direct and immediate descendant of *Howascolex* is that the latter is found in Madagascar, the former in India and New Zealand.

But let us state the case a little more fully. The characters of *Notiodrilus* which are important from a phylogenetic and therefore from a systematic point of view are:—acanthodriline disposition of the posterior portion of the male organs, holoandric



condition of the anterior male organs, lumbricine arrangement of the setae, meganephridia only, and spermathecae opening in 7/8 and 8/9. *Howascolex* is exactly the same in all these features, except that micronephridia coexist with the meganephridia. *Octochaetus* also presents the same features, except that micronephridia exist alone. Now we have reason to suppose that a pure micronephridial condition did not arise throughout the body at a single bound, but that it was preceded by a mixed mega- and micronephridial condition;—one in which, apparently, the whole of the meganephridium in each segment had not dissolved into micronephridia, but a portion remained still as a recognizable meganephridium. Such intermediate forms exist elsewhere at the present day (*Megascolides*, *Lampito*). Therefore, even if we had not *Howascolex* before us, we should have to postulate a form which by its definition would coincide with *Howascolex* as the immediate ancestor of *Octochaetus*, and the intermediary between *Octochaetus* and *Notiodrilus*.<sup>1</sup>

I consider therefore that the solution of the problem of classification is to be found in reckoning the Octochaetinae as beginning with *Howascolex*, and placing *Erythraeodrilus* and *Octochaetus* as independently evolved descendants of *Howascolex*; the line *cd* in the foregoing chart is therefore to be considered as that which delimits the Octochaetinae from the Acanthodrilinae.

### Family GLOSSOSCOLECIDAE.

#### Genus PONTOSCOLEX.

West Haputale Estate, Ceylon, 6200 ft.; dug from earth; Dec, 1913 (*S. W. Kemp*). Four specimens of a species of *Pontoscolex*, probably *P. corethrurus*, but the specimens were not fully mature.

<sup>1</sup> It is no doubt possible to agree with the above (which is indeed almost self-evident), and still, on the principle that the facts of geographical distribution are an essential part of the definition of a group, to hold that two (morphologically) indistinguishable genera are nevertheless to be kept separate. The point is that it seems premature at present to discuss what must, after all, be an extremely rare exception to the general rule, in connection with *Howascolex* and the putative ancestor of *Octochaetus*.

I give a few details of the nephridial system in the anterior part of the body, as far as they can be made out by dissection under the binocular dissecting microscope. The subject has interested previous observers (*cf.* Beddard, 2, pp. 48, 655); the condition which I found differs, however, from that described by Beddard for what is presumably the same species, viz. *P. corethrurus*.

It is necessary first to glance at the septa. The first is attached to the parietes at the level of groove 5/6; the second at 6/7, third at 7/8, and the fourth at the level of 9/10. It appears at first sight as if a septum is missing between 7/8 and 9/10; as will be seen, this is not the case; what has happened is that septum 8/9 has been shifted backwards. All the above septa are thickened.

The next septum is attached at the level of groove 10/11, and is thin; subsequent septa are attached at subsequent grooves,—11/12, 12/13, 13/14, etc., and may be described as very thin. These may be taken as corresponding to the grooves at which they are attached; it follows therefore that septum 9/10 has disappeared; but since, as said above, septum 8/9 has shifted back, the hiatus appears to be situated more anteriorly.

The justification for this view is the disposition of the nephridia. What is apparently segment x contains two pairs of nephridial coils, what is apparently the united segments viii and ix contains one only. The external apertures of the nephridia are near the anterior borders of their respective segments; and though the nephridial coil belonging to segment ix has been pushed backwards by the backward shifting of septum 8/9, the external aperture has remained in its original position; so that the nephridial tube of ix has now, passing forwards, to pierce the (true) septum 8/9 (the last thickened septum) in a forward direction in order to arrive at its external aperture.

The nephridia of segments viii, vii, and vi have their normal disposition. Those of v, lying deeply within the cone-shaped septum 5/6, debouch normally on the surface; but the coils constituting their posterior ends, and lying by the side of the anterior end of the gizzard, are apparently connected with similar coils of the nephridia of iv and iii. I could not separate the posterior ends of these three nephridia; but whether they merely interlace, or whether they communicate, I cannot say. The external openings of the organs belonging to iv and iii have the normal position.

The nephridium of segment ii forms a large and close coil on the side of the oesophagus, behind the pharynx and in front of the gizzard; from this there passes forwards a thick tube which enters the hinder end of the pharynx. This is a much more intimate and direct connection of nephridia and alimentary tube than that described by Beddard for *P. corethrurus*, where a nephridium opens on to the surface in segment ii, but owing to the great retractility of the anterior part of the body, this opening may actually at times come to lie within a temporary buccal cavity.

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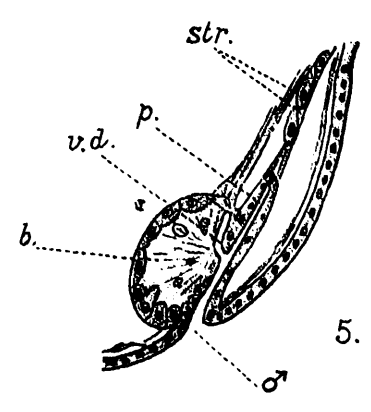
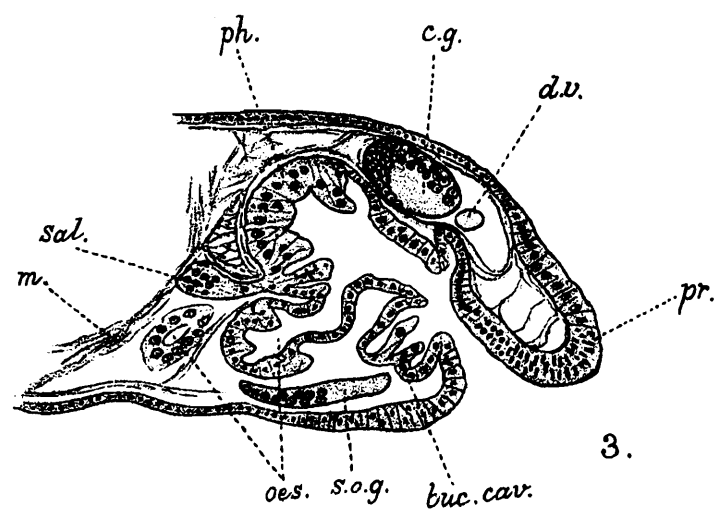
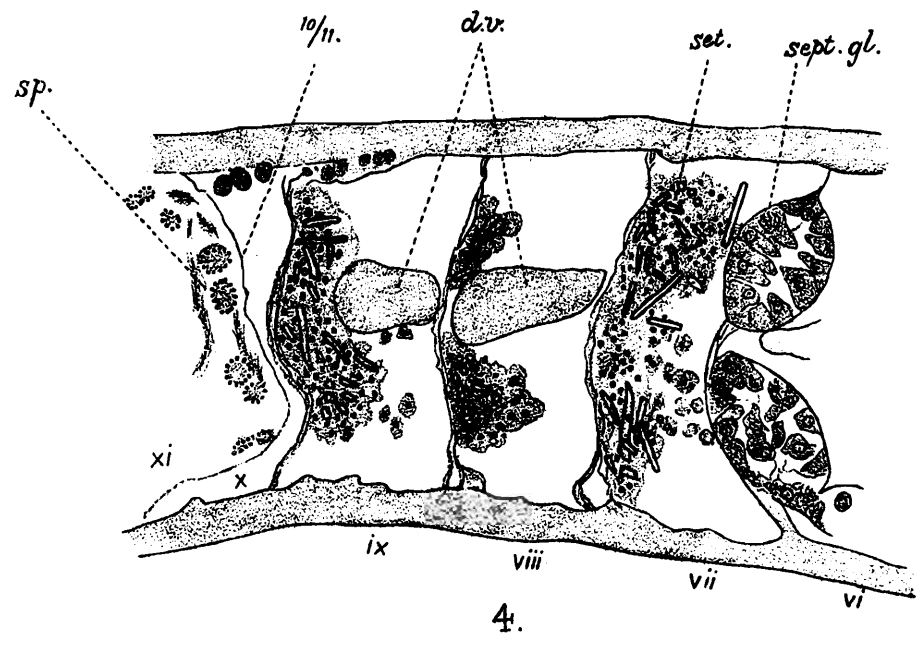
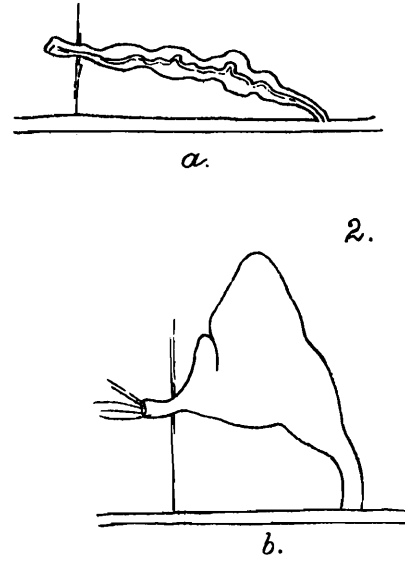
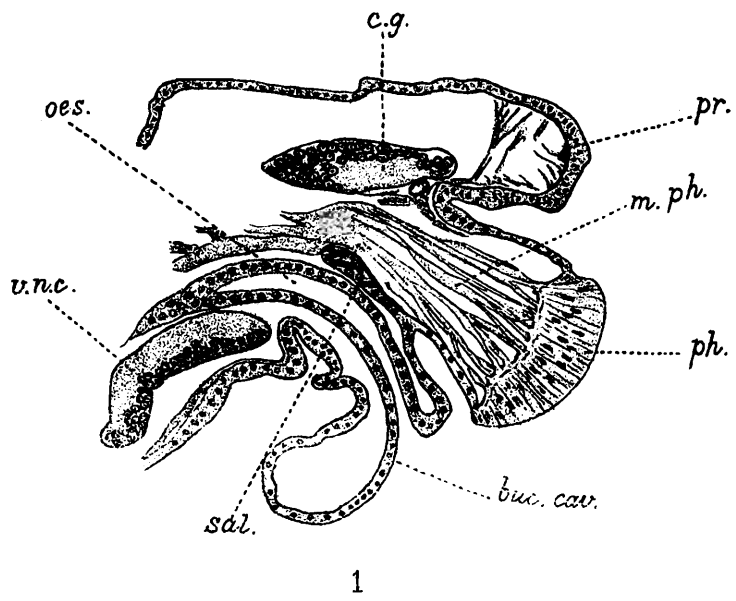
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## EXPLANATION OF PLATE VI.

Figs. 1, 3 and 4 drawn with Zeiss's Abbe's drawing apparatus.

- Fig. 1.—*Enchytraeus barkudensis*; longitudinal section of anterior end, showing everted pharynx;  $\times 116$ .  
*buc. cav.*, floor of buccal cavity everted; *c. g.*, cerebral ganglion; *m. ph.*, muscular strands attached to pharyngeal 'sucker'; *oes.*, oesophagus; *ph.*, pharyngeal 'sucker'; *pr.*, prostomium; *sal.*, salivary gland; *v. n. c.*, commencement of ventral nerve cord.
- „ 2.—The same; two nephridia, from an entire specimen in cedar oil; *a.*, from segment ix; *b.*, from a postgenital segment.
- „ 3.—*Fridericia carmichaeli*, section of anterior end a little to one side of median line;  $\times 116$ .  
*buc. cav.*, folded epithelium in floor of buccal cavity; *c. g.*, cerebral ganglion; *d. v.*, dorsal vessel (or one of the two branches into which its anterior end divides); *m.*, muscular band passing obliquely downwards from dorsal aspect of pharynx to ventral body-wall; *oes.*, oesophagus; *ph.*, the cup-shaped pharynx; *pr.*, prostomium; *sal.*, salivary gland; *s. o. g.*, suboesophageal ganglion.
- „ 4.—The same; horizontal section through dorsal portion of segments vi—xi, showing aggregations of coelomic corpuscles with setae and fragments of setae imbedded. The setae catch the eye much more strikingly in the actual specimen, where they are bright and refractile. The small clear circles, e.g. in segment viii, are setae cut transversely; the nuclei of the corpuscles are shown either black or with dotted interior. Constituents of body-wall not separately shown;  $\times 140$ .  
*d. v.*, dorsal vessel; *sept. gl.*, septal gland of segment vi; *set.*, mass of coelomic corpuscles with setae and setal fragments,—similar masses are seen in viii and ix; *sp.*, sperm morulae and spermatozoa; 10/11, septum 10/11; vi—xi, the corresponding segments.
- „ 5.—The same; penial bulb in transverse section;  $\times 210$ .  
*b.*, penial bulb; *p.*, penial lumen; *str.*, strands of muscular or connective tissue attaching bulb and penial tube to lateral body-wall; *v. d.*, termination of vas deferens;  $\sigma$ , male aperture.



A.C.Chowdhary, lith.

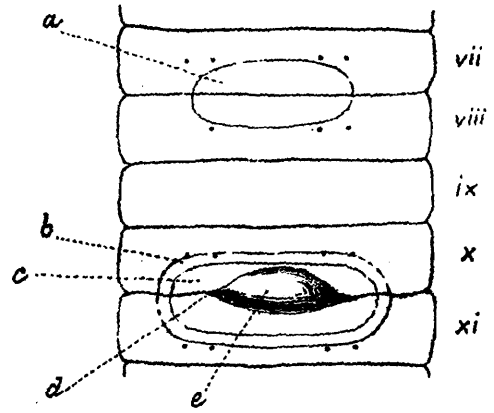
INDIAN OLIGOCHAETA

#### EXPLANATION OF PLATE VII.

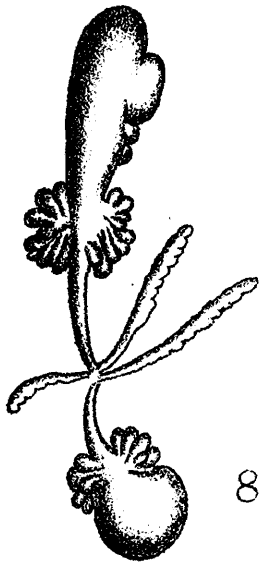
- Fig. 6.—*Drawida ghatensis*; a seta from segment viii;  $\times$  160.
- „ 7.—*Drawida chalakudiana*; genital region, diagrammatic. *a*, anterior genital area; *b*, light margin of posterior area; *c*, darker coloured interior of posterior area; *d*, shallow part of groove 10/11; *e*, median tubercle; vii—xi, the corresponding segments.
- „ 8.—*Erythraeodrilus kinneari*; spermathecae of one side, with diverticula and accessory spermathecae almost meeting at their outer ends in the body-wall of segment viii. From a dissection.
- „ 9.—*Megascolides hastatus*; penial seta. *a*, distal portion,  $\times$  90; *b*, extreme end,  $\times$  about 600.
- „ 10.—*Megascolides duodecimalis*; spermatheca, the small diverticulum showing at the base.
- „ 11.—The same; end of penial seta;  $\times$  *ca.* 400.
- „ 12.—*Megascolides pilatus*; the distal ends of two penial setae, seen from different aspects;  $\times$  *ca.* 350.
- „ 13.—*Comarodrilus gravelyi*; region of male apertures.
- „ 14.—*Perionyx bainii*; region of male apertures.  $\sigma$ , male aperture; *t*, overhanging papilla, or 'tag'



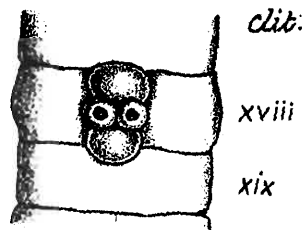
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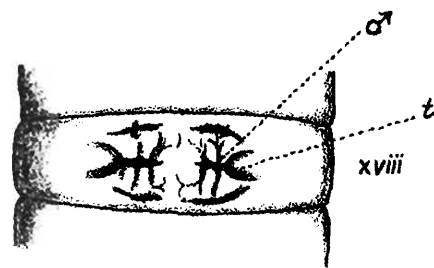
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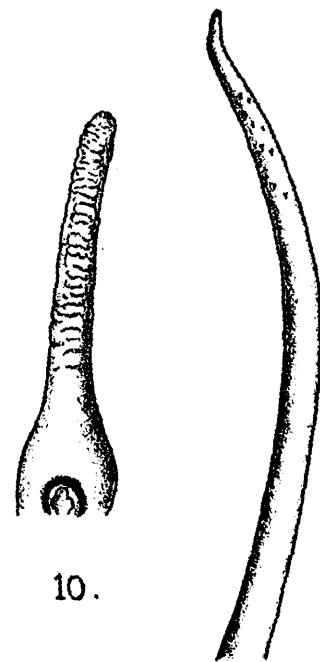
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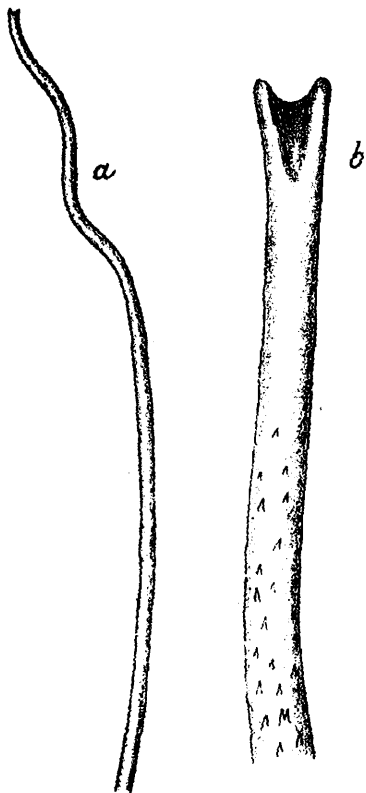


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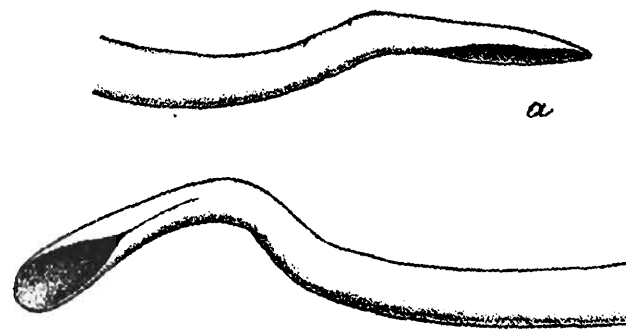


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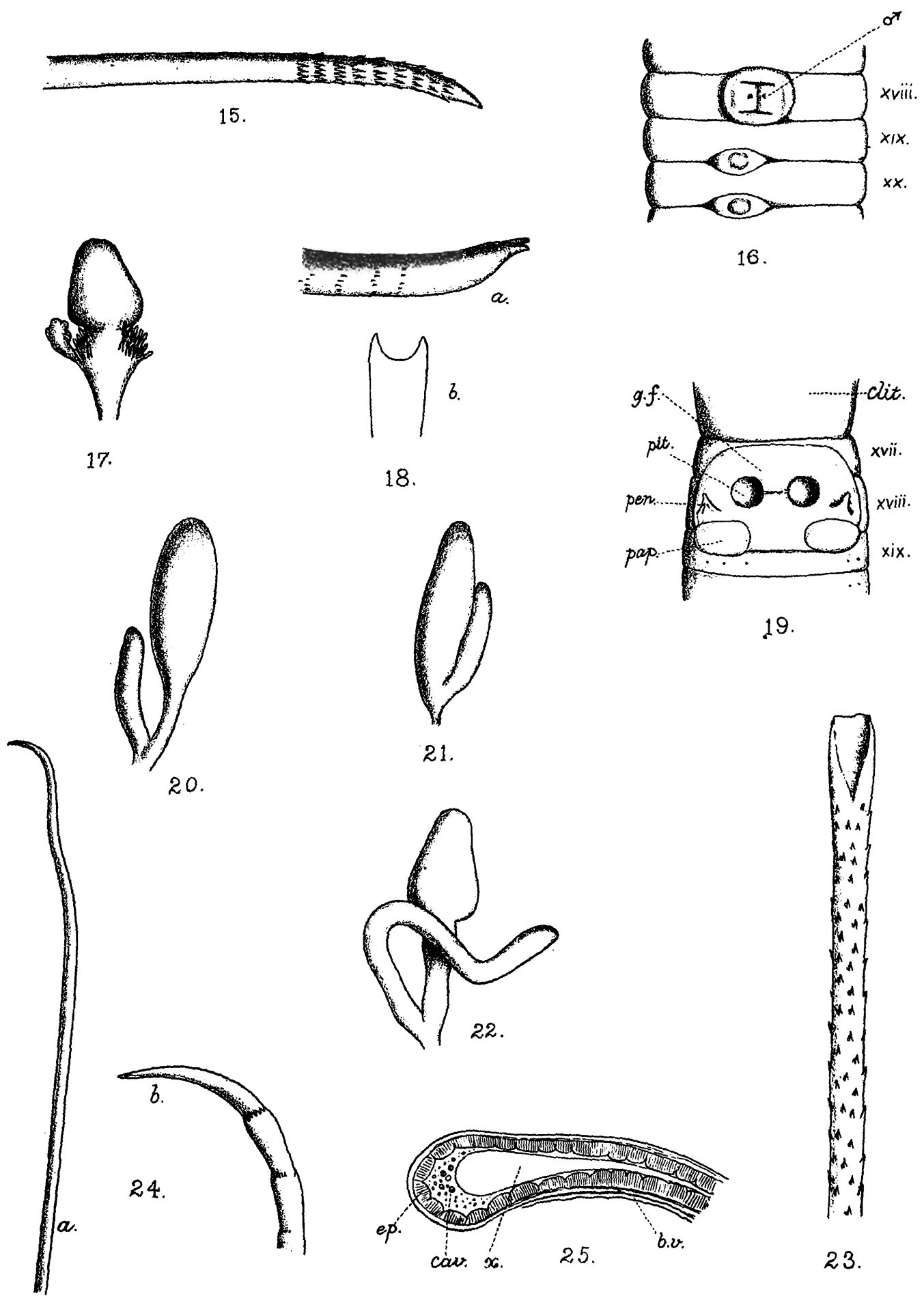
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b

A.C. Chowdhary, lith.

## EXPLANATION OF PLATE VIII.

- Fig. 15.—*Perionyx bainii*; penial seta;  $\times$  ca. 300.
- „ 16.—*Megascolex escherichi* var. *papillifer*; genital field;  $\sigma$ , male aperture.
- „ 17.—*Megascolex campester*; spermatheca. The appendages on the upper swollen part of the duct are micronephridia.
- „ 18.—The same; distal end of a penial seta. *a.*, as seen under the microscope,  $\times$  about 400. *b.*, represents what would probably be seen if the end of the seta could be rotated through a right angle; but this view is not obtained, since the setae, owing to the curve of the shaft, lie on the slide in the position of *a.*
- „ 19.—*Megascolex hortonensis*; genital area. *clit.*, clitellum; *g. f.*, the surface of the thickened genital field; *pap.*, flat, slightly raised papillae; *pen.*, penis; *pit.*, depression on segment xviii; xvii—xix, the corresponding segments.
- „ 20.—The same; spermatheca.
- „ 21.—*Megascolex kempi*; spermatheca.
- „ 22.—*Megascolex varians* var. *insolitus*; spermatheca.
- „ 23.—The same; distal end of penial seta;  $\times$  220. The whole of the portion which is clothed with spines is shown.
- „ 24.—*Megascolex sextus*, penial seta, *a.*, showing general shape; *b.*, more highly magnified ( $\times$  300) distal extremity.
- „ 25.—*Megascolex polytheca*; spermatheca, in glycerin after clearing. *b. v.*, blood-vessel running along its side; *cav.*, portion of cavity containing only granular matter; *ep.*, epithelium lining cavity and duct; *x.*, transparent mass, filling greater part of cavity;  $\times$  90.



INDIAN OLIGOCHAETA

A.C.Chowdhary, lith.

### EXPLANATION OF PLATE IX.

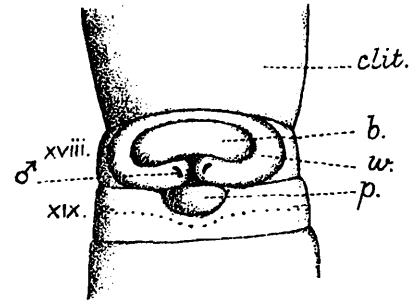
- FIG. 26.—*Megascolex polytheca* var. *zonatus*; spermatheca.  
,, 27.—*Megascolex kavalaianus*; spermatheca.  
,, 28.—*Megascolex phaseolus*; male genital region; *b.*, bean-like elevation on xviii; *w.*, the ring-like wall, cleft behind; *p.*, papilla on xix; *clit.*, clitellum;  $\sigma$  male pore; xviii, xix, the corresponding segments. Drawn from the only specimen showing the papilla on xix.  
,, 29.—The same; spermatheca.  
,, 30.—*Megascolex filiciseta*; penial seta. Lateral view of distal end; this seta was free from its sheath, and shows a relatively small number of the pinna-like spines;  $\times$  about 500.  
,, 31.—The same; a young seta in its sheath, with numerous spines, 16 on each side (not 17, as in the lower row);  $\times$  about 500.  
,, 32.—*Megascolex cochinensis*; male genital area. *clit.*, clitellum; *x.*, its posterior border.  
,, 33.—The same; spermatheca.  
,, 34.—*Megascolex konkanensis* var. *longus*; prostate of right side.  
,, 35.—The same; spermatheca.



26.



27.



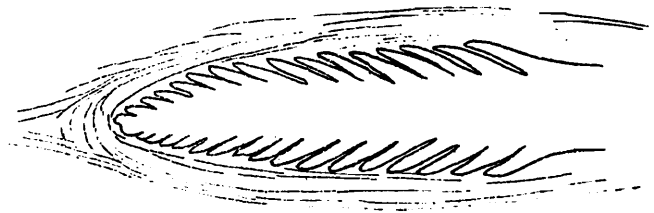
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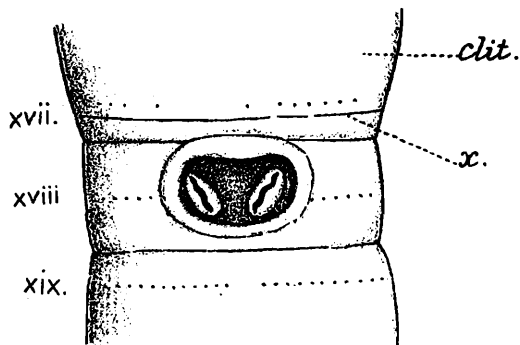
29.



30.



31.



32.



33.



34.



35.

A.C. Chowdhary, lith.