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# CONTENTS.

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## CONTENTS OF No. CXXXIII, N.S., AUGUST, 1892.

### MEMOIRS:

	PAGE
The Anatomy of <i>Pentastomum teretiusculum</i> (Baird). By W. BALDWIN SPENCER, M.A., Professor of Biology in the University of Melbourne. (With Plates I—IX) . . . . .	1
On the Minute Structure of the Gills of <i>Palæmonetes varians</i> . By EDGAR J. ALLEN, B.Sc., University College, London. (With Plate X) . . . . .	75

---

## CONTENTS OF No. CXXXIV, N.S., NOVEMBER, 1892.

### MEMOIRS:

On the Development of the Optic Nerve of Vertebrates, and the Choroidal Fissure of Embryonic Life. By RICHARD ASSHETON, M.A., Demonstrator of Zoology in the Owens College. (With Plates XI & XII) . . . . .	85
The Larva of <i>Asterias vulgaris</i> . By GEORGE W. FIELD, M.A. (With Plates XIII, XIV & XV) . . . . .	105
The Development of the Genital Organs, Ovoid Gland, Axial and Aboral Sinuses in <i>Amphiura squamata</i> ; together with some remarks on Ludwig's Hæmal System in this Ophiurid. By E. W. MACBRIDE, B.A., B.Sc., Scholar of St. John's College, Cambridge. (With Plates XVI, XVII & XVIII) . . . . .	129
A New English Genus of Aquatic Oligochæta ( <i>Sparganophilus</i> ) belonging to the Family Rhinodrilidæ. By W. B. BENHAM, D.Sc.Lond., Aldrichian Demonstrator of Anatomy, Oxford. (With Plates XIX & XX) . . . . .	155

## CONTENTS OF No. CXXXV, N.S., JANUARY, 1893.

MEMOIRS :	PAGE
On the Relationships and Rôle of the Archoplasm during Mitosis in the Larval Salamander. By JOHN E. S. MOORE, A.R.C.S. (From the Huxley Research Laboratory, Royal College of Science, London.) (With Plate XXI) . . . . .	181
On the Occurrence of Embryonic Fission in Cyclostomatous Polyzoa. By SIDNEY F. HARMER, M.A., B.Sc., Fellow of King's College, Cambridge, and Superintendent of the University Museum of Zoology. (With Plates XXII, XXIII & XXIV) . . . . .	199
Two New Genera and some New Species of Earthworms. By FRANK E. BEDDARD, M.A., F.R.S., Prosector to the Zoological Society of London. (With Plates XXV & XXVI) . . . . .	243
Observations on the Gregarines of Holothurians. By E. A. MINCHIN, B.A., Assistant to the Linacre Professor of Human and Comparative Anatomy, Oxford. (With Plates XXVII & XXVIII) . . . . .	279
A New Sporozoon in Amphioxus. By E. C. POLLARD, B.Sc. (With Plate XXIX) . . . . .	311
Studies on the Protochordata. By ARTHUR WILLEY, B.Sc.Lond., Columbia College, New York. (With Plates XXX & XXXI) . . . . .	317

## CONTENTS OF No. CXXXVI, N.S., APRIL, 1893.

MEMOIRS :	
Description of a New Species of <i>Moniligaster</i> from India. By W. BLAXLAND BENHAM, D.Sc.Lond., Aldrichian Demonstrator of Comparative Anatomy in the University of Oxford. (With Plate XXXII) . . . . .	361
Note on a New Species of the Genus <i>Nais</i> . By W. BLAXLAND BENHAM, D.Sc.Lond., Aldrichian Demonstrator of Comparative Anatomy in the University of Oxford. (With Plate XXXIII) . . . . .	383
On a New Organ in the Lycoridea, and on the Nephridium in <i>Nereis diversicolor</i> , O. F. Müll. By E. S. GOODRICH, F.L.S., Assistant to the Linacre Professor of Human and Comparative Anatomy, Oxford. (With Plates XXXIV & XXXV) . . . . .	387

CONTENTS.

v

	PAGE
Nephridia and Body-cavity of some Decapod Crustacea. By EDGAR J. ALLEN, B.Sc., University College, London. (With Plates XXXVI, XXXVII & XXXVIII) . . . . .	403
Note on the Cœlom and Vascular System of Mollusca and Arthropoda. By E. RAY LANKESTER, M.A., F.R.S., Linacre Professor, Oxford . . . . .	427
Contributions to a Knowledge of British Marine Turbellaria. By F. W. GAMBLE, B.Sc., Berkeley Fellow of Owens College, Manchester. (With Plates XXXIX, XL & XLI) . . . . .	433
Peculiarities in the Segmentation of certain Polychætes. By FLORENCE BUCHANAN, B.Sc., from the Zoological Laboratory of University College, London. (With Plate XLII) . . . . .	529
 REVIEW :	
The Nephridia of Leeches . . . . .	545

## Two New Genera and some New Species of Earthworms.

By

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With Plates XXV & XXVI

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IN this paper I describe a number of new species of earthworms which I have received during the last year or two from friends resident abroad, or from the Royal Gardens at Kew. Some of these were received alive; I was therefore able to preserve them carefully for histological examination.

### 1. *Polytoreutus magilensis*, n. sp.

Through the kindness of the Rev. H. W. Woodward, priest in charge of the Universities Mission at Magila, East Central Africa, I obtained a quantity of earthworms from that district. My thanks are also due and tendered to Colonel Sir Euan Smith, who was so good as to mention my wishes to Mr. Woodward.

The earthworm fauna of eastern tropical Africa has been principally studied by Dr. W. Michaelsen, who has published several interesting memoirs upon the subject;<sup>1</sup> the bulk of the

<sup>1</sup> "Beschreibung der von Herrn Dr. Franz Stuhlmann im Mündungsgebiet des Sambesi gesammelten Terricolen," 'Jahrb. Hamb. wiss. Anst.,' vii.

"Beschreibung der von Herrn Dr. Fr. Stuhlmann auf Sansibar und dem gegenüberliegenden Festlande gesammelten Terricolen," 'Jahrb. Hamb. wiss. Anst.,' ix.

<sup>2</sup> "Die Terricolen der Berliner Zoologischen Sammlung," 'Arch. f. Naturg.,' 1891.

species belong to the family Eudrilidæ, and to that section of the family characterised by unpaired male genital orifices, which are grouped together under the name of "Teleudrilinen" by Dr. Michaelsen.

The worms which I received from Mr. Woodward belonged to two species; the majority of the specimens were small slender worms, apparently referable to Michaelsen's *Stuhlmannia variabilis*. There were also about a dozen large worms which I refer to the genus *Polytoreutus*, but distinguish as a new species.

### § External Characters.

*Polytoreutus magilensis* is a larger species than *P. cœruleus*. An individual which I selected for measurement was  $14\frac{1}{2}$  inches in length, with a diameter of 8 mm.; this specimen consisted of 270 segments.

The colour of the preserved worms is of a dark violet dorsally, and yellowish below. The pigment is seen on a microscopic examination to be disposed in a network on each segment. The clitellum is yellowish.

The prostomium is broad, and is not continued on to the buccal segment. The setæ are disposed as in the only other species of the genus; the dorsal setæ are strictly paired, the distance between the two setæ being about half that which separates the two setæ of the ventral pair. On the anterior segments there is a tendency for the setæ to become obsolete; this is a rare occurrence among the terricolous Oligochæta, though not uncommon among the lower aquatic Oligochæta. There was nothing remarkable about the form of the setæ, and there were no modified setæ anywhere. On a good many segments of the body—particularly upon those behind the clitellum—there were a series of points conspicuous from the absence of pigment, and lying between the setæ; they have much the appearance of setæ when examined without the aid of a lens; and as they lie between the real setæ, they give the worm the look of a Perichæta—a resemblance which is increased by the fact that the segments are for

the most part marked by a median ridge. On mounting in glycerine a portion of the body-wall, embracing several of these clear spots, they are seen to be distinguished from the surrounding integument, not only by an absence of pigment, but also by an absence of glandular cells; they are, indeed, the representatives of the peculiar and characteristic sense-organs of the Eudrilidæ; as in *Hyperiodrilus*, and, in fact, in all other genera where these organs occur, they lie with the long axis horizontal; the central core as well as the numerous coats surrounding it were quite plainly visible in glycerine preparations.

The nephridiopores are very conspicuous; they lie in front of the dorsal setæ, but are not definitely related to either of the two setæ of the pair. They are especially obvious upon the clitellar segments, owing, of course, to the distended integument of those segments. The first pair of nephridiopores lie on the intersegmental furrow 2—3.

There are no dorsal pores.

The clitellum occupies Segments 13—17. It is developed all round the body, except on the 17th segment, where it is invaded by a portion of the large genital protuberance. The grooves between the clitellar segments are always more or less distinct.

The genital protuberance (see fig. 10) is an oval raised area about 8 mm. in length, which occupies the middle part of Segments 17, 18, and 19. The area which forms this protuberance roughly corresponds in extent to the space between the outer setæ of the ventral couples. Its colour is precisely that of the clitellum. It bears two apertures, one behind the other. The anterior of the two is the male genital aperture; it is a wide slit-like orifice between Segments 17—18; it has a crescentic form, the convexity being directed forwards, as illustrated in fig. 10. The posterior orifice is that of the spermathecæ; it is small and also slit-like, so narrow as to be often invisible; it lies on the border line between Segments 18—19. The genital protuberance is marked by two ridges running at right angles to each other: one runs transversely

and bears the spermathecal orifice; the other runs along the middle line of the body, at right angles to the former. Four sucker-like depressions are thus formed, which are most marked in a specimen in which the muscular sac at the male pore is partially everted. They probably serve as accessory organs of copulation. The oviducal pores are paired, and lie upon Segment 14; they are placed at about the middle of the segment, and are more ventral in position than are the nephridiopores.

#### § Internal Anatomy.

The pharynx terminates at the end of the 4th segment, and is immediately followed by the gizzard, which lies in Segment 5. The œsophagus is furnished with three median, ventral, glandular diverticula—the “Chylustaschen” of Michaelsen. These are nearly spherical bodies of a reddish colour, and lie in Segments 9, 10, and 11. In Segment 13 are a pair of trilobed calciferous glands. The intestine commences in Segment 14. The alimentary tract is, therefore, in all respects like that of *Polytoreutus cœruleus*.

The dorsal blood-vessel is single, and communicates in some of the anterior segments with the ventral vessel by a series of hearts; those of Segments 10 and 11 are especially enlarged.

Some of the anterior intersegmental septa are thickened, those between Segments 5—11 particularly so. There is one septum in front of the first of these; the septum between Segments 11—12, though more delicate than those which come before, is stouter than those which follow. The thickened septa are cup-shaped, the concavity being forwards.

The nephridia are paired organs.

The reproductive organs are very remarkable. They are on the whole similar to those of the other species, but differ in detail; these differences are quite sufficient to distinguish the two East African species.

The testes I could not discover; they probably lie within the sperm-sacs, which have, as in *Polytoreutus cœruleus*, a very remarkable configuration. Attached to the septum dividing Segments 11—12 there is on each side of the intes-

tine a solid-looking white body, which is simply a dilatation of the sperm-duct filled with sperm; the opaque white colour is of course due to the contained sperm. The funnel which is connected with one end of this dilated region was evident in one specimen; it lies within the sperm-sacs. These latter commence at the septum dividing Segments 10 and 11 as a narrow tube placed below the intestine, and enclosing the ventral blood-vessel. The two hearts of this segment join the ventral blood-vessel within the sac, as is shown in the figure (fig. 8). A very short way back the sperm-sac divides into two narrow tubes, each of which runs close to the dilated extremity of the sperm-duct, and appears to be connected with it. Behind the septum the two sperm-sacs, which have still the character of very narrow tubes, gradually approximate and pass back in close continuity to each other, and to the dorsal wall of the intestine. In another example the sperm-sacs commenced at the septum, just behind the oval dilatation of the sperm-duct already referred to. In this worm the funnel of the vas deferens was quite visible; it lies just within the beginning of the sperm-sac, but in the 11th segment; the orifice of the funnels is directed backwards, as is so often the case with the Eudrilidæ. The sperm-sacs in this individual were of unusually great length; they passed back to as far as the 60th segment. The sperm-sacs are divided into two regions: the anterior part, as far as about the 30th segment, consists of a narrow tube which lies perfectly free in the body-cavity; it is not attached to the intersegmental septa, which are largely defective dorsally; when the body is opened the sperm-sacs require no dissection to set them free. The posterior section of these tubes has a different structure; the walls become thicker and sacculate, being constricted at the septa; in one specimen the two sacs were united at the distal extremity; in another the sacs remained independent, though closely approximated. The length of the sperm-sacs was 65 mm. in one worm; they were longer in another. They appear to be more extensively developed than in *P. cœruleus*; and Dr. Michaelsen says

nothing in describing that species of the specialisation of the sacs into two regions. The immense length of the sperm-sacs is only paralleled among the Geoscolicidæ; these organs are not, as a rule, very long in the family Eudrilidæ.

The sperm-ducts are single, one on each side of the body: they leave the dilatation which lies immediately behind the funnel, and pass straight back to the atria; they communicate with the atria a little before their opening into the terminal bursa.

The atria are large; they measure about 36 mm. in length. The greater part of the atrium is a tube of considerable calibre, with thick glandular wall. Internally it is longitudinally ridged; the proximal part of the atrium is much narrower: the two atria join before opening into the median bursa.

The sperm-duct of each side opens into its atrium some way in front of the external orifice. The atria extend through about sixteen segments. The glandular part is of a tube-like form, but of an irregular contour; it is partially constricted at intervals; there is, however, nothing like the regular diverticula figured by Michaelsen in *P. cœruleus* (1). Figs. 8, 9 show the arrangement of the atria in this species.

The female reproductive system is illustrated in figs. 7, 9; it differs in some respects from that of *P. cœruleus*. The external orifice of the spermatheca lies, as already mentioned, behind the male pore, on the boundary line between Segments 18—19. This aperture communicates with a sac, which immediately divides into two; these pass round on each side of the nerve-cord, and reunite at some distance from the point at which the sac divides: the sac does not embrace the alimentary canal. A wide unpaired sac is thus formed, which is not quite so long as the atria. It is of about the same calibre. The interior of the sac is marked by numerous folds, arranged to form a network. The sac is half an inch in length.

In dissections of the worm a pair of elongated pouches were always to be seen rising up on either side of the intestine, in

the neighbourhood of the termination of the median sac already described. These sacs really form part of the spermatothecæ, with which they are connected as shown in the figure (fig. 9). At a distance of half an inch or so from the cæcal extremity each sac comes into close relations with the posterior part of the large spermatothecal sac; at these points, which are quite close to the external orifice of the sac, there is a communication between the two. Each sac then passes forwards in close contact with the body-wall, and is slightly constricted at the septa. The two sacs (right and left) appear to be perfectly separate from each other, and indeed the muscular terminal sac of the atria intervenes; but on removing the nerve-cord, which fills up the space between them, the two sacs are seen to be joined by about seven narrow bridges, which form a ladder-like arrangement shown in the figure. Two of these transverse connections lie behind the atrial aperture, while the remainder lie in front; anteriorly each sac diverges to one side, and becomes connected with the oviduct and egg-sac. Although the above description of the complicated spermatothecal apparatus of *Polytoreutus magilensis* appears to show a considerable difference from Dr. Michaelsen's species, a comparison of my figures (figs. 7, 9) with his (loc. cit., Taf. i, fig. 10) of the corresponding organs in *Polytoreutus cœruleus* will readily permit of a detailed homology. In both worms the spermatothecal pouches are only incompletely fused; but the fusion between the originally separate sacs (?) has taken place in a different manner. In *Polytoreutus cœruleus* the spermatotheca has two pairs of diverticula near to the external orifice; these correspond respectively to the parts lettered *b* and *c* in the figure illustrating *Polytoreutus magilensis*: *b* still retains considerable traces of the double condition. The unpaired median pouch in *Polytoreutus cœruleus*, which is continuous anteriorly with the egg-sacs, is nearly completely double in *Polytoreutus magilensis*.

It seems probable that the structures spoken of here as

“spermatothecæ” are, as in *Libyodrilus*,<sup>1</sup> for example, cœlomic pouches, which have acquired a connection with the exterior; such pouches occur apparently in all Eudrilids, and indeed are the most characteristic feature of that group of Oligochæta. They may, as in *Hyperiodrilus*,<sup>2</sup> contain a true spermatotheca. I have failed after careful search to find anything of the kind in the present species. The anterior end of the spermatothecal sac becomes connected with the efferent apparatus of the female organs in a way that hardly differs from *Polytoreutus cœruleus*. Fig. 7 illustrates the several organs as seen in a glycerine preparation; the results obtained by these means were checked by a comparison with a series of sections. The end of the spermatothecal sac is connected with a somewhat contorted tube which opens freely into its interior; this tube has thick muscular walls and a lining of ciliated epithelium; it passes into a wide chamber (*E. s.*) which lies close to the receptaculum (*R. o.*); with this is connected the oviducal funnel opening into the interior of the receptaculum and the oviduct, which passes in a straight line to the oviducal pore upon the 14th segment; the wide chamber also seems to give rise to a few cœcal tubes in which are lodged bundles of spermatozoa such as Michaelsen has figured<sup>3</sup> in *Polytoreutus cœruleus*. The region of the spermatotheca into which the oviducts open presumably lodges the ovaries, but I have not been able to see these organs; they are possibly, as in *Libyodrilus*,<sup>4</sup> only present in younger stages, and afterwards disappear. This region of the spermatothecal sac, however, contains an immense mass of spermatophores, which have the form illustrated in fig. 11. The spermatophores are of

<sup>1</sup> “On the Structure of an Earthworm allied to *Nemertodrilus*, Mich., with Observations upon the Post-embryonic Development of Certain Organs,” ‘*Quart. Journ. Micr. Sci.*,’ vol. xxxii.

<sup>2</sup> “On the Structure of the Two New Genera of Earthworms belonging to the Eudrilidæ, and some Remarks on *Nemertodrilus*,” ‘*Quart. Journ. Micr. Sci.*,’ vol. xxxii.

<sup>3</sup> *Loc. cit.*, Bd. ix, Taf. iv, fig. 30, *sk.*

<sup>4</sup> *Loc. cit.*, vol. xxxii, p. 568.

considerable length, and are coiled into an inextricable tangle. Each spermatophore is wider at one end; the spermatozoa are attached by their heads to a central core of a clear appearance, which is but faintly stained by borax-carmin. In transverse sections (fig. 12) the whole of the anterior end of the sac is seen to be filled with these spermatophores, which are cut in different directions. It is very interesting to notice the peculiar form of these spermatophores; peculiar, that is to say, as compared with other earthworms. They bear, on the other hand, a very close resemblance to the spermatophores of *Tubifex*<sup>1</sup> in course of formation. The immense number of spermatophores may perhaps be the cause of the enormous development of the sperm-holding apparatus; I found the spermatophores throughout the entire series of sacs which communicate with the female generative pore. In those Eudrilids (e. g. *Eudrilus* itself) where there are not spermatophores of this kind, the sacs are very much less developed. Michaelsen thinks that in *Stuhlmannia variabilis* the large size of these pouches is connected with viviparity. This would be a highly interesting fact were it proved. Michaelsen found in the interior of the spermatothecal sacs of this species granular masses which seemed to be surrounded with a peripheral layer of cells; naturally Dr. Michaelsen could not speak positively of the nature of these bodies, but he suggests that they may be embryos in course of development. I have examined the same species, and find that the large unpaired sac of *Stuhlmannia* contains only a mass of spermatozoa not agglutinated to form spermatophores. The circular canal surrounding the intestine, and also in communication with the median sac, is filled with what appears to be disintegrating spermatozoa, around which are numerous cells; but it is easy to see in my preparations that these cells are not ova, and that they have no relation to any embryonic structures; they are simply "lymph-corpuses," the function of which, as it appears to me, is merely that of getting rid of dead or per-

<sup>1</sup> 'System und Morphologie der Oligochaeten,' Taf. x, figs. 12 and 15.

haps superfluous sperm. These cells were for the most part loaded with granules, and some of them stained very deeply.

It is curious that while, as already stated, the entire spermathecal apparatus of *Polytoreutus magilensis* is filled with the spermatophores, whose structure has been described, the extreme end of the sac close to the egg-sac itself should invariably contain only a few bundles of spermatozoa, not compacted into spermatophores. The facts suggest that it is in this region that impregnation of the ovum takes place; that here the spermatophores received from another individual are dissolved, and the spermatozoa set free to do their work.

## 2. *Trichochæta hesperidum*, nov. gen., n. sp.

I found this new genus and species upon a single example of an earthworm from Jamaica, which I received alive together with a number of specimens of a *Perichæta* from Kew Gardens.

As the worm was not fully mature I can only give an incomplete account of its characters.

### § External Characters.

The general form of the species is very like *Pontoscolex arenicola*; the colour also recalls that species, and the irregularly alternating setæ. As both worms come from the same island I imagined at first that I had before me a specimen of either *Pontoscolex arenicola* or of *Diachæta littoralis*. But the species which I describe here differs in so many points from either of these two that it should, in my opinion, form the type of a new genus. It belongs to the family Geoscolicidæ, mainly, though not exclusively, a New World family.

The specimen measures about  $2\frac{1}{2}$  inches in length, and is of a robust form. Schmarda's figure of *Pontoscolex arenicola* represents the general appearance of the present species. As in many of the Geoscolicidæ, there is a prostomium. Fig. 4 illustrates the first few segments of the body viewed laterally; a narrow process of cylindrical form, and

terminating in a blunt rounded extremity, projects apparently out of the mouth, and might easily be mistaken for a prostomium if the worm were in a poor state of preservation.

This structure, however, differs from the prostomium of nearly all other Oligochæta: in *Sutroa*, for example, which possesses a long prostomium, the buccal lobe is simply prolonged; this is also the case with the few Naids that have a long prostomium. In the earthworm described in the present paper the conical process which looks like a prostomium arises within the buccal cavity. The examination of a series of transverse sections (fig. 1) shows that it is a process of the tissues lying outside the epithelium of the buccal cavity, which is covered by a layer of epithelium continuous with that of the buccal cavity. In such a series of sections the process in question appears first of all as lying freely within the buccal cavity; it is covered with a layer of tall, closely packed epithelial cells. The interior of the process contains a few muscular fibres and a number of large nerve-twigs. Further back the process is seen to lie in a diverticulum of the buccal cavity, which it nearly fills. Further back still the epithelium lining this diverticulum becomes continuous with the epithelium covering the process. This occurs just above the cerebral ganglia. It is evident from the structure of this process that it can be everted and retracted; containing as it does nerve-filaments arising from the cerebral ganglia, it probably serves as a tactile organ. The only other earthworm which is provided with an organ that is at all comparable to this process is *Rhinodrilus*; Perrier, however, states that the anterior "tentacle" of *Rhinodrilus* has no relation to the digestive tract: it is simply a process of the body. But Vaillant<sup>1</sup> remarks of the same species, "D'après mes notes, ce ne serait pas une véritable trompe, mais une extroversion de la partie antérieure du tube digestive, elle paraissait entourée à la base par la bouche, ornée d'une sorte de lèvre frangée." My own description<sup>2</sup> of

<sup>1</sup> "Annelides," in 'Suites à Buffon,' t. iii, p. 190, foot-note.

<sup>2</sup> "On the Structure of a New Genus of Lumbricidæ (*Thamnodrilus*)," 'Proc. Zool. Soc.,' 1887.

“*Thamnodrilus*” *Gulielmi* (really a *Rhinodrilus*, as I pointed out later), and the figures published in illustration of that description, bear out, so far as they go, M. Vaillant’s opinion, and are not confirmatory of the earlier view of M. Perrier. I figured (*loc. cit.*, p. 157, fig. 2) a conical body protruding from the mouth aperture, and surrounded by that orifice, which evidently corresponds to the structure described here in *Trichochæta*. As this process is not attached to the first segment of the body, I stated that there was no prostomium. The resemblance in this particular between *Rhinodrilus* and *Trichochæta* is, of course, of additional interest, inasmuch as they both belong to the same family of earthworms. A protrusible proboscis of this kind is not found in any other Oligochæteous Annelid. It must be noticed that it is not a diverticulum of the pharynx, but of the buccal cavity, though arising close to the junction of the two sections of the gut. Both buccal cavity and pharynx belong, it must be remembered, to the stomodæum.

The epidermis presents the usual characters. The peculiar refractive bodies found in the epidermis of *Pontoscolex*, and so distinctive of that genus, are entirely absent. If a portion of the dermo-muscular tube be mounted in glycerine, and the different layers be successively brought into focus, the following is the appearance of the different structures:—The epidermis appears to consist of large nucleated polygonal cells only; these are, however, the gland-cells, between which lie the interstitial cells, forming a meshwork. Bringing the circular muscular layer into view, its fibres are seen to be limited to the anterior and posterior borders of each segment, leaving the middle free, or traversed by a few fibres only, which give the appearance of a loose meshwork. The longitudinal layer beneath this forms a nearly continuous sheet, broken only by the implantation of the setæ. In transverse sections the spaces in the circular muscular layer are seen to be filled with a granular substance containing interspersed nuclei. We have evidently to do with an exaggerated de-

velopment of the "lymph spaces" found in the muscular layers of all Oligochæta.

The setæ are, as in the Geoscolicine genera *Pontoscolex*, *Diachæta*, and *Onychochæta*, disposed irregularly, though there are but eight to each segment. As in *Diachæta*, there are fourteen rows; as in *Diachæta Thomasii*, the ventralmost seta on each side of the nerve-cord is repeated from segment to segment without any alteration in its position. There are thus two rows of setæ, which are perfectly regular and in line. The form of the setæ differs from that of any setæ that have been hitherto met with in the Oligochæta, unless, indeed, the setæ of *Hypogæon hirtum* are similar. Savigny<sup>1</sup> speaks of the setæ of that species, which has not been met with again, as being spiny; moreover, Savigny mentions that the clitellum is "entièrement recouverte de soies inégales, disposées confusement." It may be that *Hypogæon hirtum* is a near ally of, if not identical with, the present species. It comes from America, near to Philadelphia.

In *Trichochæta hesperidum* the free extremity of the setæ (see fig. 2) is furnished with six or eight short and delicate processes, which end in a point directed forwards; otherwise the shape of the setæ conforms to the usual pattern found in earthworms: the extremity is, however, as in the worm *Pontoscolex corethrurus*, slightly bifid at the extremity; there is a small semicircular notch. The setæ at the end of the body are exactly of the same form, and are no larger than elsewhere.

### § Internal Anatomy.

The alimentary canal has a large gizzard in Segment 6. There are no calciferous glands.

Behind the gizzard are several thickened intersegmental septa. There are five of these—the same number as in *Diachæta Thomasii*.

The nephridia are, as in all other Geoscolicidæ, paired

<sup>1</sup> 'Système des Annélides, principalement de celles des Côtes de l'Égypte et de la Syrie, &c.,' p. 104.

structures. The external orifice does not appear to be provided with the cup-like sphincter found in *Pontoscolex* and *Onychochæta*. In the posterior segments of the body are the "pyriform vesicles" so characteristic of *Pontoscolex*; they seem to open, as in *Pontoscolex*,<sup>1</sup> into the duct of the nephridium, and not separately on to the exterior. As in many *Geoscolicidæ*, the anterior pair of nephridia are larger than those which follow: these enlarged organs correspond to the "glandes à mucosite" of *Pontoscolex*; but in that worm the glands do not open into the buccal cavity, although they may be sometimes temporarily retracted, so as to open into it by the introversion of the anterior segments. In *Trichochæta*, on the other hand, there is no doubt about the fact that these first nephridia do open into the buccal cavity. The only other species among the *Geoscolicidæ* in which these nephridia open in the same way into the alimentary canal is the recently described *Rhinodrillus ecuadoriensis*.<sup>2</sup>

One of the most noteworthy characters of this worm is the form of the sperm-sacs (see fig. 4); in many *Geoscolicidæ* the sperm-sacs are of great length, and present only to the number of a single pair. In *Geoscolex forguesi* the extreme is reached, the sperm-sacs occupying forty-six segments; but even those dimensions are exceeded by the Eudrilid *Polytoreutus magilensis* described in the present paper. In *Trichochæta* the sacs occupy about fifteen or twenty segments; they lie on each side of the gut, and appear on a dissection of the worm as two thin white threads which have not so great a diameter as the nerve-cord. Proximally—that is, near to their origin from the septa—the two sacs are narrow with even contours; further back they present the remarkable appearance shown in fig. 3. The sac is provided with a double series of diverticula, which vary in length from mere nipple-

<sup>1</sup> F. E. Beddard, "Observations on the Structural Characters of Certain New or Little-known Earthworms," 'Proc. Roy. Soc. Edin.,' vol. xiv, p. 160.

<sup>2</sup> "An Earthworm from Ecuador," 'Ann. Mag. Nat. Hist.,' ser. 6, vol. ix, p. 240.

like processes to long tubular cæca, many times as long as the diameter of the sac from which they arise. There appears to be no regularity in the arrangement of these cæca; they are not symmetrically disposed, nor are the longer outgrowths arranged in a definite fashion with reference to the shorter cæca. The walls of the sperm-sacs (fig. 6) appear to be almost entirely cellular; the muscular coat, though present, is extremely thin. They contained no developing spermatozoa, which may perhaps account for their fineness. There are three pairs of spermathecae, apparently lying in Segments 7, 8, and 9. Like the spermathecae of other Geoscolicidæ, they have no diverticula; they are exceedingly slender pouches of great length (see fig. 5), longer than those of any allied form: the muscular fibres in the walls of the spermathecae cross each other diagonally—forming, in fact, a double spiral.

The Geoscolicidæ of Rosa fall into two groups, which are also marked by their geographical distribution. The relation between the classification of the family and the distribution has not yet been pointed out; I may therefore call attention to the following facts.

I previously divided the group into three families—Urochætidæ, Geoscolicidæ, and Rhinodrilitidæ, but I am now of opinion that my division is not the most satisfactory; nor do I think that Benham's two families are more satisfactory: these families are Geoscolicidæ and Rhinodrilitidæ.

I am disposed to think that the scheme here advanced is more in accord with what we know of the structure of these worms; I would divide them into two families—Geoscolicidæ and Microchætidæ.

The first family—Geoscolicidæ—includes my two families Urochætidæ and Geoscolicidæ—Hormogaster and Glyphidrillus, and + Urobenus, Rhinodrillus, and Anteus; it equals Benham's Geoscolicidæ + Rhinodrillus and Urobenus.

It includes, therefore, the following genera:

Pontoscolex (=Urochæta).  
 Diachæta.  
 Onychochæta.  
 Trichochæta.  
 Rhinodrillus (=Thamnodrilus).  
 Anteus.  
 Geoscolex (=Titanus).  
 Urobenus.

These genera agree to differ from the next family in the following points :

1. Spermathecae one to four pairs, placed in neighbourhood of gizzard.

2. No copulatory papillae.

Besides these characters, which are absolutely distinctive, there are others which are found in this family but not in the next—e. g. prostomium sometimes absent; setae often ornamented, particularly upon the clitellum; peculiar glandular diverticula connected with the posterior nephridia; setae often irregular in arrangement; sperm-sacs may be one pair, very long; egg-sacs absent (this is perhaps characteristic of the family).

These genera are, with the exception of *Pontoscolex*, confined to the New World; the genus *Pontoscolex* is so ubiquitous that it can hardly be safely assumed that its presence in the tropical parts of the Old World is due to man's agency.

The second family, *Microchætidae*, will include these genera :

*Microchæta*.  
*Brachydrillus*.  
*Bilimba*.  
*Kynotus*.  
*Glyphidrillus*.  
*Callidrillus*.

These six genera agree in the following assemblage of characters :

1. Spermathecae usually many small pouches in a segment, placed in the neighbourhood of the ovaries.

2. Copulatory papillae present in nearly every case.

Perhaps Benham's genus *Eminodrilus* will prove to belong to this family. All these genera are natives of the tropical parts of the Old World, particularly of Africa and Madagascar.

### 3. *Pygmæodrilus lacuum*, n. sp.

I have had five or six specimens of this species, they were obtained alive from Kew; the habitat of the species is Lagos, West Africa.

#### § External Characters.

It is a small species, measuring about an inch in length, and is composed of about 120 segments. The anterior end of the worm (see fig. 14) is rather pointed, owing to the sudden increase in diameter of the segments after the 3rd. The prostomium is short, and rounded anteriorly; it is continued by grooves on to the buccal segment; these grooves (fig. 15) meet at an acute angle. The real demarcation between the prostomium and the peristomial segment is perhaps the transverse groove shown in the figure. There are dorsal pores which commence at any rate at the posterior boundary of the 6th segment, if not before.

The clitellum is extensive; it begins at the middle of Segment 13, and extends as far as the middle of Segment 26, occupying therefore thirteen segments; it is only developed on the dorsal side of the body: the ventral region between the ventral setæ is covered with epidermis which has the structure of that on the non-clitellar segments.

The setæ are paired; they show no modification upon any segment or segments; they commence as usual upon the 2nd segment of the body. The ventral setæ of Segment 17 are absent.

The first four segments of the body are not secondarily divided into annuli; Segment 5 is biannulate; the next four are triannulate; the next few are divided by furrows into about five annuli.

The only apertures visible upon the exterior of the body are those of the spermathecae and the atrial pores.

The spermatothecal pores lie on the boundary line between Segments 8 and 9, in line with the ventral couples of setæ.

The atrial pores are upon Segment 17, corresponding in position to the absent ventral setæ of this segment. Each is situated upon an elevation of oval contour, not fused across the middle line with its fellow.

There are no genital papillæ.

### § Internal Anatomy.

My investigations into the internal anatomy of this worm are less complete than they might otherwise have been, owing to the fact that the alimentary canal was full of sand, which greatly damaged the sections and prevented me from satisfactorily determining certain points.

As in many other earthworms, a few of the foremost intersegmental septa are greatly thickened, and are attached ventrally along lines which do not correspond with the intersegmental grooves. There are five of these thickened septa, which lie between Segments 5—10.

The body-cavity is largely occupied by numerous corpuscles; they are particularly abundant in the segments after the 12th, but I found them as far forwards as the cavity of the prostomium. These cells have a circular contour or are slightly oval; the outline appears crenate, an appearance which seems to be due to the presence of a peripheral layer of excreted particles, a few of which are also scattered through the cell. The nucleus is comparatively large, and always very much more darkly stained than the surrounding protoplasm, which is but faintly tinged by borax carmine. Among the cells were, here and there, aggregations of darkly stained spherules. The existence of numerous cœlomic corpuscles seems to characterise the tropical species of earthworms; but generally these cells are loaded with granules.

The nephridia commence in the 6th segment; in Segment 5 I found the funnel of this nephridium, but there was no

nephridium belonging to that segment to be discovered. The nephridia are paired, and are not absent from the genital segments.

The buccal cavity occupies the first three segments of the body; as usual, the cerebral ganglia lie at the junction of this with the pharynx. The epithelium of the first section of the buccal cavity is like that which covers the prostomium; that is to say, the cells are narrow and deep, with a few oval glandular cells scattered among them; there are, indeed, more glandular cells than in the prostomial epidermis, but not so many as in the epidermis of the general body surface. Behind this region, which is about half the length of the buccal cavity, the tube becomes contorted so as to be able to be stored away in the limited space available; this region is lined with columnar cells considerably wider than those of the first section of the buccal cavity. This part of the buccal cavity has an extraordinarily rich nervous supply; these nerves are not merely delicate filaments concerning whose existence there might be some doubt, but stout nerves which form an almost continuous layer (probably really a plexus) beneath the epithelium—immediately beneath it, and divided from it by no structures. These nerves are exceedingly conspicuous from the fact that the nerve-cords are unstained, and therefore contrast with the deeply stained epithelium beneath which they lie; frequent nuclei are interspersed among the fibres. These nerves are connected with a large visceral ganglion. A rich nervous supply, limited to the anterior part of the alimentary tract (or at least most highly developed there) of an animal which, as it swallows all before it, can hardly be accused of possessing a very delicate or discriminating palate, is remarkable. Earthworms, however, in addition to swallowing the earth as they tunnel their way through it, draw down leaves into their burrows; for the selection of these leaves the nervous mechanism referred to may be useful. It is also possible that the buccal cavity is everted as in *Perichæta*; but although I received the worms alive I did not notice anything of the kind. In that event it might be used as a tactile organ, which

one would imagine to be of more use to an earthworm than an organ of taste.

The pharynx begins in Segment 4. Septal glands are well developed. In Segments 6 and 7 are gizzards—one to each segment, with tolerably thick muscular walls. The œsophagus extends as far back as the end of the 11th segment; in the next segment the intestine commences. The calibre of the œsophagus is less than half that of the intestine; it is furnished in Segment 9 with a pair of diverticula which appear to be very like those of *Pygmæodrilus quilimanensis*: the basal part where they arise from the œsophagus is wide, but the pouches narrow towards the free extremity, which is obtusely pointed. The structure is that of the calciferous glands of other earthworms.

**Generative Organs.**—These are somewhat intermediate between those of a new genus, *Gordiodrilus*, recently described by myself, and other *Cryptodrilidæ*. There are only a single pair of testes, which are, as is the case generally among earthworms when there is only a single pair, in Segment 11; the sperm-sacs are in Segment 12, and are of a racemose form; in Segment 11 also there was a mass of developing sperm. The ovaries are in the 13th segment; the oviducts are perfectly normal, and there are no egg-sacs. The sperm-ducts in correspondence with the testes are a single pair, the funnels lying of course in Segment 11. The sperm-duct of each side passes back close to the peritoneum of the ventral body-wall; arrived at the 17th segment the sperm-duct perforates the body-wall; just before entering the body-wall it becomes slightly wider, and is invested by a moderately thick muscular tunic; but the lining epithelium is still ciliated. The sperm-duct at this part of its course lies behind the atrium; when it enters the body-wall it passes obliquely in a slightly forward direction, and opens into the duct of the atrium just before the external orifice of the latter, and on to its posterior side. The atria are a single pair of tubular bodies, which consist, as in most earthworms, of a distal muscular portion and of a proximal glandular portion. The

glandular portion is, as in *Gordiodrilus* and *Ocnodrilus*, lined by a single layer of large columnar glandular cells.

The calibre of the tube is, however, rather greater than in either of those two genera; but still there is no indication of the double layer of cells such as is found in *Acanthodrilus*, &c. As already mentioned, no penial setæ exist. There are a single pair of spermathecae in Segment 9. One of these is shown in fig. 16, partly in optical longitudinal section; the pouch itself is large and somewhat oval in form; the duct is long, but not so narrow in proportion to its length as in *Gordiodrilus tenuis*. The pouch is lined by a single layer of columnar cells (fig. 16, *a*) which are irregularly defined at the free extremities; they are here prolonged into short processes, and contain clear vesicles: this is no doubt associated with the production of a slightly granular substance occupying the interior of the pouch. There were no spermatozoa to be found. The duct of the spermatheca is lined by an epithelium of a non-glandular appearance, and has a muscular investment which is present as an excessively thin layer upon the pouch itself; there are no diverticula.

I refer this worm to the genus *Pygmæodrilus* chiefly on account of the form and position of the œsophageal appendages. In certain other points it differs from *P. quilimanensis*, *P. bukobensis*, and *P. affinis*, the remaining species of the genus, and from *Gordiodrilus*, with which *Pygmæodrilus* has affinities.

The investment of the end of the vas deferens by muscular fibres does not form a very important point of resemblance between *P. lacuum* and *P. quilimanensis*, since the same differentiation occurs in *Microdrilus* (nov. gen.). Michaelsen says nothing about the structure of the atria in the other species of the genus. The form of the spermathecae is very different in *P. lacuum* from what is found in the three remaining species. It is rarely the case that diverticula are present and absent in the same genus, or even in the same family. The only instances that I can at present recall are *Acantho-*

*drilus Spegazzinii*, in which Rosa asserts the absence of diverticula; as a rule this genus of course has diverticula. In the absence of diverticula, and in the length of the spermathecae, *P. lacuum* resembles *Gordiodrilus*. If Michaelsen had not described the genus *Pygmæodrilus* I should certainly have referred the present species to that genus.

#### 4. *Siphonogaster Millsoni*, F. E. B.

*Siphonogaster Millsoni*, F. E. Beddard, P.Z.S.,  
1890, p. 48.

Two or three years ago Levinsen<sup>1</sup> described a remarkable worm from the banks of the Nile, characterised by having a pair of long processes arising from the ventral side of the body a little behind the head. A year ago I contributed to the 'Proceedings of the Zoological Society' a short notice of another worm, evidently referable to the same genus, from Lagos, West Africa. I have lately, through the kindness of Mr. Alvan Millson acquired a large number of examples of the latter species, many of them in an excellent state of preservation for section cutting; I am able, therefore, to add something to the very fragmentary account I gave formerly of the structure of *Siphonogaster Millsoni*.

I shall give some of the most interesting facts in its anatomy, and refer to the specific characters at the end of the description.

#### § External Characters.

The most striking external peculiarity of the Oligochæte, which is of about the same bulk as the average-sized British Lumbrici, is of course the pair of appendages already referred to; they arise from the 18th segment. The appendages vary in size in individuals, a variation which I take to be indicative of

<sup>1</sup> "Om to nye Regnormslægter fra Ægypten," 'Vidensk. Medd. Kjoebn., 1889.

the stages of sexual maturity. In some specimens they were fully as long as they are figured by Levinsen;<sup>1</sup> in others they were no longer than I have already figured them<sup>2</sup> in the present species. These outgrowths are undoubtedly penes, as Levinsen thought. I have found that the vas deferens traverses them, opening on to the exterior at about the middle. But I imagine that they must perform some other function in addition to that of serving as intromittent organs for the sperm; they are so altogether out of proportion to the fine canal which perforates them; and besides, there are no correspondingly large organs to receive them during copulation. The structure of the penis is displayed in fig. 19. In cross section they are roughly semicircular; the ventral surface is, however, not flat; as shown in fig. 19, it has a broken surface. Here and there are deepish depressions, caused apparently by the unequal contraction of the muscular fibres. There was no regular infolding of the two edges of the penis, such as Levinsen figures in *Siphonogaster ægyptiacus*.

The under surface of the penis is also broken by deep depressions, which serve probably as suckers. I generally found two of these near to the attachment of the organs to the body-wall; but there are others all along the penis, which are not as a rule so marked; from the bottom of these depressions arise the setæ. In sections through the penis they have the appearance represented in fig. 19. The epithelium which lines these semicircular pits is very glandular; the cells are deeply stained, and are laden with spherical granules. The setæ spring from the bottom of these pits; the shape of the setæ is illustrated in fig. 21. So far as I could ascertain all the setæ arose from pits, but these pits are of very various sizes; as a rule they are inconspicuous, not visible at all, in fact, by the unarmèd eye; but there are usually two large ones near to the base of the penis, as figured in fig. 18, *Sv.*; these, however, are not always present, or are, at any rate, not always obvious. The epithe-

<sup>1</sup> Loc. cit., tab. vii, figs. 1 and 2.

<sup>2</sup> "On an Earthworm of the Genus *Siphonogaster* from West Africa," 'Proc. Zool. Soc.,' 1891, p. 48.

lium of the penis is like that of the general body surface, but underneath the epithelium is a layer of glandular cells, which are prolonged into fine processes that penetrate between the cells of the epithelium. Occasionally this was very apparent, owing to the fact that the cells in question were laden with darkly staining granules. The structure of the lower surface of the penis is, indeed, closely like that of the clitellum of other earthworms. In the present species I have been quite unable to discover a clitellum; it is rather risky to assert the absence of this characteristically Oligochæteous organ; for a long time it was thought to be absent in *Moniligaster* until its presence was proved by Professor Bourne; in *Siphonogaster*, however, the structure of the penis, as well as its large size, is quite in accord with the view that it may possibly perform the function of a clitellum. This organ is, as Levinsen pointed out, very vascular; one particularly large trunk (fig. 18) runs along the whole length; besides this there are two smaller longitudinal vessels. All these send off branches which ramify in the walls of the penis.

The great vascularity of the organ led Levinsen to regard it as in all probability performing a respiratory function in addition to a reproductive. This may be so, but the large development of unicellular glands would surely need a correspondingly rich development of the blood-capillaries.

I should mention that the penial processes are quite solid; there is no prolongation into them of the body-cavity: they do contain irregular spaces due to the lax arrangement of the muscular and vascular tissues which fill up the interior; but these spaces appear to be perfectly independent of the cœlom. In relation to this question of cœlom an important fact in the structure of the penes is the presence of apparently excretory tubules; these are quite conspicuous, and (fig. 19, *n.*) show every resemblance to the nephridia; they are contorted tubes with an intra-cellular lumen. I traced them some distance into the thick lower wall of the penis, and was successful in discovering the actual orifice on to the exterior; traced in the other direction

they ceased to exist very soon. I could find no connection with the paired nephridia of the segment, and the apertures of these paired nephridia were visible quite close to the point of origin of the penis.

The nephridia lie at a lower level than the sperm-duct ; they cannot, therefore, be confused with it ; besides, their calibre is considerably less, as can be seen by an inspection of fig. 19. I could not discover any cilia in the nephridia ; cilia were extremely conspicuous in the sperm-duct. The nephridia appear to form a network ; it was common to see the tube showing indications of branching, such as are exhibited in fig. 19 ; here and there the tubes communicated with the exterior. I looked very carefully for any connection between the nephridia and the sperm-ducts ; no such communication could be found, and as a matter of fact the position occupied by the nephridia is different from that occupied by the sperm-ducts. I did not make any attempt to count the number of pores in the penis, but there are undoubtedly a considerable number. The occurrence of excretory tubules in this organ is a remarkable fact. I have already mentioned that the penial processes do not appear to contain any prolongation of the cœlom ; they are simply processes of the body-wall, solid processes without any continuation of the body-cavity. There is furthermore, as has also been mentioned, no connection between the nephridia of the penes and the nephridia of the segment whence they arise ; it is difficult, therefore, when we consider all these facts, to believe that the nephridia "are cœlom." Before taking leave of these organs I ought to mention that the funnels, if present, entirely escaped my notice. As there is no body-cavity in the penes the absence of internal apertures is not to be wondered at.

If the penes are ever broken off from the body, and can lead an independent existence for a short time, it would be quite excusable to put them down as aberrant and probably parasitic Annelids, connecting the Oligochæta with the Hirudinea ; the ciliated vas deferens passing along the middle line would be the alimentary canal, and the existence of independent excre-

tory tubes would almost decide the matter of their being independent organisms.

### § Internal Anatomy.

The reproductive organs are peculiar in a few respects; not, however, the testes and the sperm-sacs: the former occupy the usual segments in which those gonads lie, viz. 10th and 11th. The sperm-sacs are voluminous; they extend from the 9th to the 12th segment. The sperm-ducts open into Segments 10 and 11 by large folded funnels. The tubes connected with these plunge at once into the thickness of the body-wall, and the two tubes of each side fuse. The single sperm-duct thus formed passes back still embedded in the body-wall near to the junction of the circular with the longitudinal muscle layer, but distinctly in the latter; it runs into the penis, and opens, as already mentioned, at about the middle of this organ, on to the exterior.

The ovaries are paired, and lie in Segment 13; they are of rather a peculiar form, being narrow, transversely elongate bands; the ripe ova occupy the unattached margin of the gonads. The oviducts lie in the following segment; the funnel, however, does not open into Segment 13, as is nearly universally the case; indeed, the only exception hitherto described is *Plutellus*. M. Perrier stated<sup>1</sup> that in that genus the oviducts were limited to a single segment; this statement has not, however, met with entire acceptance.<sup>2</sup> There is no doubt about the matter in *Siphonogaster*; it is quite plain in longitudinal sections, which are adapted for proving such a point without leaving much room for doubt. There were, in one example at any rate, two pairs of egg-sacs in Segments 13 and 14 respectively; they are attached to the front wall of those segments.

I could not find any trace of spermathecae. But, as is well known, these organs are occasionally wanting in *Oligochæta*.

<sup>1</sup> 'Arch. de Zool. Exp.,' t. ii.

<sup>2</sup> W. B. Benham, "Description of Three New Species of Earthworms," 'Proc. Zool. Soc.,' 1892, p. 137.

The alimentary canal is entirely without a gizzard; after the pharynx the narrow œsophagus extends for a considerable distance, terminating in the intestine in Segment 17. The first part of the œsophagus as far back as Segment 9 is not greatly vascular; the rest of the œsophagus is particularly richly supplied with blood-capillaries; it has, however, no calciferous glands or diverticula of any kind; the terminal section of the œsophagus, occupying Segments 13—15, is wider than the portion in front; the intestine is at first (for one segment) hardly wider; it suddenly increases to double the previous width. There seems to be no typhlosole. I have not attempted to work out the anatomy of the circulatory system, but the few following points may be noted. In Segments 8—12 are a series of hearts connecting the dorsal with the ventral blood-vessel; there seems to be no supra-œsophageal vessel.

#### § Affinities of *Siphonogaster*.

In the incomplete description of the worm, which was based upon examples kindly forwarded to me from Kew by Mr. Thiselton Dyer,<sup>1</sup> I pointed out certain apparent differences from *Siphonogaster ægyptiacus* of Levinsen. The examination of the large series of well-preserved specimens recently received from Lagos through the kind instrumentality of Mr. Alvan Millson leads me to the belief that there is only one species of *Siphonogaster*; the only possible difference that I can see is that in *Siphonogaster ægyptiacus* the setæ upon the penial appendage are irregularly disposed; in all the worms from Lagos these setæ are largely paired, though not perfectly regular; in any case there were very rarely more than two setæ in a transverse row. Levinsen's account is necessarily so imperfect that the question of the species cannot yet be decided. Hence I retain provisionally the specific name applied by me to these worms.

Dr. Michaelsen has lately described two other species of

<sup>1</sup> "On an Earthworm of the Genus *Siphonogaster* from West Africa," 'Proc. Zool. Soc.," 1891, p. 48.

this same genus<sup>1</sup> from the shores of Victoria Nyanza ; these have been named *S. Emini* and *S. Stuhlmanni*; both these species are founded upon fragments which, however, included the penial process. The small size of these processes in *S. Emini* I should look upon as a sign of immaturity. So far as can be gathered from the necessarily incomplete account given by Michaelsen, these species agree with that described in the present paper in their essential structures. Michaelsen considers that their systematic position is a matter of doubt ; the presence of penial processes, as he remarks, suggest the *Teleudrilini*, a view which is of course not supported by the absence of prostates and spermathecae. My own observations recorded here serve, I think, to fix with something like certainty the systematic position of the worm.

It will be obvious from the above account of the anatomy of *Siphonogaster* that it is a member of the family *Geoscolicidae* of Rosa. I myself and others thought that the genus would prove to be, as are the majority of tropical African earthworms, a *Eudrilid*; it is abundantly clear that this surmise was incorrect. On p. 257 of the present paper I have attempted to revise Benham's classification of these intra-clitellian worms ; since writing that passage a paper by Rosa<sup>2</sup> has come into my hands, which is practically in accord with what was there said. I may point out that the structure of *Siphonogaster* further confirms the justice of separating the Old from the New World genera. I would particularly direct attention to the presence of egg-sacs in *Siphonogaster*; these sacs do not, so far as we know at present, occur in the American forms ; they have been found in a good many Ethiopian and Indian genera.

<sup>1</sup> "Beschreibung der von Herrn Dr. Fr. Stuhlmann am Victoria Nyanza gesammelten Terricolen," 'Jahrb. Hamb. wiss. Anst.,' Bd. ix.

<sup>2</sup> "*Kynotus Michaelsenii*, n. sp.," 'Boll. Mus. Comp. Zool.,' vol. vii, No. 119.

Genus *Siphonogaster*, Lev.

*Siphonogaster*, Levinsen. 'Vidensk. Med. fra den naturh. Foren. i Kjoebenhavn,' 1889, p. 319.

Moderate-sized Oligochæta belonging to the family Geoscolicidæ; setæ eight in a segment, ornamented,<sup>1</sup> paired; on the 18th segment a pair of penial processes, upon the middle of which open the sperm-ducts, armed with modified setæ and furnished with suckers; sperm-ducts running within the thickness of the body-wall; spermathecae absent; œsophagus without gizzard or calciferous glands.

*Siphonogaster* *Millsoni*, F. E. B.

*Siphonogaster* *Millsoni*, F. E. Beddard. 'Proc. Zool. Soc.,' 1891, p. 48.

Body square in transverse section behind the penial processes, the paired setæ lying at the corners; the dorsal region of the body-wall much thinner than elsewhere; penial setæ arranged in pairs, though not with absolute regularity.

Hab.: Lagos, West Africa.

5. *Alvania* *Millsoni*, nov. gen., n. sp.

Among a number of earthworms recently sent to me from Lagos by Mr. Alvan Millson, Assistant Colonial Secretary, are three or four examples of a small worm belonging to the family Eudrilidæ. So many new genera have been lately described of this characteristically African family, and so many of them are imperfectly known, that I hesitate before placing the species to be described here in a new genus; and yet it appears, as will be seen in the sequel, to possess characters which, as the genera are now limited, entitle it to generic rank. In any case I include it for the present in a new genus allied to *Heliodrillus*, which it approaches more closely than

<sup>1</sup> This is of course another reason for referring the genus to the Geoscolicidæ.

any other genus. The worms, of which I had about half a dozen specimens, measured two inches or so in length. The colour was evidently entirely lost in the process of preservation; but it appears that little or no integumental pigment is present.

### § External Characters.

In the disposition of the setæ this worm resembles the genera *Heliodrilus* or *Hyperiodrilus* (which Michaelsen would unite in one genus), *Paradrilus*, and *Preussia*. The setæ are paired, but the two setæ of the ventral couples are much further apart than are the two setæ of each dorsal couple, which are strictly paired; the setæ are, in fact, arranged precisely as in the genera above mentioned. There was nothing peculiar about their form that I could find. They tend to disappear upon the clitellum.

The most striking external character was exhibited by the male reproductive apparatus (fig. 23); the opening of the atria, a single pore, was upon the border line between the 17th and the 18th segment; it was marked by a slight protuberance of a hemispherical form. From this a groove, bordered by a raised margin on each side so as to form a trough, ran forward up to the 14th segment in one case, to the 15th in another; at the boundary line between Segments 15 and 16 this groove became divided into two at an angle of nearly forty-five degrees; the two grooves end in a rounded prominence; these no doubt serve the purpose of penes. The existence of these penial processes ought, perhaps, to have led me to refer the genus to my genus *Hyperiodrilus* or to *Stuhlmannia*, but in the present species the spermathecal orifices are further forward than in either of the two genera mentioned; they lie, in fact, upon the 10th segment, whereas in both *Hyperiodrilus* and *Stuhlmannia* these pores are upon the 13th segment. The oviducal pores, as in all Eudrilids with the remarkable exception of *Libyodrilus* (not an exception if we go by internal segmentation), lie upon the 14th segment.

The variability in position of the penes, though remarkable,

is precisely what we find in the two other genera in which there is a penis or are penes. I have pointed out that in *Hyperiodrilus* these processes of the body-wall may arise from either the 16th or from the 17th segment; in *Stuhlmannia variabilis*, which has received its name on account of the variability in the position of this organ, Michaelsen has depicted it as arising from either the 15th or the 17th segment.<sup>1</sup>

The prostomium is conspicuous, and extends for a little way on to the 1st segment.

The clitellum is developed all round the body, and occupies Segments 15—17. In one specimen which I examined, mounted as a flat preparation, there were no setæ upon the 17th segment, and only one pair (the ventralmost of each side) upon 15 and 16 (see fig. 24).

#### § Internal Anatomy.

In dissecting the worm the most salient character appears to be the existence of five separate gizzards lying in Segments 18—22; this character, of course, allies the worm to the genera *Hyperiodrilus* and *Heliodrillus*; the latter are the only Eudrilids in which the gizzards have this unusual location; this fact, indeed, seems to have led Michaelsen to associate the two into one genus.

In other respects the alimentary canal of this worm does not show any differences from the alimentary canal of *Heliodrillus*; there are three ventral pouches in Segments 9, 10, 11; in Segment 13 are the calciferous glands. The first recognisable septum divides Segments 4—5; this and the seven following are thicker and stronger than the other septa. The nephridia commence in the 4th segment; their external apertures are in front of the dorsal couple of setæ.

This species differs from *Heliodrillus lagosensis* and from *Hyperiodrilus* in having no integumental sense-organs, which are found in so many Eudrilidæ. This is one of the

<sup>1</sup> "Beschreibung der von Herrn Dr. Fr. Stuhlmann auf Sansibar und dem gegeneberliegenden Festlande gesammelten Terricolen," 'Jahrb. Hamb. wiss. Anst.,' Bd. ix, Taf. ii, figs. 13 and 14.

principal facts which lead me to doubt the justice of including this worm in either of those genera ; and, as will be seen presently, there are other points, in the structure of the reproductive organs, that are at variance with that view of the systematic position of the species.

There are two pairs of testes attached to the anterior wall of Segments 10 and 11. The testes of the 11th segment are enclosed within the sperm-sac of that segment ; the testes of Segment 10 are also enclosed in a sac, which also includes the dilated end of the sperm-duct. The sperm-ducts, as in so many Eudrilidæ, widen out just before opening by its funnel into the interior of the sperm-sac ; furthermore the funnel is placed a segment behind that which it ordinarily occupies ; this is so in many Eudrilidæ. The sperm-duct thus perforates the septum twice before opening into the cœlom ; the facts are now so well known that I need not enter into the matter at length. The two atria open by a common pore upon the border line between Segments 17—18 ; they have the usual tubular form, and the sperm-ducts open into them considerably in front of their external orifices.

The female reproductive organs (fig. 26) are somewhat intermediate between those of *Heliodrillus* and those of *Paradrillus* ; the ovaries, as in both genera, are each enclosed in a sac attached to the front wall of Segment 13. The stalk of this sac lodges the tube of the nephridium as it passes towards the funnel ; the sac of each side runs forward and widens out to form a dilated sac which partially involves the end of the oviduct. From this dilated sac a narrow tube communicates with a long spermathecal sac ; the spermathecal sac is divided into two regions separated by a slight constriction. At the constriction the lining of cells is much increased in thickness, and seems to obliterate the lumen ; the mass of cells project for some distance into the anterior part of the sac, which is narrower than the posterior part. There appeared to be no actual connection between the lumina of the two. The arrangement of this part of the spermathecal sac is on the principle of a lobster trap ; there is no facility for

the exit of any contents of the posterior section of the sac, but spermatozoa could seemingly pass up from the external orifice. The spermathecal sac, however, contained no spermatozoa and no ova. From the dilated sac above referred to as communicating with the spermathecal sac (called by Michaelsen "Eitrichterblase") arises a somewhat narrow tube which passes over the œsophagus and unites with its fellow of the opposite side of the body. I followed the course of these tubes with great care in a complete series of longitudinal sections, for I thought at first that they might open into the intestine, as Rosa has shown for *Paradrilus Rosæ*;<sup>1</sup> there was, however, no such connection.

This pericœsophageal sac contained a few ova. The egg-sacs (receptacula ovarum) lie in the usual position; they communicate by a short duct with the ovarian chamber; into them also opens the oviduct by a narrow aperture. The ripe ova are enclosed in a stoutish membrane, in which I did not observe any striations. The oviduct of each side opens on to the exterior upon the 14th segment. A little way in front of the external pore the oviduct gives off a short cœcum, which is enclosed in the same muscular sheath with the oviduct. I believe that this cœcum is not to be compared with a diverticulum of the ampulla of the ovarian tube figured by both Rosa and Michaelsen; for the oviduct has of course nothing to do developmentally with the series of cœlomic pouches which constitute the egg passages. I am not, however, in a position to suggest with what it is homologous.

The female reproductive organs of this Eudrilid are not exactly like those of any other species at present known; it approaches most nearly to *Hyperiodrilus* and to *Paradrilus*. It differs from the former and agrees with the latter genus in having no true spermatheca, but only a cœlomic pouch discharging those functions which in other earthworms are performed by spermathecæ. In *Metadrilus*, *Stuhlmannia*, and *Hyperiodrilus* the gut is surrounded by a

<sup>1</sup> "Die exotischen Terricolen des k. k. nat. Museums," 'Ann. nat. Hofmus.,' vi, p. 389.

ring of tubing derived from the cœlomic species connected with the egg-conducting apparatus. In *Paradrilus* the homologous pouches open into the interior of the gut.

The following may serve as a definition of the genus.

*ALVANIA*, nov. gen.

Setæ paired, ventral setæ separated by a wider interval than dorsal. Clitellum 15—17; male pore upon 17—18, connected by a groove with two penes upon 14 or 15. Spermathecal orifice upon 10. No integumental sense-organs. Alimentary tract with five gizzards beginning in 18; calciferous glands in 13; calciferous pouches in 9, 10, 11. Ovaries enclosed in separate sacs; ampullæ of egg-conducting apparatus communicating above gut, and connected with a long spermathecal sac; true spermathecæ absent. Funnels of sperm-ducts depending from anterior walls of Segments 11 and 12; sperm-ducts therefore perforating these septa twice, dilated before termination in funnels. Atria paired, but opening by a common orifice. No penial setæ.

I do not propose to attempt a definition of the species.

## EXPLANATION OF PLATES XXV &amp; XXVI,

Illustrating Mr. Frank E. Beddard's paper on "Two New Genera and some New Species of Earthworms."

FIGS. 1—6.—*Trichochæta hesperidum*.

Fig. 1. Diagrammatic longitudinal section through proboscis and anterior segments. *Neph.* First nephridium. *Or.* Its orifice.

Fig. 2. Seta. *a.* The whole seta. *b.* Tip of seta, more highly magnified.

Fig. 3. Part of sperm-sac.

Fig. 4. Anterior segments, twice the natural size.

Fig. 5. Spermatheca.

Fig. 6. A portion of sperm-sac, highly magnified.

FIGS. 7—12.—*Polytoreutus magilensis*.

Fig. 7. Portion of female reproductive apparatus. *R. o.* Receptaculum ovarum. *O. d.* Oviduct. *E. s.* Egg-sac. *a.* Tube leading to *sp.*, spermathecal sac.

Fig. 8. Reproductive organs. *v. d.* Dilated extremity of vas deferens. *Sp. s.* Sperm-sacs. *e.* Extremity of same. *b, c.* Spermathecal apparatus. *a.* Atrium. *O. d.* Oviduct. *Ca.* Calciferous gland.

Fig. 9. Spermathecal apparatus, more highly magnified. *R. o.* Receptaculum ovarum. ♀. Female pore. *B.* Bursa copulatrix. Other letters as in Fig. 8.

Fig. 10. Genital segments from below. *Od.* Oviducal pores: ♂, male pore; ♀, spermathecal pore.

Fig. 11. A spermatophore.

Fig. 12. Section through a portion of the spermatheca. *m.* Muscular walls. *ep.* Lining epithelium. *s.* Spermatophores cut in every plane.

FIGS. 13—16.—*Pygmæodrilus lacuum*.

Fig. 13. The worm, natural size after preservation.

Fig. 14. Prostomium and anterior segments, lateral view.

Fig. 15. Prostomium and anterior segments from above.

Fig. 16.—Spermatheca. *a.* lining epithelium.

FIGS. 17—22.—*Siphonogaster Millsoni*.

Fig. 17. Head end of the worm, natural size from below. *p.* Penial appendages.

Fig. 18. One of the penes more highly magnified; the three principal blood-vessels are indicated. *s.* Seta. *Sv.* Sucker.

Fig. 19. Longitudinal section through a portion of penis. *v. d.* Vas deferens, with its external orifice. *Bl.* Principal longitudinal blood-vessel. *n.* Nephridia. *Sv.* Sucker, with penial seta protruding.

Fig. 20. Seta: *a*, less highly magnified; *b*, more highly magnified, to show sculpturing at the tip.

Fig. 21. Penial setæ. *a*. Seta from below; *b, c*, in profile. *d.* Extremity, more highly magnified in profile. *e.* The same from beneath.

Fig. 22. Epidermis (*e.*) and subjacent glandular cells (*gl.*) of penis; the ducts of the latter are seen to have pushed their way between the epidermic cells.

FIGS. 23—26.—*Alvania Millsoni*.

Fig. 23. Ventral view of genital segments. ♂. Male pore. *p.* Penial processes. The clitellar segments are indicated by roman numerals.

Fig. 24. Another specimen, in which the penial processes are not developed.

Fig. 25. A portion of one of the ventral calciferous pouches. *e.* Lumen of gland-tubes. *G.* Cells of peritoneum (?) lying between them. *Bl.* Blood-capillaries.

Fig. 26. The female reproductive apparatus of one side. ♀. Oviducal pore. *O. d.* Oviduct. *c.* Cæcum of oviduct. *R. o.* Receptaculum ovarum. *b.* Sac crossing over intestine and fusing with that of opposite side. *Sft.* Spermathecal sac. *Sp. or.* Its orifice. *o. s.* Sac surrounding ovary, partially cut away to show ovary lying within it.

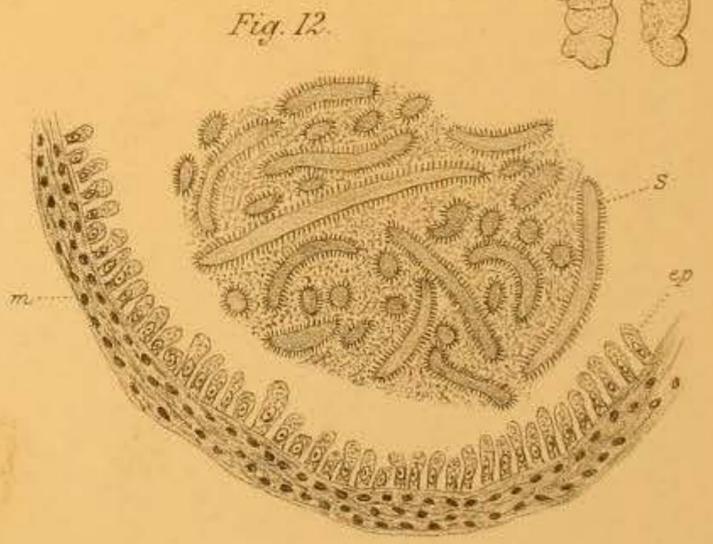
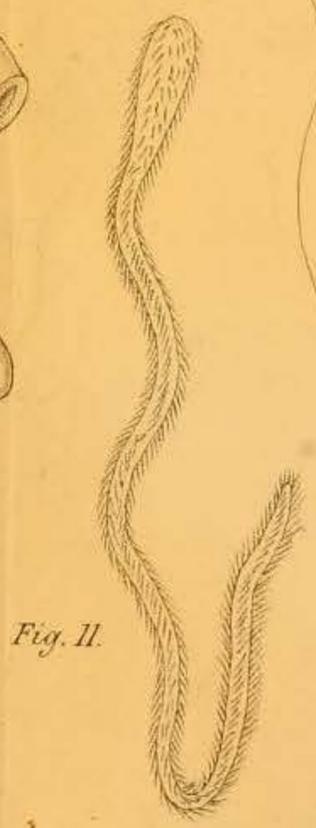
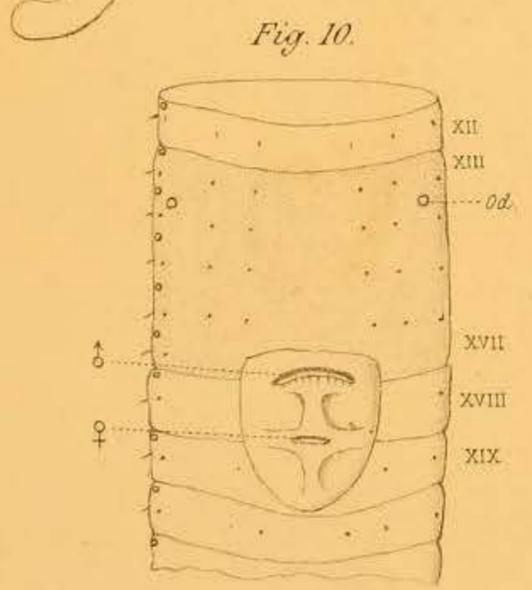
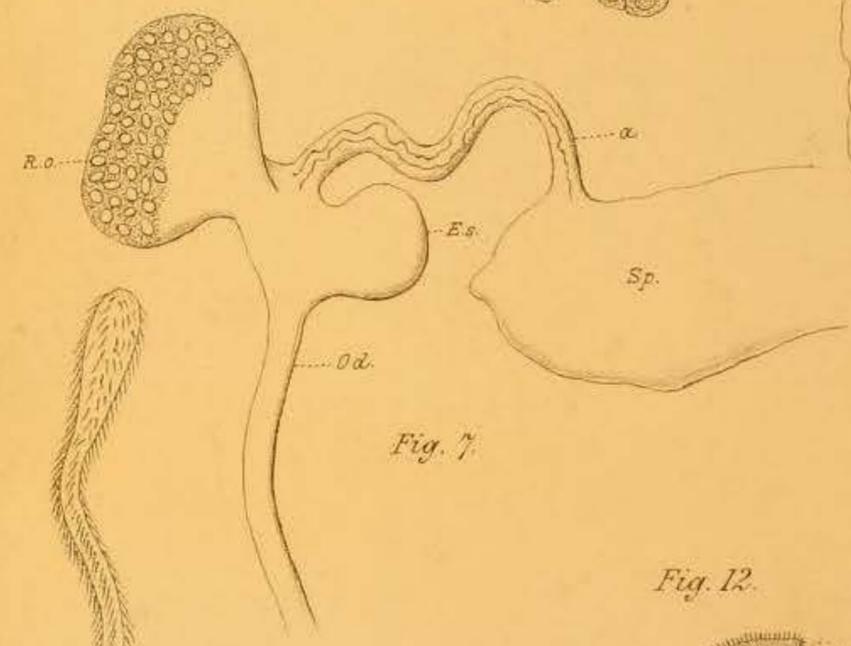
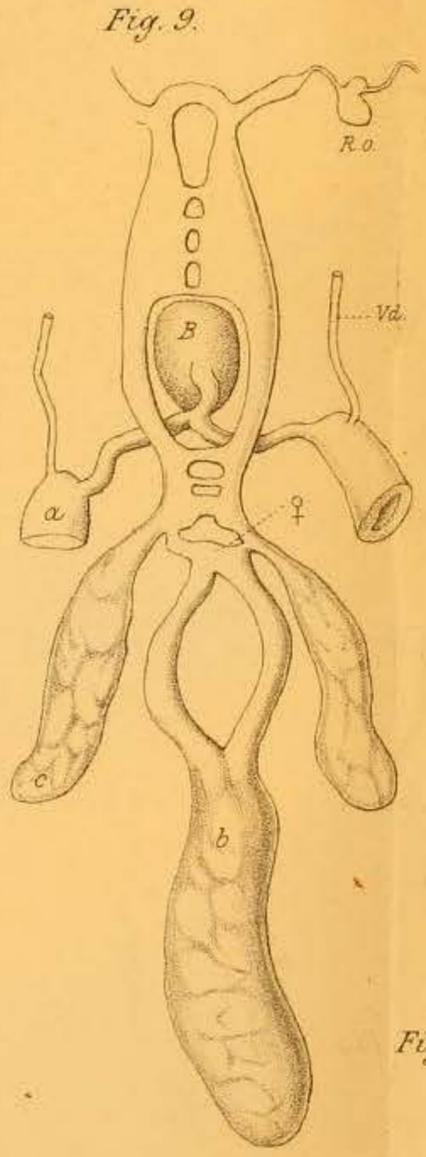
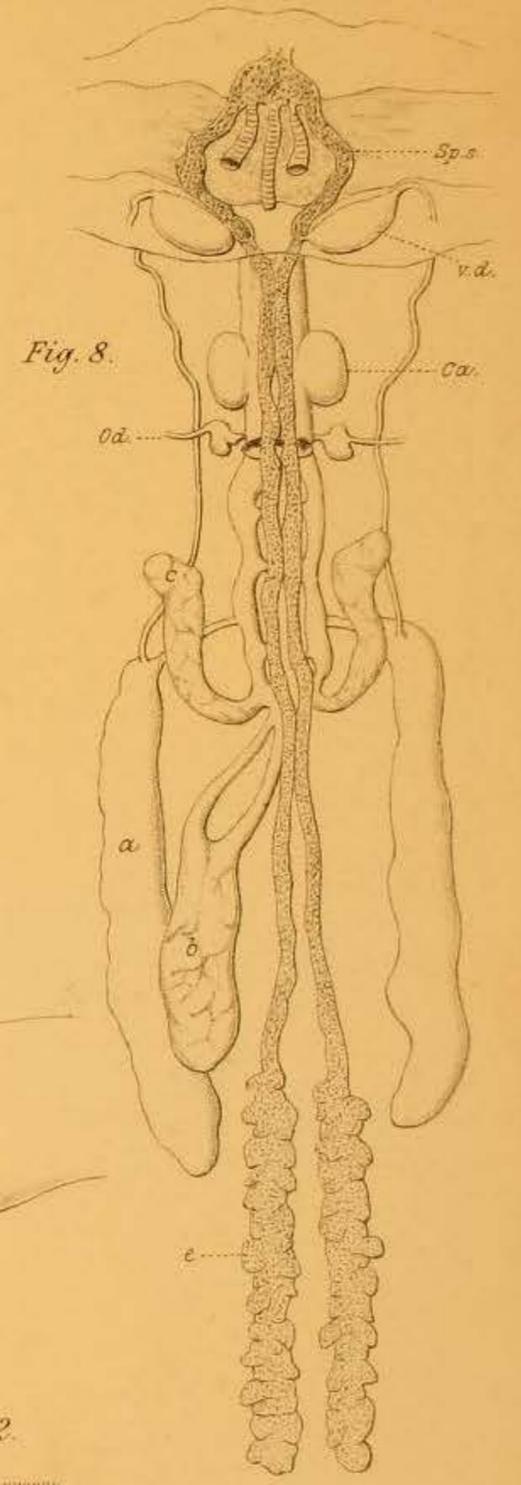
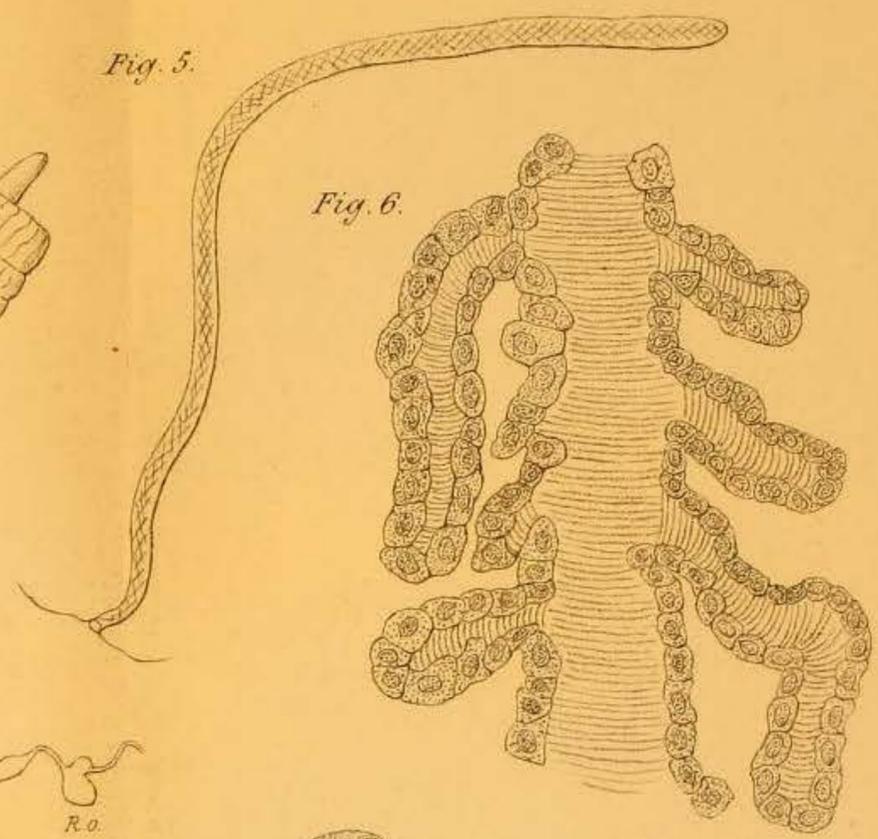
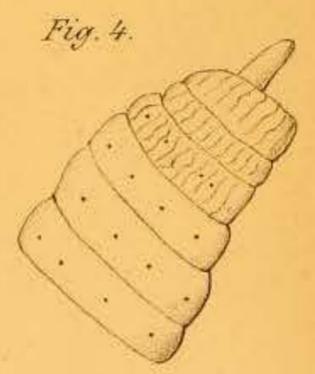
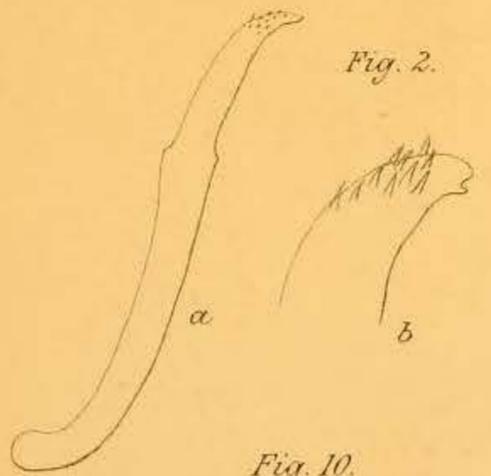
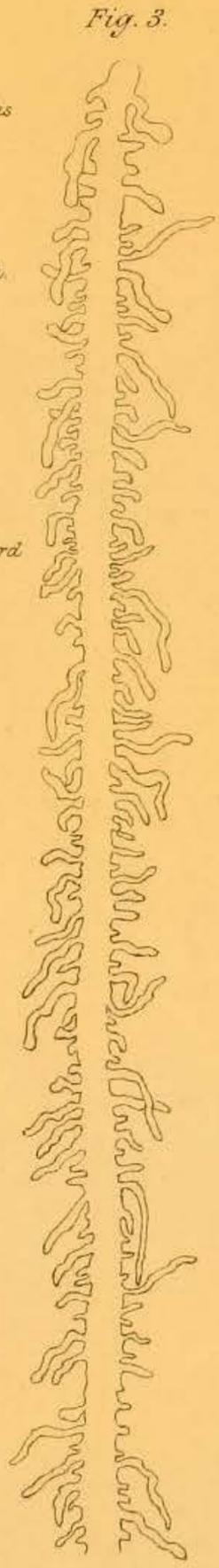
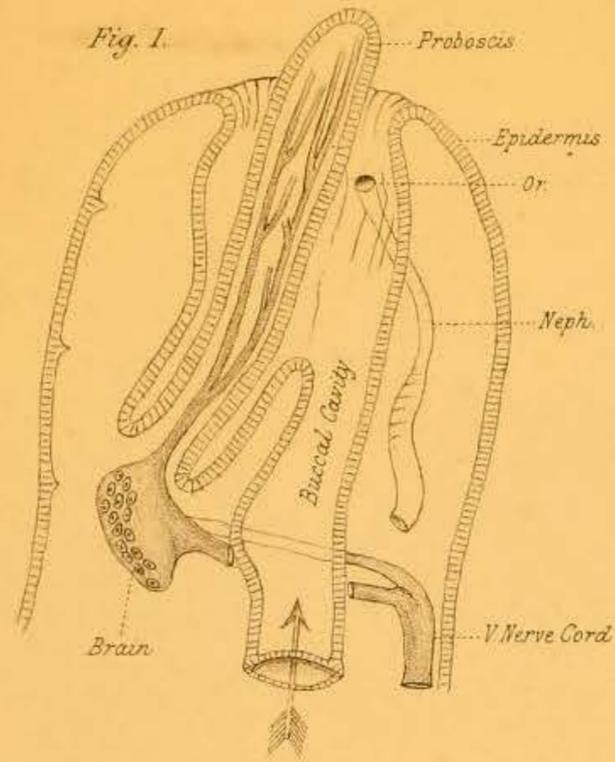


Fig. 13.

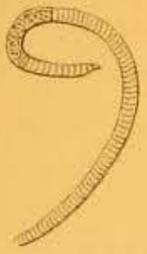


Fig. 14.

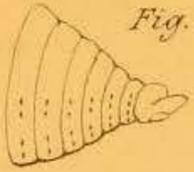


Fig. 15.



Fig. 16.

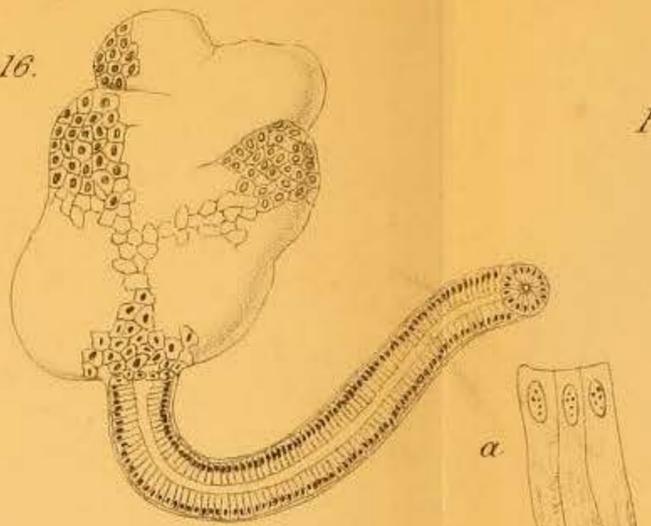


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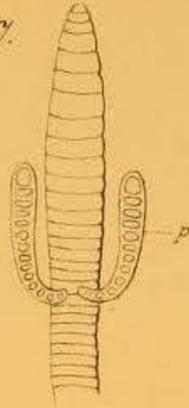


Fig. 20.



Fig. 21.

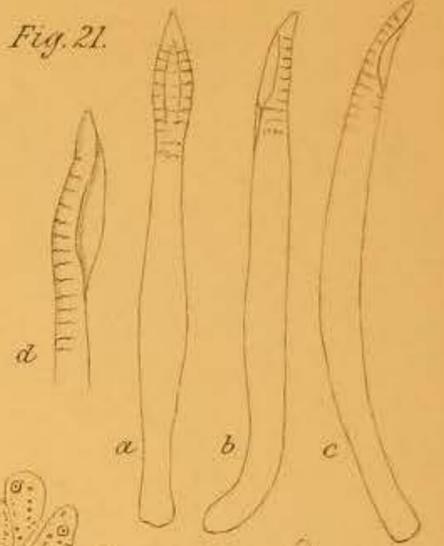


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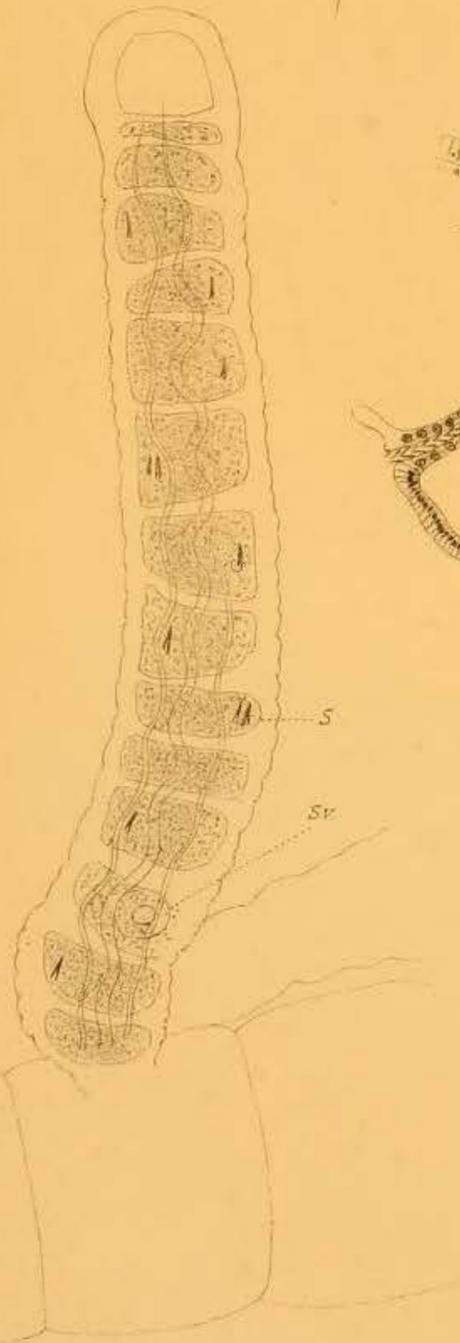


Fig. 19.

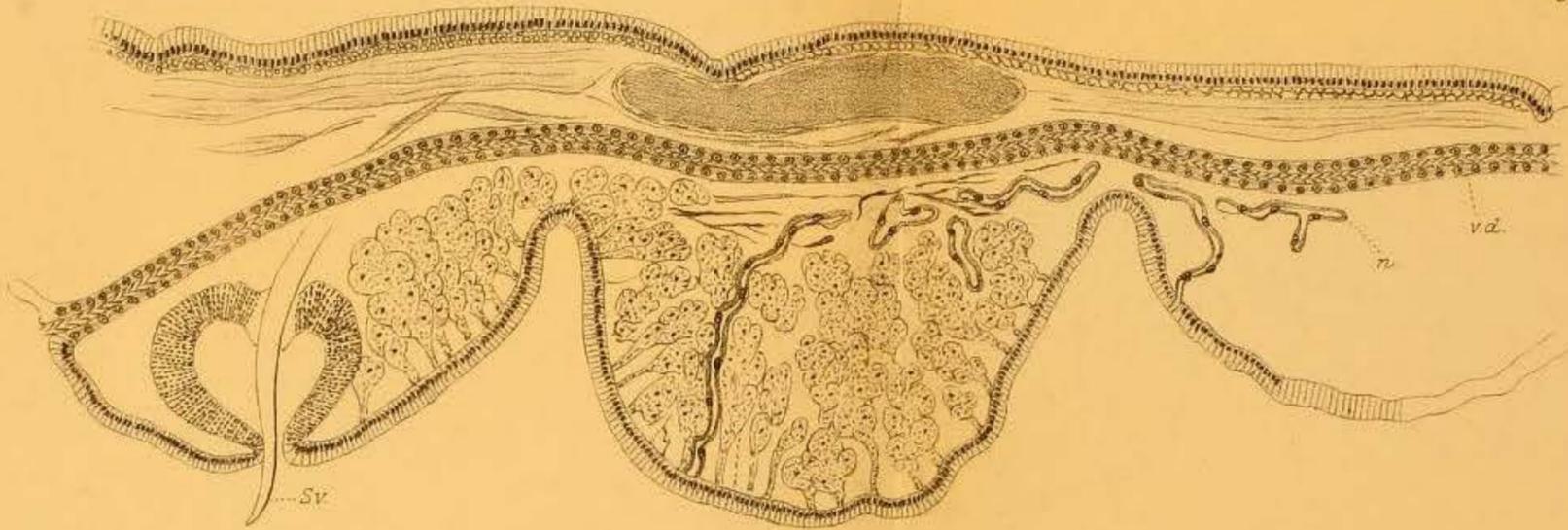


Fig. 22.

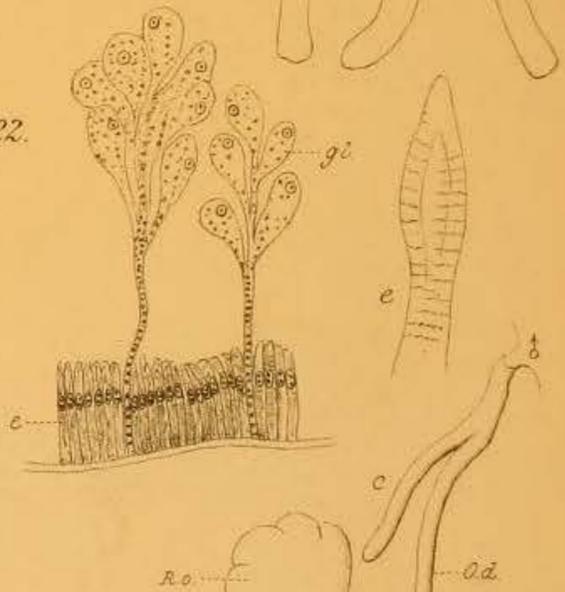


Fig. 23.

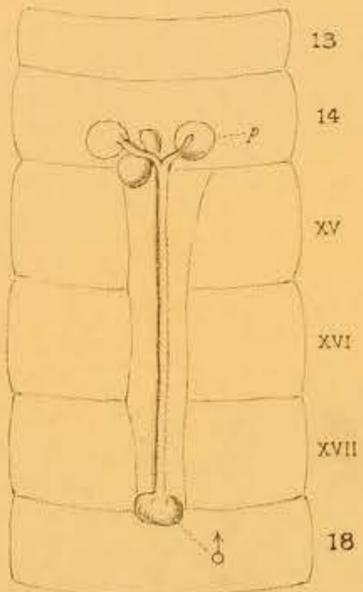


Fig. 24.



Fig. 25.

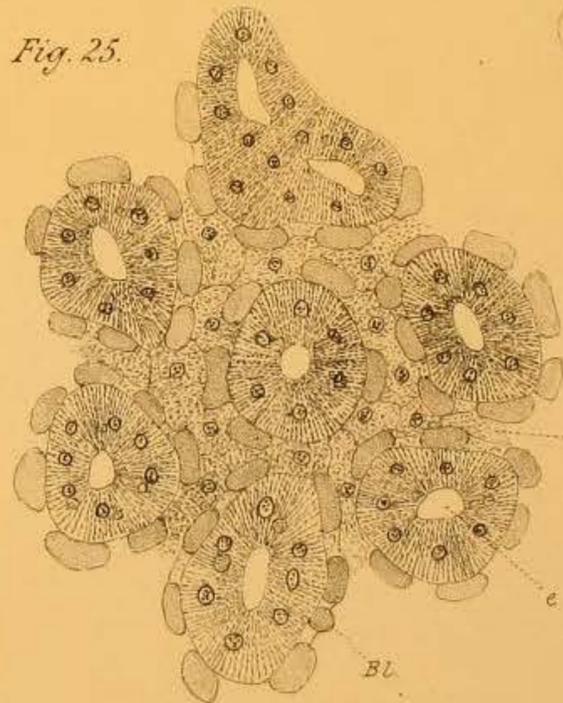


Fig. 26.

