

II.—On some littoral Oligochæta of the Clyde. By J. Stephenson, M.B., D.Sc. (Lond.); Major, I.M.S.; Professor of Biology in the Government College, Lahore. Communicated by Professor D'ARCY W. THOMPSON, C.B. (With Two Plates.)

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INTRODUCTION.

The following paper contains an account of certain of the littoral Oligochæta of the Firth of Clyde, found at and near Millport on the Island of Cumbrae, and at Wemyss Bay on the mainland. The investigation was begun during a two months' stay at Millport, from May to July, 1909, at which time I was working in the Marine Biological Station there, and it was completed after my return to India. I have to thank Mr R. ELMHIRST, the Superintendent of the Station, for his constant kindness, and for the courtesy with which he placed all the appliances and resources of the Station at my disposal.

In 1906, according to SOUTHERN (12), of the more than one hundred species of Enchytræids then known, only twelve had been recorded from Great Britain, and only seven from Ireland. The number of known species of Enchytræids, as well as of other limicolous Oligochæta, has been considerably increased since then, and, mainly owing to SOUTHERN (12, 13, 14), this portion of the fauna of the British Isles has also become better known; but, as that author remarks, "the large number of new species and of additions to the British list shows how much work remains to be done on this order before our knowledge can be considered in any way complete."

The ten species of which an account follows are, with the exception of one Tubificid (*Tubifex costatus*, Clap.), all Enchytræids. I need not say that the list is very far indeed from exhausting the littoral Oligochæte fauna of the Clyde; it contains, indeed, only those forms to which I have devoted a fair amount of attention. The several species are, I think, interesting in various ways—some (*Lumbricillus tuba*, *L. viridis*, *Enchytræus nodosus*, *E. dubius*) because they are new; others (*Tubifex costatus*, *Marionina semifusca*, *Lumbricillus subterraneus*, *Enchytræus sabulosus*) because,

though not new, they have hitherto been recorded but once or a few times, and there are still lacunæ to be filled before our knowledge can be considered complete; or lastly, as *Enchytræus albidus*, a well-known and widely distributed form, but at the same time one which appears to be very variable, and the Clyde specimens of which show peculiarities of their own.

One further point may perhaps be noted here, rather than in the body of the paper—namely, the relationship between the genera *Lumbricillus* and *Enchytræus*.

The characters serving to distinguish these genera may be said to be four. (i.) The setæ of *Lumbricillus* have a double, or f-shaped curve; those of *Enchytræus* are straight, with, however, a small hook-like curve at their proximal end. (ii.) The presence or absence of a penial bulb; EISEN (4) not only makes this a distinguishing feature between the genera, but proposes it as a chief means of dividing the Enchytræidæ into two sub-families, the Lumbricillinæ which have, and the Enchytræinæ which have not this structure (*cf.* below, under *Enchytræus nodosus* and *Lumbricillus viridis*). (iii.) The 'copulatory glands' or 'Bauchmarkdrüsen,' are supposed to be distinctive of the genus *Lumbricillus*; thus BEDDARD (1) writes: "One of the most characteristic structural features of the genus, though confined to a few species, is the outgrowths of the ventral nerve-chord in certain segments." (iv.) The multilobed testes of *Lumbricillus* are also one of its chief generic characters.

If certain of the forms here described be examined with regard to these characters, the following conditions are found: *Lumbricillus viridis*, while in the other points showing a typical Lumbricilline structure, has, in the anterior part of its body, setæ of the typical *Enchytræus* form, while the posterior setæ show only a very faint double curvature. *Enchytræus nodosus*, though its setæ are for the most part typically those of the genus in which I have placed it, shows in certain cases setæ with an indication of a double curvature, copulatory glands, and a penial bulb, *i.e.* Lumbricilline characters are present; the testes, however, are single on each side. *Enchytræus dubius* has setæ which are throughout similar to those described as typical for the genus to which I have referred it; while in the possession of lobed testes, copulatory glands, and a penial bulb (though this latter is bifid internally), it agrees with *Lumbricillus*; I may add that it has red blood, a feature commoner in the species of *Lumbricillus* than in those of *Enchytræus*. Finally, *Enchytræus albidus*, a very fairly typical species of its genus, has nevertheless an imperfect penial bulb, surrounded, it is true, by other and smaller aggregations of gland cells (*cf.* below, under *E. nodosus*).

It would therefore appear that not only are the two genera closely allied, but that a number of intermediate forms exist which serve to bridge over the interval between the two.*

* With regard to the existence of copulatory glands in the genus *Enchytræus*, SOUTHERN has recorded their occurrence in *E. lobatus*; and there is also a penial bulb in this species (14).

Tubifex costatus (Clap.).

This worm was first very briefly described by CLAPARÈDE in 1863. It was rediscovered by BENHAM in material from Sheerness in 1891, and was fully described by him (2), especially with regard to its setæ and genital organs, in a paper with many excellent illustrations.

The species was placed in a separate genus, *Heterochæta*, by its original discoverer, as well as by BENHAM; and this distinction is also assigned to it by VEJDOVSKY (16) and BEDDARD (1). MICHAELSEN, in the body of his work on the Oligochæta (11), includes it in the genus *Psammoryctes*, but in the appendix (p. 522) unites this genus with *Tubifex*, and the worm thus becomes *Tubifex costatus*.

SOUTHERN (14) records it from between tide-marks on the Irish coast, but gives no description; he refers to its mention by FRIEND, in a paper which I have not seen (*Irish Nat.*, 1897). EVANS (5) records it from the Haddingtonshire coast.

The worm is thus, apparently, described with any degree of completeness only in BENHAM's paper; a few additional particulars, and an account of one or two features in which my specimens differ from BENHAM's, may therefore be of interest.

The worms were found at Fintry Bay, about high-water mark, under moist stones, at a place where fresh water was running down on to the shore. They live for days in half salt, half fresh water. Their average *length* was greater than that of previous records, being about an inch (CLAPARÈDE 16 mm., BENHAM $\frac{2}{3}$ of an inch); specimens were met with up to an inch and a quarter. In *colour* they were of various shades of red, the anterior part of the body being paler; as also the genital segments on account of the presence of genital products. The number of *segments* was sixty-three to sixty-seven (about forty, BENHAM).

The detailed account of the setæ given by BENHAM must exhaust the subject. Briefly, the setæ are all of the ordinary double-pronged type, except those of certain dorsal bundles in the anterior part of the body, where they are 'palmate' (segments v.-xiv.). I may add that in length the ventral setæ in the anterior part of the body are about .11 mm., in the posterior about .086 mm.; the palmate setæ average .095 mm. The numbers per bundle in the Millport specimens were rather greater than those found by BENHAM; thus in the ventral bundles there were up to seven in the anterior part of the body, not more than two or three in segments x.-xv., and posterior to this four, three, two, or one only; the palmate dorsal setæ were in bundles of six to thirteen, the double-pronged dorsal setæ posterior to these in bundles of four, three, two, or one, like the corresponding ventral setæ.

BENHAM looked for a long time in vain for intermediate forms between the two types of setæ. These 'multidentate' forms are very common in the Millport specimens; some are figured in fig. 1. As to their distribution, they are found in the segments in front of and behind those containing the palmate setæ; thus the most anterior dorsal bundles (ii. and iii.) may either consist of the usual doubled-pronged setæ or of these irregular

forms. In segments xiv.–xviii. doubled-pronged and palmate setæ may be mixed ; or the bundle on one side may consist of double-pronged, on the other side of palmate setæ.

The *circulatory system*, briefly referred to by BENHAM, deserves description (Pl. I. fig. 1). The dorsal vessel is connected with the alimentary wall and covered by chloragogen cells as far forwards as the tenth segment, where it becomes free ; from the seventh to the second segment it gives off prominent lateral loops, non-contractile, tortuous, running on the inner face of the body-wall. The dorsal vessel bifurcates at the junction of prostomium and first segment ; the branches unite again below about the level of the setæ of segment iv. The ventrally situated vessel which is thus formed is outside the chloragogen cells ; it unites posteriorly with the subintestinal in the eighth segment.

The suprintestinal vessel is present on the alimentary canal, covered by chloragogen cells, from about the place where the dorsal vessel leaves the intestine to the fifth segment anteriorly. It gives origin in segment viii. to the two hearts, greatly dilated vessels, one on each side, which contract from above downwards, and, as BENHAM has

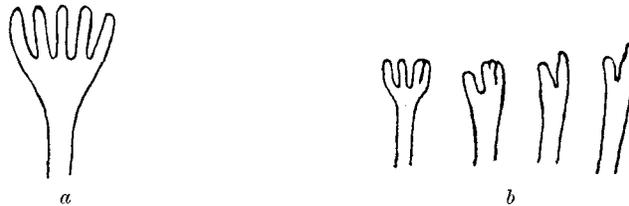


FIG. 1.—*a*, a multidentate seta from the fourth segment of a specimen of *Tubifex costatus*.
b, intermediate forms of setæ from the fourth segment of a specimen of *Tubifex costatus*.

remarked, alternately ; these hearts, approaching each other ventrally at the level of septum $\frac{8}{9}$, are prolonged almost parallel to each other, without immediately uniting, backwards through the ninth segment ; they then join to form the ventral vessel, which is continued backwards below the alimentary tube in the body cavity.

There remains to be mentioned the subintestinal vessel, a single median channel, on the intestinal wall within the investment of chloragogen cells. This can be distinguished in sections as far back as segment xiv. ; in segment xii. it is equal to the ventral vessel in size, in segment x. larger ; it soon becomes small again, and dies away on the intestine in the anterior part of the eighth segment, after receiving the posterior end of the ventrally situated vessel previously described. The relations of these several vessels are illustrated diagrammatically in Pl. I. fig. 1.

The parietal plexus is most copious in the posterior part of the body ; the loops branch and reunite on the inner surface of the body-wall, but do not penetrate the circular muscular coat ; these branches on the body-wall are of considerable size—indeed, are of the full diameter of the loop which gives origin to them before it divides up.

The shape of the *cerebral ganglion* is sometimes made use of in specific diagnoses.

It may be mentioned that it is about as long as broad, is somewhat narrower behind than in front, and is slightly indented posteriorly. It is contained in segment i.

With regard to the *genital organs*, only certain points in connection with the atrium and spermatheca need be considered. The atrium, according to BENHAM, shows a division into two parts, which he distinguishes as glandular and non-glandular, of almost equal extent, the lining cells of the first part being cubical and vacuolated, as if a secretion had been discharged, while the cells of the second part are flat. In my specimens also, two regions are to be distinguished; but the first region is very much less extensive than described by BENHAM, and extends only for a very short distance on both sides of the entrance of the prostate; the prostate enters the atrium almost immediately beyond the ending of the vas deferens (*cf.* BENHAM'S fig. 18), and the glandular cells extend about equally on both sides of this point. In character these cells are tall and filled with deeply staining granules, but not vacuolated.

The spermathecæ present an external portion, narrowing gradually towards the aperture, with a vertical position in the segment, and a long, more dilated, sausage-shaped cavity, bent into a number of curves; the whole being either confined to segment x., or extending forwards into ix., or backwards to the level of xii. This second internal and far more extensive portion is, in my specimens, lined by tall columnar cells of large size, extensively vacuolated; the vertical portion, or duct, in extent about half the vertical diameter of the segment, is lined by more solid-looking smaller columnar cells, the outlines of the individual cells being often indistinguishable.

Marionina semifusca (Clap.).

This worm was first described in 1861 by CLAPARÈDE (3), who discovered it in the Hebrides. His account deals almost entirely with the reproductive organs; beyond this it includes only a few short statements as to size, colour, nephridia, and cœlomic corpuscles. SOUTHERN (13, 14) has recently recorded the same species in both Ireland (Dublin Bay) and Scotland (Dalmeny, where the specimens were collected by EVANS), and has given (14) further particulars of its anatomy. The following account deals principally with points which have not yet received detailed attention.

The worms were found at Fintry Bay, about high-water mark, under moist stones, at a place where fresh water was running to the shore; and subsequently at Balloch, in a similar locality.

Length 16 mm. *Segments* forty-two. *Colour* light red, whiter in front of the clitellum. Both ends blunt; head-pore at the junction of prostomium and segment i.; clitellum embracing segments xii. and xiii.

The *setæ* are of the same character throughout, in both dorsal and ventral bundles. They are slightly curved in a J-shape, the distal curve, however, being much less in extent than the proximal, which is a long, gentle sweep; they are comparatively slender, and pointed at both ends (fig. 2). In number they are, in front of the clitellum,

usually six, varying from five to eight ventrally, and four, five, or six dorsally; in the post-clitellial segments the numbers are about the same, except that nine were once met with in one of the ventral, and seven in one of the dorsal bundles. Ventral setæ are absent in segment xii., in which also the dorsal setæ are few or absent.

The length of the setæ is on the average about $\cdot 1$ mm. ($\cdot 095 - \cdot 108$ mm.). There is no appreciable difference in length between ventral and lateral setæ, or between those in the anterior and those in the posterior part of the body. There is, however, a difference between the various setæ of a bundle; the setæ are disposed fan-wise in each bundle, and the outer setæ are rather longer than the inner, the length decreasing from the outer to the inner side with some regularity. In illustration,

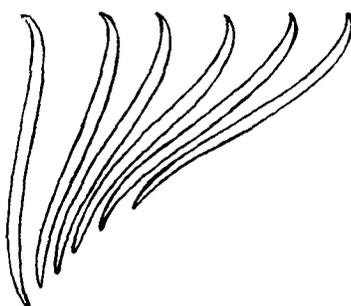


FIG. 2.—A setal bundle of *Marionina semifusca*.

the following figures may be given (*cf.* also fig. 4); the numbers represent the lengths of successive setæ from outer to inner side of the bundles:—

	{	$\cdot 099$	$\cdot 099$	$\cdot 09$	$\cdot 0855$	$\cdot 0855$	$\cdot 0855$
Ventral setæ		$\cdot 099$	$\cdot 099$	$\cdot 0967$	$\cdot 09$	$\cdot 09$	$\cdot 09$
		$\cdot 101$	$\cdot 101$	$\cdot 101$	$\cdot 101$	$\cdot 099$	$\cdot 099$
		$\cdot 101$	$\cdot 101$	$\cdot 099$	$\cdot 099$	$\cdot 0945$	
	{	$\cdot 099$	$\cdot 0945$	$\cdot 0855$	$\cdot 09$		
Dorsal setæ		$\cdot 0945$	$\cdot 0922$	$\cdot 09$	$\cdot 0922$		
		$\cdot 0967$	$\cdot 0967$	$\cdot 0922$	$\cdot 09$		
		$\cdot 101$	$\cdot 0967$	$\cdot 09$	$\cdot 0877$	$\cdot 0832$	

As regards the *alimentary canal* and its appendages, the pharynx has the usual form, and occupies segments ii.–iii.; the œsophagus is narrow, and begins to be clothed by chloragogen cells in segment iv.; the tube, though still narrow, dilates a little in segments ix.–x.; it is again very narrow in the genital segments, and finally swells and assumes the usual characters of the intestine in segment xiv. There are no peptonephridia. As remarked by SOUTHERN, the septal glands are large (Pl. I. fig. 2); they extend farther back than usual, one pair being situated always in segment vii. (*cf.* SOUTHERN), and there may be a pair in segment viii. The chloragogen cells are of a very decided brown.

The *dorsal vessel* begins in segment xiv. (xiii. SOUTHERN), and bifurcates at the junction of prostomium and first segment; the two branches into which it divides reunite ventrally in segment iv. to form the *ventral vessel*. The *lateral commissural vessels* are four on each side; the first begins above in segment ii. and ends below in the

anterior part of iv. ; the second begins above, near the junction of iii. and iv., and ends below, just behind the first ; the third is wholly contained in segment iv., the fourth in v. The last two join the ventral vessel below, the first two join the branches which unite to form the ventral vessel.

The *cœlomic corpuscles* are round or broadly oval, disc-shaped, and granular ; they are of large size, measuring in the fresh state from 22 to 36 μ ; as seen in sections, however, they are smaller, and average 20 μ , the largest measured being 25 μ . They are not obviously nucleated in the fresh condition ; the nucleus is conspicuous in stained preparations, lying in the middle of a loose reticulum. They are very numerous, and the body-cavity may be crowded with them.

The *nephridia* begin in segment v., but are absent in xii. and xiii. The ante-septal portion consists of the funnel only ; the post-septal is a large ovoid mass, coloured by a

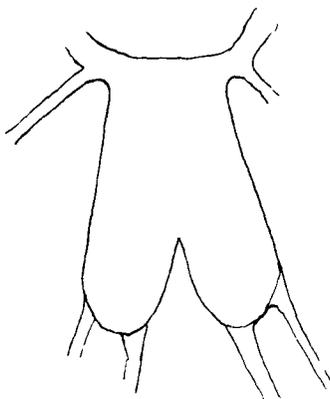


FIG. 3.—Cerebral ganglion of *Marionina semifusca*.

brown pigment in its anterior half ; the tube is loosely coiled within the mass of the organ. The external openings are in this species easily visible when a specimen is examined from the ventral surface ; they are in front of the ventral setæ. According to the evidence of sections, the duct comes off from the mass of the gland well in front of the middle, though this was not made out in the living specimens ; but both modes of examination show that it runs backwards to the external aperture, not forwards, as figured by CLAPARÈDE for his specimens.

The *cerebral ganglion* is one-and-a-half times as long as broad ; anteriorly the margin is straight, posteriorly the ganglion is deeply indented (fig. 3). The *ganglia* on the *ventral nerve-cord* are conspicuous, especially in the anterior part of the body. “*Copulatory glands*” occur in the neighbourhood of the genital segments (*cf.* SOUTHERN).

The *testes* are large, equal in length to the anterior half of segment xi. ; they are somewhat triangular in shape, attached by their narrow end, with the base of the triangle directed posteriorly. The *funnel* is short, ovoid, one-and-a-half times as long as broad, with an obvious lumen in which ciliary action is very visible ; in general structure it resembles related forms. The *sperm morulae* appear to be confined within the limits of segment xi., septum $\frac{1}{2}$ being slightly bulged backwards. The *vas deferens* is thin,

much coiled, and may extend backwards behind the clitellum. The *penial gland* in my specimens seems to differ from the descriptions of CLAPARÈDE and SOUTHERN. According to the former, "ils occupent la cavité periviscérale en entier, dans le onzième segment, produisant même souvent une dilatation du corps dans cette région"; in the diagnosis of the species they are called "énormes," and in the figure are shown as being kidney-shaped. SOUTHERN calls them 'large,' and describes and figures them as cylindrical.

I find that they are somewhat flattened ventrally where they are sessile on the body-wall, but for the rest are spherical, and my specimens seem to give no hint of either a kidney-shaped or cylindrical form. They are large, as in most related species, but not, I think, so large as to call for any special remark; and in my specimens they do not by any means fill the cœlom in their segment, nor cause a bulging of the body-wall.

The *ovaries* are smaller than the testes, and are attached as usual to the posterior face of septum $\frac{1}{2}$. The *ova*, when detached, are seen in sections free in segment xii., and are confined to this; in the living they appear at the level of segment xiii., perhaps through the bulging backwards of the septum. The *funnel* is small, and the *oviduct* short.

The *spermathecae* consist of an ampulla, duct, and gland-cells, having the appearances and relations described by CLAPARÈDE. The ampulla is continuous with the œsophagus, but I have not been able to trace a continuity of lumen between the two. The wall of the ampulla is thin, and the cells composing it are flattened. The cells of the wall of the duct are in a single layer, and are not covered externally by muscle-fibres. The gland-cells at the base of the duct are continuous on the one hand with the epithelial cells of the surface of the body, and on the other with those of the duct; the muscular layer of the body-wall is continued amongst and between them, the cells being so much elongated that they extend inwards a considerable distance beyond the level of this muscular layer.

The clitellum appears as a mixture of clear and hyaline areas. Clitellar cells are absent over the situation of the penial glands.

Sporozoa occur in the œsophagus.

As BEDDARD (1) remarks, there would seem to be a mistake in CLAPARÈDE's description of the gonads; the testis he places in segment x., and the ovary in xii. (*i.e.* xi. and xiii. according to our notation). I do not understand, also, how he comes to speak of both testis and ovary as being single; he is evidently speaking of the glands themselves, not of the aggregations of sperm morulae or ova ("les organes sont fixés par un pédoncule à la paroi du corps [or, rather, to the posterior face of the respective septa] . . . les produits, savoir les zoospermes et les œufs, tombent, une fois arrivés à maturité, dans la cavité periviscérale").

I do not consider the identification of the above form with CLAPARÈDE's species to be absolutely certain, since CLAPARÈDE's description is incomplete, and, in regard to the points mentioned by him, there are a number of differences to be taken into account,

The length is perhaps not very important, but the direction of the duct of the nephridia, and the shape and size of the penial glands may also be mentioned. It is principally the characters of the spermathecal apparatus which have determined me to identify my specimens with his description.

Lumbricillus subterraneus (Vejd.).

Under the name *Pachydrilus subterraneus*, VEJDOVSKY (15), in 1889, described an Enchytræid which he had first found in a well at Prague; some worms sent to him subsequently from Lille, where they had been discovered in the water-pipes of the town, were found to belong to the same species. The next record of the occurrence of this form is by SOUTHERN (14); a large number were sent to him from the sewage works at Belfast, and the same species was also found by him in a stream in Lancashire which was excessively contaminated with trade effluents. In the present case, the third record, the worms occurred on the seashore, about high-water mark, where they must at times be exposed to the influence of salt water.

Though there can be no doubt about the identity of the present form with that described by VEJDOVSKY, I add here a number of anatomical particulars, since in certain points the original description is somewhat brief. This is the case, for example, with regard to the setæ; the structures known as "copulatory glands," or "Bauchmarkdrüsen," were also not described by VEJDOVSKY (and may therefore have been absent); in consequence, this species is represented by BEDDARD (1) (p. 325, in the key to the various species of the genus) as not possessing them, which might possibly lead to some confusion; they were present in SOUTHERN'S specimens.

Found about high-water mark, Fintry Bay, under moist stones, at a part where fresh water was running to the shore; and again at Balloch. The animals live well for several days in a mixture of equal parts of salt and fresh water, and equally well in altogether fresh water.

Length up to 1 inch (25 mm.); fairly stout, tapering towards both ends, most gradually towards the anterior end. *Colour*, various shades of red, whiter about the genital region; ova visible as distinct pinkish-white masses. *Locomotion* by wriggling.

Segments forty-nine to fifty-seven. *Prostomium* blunt, with a number of small papilliform projections. *Clitellum* includes segments xii.-xiii., and may encroach on xi.

Setæ.—The dorsal series are dorsal, not lateral, in position; in the ante-clitellial segments they number four to eight per bundle; in segment xii. fewer, two or three; in the post-clitellial segments three to seven. The ventral series number five to eleven in the ante-clitellial, three to eight in the post-clitellial segments; there are no ventral setæ in segment xii. The setæ are of the same type in the two series of bundles; each seta (fig. 4.) is J-shaped, the proximal of the two curves being the more gradual; each is moderately stout, and is thickest about the middle of its length, but there is no distinct nodulus; the point is single. The setæ of a bundle are arranged fan-wise, and

the outer setæ of a bundle are longer than the inner, each bundle forming a graded series; thus the lengths of the setæ of a bundle of five in segment x. were, from the outer to the inner side, 106, 101, 97, 90, 81 μ ; in another bundle the lengths were 104,

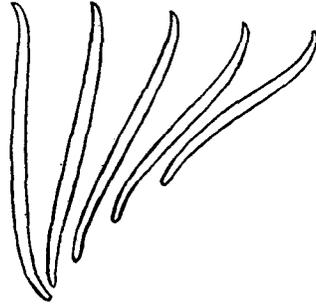


FIG. 4.—A setal bundle of *Lumbricillus subterraneus*.

100, 94, 90, 83 μ . The longest setæ are thus rather more than .1 mm. in length; in thickness they are about 5–6 μ . The ante-clitellial of both dorsal and ventral series are on the average rather longer than the post-clitellial.

The *pharynx* occupies segments ii.–iii. The *oesophagus* begins to be covered with chloragogen cells in vi.; it presents no dilatations or diverticula, and passes into the intestine about segment xvi.; this latter portion of the alimentary canal is bulged interseptally and constricted at the septa. *Septal glands* (Pl. I. fig. 3) are present in segments iv., v., and vi.; those of each side are, as usual, longitudinally connected; the glands in iv. are small, in v. are spread out on the septum ($\frac{5}{6}$), and in vi. are large, lying mainly longitudinally in the segment.

The *dorsal vessel* varies somewhat in its place of origin; this may be from the thirteenth to the seventeenth segment; it bifurcates in the prostomium. There are four *lateral commissures* on each side; the first of these arises dorsally in the posterior part of segment iii. and runs forwards into ii., or even i.; the second arises dorsally in the anterior part of iv., and runs forwards into iii.; the third belongs altogether to iv., and the fourth to v. The *ventral vessel* bifurcates anteriorly in iv.; it exists as a definite vessel as far back as the anus, being frequently separated from the intestine, so that a "window" intervenes between the two. The appearance of the 'sinus' in the alimentary wall when the posterior part of the body was much engorged, the animal dying and the blood coagulating, was that of a thick, close-set network of large vessels, with hardly any interspaces between them. The *blood* is red.

The *nephridia* begin in segment vii.; each is an ovoid mass, with a very small ante-septal portion; there is a slight brown pigmentation in the anterior part of the post-septal. The tube is loosely coiled within the mass; the duct leads forwards from its lower surface in front of its posterior end, and is much shorter than the body of the nephridium. The *cælotomic corpuscles* are irregularly pear-shaped or oval granular nucleated cells. There are also to be seen in the body-cavity a number of smaller spherical refractile bodies.

The *cerebral ganglion* is rather longer than broad, indented posteriorly but not anteriorly; two small dark dots are to be seen, one on each side, in its posterior part (*cf. Enchytræus albidus*). Ganglionic swellings are well marked in the anterior portion of the ventral cord, but some distance behind the genital segments they become scarcely noticeable, the nerve cells being distributed over the whole length of the cord. The cord encloses a "central canal."

The "*copulatory glands*" are present in segments xiii. and xiv. as conspicuous lobed masses around the ventral cord, their centre at a level just posterior to the insertion of the *setæ* (Pl. I. fig. 4). Each gland consists of a mass of large cells, spherical, pear-shaped, or polygonal, which is situated ventral to and on each side of the cord. These cells do not quite meet above the cord, but, connecting those of one side with those of the other over the dorsal surface of the cord, there appears in sections a deeply staining band. The dorsal surface of the cord is indented between the cells of the two sides in the middle line.

The glands are attached to the ventral body-wall by an almost homogeneous stalk; the circular muscular coat appears interrupted at intervals along the area of attachment (the fibres being presumably displaced), so that the stalk of the gland seems here to fuse with the epidermis. The body of a number of these cells stains very lightly, and shows an appearance something like that of an empty reticulum; the nuclei of the gland-cells stain evenly; those of the nerve ganglion cells which immediately surround the cord show, on the contrary, a number of distinct granules of chromatic material.

The *testes* form a bunch of pear-shaped masses, attached by their narrow ends to septum $\frac{10}{11}$; they shift with the movements of the worm, appearing now on one side, now on the other side of the septum. Their products get forward into segment viii., and fill segments ix. and x.

The *sperm funnels* may be as much as nine times as long as broad. They are, however, here as in other species very contractile, and may shorten (*e.g.* on teasing) to as little as twice as long as broad. Even in the body they may appear only about four times as long as broad, and vary. The *vas deferens* does not extend posteriorly beyond the clitellum; it forms a fairly small coil, equal when uncoiled to about half a dozen segments; it has a fine lumen, in which, in teased specimens, active ciliation can be seen to be going on. The *male apertures* appear as semicircular fissures, convex towards the middle line. The *penial bulb* is a spherical mass of considerable size, its diameter about a quarter of the whole diameter of the body; the *vas deferens* penetrates the bulb laterally to its centre; the bulb is attached to the body-wall by a strand of tissue which passes dorso-laterally upwards from the upper surface of the mass.

The *ovaries* are on the posterior face of septum $\frac{11}{12}$; ova are found as far forwards as segment viii., and backwards far behind the clitellum.

The *spermathecal apparatus* in the living animal consists of a somewhat spindle-shaped mass, in which ampulla and duct are not to be distinguished; a mass of

glandular cells surrounds the aperture. On examining a series of sections, the ampulla is found to comprise the internal half of the mass; it is ovoid or somewhat pear-shaped, communicating with the œsophagus by its narrow end; its walls are lined by a low cubical epithelium, and in the lumen, arranged as a layer all round, are usually numerous deeply staining heads of spermatozoa. The duct, or outer half of the mass, is not sharply delimited from the ampulla, though often, in sections, appearing to be separated from it by a kink in one or other wall; its lumen is narrow, and it is lined by high columnar cells; it has a well-marked muscular investment. The gland-cells near the external aperture are really the lining cells of the duct, which here extend outwards, breaking through the muscular investment of the duct, which can still be seen in places between the cells; their nuclei are peripherally situated, outside the muscular layer, and the cells are continuous at the orifice with the surface epithelium. The above details are shown in Pl. I. fig. 5.

Certain parasites (Gregarines) are seen in the body-cavity in several specimens. The body of these sporozoa is dark and opaque, their nucleus clear; the length of the double animal is about .5 mm.

The alimentary canal also usually contains numerous sporozoa, with a much-elongated, deeply staining nucleus; the whole width of the lumen of the alimentary tube may be packed with them. In one series of sections one of these forms is present in the spermatheca, into which it had probably wandered from the œsophagus.

The specimens of this species sent to VEJDovsky from Lille differed from those previously obtained in Prague in having gland-cells round the apertures of the spermathecæ. It will be seen that in this respect the Millport specimens agree with those from Lille; SOUTHERN's specimens also possessed these glands. It is noteworthy that the same or a similar parasite should occur both in VEJDovsky's specimens and mine; in mine, however, two individuals were commonly found joined together, which appears not to have been the case in the previous specimens.

Lumbricillus tuba, n. sp.

Common; found about high-water mark, Millport.

In *length* this species is from $\frac{1}{2}$ " to $1\frac{1}{4}$ "; it is tapering at both ends, more so anteriorly. Its *colour* is pale pink, the anterior half lighter than the posterior; ova may be seen as brilliant white spots; the whole animal is fairly transparent. The worms move when disturbed in an active, wriggling, nematoid manner.

The number of *segments* varies within only narrow limits—thirty-five to thirty-nine.

Prostomium blunt; *head-pore* present, but no dorsal pores.

The *setæ* are of the same type in both ventral and lateral series; they are somewhat J-shaped, but the distal curve is very slight; they are comparatively slender; there is no definite nodulus, but the shaft is slightly thicker a little distal to its middle. They are arranged in a fan-like manner in each bundle; the outer setæ of a bundle are not, as in *L. subterraneus*, longer than the inner.

The ventral setæ are usually four to six (occasionally seven) in a bundle—commonly six in the anterior, five in the posterior part of the body; there are no ventral setæ in segment xii. The lateral setæ are three to five in a bundle, except that in segment xii. there are only two, or one, or none.

In length the setæ are about .07–.08 mm., the ventral being on the whole a little longer than the lateral.

The *alimentary canal* has the usual relations. *Septal glands* are present in connection with septa $\frac{4}{5}$, $\frac{5}{6}$, and $\frac{6}{7}$; they are enclosed within the septa, which split to contain them, and thus suspend them to the body-wall; they are less bulky than in some other species. *Chloragogen cells* begin in segment vi.; they are very finely granular. There are no *peptonephridia*. The *œsophagus*, narrow as far as segment vii., dilates in a fusiform manner from vii. to x., and in this region it may be intersegmentally constricted like the intestine; it is narrow in the genital segments, and widens to form the intestine in xv.

The *dorsal vessel* begins in the thirteenth, fourteenth, or fifteenth segment, and bifurcates at the junction of the prostomium and first segment. The *ventral vessel* is distinct throughout the body, and bifurcates in segment iv. There are four pairs of *lateral commissures*; the first originates from the dorsal vessel in segment iii. and passes forwards into segment ii.; the last belongs to the fifth segment. The *blood* is a light yellowish red.

There are numerous *body-cavity corpuscles*, nucleated and granular, mostly of the form of circular, bean-shaped, or elongated pear-shaped discs; some appear to have the form of elongated needles.

The first *nephridium* appears to be situated usually in segment viii.; it was seen in vii. once, and once seemed to be in ix. The ante-septal portion of each is small; the margin of the funnel projects on one side as a tag, from which long cilia wave down the lumen of the tube; there are no outward cilia on the margin of the funnel. The post-septal portion is elongated, and in its anterior part is of a brownish colour (*cf. L. subterraneus*); the duct is shorter than the post-septal portion, and is directed obliquely downwards and backwards to the aperture; just within the aperture the lumen is in sections seen to be dilated to form a small ampulla.

The *cerebral ganglion* is indented posteriorly, while its anterior border is almost straight; its lateral margins diverge somewhat posteriorly. The ganglion is about one-and-a-half times as long as broad. The *ventral nerve-cord* has “*copulatory glands*” associated with it in segments xiii., xiv., xv., and xvi.; these closely embrace the cord laterally, but do not cover it on its dorsal surface.

The *testes* are pear-shaped masses, in two groups, one on each side; they are attached to septum $\frac{10}{11}$ near the body-wall, laterally in the segment; the lobes themselves may be either in segments x. or xi., according as the movements of the animal force them one way or the other; the septum must therefore have considerable deficiencies. Spermatozoa usually occupy segments x. and xi., and may get forward into ix.

The *funnels* are barrel-shaped, and comparatively short—from one-and-a-half to two-and-a-half times as long as broad; they have an everted lip. The *vasa deferentia* are contained in segment xii., and do not extend beyond this; they are long, very narrow, and closely coiled tubes; their length was roughly estimated at about fourteen times that of the funnel. The *male aperture* has associated with it a large spherical penial gland; the apertures lie in an area where the surface epithelium is low and cubical, and sharply marked off from the high clitellar epithelium around (Pl. I. fig. 6); each aperture is at the anterior part of the glandular mass, and is lined by a continuation of the surface epithelium, with characters unchanged; the short tubular passage thus constituted passes obliquely backwards for a short distance from the surface, and after receiving the termination of the vas deferens on its upper wall, ends behind by dividing into about three short branches

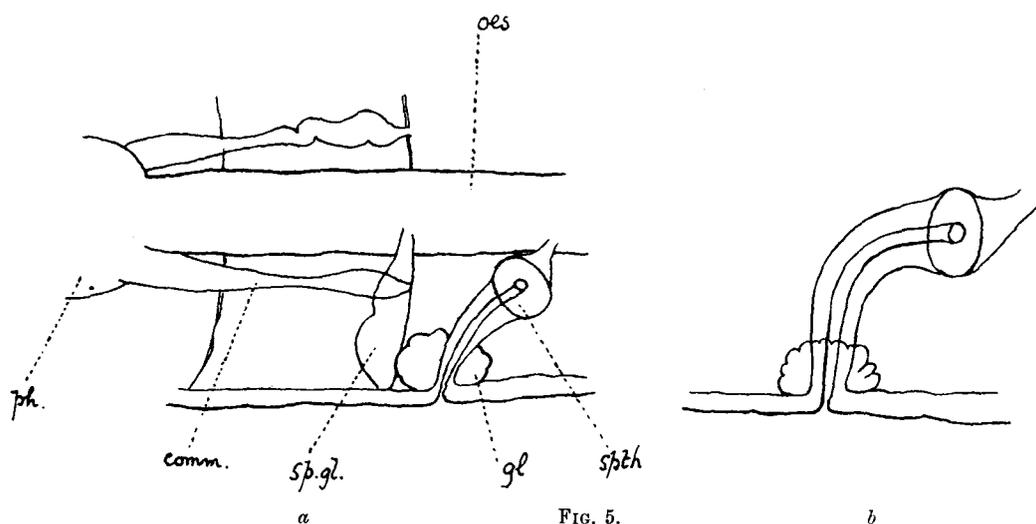


FIG. 5.
a, anterior part of alimentary canal of *Lumbricillus tuba*, with appendages, illustrating appearance of spermatheca in the living animal. *b*, another representation of the appearance of the spermatheca in the same species.
Comm., communicating strand between septal glands and pharynx; *gl.*, gland-cells round aperture of spermatheca; *oes.*, oesophagus; *ph.*, pharynx; *sph.*, spermatheca; *sp.gl.*, septal gland.

(Pl. I. fig. 6). The *penial gland* is penetrated by the terminal part of the vas deferens, which enters the mass above, rather towards its lateral surface; the gland has a muscular capsule, and is composed of elongated cells, which are individually very distinct—much more so, for example, than in my specimens of *L. subterraneus*; these cells are arranged so that they radiate around the vas deferens in its course through the mass, and around the branching invagination of the external surface of the body (see description of male aperture above).

The *spermathecæ*, with their ducts, present a very characteristic appearance in the living animal, and may be designated as 'trumpet-shaped' (figs. 5*a*, 5*b*). The ampulla is small, subspherical, thin-walled in its equatorial region, but with much thicker walls over its dome, *i.e.* around the situation of its communication with the oesophagus (Pl. I. fig. 7); the difference being due to the different height of its epithelial lining. The duct is thick-walled, much longer than the ampulla, produced from the

ampulla without definite external demarcation between the two, and, as a rule, narrowing gradually towards the external aperture, so as to form an elongated and inverted cone. The lumen of the duct is narrow throughout; the cells of which the inner layer of its wall is composed are covered by a conspicuous layer of muscular fibres, arranged longitudinally; a cord of some hyaline matter (? coagulum) almost fills the lumen of the duct, in which may also lie a few spermatozoa. The duct is slightly invaginated into the cavity of the ampulla, though this is not evidenced externally; there is consequently a circular trough around the ampullary opening of the duct, and in this trough the spermatozoa frequently lie coiled (Pl. I. fig. 7). Surrounding the outer end of the duct is a fairly large lobulated gland, the cells of which are continuous with, and a modification of, the external epithelium round the aperture. Their inner ends are prolonged for a considerable distance within the muscular coat, as in other forms (Pl. I. fig. 8) (*cf.* *L. subterraneus*, *Enchytræus albidus*, *L. viridis*). The whole of the gland-cells are behind the level of septum $\frac{4}{5}$, and the aperture is thus not in the intersegmental furrow, but posterior to this, on the anterior part of segment v.

The characteristic trumpet or funnel-shape previously referred to is due to the gradual increase in the external diameter of the duct as it is followed inwards (the lumen is narrow and of the same diameter throughout); the margin of the funnel (fig. 5a) is the optical expression of the junction of the thick-walled duct with the thin-walled ampulla; a small inner circle is the opening of the duct into the cavity of the ampulla.

The *clitellum* extends over segments xii. and xiii.

The intestine, in its anterior part at least, may be full of sporozoan *parasites*.

I was for some time undetermined as to whether I should unite this form with *Lumbricillus (Pachydrilus) litoreus*, HESSE (9). Though the descriptions agree in a number of points, they vary slightly in certain others, and considerably in the following: (i.) The length of the present form may be nearly twice that given for *L. litoreus*; (ii.) the number of setæ in the ventral bundles is four to six or seven in the present form, six to ten in *L. litoreus*; (iii.) the cœlomic corpuscles are more various in form, and contain a nucleus which is obvious in the fresh condition in the present species; (iv.) the copulatory glands occur in segments xiii.–xvi., *i.e.* extend one segment farther back than in *L. litoreus*.

The chief distinction, however, is in (v.) the spermathecæ and their ducts; in *L. litoreus* the ampulla, according to the original description and its accompanying figure, is of comparatively large size, elongated in shape, with walls of the same thickness throughout, gradually merging into the duct, which latter is much shorter than the ampulla, and has two separate glandular masses at its aperture. In the present form the ampulla is small, subspherical, with extremely thin walls in its equatorial portion, thicker near its junction with the œsophagus; there is, internally, a very sharp demarcation between ampulla and duct, the latter being much longer than the ampulla, and being surrounded by a complete circle of large gland-cells at its aperture. The very

characteristic appearance of the spermathecæ in the fresh specimen, by which this form is easily identified, has been alluded to.

Since the form and relations of the spermathecæ and their ducts are among the most valuable characters for the discrimination of species in this group, it would seem advisable to separate this form under a special name; the designation *tuba* is meant to refer to the trumpet-like appearance noted above.

Lumbricillus viridis, n. sp.

Found at Wemyss Bay, under stones below high-water mark, where fresh water was running to the shore.

Length 1 inch; the worm is stout, with a tapering anterior end. All but the anterior part of the body is of a green colour, due to the alimentary canal. They are active animals, and exhibit nematode-like contortions. *Segments* forty-five to forty-nine.

The *prostomium* is bluntly conical. Numbers of hyaline cells are found in the superficial epithelium, arranged in fairly regular transverse rows over the whole extent of the body, most regular in its posterior part.

The *setæ* are in the usual four rows, two ventral and two lateral. They are straight, or almost straight, with a slight and usually gentle curve at their proximal end. Their points, especially on the anterior part of the body, are often blunt; indeed the ends may be almost square, with rounded corners; posteriorly sharper points are common. They are arranged fan-wise in the bundles; all the *setæ* of a bundle are not of the same length, but while in the ventral bundles the inner (ventral) are shortest, in the lateral bundles the shorter *setæ* are those on the dorsal side of the bundle. Thus in a bundle of seven ventral *setæ*, in the anterior part of the body, the lengths of the individual *setæ*, from the outer to the inner, were .105, .105, .105, .09, .085, .078, .066 mm.; in another bundle, similarly, .112, .112, .105, .10, .095; in a lateral bundle situated more posteriorly, the lengths of the *setæ*, beginning with the ventralmost seta of the bundle, were .090, .08, .075.

The average length of the *setæ* is therefore about one-tenth of a millimetre, longer ones occurring in the anterior part of the body; their thickness is about .005 to .0045 mm. The number of *setæ* per bundle is five, six, or seven in the ventral series in front of the clitellum, three or four posterior to this; there are no ventral *setæ* on segment xii. The lateral *setæ* are four or five, exceptionally three, in a bundle in front of the clitellum, two or three behind this.

Notwithstanding the fact that the *setæ* have been described above as straight or almost straight, I believe that the majority of them are to be considered as slightly, though very slightly, J-shaped. It is perhaps allowable to dwell for a moment on this point, since the genus *Lumbricillus*, in which the present form must, I think, be included, has J-shaped *setæ*, and straight *setæ* would be a curious anomaly.

Fig. 6, *a*, representing a bundle of seven *setæ* from an anterior segment, and drawn

with the camera lucida, shows that the setæ have in this particular instance blunt, in some cases almost square, ends, and are without trace of a distal curvature; their proximal ends, however (with the exception of the innermost seta but one), show a gentle and gradual curvature, not the somewhat sharp curve seen in the genus *Enchytræus*. The figure was drawn from a specimen in glycerin, and since the setal bundles are not perfectly flattened, their two ends are at different levels and there is, perhaps, some optical distortion. This, however, will not apply to the single seta drawn in fig. 6, *b*: this was found in a section mounted in the usual way in balsam; it belongs to segment iv., and was drawn with the camera under an oil immersion lens. It will be seen that its distal portion is perfectly straight, and that it has a hooked inner end, the shape being that

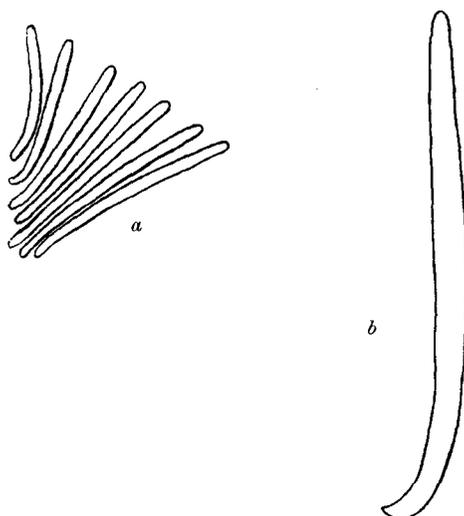


FIG. 6.—*a*, group of setæ from an anterior segment of *Lumbricillus viridis*.
b, straight seta from segment iv. of a specimen of *Lumbricillus viridis*.

characteristic of the genus *Enchytræus*. Such "straight" setæ therefore do occur in the anterior part of the body, in the present form.

Fig. 7, *a*, shows two setæ of a posterior bundle, drawn with a camera under an oil-immersion lens; the ends of the setæ are obliquely pointed as in *Lumbricillus*, not with the straight points seen in the genus *Enchytræus*.

I tried the effect of potash on the worms; but they are so stout and firm that a strong solution of KOH has to act on them for hours before they collapse and flatten so as to present the setal bundles in one plane; the setæ then appear swollen and have evidently lost their true shape. Nevertheless, a double curvature of the *Lumbricillus* type, though not to be recognised in most of the anterior setæ, is then often fairly obvious in the setæ of the posterior bundles. Thus fig. 7, *b*, shows two setæ of a posterior bundle in which this curvature is quite obvious; and fig. 7, *c*, shows a fairly distinct double curve in a seta as far forward as segment viii.

As supporting the view of the affinity of the setæ with the *Lumbricillus* rather than with the *Enchytræus* type, the fact of the difference in length of the setæ of a

bundle may be mentioned. In the genus *Enchytræus* the setæ of a bundle are, as is well known, of equal length.

Summing up, it may be stated, that while setæ of the typical *Enchytræus* type occur in the anterior part of the body, those of the posterior segments usually, and even some of those in the anterior segments occasionally, show a faint double curvature of the type found in the genus *Lumbricillus*.

The *cælotomic corpuscles* are grey by transmitted light, flat, oval, or pear-shaped, and granular, with a distinct, clear nucleus. As seen in sections they are mostly $\cdot 025$ to $\cdot 032$ mm. in their long diameter.

The *septa* are thick and muscular, in accordance with the general build of the

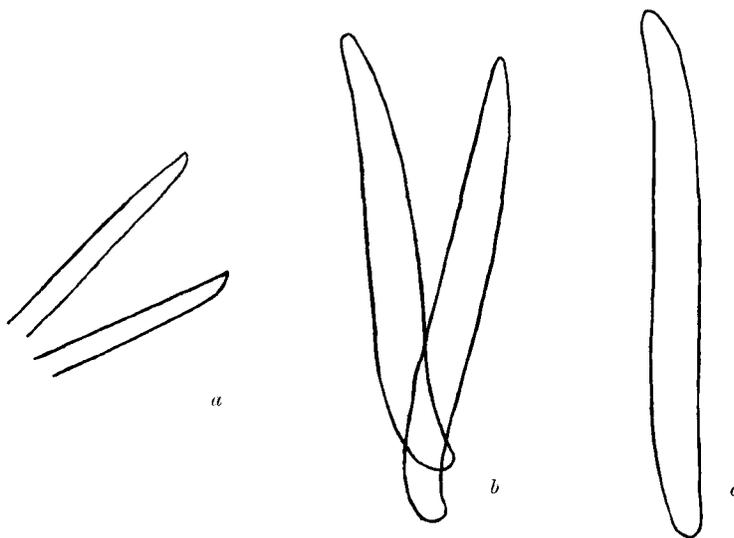


FIG. 7.—*a*, distal ends, obliquely truncated, of two setæ of a posterior bundle of a specimen of the same. *b*, two setæ of a posterior segment of a specimen of the same, showing double curvature; the more strongly curved ends are the proximal. The setæ are swollen owing to the action of strong caustic potash solution. *c*, seta from segment viii. of a specimen of the same, showing slight double curvature; swollen by the action of caustic potash.

animal. It may be added that the retractor muscles of the pharynx are also very bulky, and that the muscular coat of the œsophagus is very well marked.

The *alimentary canal* begins to be covered with chloragogen cells in segment iv.; these cells become more numerous behind the septal glands, after which point the canal has a dark green colour. The œsophagus widens a little in segment vii., but there is no marked dilatation at any part of the tube. There are no peptonephridia. Septal glands occur in segments iv., v., and vi.; the last two pairs are bulky, especially those of segment vi., which bulge backwards beyond the setæ of segment vii.

The *dorsal vessel* begins in segment xiii., and the *blood* is red.

The *nephridia* are solid masses, with a very small anteseptal portion. The organs are elongated, ovoid, narrow and compressed laterally, the duct leading downwards from near the posterior end.

The *cerebral ganglion* is comparatively small for the size of the worm, squarish in

shape, about as long as broad, and indented posteriorly. The *ventral nerve-cord* is characterised by the possession, through the whole of the anterior part of the body, of aggregations of cells in each segment which embrace the cord ventrally and laterally. These cells, though nowhere forming very prominent masses, correspond in appearance with those which constitute the "Bauchmarkdrüsen" or copulatory glands of other forms. They are mostly, in sections, pear-shaped or spindle-shaped, with very feebly staining, slightly granular protoplasm and deeply staining nucleus; they are of considerable size, and while they leave the dorsal side of the cord uncovered, frequently appear flattened over its sides and ventral surface, so as to give the appearance here of concentric layers. At the site of their occurrence the cord appears stalked in transverse section, being connected with the surface epithelium by prolongations of the cells.

The *testes* are composed of six, seven, or more elongated club-shaped or pear-shaped masses on each side, springing from the ventral part of septem $\frac{1}{11}$. Sperm morulæ collect in segments x. and xi. The *funnel* is long, nine or ten times as long as broad; the length, however, varies, and may appear to be only about seven times the breadth; the funnels are bent on themselves; the nuclei of the cells of which they are composed are, as usual, peripherally situated. The *vas deferens* is considerably coiled; it does not, however, extend backwards behind the clitellum; in diameter it measures .02 mm. There is a *penial bulb* of considerable size, its diameter being more than a quarter, nearly a third, of the diameter of the animal's body; the bulb has a well-developed muscular covering; the cells of which it is mainly composed are much elongated, radially arranged, the nuclei being crowded together peripherally; the lumen is almost central.

Ova are found in segments xii. and xiii.

The *spermatheca* are characterised by a spindle-shaped ampulla which communicates with the œsophagus; its external end is continued into the duct without evident demarcation. The duct is somewhat longer than the ampulla, and of about half the diameter of the latter; it is surrounded by prominent gland-cells round its external aperture. The epithelium of the ampulla is columnar, but of very irregular height; the nuclei of the cells are much elongated. In the duct, the epithelium is lower, and the nuclei are spherical; the muscular coat of the duct is situated between and amongst the cells, the nuclei of the latter being all external to the muscular layer; in the ampulla the muscular coat is, however, quite external to the epithelium. Both ampulla and duct are lined by a thick cuticular coat, continuous at the orifice with the very thin cuticle of the body-surface. The prominent collection of gland-cells round the duct near its external aperture consists of the epithelium of the duct, here much elongated and extending outwards far beyond the muscular layer of the duct.

The *clitellum* is only peculiar in that it dies away gradually in front, without any definite line of demarcation.

Sporozoa are present in the alimentary canal.

This species has a very distinctive appearance, and can be immediately recognised by its stout form, active, wriggling, nematode-like movements, and especially by its green colour.

The position of this species with regard to the setæ has been discussed above, where it was shown that it holds, in this respect, an intermediate position. The lobed testes and the large compact penial bulb, however, determine the decision to place it in the genus *Lumbricillus*. The importance of this last feature, the penial bulb, in classification, has lately been insisted on by EISEN (4), who distinguishes two sub-families, *Lumbricillinæ* and *Enchytræinæ*, according to whether the penial glandular structures are or are not confined within a single bulb; in the *Lumbricillinæ* are included *Lumbricillus*, *Marionina*, *Buchholzia*, *Stercutus*, *Bryodrilus*, *Henlea*; in the *Enchytræinæ*, *Enchytræus*, and *Michaelsena*.

The 'Bauchmarkdrüsen' are also a feature of the genus *Lumbricillus*. In the present species they are widely distributed, occurring throughout the whole of the anterior part of the body, but are small in size, and are only recognisable as such from the character of their cells as seen in sections. This comparatively undifferentiated condition may be contrasted with that which occurs in *Lumbricillus subterraneus*, where the glands, though few in number, are individually large and prominent.

In a number of species in which the aperture of the spermathecal duct is surrounded by gland-cells, the muscular layer of the body-wall is continued between these cells, in the manner described and figured for *Lumbricillus tuba* (*v. ant.*; also *cf. Enchytræus albidus, post.*); when, following the duct inwards, these gland-cells give place to the ordinary epithelium of the duct, we find, however, that the muscular layer is usually to be found outside the duct epithelium. In this species, however, the muscular layer is still to be found amongst and between the duct epithelium, having the same relations here as near the aperture.

Enchytræus nodosus, n. sp.

Found at Wemyss Bay, near high-water mark, where fresh water ran to the shore.

Length $\frac{1}{3}$ inch (8 mm.); small and thin, not tapering at either end. In *colour* the animals are intensely white over part, especially the posterior part, of their extent, but clear and transparent for the rest; there may be only irregularly distributed white spots, or, as commonly, the posterior half of the body has intensely (opaque) white margins; this opaque white coloration is due to aggregations of cœlomic corpuscles. Under the microscope the animal is, except for these aggregations, extremely transparent; and the *clitellum*, which extends over segments xii. and half of xiii. (to the level of the setæ of the latter), is hardly less transparent than the rest of the body. *Segments* thirty-two to thirty-nine.

The *setæ* are of the straight type, with proximal hook (fig. 8, *a*); the sharpness of this hook varies, and in certain cases there is a faint indication of a double (J-shaped) curvature (fig. 8, *b*). *Setæ* are absent (both ventral and lateral) in segment xii.; elsewhere

they are regularly two per bundle in both series throughout the body ; three were noted once only, one occasionally.

There are no *peptonenphridia*. *Septal glands* occur in the usual segments, those of iv. and v. being single, bulky, and situated dorsally over the œsophagus ; in segment vi. there is a pair, elongated and extending a considerable distance backwards (Pl. I. fig. 9). The *œsophagus*, narrow in the region of the septal glands, is wider in segments vii.-ix. ; it narrows again in the genital region, and widens to become the intestine in segment xiv. The *intestine* is not constricted at the septa. The *chloragogen cells* are noteworthy ; they are large, with large refractile oil globules ; in sections they appear colourless, without brown or yellow granular pigment, and very markedly vacuolated, as if their contents had been dissolved out ; there are several or many large vacuoles in each cell. They are present here and there in segments v. and vi., though they can hardly be said to begin before vii. ; they are numerous and distinct in viii.-x., though

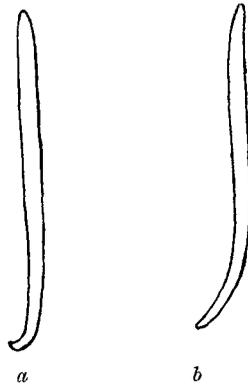


FIG. 8.—*a*, seta of *Enchytræus nodosus*.
b, a seta of *Enchytræus nodosus* showing a slight double curvature.

not completely covering the œsophagus, and in particular they leave the tract of the dorsal vessel uncovered ; they are absent in the genital region, and begin again, thenceforward forming a complete investment of the intestine, in segment xiv.

The *dorsal vessel* begins at the level of the setæ of segment xiii., and bifurcates at the junction of the prostomium and first segment. The *blood* is colourless.

The *cœlomic corpuscles* are flat, circular, and, as measured in sections, are from '014 or less up to '019 mm. in diameter. They are opaque by transmitted light, with a clearer nucleus ; the opacity is due to numerous refractile oil-like corpuscles crowded together so as to fill up the whole body of the cell.

The *nephridia* (fig. 9) begin in segment viii. The ante-septal portion is of considerable size, somewhat ovoid in shape, about one-third as long as the post-septal ; the open mouth of the tube is clothed with fine cilia, and its margin projects on one side as a short, overhanging process ; cilia beat in the tube in a downward direction, and the tube undergoes many windings before it reaches the level of the septum. A narrower neck connects the ante-septal with the post-septal portion ; the latter is elongated, narrow

from side to side, with many and irregular windings of the lumen. The duct is stout, and leads downwards from the posterior end of the body of the organ; in length it is about one-third of the post-septal.

The *cerebral ganglion* is elongated, reaching as far as the level of the setæ of segment ii. Its lateral margins diverge posteriorly, where it is indented at a blunt angle, as shown in Pl. I. fig. 9. The *ventral nerve-cord* shows small "copulatory glands" (Bauchmarkdrüsen) in segments xiv. and xv.; the cells of the glands embrace the cord laterally and ventrally, but not dorsally; owing to the connection of these cells with the surface epithelium, the cord appears stalked in transverse sections at these situations; there is externally a small transverse ridge opposite each gland.

The *testes* are one on each side, in the usual position. The *seminal funnels* are four times as long as broad, of the usual cylindrical form, but a little narrower towards their attachment to the septum; the lumen is obvious in the living condition, and in sections is seen to be not central but nearer the inner side; the margin of the internal aperture, where the spermatozoa enter the tube, is everted, so as to form a small true

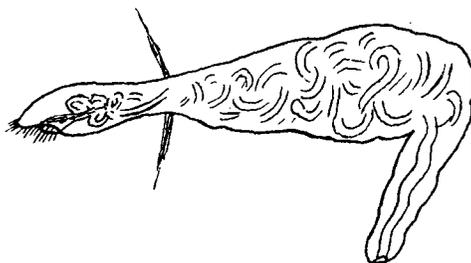


FIG. 9.—Nephridium of the same.

funnel, of a single layer of low columnar cells, perched on the cylindrical structure that usually goes by the name of 'funnel.' The *vas deferens* is thin, .0075 mm. in diameter; it is but little coiled, reaches back to the level of segment xiii., and penetrates the penial gland nearer the outer than the inner side of the latter. The *male aperture*, in segment xii., consists of an invagination of the surface epithelium in a direction obliquely upwards and outwards (Pl. II. fig. 10); this invagination, narrow from side to side, receives the end of the *vas deferens*, not at its upper extremity, but on its inner wall; the invagination and its immediate neighbourhood are covered by a distinct and fairly thick cuticle. The *penial gland* (Pl. II. fig. 10) is a single ovoid mass on each side, consisting of much-elongated cells with nuclei near their internal ends; their external ends form the inner wall of the invagination previously referred to; the gland has a distinct though feeble muscular covering, and muscular strands pass obliquely upwards from its surface towards the lateral body-wall; other strands, passing over it obliquely from the ventral to the lateral body-wall, appear, so to speak, to bind it down.

The *spermathecæ* consist of ampulla and duct, both of which present, especially in sections, a peculiar appearance, from the fact that the cells of which they are composed are irregular in size, shape, and disposition, and thus are very far from forming a regular

epithelial lining (Pl. II. fig. 11). The ampulla communicates as usual with the œsophagus; in the living specimen it appears somewhat irregularly spherical, with projecting bosses. In sections the cavity is irregular in shape, possessing a few small saccular diverticula; the cells composing the wall are comparatively few, large in size, irregular in shape and arrangement, and do not form a regular epithelial layer. The spermatozoa penetrate between the cells, and the appearances in sections seem to show that they burrow into the cells themselves; they also seem to penetrate the wall, and are found lying on the outer surface (Pl. II. fig. 11). The ampulla possesses no muscular covering. The duct leads obliquely forwards to the exterior; it is a little longer than the ampulla, and, like the latter, appears in the living condition to be studded with small rounded projections, smaller, however, than those of the ampulla; round the external aperture these projecting cells are again larger, and form a distinct rosette of glands. The statements as to irregularity of shape and disposition of the cells, and absence of a definite epithelium, already made for the ampulla, hold also for the duct; so that, except near the external aperture, it is difficult to follow the lumen in sections. The cuticle of the surface is invaginated for some little distance at the external aperture, and muscular fibres continuous with those of the body-wall are conspicuous among the cells of the duct; but these latter are not continued on to the ampulla.

The *clitellar cells* are entirely wanting over the mid-ventral region of the body, along an area whose breadth is the distance between the male apertures of the two sides (Pl. II. fig. 10).

The species to which the present form shows most resemblance, at least externally, seems undoubtedly to be *Enchytræus argenteus*, MICHAELSEN (11). The same opaque white colour characterises both, and in both is due to the same cause—the presence of opaque granular cœlomic corpuscles; further, owing to the varying aggregations of these corpuscles in different parts of the body, the whiteness is not uniform in either.

But, apart from such indifferent features as the colourless blood and the absence of peptonephridia in both (probably, since MICHAELSEN does not mention these structures), the resemblances seem to end here. The differences in size (*E. argenteus*, 2·5–5 mm., present form 8 mm.), in number of segments (*E. a.* twenty-three to thirty, present form thirty-two to thirty-nine), and in number of setæ per bundle (*E. a.* two or three, present form regularly two), are not very great; the chief differences are those of the cerebral ganglion, nephridia, seminal funnel, and spermathecæ.

The cerebral ganglion has a rounded posterior end in *E. argenteus*, while in the present form it is indented posteriorly; the seminal funnel is short, somewhat longer than broad in the former, while it is four times as long as broad in the latter. The ampulla of the spermatheca is of an inverted pear-shape in the former, and the duct is simple (without gland-cells); the peculiarities of these structures in the present form have been described above. The nephridia of *E. argenteus* are not constricted at their passage through the septa, and the lumen forms a small number of regularly arranged and consecutive loops in the post-septal portion; in the form under description there is

a constriction at the septum, and the lumen undergoes many and irregular windings in the post-septal portion. I propose, therefore, to consider the present form as a new species, under the name *Enchytræus nodosus*.*

It is interesting to note here again, as has already been done from the other side in the case of *Lumbricillus viridis*, indications of transition between the genus *Enchytræus* and the Lumbricilline group. In the present case these are (1) the seta shown in fig. 8, *b*, with its double curvature, as opposed to the straight setæ of *Enchytræus*; (2) the presence of small 'copulatory glands' in segments xiv. and xv.; and (3) the definite and single penial bulb. I have already referred to the importance assigned by EISEN to this structure, and to the fact that this author distinguishes two sub-families, the Lumbricillinæ and Enchytræinæ, according to the presence of a single penial bulb, or its substitution by a number of separate aggregates of gland-cells.

It seems doubtful whether the presence or absence of a penial bulb is of sufficient importance to serve as a basis for the distinction of sub-families, or even, perhaps, of genera. And it is interesting in this connection to compare MICHAELSEN's figure (10) of the structures round the male genital aperture in *Enchytræus möbii* (= *albidus*), which shows that there is there a true "penial bulb" surrounding the end of the vas deferens, such as is met with in *Lumbricillus*; it is, however, of comparatively small size, and there are in addition separate aggregates of gland-cells on each side of the bulb. In other words, there is a condition intermediate between, or representing a combination of, those described by EISEN as characteristic of his two sub-families.

Enchytræus dubius, n. sp.

Found under stones, between tide-marks, at Wemyss Bay. While the majority of specimens of other species of Enchytræids were sexually mature from May to July, in this case the greater number of specimens were without sexual organs.

The animals showed a great tendency to curl up. In *length* they were half an inch (12 mm.) or less. In *colour* they were whitish; examined with a lens they were only moderately translucent under pressure, and showed a considerable amount of white opacity in the middle region of the body along the borders of the alimentary canal, due to aggregations of coelomic corpuscles and chloragogen cells. The clitellar region was no more opaque than the rest of the body.

Segments, forty-four. *Prostomium* rounded or very bluntly conical, with minute secondary projections. *Head-pore* between prostomium and first segment.

The *setæ* are in four rows, two ventral and two lateral. With very rare exceptions, there are two setæ per bundle throughout, except that ventral setæ are always absent in segment xii. Both ventral and lateral setæ are of the same shape, straight, with a

* The *E. parvulus* of FRIEND (6, 7), is doubtfully identified by MICHAELSEN (11), with *E. argenteus*. The data do not permit a detailed comparison of *E. parvulus* with the present form; but the two would seem to differ, at any rate, in the numbers of the setæ and shape of the cerebral ganglion, and less markedly in size and number of segments.

proximal curve, thickest in the middle (v. fig. 10, *a*). In length, the setæ vary considerably, from .045 to .072 mm.; the average is about .06 mm. There is no constant difference between the lengths of ventral and lateral setæ; nor between those of the anterior and posterior regions of the body, except that the average length of the posterior is perhaps a little less than that of the anterior setæ.

The setæ also vary considerably in thickness, viz. from .006 mm. to .0045 mm. The sharpness of their points varies, probably to some extent at least with age; newly formed setæ (in which the basal curved portion is not yet present) have sharp points, while in others they may be quite blunt, almost truncated.

Many setæ show a refractile, elongated, sometimes spindle-shaped body in their centre, about the middle of their length (in glycerin preparations); the appearance is possibly due to some separation of the component fibrils (fig. 10, *a*). The setæ appear to be shed periodically; there may occasionally be seen two newly forming setæ with an old one, in the same bundle, and thus there is presented the appearance of three setæ per bundle.

The *alimentary tract* shows no demarcation into separate regions between the



FIG. 10.—Setæ of *Enchytræus dubius*: *a*, pointed; *b*, blunt, with refractile appearance in its centre.

pharynx in the second and third segments and the intestine, which begins suddenly in the fourteenth. The septal glands in segments iv. and v. are of moderate size, those in segment vi. are large; the individual cells composing the glands are visible in the fresh state. There are no peptonephridia. Chloragogen cells begin in segment vii., or there may be a few in segment vi.; they are comparatively few and discrete up to xi., absent in xii. and xiii., numerous and close-set from xiv. onwards till near the posterior end, where they are fewer, and finally absent. The cells are of large size, with prominent oil-drops; in sections they are tall, elongated vertically to the alimentary wall, and present numbers of vacuoles. The alimentary canal is attached by stout strands to the ventral body-wall in each segment.

The *dorsal vessel* may begin in segment xiv., or at the posterior boundary of segment xii.; it bifurcates in the prostomium. The *ventral vessel* is formed about the level of septum $\frac{3}{4}$ by the union of the two terminal branches of the dorsal vessel. There are four *commissural loops* in the anterior part of the body; these are contained mostly in the third and fourth segments, but their exact position is not, apparently, always the same. The *blood* is red.

The ante-septal portion of the *nephridia* is small; very fine cilia are attached to the rim of the funnel, and longer cilia beat down the lumen; the post-septal is of

a stout ovoid shape; the duct or terminal portion of the nephridium comes from the posterior end of the post-septal, is remarkably stout, constricted at the orifice, has a vertical course, and is equal to the post-septal in length.

The *cœlomic corpuscles* are numerous, and have the form of large flat discs, irregularly circular or oval in shape, very coarsely granular, with a small nucleus which is not obvious in the fresh state but is visible in stained preparations. By transmitted light the corpuscles are grey. In diameter, they were estimated at about $\cdot 045$ mm. in the living animal; but in sections they are about $\cdot 03$ mm., the largest being $\cdot 033$. As in so many species, they may be discharged in large numbers from near the anus under pressure; after being shed they become regularly circular in outline.

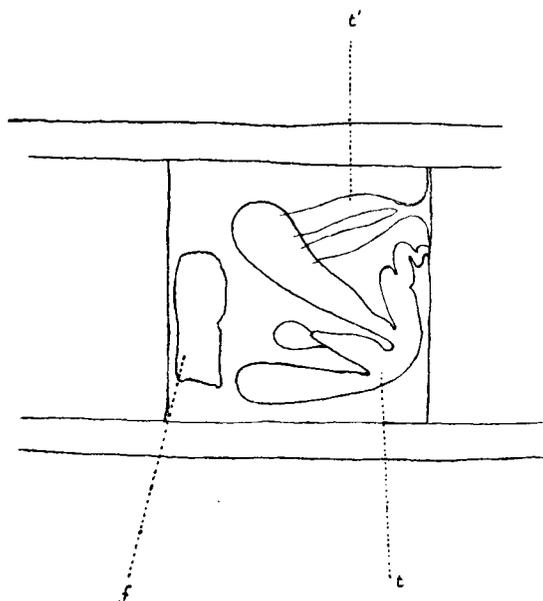


FIG. 11.—Outline of male organs in segment xi. of a specimen of the same (sketch from the living animal):
f., funnel; *t.*, testis of one side; *t.*¹, testis of the other side, faintly seen.

The *cerebral ganglion* is nearly twice as long as it is broad, is deeply indented posteriorly, and extends back as far as the level of the setæ of the second segment.

The *testes*, on the posterior face of septum $\frac{10}{11}$, are large, and resemble somewhat those found in the genus *Lumbricillus*. They have a limited origin from the septum; from this limited origin there springs an elongated, coiled, or bent cellular cord, which may swell to an irregular bulky mass, and gives off, near or at some distance from its base, two or three branches, of the same character, and, it may be, almost of the same size as itself (fig. 11, Pl. II. fig. 12). Sperm morulæ may be present in all segments from vi. to xiii.

The *funnels* are comparatively small, about four times as long as broad, narrower towards their attachment to the septum. The *vas deferens* is long, thin, coiled, in segment xii. The *penial gland* is not large; its peculiarity is that it is bifid internally; thus in a series of longitudinal sections it is first met with as a single mass (fig. 12, *a*),

while, nearer the middle line, it is completely double (fig. 12, *b*). It is attached by two thick strands, composed of cells with large oval nuclei, to the dorso-lateral body-wall. A portion of the strands, which are so disposed as to be one anterior and one posterior, passes internal to the gland ventrally to be inserted into the ventral body-wall; the glands are thus to some extent bound down by the strands. Dorsally the strands split up and radiate to their attachments.

The ovaries have the usual position. Ova are found in segments xii. and xiii.

The spermathecæ in segment v. are not large, and have the form of an elongated spindle, somewhat bent on itself. The communication with the oesophagus is narrow. Gland-cells are disposed in radial masses round the external aperture. There is no distinction of ampulla and duct to be made out in the entire animal; sections, however,

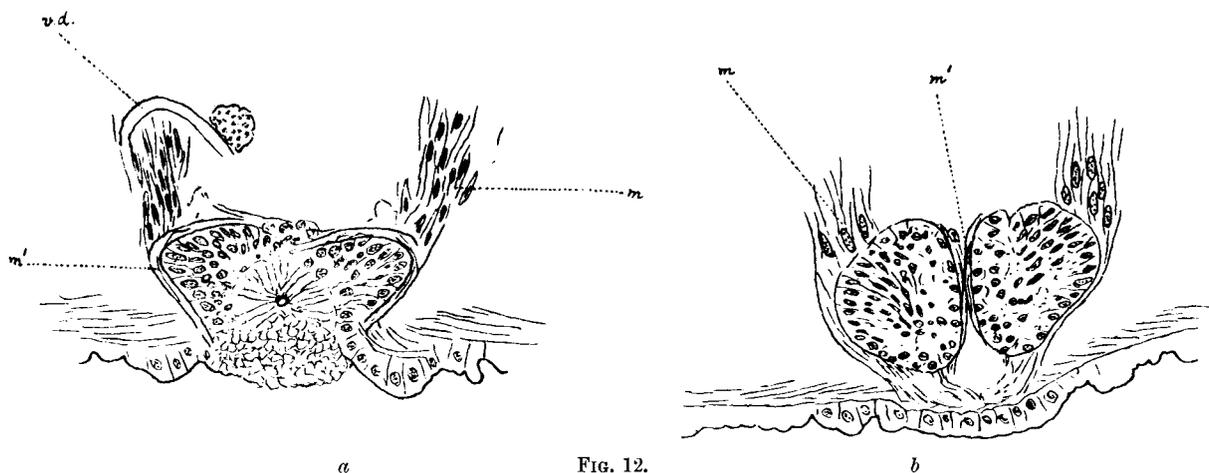


FIG. 12.

a, longitudinal section through outer part of penial gland of the same.

b, a similar section, a little internal to the previous one. The penial gland here appears double.

m., muscular (cellular) strands attaching penial gland to body-wall; *m.*¹, muscular covering of gland itself; *v.d.*, vas deferens before entering the gland.

show a small ampulla with thin walls, and a much longer and thicker walled duct, with a fairly wide lumen (Pl. II. fig. 13). The walls of the duct are composed of columnar cells, and appear markedly transversely striated in the living condition (Pl. II. fig. 14).

It is possible that the ampulla would be relatively larger if it were swollen by spermatozoa; none of the organs in my preparations, however, contain any.

Copulatory glands ("Bauchmarkdrüsen") are well marked in segment xv.; the mass of cells closely invests the cord, and projects upwards on each side above the level of the cord; there is, in longitudinal sections, a small papilliform projection of the surface of the body at the level of the middle of the gland.

In xiv. the copulatory gland is smaller, but still projects on each side above the level of the cord. In segments anterior to this, from xiii. to ix., the cells around the cord in the posterior part of each segment appear to be of the same nature, as evidenced either by the papillary projection on the surface or by the fact that the cells penetrate the muscular layers of the body-wall to become continuous with the surface epithelium.

I have referred in the Introduction to the several Lumbricilline features exhibited by this worm.

Enchytræus sabulosus, Southern.

This species was discovered by SOUTHERN (12) in Dublin Bay, living under stones and amongst the gravel at high-water mark. This is apparently the only record of its occurrence; I therefore give a few notes on Scotch specimens which I believe to be identical with it.

The worm was found at Wemyss Bay, under stones near high-water mark, at a spot where fresh water was running to the shore.

Length about $\frac{3}{4}$ inch (18 mm.); *colour* white. Anterior end tapers somewhat, posterior end blunter. *Prostomium* bluntly conical. *Segments* forty-six to forty-nine. *Clitellum* on segments xii.-xiii.

Setæ of the form usual in the genus, in length .071 to .088 mm. Their peculiarity lies in the number per bundle—with few exceptions three in the ante-clitellial, two in the post-clitellial bundles; occasionally there are three setæ in a post-clitellial bundle, and young replacing bundles are sometimes seen near the functioning bundles. In segment xii. there are no ventral setæ, and the dorsal setæ are in this segment two per bundle. The fact that in my specimens the post-clitellial bundles have only two setæ is the most important difference from SOUTHERN's description; for he states that the number is regularly three throughout the body.

Septal glands bulky, the last pair being the largest. *Peptonephridia* (Pl. II. fig. 15) as small hollow tubes, bent once or twice, or slightly coiled, extending backwards as far as the first pair of septal glands, and opening anteriorly close together into the pharynx on its dorsal wall. I have no note of any special peculiarity of the *chloragogen cells*, which begin in segment vii.; SOUTHERN considers their large size and their oil-drops to be of value as a specific distinction.

The *dorsal vessel* begins in segment xv. (junction xvi. and xvii., SOUTHERN). The *blood* is colourless. The *celomic corpuscles* are irregular, ovoid or pear-shaped, granular, with a clear nucleus. The *nephridia* are as described by SOUTHERN; they begin in segment vii.

The *cerebral ganglion* is one-and-a-half times as long as broad (Pl. II. fig. 15), its sides nearly parallel, its posterior end rounded, not indented. Two small dark spots may be seen on it, as in specimens of *E. albidus*; but they are not so conspicuous in the present form. The *ventral nerve-cord* shows ganglionic swellings in segments ii., iii., and iv.; thereafter the swellings are slight or absent, and the cord, as seen in the living animal, is of the same thickness throughout.

The *sperm morulæ* may bulge forwards as far as the level of the setæ of segment viii. The *sperm funnels*, about four times as long as broad, are as described by SOUTHERN. The *vas deferens* is a stout tube, not much coiled, extending back as far as segment xviii. The *glands* round the male aperture are constituted by a number of separate aggregations of cells, and do not form a single penial bulb.

The *spermathecal apparatus* is represented in Pl. II. fig. 15; the general form is somewhat similar to that illustrated in SOUTHERN'S figures; the ampulla, comparatively small, spherical or slightly elongated, is smaller, and the duct, tuberculated as in *E. albidus*, is thicker than there depicted.

Enchytræus albidus (Henle).

This worm has frequently been described, but under a very large number of different names. According to the synonymy given by MICHAELSEN (11), thirteen authors have, in eighteen papers, given to this animal five generic and twelve specific names. Perhaps the fullest account of the worm is that given by MICHAELSEN (10) in 1886, in his thesis *Untersuchungen über Enchytræus Möbii, Mich., und andere Enchytræiden*; GOODRICH

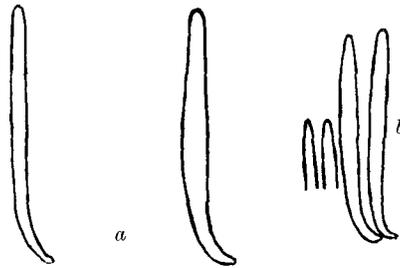


FIG. 13.—*a*, two setæ of *Enchytræus albidus*.
b, a bundle of setæ of *Enchytræus albidus*, showing two immature replacing setæ, along with two fully formed setæ which are destined to drop out.

(8) has more recently, under the name *E. hortensis*, described a form which MICHAELSEN considers identical with the above, and has paid special attention to the nephridia and cœlomic corpuscles. A few remarks, chiefly in regard to points in which the Millport specimens vary from the above descriptions, will therefore be sufficient.

The worms were found about high-water mark in places where fresh water was running to the shore; it was common under stones, and also among the roots of plants. In *length* specimens are $\frac{2}{3}$ to $1\frac{1}{4}$ inches; they are comparatively stout, the anterior end tapering, the posterior blunter; they are whitish in *colour*, fairly transparent, and easy to examine by the microscope in the living state. *Segments* fifty-two to sixty-six. The *clitellum* occupies segments xii. and xiii. The animals move by crawling, or at times by wriggling; they often throw themselves into nematode-like contortions; at rest, in a dish, they curl themselves up.

As to the *setæ*, previous descriptions, and fig. 13, *a*, will be a sufficient guide as to their shape. There are no ventral setæ in segment xii.; they are more numerous in the anterior than the posterior segments, the numbers being three to five (commonly four) in the ante-clitellial ventral bundles, two to four (commonly three) in the post-clitellial ventral bundles; for the lateral bundles the numbers are two to four

ante-clitellial, and two or three post-clitellial. In length the setæ of the posterior part of the body appear to be, on the average, rather longer than those of the anterior; the longest may measure up to .1 mm. The bundles are replaced during the life of the animal (fig. 13); thus there may appear to be eight setæ in a bundle, but of these one group of four will be immature, wanting the proximal hooked end.

The *alimentary tract* (Pl. II. fig. 16), with its appendages (septal glands, peptonephridia), corresponds with previous descriptions, except that I have not found, as GOODRICH states for his form, the last pair of septal glands smaller than the others. The *dorsal vessel* may take its origin from the intestinal sinus in segments xiv., xv., xvi., xvii., or xviii; the *lateral commissures* may be four in number, in segments ii., iii., iv., and v., but I am not satisfied that this number and arrangement are constant. The *blood* is colourless.

One kind of *lymph corpuscles* only is mentioned by MICHAELSEN—flat, oval, or pear-shaped cells, nucleated, with a large nucleolus; GOODRICH mentions three kinds, and gives a detailed description of each. In my specimens I noted two forms of cœlomic corpuscles—one granular, flat, irregularly pear-shaped or oval, and nucleated, corresponding to MICHAELSEN's description; the other spherical or irregular, not flattened, homogeneous, more refractile than the first type, apparently not nucleated and not so numerous as the first kind. These may perhaps correspond to the first type of cœlomic corpuscle described by GOODRICH.

The *cerebral ganglion* lies in segment i., attached to the dorsal wall of the buccal cavity; it is one-and-a-half times as long as broad when the head is extended; its posterior border is convex or flattened. The two authors already quoted both found it to be slightly indented behind. A pair of spots occur near the posterior margin of the ganglion, dark by transmitted light. They were often very large and conspicuous, and sometimes contained a few refractile particles besides the usual granular matter of which they seemed to be made up. They were not always quite symmetrically placed (Pl. II. fig. 16).

There is a well-marked tubular cavity dorsally in the substance of the *ventral nerve-cord* all through the clitellar region, and for some distance in front of this; it splits up into several smaller tubes in the region of the last septal glands, and some of these tubes can be followed for some distance farther towards the head.

The *funnels* of the vasa deferentia vary much in shape; when the animal stretches itself out, they may be seven or eight times as long as broad; ordinarily they are perhaps about five times, and sometimes may appear as little as three times as long as broad. The *vasa deferentia* may extend backwards as far as segment xxi. The *vesiculæ seminales* are constituted by a bulging forwards of septum $\frac{10}{11}$; thus masses of spermatozoa are seen to surround the œsophagus in segments x. and xi., or ix., x., and xi.

The shape of the *spermathecæ* deserves mention, since it differs from that described by the two authors previously quoted. Thus MICHAELSEN's figure shows the cavity of

the spermatheca as squarish, with no special bulging anywhere; while, according to GOODRICH, the œsophageal and external openings of the spermatheca are about at the same level, but the cavity of the ampulla is produced backwards into a large posterior sac. In my specimens the spermathecæ appear in an early stage of their development as simple tubes, not dilated anywhere, passing obliquely backwards from their external opening between segments iv. and v. to the œsophagus. In the fully formed organ the ampulla is large, ovoid in shape, with long diameter antero-posterior; it fills up the space on each side between the œsophagus and body-wall. It opens into the œsophagus near its posterior end, the aperture of communication being ventrally placed with regard to the cavity of the ampulla. In front the ampulla passes into the duct, the boundary between the two being, in the fully dilated condition of the ampulla, quite sudden. The duct is about as long as the ampulla, and forms a stout tube, straight, or more usually, in the contracted condition of the animal, somewhat bent; the outline of the tube is irregular, appearing to be studded with small excrescences; these irregularities are due to the projection of the cells of which it is composed beyond the muscular layer.

Some ciliated *parasites* were seen on one occasion in the body-cavity.

I think there is no doubt that this worm is most suitably included under *E. albidus*, in spite of a few divergences from previous descriptions. These divergences seem to be the following:—(i.) Extent of elitellum; this MICHAELSEN gives as half xi. to half xiii., while his figure shows it as extending nearly to the anterior border of xi., and leaving a large part of xiii. unincluded; (ii.) the lymph-corpuses (*v. sup.*); (iii.) the dark spots on the cerebral ganglion (which may, however, merely have gone unrecorded); (iv.) the difference in the canals of the ventral nerve-cord in MICHAELSEN'S description and mine; (v.) the difference in the shape of the spermathecæ. To these may be added the fact that I have not noted in my specimens collections of sensory cells near the apertures of the spermathecæ, as figured by MICHAELSEN.

Fridericia bulbosa (Rosa).

This species is widely distributed, and has recently been recorded from Ireland (14). It appears, however, to be somewhat variable, and different authors have given different descriptions of, for example, the shape of the cerebral ganglion, the form of the peptonephridia, and the ducts of the spermathecæ with regard to the presence or absence of gland-cells round the orifice. A brief account of the features in which, from the descriptions of previous observers, some amount of variation appears to have been established, may therefore be of interest.

The first point is the habitat of the Millport specimens. They were found under stones, between tide-marks, at Balloch. The species lives, according to MICHAELSEN (10), in rotten wood or damp leaves; indeed the genus *Fridericia* as a whole "is terrestrial, and found in the driest localities" (BEDDARD, 1, p. 312), a fact which BEDDARD brings into relation with the occurrence of dorsal pores in the genus.

As to its anatomical features, the worm was $\frac{1}{3}$ to $\frac{1}{2}$ inch (8 to 12 mm.), in length, filiform, white in colour, very sluggish. Prostomium short, rounded; head-pore visible as a somewhat elongated slit, at the junction of prostomium and first segment; clitellum extending over most of xii. and half or more of xiii.; segments thirty-eight to forty-five. Dorsal pores from vii. onwards, some little distance behind the septa; with two cells in relation to each, granular and with large nuclei, one anterior and one posterior.

The *setæ* are absent in xii.; form, numbers, and distribution as previously recorded. The larger (outer pair) *setæ* are comparatively short in the first segments (.047 mm.), and their length increases towards the clitellar region, near which it attains a first maximum (.066 mm.); diminishing in the middle region of the body (.048 mm.), the length again increases, and reaches a second maximum, higher than the first (.075 mm.), near the posterior end. Their thickness varies a little; it is often about a tenth of their length, or even more, *i.e.* .0044 to .0057 mm. (*cf.* fig. 14, *a*).

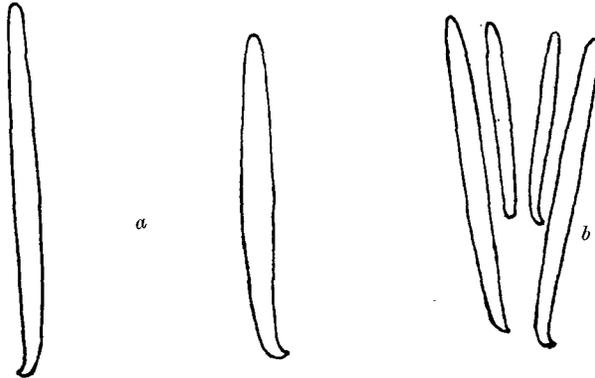


FIG. 14.—*a*, large *setæ* of *Fridericia bulbosa*.
b, a group of *setæ* of the same, showing
relation of smaller *setæ* to the larger.

The smaller *setæ*, included between the larger in the anterior part of the body, have their outer ends on a level, or almost so, with the ends of the large *setæ*, but their hooked inner ends are at a more superficial level. In length they are about two-thirds the size of the larger, *i.e.* .03 to .04 mm. (*cf.* fig. 14, *b*).

The *peptonephridia* enter the oesophagus in segment iv., and extend back to the level of the *setæ* of v. They are not, in my specimens, branched or expanded at their ends.

The *dorsal vessel* originates in segments xix., xx., or xxi. The *blood* is colourless.

The *calomic corpuscles* are all of one kind, large, flat, oval discs, granular, nucleated, up to .022 mm. in diameter. The *nephridia* have the characters given in previous descriptions, the ante-septal portion being comparatively large, about one-third to one-fourth the length of the post-septal. The *cerebral ganglion* is twice as long as broad, with a rounded posterior end; it extends back a considerable distance into segment ii.; its lateral margins converge somewhat towards the front. The ventral *nerve-cord* has copulatory glands ("Bauchmarkdrüsen") associated with it in segments xiii. and xiv.

This species shows the commencement of definite *sperm* and *ovisac*; septum $\frac{1}{2}$ is markedly bulged backwards, so as to reach what would normally be the hinder limit of the next posterior segment, and the developing sperm-morulæ, contained in the sac so formed, do not pass beyond it; similarly the ova are contained in a posterior bulging of septum $\frac{2}{3}$.

The *funnels* are between two and three times as long as broad; the *vas deferens* is a coiled narrow tube, confined to segment xii.; there is a well-marked *penial bulb* immediately on the inner side of the termination of the vas deferens at the male aperture; the vas can thus hardly be said to perforate the bulb (Pl. II. fig. 17). The *spermatheca* and its duct have the form and relations described by previous observers; there are, in my specimens, no glands round the duct or its aperture.

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EXPLANATION OF PLATES.

FIG. 1. Diagram of the vascular system of *Tubificæ costatus*.

FIG. 2. Part of the anterior end of *Marionina semifusca*.

Amp., ampulla of spermatheca; *comm.*, communicating cord from septal glands to pharynx; *d.*, duct of spermatheca; *gl.*, gland-cells round spermathecal aperture; *n.*, nephridium of segment v.; *æs.*, œsophagus; *s^a-s^b*, septal glands of the fourth to the sixth segment; *ph.*, pharynx; *sp.*, septum $\frac{5}{6}$.

- FIG. 3. Part of the anterior end of *Lumbricillus subterraneus*.
*Comm.*¹, communicating strand from septal gland of the fifth to that of the fourth segment; *spth.*, spermatheca (duct and ampulla not distinguishable). Other references as for fig. 5.
- FIG. 4. Transverse section of ventral nerve-cord and 'copulatory gland' of *Lumbricillus subterraneus*. × 640.
b. bridge of deeply staining tissue connecting the two sides of the gland dorsal to the cord; *c.*, central canal of the nerve-cord; *c.m.*, circular muscular layer; *ep.*, surface epithelium, in which cell outlines are indistinguishable; *gl.*, a cell of the copulatory gland, the body of the cell staining equably; *gl.*¹, another gland-cell, the cell body showing a reticular structure and staining very slightly; *l.m.*, longitudinal muscular layer; *n.*, fibrous part of nerve-cord, below and to the right of which are seen the granular nuclei of the ganglion cells; *st.*, 'stalk' of attachment of copulatory gland to the surface epithelium.
- FIG. 5. Longitudinal section through spermathecal apparatus of *Lumbricillus subterraneus*. × 220.
Al., alimentary canal; *amp.*, ampulla of spermatheca; *ap.*, aperture of its duct; *c.*, circular muscular layer of body-wall; *d.*, duct of spermatheca; *ep.*, surface epithelium; *gl.*, gland-cells near aperture of spermatheca; *l.*, longitudinal muscular layer of body-wall; *m.*, muscular layer of duct of spermatheca; *m.*¹, the same layer between the cells, where these are elongated and glandular; *s.gl.*, septal gland; *spz.*, spermatozoa in ampulla of spermatheca.
- FIG. 6. Longitudinal section through male aperture of *Lumbricillus tuba*. × 250.
Cl., clitellar epithelium; *ep.*, lower, more deeply staining epithelium round male aperture; *m.*, muscular capsule of penial gland; *m.*¹, muscular strand of attachment, cut through; *v.d.*, vas deferens; ♂, male aperture.
- FIG. 7. Longitudinal section through ampulla and first part of duct of spermatheca of the same. × 250.
Amp., ampulla; *d.*, duct; *æs.*, œsophagus; *s.gl.*, septal gland of fourth segment.
- FIG. 8. Longitudinal section through aperture of duct of spermatheca of the same, to show the continuity of the surrounding gland-cells with the cells of the surface epithelium and of the duct, and their relation to the muscular layer. × 250.
M., muscular layer clothing duct, continued ventrally between gland-cells; *s.gl.*, septal gland.
- FIG. 9. Anterior part of the body of *Enchytræus nodosus*, semi-diagrammatic.
Amp., ampulla of spermatheca; *c.g.*, cerebral ganglion; *conn.*, connection between septal glands and pharynx; *conn.*¹, that between the glands of segments v. and iv.; *d.*, duct of spermatheca; *g.*, gland-cells round aperture of spermatheca; *m.*, muscular strands attaching pharynx to body-wall; *æs.*, œsophagus; *ph.*, pharynx; *s.gl.*¹⁻³, septal glands of segments iv.-vi.; *vac.*, vacuole-like appearances in posterior part of cerebral ganglion.
- FIG. 10. Transverse section through male aperture of the same. × 550.
Cl., clitellar epithelium; *cut.*, cuticle; *ep.*, lower, non-glandular epithelium over area around and between male apertures; *invag.*, the invagination representing the male aperture, at the place where it receives the termination of the vas deferens; *m.*, muscular strand from penial bulb to body-wall; *m.*¹, muscular covering of penial bulb; *p.*, cells of penial bulb; *v.d.*, vas deferens before penetrating penial bulb; *v.n.c.*, ventral nerve-cord.
- FIG. 11. Longitudinal (somewhat oblique) section through spermatheca of the same. × 640.
Amp., cells composing wall of ampulla; *c.m.*, circular muscle layer of body-wall; *cut.*, cuticle; *ep.*, surface epithelium; *g.*, gland-cells near aperture of spermatheca; *l.m.*, longitudinal muscle layer of body-wall; *per.*, peritoneal cells; *s.gl.*, septal gland of segment iv.; *spz.*¹, spermatozoa in ampulla; *spz.*², spermatozoa between cells of wall of ampulla; *spz.*³, spermatozoa outside ampulla.
- FIG. 12. Longitudinal section through segment xi. of a specimen of *Enchytræus dubius*. × 250.
B.-v., a blood-vessel; *corp.*, cœlomic corpuscle; *dis.*, dissepiment $\frac{1}{12}$; *f.*, sperm funnel; *sp.*, mass of developing sperm cells; *t.*, testis at its attachment to septum $\frac{1}{11}$; *t.*¹, other portions of the branching testis.
- FIG. 13. Longitudinal section through spermatheca of *Enchytræus dubius*. × 250.
Amp., small dilatation, with thinner walls, at œsophageal end of spermathecal apparatus, representing the ampulla; *c.*, circular muscular fibres of body-wall; *æs.*, œsophagus; *s.gl.*, septal glands; *spth.*, main portion of spermathecal apparatus, representing the duct; *v.*, vacuole in surface epithelium.

FIG. 14. Sketch illustrating the appearance of the spermathecæ of *Enchytræus dubius* in the living animal.

FIG. 15. Anterior part of the body of *Enchytræus sabulosus*; semi-diagrammatic, from the living animal. *Amp.*, ampulla of spermatheca; *c.g.*, cerebral ganglion; *d.*, duct of spermatheca; *æs.*, œsophagus; *pnph.*, peptonephridium; *ph.*, pharynx; *pr.*, prostomium; *s.g.*¹⁻³, the septal glands of segments iv.-vi.; *i.-vii.*, segments i.-vii.

FIG. 16. Anterior part of the body of *Enchytræus albidus*, semi-diagrammatic.

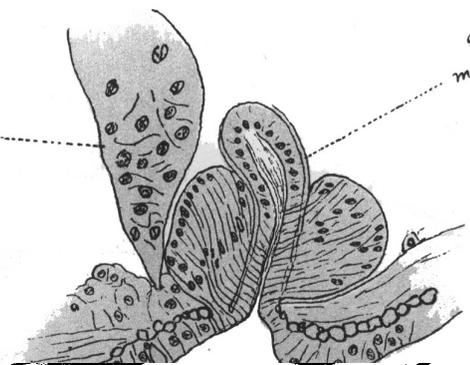
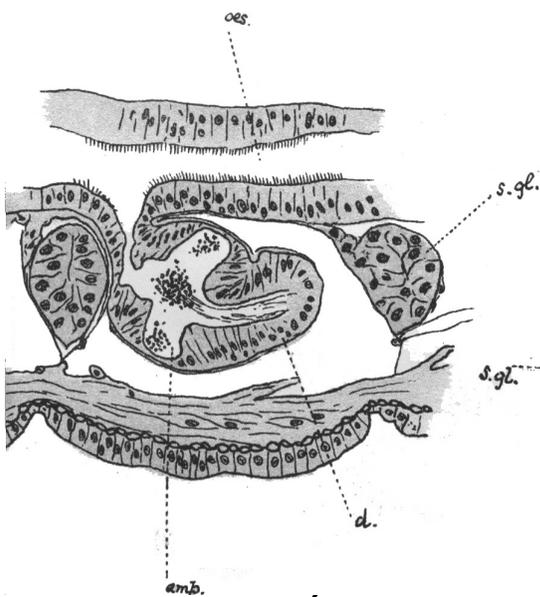
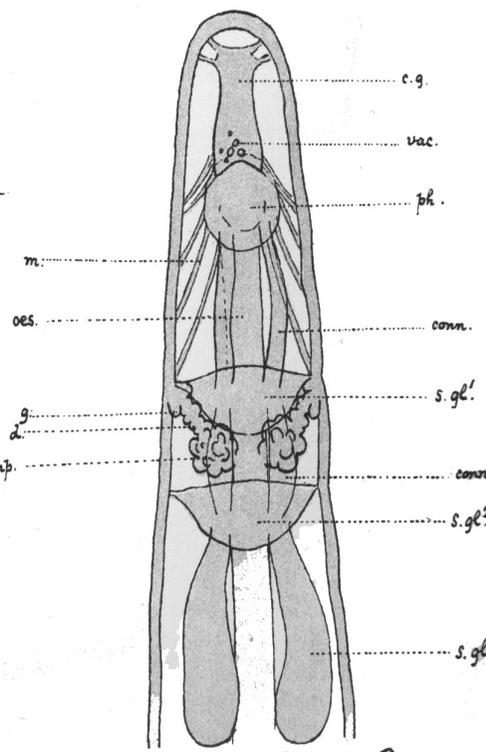
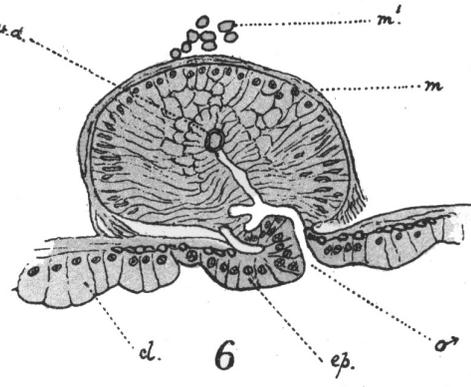
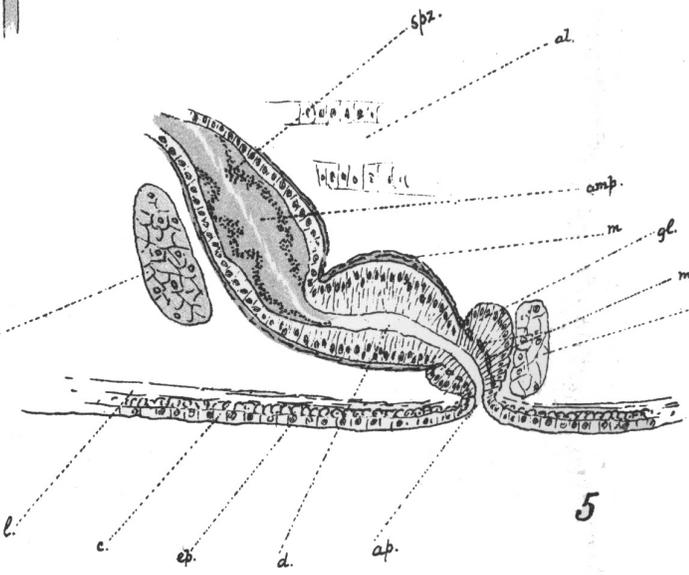
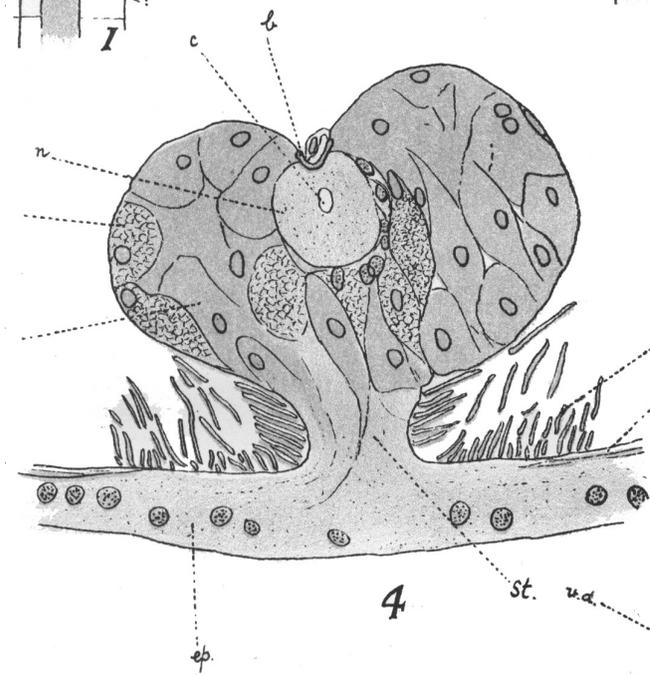
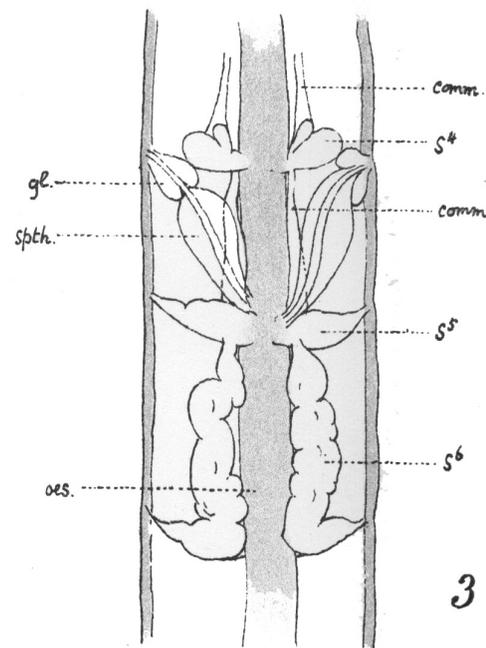
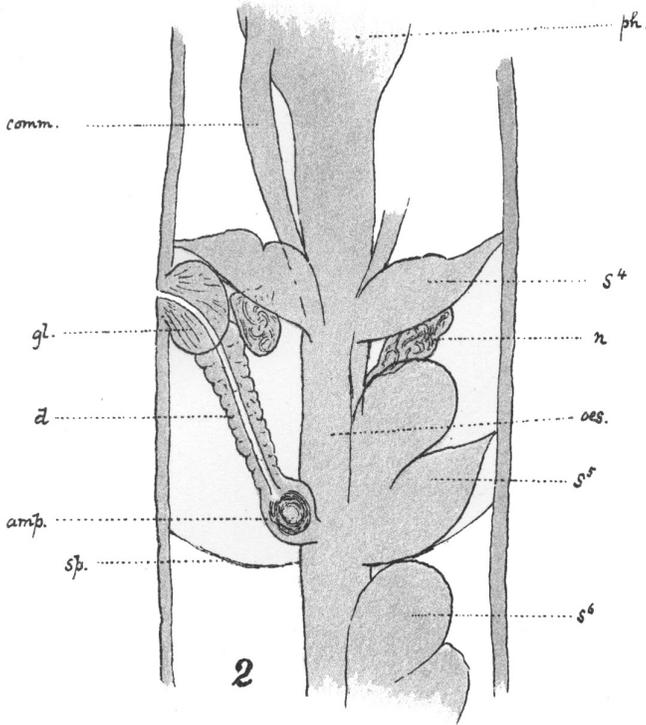
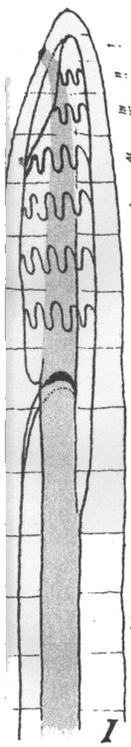
Amp., ampulla of spermatheca; *c.g.*, cerebral ganglion; *comm.*, communicating cord from septal glands to pharynx, splitting up into numerous smaller strands at its junction with pharynx; *d.*, duct of spermatheca; *æs.*, œsophagus; *pnph.*, peptonephridium; *ph.*, pharynx; *pr.*, prostomium; *s.*, dark spot in cerebral ganglion; *s.gl.*¹⁻³, the three pairs of septal glands.

FIG. 17. Ventral portion of a transverse section through the penial bulbs of *Fridericia bulbosa*. × 250.

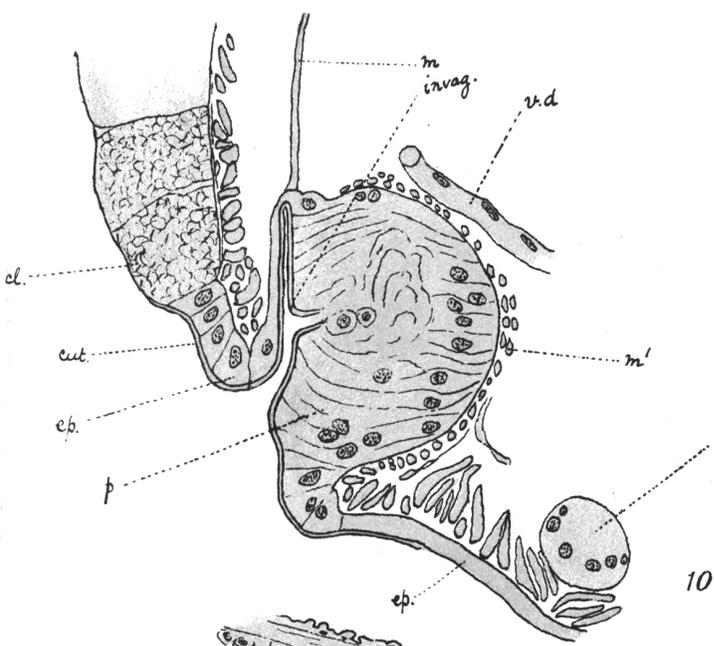
Al., alimentary canal, ventral to which are seen the ventral nerve-cord and ventral vessel; *p.*, penial bulb of one side; *sp.*, septum $\frac{1}{1\frac{1}{2}}$ bulged backwards to form a sperm-sac; ♂, male aperture.

FIGS. 4, 6, 7, 8, 10, 11, 12, 13, 17 drawn from sections by means of Zeiss's Abbé's drawing apparatus.

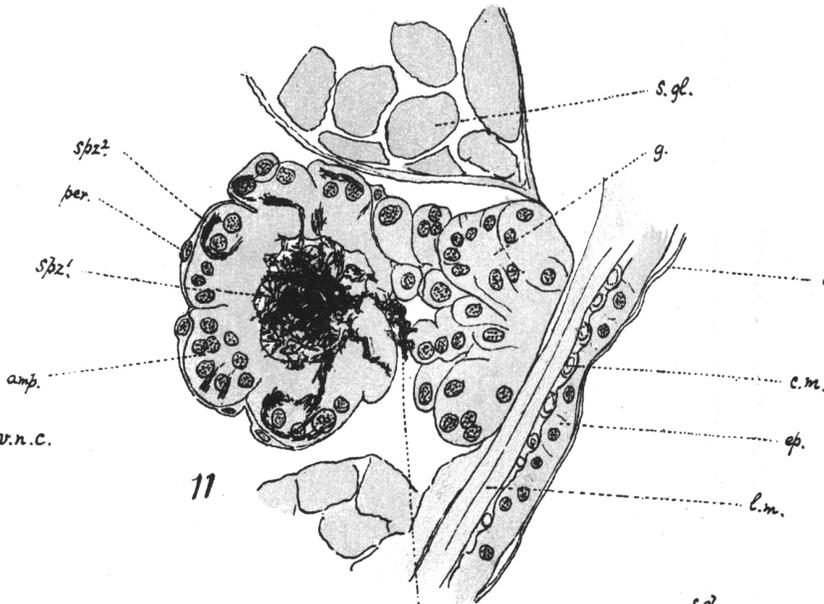
STEPHENSON: SOME LITTORAL OLIGOCHÆTA OF THE CLYDE—PLATE I.



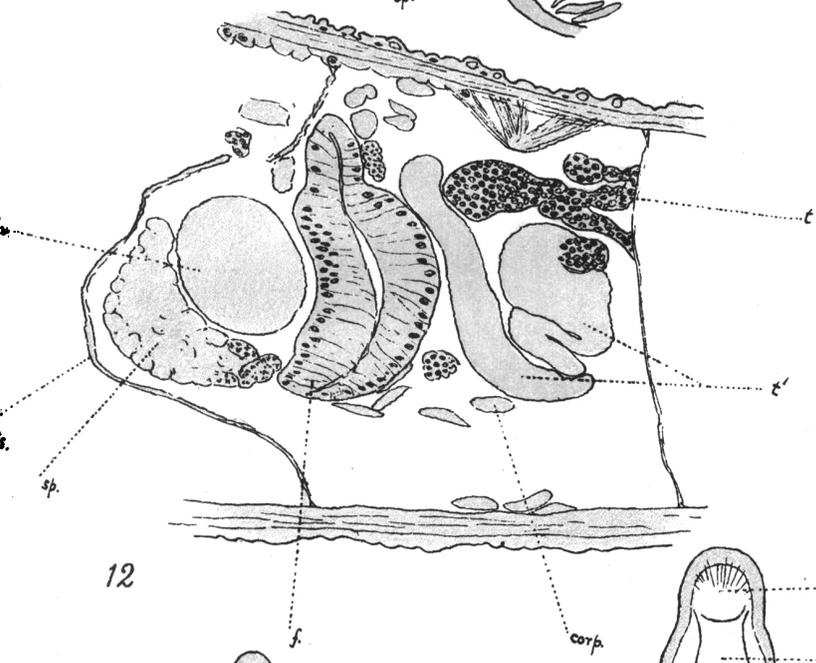
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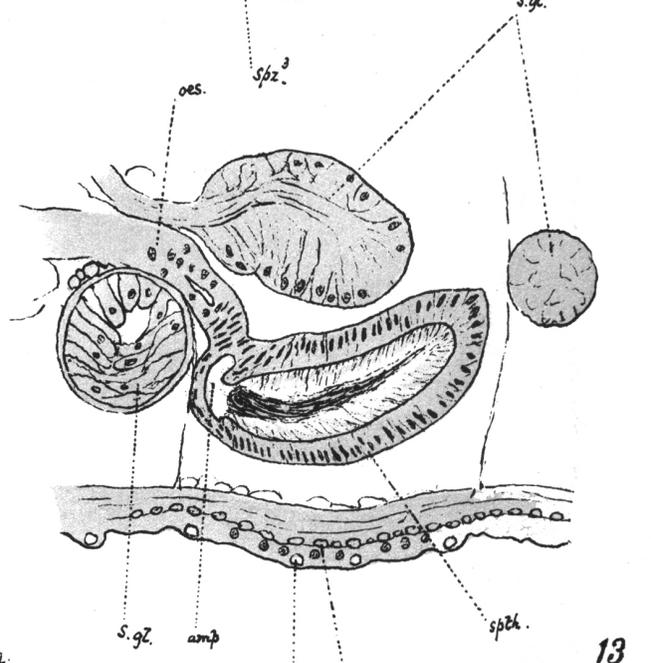
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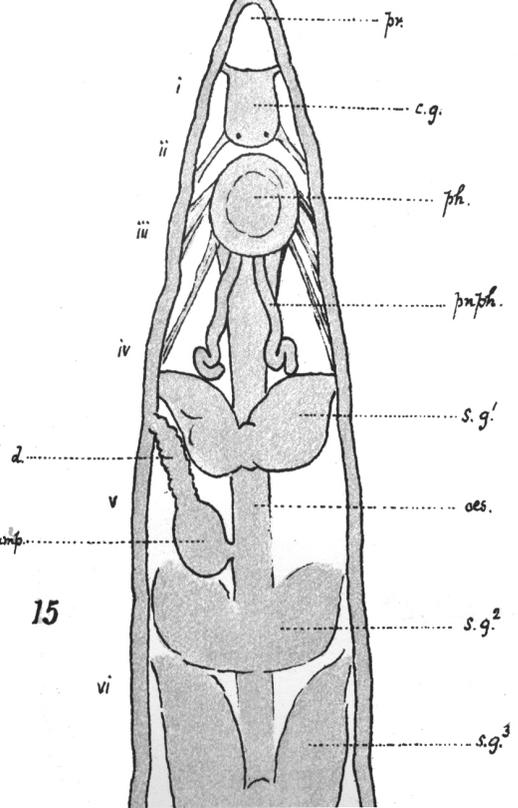
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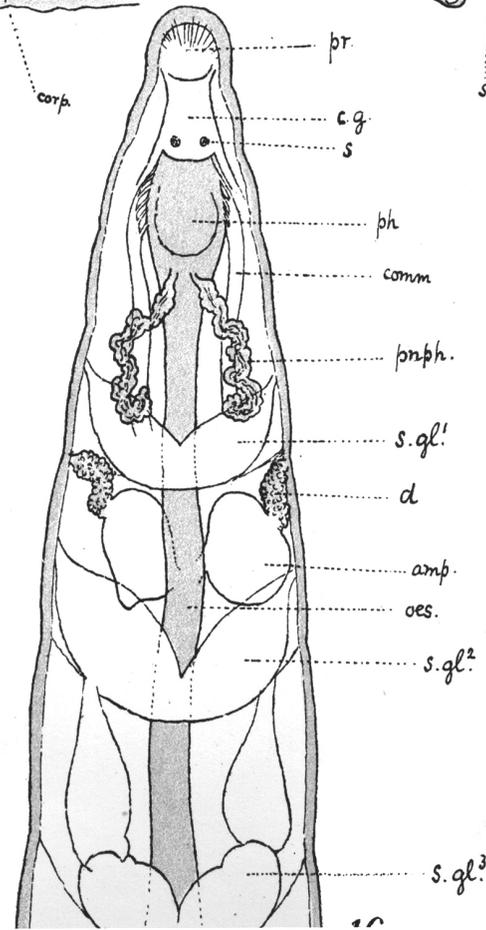
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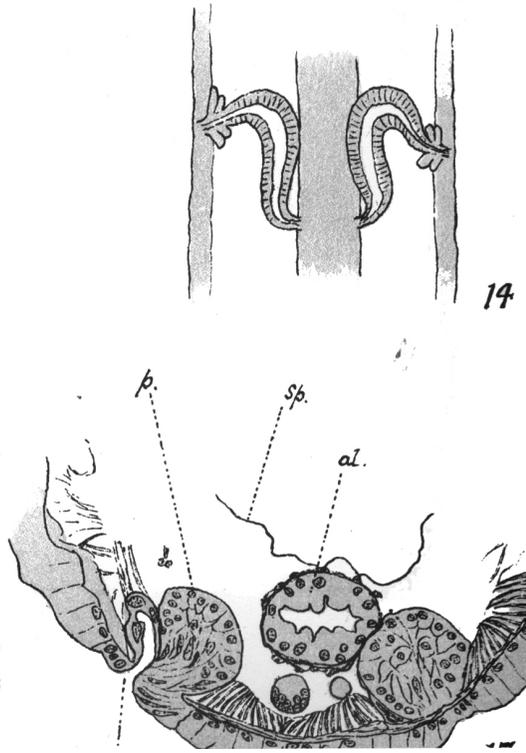
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