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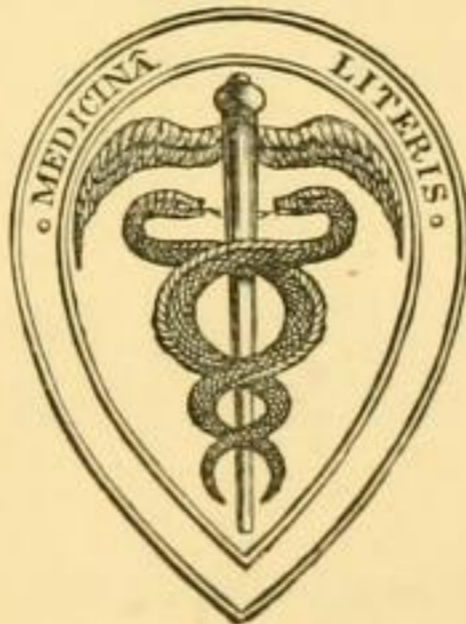
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Hekaterobranchnus Shrubsolii.
A New Genus¹ and Species of the Family
Spionidæ.

By

Florence Buchanan,
Student of University College.

With Plates XXI and XXII.

THIS worm was found at Sheppey by the members of the University College Biological Society during an expedition made there in July, 1889. It appears to have been already known to naturalists living at Sheppey, but no one had tried to identify it. Not being able to find any published account of it, I believe it to be as yet undescribed, and have therefore, at Professor Lankester's kind suggestion, undertaken the examination and description of it.²

Occurrence.—The worm was always found associated with *Haplobranchus* (described by Dr. Bourne in the 'Quart. Journ. Micr. Sci.,' 1883), and occurs therefore in soft mud at the bottom of gullies, usually overlain by an inch or so of water. It is not so tenacious of life as *Haplobranchus*, and is hence not always to be found in mud containing *Haplobranchus*. Its

¹ See, however, note at the end of this paper.

² I have been greatly helped in my investigations by the kindness of Mr. Shrubsole, of Sheerness, who has sent me up from time to time, as I required it, fresh material. I will take this opportunity of thanking him for the kind way in which he has allowed me to encroach upon his time and patience; for collecting and searching through mud to see that a particular animal, and that a very minute one, is present in it is no very easy nor interesting task.

other associates are *Nais littoralis*, *Hemitubifex* (*Clitellio*) *ater*, nematodes, and planarians. It is, however, more of a marine form than its associates, since, after heavy rain at low water, it is, Mr. Shrubsole informs me, seldom to be found, while the other forms of life may be still abundant. When present it can, as a rule, be recognised readily by its nematode-like movements and red colour, and the four tentacles waving on its head.

It is usually from about 6 to 10 mm. in length, the size varying according to the number of segments. It is, therefore, slightly larger than the *Haplobranchus*. It forms loosely coherent tubes by gathering up particles of mud round it, but inhabits each only for a very short time. It is more frequently to be found moving about in the mud.

Anatomy.—The number of segments varies. I have never counted more than forty-eight, and the greater number of specimens examined had between thirty and forty. The body is divided into regions which, as in other members of the family, are not so distinctly marked off from one another as in most sedentary annelids.

Cephalic Region.—The 1st or head-segment has a well-developed prostomium, on which are two well-marked pairs of eye-spots, one pair more dorsal and median than the other. In two out of the many specimens examined there were eight eye-spots, not, however, arranged as four pairs, but scattered and at very unequal distances apart. In another specimen there were five eye-spots, three on one side and two on the other. It is not unusual for the number of eyes to vary individually in marine annelids; it is, indeed, usual for the number to be greater in the larva than in the adult; and it would therefore seem that the eight-eyed condition is to be explained rather as a retention of a larval feature, than as due to the division of the four eyes normally found in the adult.

Behind the eye-spots, at the base of the prostomium, between it and the body of the 1st segment, are the cephalic tentacles, each containing a single contractile blindly-ending vessel (Pl. XXI, figs. 1 and 2, *t.*). They are richly ciliated all round, the cilia not being confined, as in most other

members of the family, to a single longitudinal groove. The tentacles have an annulate appearance, due to slight surface ridges on which are the cilia, and to greenish-yellow streaks crossing the tentacles here and there. Between the ridges are short, stiff, tactile hairs. The contractile vessel (figs. 2 and 12) lies freely in the cavity of the tentacle which is part of the cœlom, and in which, in transparent specimens, cœlomic corpuscles can be seen. The tentacles are situated more laterally than in most members of the family: they are placed on either side of the mouth, and slightly above it. When the animal is at rest they are bent forwards in search of food, and infusorians may be seen carried down by their cilia to the mouth. When the animal is moving and tosses its head, the tentacles stand up more or less vertically; or, when it is moving in a definite direction, they are bent back over the dorsal surface, reaching back usually to the 3rd or 4th segment.

Behind these tentacles, which, for want of a better name, I have merely called "cephalic," and dorsad of them, situated on the body of the 1st segment, is a pair of organs with the characteristic structure of *Spio* branchiæ, although a great deal larger than these usually are (figs. 1 and 2, *br.*). They are about half as long again as the "cephalic" tentacles, and of a reddish-orange colour, due to the presence of an ascending and descending blood-vessel, forming together a simple loop in each. They are ciliated, but the cilia are shorter than they are on the "cephalic" tentacles, and they do not appear to be ciliated quite all round. The vessels, not being contractile, are not readily seen except in section (fig. 10). They run close to the epidermis, projecting into the cavity of the branchia which is a prolongation of the cœlom. The one vessel is rather larger in calibre than the other. Like the "cephalic" tentacles, they may either be carried erect, or bent back over the dorsal surface. Their length, also, varies much individually. Usually when bent back they would cover the first five segments; sometimes, however, they reach back over more than eight. At the base of each branchia are two or three short capillary chætæ (fig. 1, and fig. 12, *ntp*¹.)

On the same segment (the 1st), placed ventro-laterally, almost vertically below but a little behind each branchia (fig. 1), is another group of three or four rather longer capillary chætæ, behind and below each of which is a membranous lobe—the ventral “cirrus” of most authors, the neuropodial “lamina” of others.

The body of the first segment reaches further forward on the ventral than on the dorsal surface, and is there folded, forming a kind of ventral collar (figs. 1 and 3, *v. coll.*). This fold can be traced up laterally to the base of the branchiæ, which appear to be attached to it.

Thoracic and Abdominal Regions.—On all the other segments of the body there are, as on the first, two groups of chætæ on each side, but the chætæ are longer (when of the same kind) and more numerous than on the 1st segment. Their number varies in different individuals and in different segments of the same individual, but with no constancy. Five, six, and seven are usual numbers, but sometimes there are as many as nine in a group. Seeing that they may so very easily be knocked off, and that new ones may always be forming, not much importance can be attached to their exact number in different segments and in different individuals. In the dorsal groups throughout the whole length of the body the chætæ are capillary only (fig. 4, A.). In the ventral groups they are so also in the anterior region of the body; but from the 8th segment onwards there are, as well as these, also hooked or crotchet chætæ. We may, therefore, consider the thoracic region to extend as far as the 7th segment (inclusive), and the abdominal region to begin in the 8th. There are at first two or three crotchets to about four or three capillary chætæ. More posteriorly there are usually about five hooked chætæ to two capillary ones. Each crotchet (fig. 4, c.) is three-toothed at the extremity, the one tooth being larger and more prominent than the other two, so that in some views it alone is to be seen clearly (fig. 4, c.¹). The hooked extremity is surrounded by a membrane.

¹ The name “cirrus” would imply a homology with the cirrus of the

The chætæ all arise from sacs, each group from one sac, firmly implanted in the body-wall and projecting into the body-cavity, though the ventral sacs do not project so far as the dorsal. The wall of each sac is supplied by muscles, by means of which the sac can be moved in and out as a whole. Springing separately from the body-wall behind both dorsal and ventral chætæ-bundles slightly dorsad, of the dorsal ones and ventrad of the ventral ones, are the membranous lobes known either as "cirri" or "parapodial laminæ."¹ They can readily be seen in the first few segments, but then gradually grow smaller, and are not found in the posterior region of the body. It is difficult to determine exactly in which segment they cease to exist, and whether this is constant in all, since, to see them clearly, the animal must be living and moving, and it is then not easy to count them. When the animal is killed the lobes become, by the position taken up by the worm, very difficult to see and be certain of. The dorsal ones are much closer to one another, i. e. nearer to the median line, anteriorly than posteriorly, and in the 2nd segment (the first one in which they exist) they are so close together that they seem to form, or form part of, a collar, which is therefore dorsal, and quite distinct from the ventral collar of the 1st segment (figs. 1 and 12, *d. coll.*). There are very minute stiff hairs on all these lobes, resembling cilia, but without their movement. Such hairs are also found elsewhere on the cuticle of the body-wall.

Internal Anatomy.—The body-wall consists of—(1) An outer epidermic layer of cells, in parts more than one layer thick, with a fine cuticle (figs. 5, 6, 7, and 8, *epid.*). The epidermis is thicker on the ventral surface than elsewhere. parapodium of an Errant annelid, e.g. Nereis or Phyllodoce; and it is difficult to say whether this homology exists without first deciding, by the comparison of a large number of forms, to which families of the Errantia the Spionidæ are most nearly allied, taking the Spionidæ to be, as they probably are, the living representatives (though probably degenerate) of the most primitive of the Sdentaria. A cirrus may vary so much both in form and position that we can see no reason why these membranous lobes in the Spionidæ should not represent cirri; but this, of course, does not alone in the least prove them to be true cirri.

Here and there in the epidermis, and occupying its whole thickness, are a few large coarsely granular cells with well-marked large nuclei and nucleoli, probably opening to the exterior, and secreting the material by which the animal holds the fragments together which compose its temporary tube. (2) The circular muscular layer (*c. m.*) is only very slightly developed, and can scarcely be seen except in longitudinal sections. It is best developed in the ventral region just over the nerve-cord (where there are no longitudinal ones), and can there be seen in transverse sections. (3) The longitudinal muscular layer, on the other hand, is very well developed, running in three bands, one dorsal and two ventral (figs. 5, 6, 7, and 8, *d. l. m.* and *v. l. m.*). Although a single band, the dorsal one is much more feebly developed in the median line than on either side. (4) Below this again is a delicate layer of cœlomic epithelium, forming the outer wall of cœlom, and only to be distinguished by a few nuclei scattered here and there on the extremities of the muscle-fibres (figs. 5, 6, 7, and 8, *c. ep.*).

Coming from and dividing the dorsal longitudinal muscles on either side, and stretching vertically downwards to be attached close to the thickened portion of the epidermis of the ventral surface on either side, are, in the anterior region of the body, i. e. from the 2nd to the 6th segments, very distinct dorso-ventral muscles (fig. 5, *d. v. m.*), dividing the cavity of each of these segments more or less completely into three longitudinal chambers.

Besides these there are in every segment muscles going from the ventral epidermic thickening on each side to the two setal sacs (*s. s. m.*), but these appear to be rather continuations of the circular than of the longitudinal layer. Both these and the dorso-ventral muscles are covered by a delicate layer of cœlomic epithelium.

Alimentary Canal.—The mouth is not terminal, but is overlapped by the prostomium (fig. 1, *m.*). The two “cephalic” tentacles, as already mentioned, arise just above it on either side. The pharynx extends through the first two segments

(fig. 2). Its anterior part is evertible and richly ciliated. It is almost always extruded at once when the animal is first compressed by a cover slip (fig. 3, B. *ph.*). The pharynx narrows in the posterior part of the 2nd segment to form the œsophagus, which is continued through the next few segments. The canal then gets much wider, and begins to be constricted intersegmentally by the septa. The segment in which this change from œsophagus to intestine takes place varies with the size of the individual. Posteriorly, i.e. in the posterior third or fourth of the body (again varying according to the size of the individual), it narrows again, and this part especially is exceedingly contractile. The anus is terminal (fig. 2). From it cilia can be seen moving upwards towards the mouth, indicating thereby some anal respiration. In some specimens, but not in all, ciliated ridges could be seen in the intestine just in front of the anus (fig. 11), probably the same thing as the richly ciliated swelling found in the larvæ of allied forms. The alimentary canal is lined throughout by columnar epithelium, consisting of cells one layer deep, ciliated in the pharynx and œsophagus, and also in the hinder unconstricted part, of the intestine, but apparently not in the anterior constricted part, which occupies the greater length of the body. This epithelium is much folded in the anterior region, especially in the pharynx (fig. 5, *int. ep.*), not so much in the third and fourth segments, but again in the hinder œsophageal region. It is not folded, and the lumen of the canal is wide, in the anterior intestinal region (fig. 6); afterwards it again becomes folded to some extent (fig. 7). The cells forming the folds are longer and narrower than the others (figs. 5 and 7), but their nuclei, as in the other cells, are situated close to the peripheral wall, all the nuclei together forming a very regular circular layer.

Outside the epithelial layer is a very thin circular muscular layer, best seen in the anterior region of the body (fig. 5, *c. m².*), but not seen at all distinctly posteriorly, though its presence would seem to be indicated by the muscular contractions of the whole alimentary canal. There are no longitudinal muscles to

be seen, and directly outside the circular muscle layer comes the cœlomic epithelium. Neither of these last two layers takes any share in the folds.

In one specimen which I had, which was evidently a young form with only about twenty segments, the alimentary canal was wide, and constricted intersegmentally in all the anterior segments of the body as far back as the 10th. Between the 10th and 11th segments was a deep permanent constriction, the canal continuing very narrow throughout the rest of the length of the body. This would seem to imply that the pharyngeal and œsophageal region of the alimentary canal developed late.¹ In this specimen there was green pigment all down the sides of the alimentary canal, not, as far as I could see, enclosed in any way. There were also no thoracic nephridia.

Like so many other Chætopods, this one has almost constantly present parasitic monocystes in its intestine, and these are often very numerous. They are broad at one extremity (apparently the anterior), and usually pointed at the other (fig. 13). The cortical substance forms a clear zone, wider at the anterior extremity. The medullary substance is coarsely granular, and in it, reaching to the posterior extremity, is usually a long narrow vacuole (*vac.*), which may sometimes be found bursting. Sometimes they have no vacuole, and such I at first mistook for eggs, until finding that they were in the alimentary canal and not in the cœlom. They may be seen moving backwards and forwards with the intestine, apparently incapable, while in the body at least, of any independent motion of their own. The nucleus (*n.*) is spherical and well marked, containing a nucleolus.

Vascular System.²—There is a contractile dorsal vessel

¹ But it may be that the œsophagus is developed, but resembles the part of the intestine following it in being intersegmentally constricted, since this appears to be the case in the larva of what is probably a *Spio* or *Nerine* described by Leuckart in the 'Arch. f. Naturg.,' 21st Jahrgg., 1855, p. 63, &c., and pl. ii, fig. 1. Here, however, I did not observe anything marking off the two regions of the alimentary canal from one another, as Leuckart describes in his larva.

² The whole arrangement of the vascular system is not easy to determine,

(figs. 2 and 12, *d. v.*) in the anterior region of the body, continued forwards into the prostomium. Just before it reaches the prostomium two vessels are given off, one to each branchia (*d. br. v.*). These run up the inner sides of the branchiæ, and return by vessels on the outer side (*v. br. v.*), which meet in the median line on the ventral surface in the posterior part of the first segment to form the ventral vessel (*v. v.*).¹ Before they meet each appears to give off or be joined by the single contractile vessel going to the "cephalic" tentacle (*t. v.*). The ventral vessel runs throughout the whole length of the body (figs. 2, 5, 6, 7, 8, *v. v.*), passes in the anal segment into a sinus (figs. 2, 7, 8, *sin.*) surrounding the intestine, and lying just outside the epithelium, probably between it and the circular muscular layer; or it may be that the circular muscular layer is really absent in this region, and that the sinus lying between the intestinal and the cœlomic epithelium of the alimentary canal has some contractile power of its own, as it has in other sedentary annelids, e. g. *Spirographis*,² where, however, muscular fibres are present as well. This sinus completely surrounds the intestine in the whole of its posterior non-constricted part, and is at first continued over part of the constricted part; then, however, a nucleated mass appears inside it on the median dorsal line of the wall of the intestine, and forms a longitudinal upstanding ridge. Part of the sinus closes in round this ridge, and becomes nipped off from the rest of the sinus (figs. 2 and 6, *d. s. v.*), and so is continued forwards

and what is given in the text is only what appears to me—after the examination of numerous living specimens and series of sections—to be its probable distribution. When living the animal is too opaque, when dead the vessels are seldom in the same state of contraction or expansion in two individuals. The vascular system in the highest animals even is subject to individual variation, and it may be that there are really slight individual variations in its arrangement in worms, and in this amongst others.

¹ The direction in which the blood flows in the branchiæ cannot be determined, as the vessels cannot be seen in the living. It probably may flow in either direction, from the ventral to the dorsal at one time and from the dorsal to the ventral at another.

² Claparède, 1873, 'La Structure des Annélides sédentaires.'

on the intestine, the ridge inside it being separated from the intestinal epithelium by a very fine layer of cœlomic epithelium only. Some series of sections would seem at first sight to show that the ridge was in its posterior part directly continuous with the intestinal epithelium; but a more careful examination leads rather to the conclusion that it is formed by the tucking-in of the cœlomic epithelium which lies outside the sinus on either side. It lies, however, especially posteriorly, exceedingly close to the intestinal wall. Its significance (whether physiological or morphological) is as difficult to determine as that of the so-called "Herzkörper" or "cardiac body" of certain other Polychæts,¹ which it in all probability represents. No lumen is to be seen in it here throughout its course.

In the œsophageal region the nipped-off upper part of the sinus enclosing the longitudinal ridge (fig. 2) leaves the walls of the alimentary canal, and becomes the contractile dorsal vessel which runs upwards until it comes to lie just beneath the thin part of the body-wall in the dorsal median line, *i. e.* where the longitudinal muscle layer is only very feebly developed (fig. 5, *d. v.*). It is here surrounded by a well-developed circular muscular layer (*c. m.*) to which its contractile power is due. The walls of all the other vessels and of the sinus appear to consist only of cœlomic epithelium. It is difficult to say what happens to the rest of the sinus (which is continued throughout the intestinal region) when the dorsal vessel finally leaves the wall of the alimentary canal in the œsophageal region. It certainly is not continued as a sinus, but whether it forms vessels or not is a difficult point to determine, since there are other very much coiled vessels in each segment of the œsophageal region. These coiled transverse or dorso-ventral vessels seem to me to connect the dorsal and ventral vessels (as shown diagrammatically in fig. 12), but it may be that they connect the ventral not with the dorsal, but with lateral vessels which are continuations forwards of the sinus, lying, for some part of their course at least, close to the dorsal vessel. The dorso-ventral vessels

¹ See Cunningham, "Some Points in the Anatomy of Polychæta," this Journal, vol. xxviii, 1887.

all lie freely in the cœlom. They are represented in the first segment by the vessels going to the branchiæ. In the posterior region of the body, *i. e.* where there is the sinus, it is difficult to say whether transverse vessels are present or not. In some series of sections vessels may be seen here and there leaving the upper part of the remaining sinus where the dorsal vessel is just nipped off. More posteriorly, where the sinus is continuous all round the intestine, vessels may sometimes be seen running from the ventral vessel (fig. 8, *v. v.*). These do not appear to occur regularly in every segment, and they cannot be seen at all in some series of sections which show the other parts of the vascular system clearly. But it is difficult to say whether they are really not present, or whether they are merely contracted, and therefore not seen, or not recognised as blood-vessels. We should not, therefore, be justified in concluding that the sinus represents them, although this would seem not unlikely in the most posterior region where the sinus is complete. In other Polychæts where there is a sinus (*e. g.* Scalibregnia, Trophonria, Eumenia) transverse vessels running to it from the ventral vessel are long and well marked.¹

The blood flows from behind forwards in the sinus and dorsal vessel, from in front backwards in the ventral vessel. It is probably aërated both at the anus and in the branchiæ on the head-segment, and also to some extent in the "cephalic" tentacles. It would be interesting to note whether all forms that have a sinus round the intestine have also other indications of an anal respiration. The blood is red, coloured probably by hæmoglobin. It contains, as far as I have seen, no corpuscles.

Cœlom and Nephridia.—The cœlom is partially divided into separate cavities by the septa, which are thin muscular partitions between the segments coated with cœlomic epithelium on either side. They move backwards and forwards with the intestine. There is a dorsal and ventral mesentery supporting the intestine (fig. 7), and thus dividing the cœlom longitudi-

¹ See A. Wiren, 'Beiträge zur Anat. u. Hist. d. Anneliden. Königl. Sv. Vet. Akademiens Handlingar,' Bd. xxii, No. 1.

nally into two halves. Besides this there are in the anterior region the three longitudinal chambers separated from one another by the dorso-ventral muscles.

There are nephridia of two kinds. In the anterior (thoracic) region of the body there are at once seen in the living (fig. 1) two green tubes, one on either side of the alimentary canal. On further examination each is seen to be bent on itself, and cilia may be seen moving in it, especially well seen at the bend of the tube which is in the posterior part of the 6th segment. As far as I can make out from examination of the living and from sections, the opening to the exterior is between the second and third ventral bristle bundles, in the hinder part of the 2nd segment. By analogy we should expect the internal opening to be in the septum dividing the 1st from the 2nd segment. Whether this is so or not I am unable to say; I can trace the lumen of the internal limb in longitudinal sections up into the 2nd segment to the level of the second pair of bristle bundles, but it is difficult to trace further. It may be that the septum is temporarily bent back, so as to lie partly within the 2nd segment. In transverse sections the internal limb (fig. 5, *neph. i.*) is not at all easy to see and to trace, since it lies almost in the dorso-ventral muscles or is obscured by them. The external limb (fig. 5, *neph. e.*) lies below the internal one on either side of the ventral vessel, with it in the middle one of the three longitudinal cavities shut off by the dorso-ventral muscles. Both limbs consist of simple drain-pipe cells. These nephridia are probably excretory in function.¹

¹ Such thoracic nephridia in other sedentary annelids have been called "tubiparous glands" by Claparède and others; but it is more probable, as has been pointed out by Cosmovici, Soulier, and Brunotte (as quoted by Meyer in the 'Zool. Mith. v. Neapel' for 1888), that it is the unicellular glands of the epidermis, not the thoracic nephridia, which secrete the material for fixing together the particles of mud or sand of which the tube is formed, since worms from which the thoracic region of the body has been entirely removed can still form tubes, and since the tube does not begin to be formed until after the development of the unicellular glands. In favour of this view is the fact that, in forms most nearly allied to the one we are here considering, which are more tubicolous in habit, there are not these modified thoracic nephridia.

In the young specimens above mentioned (p. 182) these tubes were not to be seen, showing probably that they also develop late with the œsophagus.

The second kind of nephridium is found in the abdominal region of the body only of those individuals in which the gonads are developed, a single pair in each segment in which there are gonads. In such individuals they may be seen very distinctly in transverse section (fig. 8, *neph.*). They are very short, simple, uncoiled, ciliated tubes (fig. 14). But here, again, it is very difficult to say with absolute certainty whether they lead through a septum from one segment to the next, or whether they lie wholly in a segment.

In individuals in which there are no genital products present they are, if represented at all, at any rate functionless, and with no lumen. They serve, therefore, as genital ducts.

Genital Organs. — The sexes appear to be distinct, though I am not sure that I have seen any specimens with ova. As is usual in marine annelids, the generative products develop only at certain seasons of the year, and at other times the males and females are indistinguishable. In living specimens which I examined in the summer I thought I saw eggs, i. e. I saw bodies resembling eggs, but forget whether I distinctly saw them in the cœlom, or only inferred them to be there. They may, therefore, have been only parasites. Unfortunately, thinking that I was sure to get plenty more with eggs, I did not preserve or cut sections of any of them.

The sperm-mother cells are oval or spherical, with well-marked nuclei which may be seen dividing. Masses of them may be seen in the ripe male individual on either side of the intestine just above the nephridium, and attached to the cœlomic epithelium surrounding the sinus of the intestine in all the hinder abdominal segments (fig. 8, *test.*). Spermatozoa with long tails may also be seen. Together they occupy almost the whole cavity of the cœlom in the region where they are developed. In the one ripe male individual of which I was able to cut sections, which was a specimen with thirty-five segments altogether, the gonads (and consequently the

nephridia) were present in the posterior twenty-two segments, i. e. from the fourteenth to thirty-fifth inclusive.

Nervous System.—There is a supra-œsophageal ganglion nearly filling the prostomium (fig. 2, *gng.*), and probably supplying the much-thickened epidermis of the anterior region of the prostomium, the eyes, and the anterior pair of tentacles.¹ From this a commissure goes down on either side to join the ventral nerve-chain, which runs throughout the whole length of the body as a double cord in the much-thickened epidermis of the ventral surface (figs. 5, 6, 7, and 8, *n. c.*). The two cords are distinct from one another, although very close together. There are no ganglionic swellings on them. Very minute giant-fibres (“neural canals,” “fibres tubulaires,” “neurochords”) may be made out by careful staining in each cord on its dorsal and inner side. In sections stained with hæmatoxylin each appeared as a hollow tube, containing a shrunken homogeneous mass inside (figs. 5, 6, and 7). In other sections, stained with borax-carminé (fig. 8), the giant-fibres were more difficult to distinguish from the rest of the nerve-cord, the homogeneous mass not having shrunk away from its sheath. A similar position for these structures has been noted in the anterior region of *Nerine foliosa*, Sars, and in *Scolecolepis vulgaris*, Johnst., amongst the Spionidæ. In *Prionospio* there are also two neural canals, but these are inferior in position.² In forms belonging to other families the same position of the giant-fibre with regard to the nerve-cord is found, e. g.³ *Arenicola* (Telethusidæ), *Trophonia* (Chlorhæmidæ), *Sabellaria* (Hermellidæ).

Affinities.—*Hekaterobranchus* I take to belong to the family Spionidæ on account of (1) the single pair of tentacles containing a single blindly-ending vessel; (2) the branchiæ, each containing an afferent and efferent vessel not connected with one another by capillaries; (3) the very superficial posi-

¹ Jacobi, ‘Polydoren d. Kieler Bucht,’ 1883, p. 23.

² M’Intosh, “On the Structure of the Body-wall in the Spionidæ,” ‘Proc. Roy. Soc. Edin.,’ vol. ix, pp. 123—129.

³ See Cunningham, “Some Points in the Anatomy of the Polychæta,” this Journal, vol. xxviii.

tion of the nerve-cord, the distinctness of the two cords from one another, and the absence of ganglionic swellings.

It differs from all other genera of the family Spionidæ in the possession of only one pair of dorsal branchiæ.¹ These are on the first or head-segment. They are found in this position as well as on the following segments in some species of some of the other genera (e. g. *Spio fuliginosus*,² *Scolecolepis vulgaris*, and *Scolecolepis cirrata*³). The single pair of branchiæ of *Hekaterobranchnus* are much larger and more developed than are any of the numerous branchiæ of other Spionidæ. This reduction in number of the branchiæ, their increase in size, and their position on the head together seem to indicate that the worm once led a more sedentary life than it now does. Other facts leading to the same conclusion are—the presence of a ventral collar, the single pair of modified thoracic nephridia, the reduction of the parapodia, and, as in all other sedentary annelids, the possession of crotchet chætæ.

It is true that most genera of the family Spionidæ, with a much greater number of dorsal branchiæ, inhabit now much more distinct tubes than *Hekaterobranchnus*. It would appear, therefore, either that they have not yet degenerated so far as *Hekaterobranchnus* from the ancestral *Spio*, or that *Hekaterobranchnus* has developed other modes of respiration which other Spionids have not, e. g. the anal respiration and that of the cephalic tentacles. For although in other genera the cephalic tentacles do serve as respiratory organs, they do so to a very slight extent only: they are ciliated only on one side, and they serve mainly as prehensile and tactile organs; whereas here they are ciliated all over, and probably

¹ See, however, note at the end of this paper.

² Claparède, 'Ann. Chæt. du G. de Naples,' 1868, part ii, pl. xxiii, fig. 1. In the text (p. 63) Claparède says the branchiæ begin on the second segment; but this is evidently a slip, as, in his definition of the species (p. 62), he says, rightly enough, they begin on the first setigerous segment; and here, as in most, if not all the Spionidæ, the first segment is setigerous.

³ Malmgren, 'Ann. Polych.,' 1867, pl. x, figs. 54A and A'.

serve to a much greater extent for respiration, though retaining their other functions as well.

The ventral collar, usually taken as a characteristic of the family Serpulidæ, has not been actually mentioned as present in the Spionidæ. Judging, however, from a very incomplete and imperfect figure given with the Report on Annelids by Webster and Benedict in the 'Commissioner's Report of Fish and Fisheries for the United States' in the year 1881, there would appear to be a collar of the same sort in *Streblospio Benedicti*.¹

Large modified thoracic nephridia are found in several families of sedentary annelids, e. g. the Terebellidæ, Hermellidæ, Serpulidæ, and Cirratulidæ, sometimes a single pair only, sometimes two or even three pairs, and sometimes, as in the Serpulidæ, one pair with a common opening to the exterior. They have not been described in other genera of the family Spionidæ.

The sinus round the intestine has also not, as far as I am aware, been described in other Spionids, but a vascular plexus occurs round the intestine in some forms, e. g. *Nerine cirratulus*.² A sinus is found in the Serpulidæ, Chætopteridæ, Ariciidæ, Terebellidæ, and in many of the Cirratulidæ amongst others, but cannot be regarded as of much classificatory importance.

The dorsal collar of the 2nd segment is not found in other Spionids, nor in other families; but in some Spionids, e. g. *Spiophanes Verrilli* (described in the same paper by Webster and Benedict), there is a membranous ciliated dorsal ridge connecting the bases of the opposite so-called "cirri" on every segment from the 6th backwards, and this may be something of the same kind.

We see, therefore, that *Hekaterobranchus* has many characters in common with the Serpulidæ,³ and I think there is good reason to regard it as the degenerate descendant of a form

¹ See note at the end of this paper.

² Claparède, 'Annélides sédentaires,' 1873.

³ It also has many characters in common with the Cirratulidæ which other Spionids have not. This family is notably closely allied to the Spionidæ, being probably an earlier and more primitive offshoot than the Serpulidæ.

from which the ancestors of the two families (Spionidæ and Serpulidæ) have been derived. It would appear to be nearest to the tribe Amphicoridæ of the family Serpulidæ.

In order to grant that Hekaterobranchus does thus connect the two families we must follow Meyer in his recent and very interesting paper on the homologies of the branchiæ of the Serpulidæ ('*Mitth. Zool. St. v. Neapel*,' vol. viii, 1888), and grant that the cephalic branchiæ of the Serpulidæ are developments of the cephalic tentacles of the Spionidæ. The branchiæ of the Serpulids have been clearly shown to be prostomial organs, both in development and in innervation. The tentacles of the Spionids are, according to Leuchart,¹ and Leuckart and Pagenstecher,² prostomial in origin. According to Jacobi ('*Polydoren der kieler Bucht, Inaugural Dissertation zur Erlangung der Doctorwürde*, 1883, pl. ii, fig. 27, p. 23) they are innervated from the prostomial ganglion. So far we should have no difficulty in deriving the complex branchiæ of Serpulids from the simple tentacles of Spionids. Were the simple remaining pair of dorsal branchiæ of Hekaterobranchus to disappear, still more work would be thrown on the cephalic tentacles; and an organ with these important functions (respiration, prehension, and tactile sensibility) localised in it would be subject to great variation, and would consequently develop rapidly. Thus we should find these organs first multiplying, but remaining simple as in Haplobranchus and Manayunkia,³ then each becoming more complex and giving off secondary rays, as in Fabricia and Amphi-

¹ '*Arch. f. Naturg.*,' 21st yr., p. 63, &c., pl. ii. Leuckart says they develop on either side of the "Kopfhöcker" (? = prostomial crest), between it and the enlarged "upper lip." This "upper lip," he says, marks the boundary between the pro- and peri-stomium; and where the tentacles join it there is a group of long cilia on either side, probably representing the remains of the cephalotroch of the larva.

² '*Müller's Archiv*,' 1858, pp. 610—613, pl. xxiii. Here it is said that the middle ciliated band of the larva separates the body into two halves, from the anterior of which the prostomium with the tentacles is formed, and from the posterior of which all the body-segments are formed.

³ Leidy, '*Proc. Acad. Nat. Sci. Philadelphia*,' pp. 204—212, pl. ix.

glena; and, finally, both primary and secondary rays multiplying greatly until we get the complex condition of other Serpulids (tribes Sabellidæ, Serpulidæ proper, and Erioglyphidæ); and in all these forms, even in the most elaborate, the same structures can be traced.

In *Haplobranchus* and *Manayunkia* there is a single pair of tentacles, with the same single blindly-ending contractile vessel running up them as in *Hekaterobbranchus* and other Spionids.¹ The other tentacles, which I would regard as multiplications of this one, have not as yet the contractile vessel developed in them; but their cavity is, as I have been able to ascertain from sections of *Haplobranchus*, in continuity with that of the tentacle containing the blood-vessel some way above the base.

In *Amphiglæna* and *Fabricia* all the branchial rays, and not a single pair only, have the contractile vessel in them. That they also still retain their tactile function is shown by the fact that each ray is non-ciliated, but provided with short, stiff, tactile hairs at its apex. In all the other Serpulids there is the same single contractile vessel ending blindly in each secondary ray.²

¹ Bourne calls these "palps" in *Haplobranchus*, but says their homology is difficult to determine. They are certainly, as confirmed by sections, ventral in position. Leidy says that they are dorsal in position in *Manayunkia*, but apparently this has not been confirmed by sections. If there is this difference in position in what would at first sight (cf. the figures of Bourne and Leidy) appear so very evidently to be the same thing, it seems to me that it would go far towards showing that all the tentacles on the head of either form are developments (multiplications) of one, it being indifferent in which one the original characteristic contractile vessel develops.

² It will be seen from the above that if I accept Meyer's premises, I do not agree with him in his conclusions with regard to the relationships of the Serpulidæ inter se. That is to say, I do not regard the tribe Amphicoridæ, to which *Haplobranchus*, *Manayunkia*, *Fabricia*, and *Amphiglæna* belong, as degenerate from higher existing tribes, but rather as primitive; i. e. I regard these forms as the descendants (degenerate undoubtedly in many ways) of a form more primitive than the ancestors of any of the other existing tribes. No doubt, as Meyer remarks, they once led a much more sedentary life than they now do; but it does not therefore necessarily follow that they are

Granting, therefore, that the cephalic tentacles of the Spionidæ are prostomial, there would seem to be little or no doubt of their homology with the branchiæ of the Serpulidæ. But may we grant this? The transverse section of *Nerine* given by Claparède in his 'Structure des Annélides sédentaires,' 1873, pl. xv, fig. 1, would seem directly to contradict Jacobi's figure and explanation already referred to. Setæ are never found on the prostomium; yet, according to Claparède, there are setæ at the base of the cephalic tentacles in *Nerine cirratulus*.¹ Also, according to Claparède ('Beobachtungen ü. Anat. u. Entwicklungsgesch. wirbellöser Thiere,' 1863, p. 71), and Claparède and Mecznirow ('Zeitsch. f. w. Zool.', vol. xix, pp. 172 and 177), they develop not from the prostomium but from the peristomium. Claparède evidently never thought of these tentacles as being anything but peristomial, and a good many of the figures in his 'Annélides Chætopods du Golf de Naples (1868)' would seem to point to the fact. He very seldom, however, gives here a ventral or lateral view, and it is therefore very difficult to determine what is truly prostomial. From dorsal views only one is very apt to mistake the crest which is developed on the prostomium, but also sometimes on one or two of the segments as well, for the prostomium. Whether Claparède would have come to different conclusions had he had the question before him is of course impossible for us to say, but he is, as a rule, such an accurate observer that, without further examination of the same forms that he describes, we are not, I think, justified in concluding, as Meyer does, that this was a "Beobachtungsfehler." The point can only be decided by a renewed study of the development, and by further observations on the living in as many genera as are obtainable,² since in spirit specimens, even when degenerate from ancestors of now existing forms. Meyer's arguments are, in my opinion, insufficient to prove this.

¹ Unfortunately, in the only specimens of *Nerine cirratulus* I was able to procure for examination the tentacles had fallen off, and I was unable to confirm Claparède's observation.

² The forms described in the 'United States Fishery Reports' would no doubt prove of great interest if properly figured, but unfortunately the writers

the tentacles remain attached, it is very difficult to make out their point of attachment, though sections of well-preserved specimens would also be of value. Meyer appears to think that there is sufficient evidence of their prostomial nature, and he goes on to show that both they and the branchiæ of Serpulids probably represent the palps, not the so-called "prostomial tentacles" of the Errantia (e.g. *Nereis* and *Polynoë*).¹ He considers (pp. 614, 615) that there is a good deal of evidence that the tentacles of Spionids originate ventrally on either side of and slightly in front of the mouth, and only later move upwards more on to the dorsal surface. He regards the small quite anterior tentacles of *Polydora antennata* and others as representing the "prostomial tentacles" proper of the Errantia. He also quotes in support of his view Pruvot's observations on the nervous system of annelids, which led that observer to conclude that the branchiæ of Serpulids probably represent the palps of the Errantia.² Again, he shows that in the adults of some of the Spionidæ (e.g. *Polydora antennata*), Chætopteridæ (e.g. *Telepsarus costarum* and *Phyllochætopserus*), and Cirratulidæ (e.g. *Heterocirrus frontifilis*) the tentacles are much more ventrally placed than in others; and in some cases, as in *Heterocirrus*, they are situated quite ventrally in front of the mouth. In this view, if the prostomial nature of the tentacles may be granted, I entirely agree with him. He might also have given instances amongst the Errantia in which the palps are much higher up on the lateral surface than usual, e.g. *Stau-rocephalus*.³ It may also be of some significance, though perhaps

of the report have taken care to figure most of the forms without their characteristic tentacles, or else to figure the tentacles with some very limited portion of the head only.

¹ For definitions of the different tentacles on the head of polychæt worms see Bourne's paper on "*Haplobranchus*" above referred to, footnote to p. 169.

² 'Arch. de Zool. Expérimentale,' 2nd series, vol. iii, 1885, pp. 314, 322.

³ Claparède, 'Ann. Chæt. du G. de Naples,' part i, pl. vii, fig. 2A. Compare also Bourne's description of the palps in the *Polynoina* ('Trans. Linnæan Soc.,' 1883, 2nd series, "Zoology," vol. ii, part vii, p. 351). He says, "The palps differ from all other tentacular structures in being muscular along their whole length. They are capable of great elongation and contraction."

not much, that the ciliated groove of the tentacles of most Spionids is used in conveying food down to the mouth, the cilia being continuous with those of the mouth opening, which would make it the more probable that the tentacles were once outgrowths of the side of the mouth. According to this view, the name "palp" given to the most ventral pair of cephalic tentacles of *Haplobranchus* by Dr. Bourne might be retained, but extended so as to include the other tentacles as well. Dr. Bourne in his paper regards these other tentacles as peristomial, from a certain superficial resemblance they bore to the peristomial tentacles of *Nereis*, and he tries to show that the cephalic branchiæ of the *Serpulidæ* are peristomial; but, as Meyer has shown, there is no evidence of fusion of ganglia in the *Serpulidæ* as there is in the *Nereidæ*. When Dr. Bourne wrote his paper, however, he was unaware of the existence of *Manayunkia*, which was first described in the same year (1883), or he might have been led to different conclusions with regard to what he has called "peristomial tentacles."¹

They originate [sections of *Polynoë* (*Harmothoë*) *areolata*] just where the prostomium joins the peristomial and buccal somites, although they appear to have more connection with the prostomium than with the other somites. Their nerve-supply appears to come from the supra-oesophageal ganglion." Such a description would need but little modification to serve for the tentacles of some of the *Spionidæ* (e.g. *Polydora antennata*) and *Cirratulidæ* (e.g. *Heterocirrus frontifilis*). Bourne does not mention a contractile blindly-ending vessel in them, but there is this in *Staurocephalus*. The chief difference is the absence of cilia on the palps of *Polynoë*.

¹ As regards the rest of Meyer's view, I should like to point out that in *Hekaterobranchus* the lateral parts of the collar are evidently not formed by the ventral cirri, since these are present quite independently as well on the 1st segment. The collar appears to be a mere folding of the ventral surface; if anything it could only be the dorsal cirrus which assists in forming it. I have especially looked for the "Wimper-organe" on the prostomium, which Meyer mentions (p. 639) as a feature which we might expect to find in the *Spionidæ*, but have been unable to find any trace of them. I may also mention in reply to Meyer's suggestion (vol. vii, p. 723) that there are probably thoracic nephridia with a single external duct in *Haplobranchus*, that in my sections of *Haplobranchus* I have been unable to find any trace of such an arrangement; and I even doubt whether what Bourne marks "gl" in his figure of *Haplobranchus* are to be regarded as nephridia at all. There is

SYSTEMATIC DESCRIPTION.

Family Spionidæ.

Hekaterobranchnus,¹ gen. n.

Spio quadricornis, Lam., 'Anim. s. Vert.,' vol. v, p. 319.²

A single pair of dorsal branchiæ, situated on the 1st segment, and very large.

no trace whatever of a lumen in them, and consequently none of external or internal openings. In *Haplobranchus* there are the same pigmented organs of unknown function on the bases of the branchiæ, in some specimens at least, as are described and figured by Mecznirow in *Fabricia* ('Zeit. f. wiss. Zool.,' vol. xv, p. 331, and pl. xxiv, fig. 8). Can these represent the prostomial ciliated pits from which Meyer considers (vol. viii, pp. 629—634) the most anterior portion of the common median duct to the exterior of the modified thoracic nephridia of *Serpulids* is to be derived? They open separately to the exterior on either side beneath the collar. Mecznirow does not say whether the common aperture to the exterior of the pair of nephridia he describes in the 2nd segment is on the prostomium or not.

I will also mention that there is a sinus round the intestine in *Haplobranchus*, as Dr. Bourne suggests there may be. In the anterior region I cannot in my sections see the dorsal vessel he mentions. The alimentary canal nearly touches the body-wall dorsally. The cœlom, however, in this region is divided into distinct longitudinal cavities, four, or more anteriorly, two, on each side.

My sections would also seem to show that *Haplobranchus* has an evertible pharynx, which, when inverted, reaches back into the 2nd segment. But further investigation is needed.

¹ "Ἐκατερος = each (singly) of two. The name is meant to imply that two kinds of branchial organs are present, and that there is one single pair of each kind.

² I have identified this form with the *Spio quadricornis* of Lamarck, because it with its four horn-like tentacles (tentacles proper and branchiæ) is exceedingly suggestive of the name—much more so than the animal—*Spio crenaticornis* figured by Montague, to which Lamarck refers. (Lamarck refers to it as "*Diplotus hyalina*" because Montague's figures are wrongly numbered, but according to the text the figures 6 and 7 of pl. xiv ('Trans. Linnæan Soc.,' xi) should be marked as *Spio crenaticornis*.) It is extremely probable that Lamarck saw *Hekaterobranchnus*, and gave the name "*Spio quadricornis*" to it; and that he wrongly identified it with *Spio crenaticornis*, Montague, which was probably also not a *Spio* at all, but a *Leucodore*.

Cephalic tentacles not grooved, but ciliated all over.

Prostomium well developed, bearing four eyes.

1st segment prolonged forwards on the ventral surface to form a collar.

Pharynx evertible and richly ciliated.

A single pair of thoracic nephridia, opening to the exterior in the 2nd segment, reaching back into the 6th segment, and thence bending forwards again.

Giant-fibres minute, one in each nerve-cord near the upper and inner surface.

Dorsal "cirri" forming a sort of collar in the 2nd segment.

H. Shrubsolii, sp. n.

The following characters are probably of specific value.

Ventral crotchet chætæ begin in 8th segment, accompanied by a few capillary chætæ.

Shape of chætæ (fig. 4).

Sinus round intestine posteriorly.

Intra-vascular ridge in dorsal vessel.

Thoracic nephridia green.

Habitat.—The mouth of the Thames.¹

POSTSCRIPT.

WHILST the foregoing paper was in the press I succeeded in obtaining Webster's original description of the genus *Streblospio*, which is in the 39th Annual Report of the Trustees of the New York State Museum of Natural History. Had I seen the full description of this genus earlier, I should have been loth to make a new genus for a form which may well be included in Webster's genus. But having seen a figure of the head of *Streblospio*, and this not even suggesting to me the identity of the genus I was studying with the one figured, I contented myself with merely mentioning (p. 190) what appeared to be one point of resemblance between the two

¹ Mr. Shrubsole informs me that he has found both this form and *Haplobranchus* as far up as Gravesend on the south side of the river.

forms, and did not concern myself with hunting for the fuller description before sending my paper to the press.

From the description which I have now seen, it appears to me highly probable that *Hekaterobranchus* will have to be regarded, for the present at least, in virtue of its single pair of branchiæ placed on the head, its ventral collar, and its dorsal collar (equivalent to the so-called dorsal "pouch" of Webster), as a new species of the genus *Streblospio*, rather than as a distinct genus. There are, however, differences between the two forms, which might rank as generic differences were there a large number of forms with their common characteristics known. For instance, the "conical median papilla or cirrus" on the anterior margin of the first segment, the short conical dorsal cirri of the posterior segments succeeding and replacing the plate-like lobes of the anterior, the fact that the "proboscis is incomplete above" (though, as I have failed to grasp what this means, I cannot attach much importance to it), the absence of thoracic nephridia (unless the dark green colour observed in the first eight segments of a few specimens was due to their presence), are all features in *Streblospio* which might prevent the association of *Hekaterobranchus* with it as one genus. How much, or how little, importance is to be attached to these differences is difficult to say without comparing the two forms, or at least proper representations of them, side by side. The drawings published by Mr. Webster of his *Streblospio* are so fragmentary and rough that I cannot undertake to form a final opinion on the subject by their aid alone.

EXPLANATION OF PLATES XXI and XXII,

Illustrating Miss Florence Buchanan's paper on "Hekatero-branchus Shrubsolii, a new genus and species of the family Spionidæ."

FIG. 1.—Lateral surface view of the whole animal. *pro.* Prostomium. *m.* Mouth. *t.* Cephalic tentacles, with cilia and tactile hairs. *br.* Branchiæ. *v. c.* Ventral collar of 1st segment. *d. c.* Dorsal collar formed by the two "cirri" of the 2nd segment. *a.* Anus. The ventral crotchet chætæ are seen beginning in the 8th segment.

FIG. 1A.—The same, natural size.

FIG. 2.—Semi-diagrammatic view of the left side of the animal from the inside, as would be seen were the animal cut in two by a longitudinal, vertical, nearly median section. The tentacle (*t.*) and branchiæ (*br.*) are supposed to have been cut separately. The digestive, vascular, nervous, and excretory systems are shown. *m.* Mouth. *ph.* Pharynx. *æs.* Œsophagus. *int.* Intestine (large, intersegmentally constricted part). *int'.* Intestine (narrow, non-constricted part). *a.* Anus. *d. v.* Dorsal vessel. *t. v.* Vessel of tentacle (its junction with the branchial vessel, which meets the ventral vessel, is seen in Fig. 12). *d. br. v.* Branchial vessel in connection with the dorsal vessel. *v. br. v.* Branchial vessel in connection with ventral vessel. *v. v.* Ventral vessel. *sin.* Sinus. *d. s. v.* Dorsal vessel nipped off from the rest of the sinus, but lying close to the wall of the intestine, containing the intravascular ridge. *n. c.* Nerve-cord. *gng.* Prostomial ganglion. *neph. e.* External limb of thoracic nephridium, opening to the exterior in the 2nd segment. *neph. i.* Internal limb of thoracic nephridium. *cæl.* Cælom. *sept.* Septa. Longitudinal muscles would really be seen in such a view underlying the epidermis, but are omitted for the sake of clearness.

FIG. 3.—Ventral view of anterior extremity. A. Showing ventral collar (*v. coll.*), and prostomium lying beneath it. The collar is pushed forwards, and so covers the mouth. B. The pharynx (*ph.*) everted, hiding the prostomium.

FIG. 4.—Chætæ. A. Notopodial capillary chætæ. B. Neuropodial capillary chætæ. C. Neuropodial crotchet (side view). C'. The same (ventral view).

FIG. 5.—Transverse section through the thoracic region of a specimen in which no gonads were developed (stained with hæmatoxylin). *Epid.* Epidermis. *c. m.* Circular muscle layer of body-wall. *c. m¹.* Circular muscle layer of dorsal vessel (*d. v.*). *c. m².* Circular muscle layer of alimentary canal. *d. l. m.* Dorsal longitudinal muscles of body-wall. *v. l. m.* Ventral longitudinal muscles of body-wall. *c. ep.* Cælomic epithelium. *cæl.* Cælom. *int. ep.* Intestinal epithelium. *ntp.* Notopodial chætæ. *nrp.* Neuropodial

chætæ. *ntp.* Notopodial "cirrus." *nrp.* Neuropodial cirrus. (The right side of the section is behind the left.) *s. s. m.* Muscles going to setal sacs. *d. v. m.* Dorso-ventral muscles. *gl.* Gland-cell in epidermis. *neph. e.* External limb of thoracic nephridium. *neph. i.* Internal limb of thoracic nephridium. *vasc. r.* Intra-vascular ridge in *d. v.* dorsal vessel. *v. v.* Ventral vessel. *d. v. v.* Parts of dorso-ventral vessel. *n. c.* Nerve-cord. *g. f.* Giant-fibre.

FIG. 6.—Transverse section of the same worm through the anterior abdominal region. The section is taken just in front of a septum, and therefore the intestine does not occupy so much room in section as it otherwise would. The dorsal vessel (*d. s. v.*) is separated from the intestinal sinus; the intra-vascular ridge (*vasc. r.*) is very close to but distinct from the wall of the intestine. Other letters as in Fig. 5.

FIG. 7.—Transverse section of the same specimen through the posterior abdominal region, where the intestine is not constricted intersegmentally. *sin.* Sinus, complete all round the intestine. *mes.* Dorsal mesentery. *mes'.* Ventral mesentery. Other letters as in Fig. 5.

FIG. 8.—Transverse section through another specimen, in which the gonads are developed (stained with borax-carmin). *test.* Testes. *neph.* Nephridia, seen opening to the exterior on the left-hand side of the figure in *ext.* A parasite (*par.*) is seen in the intestine. The section is taken farther back than that represented in Fig. 6, and consequently the sinus shows no trace of the dorsal vessel. From the ventral vessel (*v. v.*) a branch is seen passing off on the right-hand side. Other letters as in Fig. 5.

FIG. 9.—Transverse section of cephalic tentacle. *epid.* Ciliated epidermis. *c. m.* Circular muscle layer. *l. m.* Longitudinal muscle layer. *c. ep.* Cœlomic epithelium. *cæl.* Cœlom (containing cœlomic corpuscles in the living). *t. v.* Vessel of tentacle.

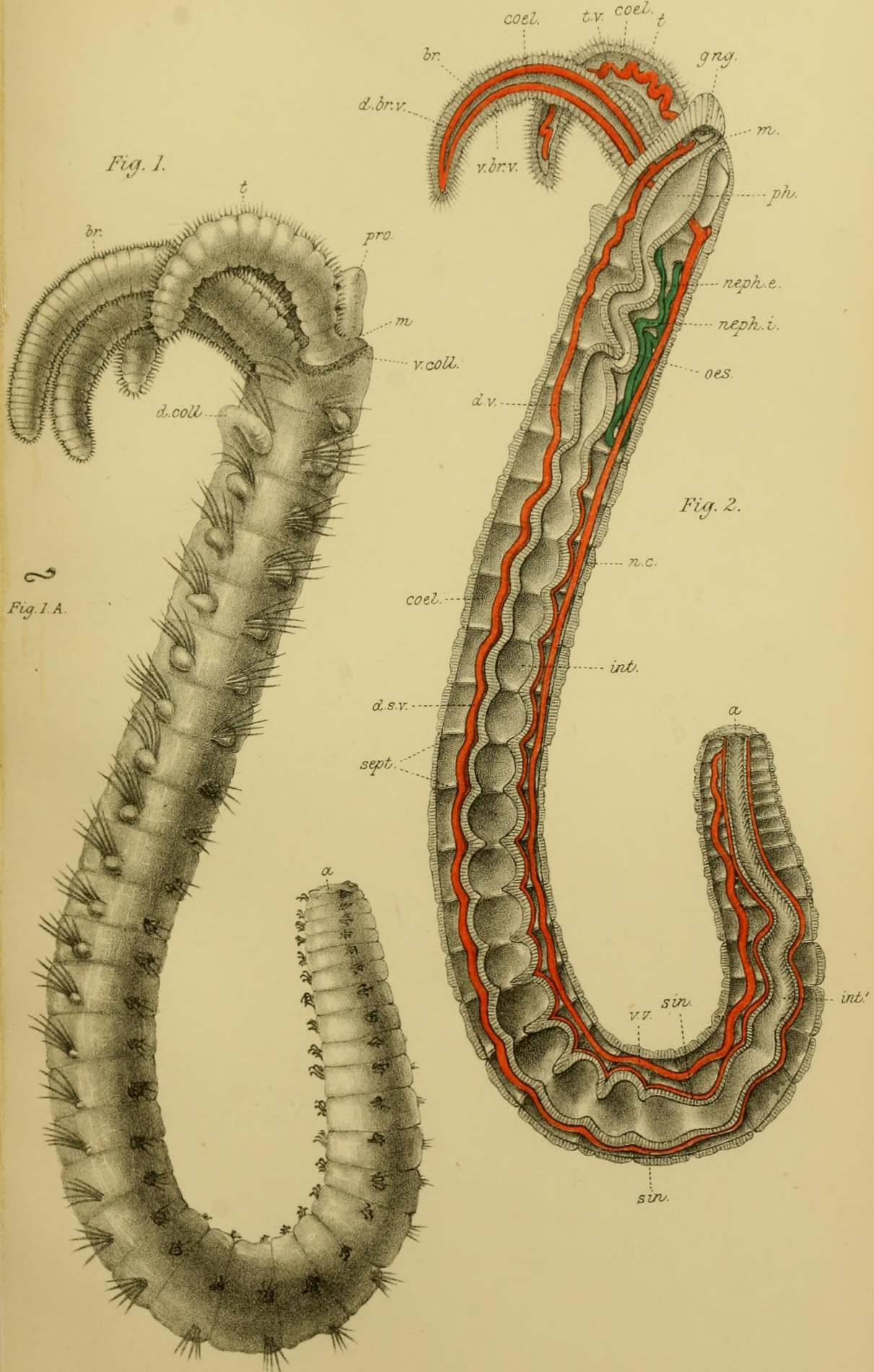
FIG. 10.—Transverse section of branchia. *d. br. v.* Branchial vessel in connection with dorsal vessel. *v. br. v.* Branchial vessel in connection with ventral vessel. *cæl.* Cœlom. Other letters as in Fig. 9.

FIG. 11.—Dorsal view of the posterior extremity of the body of a specimen in which the ciliated ridges could be seen in the intestine (*int.*), just in front of the anus (*a.*).

FIG. 12.—Semi-diagrammatic dorsal view of the head to show the probable arrangement of vessels. *Pro.* Prostomium. *ntp¹.* Notopodial chætæ of 1st segment. *nrp¹.* Neuropodial chætæ of 1st segment (with "cirrus"). *d. c.* Dorsal collar (notopodial "cirri") of 2nd segment. *d. v.* Dorsal vessel. *d. br. v.* Branchial vessel in connection with dorsal vessel. *v. br. v.* Branchial vessel in connection with ventral vessel. *v. v.* Ventral vessel. *t. v.* Vessel of cephalic tentacle. *d. v. v.* Coiled dorso-ventral vessel.

FIG. 13.—Parasite from intestine (*Monocystis hekaterobranchii*). *vac.* Vacuole. *n.* Nucleus.

FIG. 14.—Abdominal nephridium. *ext.* Its external opening.



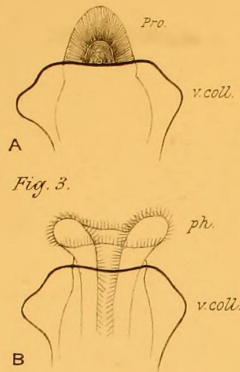


Fig. 3.

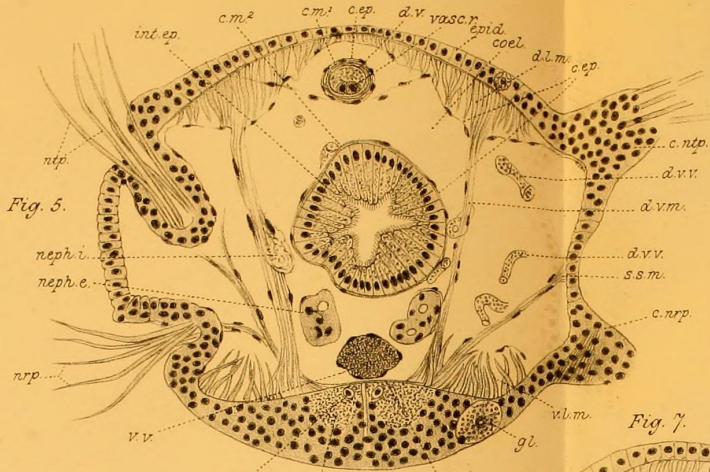


Fig. 5.

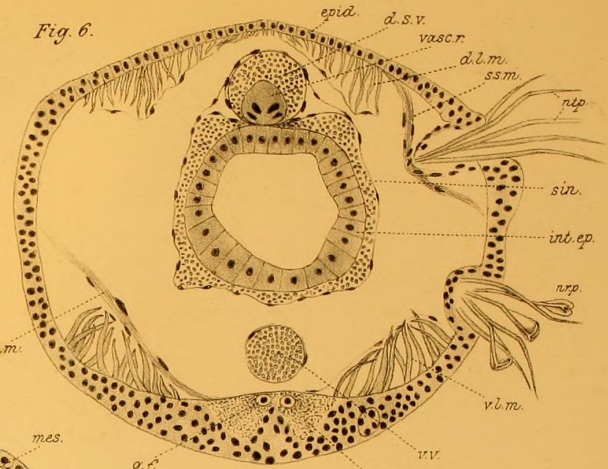
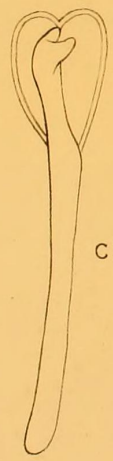
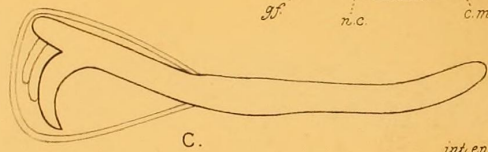
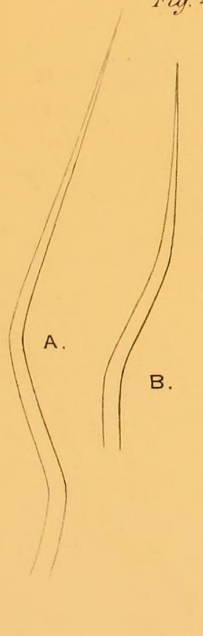


Fig. 6.

Fig. 4.



C'

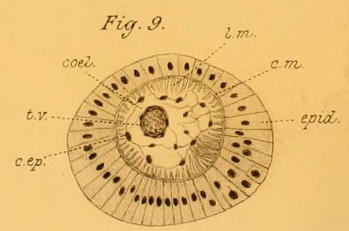


Fig. 9.

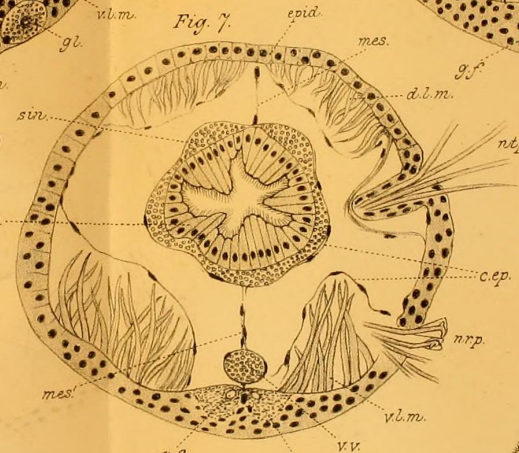


Fig. 7.

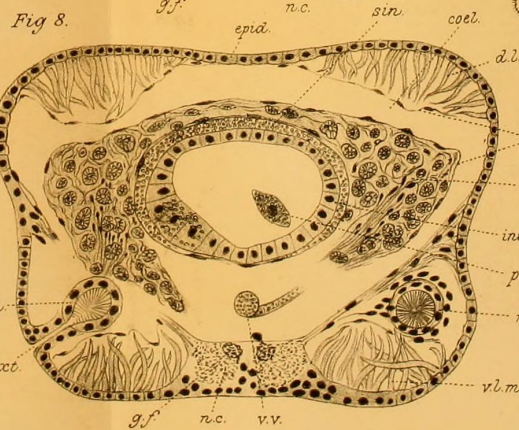


Fig. 8.

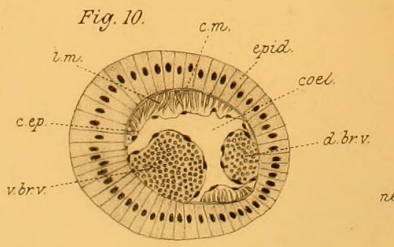


Fig. 10.

Fig. 13.

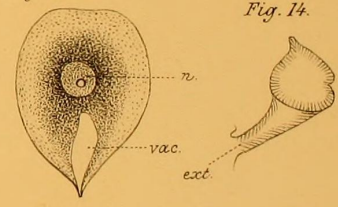


Fig. 14.

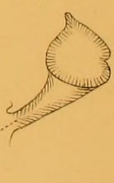


Fig. 12.

