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OF THE

ROYAL SOCIETY OF EDINBURGH.

VOL. XXXVI. PART II.—(Nos. 9 TO 21)—FOR THE SESSION 1890–91.

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(Issued November 10, 1891.)

XXI.—*On the Anatomy of* Ocnerodrilus (Eisen).

By Frank E. Beddard, M.A., Prosector of the Zoological Society of London, Lecturer on Biology at Guy's Hospital. (With a Plate.)

(Read 2nd March 1891.)

The worms which form the subject of the present communication were forwarded to me, in a living condition, from Kew Gardens.

I have received lately a considerable number of living Oligochæta from those Gardens, through the kindness of Mr Dyer,* who permitted me to have the earth arriving from different parts of the world in the Wardian cases, in which plants are packed for travelling, thoroughly sifted, with a view to preserving the worms which had been accidentally included. By these means I have succeeded in obtaining some very interesting new forms, as well as a number of others which are still imperfectly known. The species which I describe in the present paper appears to be a new species of Eisen's genus *Ocnerodrilus*. The genus *Ocnerodrilus* was formed by Eisen in 1878 [1] for a small worm found in Fresno County, California. The specimens were all met with in "an irrigation box," where they were found crawling among the algæ which covered the boards. It is evidently, therefore, aquatic in its habits, but Eisen contrasts its slow movements with the rapid swimming of *Lumbriculus* and *Rhynchelmis*, comparing it in general appearance with a small species of *Lumbricus*.

My own specimens, eight in number, came from British Guiana in a Wardian case containing plants; they also presented the appearance of a small Earthworm rather than of any Lumbriculid with which I am acquainted. The colour, which seems to agree with that of *Ocnerodrilus occidentalis*, is reddish, caused of course by the blood seen through the transparent body-walls, which are, however, rather thick for so small a worm. These specimens may be terrestrial in habit, but there was a *Pachydrilus* in the same earth with them, which may perhaps indicate an especially moist locality. As, however, *Allurus* can live equally well in earth and in water, it is not surprising to meet with other forms which possess the same power of adapting themselves to different circumstances. The size of the species, when contracted by the corrosive sublimate with which they were preserved, is shown in fig. 5; it is therefore somewhat smaller than *Ocnerodrilus occidentalis*. During life, it is almost unnecessary to state, these dimensions were considerably exceeded by the power of extension of the body which the worm possessed.

* I desire also to record my appreciation of the careful way in which Mr Crisp, one of the employés at Kew, has sorted out and transmitted to me these and other specimens.

The genus has been recently met with by EISEN in Central America, but at present there are no particulars as to the structure of the four new species, which he briefly mentions as having been found by himself [**2**, p. 5, footnote].

Ocnerodrilus, therefore, has probably a wide range over the warmer parts of the American continent, and is, so far as we know at present, confined to that continent.

I. STRUCTURE OF *OCNERODRILUS*.

§ *External Characters.*

Figure 5 shows an individual of the natural size after preservation in corrosive sublimate, followed by alcohol. Fig. 2 illustrates some of the principal external characteristics.

The *prostomium* is present, but not in any way specially remarkable.

The *setæ* are strictly paired, and are of the usual shape that is met with in Earthworms. There is no modification of the clitellar setæ, except that the ventral pair of segment XVII in fully mature individuals are totally wanting.

Dorsal pores are absent.

The *clitellum* includes segments XIII–XVIII; it commences and terminates abruptly.

The *nephridiopores* open in front of and a little to the outside of, the ventral pair of setæ; there are a pair to each segment, commencing with the third.

The *spermathecal pores* lie between segments VII and VIII, on a line with the ventral setæ.

The *oviducal pores* are upon the XIVth segment, in front of the ventral pairs of setæ. The *male pores* occupy a corresponding position upon the XVIIth segment, though the setæ are absent.

Judged by external characters only, *Ocnerodrilus* would be referred to the Cryptodrilidæ among Earthworms. We shall see that its internal anatomy shows many resemblances to that family.

§ *Body Wall.*

EISEN gives no account of the histology of the body wall in *Ocnerodrilus*, referring only to the characters of the setæ, which are figured [**1**, pl. i. fig. 2). Nor is the clitellum described. This organ is of great importance in determining the affinities of the different genera of Oligochæta, particularly in some families. Had the clitellum been developed in any of the specimens examined by EISEN, he would hardly have referred the genus to the family Lumbriculidæ.

A considerable proportion of my examples were furnished with a fully developed clitellum; but there were others, fully mature as regards the sexual organs themselves, in which there was no trace of a clitellum. EISEN states that his species is mature in the

latter part of October. This statement implies that, as in the Lumbriculidæ and other families of aquatic Oligochæta, *Ocnerodrilus* passes the greater part of the year in a state of reproductive inactivity. My own specimens must have been collected in June or July, and I think it very probable that, as in Earthworms generally, some individuals are mature during every month of the year. In any case the *clitellum*, when developed, is very extensive, and easily recognisable in the worm without a microscopical examination. It commences at the XIIIth segment, and extends back as far as the XVIIIth, thus occupying altogether six segments. It is absolutely limited to these segments, and does not, as is so often the case with this organ, trespass upon a portion of the adjoining segments at either end.

The extent and position of the clitellum alone, without going into any details of structure, is sufficient to show how much *Ocnerodrilus* differs from any of the aquatic groups which are known.* In most of these the clitellum consists of a small number of segments—not more than four, and generally less—which immediately surround the genital pores. *Ocnerodrilus* is, however, like all the "*Limicolæ*," and the majority of Earthworms, intraclitellian in PERRIER'S sense, *i.e.*, the oviducts and sperm ducts open on to this modified region of the integument. The intraclitellian condition is regarded by BENHAM [9] as the more primitive; but it is difficult to see any reason for it shifting back to a point far behind the generative apertures, as is the case with the Lumbricidæ (*sensor stricto*). Supposing this to be explained, it is then equally difficult to account for the fact that in *Perichæta* the male apertures usually lie behind the clitellum.

In *Ocnerodrilus* and other forms it looks very much as if the clitellum had extended to keep pace with the changed position of the male pores.

I formerly advocated the same view as Mr BENHAM, for the reason that the glandular lining of the atria has a certain relation to the structure of the clitellum. In Earthworms, where the clitellum consists of two distinct layers of cells, the atrium is lined with two layers of cells, on the whole similar to those of the clitellum. On the other hand, the aquatic genera, with a clitellum consisting of only a single layer of cells, have atria which are lined by a single layer of cells only. I shall, however, point out later that *Ocnerodrilus* forms an exception to this rule, at present the only one known. Unless this can be explained on other grounds, it is necessary to abandon this view of the relations of the atria to the clitellum. I am still, however, disposed to believe that the intraclitellian position of the generative opening is the primitive one. It seems to be the most natural position for the development of the clitellum.

In its minute structure the clitellum of *Ocnerodrilus* differs from all the aquatic families, and agrees with Earthworms. In all of the former the clitellum consists of a single layer of cells only, while in Earthworms there are two distinct layers, and *Ocnerodrilus* (see fig. 14) is in this respect an Earthworm, and differs from the Lumbriculidæ.

* With regard to the Lumbriculidæ, the number of segments occupied by the clitellum has not yet been accurately described in many types. In *Rhynchelmis*, VEJDOVSKY [15] implies that the clitellum occupies segments VIII–XVI.

This difference, which really distinguishes CLAPARÈDE's two groups of Limicolæ and Terricolæ, can hardly be due to the small size of the former group, for many of them considerably exceed *Ocnerodrilus*, *Microscolex*, and some other forms in bulk; it must therefore have some importance.

The only explanation that suggests itself to me is the need in terrestrial forms for an especially thick cocoon to prevent evaporation and drying up of the contents; a thin-walled cocoon would be in this respect sufficient for those forms which live in water, or particularly damp localities. On the other hand, it must be remembered that the increased thickness of the clitellum in terrestrial forms is accompanied by an increased specialisation in the cells. BENHAM figures four kinds of cells in the clitellum of *Microchæta*, and the clitellum of other Earthworms seems to me to be equally complicated. It is possible, therefore, that the structural diversity of the elements composing the clitellum implies a physiological specialisation. The clitellum may perform more functions than that of secreting the cocoon.

§ *Alimentary Canal.*

The first section of the alimentary tract is a very thin-walled *buccal cavity*, which is evidently capable of being to a certain extent protruded at the will of the animal. In one of the specimens studied by longitudinal sections the buccal cavity was slightly everted, but did not actually project beyond the oral aperture; its thin walls are attached by comparatively few muscular strands to the parietes. It is these facts which lead me to the inference that the buccal cavity can be protruded without the oral cavity, though I did not notice anything of the kind in the living specimen.

The *pharynx* immediately follows the buccal cavity, and occupies only a single segment, the IIIrd. It agrees in structure with the pharynx of many Earthworms, having the usual mass of muscles upon the dorsal surface; into this, as is also generally the case, there project slight diverticula of the lumen of the alimentary tube.

The *œsophagus* is a narrow tube, extending as far back as the end of the VIIIth segment. The lining epithelium consists of narrow columnar cells, which are covered with a very thin chitinous layer. The lining membrane of the œsophagus is thrown into irregular folds. Its muscular walls are tolerably thick. In segment IX the œsophagus becomes widened out, and receives the ducts of a pair of glandular appendices (fig. 4*d*), which lie in this segment. These structures evidently correspond to the "sac-like appendices" of which EISEN has recorded the presence in *Ocnerodrilus occidentalis*; they seem, however, in my species to be situated a segment further back. EISEN has stated that there is no structure in the Limicolæ with which these glandular diverticula can be compared. I am inclined, however, to compare them with the "Chylus Taschen" of the Enchytræidæ on the one hand, and with the calciferous glands of the terrestrial Oligochæta on the other. Among the Lumbriculidæ they do not appear to have any equivalent.

These bodies are not, as might possibly be inferred from EISEN's description, simple diverticula of the œsophagus; their lumen is divided up by a network of anastomosing folds of epithelium, the subdivision being more complete towards the blind end of the gland. The aperture into the œsophagus is very wide. The epithelium of the gland appears to be everywhere ciliated, and the alimentary tract from the orifice of the glands becomes ciliated. The structure of the glands is much like that of the calciferous glands of many Earthworms, which are in some cases, at any rate, ciliated.* The corresponding structures in certain species of *Enchytræus* are also ciliated, though here the cilia are undergoing degeneration [*cf.* MICHAELSEN, **17**, figs. 5, 6, *dt*].

In the Xth and XIth segments the œsophagus, which is, as already mentioned, ciliated, is extremely narrow, and has tolerably thick muscular walls.

In the XIIth segment it suddenly increases to more than double its previous dimensions, and undergoes no further change, except that it becomes narrower as the body of the worm narrows towards the anus.

It is important to point out that there is *no trace of any gizzard*, and that *the intestine has no typhlosole*, and no cæca or glands of any description.

EISEN has correctly noted the presence of *septal glands* in this Oligochæt, which in his species occupy the first few segments through which the œsophagus passes.

Ocnerodrilus Eiseni also possesses these organs. This genus is at present almost the only type of Oligochæt with unmistakable points of affinity to Earthworms, in which these structures, so characteristic of many of the lower Oligochæta, occur. The only other parallel instance known to us is *Photodrilus*, an Annelid which shows other points of resemblance to *Ocnerodrilus*. GIARD, who has investigated the anatomy of *Photodrilus*, writes as follows with regard to the septal glands:—"Dans la région antérieure (anneaux 5 à 9) l'œsophage est recouvert latéralement et dorsalement par des glandes volumineuses qui vont en décroissant d'avant en arrière; la plus petite est située dans le neuvième anneau. Je les considère comme homologues des glandes septales, découvertes par VEJDOVSKY chez les Enchytræides. Malgrè la place qu'ils occupent contre l'intestin ces organes ne sont pas des glandes digestives; ils débouchent au dehors du côté dorsal et je crois que c'est à leur sécretion qu'il faut attribuer la propriété photogénique du *Photodrilus*." EISEN says nothing about the apertures of the glands in question in *Ocnerodrilus;* but the ordinarily accepted view is that they open into the œsophagus. HENLE was, according to VEJDOVSKY, the first to detect an opening into the pharynx. VEJDOVSKY asserted that in *Anachæta bohemica* the glands in question did open into the pharynx; but as there were isolated masses of gland-cells totally unconnected with the collecting duct, he preferred to use the term "septal" gland instead of salivary gland. Further details as to *Anachæta bohemica* are to be found in his monumental work upon the Oligochæta [p. 105], where it is stated that the glands possess a lumen communicating

* In *Acanthodrilus antarcticus* and in the young of *A. multiporus*. I do not know how far this ciliation is prevalent among Earthworms.

with that of the duct. The isolated masses are figured, and it is shown that they have no connection with the duct.

These latter—although it is stated that their structure is that of the large septal masses which are connected with the duct—are compared to the "Zellenwucherungen" which occur on the dissepiments of *Tubifex* and other forms.

Besides occurring in other Enchytræids, septal glands are found in the Lumbriculid *Phreatothrix pragensis* and in *Naidium* and *Pristina*. Vejdovsky's statement that they also occur in *Criodrilus* is not referred to by Rosa [**11**].

Dr Michaelsen, in one of his admirable papers upon the Enchytræidæ [**17**], notes some important facts with respect to the septal glands of *Stercutus niveus*.

The difficulty of discovering the duct is stated to be due to the fact that they can only be properly seen when the glands are in action. The duct is figured (but without a lumen) attached to the dorsal pharyngeal wall. In *Mesenchytræus setosus* multipolar ganglion cells were discovered in the interior of the septal glands, and the connection of these with brain explains why the earlier observers regarded the septal glands as ganglia.

In *Ocnerodrilus Eiseni* almost the entire space lying between the walls of the œsophagus and the parietes of segments was occupied by the septal glands.

§ *Vascular System.*

I regret my inability to give anything like a complete account of the circulatory organs of *Ocnerodrilus Eiseni*. This is, however, the less to be regretted, since Eisen has given a tolerably full description, illustrated by one good figure, of the circulation in *Ocnerodrilus occidentalis* [**1**, pl. 1, fig. 8]. But if I had been aware that the worms, when they first arrived from British Guiana, belonged to this genus, I should have made greater efforts to study the distribution of the blood-vessels before preserving the specimens for microscopical investigation. As it was, the pressure of other work led me to preserve them at once. However, I can say something about these organs, since I succeeded in satisfactorily preserving the worms with acid corrosive sublimate and alcohol, which left the blood-vessels very distinct in sections.

I quite agree with Eisen in regarding the vascular system of *Ocnerodrilus* as widely removed from that of the Lumbriculidæ. I do not follow him, however, in his comparison with the Tubificidæ. This comparison is based upon the presence of the "large pulsating hearts" in segments VIII and IX. It is perfectly true that many of the Tubificidæ, *e.g.*, the genus *Limnodrilus*, are characterised by these vessels. But Eisen did not mention that, as his enumeration of the segments of the Oligochæta differs from that of Claparède, who first distinguished *Limnodrilus* [**19**] from *Tubifex*, the position of the hearts is really different; according to Eisen's figure, they are in segments IX and X in *Ocnerodrilus* (VIIIth and IXth *setigerous* segments).

In my species I find that, as EISEN has discovered, there are (fig. 3*h*) two pairs of specially dilated perivisceral vessels, but that they lie in segments X and XI instead of IX and X. A comparison with *Limnodrilus* is thus rendered less valid. In *Microscolex* and *Photodrilus* there are three pairs of such vessels—in X, XI, and XII, and it is rather with these that I should be disposed to compare *Ocnerodrilus.* The reduction of the last pair of the three in *Microscolex* and *Photodrilus* brings about the condition which characterises *Ocnerodrilus.* As compared with these forms, therefore, *Ocnerodrilus* occupies a lower position, which I am inclined to attribute to degeneration. The *dorsal vessel* is simple; and there is a supra-intestinal trunk (fig. 3, *s.n.*).

§ *Nephridia.*

Dr EISEN found that in *Ocnerodrilus occidentalis* "the segmental organs are present in all setigerous segments except in the 13th and 16th. In the former they are replaced by the oviducts, and in the latter by the efferent ducts and receptacle."

This is not the case with my species.

In a mature individual with the clitellum fully developed, which was studied by means of longitudinal sections, the nephridia were clearly visible in all the segments of the body, commencing with the IIIrd, excepting only the XIth and XIIth.

The shape and structure of certain of the anterior nephridia agrees perfectly with EISEN's description and figures; and I can fully bear out, from my own observations, his comparison with the nephridia of the Tubificidæ. *The appearance of the nephridia is quite unlike that of any earthworm, owing to the entire absence of blood-capillaries.* This point is not specially remarked upon by EISEN, though he figures no capillaries. This is the first instance of an Oligochæt having, as I shall point out later, marked affinities with a particular family of Earthworms in which the nephridia are not furnished with a plexus of vascular capillaries. Correlated with the absence of blood-vessels is the very small development of the peritoneal layer surrounding the organs. EISEN does not indicate in his figure any trace of such a structure at all, and I cannot say that I have been more successful in detecting its presence in the nephridia of the anterior segments.

I understand from EISEN's description that the nephridia of *Ocnerodrilus occidentalis* present the same characters throughout the whole body, and he particularly remarks upon "the absence of large translucent cells like those found in *Rhynchelmis.*" I have also already stated that this applies to the anterior nephridia of *Ocnerodrilus Eiseni;* but from segment XX onwards the nephridia are seen to be partly embedded in a huge mass of clear cells. A section through a nephridium of this segment is illustrated in fig. 9. At the bottom of the figure are seen some of the coils of the tubules. These are surmounted by a mass of cells, and a little to the left is another mass of similar cells, which in the section selected for illustration appears to have no connection with the mass. This, however, is merely due to the fact that the particular section does not show the connection. The mass of cells in which the nephridium is partly embedded consists of

elements of two kinds: firstly, large clear cells (*b*) with a deeply stained nucleus and a very evident limiting membrane; and secondly, small granular deeply staining cells (*a*). The latter I believe to be simply perivisceral corpuscles which have become attached to the mass of hyaline cells. They agree in every particular with cells found floating freely in the perivisceral fluid.

The mass of clear cells partly surrounding the nephridia are no doubt modified peritoneal cells, which correspond to the similar cells which are found in connection with the nephridia in the Lumbriculidæ, Phreoryctidæ, and some other aquatic Oligochæta. Among Earthworms, *Pontodrilus* is furnished with similar cells. This discovery was made by PERRIER [**21**], and is justly regarded by him as a point of affinity between *Pontodrilus* and some of the lower Oligochæta. PERRIER'S figure [**21**, pl. xiv., fig. 11] does not represent the microscopic appearance of these cells very well if they are exactly like those of *Ocnerodrilus*. Another point of resemblance between *Pontodrilus* and *Ocnerodrilus* is the commencement of these cellular masses round the nephridium in the XIXth (*Pontodrilus*) or XXth (*Ocnerodrilus*) segment. But in *Pontodrilus* there are no nephridia before the XVth segment, whereas in *Ocnerodrilus* these organs commence in the IIIrd.

I have stated that there are no nephridia in the XIth and XIIth segments.

The XIIth segment is very much reduced as compared with the neighbouring segment. On each side of the body it is occupied by a mass of cells, perfectly independent of the alimentary tract, which is illustrated in fig. 10 of the plate. This mass occupies nearly the whole of the available space, and towards the dorsal side of the body (the right of the figure) completely fills the segment from side to side; ventrally the mass of cells becomes narrower, and is bent upon itself. The bending is not shown in the figure. The cells of which this body is formed are of two kinds, which it is unnecessary to describe further as they agree perfectly with the cells surrounding the nephridia of the posterior segments. In the XIth segment is a similar mass, which is, however, much smaller.

These bodies seem to me to represent the last trace of the nephridia of the XIth and XIIth segments. This is probably accompanied by an increase in the number of the clear peritoneal cells which exists in the following nephridia, though they are very few in number as compared with the nephridia of the posterior segments. There is, in fact, not a complete change, as in *Pontodrilus*, between the anterior and posterior sets of nephridia. I could find no hyaline cells attached to the nephridia of the first three or four segments; but from this segment to the XXth a few such cells were present; and I believe that the peculiar bodies of the XIth and XIIth segments are simply due to a proliferation of these cells after the disappearance of the nephridium.

The funnels of the nephridia are small and composed of comparatively few cells. One side of the funnel (see fig. 11) is considerably longer than the other; the cilia are well developed. As the nephridia of segments XI and XII are rudimentary, I was naturally unable to find any nephridial funnels depending into the Xth and XIth segments. Nor did I succeed in observing any nephridial funnel attached to the posterior wall of segment XIII. The nephridia of segment XIV, however, are present and well developed. From

the XIVth segment onwards I easily found the funnels, and also in segments VI–IX. I did not observe any funnels in the segments anterior to this, but as they were so crowded with the septal glands, it is more than probable that the funnels were there but escaped my observation.

The easiest way of demonstrating the external pores of the nephridia is to divide the worm longitudinally, and then to mount the two halves in glycerine. The duct of the nephridium is much more plain in specimens treated in this way than in either longitudinal or transverse sections.

Fig. 2 represents the anterior segments of a specimen of *Ocnerodrilus Eiseni*, with the nephridiopores indicated. As will be seen, they lie in front of and a little to the outside of the ventral pair of setæ in all the segments except the first two and XI and XII.

§ *Testes.*

In the position of these bodies *Ocnerodrilus Eiseni* differs much from *Ocnerodrilus occidentalis*. Eisen [**1**, p. 8] says:—"In *Ocnerodrilus* . . . . we find always two pairs of testes of rather minute development and constant size. One pair is situated in the VIIIth setigerous segment, where it is affixed to the dissepiment between the VIIIth and IXth segment. The second pair is found in the Xth segment, but is affixed to the dissepiment between the IXth and Xth segments. Thus we find the testes affixed to two consecutive dissepiments, but not in two consecutive segments." This description agrees with his figure [**1**, pl. i. fig. 9], but not with the definition of the genus given on p. 2 of his Memoir. It is there stated that "the testes are two pairs in the VIIIth and IXth setigerous segments."

In a more recent work [**2**, p. 5, footnote] Eisen redefines *Ocnerodrilus*, writing that the testes are "two pairs in IXth and Xth segments."

If the latter definition is to be accepted, with the proviso that "IXth and Xth segments" means IXth and Xth *setigerous* segments, *Ocnerodrilus Eiseni* agrees with other species of the genus.

The *testes* are small bodies, lying on the Xth and XIth segments, as in all Earthworms where there are two pairs present. Although they are not larger than the testes of other Earthworms, they are large as compared with the size of the worm; they extend right across the segment.

The first pair of testes are attached to the anterior wall of the segment, and are somewhat fusiform in shape. The second pair are attached in a corresponding position to the anterior wall of the XIth segment (see fig. 8), and have the same shape. It is a little difficult to be certain, in the case of the second pair of testes, whether the attachment is to the anterior or to the posterior wall of the segment. They reach right across, as shown in fig. 8, and come into close contact with the sperm sac of the XIth segment, where it passes through the septum to become continuous with the sperm sac of the XIIth segment.

The testes are not enclosed within the sperm sacs, though they are in contact with them for nearly the whole of their length.

The minute structure of the testes calls for no particular description.

§ *Sperm Sacs.*

The *sperm sacs* are not mentioned by EISEN. They are, however, present in *Ocnerodrilus Eiseni*, and indicate a closer resemblance to Earthworms than to any Lumbriculid.

There are in all four pairs of these sacs, situated in segments X, XI, XII, and XIII.

Each sperm sac consists of a delicate nucleated wall, and its interior is not subdivided by trabeculæ as it is in Earthworms. The sperm sacs were in every instance crowded with masses of developing spermatozoa, and they often contained a few—but a very few—Gregarines. The sacs are of rounded but somewhat irregular form; those of the XIth and XIIth segments are pressed out of shape by the large "hearts" of those segments.

The sperm sacs of the Xth segment (fig. 1) are perfectly independent of those of the next segment, and they are also independent of each other, though they nearly come into contact on the dorsal side of the intestine. As already mentioned, each sperm sac is in close contact with, but does not enclose, the testis of its side. Neither does it enclose the funnel of the vas deferens.

The sperm sacs of segment XI have the same relations to the testes, and the same absence of any relations to the vas deferens funnels; they become attached to the septum, dividing this segment from the XIIth by a slender cord which perforates the septum, and is continuous with the sperm sac of segment XII. There is, however, no continuity of lumen between the two sperm sacs, though very possibly this may occur at certain stages of development.

The sperm sac of the XIIth segment projects through the septum for a considerable distance into segment XIII. The aperture of communication is quite wide.

It follows from the above description that the sperm sacs of *Ocnerodrilus* agree in their general form with those of Earthworms, but differ from Earthworms and agree with the lower Oligochæta in the fact that their lumen is not divided into numerous compartments by anastomosing trabeculæ.

§ *Vasa Deferentia.*

The *vasa deferentia* commence with the funnels in the Xth and XIth segments. Generally the funnels of the vasa deferentia lie opposite to their testes, but in *Ocnerodrilus* the funnels lie below the testes, which, as already said, extend right across their segment. The simple character of the funnels is shown in EISEN's drawing, which would represent *Ocnerodrilus Eiseni* as well as *O. occidentalis*.

The two vasa deferentia unite before they open on to the exterior, but I am not certain as to the segment in which this junction is effected. In *O. occidentalis* it appears to be segment XVI.

Atria.

These organs were noted by EISEN in his original paper upon *Ocnerodrilus*, but regarded, on account of their opening on to the exterior independently of the vasa deferentia, as spermathecæ.

VEJDOVSKY [**15**, p. 149], in a woodcut illustrating the male ducts of the Annelid, figures this supposed spermatheca as an atrium.

That this interpretation, which I have myself already accepted, is correct, I am able to prove in the present paper. EISEN himself has lately admitted the justice of VEJDOVSKY's correction of his statement [**15**]. He says in a footnote to p. 5: "The organs which I have there described as seminal receptacles are undoubtedly nothing but the atrium. During a recent visit to Central America I found four new species of *Ocnerodrilus*, and a cursory microscopic investigation showed me immediately that the seminal receptacles existed in several pairs in some of the anterior segments, which makes it evident that the large bodies which open in the same porus as the efferent ducts must be considered as atrium. In the Californian species, which I described as *O. occidentalis*, these small seminal receptacles were evidently overlooked." I refer to the last-mentioned point on p. 14. As to the *atria*, I find in my species that they *do not open on to the exterior independently of the vasa deferentia.* It is very possible that the study of the living worm as a transparent object might lead to this conclusion, since the vasa deferentia only communicate with the atria just before the latter open on to the ventral surface of the body. On the other hand, it is equally possible that both EISEN and myself are right, and that there is actually this difference between the two species, which are nevertheless in other respects closely allied. The degree of connection between the vasa deferentia and the atria in the Oligochæta presents a most interesting series of modifications between absolute independence at one extreme and perfect continuity at the other.

The following Table indicates the several stages, so far as they are known at present:—

I. Atria presenting the appearance of a simple terminal dilatation of the vas deferens (or vasa deferentia)—

Chætogaster, Tubifex, Psammoryctes, &c.

II. Vasa deferentia opening into the atrium at the side—

Lumbriculidæ, Eudrilidæ, Moniligaster.**

III. Vasa deferentia opening into the atrium at the commencement of the non-glandular portion—

Perichæta, Pontodrilus, &c.

IV. Vasa deferentia opening into the atrium just before its opening on to the exterior—

Ocnerodrilus Eiseni.

V. Vasa deferentia opening independently of and just behind the atrium—

Typhæus, Rhododrilus.

VI. Vasa deferentia opening independently of the atrium in the next segment—

Neodrilus, Acanthodrilus.

* In these Oligochæta there is hardly any distinction between a glandular and non-glandular section of the atrium.

It will be noticed from the above list that it is almost entirely among Earthworms that we meet with this tendency for the vasa deferentia to become separate from the atria.* If it were not for the striking instance to the contrary afforded by the Eudrilidæ, this point alone would be sufficient to justify the reference of *Ocnerodrilus* to Earthworms. As it is, the relationship of the vasa deferentia to the oviducts is an important point of difference from all the Lumbriculidæ.

In Dr Eisen's figure [**1**, pl. i. fig. 9, *r*, *s*] the atria are represented as passing back as far as the XXVIth segment in a slightly undulating course, which is more marked towards their cæcal extremity. I have found that in my species the atria may also be, but are not always, directed posteriorly from their point of opening on the XVIIth segment. It is this position of the atria which gives them so unusual an appearance in Eisen's figures, and perhaps led him to regard them at first not as atria but as spermathecæ. As a matter of fact, very little importance can be attached to the position occupied by these organs in Oligochæta, where they extend through more than one segment. As a general rule, they are more or less coiled up, and are limited to two or three segments in the neighbourhood of that which bears their external orifice. But even in *Acanthodrilus*, where this has been, according to my experience, always the case, there is one species, viz., *Acanthodrilus spegazzinii*, in which the four atria extend back through a large

* I assume that the structures which have been usually termed "prostates" in the Earthworm correspond to the atria of the aquatic genera. This question has been lately revived by Benham, who is not of my opinion [**10**].

Before pointing out the reasons which lead me to adhere to my own view, I would say a few words concerning an apparent confusion in my description which is pointed out by Benham. He says: "Beddard takes up rather a curious position in regard to the prostate of *Moniligaster*. For him, the *peritoneal coat*, outside the muscular wall of the atrium, is the 'prostate,' and is homologous with the 'Cementdrüse' (or prostate) of *Tubifex*. Now this prostate in *Tubifex* has been shown by Vejdovsky to be formed by a proliferation and outgrowth of the atrial epithelium at a certain point, which bursts through the muscular wall of the atrium and projects into the body cavity. The atrial epithelium is derived from the epidermis, so that the 'Cementdrüse' is epiblastic, whereas the glandular covering of the 'atrium' of *Moniligaster*, *Stylaria*, *Rhynchelmis*, &c., is mesoblastic,—if it is in reality a modification of peritoneal cells. Hence Beddard would regard the *epiblastic* 'prostate' (Cementdrüse) of *Tubifex* as the homologue of the *mesoblastic* covering of the atrium of *Moniligaster*!!"

In my own Memoir, to which Benham refers [**23**], I compare (on p. 120) the glandular investment of the atrium of *Moniligaster* with a corresponding investment of the atrium in *Rhynchelmis*, which I write down as "prostate," indicating by the inverted commas that I follow the nomenclature of Vejdovsky. Further on I again (on p. 126) make use of the term prostate in describing this glandular investment, but have omitted the inverted commas, which renders my terminology a little confusing. I do not, however, in that paper compare the glandular investment of the atrium in *Moniligaster* and *Rhynchelmis* with the Cementdrüsen of *Tubifex*.

In a *preliminary* notice of these facts, however [**22**], I did make this comparison, which appeared to me to be to some extent justified by the remarkable fact that the Cementdrüsen of *Tubifex are not covered* by a peritoneal coating. I came to the conclusion later that the apparent discrepancy between Vejdovsky's statements and figures might be of less importance than I had thought it.

As to the terminal glandular structures attached to the vasa deferentia of Eudrilidæ, Perichætidæ, Acanthodrilidæ, &c., it appears to me impossible to refer them to more than one category.

Mr Benham indicates very clearly (except in fig. 4) the different layers which constitute these organs in a number of types, but omits any representation of the family Eudrilidæ; it is precisely here that we meet with conditions which render it impossible to distinguish between "atrium" and "prostate." Mr Benham allows "that a *portion* of the prostate of *Perichæta*, *Eudrilus*, and other genera in which the sperm duct and the prostate join, is probably the homologue of the 'atrium' of *Tubifex*." To follow out this admission to its logical conclusion it is necessary to draw a distinction between the part immediately preceding and the part immediately succeeding the point of opening of the vasa deferentia; that is to say, we must regard as different two parts of a tube in the Eudrilidæ and in the Lumbriculidæ between which there is no trace of a break, and not the faintest difference in minute structure!!

number of segments (as far as the XXXVth) from their external pores. As these organs probably grow inwards from an invagination, various circumstances might easily prevent their growing in one direction or prevent their growth in another, and thus lead to great variations in the amount of the coiling of the tube.

In one specimen which I examined the atrium of one side of the body was divided into two tubes, which, passing under the nerve cord, lay upon the side of the body opposite to that upon which the external pore was situated.

The atrium, as shown in Dr EISEN's figures [1, pl. i. figs. 4, 9], is divisible into a muscular and a glandular region; this is usually the case with the atria in Earthworms, though not in *Nemertodrilus* [BEDDARD, 5]. The muscular portion communicates directly with the exterior; it is lined by a low layer of epithelial cells which is surrounded by a thick coat of muscular fibres, chiefly circular in direction. The glandular portion of the atrium is in certain points peculiar. The great length of the atrium, extending as it does as a cylindrical tube through a considerable number of segments, recalls the tubular atrium of *Pontodrilus*, *Acanthodrilus*, *Dichogaster*, and some other genera of Earthworms, and I had expected to find its structure identical with that of the atria of those Oligochæta. I find, however, that in *Ocnerodrilus Eiseni*, as in *Ocnerodrilus occidentalis*, *the atrium is lined by a single layer of glandular cells.* This difference in minute structure is of some importance. In all Earthworms in which a "tubular" atrium is present its glandular epithelium consists of two distinct strata of cells, which are not unlike those of the clitellum. It is only in the Moniligastridæ and in the "Limicolæ" that the glandular part of the atrium agrees with the non-glandular portion in having an epithelial lining only one cell thick. *Ocnerodrilus* and *Moniligaster*, therefore, render it impossible to utilise this character as distinctive of the "Limicolæ," which it otherwise would be.

But, in any case, the possession of an atrium showing this structure is a point of similarity to the lower aquatic Oligochæta.

It might be supposed to bear some relation to the small size of the worm were it not for the fact that in *Microscolex*, which is hardly larger, the atrium has the characteristic structure of Earthworms.

Fig. 13 of the Plate illustrates a transverse section through the atrium. It is covered externally by a very thin peritoneal layer, which appears to contain a few delicate muscular fibres; the nuclei belonging to this layer were very evident. The lining epithelium looks at first sight as if it were made up of a layer of large glandular cells only. These cells are somewhat oblong, oval in shape, and have abundant granular contents which are not stained by the colouring reagent used (borax carmine); towards the base of the cell is a large spherical deeply-staining nucleus.

The glandular cells lining the atrium are separated from each other by darkly stained but very thin structures, which are really non-glandular cells. A few of these can be always seen in a given section to be furnished with a nucleus (see fig. 13) placed near to the middle of the cell.

§ *Spermathecæ.*

Eisen did not record the presence of spermathecæ in *Ocnerodrilus occidentalis*, but subsequently found these organs to be present in several other species of the genus from Central America. This discovery led him to suspect that the organs in question must have been overlooked in *O. occidentalis*. This supposition may not be necessary, for these organs certainly do not exist in *Criodrilus lacuum* [see Rosa, **12**] and in *Lumbricus Eiseni* and *Allolobophora constricta;* possibly also a species of *Perichæta* has no spermathecæ [Beddard, **4**]. *Ocnerodrilus Eiseni* has a single pair of spermathecæ in the VIIIth segment, which open on a line with the ventral pair of setæ into the furrow which separates this segment from the VIIth.

The spermathecæ (fig. 6) are a pair of spherical sacs, without any trace of a diverticulum.

I found them to be absent in some of the specimens which I examined; and this fact suggests that they may really occur in *O. occidentalis* and have been overlooked. The specimens of *O. Eiseni* in which I found spermathecæ were fully mature, with the exception of the clitellum, which was quite undeveloped. On the other hand, examples with a fully formed clitellum showed no traces of spermathecæ. This is somewhat remarkable, as one is inclined to associate the presence of a clitellum with complete maturity of the other organs belonging to the reproductive system. It is possible that this relation is only an accidental coincidence. The absence of a diverticulum is to be noted in relation to the affinities of the worm. Among Earthworms, all the genera included in my family [**3**] Cryptodrilidæ possess one or more diverticula appended to the spermathecæ; and it is with this family that *Ocnerodrilus* would have to be associated if it were definitely referred to the terrestrial Oligochæta. The absence of diverticula is therefore a point of resemblance to the Lumbriculidæ, Phreoryctidæ, and other families of aquatic Oligochæta.*

§ *Ovaries.*

The position of the ovaries in *Ocnerodrilus Eiseni* appears to be very different from that of *O. occidentalis*. In the latter they occupy a very unusual position, in their segment being situated upon its posterior wall; they are stated to lie in the XIIth segment (XIth setigerous) on the mesentery, between that and the XIIIth. Among Earthworms, *Acanthodrilus annectens* and *A. multiporus* are the only species known in which the ovary lies on the posterior wall of the segment. Nor is this a point of resemblance to the Lumbriculidæ, for Vejdovsky has figured [**15**] both in *Phreatothrix* and *Claparedilla* the ovaries as attached to the anterior wall of their segment, which is here the XIth.† In *Ocnerodrilus Eiseni* the paired ovaries occupy the position which they are found to

* I am inclined to think that Rosa's failure to find spermathecæ in *Microscolex dubius* may be due to the fact that they are only, as in *Ocnerodrilus*, present for a short period.

† Vejdovsky's figures of *Phreatothrix* [**15**, pl. xi., figs. 18, 19] show the XIth as the ovarian segment, but his table on p. 132 states the Xth segment.

occupy in the vast majority of Earthworms ; that is to say, they are attached to the front wall of the XIIIth segment near to the ventral body wall. In this species, however, the XIIth segment has a very restricted lumen, and it appears to me quite possible that the delicate septum which separates this segment from the XIIIth may have been overlooked by EISEN, who studied only the living worm as a transparent object. This suggestion is perhaps hardly borne out by the figure which he gives of the entire reproductive system of the Annelid. I feel convinced, however, that there must be some error in EISEN's description and figure, as it would be difficult from his statements to understand how the ova could reach the exterior. I am not aware that there is any case known in which the ovary lies in a different segment from that which contains the oviducal funnels, except *Sutroa* [see EISEN, **2**]. I am of opinion that these apparent exceptions require reinvestigating before they can be regarded as certain. Contrary to EISEN's statement, I did find ova detached from the ovary and floating freely in the perivisceral cavity of the XIIIth segment. In one specimen there were two such ova on one side of the body, and six on the other. As my sections formed a continuous series, cut by the Cambridge Rocking Microtome, I am confident of this fact. I imagine, from the absence of any mention of the clitellum in EISEN's description, that this organ was not yet developed in his specimens, and that the worms were therefore not fully mature. This may account for the fact that he did not see any ripe ova floating freely in the body cavity.

The point may be in reality one of some little importance in relation to the question of the affinities of *Ocnerodrilus*. A large number of Earthworms have been shown to develop special sacs for the reception of the ripe ova; probably the majority are thus provided. Similar structures occur in a considerable number of genera belonging to the "Limicolæ"; but there are several, particularly among the Enchytræidæ, where these receptacles do not occur.

§ *Summary.*

Ocnerodrilus Eiseni presents the following structural characters :—

The *setæ* are strictly paired, and are of the usual Lumbricid pattern. They are not modified upon the clitellum; the ventral pair are wanting upon the XVIIth segment, which bears the apertures of the vasa deferentia and atria.

The *clitellum* occupies segments XIII–XIX. It has the same structure as in Earthworms.

The *nephridiopores* open in front of the ventral pair of setæ.

The *oviducts* open upon the XIVth segment.

The *atrial pores* are upon the XVIIth segment.

The *spermathecal pores* are in the IXth segment, on the border line between this and the VIIIth segment, in front of the ventral setæ.

There are no *dorsal pores.*

The *alimentary tract* consists of (1) *a buccal cavity* occupying the first three segments ;

(2) *a pharynx* with muscular walls, extending from this point to the end of the Vth segment; (3) a narrow *œsophagus* with much-folded walls, which become widened out in the VIIIth segment, where it receives (4) a pair of *calciferous glands.* (5) The *ciliated intestine* is a very narrow tube in segments IX and X, after which it is suddenly widened but has no typhlosole.

The *brain* lies between segments III and IV.

The *vascular system* is chiefly remarkable for the presence of two large hearts—one pair in the Xth, the other pair in the XIth segment.

The *nephridia* are paired, and exist in all the segments from the IIIrd; in some of the genital segments they become degenerate, viz., the XIth and XIIth.

The *reproductive organs* consist of (1) two pairs of *testes* in segments X and XI, attached to the front wall of the segment; (2) of a pair of *ovaries* occupying a corresponding position in segment XIII; (3) of *vasa deferentia*, which open into the segments containing the testes, and pass back, becoming fused, to open on to the exterior in common with (4) the *atria*, which are long, often coiled, tubes, divisible into a muscular and a glandular portion. The epithelial lining consists throughout of a single layer of cells; (5) the *oviducts* open into the XIIIth segment by a funnel, and on to the exterior of segment XIV. There are no egg-sacs, and the ova are of comparatively large size and few in number. (6) One pair of *spermathecæ*, without diverticula, exist in segment VIII.

II. Systematic Position of *Ocnerodrilus*.

In discussing the affinities of *Ocnerodrilus* I shall pass over the question of Claparède's division of the Oligochæta, since most of those who have subsequently studied the group agree in rejecting it. Rosa, however, retains the Terricolæ. As I have already pointed out [3], his definition of this group hardly excludes *Phreoryctes*, which is indeed a link between the Lumbriculidæ and certain Earthworms.

The most recent contribution to this question is a paper by Benham [9], chiefly devoted to the classification of Earthworms, but containing also some observations upon the major divisions of the group Oligochæta.

Mr Benham divides the Oligochæta into two sub-classes, viz., Naidomorpha and Lumbricomorpha, to be distinguished by the occurrence or non-occurrence of asexual reproduction.*

There are few other points which distinguish these groups. Mr Benham mentions the situation of the male genital pores upon or in front of segment VII, the colourless blood, and the frequent "cephalisation."

We must strike out the second character, since the blood is coloured in Naids; also the third character, on account of the absence of setæ on the anterior segments of *Onychochæta* and *Deodrilus* (Beddard, Nos. 6 and 7).

* We require, however, more information about *Ilyodrilus*, which resembles the Naidomorpha in certain points.

I am inclined, however, to agree with Mr BENHAM, and to retain this group on account of the occurrence of the asexual mode of generation.*

The second sub-class, Lumbricomorpha, contains all the remaining Oligochæta, which are divided into two series, Microdrili and Megadrili.

The only character which absolutely distinguishes these two is the presence in Megadrili of a capillary network upon the nephridium, and its absence in Microdrili, and it is admitted that this difference may be due to size. *Ocnerodrilus* renders this division no longer tenable.

Mr BENHAM has, however, not mentioned three points, which he might have used to distinguish the two groups. These are—(1) large size of ova, (2) clitellum consisting of only a single layer of cells, (3) sexual maturity at a fixed season. Until the publication of the facts contained in the present paper, these points would, so far as I am aware, apply to all Microdrili, and to none of the Megadrili. However, in *Ocnerodrilus* the ova appear to approximate in size to those of the Microdrili. The question to be now considered is, How far are the two last points sufficient to characterise the Microdrili? If they are sufficient, it will be tantamount to restoring the old grouping into Limicolæ and Terricolæ, for the Naidomorpha in these points agree with the Microdrili. The classification would be as follows :—

I. Clitellum one cell thick.
Sexual maturity at a fixed period.

A, Asexual reproduction occurs,	*Naidomorpha.*
B, No asexual reproduction, sexually mature at fixed periods,	*Microdrili.*

II. Clitellum, composed of two distinct layers.
Sexual maturity more or less continuous.

Megadrili.

This mode of division does not appear to me so satisfactory as the one proposed by Mr BENHAM, and I should be inclined, therefore, not to divide his Lumbricomorpha, except of course into families and genera.

I do not propose to discuss the limitations of these families, as I have already done so elsewhere [**3**] in so far as concerns Earthworms.

The question is whether *Ocnerodrilus* is referable to any known family, or whether it should form a distinct family.

This genus was originally placed by EISEN [**1**] in the family Lumbriculidæ, though the reasons which led to this view are not plainly stated. Indeed, the whole paper is occupied with a description of the *differences* between *Ocnerodrilus* and other genera of Lumbriculidæ; nowhere is there any indication of what are regarded as the points of affinity between *Ocnerodrilus* and other Lumbriculidæ.

* This scheme is practically identical with that proposed by D'UDEKEM in 1853 [**13**], and further elaborated in 1863 [**14**]. The division is into "*Agemmes*" and "*Gemmipares*," these names implying the principal distinction between the two groups. Another distinction referred to is the persistence of the genital organs in the "*Agemmes*," and their appearance only at certain epochs in the "*Gemmipares*."

Vejdovsky [15] considers that there are no valid reasons for retaining this genus within the Lumbriculidæ, and points out the resemblance in the genital system to Earthworms. Later Eisen [2] himself takes the same view, and refers *Ocnerodrilus* to a distinct family.

It may be considered, I think, quite certain that *Ocnerodrilus* has no particular relation to the Lumbriculidæ. The points in which *Ocnerodrilus* does agree with the Lumbriculidæ are not sufficiently characteristic; they are as follows:—

(1) Setæ paired, not bifid at their extremities,
(2) Septal glands present (as in *Stylodrilus*),
(3) Nephridia absent in some of the genital segments,
(4) Atrium lined by a single layer of cells,
(5) Ova moderately large,

and a number of other points which are not more conclusive than the above in determining the affinities of the Worm, for they occur in many of the families of aquatic Oligochæta.

As to Earthworms, it is evidently with my family Cryptodrilidæ that *Ocnerodrilus* shows the greater number of points of resemblance, and particularly with the genera *Pontodrilus*, *Photodrilus*, and *Microscolex*. Its general resemblances to the Cryptodrilidæ are as follows:—

(1) Clitellum (composed of two distinct layers of cells), extending over segments XIII–XIX.
(2) Vasa deferentia (commencing by funnel-shaped orifices in X and XI), opening on to the XVIIth segment in common with an atrium, which is long and tubular in form, and is separable into a glandular and a muscular portion.

The special resemblances to the genera *Pontodrilus*, *Photodrilus*, and *Microscolex* may be gathered from the following Table:—

	Ocnerodrilus.	*Pontodrilus.*	*Photodrilus.*	*Microscolex.*
Setæ,	Strictly paired.	In 8 series.	In 8 series.	In 8 series.
Clitellum,	13–19	13–17	13–17	13–17
♂ pores,	17	18	18	17
Dorsal pores,	0	0	0	0
Gizzard,	0	Rudimentary.	0	Rudimentary.
Nephridia,	Commence in 3; absent in 10, 11.	Commence in 15.	Commence in 14.	Common in 5.
Atrium,	Tubular.	Tubular.	Tubular.	Tubular.
Penial setæ,	0	0	+	+
Spermatheca,	One pair in 8, no diverticula.	Two pairs in 8, 9, with diverticula.	One pair in 8, with diverticula.	Absent, or one pair in 9 with diverticula.
Typhlosole,	0	0	0	0
Subnervian vessel,	0	0	0	0
Hearts,	In 10, 11	12, 13	10, 11, 12	10, 11, 12
Septal glands,	+	0	+	0

As regards the facts of structure enumerated in the above Table, it appears that *Ocnerodrilus* shows no affinity to any one of the three genera in particular; it cannot be said to come nearest to *Pontodrilus*, or to *Microscolex*, or *Photodrilus*.

It differs from all of them in the following characters:—

(1) Greater extent of the clitellum.
(2) Setæ strictly paired.
(3) Gizzard totally absent (? as to *Photodrilus*).
(4) Spermathecæ without diverticulum.
(5) Atrium lined by a single layer of cells.
(6) Absence of a vascular network upon the nephridia.

The last four characters, which are evidently the most important, show a further simplification in the structure of *Ocnerodrilus* as compared with its nearest allies among the Cryptodrilidæ. This simplification of internal structure is in the direction of many families belonging to the aquatic Oligochæta, to none of which, however, is there more than a general resemblance, brought about merely by this simplification.

Our present knowledge, however, of the aquatic Oligochæta is much less than of the terrestrial forms; nothing can be said as to the position which *Ocnerodrilus* occupies with regard to the aquatic families until some link turns up which may give a clue. In the meantime it is evidently some way removed from even the simplest forms of one group of Earthworms to a distance which appears to me to be sufficient to need the formation of a special family for its reception. The family may be thus defined:—

Family *Ocnerodrilidæ*, Eisen.

Small Oligochæta, with paired setæ of Lumbricid pattern. Testes, two pairs in X and XI. Vasa deferentia open on to segment XVII, in company with an atrium lined by a single layer of cells only, and divided into a glandular and non-glandular portion. Ovaries paired in segment XIII; oviducts opening on to segment XIV. Ova moderately large; septal glands present, but no gizzard. A single pair of glandular diverticula of œsophagus in IXth segment. Nephridia abortive in some of the genital segments; in the posterior region of the body, imbedded in a mass of large vesicular peritoneal cells.

Genus *Ocnerodrilus*, Eisen.

Ocnerodrilus, Eisen, *Nov. Act. R. Soc. Upsal.*, 1878.

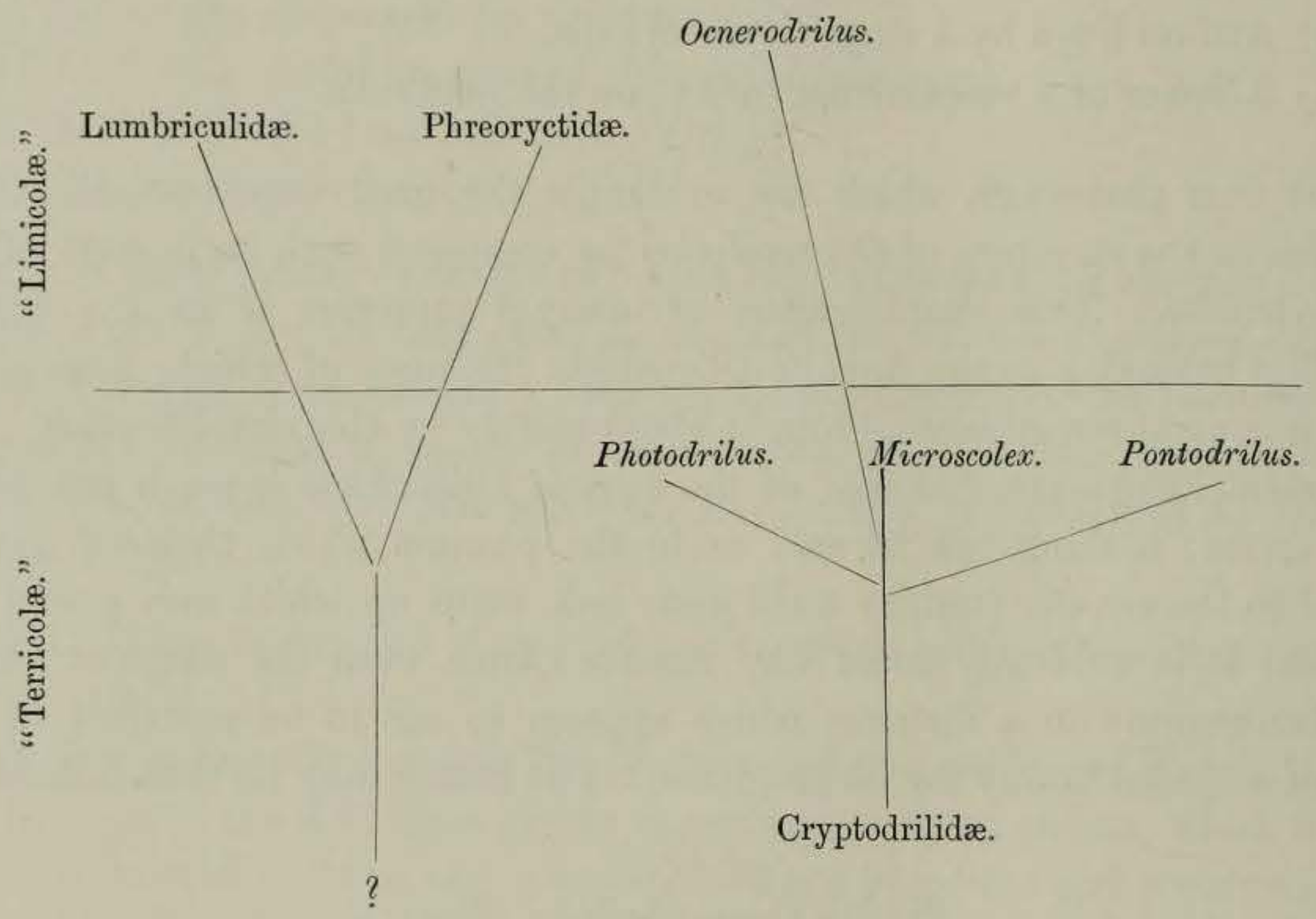
Clitellum extensive, inclosing the reproductive pores.

One or more pairs of spermathecæ in anterior segments, without diverticula. No penial setæ. Vascular system consisting of a dorsal and ventral trunk, and two lateral vessels given off from dorsal vessel in the VIIth and VIIIth segment. Two large hearts in segments X, XI.

Ocnerodrilus Eiseni, n. sp.

Clitellum occupying segments XIII–XIX. Ventral setæ of segment XVII entirely absent. Septal glands in anterior segments. One pair of spermathecæ in segment VIII opening on to border line between this segment and the one in front.

The affinities of the genus appear to me to be capable of being expressed in the accompanying scheme, which only contains those Earthworms (viz., the Cryptodrilidæ) which come nearest to *Ocnerodrilus*.



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EXPLANATION OF PLATE.

Ocnerodrilus Eiseni, n. sp.

Fig. 1. Dissection to show genital system.
Fig. 2. Ventral view of anterior segments. *n*, nephridiopores; *s*, spermathecal pores; ♀, oviducal pores; ♂, pores of vasa deferentia.
Fig. 3. Main vascular trunks in segments x. xi.; *d*, dorsal vessel; *v*, ventral vessel; *si*, supra-intestinal; *h*, heart.
Fig. 4. Alimentary canal. *ph*, pharynx; *d*, diverticula of œsophagus.
Fig. 5. The worm of the natural size.
Fig. 6. Spermatheca in longitudinal section.
Fig. 7. A seta.
Fig. 8. Longitudinal section through segments XI, XII, to show connection of testes (*t*) with sperm sac (*sp. s.*) and intersegmental septa.
Fig. 9. Nephridium in transverse section. *nph*, nephridium itself; *b*, vesicular cell; *a*, small granular cells.
Fig. 10. Rudimentary nephridium of segment XI. *sp*, intersegmental septum; other letters as in fig. 9.
Fig. 11. Nephridial funnel. *sp*, intersegmental septum.
Fig. 12. Longitudinal section through intestine. Among the columnar ciliated cells are large granular glandular cells.
Fig. 13. Atrium, transverse section.
Fig. 14. Section through a point near to opening of atrium (*atr.*) and vas deferens (*vas. def.*).

Mr F. E. BEDDARD ON OCNERODRILUS.