2. On certain Points in the Structure of *Clitellio* (Claparède).

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[Received September 5, 1888.]

(Plate XXIII.)

The sandy mud upon the shores of the Sound at Plymouth was invariably found to contain large numbers of a small slender Oligochete of a dark greenish-grey colour. The worm appears to be identical with Claparède's *Clitellio ater* [2]; the same mud also very frequently contained examples of another species of *Clitellio*, which is probably *C. arenarius* [3]. The obvious difference between these two species was the absence, in the latter, of the peculiar dark papillæ which cover the surface of the body in *C. ater*, and which appear to be characteristic of that species. I never found these worms in any other situation, and they were invariably absent from the coarser sands, which were exclusively occupied (as regards Oligochæta) by certain species of *Pachydrilus*, upon which I hope to offer some notes to the Society later.

Although Claparède has given a tolerably full account of the structure of *Clitellio*, especially of *Clitellio arenarius*, I am able to add some few facts to our knowledge of the worm; my remarks partly deal with *C. ater*, and partly with the transparent species which I shall call *C. arenarius* [4].

Clitellio ater is, as Claparède remarks, characterized by the dark colour of the integument, which, however, is not developed (fig. A, p. 486) upon the anterior extremity of the body, upon the last few segments, and upon the clitellum. The colour is due to innumerable papillæ the shape and structure of which do not appear to me to be well illustrated in Claparède's drawing [5]; on the other hand, the general appearance of the body due to these peculiar structures is very well shown in Claparède's figure [6]. They are somewhat leaf-shaped with a pointed apex, the base being attached to the cuticle; the interior of each papilla is filled with greyish-green granules.

Claparède's description of the setæ is, so far as my observations enable me to state, incorrect; he states that the setæ are arranged in two double rows, and are alike in both rows, being bifid at the extremity or terminating in a simple point. This character is, in fact,

[1] From observations made at the Plymouth station of the Marine Biological Association.

[2] Ed. Claparède, "Recherches anatomiques sur les Oligochètes," Mém. Soc. Phys. Genève, t. xvi. (1862), p. 253.

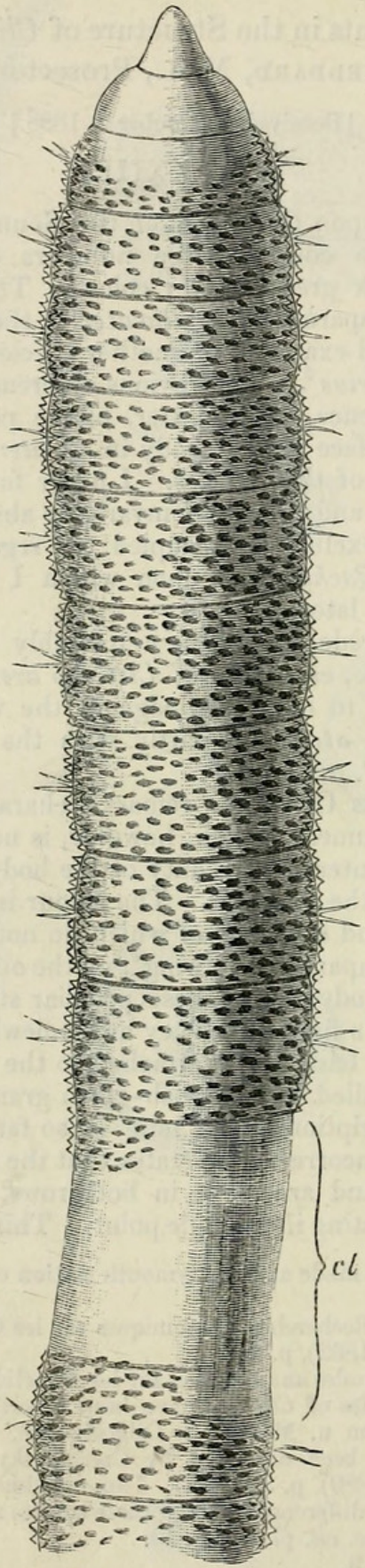
[3] Ed. Claparède, "Études anatomiques sur les Annélides &c.," *tom. cit.* p. 102.

[4] Several other species of *Clitellio* have been described, for a list of which see Vejdovsky's 'System u. Morph. d. Oligochaeten,' Prag, 1874, p. 45; the majority of these have been described by Czerniavsky (Bull. Soc. Imp. Nat. Moscou, t. lv. pt. ii. (1880), p. 324, &c.). I am not able at present to determine what are the points of difference between these species and *C. arenarius*.

[5] Recherches, &c., *loc. cit.* pl. iv. fig. 10.

[6] *Loc. cit.* pl. iv. fig. 9.

Fig. A.



Anterior segments of *Hemitubifex ater* (*Clitellio ater*, Clap.).
cl, clitellar segments.

the principal one which differentiates the genus from *Tubifex*, and is recapitulated by Vejdovsky in the systematic part of his great work upon the Oligochæta[1]. I find that in *Clitellio ater* the setæ of the dorsal pair are sometimes of two kinds—(1) bifid setæ, (2) long slender setæ (Haarborsten). On the other hand, the ventral setæ belong only to the bifid form. This, however, is not always the case; individuals of *C. ater* are frequently met with which possess only the bifid setæ; these individuals were indistinguishable in any other character from those in which hair-setæ were also present. The character of the setæ must therefore be regarded as variable. As to the number of setæ per bundle, I find that there are usually two, though sometimes more.

§ 1. *Remarks on some other Marine Species of Tubificidæ.*

Besides these two species, a considerable number of marine Tubificidæ have been described from the Western European coasts. These are:—

Tubifex benedii, d'Udekem, "Nouv. Class. Annélides Sétigères Abranches," Bull. Ac. Roy. Belg. t. xxii. (1855), p. 544.

T. hyalinus, id. ibid.

T. papillosus, Claparède, Beobachtungen über Anat. und Entwick. wirbellos. Thiere an der Küste von Normandie angestellt. Leipsic, 1863.

T. lineatus, Müller, Zoologia Danica.

T. bilineata, Montagu, MS.; Parfitt, "Catalogue of Annelids of Devon," Trans. Devon. Assoc. 1867, ii.

T. pellucidus, Montagu, MS.; id. ibid.

Peloryctes inquilina, Zenger, Bull. Soc. Imp. Nat. Moscou, xliii. pt. 1 (1870), p. 221.

The first two species are considered by Tauber[2] to belong to the genus *Limnodrilus*, for the reason that they only possess bifid setæ, a fact noted by d'Udekem in his brief description of the species. I believe him to be wrong in this identification; there is nothing in d'Udekem's description to prevent both these species from being included in the genus *Clitellio*, which, and I can confirm Claparède, is also characterized by the absence of hair-setæ. Furthermore *Clitellio* and *Limnodrilus* also agree in the possession of two pairs of "hearts," situated in segments 7 and 8 respectively. Claparède only observed one pair in *C. arenarius*, whose position he was unable to fix with accuracy. I have, however, seen two in living specimens, where they are very distinct. The presence of two pairs of specially dilated vascular arches has been described in the European species of *Limnodrilus*, and I have had the opportunity of verifying this character of the genus in a New-Zealand species, which may or may not be identical with one or other of the European species. The two genera can only

[1] System u. Morphologie der Oligochaeten, p. 45.
[2] 'Annulata Danica,' p. 71.

in fact be distinguished by the characters of the reproductive organs (see p. 490). These points are evidently appreciated by Vejdovsky [1], who suggests that *Tubifex benedii* may be a synonym of *Clitellio arenarius*. This is probably an error in printing; there can be little doubt that Vejdovsky meant to place *T. benedii* as a synonym of *Clitellio ater*, an identity which has been pointed out by Vaillant [2].

D'Udekem gives a woodcut illustrating the papillæ of his *Tubifex benedii*, and there is no doubt in my mind about the identity of this species with Claparède's *Clitellio ater*, which, however, as will be pointed out later, is not a *Clitellio* at all.

The remaining species—*Tubifex hyalinus*—is very probably the same as *Clitellio arenarius*. There is at any rate nothing to be said against this identification; and it is more probable that the species is a *Clitellio* than a *Limnodrilus*, for the reason that the latter genus is, so far as is certainly known, an inhabitant of fresh water [3].

The preliminary list of the marine fauna of Plymouth, published in the second number of the 'Journal of the Marine Biological Association,' contains a single Oligochete, *Tubifex lineatus*. This species, if it be identical with that described in Johnston's 'Catalogue of British Non-parasitical Worms' (p. 66), is certainly not a *Tubifex*, since the setæ are there stated to be entirely *f*-shaped, but not bifid; this may be due to wear, and the species is perhaps a *Clitellio*, possibly the same as *Clitellio arenarius*. This species, however, as well as *Tubifex bilineata* and *T. pellucidus*, all of which are recorded from Devon in Parfitt's 'Catalogue of the Annelids of Devon,' require investigation. Parfitt mentions the occurrence of *Clitellio arenarius* [4].

Peloryctes inquilina has been described somewhat fully by N. Zenger [5]; the species is not referred to by Vejdovsky in his account of the Tubificidæ, though the paper is quoted in his list of literature. Having been at some trouble to translate certain portions of Zenger's paper from the Russian, I can offer the following remarks upon its systematic position.

The species occurs in the "Kieler Bucht" at a depth of 12 fathoms, either living freely in the mud or sand or upon the shell of *Mytilus edulis*. Prof. Möbius, who first found the worm, considered it to be identical with Claparède's *Clitellio ater*. It is of a dark red colour, owing to its red blood and the dark papillæ on the surface. Zenger considers that the papillæ distinguish this species from *Clitellio ater*, both in their distribution and in their structure. In *C. ater* "the first head-segment is never covered by papillæ, and half the second segment as far as the setæ is also free from papillæ; papillæ are in addition absent from the space extending from the 10th to the 12th segment, which is occupied by the clitellum ....;

[1] Syst. u. Morph. d. Oligochaeten, p. 45.

[2] Essai de Classification des Annélides Lombriciens," Ann. Sci. Nat. (Zoologie), t. x. (1868), p. 251.

[3] Forel (Bull. Soc. Vaud. xiii.), however, describes a *Clitellio* from the Lake of Geneva (*cf.* footnote to p. 494).

[4] Trans. Devon. Assoc. 1867, vol. ii.

[5] Bull. Soc. Imp. Nat. Moscou, 1870.

in *Peloryctes inquilina* the extent of the clitellum and the distribution of papillæ is variable. I had fully developed sexual individuals in which there was not a trace of clitellum ; all the area of segments 10–12 was covered with papillæ like the rest of the surface of the skin ; in others, on the contrary, either segments 9 and 10 or 10 and 11 were devoid of papillæ. In the anterior part of the body all the first three segments were sometimes devoid of papillæ, sometimes only the head. Finally the last 10 or 11 segments were often without papillæ."

It does not appear to me that these facts are necessarily opposed to the view that *Peloryctes inquilina* is synonymous with *Clitellio ater*. It is a well-established fact that the clitellum is variable in its appearance ; and I have myself observed specimens of *Clitellio ater* in which the clitellum was fully developed and without papillæ, or not developed and with papillæ. The hinder end of the body in my specimens was generally, if not always, devoid of papillæ. Claparède does not apparently mention this fact, but his description of the species is very brief and incomplete. With regard to the absence of the papillæ on some of the anterior segments, I may state that in my specimens the papillæ commenced rather gradually and that those upon the anterior segment were, at least in some individuals, considerably smaller than the papillæ of the following segments ; this may perhaps account for the discrepancies between Zenger's observations and those of Claparède. There may be something in the structural differences between the papillæ of *Peloryctes inquilina* and those of *C. ater* ; the papillæ of the former species are stated by Zenger to resemble very closely those of *Pachydrilus verrucosus*. The setæ of *Peloryctes inquilina* are all bifid, but they are alleged to differ from those of *Clitellio ater* in the number per bundle—a character which I cannot admit to be valid, as I have found great differences in this respect between individuals of *C. ater*, and indeed of other species of Oligochæta ; it is, I think, recognized that in those forms with a large number of setæ in the bundle the number is variable.

Another point which Zenger raises is the characters of some of the transverse branches which unite the dorsal and ventral trunks in some of the anterior segments. In the 7th, 8th, and 9th segments of *Peloryctes inquilina* these trunks are specially dilated, and this difference from other Tubificidæ is regarded, in conjunction with the other points of difference, as sufficient to necessitate the establishment of a new genus. The generic name is Leuckart's, and was originally applied to *Clitellio arenarius* until the latter was shown to be identical with Savigny's *Clitellio arenarius* ; Zenger therefore, and this proceeding of his will not be admired by those who regard zoological nomenclature as a serious subject, resuscitates the name *Peloryctes* to apply it to his species.

In the examples of *Clitellio ater* which I studied I found it to be by no means so easy as in *Limnodrilus* to distinguish any of the vascular arches of the anterior segments as specially enlarged ; in some specimens, however, the vascular arch of the 8th segment, as in *Tubifex*, was decidedly stouter than the rest ; in other specimens this difference was not so striking, and then the arches of 6, 7, and 8

appeared to be equal and stouter than the more anteriorly situated trunks. The description which Zenger gives of the reproductive organs is, as he himself admits, imperfect. The most important point which he mentions is the presence of spermatophores, which were little known at the time when he wrote. There is nothing in his description of the reproductive organs to distinguish *Peloryctes inquilina* from *Clitellio ater*.

On the whole the identity or non-identity of *Peloryctes inquilina* with *Clitellio ater* must be for the present regarded as an open question, though I am disposed to think that they are identical.

§ 2. *Anatomy of* Clitellio.

Generative Organs.—Claparède's account of the reproductive organs of *Clitellio* is by no means complete.

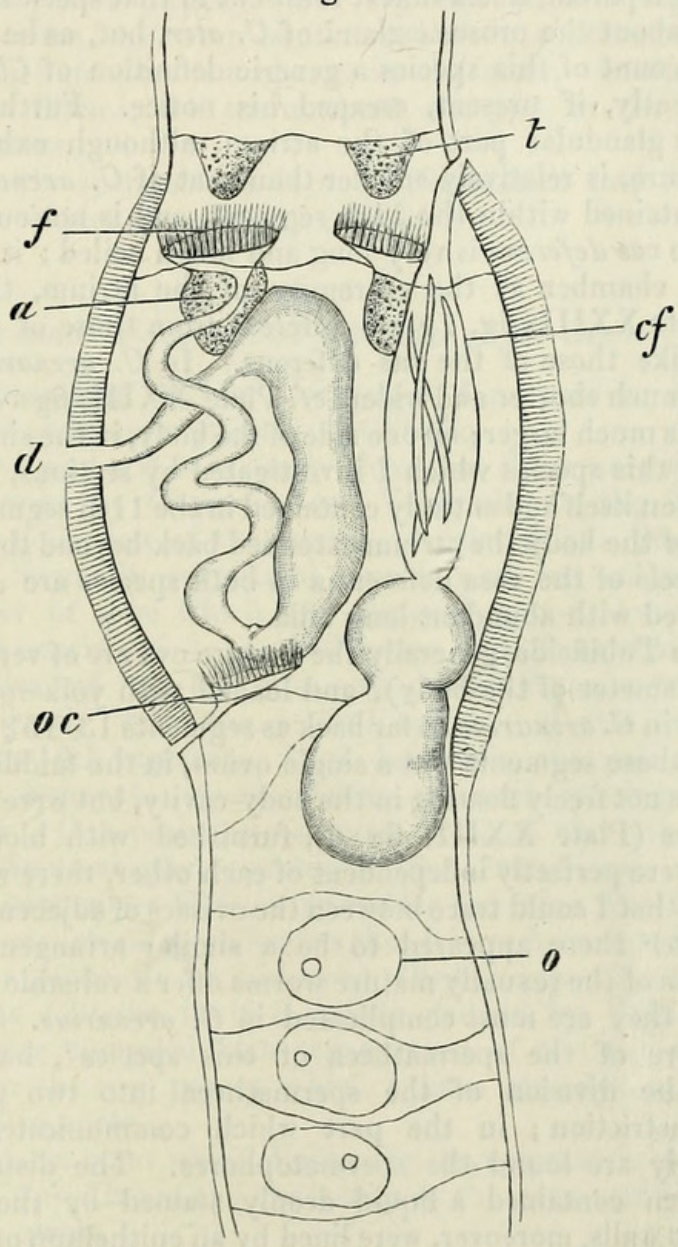
He has confounded, as so many writers have done, the *testes* with the *vesiculæ seminales*; the former organs are not described by Claparède. I find that the testes differ in no important particular from those of *Tubifex*; they lie (see Plate XXIII. fig. 1), as in that genus, in the 10th segment, into which open the funnels of the vasa deferentia; each organ is long and narrow, somewhat swollen at the base of attachment to the body-wall. The *vesiculæ seminales* (testes of Claparède) were not, judging from Claparède's description, fully developed in any of the specimens studied by me. The 10th segment in one specimen contained a mass of developing spermatozoa about equal in size to a similar mass occupying a large portion of segment 11. In the latter case, however (Plate XXIII. fig. 3), the mass of developing spermatozoa was enclosed in a thin-walled sac abundantly furnished with blood-vessels which was confined to this segment, and did not extend back through several segments.

The generative system of a young example of *C. arenarius* is depicted in Plate XXIII. fig. 1; it will be seen that the funnels of the vasa deferentia open into the 10th segment, but the cells of which they are composed are not ciliated. The *vasa deferentia* pass in a slightly sinuous course to the atrium, which opens externally, not far from the posterior border of the 11th segment. The *atrium* in the undeveloped condition is lined by a simple non-glandular columnar epithelium; it is invested externally by a thin coat of muscles, outside of which is a tolerably thick layer of glandular peritoneal cells. The *spermathecæ* lie in the 10th segment, and at this stage are simple pyriform vesicles. Upon the anterior face of the septum which separates the 11th from the 12th segment, and corresponding exactly in position to the funnel of the vasa deferentia, is a disk-shaped layer of columnar cells, which is evidently the *oviduct*; the cells at this stage are, like the cells of the vasa deferentia funnels, not ciliated. In the sexually mature animal the oviduct-funnels are extremely conspicuous (fig. B & Plate XXIII. fig. 2) cup-shaped organs, with abundant cilia. At the time that I made this observation, I was not acquainted with any observations upon the structure of the Tubificidæ later than those of Vejdovsky[1]; I concluded

[1] System u. Morph. d. Oligochaeten. Prag, 1884.

therefore that I should have the pleasure of recording for the first time the presence of oviducts in the Tubificidæ, and finally exploding the very improbable hypothesis that in these worms the penis-sheath is the homologue of an oviduct. I find, however, that Dr. Stolć has already [1] demonstrated these organs in *Ilyodrilus* and *Psammoryctes*;

Fig. B.



Genital segments of *Clitellio arenarius*. The atrium of the right side and the left spermatheca have been removed. *t*, testes; *f*, vas deferens funnel; *d*, male genital orifice; *a*, ovary; *oc*, oviduct; *cf*, spermatheca, containing spermatophores; *o*, ripe ova in egg-sacs.

my own discovery of the oviducts occupying an identical position in *Clitellio* and in *Hemitubifex ater* (= *Clitellio ater*, see below p. 494) lends further support to Dr. Stolć's contention that these organs will be found to be invariably present in the Tubificidæ.

The *ovaries* are situated in the 11th segment on the anterior mesentery, close to where this is perforated by the vas deferens.

[1] Zool. Anzeig. Bd. viii. p. 660.

The sexual organs of the mature worm, with a fully developed clitellum, differ to a certain extent in the two species which I have studied.

In *C. ater* there is a distinct and large *prostate gland* (Plate XXIII. fig. 7), which opens into the distal extremity of the glandular part of the atrium. In *C. arenarius* I have been unable to find such a gland, and Claparède states that it is absent in that species; he makes no remark about the prostate gland of *C. ater*, but, as he prefixes to his brief account of this species a generic definition of *Clitellio*, the gland evidently, if present, escaped his notice. Furthermore, in *C. ater* the glandular part of the atrium, although exhibiting the same structure, is relatively smaller than that of *C. arenarius*; it is entirely contained within the 11th segment, and is not curved upon itself. The *vas deferens* is very long and much coiled; it opens into a rounded chamber at the extremity of the atrium, the cells of which (Plate XXIII. fig. 7) are different from those of the atrium and more like those of the vas deferens. In *C. arenarius* the vas deferens is much shorter and wider (*cf.* Plate XXIII. figs. 5, 6), while the atrium is much larger; on one side of the body, in the single mature example of this species which I investigated by sections, the atrium was bent upon itself and entirely contained in the 11th segment; on the other side of the body the atrium extended back beyond this segment.

The funnels of the vasa deferentia in both species are cup-shaped and furnished with abundant long cilia.

As in the Tubificidæ generally the mature ova are of very large size (half the diameter of the body), and loaded with yolk-spherules: I found them in *C. arenarius* so far back as segments 13–15; in the first and last of these segments was a single ovum, in the middle one two; the ova were not freely floating in the body-cavity, but were enclosed in distinct sacs (Plate XXIII. fig. 4), furnished with blood-vessels; these sacs were perfectly independent of each other, there was no communication that I could trace between the ovisacs of adjacent segments.

In *C. ater* there appeared to be a similar arrangement. The *spermathecæ* of the sexually mature worms offer a valuable differential character; they are most complicated in *C. arenarius*. Claparède, in his figure of the spermatheca of this species [1], has correctly indicated the division of the spermatheca into two parts by a median constriction; in the part which communicates with the exterior only are found the spermatophores. The distal pouch in my specimen contained a liquid deeply stained by the colouring reagent; its walls, moreover, were lined by an epithelium of a different character to that found in the proximal part of the spermatheca. In *Tubifex rivulorum* [2] there is a corresponding specialization of the lining epithelium, but here there is no constriction developed between the different regions of the pouch.

In Claparède's figure this constriction is not sufficiently marked; in my specimen (see fig. B, p. 491) the two halves of the spermatheca are joined by an extremely narrow neck.

[1] Études, &c., *loc. cit.* pl. iii. fig. 4.
[2] Vejdovsky, *loc. cit.* pl. ix. fig. 17.

The spermatheca extends beyond the 10th segment, in the sexually mature individual it reaches back as far as the 13th segment; where it traverses the boundary-line between the 11th and 12th segments, the next septum, *i. e.* that which divides segments 12 and 13, comes into close relations with the septum dividing segments 11, 12 (see p. 491, fig. B); at this point the two septa almost fuse and the spermatheca passes directly from segment 11 into segment 13; where it traverses the two mesenteries there is another constriction, but the epithelium does not change in character. In *Spirosperma*, according to Eisen [1], the spermatheca occupies in the same way several segments.

In *C. ater* the spermatheca is not differentiated into two regions and it only occupies one segment (the 11th).

§ 3. *Systematic Position and Affinities of the Genus* Clitellio.

In the remaining part of this paper I propose to discuss the affinities and systematic position of *Clitellio*.

In the first place, it is perfectly clear that these worms have been rightly assigned by Claparède and Vejdovsky to the Tubificidæ. Vejdovsky's definition of the family, translated into English, is as follows:—"Normally segmented Annelids of red colour, with a large number of setæ which are disposed in four bundles. The seta-bundles consist of 3–10 bifid setæ, and occasionally, in the dorsal bundles, of hair-like setæ; the lateral vascular trunks communicate directly with the ventral vessel. Testes in the 9th, ovaries in the 10th segment. Vasa deferentia, one pair opening on to the 10th segment. Spermathecæ, one pair opening on to the 9th segment. Ova probably escaping between the 9th and 10th segments. Spermatophores present in the spermathecæ. Aquatic." In all these particulars *Clitellio* resembles the other Tubificidæ, and there are no structural peculiarities that I have been able to discover by which the genus can be said to be allied to any other family.

The genus *Clitellio* itself is briefly defined by Vejdovsky, his definition being compiled from the account of the genus given by Claparède in the two papers which I have already so frequently had occasion to quote.

The two facts upon which Vejdovsky lays stress in his generic definition of *Clitellio* are the characters of the setæ and the absence of a prostate gland.

So far as the first of these characters is concerned, *Clitellio ater* agrees with Eisen's genus *Hemitubifex* [2], and it has a prostate gland. It is, in fact, clear that the two species which I have investigated differ in so many particulars, that they cannot, as the family is at present divided, belong to the same genus.

The principal characters of the two species are as follows:—

[1] G. Eisen, "Oligochætological Researches," Report of Commissioner for Fish and Fisheries for 1883 (Washington, 1885), p. 922.

[2] G. Eisen, *loc. cit.* p. 889.

	C. arenarius.	*C. ater.*
1. *Setæ*	Bifid setæ only present.	Bifid and hair-like setæ in the dorsal bundle; only bifid setæ in the ventral bundle. Sometimes no hair-setæ.
2. *Vas deferens*	Short and wide.	Long and slender and much coiled.
3. *Atrium*	Long and bent upon itself, or extending through several segments.	Short and straight, confined to the 11th segment. Extremity of vas deferens dilated into a special chamber.
4. *Prostate*	Absent.	Present.
5. *Spermatheca*	Specialized into two regions; extending through several segments.	Not specialized; confined to one segment.

Clitellio ater agrees in Nos. 1, 2, 3, 4 with *Hemitubifex*, and the spermathecæ only differ in being without the glandular appendices which Eisen figures in *Hemitubifex insignis*. This latter point is one which I should regard as being only of specific value. It is only by the occasional absence of the hair-setæ in the dorsal rows, and the dilatation of the vas deferens, that this species differs from *Tubifex*. I have not mentioned in the Table the fact that the penis is chitinous, because this character does not differentiate the two species which are compared in that Table; it does, however, distinguish *Hemitubifex* from *Tubifex*.

Eisen met with *H. insignis* in Sweden, in fresh water, so that its habitat is rather different from that of *Clitellio ater* [1].

Clitellio arenarius agrees with *Ilyodrilus* in having a short thick efferent duct, but it does not appear to resemble that genus in much else except perhaps in the absence (?) of prostate glands. Stolc was unable to find these glands in *Ilyodrilus coccineus*; Eisen, however, figures them in several species, though apparently their presence is not referred to in the text of this paper. On the whole it seems advisable to retain the generic name *Clitellio* for *C. arenarius*, and it may be thus characterized:—

Clitellio, Claparède.

Clitellio, Claparède, "Etudes anatomiques, &c.," Mém. Soc. Phys. Genève, t. xvi. 1862, p. 102.

Marine Tubificidæ of an elongate slender form. Bifid setæ only. Vas deferens wide and short; atrium very long; no vesicula seminalis; no prostate glands; penis with a chitinous covering. Oviduct present in 11th segment. Egg-sacs in segments 13, 14, 15. Spermathecæ very large, occupying several segments, differentiated into two regions, separated by a constriction. Spermatophores elongate.

This genus will only contain *C. arenarius* [2].

Clitellio ater must, I think, be included in Eisen's genus *Hemitubifex*.

[1] It should be mentioned that the effect of the two rivers which enter the Sound at Plymouth, and the breakwater which extends across its mouth, is to render the water somewhat brackish.

[2] The other species of the genus must be regarded with Vejdovsky as "*incertæ sedis*."