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TRANSACTIONS OF THE SOCIETY.

V.—*British Tubificidæ.*

By Rev. Hilderic Friend, F.L.S., F.R.M.S.

(*Read December* 20, 1911.*)

In his splendid Monograph of the Order Oligochæta, Beddard remarks respecting this family that what is wanted is a careful study of the living worms by one naturalist who is able to devote a good deal of time to what is, after all, a very small matter (p. 229). And again, living material is essential for the proper description of these Tubificids (p. 251). The more one studies them the more does one feel the truth of these remarks. After all that has been done, the group is still very little known, and the confusion is extreme. I am able, however, as the result of long and careful study of living material, gathered from every part of the country, to throw a little light on some of the problems, and add somewhat to our knowledge of the Tubificids of Great Britain.

I.—Historical Sketch.

The year 1865 saw the publication of a Catalogue of the British Non-parasitical Worms in the British Museum, compiled by Dr. G. Johnston. On turning to page 64 *et seq.* we find reference to three species of worms known as *Sænuris* (Hoffmeister, 1843), and a species of *Clitellio* (Savigny). The first of these is named *Sænuris tubifex*, which has many possible aliases, is said to be found plentifully in the mud of the River Thames, and to be common in shallow

* N.B.—Since this paper was written in the autumn of 1911, much advance has been made in the study. A valuable Memoir by Pointner (Zeitschr. wiss. Zool., xcviii. pp. 626–76, with 3 figures in the text and 2 plates) had not then come to hand, but I have drawn attention to some of the most interesting points in revising the proofs.—H. F.

ditches with a bottom of fine mud, in which the worm constructs an erect cylindrical tube for its protection. The assumption is that there was one species of *Tubifex*, just as there was one *Lumbricus*, and here our trouble begins. Every observer for the last fifty years, at home and abroad, has both been baffled himself, and helped to baffle others, because we have never yet obtained a clear definition of "tubifex." It is assumed that the *Lumbricus tubifex* of Müller, the *Tubifex rivulorum* of the books, and a number of other worms, all refer to one and the same species. A worm was found in the mud, described, and named *Tubifex*. Then another writer found a worm and described it, but again called it *Tubifex*; and, when half a dozen or more different worms had been so described, the question was how to find a clear set of species-characters which would combine all that the various writers had observed. Thus it resulted that *Tubifex* was said sometimes to possess only forked setæ, at other times capillary setæ as well, while it might even possess pectinate at times in addition. One writer said no penis-sheath was present, another that it was; then one described the sheath as resembling a vase, and another as being several times longer than broad: never dreaming that all the time different species, and even different genera, had been under observation. Thus the true *Tubifex* in time became a chimera.

Lankester was one of the first English authors of note to take up the subject. In 1871 he published an article in the Ann. and Mag. Nat. Hist., in which he dealt with a form of Tubificid known as *Psammoryctes*, found in brackish water at Barking. In 1885 appeared Eisen's valuable Oligochætological Researches, and a considerable addition was thereby made to our knowledge of the family. But it was not till 1891 that any very serious work was undertaken on the British species. In that year Benham published a paper in the Q.J.M.S. (xxxiii. p. 187 *et seq.*), which dealt in detail with *Heterochæta*, and supplied valuable notes on *Psammoryctes*, *Spirosperma*, and *Tubifex*. Benham records the discovery of *Spirosperma* in the Thames and in the Cherwell, as well as the occurrence of *Heterochæta*, *Hemitubifex*, and *Clitellio* at Sheerness. While Vejdovsky, Stolč, and others were doing good work on the Continent, Beddard was helping forward the work at home. The Monograph already alluded to was published in 1895, and showed that the Tubificids then known had been grouped under some fifteen or more different genera. It would be impossible, however, to gather from Beddard how many of these genera were represented in the Annelid fauna of Great Britain, except that *Branchiura* is described as found in the Victoria Regia tank in Regent's Park, London, and *Vermiculus* was found by Goodrich at Weymouth.

Among the many Continental writers to whom reference might be made we must pause at the names of Michaelsen, Bretscher, Piguet, and Ditlevsen, since their researches are of special interest

in relation to our British forms. In 1900 Dr. Michaelsen rendered splendid service by the publication of his invaluable work on Oligochæta (Das Tierreich). He does not, indeed, add much to the material supplied by Beddard in this family, except that he gives us a clue to the British species. By a little study of his pages one is able to gather that in 1900 some forty species of Tubificids, ranged under a dozen genera, had been recorded, of which nine only were given for these Islands. Bretscher about the same time described some new species of Annelids belonging to this group. They were found by him in Switzerland, and when we come to the systematic part of our study it will be necessary to refer to him again.

Ditlevsen published in 1904 an important paper on Danish Oligochæts, and although he makes several mistakes, we owe to him the confirmation of some of Beddard's acute observations on the relation of certain Tubificids to the Naids. It is to be regretted that he ignored the generic distinctions of other writers, and following the unfortunate Appendix to Das Tierreich, reduced all the genera to three, viz. *Tubifex*, *Psammoryctes*, and *Clitellio*. The misfortune is the greater since Southern, our only Irish authority on the subject, followed his lead, and has thereby tended greatly to confuse our knowledge. In 1909 Southern described four new species, two of which he places correctly under *Limnodrilus*, and two under Michaelsen's and Ditlevsen's confusing *Tubifex*. He makes the total known British Tubificids in that year sixteen.*

I have been aided in my researches by a Government Grant, and have been enabled, especially during the past twelve months, to add considerably to our knowledge. These studies were commenced twenty years ago, but for some time were allowed to lapse, owing to the indifference with which they were received, and the pressure of other work. It will be seen from what follows that our list is already greatly enlarged, while my material shows that several other species yet remain to be described. My position lies midway between that of Eisen and Beddard. The former asserted in 1885 that the class would, he felt sure, in the near future be found to contain thousands of forms. On the contrary, Beddard in 1895 (ten years later) surmised that a revision of the genus *Limnodrilus* would probably reduce the species considerably. Beddard's position is now shown to be untenable. A more careful study of detail and a fuller knowledge of the essential organs has enabled us to distinguish things which differ and make the diagnosis much more complete.

What is needed to-day is not a fusion of genera so much as a fuller study of species from all parts of the world. The foundations

* Since this paper was read I have consulted the article by Pointner (Zeitschr. wiss. Zool., xcviii. (1911) pp. 626 *et seq.*), on Oligochæts of Gratz, to which reference will be made later. I have also made a study of Claparède's work in Mem. Sc. Phys. Geneva, 1862-3.

already laid are all the better for being fairly broad, as we see when we take a glance at the genus *Limnodrilus*, for example, which contained only three European species when Vejdovsky published his System und Morphologie in 1884, but now consists of something like twenty well-defined species.

In order to show how easily confusion may arise in identifying these Annelids, it may be well to give a few typical gleanings from different parts of the country. I take the entries at random from my note-books.

1. A pool near Smisby, Ashby-de-la-Zouch:—*Tubifex* (= *Ilyodrilus*) *campanulatus* Eisen; *Limnodrilus papillosus* Friend; *L. aurostriatus* Southern; *L. aurantiacus* Friend; *L. nervosus* Friend; *Tubifex bonneti* Claparède. No fewer than five distinct species in a little mud brought away in a 2-oz. bottle.

2. A ditch at Newark, October 13, 1911:—*Tubifex* (= *Ilyodrilus*) *campanulatus* Eisen; *Limnodrilus hoffmeisteri* Clap.; *L. papillosus* Friend; *Ilyodrilus robustus* Friend.

3. A gutter running into the Trent at Gunthorpe, Notts, November 8, 1911:—*Tubifex tubifex* O. F. Müller; *Limnodrilus papillosus* Friend; *Ilyodrilus robustus* Friend.

4. The River Thames at Tower Bridge, collected for me by Mr. C. S. Todd, of Tottenham, September 30, 1911:—*Limnodrilus hoffmeisteri* Clap.; *Monopylephorus trichochætus* Dit.; *Tubifex tubifex* O. F. Müller; *Limnodrilus longus* Bretscher; *Psammoryctes barbatus* Grube; *Limnodrilus papillosus* Friend.

5. Banks of a stream at Netherhall, in Derbyshire, November 16, 1911:—*Rhyacodrilus falciformis* Bretscher; *Tubifex tubifex* O. F. Müller; *Ilyodrilus robustus* Friend; *Limnodrilus papillosus* Friend.

Two things should here be noted. First, that no mention is made of such worms as *Paranais*, *Marionina*, *Pachydrilus*, *Nais*, or *Stylaria*, which at first sight closely resemble most of the Tubificids. And, secondly, that the lists represent minimum gleanings, and are not in any way to be regarded as exhaustive.

II.—Descriptive.

While the bulk of the generic names which have been devised for members of this family, such as *Tubifex*, *Limnodrilus*, or *Ilyodrilus*, throw no light on the structure of the Annelids, a few have been selected with a view to helping us in that direction. *Branchiura*, *Monopylephorus*, and *Bothrioneuron* tell of processes on the tail and other points of interest. But they also land us in difficulty when we find a *Branchiura* without branchiæ, and a *Monopylephorus* which has paired organs instead of unpaired. Evidently something is wrong here.

All kinds of organs have been seized upon by systematists in order to secure some satisfactory method of arrangement. One has

emphasized the value of the nervous system and the ganglia of the head; another has dwelt on the vascular arrangement, the shape of the segmental organs (nephridia), or the presence or absence of penial setæ and a penis-sheath. The building of a tube was at first regarded as characteristic, but it is now known that practically all the true *Tubificids* plunge their heads in the mire and sway their tails in the water, thus making a kind of tube; whereas real tubes are usually fabricated when the worm is injured, in danger, or passing through some special phase of its life-history.

I propose to take, first, such genera as are easily differentiated, and leave over the more complex groups till we have become familiar with the main characteristics. It will be easy afterwards, when our knowledge is a little more complete, to throw the whole into a suitable order and classify the genera on a definite plan. And as experience teaches me that the setæ are the most constant, if not by any means the most important characteristic, I shall lay considerable stress on the number, shape, variety, and disposition of these external features, and show how by their more careful study it will be possible for us in the future to avoid many of the errors into which earlier observers have been led.

GROUP I.—Capilliform Setæ (Haarborsten) Absent.

A.—Forked Setæ only present.

Beginning with those whose setæ are all of one kind, and will therefore afford a ready means of identification, I select the genus *Limnodrilus* for our first consideration. Beddard's brief diagnoses of the species are unfortunately valueless, because they omit many of the most essential characters. Michaelsen has extended the descriptions somewhat, but even he does not always make the details clear. Hence the need of a fuller elaboration.

I. Genus **Limnodrilus** Clap.

This is, perhaps, the best defined genus in the family. Forked setæ only are present; these in four bundles which vary in number and shape in the different species. Contractile hearts in segments 8 and 9 as a rule. A chitinous penis-sheath usually * present, whose length always exceeds its breadth. Male efferent apparatus carrying a prostate. Spermathecæ in the 10th segment, usually with spermatophores. Male apparatus opening in segment 11.

Fresh-water Annelids, found in Europe, North America and Japan. Beddard (1895) allowed 10 species; Michaelsen (1900) gives 9 with 3 others which are uncertain. Of these 2 are entered

* See, however, Pointner's article, and the note on *Limnodrilus papillosus* Friend, *infra* p. 276.

by Michaelsen as British. Southern (1909) makes 5 species for England and Ireland, himself describing 2 new species which are both well defined and fairly distributed in these islands.

1. *Limnodrilus hoffmeisteri* Clap.

A brownish coloured or red worm, varying much in length, from 20–25 mm., and numbering 90 segments and upwards. The prostomium is short. Setæ from 4–8 in anterior bundles, with short teeth. Pharynx reaching to the third segment. Brain deeply incised in front, and slightly concave behind. Penis-sheath slightly bent, about 11–12 times as long as broad. Nephridia of anterior segments with glandular cells. [N.B. Vejdovsky (System und Morph., p. 47) gives the penis-sheath as 6–7 times longer than broad. He is followed by Beddard. Michaelsen gives "about 11 times."]

The foregoing definition may be extended from notes made during many years, but especially from observations on specimens taken in the Thames during the past year. Here is a typical entry:—Kew, August 28, 1911. Adult. Setæ 5–8 in front, 3 behind. No setæ on girdle segment. Head pointed, blood intense red. Largest heart in the 9th segment. Penis-sheath 12 × 1, slightly bent. Chloragogen cells begin in segment 5, circular when forced out. Girdle includes part of adjoining segment. Spermathecæ in 10 vary in appearance with age and position, cellular at the distal end.

To show how variable the individuals are I give other records. Tower Bridge, London. Collected by Mr. Todd. Head small and short, about the same length as the first segment (or peristomium). Setæ very variable in number, 3–7 in front of body, 3–4 in middle, slender; teeth small, of about equal length. Largest heart in 8, smaller in 9; penis-sheath fully developed but rather short. Setæ wanting ventrally near male aperture, but present dorsally. Spermathecæ large, with slit-like apertures, but no spermatophores visible in any position, though quite mature. Another specimen from the same locality showed length 25–30 mm., with 160 segments; setæ like the last, but penis-sheath longer, or about 1½ × 1. Thus the length, number of segments and setæ, and length of penis-sheath are very variable.

In a ditch at Newark I found on October 13 a worm which recalls Eisen's *L. steigerwaldi*, which Michaelsen places here. My notes are as follows:—Setæ almost always 6 in front bundles, upper tooth smallest, nearly close pressed to the lower. Setæ behind the girdle decreasing in number to 4, 3, and 2 per set, stronger, and with teeth wider apart. Lower tooth stouter than the upper. Penis-sheath bent, 4–6 times as long as broad. Chloragogen cells begin in the 5th segment.

Yellowish cells or glands are often found in the integument of this species. Spermatophores were found in specimens examined October 27 from the Thames, two or more in each spermatheca. I have taken the worm from the Severn at Worcester and various other localities. While examining specimens from the Thames in October I had the good fortune to see the cocoons being passed over the head. They seem to have suffered from the fact that the worms had been sent to me by post and kept for some days in a box; but several important facts were observed, and some curious problems suggested.

Since the foregoing notes were written I have again examined a large number of adult specimens from the Thames and elsewhere, and have at last found the reason for the conflicting descriptions which the different authors supply.

L. hoffmeisteri Clap. is the most variable and unstable of all the species yet known to me. I am now engaged in tracing out the history of the species as well as the synonymy. It will be necessary, probably, when my work is complete, to define the type and at least two clearly marked varieties. I may hint at the result which is likely to be attained.

(1) *L. hoffmeisteri* Clap., type. Length 25–30 mm. Setæ 7–8 in front. Penis-sheath about 11 times longer than broad.

(2) *L. hoffmeisteri* Clap. var. *steigerwaldi* Eisen. Length 30–40 mm. Setæ 6 in front. Penis-sheath about 8 times longer than broad.

(3) *L. hoffmeisteri* Clap. var. *tenellulus* Friend. Length 20–30 mm. Setæ 4–5 in front. Penis-sheath about 4–6 times longer than broad. A delicate, well-marked variety, found in Thames mud at the Tower Bridge, with the type and other Tubificids.

Further details can be given when the species and varieties have been more fully worked out.

Beddard, Monograph of the Order Oligochæta, 252. Michaelsen, Das Tierreich, x. 43–4; and especially Vejdovsky, System und Morphologie, 47–8.*

2. *Limnodrilus udekemianus* Clap.

Colour usually red in front with yellowish tail, the chloragogen cells being brown. Prostomium rounded, longer than broad, anterior segments having a narrow annulus together with a wider front annulus carrying the setæ. The setæ differing strikingly from those of *L. hoffmeisteri* Clap., inasmuch as the upper tooth greatly exceeds the lower in length: 5–8 in each front bundle. Pharynx reaches

* Since this paper was read I have been able to consult Claparède's original Memoir. He gives the length as 25–35 mm., number of segments 55–95, setæ 6–8 per bundle in front, 4–6 in the middle and 2–3 behind. The penis-sheath is put at 5–6 times longer than broad.

to segment 5. Penis-sheath straight and short, about 4 × 1. Length from 30–60 mm.

I have little to add to the excellent description of Vejdovsky. As many as three spermatophores figured by me, some 15 years ago, in specimens taken at Tipton. Reported to Irish Naturalist, v. (1896) p. 127. See Southern in Proc. Roy. Irish Acad., xxvii. (1909) sect. B, No. 8, p. 135; widely distributed. System und Morphologie, p. 47.

Limnodrilus udekemianus var. *wordsworthianus* Friend.—Length 50–70 mm., slender, slightly stouter at segments 6–14 than elsewhere. Segments from 90 upwards. Head pointed. Setæ 4–5 rarely 6 in front, with large upper tooth; present on girdle segment; three in middle of body, then in pairs to the end. Brain with two large processes in front, slightly concave behind. The pharynx in segments 2–3; head and peristomium papillose. Chloragogen cells begin in 5, dilated hearts in 8 and 9. Penis-sheath 4 or 5 times as long as broad. Spermathecæ with long duct (fig. 40).

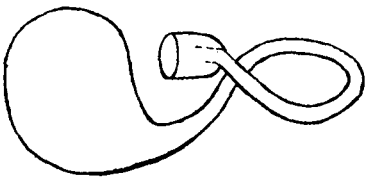

FIG. 40.

1898.—Zoologist, 4th ser. ii. p. 120. This worm was found in a disused quarry at Old Carlisle at the roots of water plants, along with typical *Udekemianus*; and notes of the two, with drawings, were made at the time from living worms. Notice the pharynx, number of setæ, shape of brain, and duct of spermatheca. On April 28, 1899, I found corresponding forms at Sutton Coldfield. It may be well for the present to regard it as a variety, but my own opinion is that we have here a good species. It differs widely from Claparède's type, as shown by his drawings, Mem. Sc. Phys. Geneva (1862) p. 243.

1909.—Southern, Proc. Roy. Irish Acad., xxvii. sect. B, No. 8, pp. 135–6.

3. *Limnodrilus claparèdeianus* Ratz.

A red worm with somewhat long prostomium. The setæ in front from 5–8 per bundle, with upper tooth longest. Brain with a deep excision behind of a squarish form. The pharynx extending back to the fifth segment. Penis-sheath 8-10 × 1, straight or slightly curved with funnel-shaped widening. Length 50–80 mm.

Vejdovsky, Beddard and others thought this species could be

readily distinguished from *L. hoffmeisteri* Clap. by the length of the penis-sheath. While this is not the case, we find no difficulty in distinguishing them if we study them side by side. The colour, length, shape of setæ, and extent of pharynx are then conclusive.

	L. hoffmeisteri	*L. claparedeianus.*
Length	20–50 mm.	50–80 mm.
Colour	Brownish	Light red
Cuticle	Thin	Thick
Setæ	Teeth nearly equal	Upper tooth longest
Pharynx	To 3rd segment	To 5th segment
Penis-sheath	4–12 × 1	8–10 × 1

This species does not seem to have been often observed in Great Britain, as not one of the usual authorities, including Southern, refers to it. I have taken it in a few localities, notably at Kew Gardens, in August of the year 1911, where it was intermixed with *L. papillosus*, and others. It is possible, however, as Bretscher and Piguet have pointed out, that there may be confusion here with the next species.

4. *Limnodrilus longus* Bretscher.

Chloragogen cells begin in fifth segment. Setæ in front bundles number 5. Penis-sheath either straight or slightly bent, upwards of 20 times longer than broad, extending through segments 10–12.

1901.—Revue Suisse de Zoologie, ix. p. 204, with two figures showing straight and curved penis-sheath. Bretscher's definition is meagre. Southern says:—"This species is distinguished by the comparative length of the penis-sheath. In the Irish specimens the length was 21 times the breadth. Bretscher gives 20 to 1 as the proportion. The sheath has a broad and shallow funnel-like expansion at the distal end. The anterior nephridia are enveloped in bladder-like cells. The length is 20–25 mm., and there are 4–7 setæ in the anterior bundles."

I first found it around Malvern, but this year specimens sent me by Mr. Todd from Tottenham have supplied me with the following facts. Length about 1 inch (20–25 mm.), segments 90, head small and pointed. Setæ 4–6, or 7 in front bundles; teeth about equal, quite unlike those of *L. udekemianus*; rather slender. In the posterior bundles the number dwindles to 3 and 2, while the teeth are wider apart. Penis-sheath very long. My camera-lucida drawing gives length as 120 to 6 = 20 × 1, with funnel at distal end represented by 11, or nearly twice the width of the proximal end, where the penis is clearly seen in the sheath. Duct by far the longest I have yet observed, with large pyriform prostate. Brain varying in appearance, but not deeply lobed or incised as in some

species. Spermathecæ well developed, gradually narrowing into the short duct, with no spermatophores present.

First British Record.—Southern, Proc. Roy. Irish Acad., xxvii. (1909) sect. B, No. 8, p. 136. Ireland. Pond in Phœnix Park, Dublin; R. Annalee, Ballyhaise, Co. Cavan. We need accurate notes on many points relating to this genus, in order that a clear idea of the boundary lines between the species, if they exist, may be obtained. The Continental authorities incline to the opinion that this is not a distinct species. It seems to be decidedly distinct in this country.

5. *Limnodrilus aurostriatus* Southern.

Worms of a bright red colour in front; tail paler, each segment with two golden rings. Length 25–30 mm., very slender. Setæ 6–8 per bundle, teeth nearly equal, but lower one thicker than upper. Teeth parallel in front bundles, divergent in posterior segments. Chloragogen cells begin in segment five. Brain almost square; contractile hearts in 8 and 9. Spermathecæ consisting of large sac and wide duct, connected by a narrow passage; each with 2 or 3 spermatophores. Atrium long and slender, penis-sheath 8–9 × 1.

As it resembles *L. hoffmeisteri* in some particulars, the differences in pharynx, integumental vessels, setæ, penis-sheath and spermatheceæ may be noted.

First British Record.—Southern, Proc. Roy. Irish Acad., xxvii. (1909) sect. B, No. 8, pp. 136–7. Since found by me at Malvern and elsewhere.

6. *Limnodrilus parvus* Southern.

Comparatively small, 12–15 mm. in length, with rounded prostomium and smooth epidermis. Segments not biannulate. Setæ 3–5 in front, lower tooth slightly longer and thicker than upper. Brain rounded, deeply concave behind, slightly convex before. Pharynx reaches back to fifth segment. Hearts in 8 and 9. Spermatheca consists of pear-shaped sac, no spermatophores seen. Penis-sheath 9–12 × 1, irregularly curved.

First British Record.—Southern, Proc. Roy. Irish Acad., xxvii. (1909) sect. B, No. 8, p. 138. Counties Dublin and Cavan, Ireland; Adlington, Lancashire. I have since found it at Malvern and with the next at Kew; also at Repton, May 12, 1911, both adult and young.

7. *Limnodrilus aurantiacus* Friend.

Length 15–20 mm. Segments ranging from 65–90 in the adult. Setæ usually 4 or 5 in front, rarely 6; 3–4 in the middle and 3–1 in the posterior regions. They vary materially in size in different

parts of the body, those in segment 5 being to those behind as 3 : 2. The penis-sheath, which I invariably found to be 13 × 1, is five times as long as the hinder setæ, and nearly four times the length of those in front. Teeth of setæ nearly equal. The chloragogen cells begin in the fifth segment or the sixth, and the septa 4/5 to 7/8 are very stout. The segments are annulated. The intestine has rich orange cells from segment 8 backwards through several segments, giving the worm a brilliant appearance. Setæ wanting ventrally near the male pore. Hearts in 8 and 9, that in 8 most prominent. Pharynx seems to extend to the end of segment 4. Spermathecæ similar to those of *L. parvus* Southern (fig. 41). Brain rounded, slightly concave behind and convex or concave in front. Large glandular nephridia in 6/7 and 7/8, then from 12/13 onward, omitting the intervening segments. The nephridia of the hinder segments with tiny anteseptal like that of Enchytræids.

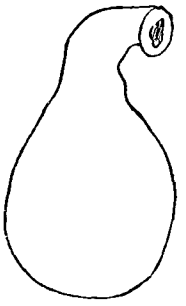

FIG. 41.

My notes show that this species is widely distributed in the South of England, from Derbyshire to Kew and Sussex. The variations are less marked than in most other species. Special points of interest are the setæ, penis-sheath, thickened septa, richly coloured orange cells to intestine, and the spermathecæ. I find some notes which do not perhaps rightly belong to the definition, but are of interest in other ways. Thus, as to the setæ; there is a difference in the shape with age. In some cases the inner setæ are regularly smaller than the outer, and supply a scheme which

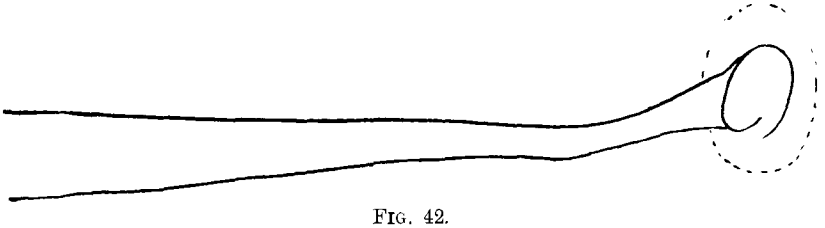

FIG. 42.

distinctly recalls that of certain Marioninas, or *Buchholzia fallax*. The penis-sheath is somewhat bent towards the distal end, and often shows a funnel which is more than twice as wide as the proximal (fig. 42). Sometimes the brain reveals a rather deep posterior incision. The eggs have been seen to extend from segments 11 to 15 inclusive. In young specimens ventral as well as dorsal setæ are present on the segments carrying the sexual organs. No spermatophores seen.

1911. Friend, in The Naturalist, No. 659, p. 414.

8. *Limnodrilus papillosus* sp. n.

Length 25–50 mm. Segments 90 and upwards. A stout, coarse worm, covered with small papillæ. Opaque, somewhat orange coloured, usually sluggish. Setæ 5 in front, coarse, upper tooth much larger than lower; number decreasing in posterior seg-

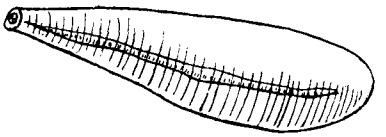

FIG. 43.

ments. Pharynx in segments 2–3; chloragogen cells beginning in 6, brown. Ventral setæ wanting near male pores in adult. Front segments annulate; hearts in 8 and 9. Spermathecæ striate, not glandular, without a separate and distinct duct (fig. 43); no spermatophores seen. No penis-sheath has yet been discovered. Brain rather deeply incised behind.

This worm, like most others, shows various modifications. In Sussex I find it $1\frac{1}{4}$ in. long, head somewhat pointed, chloragogen cells beginning in segment 6, though 5 is the more usual position; more setæ (4–8) than in the type, and much more tender and transparent. Again, a Derbyshire form shows a sac where the penis-sheath should be, and a small chitinous process (fig. 44) which might be a penial seta or a rudimentary penis-sheath. I have studied specimens in all stages of development, and regard the absence of the penis-sheath as supplying a connecting link between this genus and those in which that organ is normally wanting.*

FIG. 44.

* N.B.—Pointner has found a fresh-water Annelid at Gratz which is destitute of a penis-sheath. He therefore proposes to separate it from *Limnodrilus* and call it *Isochæta*. His definition runs thus:—Dorsal setæ the same as the ventral; hooked, but not pectinate. No capilliform setæ.

1. Penis destitute of chitinous sheath: Genus *Isochæta*.
2. Penis with chitinous sheath: Genus *Limnodrilus*.

One species only is described, and this very imperfectly, as follows:

Isochæta virulenta, Pointner.—Habit of *Limnodrilus*: dorsal and ventral setæ of the same kind; no penial setæ. Segments 2–6 biannulate, larger anterior ring carrying the setæ. Ventral setæ 4–8 per bundle in front, 2–3 in the middle, gradually dying out. In the dorsal bundles 3–4 in front, in the middle and posterior portions resembling the ventral. Teeth about equal in the middle and hinder portions, in the anterior bundles the upper tooth is longer and smaller than the under. The setæ, spermathecæ, and male apparatus are figured, but nothing is said of the length, number of segments, or other particulars. It seems, however, to be quite distinct from the species which are described in the present paper.

First found at Kew, August 1911, and since discovered in gleanings from the neighbourhood of Battle and Herstmonceux, Sussex, and various localities in Derbyshire, Notts, and Leicestershire; River Lea, Tottenham, in mud kindly sent to me by Mr. Todd, September 30, with *L. trisetosus* Friend, and other interesting forms.

9. *Limnodrilus nervosus* sp. n.

A very small, pale-coloured worm, at most 10 mm. in length, and about 40 segments. Chloragogen cells begin in segment 6, transparent and delicate, easily breaking up. Pharynx in segments 2–3; large cellular nephridia in 6/7, 7/8, recommencing in 12/13. Hearts in 8 and 9. Head pointed. as wide at the base as the first segment, or wider. Setæ 3 per bundle in segments 2–6, with large upper tooth (fig. 45). Occasionally a fourth present as a new growth. From segment 7 backwards 2 setæ only per bundle. Teeth equal; the length of the setæ being almost one-third the

FIG. 45.

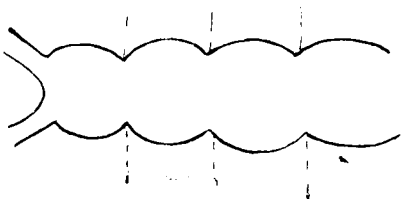

FIG. 46.

diameter of the body. The nerve-ganglia in segments 1–5 with wide expansions; bifurcation in front very strong (fig. 46).

This interesting addition to our lists was found with three other species of *Limnodrilus*, and two species of *Tubifex*, in a sample of mud from a cattle pool near Smisby, as recorded above, September 27, 1911. Found on October 3 on banks of stream at Stretton-en-le-field.

10. *Limnodrilus trisetosus* sp. n.

Small, tender worm, about 10 mm. long, of 40 or more segments. Head as long as broad when at rest, pointed when in motion. Segments annulated, those in front, as is often the case, with a wide and a narrow annulus. Setæ 3 throughout. In nearly every other species the number is greater in front than behind. Rarely a seta has fallen out, leaving 2; or a young one is forming. No ventral setæ on girdle-segment, 2 or 3 dorsally. The lower tooth somewhat (but only slightly) longer than upper, not widely separated (fig. 47), neat and well-formed, not coarse like those of *papillosus* and *udekemianus*. Pharynx reaches to the end of the 3rd segment. Chloragogen cells begin in 5, and from the girdle back-

wards orange and brown cells are intermixed as in *aurantiacus*. Nephridia very large, quite unlike those of *papillosus*. Brain slightly concave behind. Spermathecæ pear-shaped sacs without a distinct duct (fig. 48). Resembles *nervosus* in the expansion of the nerve in the front segments. No penis-sheath,* but the aperture of the male organs widening into a sac as in *papillosus* (fig. 49), which, in certain aspects, looks almost like a second spermatheca behind the true one.

Found in mud collected for me by Mr. C. Todd, in the River

FIG. 47.

FIG. 48.

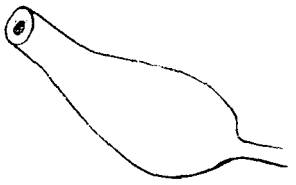

FIG. 49

Lea at Tottenham, September 30, 1911. It closely resembles a *Marionina* or *Pachydrilus* at first sight. As it was found in company with *L. papillosus* Fr., *L. galeritus* Fr., and others, it was easy at a glance to see how different it was from every other species as yet recorded for Britain.

11. *Limnodrilus galeritus* sp. n.

Length about 20 mm. Chloragogen cells begin in the fifth segment. Setæ 4 in dorsal and 5 in ventral bundles from segments

FIG. 50.

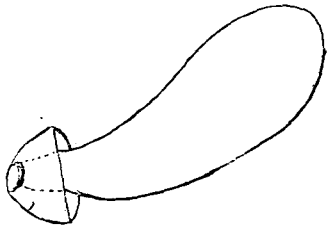

FIG. 51.

2–7, then usually 3 per bundle. Teeth equal in posterior segments; outer tooth somewhat largest in front segments (fig. 50). Very long, stout, striated duct to sperm-funnel. The penis-sheath slightly bent at the distal end behind the funnel. Shaft very slightly wider at the proximal end than at the bend. Funnel three times as wide as shaft, the length being about 15 times that of the breadth. The setæ are one-sixth the length of the penis-sheath.

* See under No. 8 (*L. papillosus*), p. 276.

The main characteristic is to be found in the shape of the spermathecæ (fig. 51), which are sac-like bodies with a distinct cap at the narrow end at the external aperture.

In mud from the River Lea, Tottenham, September 30, 1911, by courtesy of Mr. C. Todd, with *L. papillosus* Fr. and others. The setæ, penis-sheath, spermathecæ, and other points, readily distinguish it from all other known species.

I have, in addition to the foregoing, notes on other species of *Limnodrilus*, which, unfortunately, are not sufficient for the purposes of this paper, though they serve to show that much more remains to be done. A species taken at Runswick Bay, August 1, 1896, has usually 5 setæ in front, with a very small upper tooth, and two or three behind. My notes show enlarged hearts in segments 8 and 9 or 9 and 10, the hindmost being the larger. The chloragogen cells commence in 6, and the girdle covers 11–12. No penial setæ were present, nor any penis-sheath. Curious sperm-sacs were present, such as I have not noted elsewhere. If this could be rediscovered it might show that the worms which are destitute of a penis-sheath (including *L. papillosus* and *L. trisetosus*) really belong to a new genus, corresponding in some measure with Eisen's *Camptodrilus*.* It might be named *L. inæquidens*, on account of the small outer tooth of the setæ.

II. Genus **Clitellio** Savigny.

1. *Clitellio arenarius* Müller.

I have nothing to add to the accounts already given by Beddard and others, except to say that I have found the worm in various places on the English coast.

III. Genus **Rhyacodrilus** Bretscher.

Only two or at most three species are at present known. The generic characterization is therefore embodied in that of the species. In 1901, Revue Suisse de Zoologie, ix. p. 205, we find the following description:—

"*Rhyacodrilus falciformis* g. et sp. n. Länge 10 mm. Segmente ca. 3 [error for 30 ?]. Farbe bräunlich. Borsten überall doppelhakig, von der gewöhnlichen Form, ventral zu 3–5, dorsal zu 2–4 per Bündel; in 10 ventral jederseits eine grosse Geschlechtsborste, die wohl zwei mal dicker und 1½ mal länger ist als die übrigen Borsten; ihr Schaft ist gerade, dick, etwas länger als die sichelförmig gebogene und gegen die Spitze hin verjüngte distale Partie (fig. 4).

"Die Gürtel reicht von den Borsten in 9 bis zu denen in 11,

* See note on *L. papillosus*, p. 276.

also durch zwei Segmente. Der Darm beginnt in 6. Blut rot in allen Segmenten bis 11 tritt je am hintern Dissepiment eine einfache, lange, pulsirende Gefässschleife vom Rückengefäss aus. Eigentliche Seitenherzen fehlen. Lymphkörper kugelig, dicht und grob granulirt.

"Gehirn hinten in zwei lange Lappen ausgezogen, mit breitem Zwischenraum an deren Grunde (fig. 5). Spermatheken in 9, 1 Paar; kurze, breite Säcke mit breiter Oeffnung. Grosse Eier bis in 11. Hoden und Ovarien nicht beobachtet. Fundort: Fürstenalp, Bach und Brunnentrog."

Bretscher places this, without note or question, among the Tubificidæ; though one might have expected attention to be drawn to the anomalies. In 1903 (Revue Suisse de Zool. xi. p. 13) the author tells us that he had given a description of the species two years before, and adds that the spermathecæ (which he illustrates) are pear-shaped or round, with a wide slit-like aperture. The prostate is somewhat club-shaped (as figured), about four times as long as it is broad, and glandular. He adds that the creature seems to belong exclusively to the Bachfauna, but is not so much an inhabitant of the water as of the moist earth.

In 1904 Ditlevsen (Zeitschr. Wiss. Zool. lxxvii. p. 408) described the same Annelid as *Ilyodrilus filiformis* sp. n.; though he was not unfamiliar with Bretscher's work. His description sets forth the following points:—The setæ are all forked, the ventral agreeing with the dorsal, but somewhat stronger, the upper tooth larger than the under (*d* fig. 5 in original), and numbering four dorsally with five to seven ventrally in each bundle. Nephridia swollen in front of the septum (*a* fig. 3). Vas deferens (*vd* A fig. 4) long and narrow, very difficult to follow; sac-formed atrium clothed with glands. Genital setæ present, having the form of a large spoon or ladle (die Form eines grossen Löffels). Spermathecæ with small receptacle, which is probably filled with spermatozoa rather than with spermatophores.

The description given by Bretscher differs in certain details from that which I drew up on finding the worm in Derbyshire under the title *Meganympha pachydriloides* g. et sp. n. Ditlevsen, in spite of his shrewd allusion to the spermathecæ, and his contention that the genus belongs rather to the Naididæ than to the Tubificidæ, is in error in referring this species to *Ilyodrilus*, whether it be that of Eisen or of Stolč. I shall have to deal with *Ilyodrilus*, however, later. It must, therefore, suffice for the present to draw attention to the work of Bretscher and Ditlevsen, and proceed to the study of *Rhyacodrilus* as found in this country.

When I first discovered it in the summer of 1911 embedded in mud by the side of a little Derbyshire stream, the first thing that struck me was its resemblance to *Pachydrilus* or *Marionina* when seen by the naked eye. The moment it was placed under the

Microscope, however, the very large cœlomic corpuscles arrested attention, and I find the following notes taken on that occasion, and afterwards when I found that my discovery had been anticipated:—

"*Meganympha pachydriloides* g. et sp. n. Length 8–10 mm. Adult. Pale coloured, resembling a small *Pachydrilus* or *Marionina*. Segments 45. Blood red. Setæ 3, 4, 5 throughout, slender, forked, upper tooth longest in anterior bundles, teeth about equal posteriorly. Chloragogen cells begin in 5 or 6. Cœlomic corpuscles large, globular, dark, at first sight suggesting encysted Gregarines, as found in Enchytræids at Sutton Broad. A pair of penial setæ looking like pruning knives. Forked dorsal setæ present on this segment. Brain very glandular and motile, changing with every movement, deeply lobed behind. Spermathecæ roundish or pear-shaped with large aperture, not rounded but slit-like. Vascular system differing from typical Tubificid. First commissure from dorsal vessel in segment 2. Nephridia extending through more than one segment. Dilating hearts wanting.

I have made a few measurements which are of interest. The ordinary setæ are nearly half the length of the penial. The penial setæ are the length of the spermathecæ when they assume the pear-shape, and are empty. The diameter of the large cœlomic corpuscles averages about half the length of the ordinary setæ. The setæ behind are prominent, and extend a good way beyond the body-wall. In front they are about one-seventh the diameter of the body. Five or six corpuscles will lie in a row in the cœlom behind, while 12–14 would be needed to reach across the diameter in front. As confirming Ditlevsen's surmise about the spermathecæ, I may say that in November I found them full of a glairy substance, but without spermatophores. In segment 16 I observed some organs which were new to me, and need further study.

Bretscher, whose notes have a misprint, gives the segments as 30 (at least, so I understand his 3), and I have drawn attention (Nature, November 16, 1911, p. 78) to the difference between the Swiss and English types in this respect. I do not know how to explain Bretscher's remark that a large penial seta is found ventrally on either side in segment 10. I find them in segment 11. Piguet draws attention to this in his description of another species (Rev. Suisse, 1906). It must, I think, be a slip of the pen.

British Records.—At present known only from two little streamlets on the borders of Derbyshire and Leicestershire; Netherhall, summer of 1911; and Netherseal, with the next, November 29, 1911.

2. *Rhyacodrilus dichætus* sp. n.

A small, delicate worm, 6–8 mm. in length; segments 35 in number. Setæ very slender, forked, sigmoid, with the teeth about equal, like those of *R. falciformis* Bret., but numbering only 2

throughout, and so resembling the Lumbriculidæ (*Stylodrilus*, etc.). The anterior setæ appear to be rather longer than the posterior. Large cœlomic corpuscles with dark contents. Nerve-chord large and conspicuous. The dorsal vessel forming a kind of heart from segment 5 backwards to the girdle or further, and provided in these segments with strong commissures. As the specimen was immature, no penial setæ were seen. The presence of the type at once enabled me to see both the resemblances and the differences. I have had no time to look for the worm again, but as the locality is within reach of my residence, I hope shortly to collect more and riper material.

Locality.—Stream at Netherseal, in Derbyshire.

IV. Genus **Monopylephorus** Lev.

This genus, created by Levinsen in 1884, shows a marked departure from typical Tubificidæ, in the possession of an unpaired male pore. I place here the *Vermiculus* of Goodrich 1892, as well as the *Bothrioneuron* of Stolc 1888. Goodrich discovered the type at Weymouth, and details may be found in the usual authorities.

In 1904 Ditlevsen added two new European species, both of which I have found in the Thames. One of the species must be taken from the genus. At present I am working on the material collected in this country, and place two species here.

1. *Monopylephorus rubroniveus* Lev.

This is one of the few species which I have not as yet been able to study in the living condition. The definitions are given in Beddard (Monograph, p. 268), Michaelsen (Das Tierreich, x. p. 54), and elsewhere. Beddard and Michaelsen give separate accounts of *Vermiculus*, but I think there is no doubt about the fact that *Vermiculus* is one with *Monopylephorus* (= *Bothrioneuron*). This species is found on the sea coast. I have no doubt it will be discovered in due course in the Thames estuary, where I have had the good fortune during the past year to obtain so large a number of interesting species of Tubificids, including the next, which is new to Britain.

2. *Monopylephorus parvus* Ditlevsen.

Two to five forked setæ in the front dorsal bundles. The teeth are small and of equal lengths, or the upper is a little longer than the under tooth. The setæ in the dorsal bundles posteriorly are not forked. In the ventral bundles there are three to five forked setæ, in which the upper tooth is a little longer than the lower.

Brain with a small median process, and a pair of larger processes behind. The nephridia are typical, with very large upper lip to the anteseptal. Cœlomic corpuscles larger than in *M. rubroniveus*, and not so numerous. Blood system as in the type. Sperm-funnel short, leading into a spermiducal chamber; opening on the eleventh segment unpaired. An unpaired receptaculum seminis in segment 10, which receives spermatozoa; no spermatophores seen.

1904.—Ditlevsen in Zeitschr. wiss. Zool. lxxvii., pp. 427–8, figs. 25–6.

The unpaired male pore proclaims this a true *Monopylephorus*. If the receptacle contains only spermatozoa, we have a close relationship with *Rhyacodrilus*, which, indeed, it nearly resembles.

The following are my own notes, made from the study of living material, before I was aware that the species had already been described as above by Ditlevsen.

A tiny worm, 6–10 mm. long, and very slender, segments 65. Yellowish brown or straw coloured. Setæ usually 2–3 in front, rarely 4, dwindling to 2 or 1 posteriorly. Setæ in front with teeth equal, those behind with small upper tooth. On segment 11 two sets of setæ only, usually 3 in a set, with unpaired male pore between. No specialized or penial setæ. Node of setæ near the upper third. Head somewhat pointed; front segments with a wider and a narrower annulus, as in many other Tubificids. Chloragogen cells begin in fifth segment. Nephridia with small anteseptal, destitute of peritoneal cells; postseptal very large. Blood system in front segments much simpler than is usual in this family. Brain with a pair of posterior processes, nearly straight behind, concave in front, with strong anterior attachments.

In the Thames at Kew, and in Lily Pond at Royal Gardens, August 26, 1911. Collected also near the Tower Bridge, September 30, 1911, by Mr. C. Todd. None of the specimens in adult stage.

[*Monopylephorus trichochætus* Ditlevsen, which is also found in England, must be removed from this genus (1) on account of its paired organs, and (2) by reason of its setæ. See later under the genus *Ilyodrilus*.]

The genus *Telmatodrilus*, which is the only other genus at present known in this group, has not hitherto been found in England.

B.—Forked Setæ with Palmate Setæ.

V. Genus **Heterochæta** Clap.

Rightly retained by Beddard; unfortunately confused by Michaelsen with *Psammoryctes*. This genus is distinguished from the foregoing by the presence of palmate setæ (*Schaufelborsten*

Mich.), and from those of the next group by the absence of capilliform setæ or bristles. Beddard's definition of the genus is as follows:—"Setæ uncinate, except dorsal setæ of v–xiii, which are mainly palmate. Dilated hearts in viii. Spermiducal gland divisible into two regions; the glandular region (vesicular) not dilated; penis chitinous; prostates present."

1. *Heterochæta costata* Clap.

Benham has elaborated the definition (Q.J.M.S., xxxiii. (1891) p. 187 *et seq.*). Writers draw attention to the variation in the number and arrangement of setæ; but as these variations are in some instances accompanied by differences elsewhere, the species will eventually be found to number more than two, as at present diagnosed. My own material, collected in Ireland, Cumberland, Lancashire, the Thames, and elsewhere, needs careful working out before pronouncing further on the subject, and I therefore pass on to the other species, merely noting the occurrence inland as well as on the shore.

2. *Heterochæta Thompsoni* Southern.

Bright red. Length about 20 mm. Anterior dorsal setæ closely resembling those of *H. costata*, and found in segments 5 to 18, 7–10 per bundle. Remaining dorsal bundles with forked setæ only, teeth equal. Brain concave before and behind. Nephridia large, no peritoneal cells. Spermathecæ sac-shaped, long, extending into segment 9. Nail-shaped penial seta in sac; and apparatus distinctly different from that of latter species.

Rock pools, Howth, co. Dublin.

GROUP II.—Capilliform Setæ Present.

A.—Forked Setæ with Capilliform in Dorsal Bundles. Pectinate Setæ wanting.

I cannot too strongly emphasize the fact that the confusion which has up till the present existed in this family is almost entirely due to non-observance of the point that some genera have, and some have not, pectinate setæ. I deal first, therefore, with those genera which have forked setæ only with the capillary or hair bristles. It is now possible, for the first time, to bring *Ilyodrilus* definitely into the British lists. But *Ilyodrilus* is at present in confusion, since it has been differently defined by Eisen, Stolč, Ditlevsen, and others. Beddard attempted to place things right, as also did Michaelsen; but Ditlevsen's researches introduced further confusion, since he places *Rhyacodrilus* with *Ilyodrilus*, and what is undoubtedly a true *Ilyodrilus* under *Monopylephorus*. Though

I have been familiar with various species of *Ilyodrilus* for many years, it is only during the last few months that I have been able to bring anything like order out of the prevailing chaos. Eisen himself placed certain species of *Ilyodrilus* under the genus *Tubifex*—owing to his never having seen the latter. I have reason to believe that several species yet remain to be described. As the American and European genera are still chaotic, I give the generic characters for the species at present known for Great Britain.

VI. Genus **Ilyodrilus** (Eisen and Stolč revised).

Tubificid Annelids possessing two kinds of setæ, viz. capilliform and forked. The capilliform setæ limited to dorsal bundles; forked setæ dorsal and ventral, either alike or slightly different. Sometimes the anterior differ from the posterior bundles both in number and size. Spermathecæ large; spermatophores present in perfectly adult specimens. Efferent duct long or short, with prostate, atrium, and round penis-sheath.

This definition is a temporary expedient to meet the needs of British research. Revision will be needed when these researches are more complete.

1. *Ilyodrilus campanulatus* Eisen.

Brain longer than broad, narrowing posteriorly, with deep, narrow concavity. Penis broadest at middle; penis-sheath bell-shaped. Length of oviduct half that of penis. Spermatheca bent in the shape of an S, enlarged and sac-shaped. Setæ: two kinds always present, viz. hair spines and forked spines. The two prongs (or teeth) of the latter nearly equal, diverging at less than a right angle.

Habitat.—Europe, Sweden, Christianstad.

1885.—Eisen, Oligochætological Researches, p. 893, plate viii. fig. 7, *a*, *b*, *c*, *d*, as *Tubifex campanulatus.*

One of the commonest and most widely distributed of our British Tubificids; often confused with *Tubifex*. My first unmistakable record is dated "Bolton Leegate, Cumberland, April 9, 1896." Here are my original notes. "Tubificid found in mud in a little runnel by the Church. About $\frac{1}{2}$ or $\frac{3}{4}$ in. in length, coiling up and shunning observation. Bright red blood. Capilliform and forked setæ; girdle and chitinous penes. Cap. setæ 2–3 in front segments, 1 from about the 10th segment backwards. Coiled tube connected with egg-sac going back 3 or 4 segments behind the girdle. Dark chloragogen cells begin behind segment 5 (i.e. in front of segment 6). Dilating heart in 8. The worm very delicate and transparent. Setæ present in girdle segment near the penes." A sketch of the penis-sheath, which is campanulate, is given in my note-book.

Michaelsen (Das Tierreich, x. p. 49) translates Eisen's description, and places it as an uncertain species under *Tubifex*. Beddard regards it as a doubtful synonym for *T. rivulorum*. My notes show either two distinct varieties of *Ilyodrilus campanulatus* Eisen in England, or two species nearly related, and I am at present in favour of regarding the one with S-shaped spermathecæ as true *I. campanulatus*, and regarding the other as *I. bonneti* Clap. Should this surmise prove correct we shall have got rid of much confusion.

I have recently been engaged on the study of specimens collected for me by Mr. C. Todd at the Tower Bridge. The spermathecæ are often filled with Nematodes which, when coiled, closely resemble the spiral spermatophores of *Spirosperma ferox* Eisen.

2. *Ilyodrilus trichochætus* Ditlevsen.

I will first copy my original notes, then discuss the relationship. A very small worm, 8–10 mm. in length, 60–65 segments, fragile looking, but possessed of great vitality. Capilliform setæ 2 in first five segments, then 1 gradually growing smaller, and eventually dying out about segments 25–30; tail thin, yellow. Forked setæ 2–3 per bundle in anterior segments, teeth about equal; in posterior segments usually only 1 forked seta in each set. Chloragogen cells begin in 6 and die out with capillary setæ.

First nephridium in 6/7, anteseptal very small, postseptal remarkably developed. Enlarged vessels in segments 8 and 9, blood system complex, front commissures, at least in 5 and 6, with valves. Ventral vessel, as usual; forks in the fourth segment. Brain, small, incised behind, or with two lobes. Pharynx moving backwards as far as the setæ of segment 3. Front segments annulate: 1 broad and 1 narrow ring. Lumen of nephridia ciliated and capable of rapid motion.

In mud of the Thames at Kew, with *Monopylephorus parvus*, *Paranais*, *Helodrilus*, and other Annelids, August 26, 1911. Not found in adult stage.

1904.—Ditlevsen (Zeitschr. wiss. Zool., lxxvii. p. 427) describes a worm as *Monopylephorus trichochætus*; but it cannot be a *Monopylephorus*, since the organs are paired. Moreover, *Monopylephorus* has no capilliform setæ. Everything points to *Ilyodrilus* or an allied genus, but Ditlevsen's ideas of *Ilyodrilus* were confused, as we see by his placing *Rhyacodrilus* in that genus. As my Thames specimens agree in all essential points with Ditlevsen's, I retain his specific name, although it loses its meaning when applied to an *Ilyodrilus*, seeing that all the species in this genus are Trichochætes. The original may here be appended for comparison.

"*Monopylephorus trichochætus* sp. n. In den dorsalen Borstenbündeln gibt es zwei fadenfeine, haarförmige Borsten und zwei bis drei gespaltene Hakenborsten, deren oberstes Ästchen ein ganz

klein bischen länger als das intere ist. In den ventralen Bündeln finden sich drei bis vier Borsten, wie die dorsalen gespalten.

"Das Gefässsystem ist ganz wie bei *M. rubroniveus* gebaut. Die Querschlingen teilen sich wiederholt, und sowohl in diesen als auch in Rückengefäss finden sich die bei vorhergehender Art erwähnten Klappen. Die Segmentalorgane sind auch nach demselben Typus gebaut; aber die 'Oberlippe' am 'Anteseptale' ist bei *M. trichochætus* nur wenig länger als die Unterlippe (fig. 24).

"Die Männlichen Geschlechtsöffnungen liegen weiter voneinander als bei *M. rubroniveus*, und erweisen sich als zwei Löcher, (*o*, fig. 22) an jeder Seite des Bauches im elften Segment. Die Samenleiter scheinen sich frei an der äusseren Seite des Leibes zu öffnen, und nicht wie bie vorhergehender Art in eine 'spermiducal chamber' (fig. 21). Hinsichtlich des Baues stimmen die Samenleiter bei den beiden Arten sonst genau überein (fig. 22).

"Da die Samenleiteröffnungen voneinander getrennt sind, müssen auch die Oeffnungen der beiden Receptacula seminis, der Begattung halber, getrennt sein; diese liegen auch in derselben Länglinie wie die Samenleiteröffnungen im vorliegenden Segment. Das Receptaculum seminis (fig. 23) hat die Form eines Säckchens mit einem kurzen Ausführungsgang. Es füllt sich während der Begattung mit braunen Sperma; Bildung von Spermatophoren findet nicht statt."

The last sentence suggests the idea that this species comes near to *Rhyacodrilus*, which Ditlevsen regards as an *Ilyodrilus*.

I have since found *I. trichochætus* Dit. in mud received from Mr. C. Todd, who collected it at the Tower Bridge. It seems to be a connecting link between *Ilyodrilus* and *Monopylephorus*.

3. *Ilyodrilus coccineus* Vejd.

Though placed by some systematists under *Branchiura*, this species is more correctly regarded as an *Ilyodrilus* in the newer sense. *Branchiura* is found in England, but appears to be foreign. When the worms of South America come to be known, we shall probably find many true gill-tailed worms. *I. coccineus* has no branchiæ, and it is an abuse of terms to put a non-branchiate species with branchiate in the present state of our knowledge. All the authorities give definitions and references. The genus *Branchiura* has recently been sub-divided, and this species named *Taupodrilus coccineus*.

4. *Ilyodrilus robustus* sp. n.

A pale worm, about 20 mm. in length, sometimes larger and longer; segments 80 or more, with red blood.

Capillary setæ 1–3 in front segments, the longest of which equal or slightly exceed the diameter of the body. The forked setæ in front dorsal bundles seem sometimes to possess a delicate

membrane between the teeth. Forked setæ of ventral anterior bundles usually three, with upper tooth considerably larger than the lower. Forked setæ behind the girdle quite different in shape, and very robust. These gradually change about segments 8–11, so that whilst those in front of segment 8 have a character of their own, the posterior form begins immediately behind the girdle; thenceforth never more than two fully developed setæ are found in ventral and dorsal bundles. There are no pectinate setæ, and no penial setæ, but the normal forms occur in the region of the body which contains the sexual organs and pores.

This is a specially well-marked species, but the working out of so much new material has rendered it impossible for me to note all the details hitherto. The setæ are so characteristic, however, that by their aid alone I can instantly distinguish the worm from every other species.

First definite record, Ledbury, Herefordshire, Easter Monday, 1911; since found in several parts of the country.

5. *Ilyodrilus pallescens* sp. n.

One, or rarely two hair (capilliform) setæ, and two, or rarely three forked in anterior dorsal bundles; from segment 15 the capilliform setæ gradually shorten and die out. The dorsal forked setæ have equal teeth, and possibly a delicate membrane, as in *I. robustus*. The teeth are not sharp pointed as in the ventral bundles, where there are two setæ in the anterior portion of the body, with large upper tooth. The posterior setæ also have a large upper tooth, and differ entirely from those of *I. robustus* in shape, size, and number. One seta for each set, dorsal and ventral, behind. Head blunt or pointed, according to tension. Chloragogen cells begin in 6. Blood-vessels elaborate, enlarged about 7, 8, 9. Long duct in 13. Anteseptal of nephridia consisting of a small funnel, with very active cilia.

Not yet found in the adult stage. June 15, 1911, Piston Hills, Derbyshire; October 3rd, Stretton-en-le-field; Castle Gresley, and elsewhere.

Possibly the same as Bretscher's *Tubifex filiformis*, though much smaller. I give his description for the sake of comparison:—

"*Tubifex filiformis* sp. n. 4–5 cm. lang, dabei fadenartig, dünn. Borsten: Dorsal 1–2 Hakenborsten (fig. 4), ohne Mittelzähne, und 1–2 Haarborsten von verschiedener Länge; die längere zwei mal länger als die Hakenborsten und bedeutend dünner. Die Spitzen dieser letztern sind lang, stark abstehend, Schaft gerade, drei mal länger als der distale Spitzenteil, der gegen jeden etwas abgebogen ist. Ventral vom 2–3, hinten 1 Hakenborste.

"Pulsirendes Seitengefäss in 8. Die beiden vordersten Äste des Rückengefässes vereinigen in 4 zum Bauchgefäss; in den vordern

Segmentar geht je eine vielfach verschlungene Schleife vom Rücken- zum Bauchgefäss.

"Keines der zahreichen vorgefundenen Exemplare war geschlechtsreif, so dass auch hier die Beschreibung zu ergänzen ist. Die gegebenen Anhaltspunkte ermöglichen jedoch unzweifelhaft, das Objekt wieder zu erkennen. Fundort: Langensee bei Ascona."

1900.—Revue Suisse de Zool., viii. p. 447, fig. 4.

The *Ilyodrilus filiformis* of Ditlevsen is (as already stated) the same as *Rhyacodrilus falciformis* Bret.

There are points of resemblance between this species and *Ilyodrilus palustris* Dit. (Zeitschr. wiss. Zool., lxxvii. (1904) p. 408); but if his drawings are correct, the teeth of the setæ differ widely from those of *I. pallescens.*

Ilyodrilus meganymphus sp. n.

A clear, transparent worm, with large spherical, blackish cœlomic corpuscles, like those of *Rhyacodrilus*, profuse, and very characteristic, about one-third or one-quarter the length of the setæ in diameter. Length about 20 to 25 mm. (= 1 in.), with 60 segments. Chloragogen cells begin in the unusual position of segment 4. The brain (fig. 52) with four almost equal lobes or processes behind, palmate, or resembling a hand with four large fingers, setæ of two kinds, capilliform and forked. Usually 1 cap. seta and 2 forked setæ in segments 2–3 dorsally and 3–5 ventrally. Capilliform setæ die out behind segment 30, and forked setæ number 3 or 2 posteriorly, with teeth short and equal.

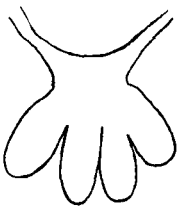

Fig. 52.

I saw no enlarged hearts in 8 or 9, and the vascular system in front was almost identical with that found in Enchytræids, so that this worm may be regarded, perhaps, as a link between the red-blooded Enchytræids (as *Marionina* or *Pachydrilus*) and the Tubificids. The head pore, which is situated on the prostomium, midway between the tip and the septum, is matched by another worm which I found in the same locality. The pharynx is in segments 2–3.

The striking characteristics are the brain, cœlomic corpuscles, head pore, forward origin of the chloragogen cells, setæ, simple vascular system without hearts, and the position of the pharynx.

VII. Genus **Branchiura** Beddard.

Branchiura Sowerbyi Beddard.

Restoring *B. coccinea* to its rightful place under *Ilyodrilus*, we have only one species of *Branchiura* at present. It occurs at

Regent's Park, Kew Gardens, and Glasnevin, Dublin. Southern (Contributions, p. 135) points out differences between the Dublin and the Regent's Park specimens, but does not suggest that they are of sufficient importance to constitute a new form. My own studies have been limited to those found at Kew. At present there is nothing new to add.

VIII. Genus **Hemitubifex** Eisen.

1. *Hemitubifex Benedeni* (= *benedii*) d'Udek.

Found on the coasts of England and Ireland. For the present we are content to retain the genus, certainly not to merge it with *Psammoryctes* as we understand it.

Distribution and references in Beddard, Michaelsen, and Southern.

2. *Hemitubifex pustulatus* sp. n.

In 1898 I published in the Zoologist some Notes on British Annelids (ser. 4, ii. p. 119), and referred a species obtained from Malahide in Ireland to *Hemitubifex benedii*, on account of the body being covered with papillæ. A wider acquaintance with our native Tubificids proves this to have been incorrect, and as no description with which I am familiar agrees with the worm under consideration, I name it anew, with the following characters:—

Setæ of two kinds, capilliform and forked. A wonderfully fine and interesting worm about an inch (25 mm.) in length. First third of the body about three times as thick as the posterior two-thirds. Number of segments about 70. Head very small in comparison with segments 5–15. Body entirely covered with uneven papillæ, very dark, in irregular rings. Capilliform and forked setæ alike going right along the dorsal portion of the body to the tail. Capilliform setæ remarkable for their number, 6–8, or as many as 9–10 in each bundle anteriorly, gradually decreasing in number towards the tail, where 1 or 2 per bundle exist. The forked ventral setæ with a very strong curve and larger under tooth. Dilating hearts in the 7th and 8th segments. Dark chloragogen cells begin in the 5th segment.

Received from Dr. Trumbull, Malahide, Ireland, April 1, 1896. Has not since been found. My types, owing to removal, are packed away, and are not at present accessible. I have not been able to refer to *Nais pustulosa* Williams (Phil. Trans. (1858) p. 96), which Beddard gives doubtfully as a synonym for *Hemitubifex benedii*. It is possible that *Peloscolex variegatus* Leidy and *Nais papillosa* (Beddard, Monograph, pp. 258–9) are related to this species, and it is much to be desired that fresh material may be obtained in order

to set the matter at rest. I cannot, at present, refer it to *Spirosperma*, notwithstanding the presence of papillæ. It resembles in some respects *Embolocephalus multisetosus* F. Smith.

B.—Pectinate Setæ with Capilliform in Dorsal Bundles.

IX. Genus **Psammoryctes** Vejdovsky.

The generic characters have been fully discussed by all the leading authorities — Vejdovsky, Michaelsen, Stolč, Lankester, Beddard, Benham, Eisen, and others.

Psammoryctes barbatus Grube.

Found in 1871 by Lankester, in brackish water at Barking, and by Benham, in the Cherwell, 1892. Lough Neagh is given by Southern as an Irish locality. I have taken it frequently, and think, with Benham (Q.J.M.S., xxxiii., pp. 208–9), that we may eventually have to make some new species.

X. Genus **Spirosperma** Eisen.

Spirosperma ferox Eisen.

My notes indicate the need of a revision and enlargement of this genus. I therefore content myself here with recording the type, which is widely distributed in Great Britain and Ireland. Many synonyms tend to confuse the student, as *Tubifex*, *Peloscolex*, etc.

XI.—Genus **Tubifex** Lamarck.

If the setæ alone were considered, I should agree with Michaelsen and some others in including *Psammoryctes* and *Spirosperma* under this genus. In any case we must, for the present, to avoid confusion, distinguish those Annelids which have pectinate setæ from those which are destitute of them. The diagnosis of Michaelsen, somewhat modified, will then be correct. We are thus able to include two species of British worms in this genus, as already described, together with one new species.

1. *Tubifex tubifex* Müller.

The type seems at present to have vanished into thin air! After all the various species which have been referred to under this head are definitely resolved, we seem to have no worm left for the typical *Tubifex*. I have at present no alternative but to copy the definition given by Michaelsen:—

"Reddish. Forked ventral setæ, with upper tooth longer than

the lower. Dorsal bundles of segments 2–15, equal toothed, possessing a middle tooth or comb. Capilliform setæ present. Middle and posterior portions of body with forked setæ only, whose teeth are equal. Male pore in segment 11, spermathecæ opening in 10, penial setæ absent. Pulsating heart in segment 8. Penis somewhat long, with a glandular extension near the base. A long, slender duct to the spermathecæ."

2. *Tubifex templetoni* Southern.

Length 10–14 mm., pink in colour and of soft consistence. Setæ of anterior dorsal bundles 1–4, capilliform with 3–4 pectinates, with fine intermediate teeth. Hair setæ very thin and flexible. Ventral bundles with 3–4 forked setæ, upper lip longer and thinner than lower. No ventral setæ in 11, nor any genital setæ. Girdle of granular cells 11–12. Front segments annulate. Pharynx to 5th segment, chloragogen cells beginning in the 6th. Brain deeply incised behind, with small median flap. Nephridia enveloped in large cells; hearts in 8–9. Spermathecæ irregular sacs with well-defined duct. Spermatophores present, and chitinous penis-sheath.

1909.—Southern (Contributions, pp. 140–1). Phœnix Park, Dublin; Sutton Park, near Birmingham, March 1899: discovered but not published; Welland, near Malvern, June 17, 1909.

3. *Tubifex globulatus* sp. n.

Capilliform setæ usually 1 in each bundle dorsally, with 3–4 pectinates, in which the inner teeth are very small and difficult to find. In the ventral anterior bundles 3–4 forked setæ, teeth nearly equal in segments 2–12. One forked seta in ventral bundles of 11, with a globular chitinous penis-sheath, and striped muscular duct.

1911.—Near Ashby-de-la-Zouch; Tower Bridge, London.

This does not exhaust my material, but, imperfect as the study is, so much that is new and valuable has been already determined, that it would answer no good end to withhold it from other workers in this very interesting field.

Addendum.—Since this paper was submitted to the Society my researches have led to the discovery of another genus belonging to the Tubificidæ, and I have now to record two new species, which I temporarily assign to the genus *Sænuris*. The genus is at once distinguished from all others by the setæ, which are *Pachydrilus*-like, on which account great confusion has arisen.

1. *Sænuris lineata* Grube. Entirely distinct from *Lumbricillus* (*Pachydrilus*) *lineatus* O.F.M., which is an Enchytræid, and occurs

in England. A true Tubificid, found in mud at Middlesbrough, February 9th, 1912.

2. *Sœnuris variabilis* sp. n. If it has been found before, this species has, on account of its papillæ, been confused with *Clitellio* or *Hemitubifex*. Setæ *Pachydrilus*-like, i.e. sigmoid, without forks, very sparsely distributed, many segments being entirely asetigerous. Usually one, sometimes two in a set. Length 10–12 mm. or more; segments about 50. Fuller details and drawings must be reserved. Collected at Gillingham, Kent, by Mr. Topps-King in December 1911.