

PRELIMINARY REPORT

ON

GENERA AND SPECIES OF TUBIFICIDÆ

BY

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WITH ONE PLATE.

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The family of the Tubificidæ, and the systematical arrangement of its species according to their anatomy, has for the last few years been the principal object of my study, and I have thought that perhaps a preliminary report on the general conclusions, at which I have arrived, may not be without some interest.

The species of this family hitherto known have been both diligently and successfully studied by such eminent anatomists as CLAPARÈDE, D'UDEKEM, LANKESTER, PERRIER and VEJDOVSKY, and I can therefore hardly expect to add much to our knowledge of them. But in this, as in other families of the Oligochæta, the species are not by far so limited in number, as has formerly been supposed, and the many new ones, which I have found, will, as I hope, in some degree elucidate the anatomy and the systematical arrangement of the species of this the most difficult family of the Oligochæta.

In the following therefore I propose to give a short account of some new genera and species found in Sweden and California, and also a systematical arrangement of the species, founded on purely anatomical characteristics.

The genera previously known are only three, viz. *Tubifex*, *Psammoryctes* and *Limnodrilus*, or at least the 4 to 5 species sufficiently described to be recognized, can all be referred to one or the other of those three genera. Of these only *Psammoryctes* has been founded on anatomical characteristics, the two other genera have been distinguished by the presence or absence of hair-spines.

So very few species of this family are however as yet known, that it is extremely difficult, if not impossible to decide upon with accuracy, what may and what may not be considered as a generic characteristic. Especially so, as we have very little knowledge of the variations of the interior

organs, which according to our present ideas are the only ones, which can furnish characteristics to distinguish genera and species.

That the presence of hair-spines, which is said to distinguish *Tubifex* from *Limnodrilus* hardly can be considered as a generic characteristic, is clearly seen by studying the genus *Hemitubifex*. The only species of this genus has generally both hair-spines and forked spines, but sometimes we find individuals with no hair-spines at all, all being short and forked. Other individuals have some few hair-spines interspersed among the forked ones. We would here have sufficient grounds to classify the same species in two very different genera, at least if attention was paid to only external characteristics.

This genus is also remarkable in an other respect. The upper end of its atrium is enlarged to a globular "vesicula seminalis", similar to that which, according to VEJDOVSKY, should characterize the genus *Psammoryctes*. But as *Hemitubifex* has no comb-like spines, and as the lower end of its atrium is glandular, as in most of the genera, I think there is reason enough to consider it entirely distinct from other new and old genera. This shows however that only a combination of characteristics can suffice to characterize a genus, and that the mere presence of different kinds of spines not always is enough to distinguish a genus from another, and also that anatomical differences should be the deciding ones in regard to both genera and species.

Of the other new genera, the genus *Spirosperma* is well characterized by its spermatophore, which is extended and spiral, and also by its conical cephalic ganglion.

Ilyodrilus has an emarginated ganglion, and an extremely short efferent duct, and is well distinguished from its allied genera. All these genera have hair-spines, and some of them also comb-like spines.

The genera with only forked spines are two, viz. the old genus *Limnodrilus* and the new genus *Camptodrilus*, which I have separated from the former on account of its having peculiar spiral muscles round its copulative organs.

The new genus *Telmatodrilus* is perhaps the best characterized in the family, and so unlike the other genera, that I prefer to place it in a separate sub-family. The mul-

tiplicity of its prostata-glands, the entire spines etc. point towards the family of Lumbriculidæ, but the invaginated oviduct connects the genus with Tubificidæ, and I can not even consider the genus as the missing link between the two families, but believe that as such we will discover genera with two pairs of efferent ducts, situated in two successive segments. I will here take the opportunity of saying a few words in regard to the vexed question of the invagination of the oviduct.

That the invagination of the oviduct is a reality, is with certainty shown by VEJDOVSKY, who has succeeded in finding the ova in situ in a sack surrounding the penis proper or one of its sheaths. But the true interior opening of the oviduct has not previously been discovered, and the supposition, that it was situated at the upper end of the atrium seemed always improbable, especially as no real opening could here be observed. In deciding upon what really is the oviduct, observations must be made especially on two parts, first: on the interior aperture of the oviduct, secondly on the existence of ova in the oviduct, and if possible on their entrance through the interior aperture of the same. Without having observed these points in the same species, if possible, the problem in question cannot be considered as solved, and all observations in other directions can be of merely approximate value. VEJDOVSKY*) has certainly seen the ova in situ, but has not observed the interior aperture of the oviduct, nor the ova entering the same, and the sack-like organ figured by him and spoken of as the oviduct, may not be the real oviduct but only a sack-like covering of the same.

I have, myself, in all the species I have dissected, found what I believe to be the true oviduct and its interior aperture, but as I have never discovered any ova in situ, having however dissected hundreds of specimens, the question can not as yet be considered solved, but only brought a step nearer its solution. I must defer to a more elaborate treatise the discussion of this subject, as my arguments would not be well understood without frequent reference being made to numerous minute drawings, the publication of which does not enter in the plan of this preliminary report.

*) Zeitschr. f. w. Zoologie. Bd. XXVII. Taf. VIII.

I will here only in a few words state my opinion of the structure of the generative and copulative organs, based upon observations made on some 17 new Californian and Scandinavian species.

The lower end of the glandular atrium constitutes the penis proper (fig. 1 to 6-p). This penis is always surrounded by several sheaths, some chitinous, one outside the other, and which do not connect with the atrium or with each other anywhere. The innermost sheath is generally chitinous, covers the penis very closely, and is in the following always called the penis-sheath (fig. 1 to 6 p. s.) This sheath is found in all species, except in *Ilyodrilus*, where its presence is very doubtful. The size of this sheath is generally diminutive, except in *Limnodrilus* and *Camptodrilus* (fig. 5 & 6. p. s.), where the innermost or penis-sheath is long and narrow, and always extends along the outside of the penis.

Surrounding the penis-sheath we find one or more chitinous or sacklike organs, generally only little exceeding the penis in size. Both those organs or sheaths, if two are present, are referable to, or constitute the oviduct proper. The interior one of these sheaths is generally chitinous (fig. 4 & 5, in-ovd) and often of the exact appearance of the interior penis-sheath: so for instance in *Limnodrilus alpestris* and *Camptodrilus spiralis* (fig. 5 in-ovd). The interior sheath of the oviduct is very seldom sack-like or muscular (fig. 3 in-ovd) as in *Limnodrilus ornatus* and *L. Steigerwaldi*. The exterior sheath of the oviduct is on the contrary never chitinous, but always sack-like, sometimes muscular. (Fig. 1 to 6, ex.ovd).

The interior entrance to or aperture of all these sheaths can always be seen, if instruments fine enough are employed, near the upper end of the penis proper, where the extended part of the atrium begins, but they are generally difficult to discern on account of their being covered with numerous longitudinal or spiral muscles, one end of which is attached to the body wall, the other to the oviduct (fig. 1 to 6, in-apt). When two sheaths belonging to the oviduct are present at the same time, I have called the oviduct double (fig. 2. 3. 4, 5), when, on the contrary, we meet with only one sheath, and that generally sack-like, we may appropriately call the oviduct single (fig. 1 & 6). The chitinous sheaths of the

oviduct and penis serve evidently to give strength to their respective organs, and to direct the motions of the penis and the ova. Only the exterior sheath of the oviduct is attached to the body-wall with its lower or exterior end, the other sheaths being all free and movable round the penis proper. The copulative organs are always surrounded by muscles which generally are straight (fig. 2), but sometimes as in the genus *Camptodrilus* even spiral, (fig. 5 & 6). Their lower end is then fixed to the body-wall from where they coil themselves spirally round the copulative organs, and, when reaching the top of the oviduct, return on the same way inside the outer spiral down to the exterior orifice of the oviduct, where they are found to be attached to the same.

What work such peculiar muscles can perform is easily understood. When relaxed their upper or interior end forms a kind of a wide funnel-shaped opening (fig. 6), especially adapted, as it seems, to the capturing of the ova, when floating in the perigastric cavity of the body. And when once caught and introduced in the oviduct, a few successive contractions may suffice to push them towards and finally through the genital porus. On the same way these muscles may also facilitate the projection of the penis or penis sheath.

The lowest or most primitive form of the oviduct is found in *Telmatodrilus*. It consists here simply of a fold in the body-wall, which in the middle is furnished with a small circular opening, through which the penis in adult specimens is projected. In this genus we find a muscular penis-sheath, but no interior sheath belonging to the oviduct.

TUBIFICIDÆ.

Subfamily 1. TELMATODRILINI n.

The atrium is furnished with several prostata-glands, (fig. 1 atr & pr). The vascular system is nearly similar to that of the Tubificini, but differs in having no distinct pulsating heart, but 5 pair indistinctly pulsating ones in the segments 6 to 10. The ventral vessel is not strictly ventral, but pushed towards one side of the body and so near to the dorsal vessel, that both really seem to be situated on the

same, dorsal side of the body. The ventral vessel is not pulsating. The spines resemble those of the Lumbriculidæ, but are more numerous in each fascicle; they are also in adult specimens entire but in young specimens sometimes imperfectly forked. The longitudinal trunks of the ventral nerve-ganglion are every where connected by transversal anastomosing nerves. The receptacle opens in the 9:th and the efferent duct in the 10:th setigerous segment.

Telmatodrilus n. gen.

Characteristics the same as those of the family.

T. Vejdovskyi n. sp.

Fig. 1.

The cephalic ganglion is emarginated in front, but posteriorly furnished with a large pointed processus. The atrium proper is semicircular, at its lower end forming a penis proper, consisting of an interior narrow tube, and an exterior large, pearshaped, cover, consisting of innumerable muscles, the proximal end of which is inserted in the fold of the integument, constituting the oviduct (fig. 1, p. d. & ovd). The segmental organs are covered with large, partly oblong, partly globular cells. The spines are 8 to 10 in each fascicle and 4 fascicles in every segment. The body is about 4 to 5 c.m. long by 1,5 m.m. wide. It is of a grayish flesh colour, with translucent bloodvessels.

Habitat: California, Fresno Co, Sierra Nevada, at an altitude of 7000 feet; generally found in swampy marshes in not too wet ground, sometimes also in decaying wood floating on or buried in the water. It is never found in the bottom of the swamp or any spring.

Subfamily 2. TUBIFICINI n.

The atrium is furnished with only one large prostata-gland. One pair of distinctly pulsating and enlarged hearts is generally to be found in the 7:th setigerous segment. The dorsal and ventral vessels situated on strictly opposite sides of the body. The two trunks of the ventral ganglion

are not connected by anastomosing transversal nerves. The spines are of several kinds, the short ones always forked. The receptacle opens in the 9th and the efferent duct in the 10th setigerous segment (at least so in all the species I have investigated).

Key to the Genera.

1. More than one kind of spines present, viz. hair-spines, comb-like spines, and forked spines; two of which kinds are always present (see however *Hemitubifex*).

A. The cephalic ganglion anteriorly furnished with a large conical processus. The spermatophores are extremely long and spirally coiled. The oviduct is single.

Spirosperma n.

B. The cephalic ganglion not furnished with an anterior conical processus. The spermatophores are short and broad and not coiled.

a. The efferent duct comparatively short and broad, never much longer than the atrium and copulative organs together. No differentiated hearts.

Ilyodrilus n.

b. The efferent duct comparatively long and narrow, always longer than the atrium and the copulative organs together.

1. The base of the receptacle is furnished with glands. The efferent duct or atrium furnished with a large vesicula seminalis. Hair-spines and forked spines, but the former not always present. No comb-like spines. The middle part of the atrium is glandular.

Hemitubifex n.

2. The base of the receptacle not furnished with glands. The middle part of the atrium not glandular. Atrium furnished with a vesicula seminalis. Three kinds of spines always present.

Psammoryctes VEJDOVSKY.

3. No glands at the base of the receptacle. The middle part of the atrium not glandular. No vesicula seminalis. Two kinds of spines viz. hair-spines and forked spines.

Tubifex LAMARCK.

II. Only one kind of spines, viz. forked spines.

1. Penis and oviduct not surrounded by spiral muscles.

Limnodrilus n.

2. Penis and oviduct surrounded by a band of spiral muscles.

Camptodrilus n.

Spirosperma nov. gen.

The cephalic ganglion anteriorly furnished with a large conical processus, which does not branch in the cephalic lobe of the body. The posterior margin is concave. The spermatophore is very long and narrow, and spirally coiled, surrounded by a pellucid sack-like membrane. The spines are of three kinds, hair-spines, forked spines and comb-like spines. The integument is thickly covered with dark convex papillæ.

S. ferox n. sp.

The penis sheath is chitinous, but only half as long as the penis proper, which is considerably swelled outside the penis sheath. The oviduct is single, muscular, not chitinous, and longer than the penis proper. The forked spines in the front segments are furnished with several prongs. The length of the body is about 20 m.m.; a cingulum is very conspicuous in adult specimens.

Habitat: Sweden, Motala river, in shallow water, also in the lake of Ifö in Scania, where it was taken by Professor W. LILLJEBORG at a depth of 25 fathoms.

Ilyodrilus n. gen.

The cephalic ganglion both anteriorly and posteriorly emarginated. The efferent ducts are broad; compared with those of other genera of the family, and also much shorter, never much exceeding the length of the atrium and penis together. The spines are of three kinds, viz. hair-spines, comb-like spines and forked spines, not all necessarily present in the same species. The prongs of the comb-like spines are much narrower in this genus than in *Psammoryctes*, and the striated membrane between the forks is of a much finer structure.

In other respects this genus resembles *Tubifex* and *Psammoryctes*. The shape of the efferent ducts is the most prominent characteristic of the genus.

The three species as yet known are easily characterized.

- a.* comb-like spines present; the receptacle is bent, not globular. The oviduct is double. *I. Perrieri* n.
b. comb-like spines present; the receptacle is bent, not globular. The oviduct single. *I. sodalis* n.
c. no comb-like spines; the receptacle is globular, not bent; the oviduct is single. *I. fragilis* n.

I. *Perrieri* n. sp.

The efferent duct is shorter than the atrium and the penis together, but of nearly the same length as the atrium alone. The penis seems to have no chitinous sheath, is very short and conical, its lower end not being thicker than its middle.

The oviduct is double, the interior one is chitinous, extended, funnel-shaped and somewhat bent and gradually tapering towards the exterior porus. The exterior oviduct is sacklike, and also considerably tapering towards the external end.

The receptacle is bent at the top, and not globular. Comb-like spines present as well as forked ones and hair-spines. Length of the body about 15 m.m. The worm is thickest at the middle.

Habitat: California, Fresno Co, in ponds round Dry Creek and Kingsriver, and in irrigation ditches on the prairie.

I. *sodalis* n. sp.

The efferent duct is slightly longer than the atrium and penis together. The lower end of the penis proper is globular, and immediately above contracted. The oviduct is bell-shaped, widest at the lower or exterior end. No penis-sheath. The receptacle is very much bent in the shape of an S, the top being considerably enlarged. Comb-like spines present, somewhat similar to the preceding species. The testes are situated in 10 segments or in the 12th to 22d setigerous segments. No differentiated hearts, only pulsating

vessels in the 7th, 8th, 9th setigerous segments. The ova are situated behind the cingulum in the segments 19 to 22. Numerous perigastric cells. Body about 25 m.m. long by 1 m.m. wide.

Habitat: California, San Francisco, in a spring at the Marine Hospital lake.

I. fragilis n. sp.

The efferent duct is longer than the atrium, oviduct and penis together. The penis is comparatively longer than in the preceding species. No penis-sheath. The oviduct is funnel-shaped, chitinous, surrounded by longitudinal muscles. The receptacle is straight, with a very large, perfectly globular top, of a very pellucid consistency. No comb-like spines, only hair-spines and forked ones. The length of the body about 15 m.m. and the width about 0,5 m.m. The body is very slightly tapering, nearly cylindrical. That of the former species was decidedly thickest on the middle and considerably tapering towards both ends.

Habitat: California, Sierra Nevada, Fresno Co, in the bottom of running springs at an altitude of 7000 feet.

Hemitubifex n. gen.

The cephalic ganglion emarginated both in front and behind. The upper end of the atrium is enlarged to a globular chamber or "vesicula seminalis" on which the prostata is grafted. The lower end of the atrium is glandular. The penis-sheath is chitinous, shorter than the oviduct. The oviduct is double, both sheaths being chitinous and funnel-shaped, and of nearly exactly the same shape. The exterior one is surrounded by longitudinal muscles. The receptacle for the spermatozoa is furnished with several winglike glands round its base. The top of the receptacle is enlarged and constitutes the receptacle proper.

The spermatophores are straight or slightly bent. The spines are of two kinds: hair-spines and forked spines. In some individuals no hair-spines are met with, and in others they are very sparingly distributed. No comb-like spines.

H. insignis n. sp.

Characteristics the same as those of the genus. The oviduct is large, entirely enclosing the penis proper. The length of the body about 25 m.m.

Habitat: Europe, Sweden, Motala river, in shallow water.

The peculiarities of this species are very great. It resembles *Psammoryctes* in having a circular chamber (improperly called "vesicula seminalis") at the top of the atrium, and in which the prostata opens. Like *Tubifex* it has hair-spines and forked spines, but the former are very sparingly distributed or even sometimes entirely wanting. *Hemitubifex* is also distinguished from all other genera in having large winglike glands round the base of the receptacle, a characteristic not met with any where else but in the *Enchytræidæ*. We may consider this genus as a connecting link between *Psammoryctes* and *Tubifex*, or *Psammoryctes* and *Limnodrilus*.

Psammoryctes VEJDOVSKY 1875.

VEJDOVSKY, Beitr. zur Oligochaetenfauna Böhmens in Sitzungsber. der Kön. Böhmischen Gesellsch. d. Wissenschaften 1875 p. 194.

The lower end of the atrium, or that part of the same organ which lies between the penis and the circular chamber, or vesicula seminalis, is not glandular, but long and very narrow. The upper end of the atrium is globular and glandular, forming a vesicula seminalis on which the prostata is grafted.

As yet only one species is known viz.

P. umbellifer KESSLER 1868.

Syn.: 1868. *Sænuris umbellifer* KESSLER. Appendix to the Proceedings of the Association of the Naturalists of St Petersburg, pag. 103—108, published in russian.

» 1875. *Psammoryctes umbellifer* VEJDOVSKY l. c. pag. 194, and: Ueber *Psammoryctes umbellifer* und ihm ver-

wandte Gattungen, Zeitschr. wiss. Zool. Bd. 27,
p. 137.

The spines are of 4 kinds, viz. two kinds of forked spines, hair-spines and comb-like spines.

For other characteristics see the excellent monograph of this genus by VEJDOVSKY.

Habitat: Europe, England, Russia, Bohemia, France, — probably widely distributed.

Tubifex LAMARCK 1818.

The cephalic ganglion both anteriorly and posteriorly emarginated. Both penis-sheath and oviduct present. The oviduct is wide and short. Two kinds of spines: hair-spines and forked spines. In the lower fascicles only forked spines, in the upper ones sometimes both forked and hair-spines.

As can be seen the above characteristics are neither very pointed, nor at all sufficient to characterize the genus; but the different descriptions of the species supposed to belong to this genus differ in so many principal points, that generic characteristics can for the present be given only in a negative way, the exterior characteristics being at present the principal ones.

If we therefore unite under one genus all species of the Tubificidæ, which have only two kinds of spines, viz. hair-spines and forked spines, and which besides have none of the principal characteristics of the other genera, — we find them to be the following:

T. rivulorum D'UDEKEM 1855.

Syn.: *T. rivulorum* D'UDEKEM J. Hist. nat. du Tubifex des ruisseaux. Mem. cour. de l'Acad. de Belgique. Tome XXVI, 1855.

Habitat: Europe.

T. coccineus VEJDOVSKY 1875.

Syn.: *T. coccineus* VEJD. Beiträge zur Oligochætenfauna Böhmens l. c. p. 193.

This and the following species are said to have the receptacle in the 10th segment and the sexual porus in the

11th. *T. rivulorum* and *T. campanulatus* on the contrary have the same organs in the setigerous segments 9 & 10, or in one segment nearer the cephalic lobe. I can not account for this seeming difference in any other way than that the respective investigators have counted the segments in different ways. D'UDEKEM, as it seems, and myself, count the first setigerous segment as the "first" segment of the body, and accordingly we find the receptacle to be situated in the 9th, and the sexual porus in the 10th segment. CLAPARÈDE and VEJDOVSKY on the contrary consider the buccal segment as the first segment, and accordingly find the sexual porus situated in the 11th segment and the receptacle in the 10th.

I have, to prevent further mistakes and in order to simplify the counting of the segments, here adopted the plan to name the two segments around the oval opening respectively "cephalic lobe" and "buccal lobe", and to assign the name of "the first segment" only to the first setigerous segment. In the single species of the true genus *Tubifex*, that I have had opportunity to examine, the receptacle is situated in the 9th and the sexual porus in the 10th setigerous segment, and I have reason to believe that the same is the rule in all the species of the genus *Tubifex*.

To avoid all possible mistakes it would be well if every investigator wrote, after the segment in question: "setigerous" or, "counted from the front-lobe of the worm", or any thing else, by which his views on the subject could be immediately ascertained without going to the trouble to look all through the work, preface, notes and all!

T. Bonneti CLAP. 1862.

Syn.: *T. Bonneti* CLAPARÈDE. Recherches sur l'Anatomie des Oligochètes pag. 230. Mém. de la Soc. de Phys. et d'Hist. nat. de Genève, Tome 6.

The most characteristic feature of this species seems to be the vase-like form of its oviduct, which is of about the same length as the penis proper.

Habitat: Europe, Switzerland.

T. campanulatus n. sp

Fig. 2.

The cephalic ganglion is longer than broad and in front considerably broader than behind, where the emargination is deep and narrow. The penis is broadest at the middle, from here tapering toward the end. The penis-sheath is of the same shape as the penis. The oviduct is bell-shaped, the widest end being turned towards the exterior porus. The length of the oviduct is only half that of the penis, but its width at the widest end is nearly three times that of the penis. The receptacle is bent in the shape of an S, with the upper end enlarged and sack-like. The limbs of the forked spines are of nearly the same length and width. The length of the body about 15 m.m.

Habitat: Sweden: Scania, Christianstad, in ponds or ditches near the town.

Limnodrilus CLAPARÈDE 1862.

The cephalic ganglion emarginated both in front and behind. The lower end of the atrium is generally long and narrow, and comparatively narrower than the corresponding part of *Tubifex* and *Ilyodrilus*. The copulative organs are not surrounded by spiral muscles, generally by longitudinal, seldom by circular ones.

The principal characteristics of the genus is evidently the total absence of hair-spines. In all other respects the genus seems to resemble *Tubifex*. It is however likely that when a larger number of species has been studied, new and more distinct characteristics may be discovered. A prominent feature of *Limnodrilus* and *Camptodrilus* is also the elongation of the copulative organs. In other genera the said organs are in general comparatively shorter, and especially the oviduct is in *Tubifex* unusually wide and short.

In the following synoptic table the two species *L. Hoffmeisteri* and *L. Udekemianus* are not classified. However carefully described by CLAPARÈDE, several points in their organisation remain as yet unknown, especially what concerns the reproductive organs, the penis and the oviduct, with their respective sheaths. These species seem to be most nearly related to *L. monticola* and *alpestris*.

Synoptic table.

A. The upper end of the penis-sheath furnished with a crown of star-like concretions. The oviduct is single.

L. ornatus n. sp.

B. The upper end of the penis-sheath not furnished with star-like concretions. The oviduct is double.

1. The penis proper projecting outside the penis-sheath and there forming a globular head.

L. Steigerwaldi n. sp.

2. The penis proper not ordinarily projecting outside the penis-sheath, and its lower end not forming a glandular head.

a. The lower end of the penis proper is truncate and somewhat wider.

L. monticola n. sp.

b. The lower end of the penis proper is pointed and narrower. The lower end of the interior oviduct is wider than its middle.

L. alpestris n. sp.

c. The lower end of the penis proper is pointed or rounded. The lower end of the interior oviduct is much narrower than its middle or upper part.

L. Silrani n. sp.

L. ornatus n. sp.

The cephalic ganglion is broadest behind and its two posterior lobes are well rounded and separated. The penis is long and slender, broadest at its upper end and from there gradually tapering towards the apex, which however is slightly swelled. The penis-sheath is long, cylindrical; widest at its lower orifice and narrowest at the middle. The upper end, near the entrance to the oviduct, is surrounded by a crown of star-like concretions probably of a chitinous consistence. The oviduct is single, sacklike, and longer than the penis-sheath. The receptacle is elongated and of a flask-like shape, sometimes narrower at the middle.

The body of the worm is long and slender, not tapering, and its epidermis is tough. The length is about 30 m.m., the width about 0,6 m.m.

Habitat: California, San Joaquin river; attached to decaying wood floating on the surface of the water of a shallow pond.

The principal characteristic of the species is the star-like concretions round the upper end of the penis-sheath.

L. Steigerwaldi n. sp.

Fig. 3.

The anterior part of the cephalic ganglion is the widest, emitting several large ganglionic lobes towards the cephalic lobe of the body. The posterior margin is abruptly emarginated, and the posterior part itself is nearly globular in form.

The lower end of the penis is globular, swelled and extends outside the penis-sheath, and being at least twice as wide as the lower opening of the same. The oviduct is muscular, widest at the middle, around the swelling of the penis proper, and from here gradually tapering towards the exterior orifice. The exterior oviduct is large and sack-like, and in the membrane of the same, numerous cell-nuclei are to be seen. The receptacle is straight, broadest at its interior apex.

The length of the body in large specimens about 80 m.m., and the width of the same about 0,75 m.m. to 1 m.m.

Habitat: California, Sierra Nevada, in the bottom of running springs in meadows at an altitude of 7000 feet.

The principal characteristic of this species is the enlargement of the lower end of the penis proper.

L. monticola n. sp.

The cephalic ganglion is nearly square, and the projections towards the cephalic lobe only two. The penis is nearly cylindrical with only a slight truncate enlargement of the external end. The penis-sheath is also cylindrical, of the same length as the penis, but also somewhat enlarged at its upper or interior apex. The oviduct is double, the interior one being chitinous; or seemingly so, and closely resembling the penis-sheath, except its lower end being in some fullgrown specimens much spread and plate-like. The exterior oviduct is as usual sack-like. The receptacle is straight and sack-like, and generally found to contain spermatophores.

The body of the worm is very slender, about 30 m.m. long by 0,5 m.m. wide.

Habitat: California, Sierra Nevada, at Seven Springs Meadow, on the east side of the north fork of Kingsriver at an altitude 8 to 9000 feet.

L. alpestris n. sp.

The cephalic ganglion is broadest behind, and in old specimens sometimes three-lobed. The ganglionic swellings of the ventral ganglion are almost circular. Of the copulative organs proper the penis and oviduct are comparatively longer than in any other species of the genus. The lower end of the penis is pointed. Both the interior and exterior openings of the penis-sheath are funnel-shaped, the exterior one being the widest. The interior oviduct is of the same shape as the penis-sheath, but somewhat longer. The exterior end of the exterior oviduct is sack-like, the interior or upper end of the same organ is very narrow and closely surrounding the lower end of the atrium. The receptacle is enlarged at both extremities, the upper one being bent and helix-like. The segmental organs are comparatively short but surrounded by a thick mass of granulated matter.

The body is about 25 m.m. long by $\frac{1}{2}$ m.m. wide. The integument is very tender, causing the worm to be easily broken.

Habitat: Sierra Nevada, California, in the mud of running springs at an altitude of 7000 feet.

L. Silvani n. sp.

Fig. 4.

The cephalic ganglion, in the larger form, is nearly twice as broad as long and sometimes three-lobed, but in the smaller form the ganglion is much longer than broad and never three-lobed. The lower end of the penis proper is rounded and somewhat swelled. The penis is only half as long as its chitinous sheath, and only slightly thicker than the lower end of the atrium. The penis-sheath is, seen from the side, gradually tapering towards its exterior apex, with the exception of an abrupt enlargement on the middle, just at the end of the penis proper. Seen from the front, however, it presents a very different appearance. It resembles in this aspect an arrow-head with a short round handle. The ovi-

duct is double, the interior one is about $\frac{3}{4}$ as long as the penis; the wanting quarter being at the upper end. Seen from the side it resembles somewhat an arrow-quiver; when seen from the front it is found tightly to enclose the exterior end of the penis-sheath, but its upper third is wider than the upper half of the penis-sheath. The exterior oviduct is more sacklike and somewhat loosely enclosing the interior genital organs. The receptacle is furnished with a large upper sacklike enlargement, which in the smaller form is bent over. The segmental organs are narrow and long, and not surrounded by globular cells. The integument is extremely tough, giving the worm a consistency nearly equal to that of a thread.

Of this species there exist two different sized forms. One 18 c.m. long and 2 m.m. wide; an other 5 c.m. long by 1 m.m. wide. Both forms differ anatomically as described above, but are connected by intermediate forms, which may perhaps be considered as beginning species.

Habitat: California, San Francisco. The large form found only in the Marine Hospital pond. The small form in the said pond, Laguna Merced, and Laguna del Tache.

Finally I will make a few remarks on the two species described by CLAPARÈDE, viz.

L. Udekemianus CLAP. 1862.

Syn.: *L. Udekemianus* CLAP. l. c. pag. 243.

L. Hoffmeisteri CLAP. 1862.

Syn.: *L. Hoffmeisteri* CLAP. l. c. pag. 248.

It is pretty evident that CLAPARÈDE did not discover the interior entrance to the oviduct in *Limnodrilus*. In referring to his above cited work, pl. I. fig. 1—4 we find the penis-sheaths *c''* and *c* figured as if they were entirely enclosed in the penis, instead of enclosing the same; and the oviduct *d''* is seen to connect with the exterior coating of the atrium, which I have found in all the species I have investigated not to be the case, but the lower end of the atrium enters the penis-sheath and forms here a penis proper. The sheath *d''*, to judge from analogies with my species, does not connect

with the atrium at all, but ends somewhere above the penis-sheath, and forms here a funnel-shaped interior opening, through which the eggs must enter.

Referring again to *Tubifex Bonneti* Pl. 2. l. c. we find this species much more correctly drawn, and in perfect analogy with *L. Udekemianus* and *L. Hoffmeisteri*.

The atrium is here seen not to coalesce with the copulative sheaths, but entering the penis-sheath, fig. 4 f., the upper end of which is not figured. The oviduct seems to be double, the interior one having its opening at l., and the exterior one somewhere above b. on the same figure. The exterior openings of both are plainly visible in the figure. The interior opening of the interior oviduct is seen at b' fig. 3, but the interior opening of the exterior oviduct *a* is not figured here. We have here however the sheaths represented and figured very much as I think they must be.

It is most likely that CLAPARÈDE first studied the species of *Limnodrilus* and afterwards in studying *Tubifex* discovered the true nature of the copulative organs. In his descriptions however he states as his opinion that the ova enter somewhere in the neighbourhood of the insertion of the prostata gland. But if they should enter here they certainly would arrive directly into the penis sheath, and not in the oviduct.

Camptodrilus n. gen.

The cephalic ganglion is emarginated both in front and behind. The copulative organs are much elongated and entirely surrounded by numerous spiral muscles, one end of which are attached to the exterior oviduct, the other to the interior surface of the body-wall, near to the genital porus.

In other respects the genus resembles *Limnodrilus*; but as a general rule it can be said that the copulative organs of this genus are longer and narrower than those of the preceding or any other genus of the family. Only forked spines are presents.

From all other genera *Camptodrilus* is well distinguished, from most of them in having only forked spines, and from *Limnodrilus* by the peculiar spiral muscles round the copulative organs. In most species the said muscles are very strong

and heavy, and can easily be detected, but in others, as in *C. spiralis*, their structure is very fine and pellucid, and they may sometimes be easily overlooked.

Only four species are as yet known, viz.

- A. The oviduct is double. The interior one is chitinous. The lower end of the penis-sheath is suddenly increased in size and platelike. *C. spiralis* n. sp.
- B. The oviduct is single and not chitinous.
- a. The cephalic ganglion broader in front than behind. The exterior end of the penis-sheath is suddenly expanded and platelike. *C. igneus* n. sp.
- b. The cephalic ganglion is nearly broader behind than in front. The lower or exterior end of the penis-sheath is very gradually increasing in width and not suddenly expanded. *C. corallinus* n. sp.
- c. The cephalic ganglion is broadest behind and well rounded. The exterior end of the penis-sheath is suddenly increased in width, funnelshaped but not platelike. *C. californicus* n. sp.

C. spiralis n. sp.

Fig. 5.

The spiral muscles surrounding the copulative organs are finer than in any other species known, and may be easily overlooked. The penis-sheath is long and narrow, and nearly perfectly straight. Its exterior end is suddenly increasing in width, but is not plate-like. The interior oviduct is of the same shape and size as the penis-sheath, only wider at both extremities. The exterior oviduct is sack-like at its lower end and somewhat resembling the same organ of *Camptodrilus igneus*. The receptacle is long, sack-like and bent at the middle. The segmental organs are not furnished with globular cells, and their interior opening not surrounded by glandular agglomerations. The spines are slightly curved, and the aperture of the prong is larger in the posterior segments than in the anterior ones.

The body is about 25 m.m. long, by 1 m.m. wide and of a steel blue colour. When touched the animal coils itself up, and alcoholic specimens are accordingly never found extended. The integument is tender.

Habitat: California, Sierra Nevada, in stagnant water in meadows, never in the running streams.

C. igneus n. sp.

The cephalic ganglion is broadest in front, and its posterior margin is deeply emarginated. The two anterior processes are covered with several globular swellings.

The penis-sheath is long and extremely narrow, its lower or exterior end is suddenly expanded and plate-like. From above this plate-like end the penis-sheath gradually increases in thickness towards the upper or inner end of the sheath. The oviduct is single and sack-like, especially so its lower end, in which cell-nuclei are plainly visible. The spiral muscles surrounding the copulative organs are very strong and distinct, unlike those of the preceding species *C. spiralis*. The receptacle is bent and sack-like, no spermatophores are found. The segmental organs are in all the segments furnished with a coating of perfectly globular cells, with plain nuclei close to the tube of the organ. The perigastric cavity contains free and floating perigastric cells.

The integument of the body is extremely tender. Colour fiery red, under the microscope yellowish. Size of the body about 30 m.m. long by 0,75 m.m. wide.

Habitat: California, Oakland, San Francisco, Santa Clara, in ponds. Adult in March.

This species is especially remarkable for its fiery red colour, which gives to the boarders of the pond, in which the animal lives, a very vivid appearance. The shape of the cephalic ganglion and the plate-like extremity of the penis-sheath, are distinct characteristics of the species.

C. corallinus n. sp.

The cephalic ganglion is nearly square and its posterior emargination rectangular. The penis-sheath is gradually increasing in width at its exterior extremity, which is somewhat bent. The oviduct encloses the penis-sheath tightly, except its lower end, which is sack-like. The ovaries are short and bent at a right angle, in which the most developed ova are found. The receptacle is short, bent and sack-like.

The segmental organs in front of the cingulum are all furnished with globular cells, but those in the segments behind the cingulum are void of the same. No glandular cells round their interior opening.

The colour of the body is yellowish red, with a light or not coloured band between every segment giving to the worm somewhat the appearance of a string of coralls. The last posterior segment is five or six times larger than the segments preceding it. The length of the body is variable, the general size being 25 to 30 m.m., but sometimes it reaches 60 to 70 millimeters with a width of 1 to 1,5 m.m. The integument is tough, giving some tenacity to the body.

Habitat: California, Fresno Co, in ponds, or even in running waters, Kingsriver, Big Dry Creek, always near the level of the prairie.

C. californicus n. sp.

Fig. 6.

The cephalic ganglion is nearly square, but well rounded behind, with a shallow emargination. The copulative organs are strongly built, and the lower end of the penis-sheath is suddenly increased in size, but its extremity is not plate-like. The oviduct is single, surrounds the penis-sheath perfectly, its lower end is however sack-like, resembling the same organ of *C. corallinus*. The spiral muscles are heavier than in any other species of the genus. The segmental organs are not furnished with globular cells. The body is of about the same size, colour and tenacity as that of *C. igneus*. The tail is distinctly segmented.

Habitat: San Francisco and surrounding places, such as Oakland, Lagunitos, Russian river, in ponds or stagnant water, only seldom in the streams.

The species of this genus being difficult to distinguish from each other, the following summary of their principal characteristics may prove useful.

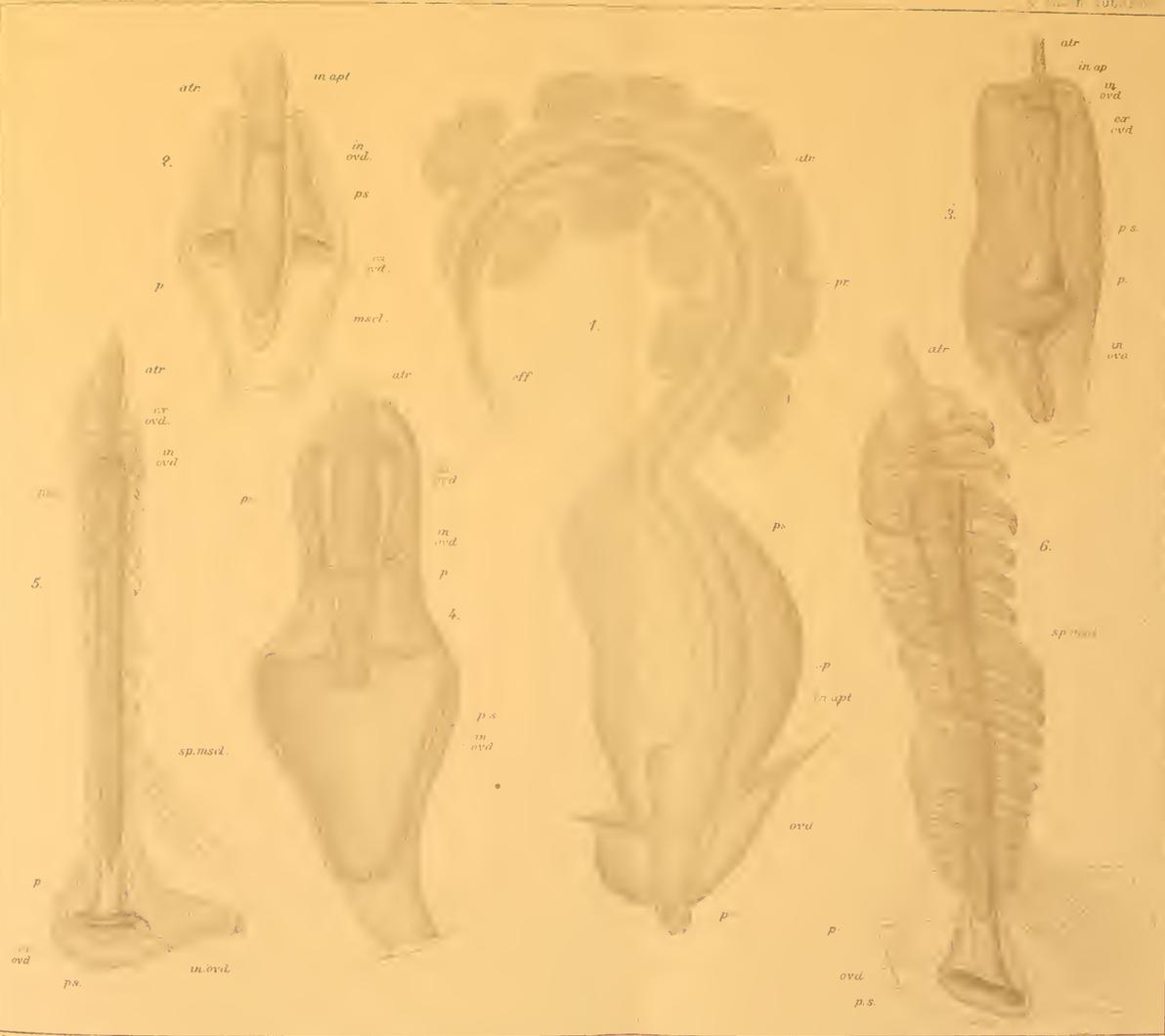
C. spiralis has a double oviduct, its penis-sheath resembles that of *C. igneus*, but is comparatively shorter. The copulative organs have also some resemblance with those of *L. alpestris*, but this species has no spiral muscles. *C. igneus* has a single oviduct, but the penis-sheath is gradually increasing in size from the middle towards the lower or exterior

end. The penis is somewhat larger than that of any other species in the genus, and the body of the worm is tougher. *C. californicus* has the exterior end of the penis-sheath suddenly expanded or increased in size, but its end is not plate-like, only trumpet-shaped. The whole organ is also comparatively shorter and thicker than in *C. igneus*. The oviduct is single.



EXPLANATION OF THE FIGURES.

- Fig. 1. *Telmatodrilus Vejdovskyi*.
A part of the efferent duct, atrium with the prostata glands, penis and oviduct.
- Fig. 2. *Tubifex campanulatus*.
Penis, penis-sheath and oviducts.
- Fig. 3. *Limnodrilus Steigerwaldi*.
Penis, penis-sheath and oviducts.
- Fig. 4. *Limnodrilus Silvani*.
Penis, penis-sheath and oviducts.
- Fig. 5. *Camptodrilus spiralis*.
Penis, penis-sheath, oviducts, and spiral muscles.
- Fig. 6. *Camptodrilus californicus*.
Penis, penis-sheath, oviduct and spiral muscles.
- atr. = atrium; eff. = efferent duct.
in. ap. = interior aperture of the oviducts.
in. ovd. = interior oviduct; ex. ovd. = exterior oviduct.
p. s. = penis-sheath; p. = penis.
sp. mscl. = spiral muscles; pr. = prostata-glands.



C. Staf Eisen, f.

1. *Ther. velox*; 2. *Ther. impar*; 3. *L. Steierw.*; 4. *L. silv.*; 5. *Campt. curv.*; 6. *Campt. curv.*

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