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LAKE SUPERIOR LUMBRICULIDS, INCLUDING VERRILL'S LUMBRICUS LACUSTRIS.

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The oligochaete material of the United States National Museum includes two bottles of specimens from Lake Superior obtained in 1871 by S. I. Smith, naturalist of the United States Lake Survey. One bottle contains eight specimens catalogued as cotypes of *Lumbricus lacustris* Verrill (U. S. N. M. Cat. No. 15,589). They were collected among *Cladophora* in 8-13 fathoms of water, on the south side of Saint Ignace Island. Aside from fragments of tubificids they include parts of specimens of two distinct species of lumbriculids. The label of the other bottle indicates that its contents were from a different collection, but gives no locality other than Lake Superior. The contents are similar to those of the first bottle and include specimens of the same two lumbriculid species and of at least two distinct tubificid genera. Since *L. lacustris* is recorded only from the locality mentioned above and from the stomachs of whitefish taken at Outer Island (Smith, S. I., 1874:697), it seems somewhat probable that the two lots of specimens are from the same locality. One of the lumbriculid species is *Lumbriculus inconstans* (F. Smith) which is already known from a considerable number of localities in the region of the Great Lakes and of the upper Mississippi Valley, and has recently been found in the Arctic regions of North America. The other is a form previously unknown and closely related to *Mesoporodrilus asymmetricus* F. Smith (1896:402).

Verrill's description of *Lumbricus lacustris* (Smith and Verrill, 1871:449) is apparently based on a combination of characters of the two lumbriculid species above mentioned and is as

follows: *Lumbricus lacustris* Verrill, sp. nov. About 1.5 inches long, 0.04 in diameter. Body round, distinctly annulated. Head short, conical, obtusely pointed. Setae spine-like, strongly curved, acute, arranged two by two, those of each pair close together. Color reddish brown.

Of these characters some apply equally well to both species. "Body round, distinctly annulated"; "setae \* \* \* arranged two by two, those of each pair close together"; are of this class. The applicability of statements concerning the length and color can not be judged, because of the poor state of preservation of the material. The diameter (0.04 inch) is correct for the specimens of *Mesoporodrilus*, but that dimension in the *Lumbriculus* specimens is scarcely three-fourths as great. The description of the setae (spine-like, strongly curved, acute), is more nearly correct for the *Mesoporodrilus* specimens, since the setae of the others are cleft at the outer extremity. The description of the prostomium probably more accurately fits the specimens of *Lumbriculus*, although applicable to the others in their poorly preserved condition.

It seems reasonable to assume that the description really combines characters of the two species, but it more nearly fits the specimens of *Mesoporodrilus*. *Lumbriculus inconstans* has had frequent mention in literature for something over twenty years. Under the circumstances the writer prefers to associate Verrill's species name with the specimens of the other genus which will accordingly be described as *Mesoporodrilus lacustris* (Verrill) F. Smith.

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#### **Mesoporodrilus** F. Smith.

Setae closely paired; simple. Clitellum on 10-12 and part or all of 9 and 13; complete ventrad. Spermiducal pore on 10; median. Oviducal pores paired; in 11/12; in line of ventral setae. Spermathecal pores median; anterior to spermiducal pore. Spermaries and spermiducal funnels paired; in 10, or in 9 and 10. Atrium elongated; differentiated into a muscular sperm reservoir and relatively small penial organ, connected by a contorted duct. Ovaries and oviducal funnels paired in 11. Spermathecae, one or two; asymmetrical in position; opening on 9 or on 8 and 9.

Type species, *Mesoporodrilus asymmetricus* F. Smith.

**Mesoporodrilus asymmetricus** F. Smith.

Length, 30 mm. Diameter, 0.5 mm. Somites, 65. Pale; without pigment. Prostomium prolonged into tentacle-like extension. Setae closely paired; simple. Clitellum,  $\frac{1}{2}9$ – $\frac{1}{2}13$ . Spermathecal pores median; two on 9. Spermaries and spermiducal funnels paired; in 10. Diameter of reservoir one and one-half times that of its lumen. Spermathecae, two; in same side of 9; sacs may extend into adjacent somite.

*Holotype*.—Cat. No. 27,235, Illinois State Laboratory of Natural History. Type locality, Quiver Lake, near Havana, Illinois.

**Mesoporodrilus lacustris** (Verrill) F. Smith.

Length, 42 mm. (?) Diameter about 1 mm. Somites, number unknown. Setae closely paired; simple. Clitellum on 9–12 and encroaching on 13. Spermathecal pores median; on 9, or on 8 and 9. Spermaries and spermiducal funnels paired; in 9 and 10. Sperm ducts, two pairs; all opening into the single sperm reservoir near its posterior end. Diameter of reservoir three times that of its lumen. Spermathecae, one, or two; asymmetrically disposed; each with elongated duct opening on 9, or on 8 and 9; and sac with thick wall, in the same or in adjacent somites.

*Cotypes*.—Cat. No. 15,589, U. S. N. M.; Cat. No. 17,947, U. S. N. M. (Lectotype, Cat. No. 15,589, U. S. N. M., selected by F. Smith). Type locality: Lake Superior, south side of Saint Ignace Island.

The specimens show evidence of maceration and are more or less fragmentary. There are no complete specimens permitting observation of length and number of somites. The specimen which serves as type for this description is one of the cotypes mentioned above; it includes fifteen anterior somites, and is cut into transverse sections. Transverse and sagittal sections were made from specimens from the other collection which are used as paratypes.

## EXTERNAL CHARACTERS.

The maximum diameter (1 mm. or slightly more) is in the clitellar somites and considerably exceeds that of the accompanying *Lumbriculus* specimens. The color of the living worms is unknown, since the "reddish brown" of Verrill's description may or may not apply to this species. The prostomium has very thin walls near the end; is incomplete in each specimen studied; and in living specimens may terminate in a tentacle-like extension, as does that of *M. asymmetricus*. The setae are slender and very similar in form to those of the last named species (Smith, 1896, fig. 9). The nodule is one-third of the length, from the distal end, and the outer third is more strongly curved. Ventral setae of the clitellar somites are about 0.225 mm. long and the diameter near the nodule is about 0.011 mm. Other setae are somewhat smaller. The relative distances between the pairs are approximately indicated by the formula:  $aa = \frac{7}{10}bc = \frac{7}{10}dd$ . The clitellum is chiefly confined to somites 9–12, but encroaches slightly on 13. The spermiducal pore is on the summit of a small median papilla near the posterior border of 10. The oviducal pores are

in 11/12 and about in line with the ventral seta bundles. The spermathecal pores are median and borne near the posterior border of their somites on small papillae. In one specimen there are two, one each on 8 and 9; and in each of the others there is a single one which is on 9.

#### INTERNAL CHARACTERS.

A satisfactory account of the internal organs is difficult and in some respects impossible, because of the poor state of preservation of the material. The alimentary tract is quite similar to that of *M. asymmetricus*, since it lacks a gizzard and is otherwise rather simple in type. The contents are such as might be expected in specimens living among algae. Diatom shells are especially abundant. A pair of transverse blood vessels connect the dorsal and ventral vessels in the posterior part of each of most of the anterior eleven somites. The relations of the vessels posterior to these somites can not be determined. The first nephridia seem to be in the eleventh or twelfth somites.

Fortunately the reproductive organs are better preserved than are most others and permit a description of most of the important characters. In the specimens sectioned, there are uniformly a pair of spermaries and a pair of spermiducal funnels in each of somites 9 and 10. The funnels of the anterior pair project freely into the posterior part of the somite, and the ducts extend along the septum to the ventral wall and along the latter to the atrium. Each of the funnels of the posterior pair is included in the anterior part of a corresponding sperm sac. The course of each duct from the funnel is first antierad, out of the sperm sac, and then ventrad along the septum to the body wall. The courses of the two ducts differ from this point, since each of them extends to the atrium which is on one side of the alimentary tract. The duct from the funnel which is on the same side as the atrium follows a rather direct course to the posterior part of the atrium, the "sperm reservoir," while the course of the duct from the other funnel is between the nerve cord and body wall to the atrial side of the worm and then posteriorly to the reservoir. The sperm ducts of the two pairs in their courses along the reservoir are at first separated slightly from its wall, but gradually approach it and are in contact with it in the posterior half, and finally penetrate the muscular wall and open into the lumen of the reservoir near its end. In one specimen the courses of the ducts along the reservoir are approximately 90° apart, while in another, two of the ducts are closely approximated.

The single atrium is on the left side in some specimens and on the right side in the type and in others. It is somewhat similar to that described and figured in *M. asymmetricus*. The term atrium is here used to include all three parts of the single asymmetrical ectal part of the spermiducal apparatus, since it is apparently homologous with one of the paired atria of *Rhynchelmis*. In the description of *M. asymmetricus* the term atrium was used in a different way and applied to a small chamber near the spermiducal pore (Smith, 1896, fig. 7, at). No such chamber is developed in *M. lacustris*. The atrium terminates in a penial organ corresponding

to the "prostate" of *M. asymmetricus*, but relatively shorter and more slender. This organ extends dorsad and laterad to a position near the opening of a sperm sac in septum 10/11, where it is connected with the anterior end of the sperm reservoir by a duct of diameter similar to that of the penial organ (0.045–0.05 mm.). The reservoir is included within the sperm sac of the atrial side of the worm and extends posteriad two to four somites, the distance varying in different specimens. In the type specimen it ends in somite 14. The wall of the reservoir includes a thin lining epithelium; several thin laminae of muscular tissue of which the fibers have a spiral direction, some to the right and some to the left; and a very thin outer layer of longitudinal fibers. The spirally arranged fibers are more nearly transverse than longitudinal, and the angles which they make with each other and with those of the superficially placed longitudinal series are approximately equal ( $60^\circ$  or  $120^\circ$ ). This arrangement is very different from that in *M. asymmetricus* in which the chief mass of muscle fibers have a slightly spiral course, but are nearly parallel with the longitudinal axis of the sperm reservoir. The diameter of the reservoir is approximately one-fifth of that of the somites containing it and the diameter of the lumen, midway of its length, is about one-third of that of the reservoir. Connected with the wall by narrowed extensions are numerous gland cells of large size which are similar to the "large prostate cells" of *Eclipidrilus frigidus* described by Eisen (1895). There is no large mass of gland cells related to the spermiducal pore, as in *M. asymmetricus* (Smith, 1896:405). Paired sperm sacs extend posteriad from septum 10/11 through four to six somites; in the type specimen at least to somite 16.

There are uniformly a pair of ovaries in 11 attached to septum 10/11, and a pair of oviducal funnels and oviducts in the same somite, related to septum 11/12. From 11/12 a pair of ovisacs extend posteriad a few somites beyond the posterior ends of the sperm sacs, which are included in the anterior part of the ovisacs. More commonly there is one spermatheca in 9, opening on the mid-ventral surface near the posterior boundary of the somite, but in one specimen there is also a second spermatheca in 8, with opening similarly placed in that somite. The spermathecal ducts have relatively small diameter and are sharply distinct from the large, rather thick-walled sacs. The sacs often invade adjacent somites and may be on either the right or left side of the alimentary tract. The diameter of the duct is about 0.075 mm., while that of the sac is often more than half of the diameter of the worm, and hence nearly ten times as great.

#### RELATIONSHIPS OF MESOPORODRILUS LACUSTRIS.

The relationships of *M. lacustris* seem very clear. In having a single atrium opening on the mid-ventral surface, and asymmetrically arranged spermathecae which also have median pores, its close relation to *M. asymmetricus* is obvious. While agreeing with this species in various other characters of generic rank, it is clearly distinguished by several characters of specific grade. Two pairs of spermaries and spermiducal



funnels instead of a single pair of each is an important difference. *M. lacustris* more frequently has a single spermatheca, and when two are present they are in different somites; while each of the two known specimens of *M. asymmetricus* has two spermathecae in one somite. The musculature of the sperm reservoir is quite different in the two species, that of *M. lacustris* being unique, while that of *M. asymmetricus* is more like that in allied genera. The relative diameters of the reservoir and its lumen are quite different in the two species. In *M. lacustris* the diameter of the lumen is but one-third of that of the reservoir, midway of its length; while in *M. asymmetricus* the diameter of the lumen is about two-thirds of that of the reservoir.

The assumption of Michaelsen (1908:163) that *M. asymmetricus* is a "reduction form" (meaning that it has been derived from an ancestral form with two pairs of male gonads and of sperm ducts) receives increased support, now that we know a closely related form with two pairs of spermaries and of sperm ducts.

The genus *Mesoporodrilus* was established for the species *M. asymmetricus* which alone among lumbriculids had median spermiducal and spermathecal pores, together with asymmetry of the related organs. Later, another genus, *Premnodrilus* F. Smith (1900), was established for a single North American species, *P. palustris*. In several characters, notably the spermiducal organs, these two genera are closely allied to the older genus *Eclipidrilus* Eisen and Michaelsen (1901:149) has seen fit to unite the three species in the last named genus. The discovery of a second species of *Mesoporodrilus* and also of a second distinct species of *Premnodrilus*, soon to be described, has led the writer to revive these generic names. Notwithstanding their close relationship to each other and to *Eclipidrilus*, each of these two genera has at least two perfectly distinct species which are much more closely allied to each other than they are to the species of the other genus. Furthermore, these two genera have been separated long enough to permit the development of a "reduction form" in each. As the oligochaete fauna of other parts of the country becomes better known, it seems highly probable that still other species may be found belonging to one or the other. Whether the two groups are at present given generic or subgeneric rank is a matter of no great consequence.

#### ***Lumbriculus inconstans* (F. Smith).**

The collections contain more specimens of this species than of *M. lacustris*, but the latter would be more likely to be selected for study because of their greater size. Scarcely any of the specimens were sexually mature. But two were noticed that are at a stage showing spermathecae and these illustrate the extreme variability among specimens of *Lumbriculus*. Neither of them has precisely the same number and arrangement of the various reproductive organs that is known in any other specimen of the genus. One specimen, from those labelled as cotypes of *Lumbriculus lacustris*, has paired atria in 10; spermaries and spermiducal funnels paired in 9 and 10; ovaries and oviducal funnels paired in 11, 12 and 13; and

spermathecae paired in 12–15. This is the first record in the species of three pairs of oviducal funnels, and this number was recorded but once by Mrázek (1907:420) among 163 specimens of *Lumbriculus variegatus*. The other specimen having spermathecae is from the other bottle and has paired atria in 10; paired spermaries and spermiducal funnels in 9 and 10; paired ovaries and oviducal funnels in 11 and 12; and paired spermathecae in 11–13.

The sperm ducts could be traced throughout most of their course in each of the two mature specimens. As noted by Mrázek (1907:434) in *L. variegatus*, the ducts are very slender, have a tortuous course, and are followed with difficulty. There is almost certainly a general correspondence in their course and in their relation to the atria, with the conditions found in *Trichodrilus*. The course of the ducts of either side is: (a) along the anterior surfaces of their septa, ventrad to the body wall; (b) along the latter, with more or less tortuous windings, to the atrium; and then (c) along its surface to the summit, where the lumen of each duct becomes continuous with that of the atrium. Each duct from 9 extends dorsad on the anterior side of the corresponding atrium and that from 10 on the posterior side.

The writer has recently received from Dr. Paul S. Welch, specimens of *L. inconstans* which were collected in Douglas Lake, near Cheboygan, Michigan, in July, 1918. One of these which is sexually mature has been sectioned and it also exhibits the *Trichodrilus* relation of spermiducal organs.

In a discussion of the position of *Lumbriculus* in the family Lumbriculidae, Michaelsen (1908:165–166) has mentioned the need for information about the relations of sperm ducts and atria in *L. inconstans*. He also suggested the possible desirability of uniting *Trichodrilus* with *Lumbriculus*. He considered the various characters which separate the two genera, as relatively unimportant. While admitting that any one of the characters might by itself be insufficient to warrant generic separation of the two groups of species, the writer considers that much more importance should be attached to the existence of a considerable number of such differences than to the presence of but one or two. An additional difference, not mentioned by Michaelsen, is in the position of the spermathecal pores. In *L. variegatus* and *L. inconstans* the pores are dorsad of the ventral seta bundles and in or near the lateral line; while in *Trichodrilus*, they are posteriad of the ventral seta bundles and in line with them, as in most lumbriculids.

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