

NORTH AMERICAN EARTHWORMS OF THE FAMILY LUMBRICIDAE IN THE COLLECTIONS OF THE UNITED STATES NATIONAL MUSEUM.

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By FRANK SMITH,

*Professor of Systematic Zoology, University of Illinois.*

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INTRODUCTION.

The classification of earthworms in common use at the present time recognizes four families of which three are represented in North America. The present paper deals with the family Lumbricidae, which is chiefly represented in Europe and Western Asia where it presumably originated. North America has scarcely a dozen indigenous species of this family as yet described and but a slightly larger number of species that are also found in the Eurasian region. A considerable number of the latter have probably been introduced into North America through the agency of European settlers. The earthworms which are most characteristic of the North American region belong to the families Megascolecidae and Geoscolecidae and will be dealt with in a subsequent paper.

The systematic literature on North American Lumbricidae is decidedly meager. Eisen was the pioneer in this field, and in 1874 listed nine species of which four were described as new. These species were recorded as from Mount Lebanon, New England, and from Niagara, Canada. Correspondence with Doctor Eisen has brought out the fact that the Mount Lebanon mentioned is really in the eastern part of the State of New York. Michaelsen described two new species from Georgia and Florida in 1894 and one from North Carolina in 1910, and in 1900 published an important paper dealing with the distribution and relationships of the lumbricid fauna of North America. Ude described a new species from Georgia in 1895, and H. F. Moore in the same year described a new species from Pennsylvania for which he had in 1893 described the new genus *Bimastos*. Finally, Smith and Gittins described two new Illinois species in 1915, and in the same year Smith published the description of a new variety together with a list of the species found in Illinois.

The Lumbricidae in the collection of the United States National Museum fortunately include specimens presented by Eisen from the original collections on which he based his descriptions of three of the new species mentioned above. These permit a description of the internal anatomy, of which a lack of knowledge had left their actual relationships in doubt.

This paper forms No. 70 of the series of contributions from the zoological laboratory of the University of Illinois.

#### TERMINOLOGY.

There is much lack of uniformity in the use of terms and symbols in publications dealing with earthworms, and hence it is desirable to explain some of those used in this paper. Those adopted are the simplest which are sanctioned by the usage of the more careful recent writers of systematic papers on the group.

Arabic numerals are used to designate the number of a somite, counting from the anterior end. When the separation between somites is obscure, advantage may be taken of the fact that the first setae are borne on the second somite. Externally the limits of somites are ordinarily indicated by transverse (intersegmental) grooves, while internally the septa serve this purpose. Not infrequently, and especially in the anterior part of the worm, there is a considerable lack of correspondence in the external and internal boundaries of somites thus indicated. Septa and intersegmental grooves for any two adjacent somites are represented by the same formula—for example,  $5/6$ —the context showing which is meant. In the Lumbricidae there are eight setae to the somite, and these are more commonly arranged in pairs. It is customary to indicate the setae of either side by the use of the letters *a*, *b*, *c*, and *d*; the ventral-most seta being designated by *a*, the next by *b*, the next by *c*, and the dorsalmost one by *d*. If the distances *ab* and *cd* are less than one-third of the distance *bc*, the setae are said to be closely paired; and if otherwise, they are widely paired, or they may be unpaired or separate. If the prostomium completely divides the peristomium and the longitudinal grooves which form its lateral boundaries extend clear to the intersegmental groove  $1/2$ , the prostomium is said to be tanylobic. If the prostomium and its lateral grooves extend only part way across the peristomium and fail to reach the groove  $1/2$ , it is called epilobic. Tubercula pubertatis are glandular ridges closely associated with the ventral edges of the clitellum on some of its somites.

The spermathecae are pouches which open to the exterior and receive sperm cells from another individual. They are the same as the seminal receptacles mentioned in many textbooks. The sperm sacs open into the cavity of 10 or 11 and store temporarily the sperm

cells produced in those somites. Each sperm sac lies in a somite adjacent to the one into which it opens. These organs are often called seminal vesicles in the textbooks.

In the following key marginal numbers in parentheses refer to other paragraphs in the key which contain alternative statements which are to be compared with the one concerned and a decision made between them.

TECHNIC.

An adequate study of earthworms for systematic purposes demands serial sections of sexually mature specimens, although much important information can be gained from careful dissections.

When there is scarcity of material and in dealing with types, the writer, beginning at the anterior end and using a safety razor blade, splits the specimen in the sagittal plane as far as desired and at least through the 16th somite. A piece on one side of this cut is removed and made into serial sagittal sections. If there is dirt in the alimentary tract in the piece to be cut, it must be removed before imbedding. One is less likely to lose sections at the end of the series if he begins sectioning on the side opposite the cut surface.

KEY TO SPECIES OF LUMBRICIDAE REPORTED IN NORTH AMERICA.

- 1 (41) Prostomium incompletely divides the peristomium, epilobic .....2.
- 2 (40) Spermaries and spermiducal funnels not inclosed in sperm vesicles. (Anterior margin of clitellum is anterior to 30 in species included in this key.) *Helodrilus*.3.
- 3 (17) Spermathecal pores, dorsal to seta line *d*, near mid-dorsum .....4.
- 4 (9) Posterior margin of clitellum not extending as far as 29; antero-dorsal surface of body pigmented with some shade of brown. Amphibious. Subgenus *Eiseniella*.5.
- 5 (6) (7) (8) Spermiducal pores on 13; clitellum on 22 or 23-26 or 27.  
*H. (E.) tetraedrus typica*.
- 6 (5) (7) (8) Spermiducal pores on 15; clitellum on 22 or 23-27.  
*H. (E.) tetraedrus hereynia*.
- 7 (5) (6) (8) Spermiducal pores on 13; clitellum on 20 or 21-24 or 25.  
*H. (E.) tetraedrus neapolitana*.
- 8 (5) (6) (7) Spermiducal pores on 15; clitellum on 20 or 21-24 or 25.  
*H. (E.) tetraedrus ninnii*.
- 9 (4) Clitellum extending posteriorly at least to 29.....Subgenus *Eisenia*.10.
- 10 (11) Setae widely paired; *ab:bc:cd=5:9:5* .....*H. (E.) venetus hortensis*.
- 11 (10) Setae closely paired .....12.
- 12 (13) Three pairs of spermathecal pores, 8/9, 9/10, and 10/11; clitellum, 24-30.  
*H. (E.) lönnbergi*.
- 13 (12) Two pairs of spermathecal pores .....14.
- 14 (15) (16) Clitellum, 24-31; tubercula pubertatis, 27-29....*H. (E.) carolinensis*.
- 15 (14) (16) Clitellum, 24, 25 or 26-32; transversely banded with brown and buff.  
*H. (E.) foetidus*.
- 16 (14) (15) Clitellum, 24, 25 or 26-31, 32 or 33; tubercula pubertatis, 29-31; without pigment.....*H. (E.) roseus*.
- 17 (3) Spermathecal pores, when present, in or ventral to seta line *d* .....18.
- 18 (22) (25) Four pairs of sperm sacs in 9-12; spermathecae present; setae closely paired .....Subgenus *Allolobophora*.19.

- 19 (20) (21) Clitellum, 27 or 28-34 or 35; tubercula pubertatis, 31 and 33 or 31-33.  
*H. (A.) caliginosus* or var.
- 20 (19) (21) Clitellum, 27 or 28-35; tubercula pubertatis, 32-34 . . . . . *H. (A.) longus*.
- 21 (19) (20) Clitellum, 29-37; tubercula pubertatis on 31, 33, and 35. *H. (A.) chloroticus*.
- 22 (18) (25) Three pairs of sperm sacs in 9, 11, and 12; spermathecae present; setae of North American species widely paired or separate . . . . . Subgenus *Dendrobaena*. 23.
- 23 (24) Clitellum, 27, 28, or 29-33 or 34; tubercula pubertatis, 31-33. *H. (D.) octaedrus*.
- 24 (23) Clitellum, 25 or 26-31 or 32; tubercula pubertatis, 28-30 . . *H. (D.) subrubicundus*.
- 25 (18) (22) Two pairs of sperm sacs in 11 and 12; spermathecae absent (sometimes imperfectly developed in *H. tenuis*) . . . . . Subgenus *Bimastus* 26.
- 26 (39) Setae more or less closely paired . . . . . 27.
- 27 (28) (35) Clitellum, 23-28; large chamber at end of sperm duct. . . *H. (B.) palustris*.
- 28 (27) (35) Clitellum, otherwise but including less than ten somites . . . . . 29.
- 29 (32) Anterior margin of clitellum, anterior to 23 . . . . . 30.
- 30 (31) Clitellum on 22-29; *ab* equal to *cd* . . . . . *H. (B.) tumidus*.
- 31 (30) Clitellum, beginning at 20-22; *ab* greater than *cd*  
*H. (B.) gieseleri* and var. *hempeli*.
- 32 (29) Anterior margin of clitellum on 24 or 25 . . . . . 33.
- 33 (34) Clitellum, 24-30 . . . . . *H. (B.) parvus*.
- 34 (33) Clitellum, 24 or 25-31 . . . . . *H. (B.) beddardi*.
- 35 (27) (28) Clitellum including 10 somites or more . . . . . 36.
- 36 (37) (38) Clitellum, 23-32 or 24-33 . . . . . *H. (B.) longicinctus*.
- 37 (36) (38) Clitellum,  $\frac{2}{3}$  25-35 . . . . . *H. (B.) welchi*.
- 38 (36) (37) Clitellum, 27-37 . . . . . *H. (B.) zeteki*.
- 39 (26) Setae, widely paired; clitellum, 26-31 or 32 . . . . . *H. (B.) tenuis*.
- 40 (2) Spermaries and spermiducal funnels inclosed in sperm vesicles; clitellum, 30-35; tubercula pubertatis, 31-34; setae separate or widely paired . . *Octolasion lacteum*.
- 41 (1) Prostomium completely divides the peristomium, tanylobic; spermaries and spermiducal funnels inclosed in sperm vesicles; sperm sacs in 9, 11, and 12.  
*Lumbricus*. 42.
- 42 (43) (44) Clitellum, 26 or 27-32; tubercula pubertatis 28-31 . . . . . *L. rubellus*.
- 43 (42) (44) Clitellum, 28-33; tubercula pubertatis, 29-32 . . . . . *L. castaneus*.
- 44 (42) (43) Clitellum, 31 or 32-37; tubercula pubertatis, 33-36 . . . . . *L. terrestris*.
- Lumbricus festivus* (Savigny), clitellum, 34-39, has been reported in Canada by Stafford (1902).

### Family LUMBRICIDAE.

Earthworms of this family have but eight setae to each somite. The anterior border of the clitellum is posterior to the spermiducal pores which in the great majority of species are on somite 15 but in a few, are one to three somites further anterior. A calciferous gland is present in the region of the gonads and a gizzard at the anterior end of the intestine. There are no typical prostate glands extending freely into the coelomic cavity. As in the great majority of earthworms, the spermaries and spermiducal funnels are in 10 and 11 and the ovaries in 13 and oviducal pores in 14.

A satisfactory grouping of the species of this family into genera and subgenera has proven to be extremely difficult. Michaelsen has recently (1910) discussed these difficulties and has reduced the number of genera to three—*Helodrilus*, *Octolasion*, and *Lumbricus*. *Helodrilus* includes the great majority of the species of the

family and is tentatively subdivided by Michaelsen into six sub-families, not very sharply defined, of which five are represented in North America.

Genus **HELODRILUS** Hoffmeister, 1845.

The chief character, by which species of this genus are distinguished, is the absence of any special sperm vesicles enclosing the spermaries and spermiducal funnels.

Subgenus **EISENIELLA** Michaelsen, 1900.

For synonymy see Michaelsen (1900a: 471).

Michaelsen (1910) has reduced this group from generic to sub-generic rank and considered its relationships to the subgenus *Eisenia* (Malm) to be so close as to hardly warrant their separation. The only character used as a basis for such separation is the somewhat shorter gizzard which is chiefly confined to the 17th somite in *Eiseniella* and ordinarily involves, in addition, more of the 18th somite in others. A much more significant character is probably to be found in the position of the oviducal pores. My study of American material of *Helodrilus tetraedrus* f. *typica*, *H. t. f. hercynia*, and Eisen's *Tetragonurus pupa* has shown in every specimen examined, the oviducal pores opening slightly mesad of *a* instead of slightly dorsad of *b*; where, as far as known, they open in all other Lumbricidae. If similar relations are found in European material, as is probable, the retention of the subgenus will be on a much better basis.

*Eiseniella* differs from the other subgenera, except *Eisenia*, in having the pores of the paired spermathecæ between the seta line *d* and the mid-dorsal line.

**HELODRILUS (EISENIELLA) TETRAEDRUS** (Savigny) forma **TYPICA**.

*Enterion tetraedrum* SAVIGNY, 1826: 184.

*Allurus tetraedrus* EISEN, 1874: 54.

*Eiseniella tetraedra* (*typica*) MICHAELSEN, 1900a: 472.

*Helodrilus* (*Eiseniella*) *tetraedrus* forma *typica* MICHAELSEN, 1910: 11.

For more complete synonymy of this and other species, see Michaelsen, 1900a.

Length, 3–6 cm. Somites, 70–90. Color, quite variable, but usually some shade of brown. Prostomium usually epilobic. Setae paired; slightly posterior to clitellum, *aa: ab: bc: cd: dd* = 3: 1: 3: 1: 6; near posterior end, *aa: ab: bc: cd: dd* = 5: 2: 5: 2: 6–8. Clitellum on 22 or 23–26 or 27. Tubercula pubertatis on 23–25 or 26. First dorsal pore on 4/5. Spermiducal pores on 13. Oviducal pores on 14, slightly mesad of *a*. Spermathecal pores on 9/10 and 10/11 between *d* and mid-dorsal line. Septa, 7/8–11/12 slightly thickened. Longitudinal partitions of the calciferous gland, narrow and the

entire gland poorly developed as compared with those of many lumbricid species. Sperm sacs in 9-12. Spermathecae on dorsal side, chiefly in septa 9/10 and 10/11. This position of the spermathecal pores is the more usual one and is stated by Cognetti (1905) to be the normal one in European specimens. It differs from the statements of Rosa (1893), Michaelsen (1900a), and of Smith (1915).

*H. tetraedrus* f. *typica* finds favorable conditions in the water-soaked banks of streams, lakes, and ponds. It is distributed generally throughout Europe and in many parts of the world where Europeans have settled. In the United States it has been reported from Pennsylvania and California.

New localities: Ohio, Michigan, Indiana, Illinois, Colorado, and Washington (Puget Sound region).

**HELODRILUS TETRAEDRUS forma HERCYNIA (Michaelsen).**

*Allurus hercynius* MICHAELSEN, 1890: 7.

*Eiseniella tetraedra hercynia* MICHAELSEN, 1900a: 473.

*Helodrilus* (*Eiseniella*) *tetraedrus* f. *hercynia* MICHAELSEN, 1910: 11.

Similar to f. *typica* except that the spermiducal pores are on 15 instead of 13.

The habitat is the same as that of f. *typica*, but the reported distribution is less extensive, being limited to parts of Europe, and in the United States to California.

New locality: It is abundant at Urbana, Illinois, in association with f. *typica*.

**HELODRILUS TETRAEDRUS forma NEAPOLITANA (Örley).**

*Allurus neapolitanus* ÖRLEY, 1885: 12.

*Eiseniella tetraedra neapolitana* MICHAELSEN, 1900a: 473.

Very similar to f. *typica* in most respects, but differs in the following: Length (maximum), 8 cm.; somites (maximum), 150; clitellum on 20 or 21-24 or 25; tubercula pubertatis on 21- $\frac{1}{2}$ 24 or 24. The spermiducal pores are on 13 as in the typical form.

Forma *neapolitana* is known from Italy and from California.

**HELODRILUS TETRAEDRUS forma NINNII (Rosa).**

*Allolobophora ninnii* ROSA, 1886: 680.

*Allurus ninnii* MICHAELSEN, 1890: 10.

*Eiseniella tetraedra ninnii* MICHAELSEN, 1900a: 473.

Similar to f. *typica*, but differs in the following respects: Somites, 120-130; clitellum on 20 or 21-24 or 25; tubercula pubertatis on 21 or 22-24; spermiducal pores on 15.

The chief difference between this form and f. *neapolitana* is in the position of the spermiducal pores.

Forma *ninnii* has been reported from Italy, Western Asia, and California.

## NOTE ON TETRAGONURUS Eisen.

*Tetragonurus pupa* EISEN, 1874a: 47.

*Allurus pupa* MICHAELSEN, 1890: 10.

*Eiseniella tetraedra pupa* MICHAELSEN, 1900a: 474.

Length, about 2.5 cm. Somites, about 40. Color, sienna-brown anteriorly; light red posteriorly. Prostomium not dividing the peristomium. Setae paired. Clitellum on 18-22. Tubercula pubertatis on 19-21. Spermiducal pores on 12.

In 1874 Eisen briefly described, in substance as above, the external characters of specimens collected by him at Niagara. He referred to their resemblance in appearance and habits to *Helodrilus tetraedrus*, then known as of the genus *Allurus*. In his paper there is no reference to their abundance. One of the specimens was presented to the United States National Museum and has afforded an opportunity for a more extended examination, including a study of the internal anatomy from sagittal sections made from one half of the anterior part of the worm. Some of the more important characters have already been announced in a brief note in *Science* (1914: 364). The following are the important anatomical characters:

Somites, 41. Clitellum on 18-22. Tubercula pubertatis on 19-21. Spermiducal pores on 11, between *b* and *c*. Oviducal pores on 10, slightly mesad of *a*. Spermathecal pores in 5/6 and 6/7, and dorsad of *d*. Evaginations at anterior end of calciferous gland in 6. Crop in 11 and 12. Gizzard in 13 and a little way into 14. But one pair of hearts, which are in 7. Spermaries and spermiducal funnels in 6 and 7. Ovaries and oviducal funnels in 9. Sperm sacs in 7 and 8; none found in 5 and 6. Spermathecae in 6 and 7; adherent to the septa, 5/6 and 6/7.

There is no satisfactory explanation for the discrepancy in the position of the spermiducal pores. It may have been due to an error in counting, or possibly there may have been a specimen in which they actually were on 12.

It is obvious that each of the locations described for these organs is four somites anterior to the position normal in Lumbricidae. We have merely to assume that a specimen of *H. tetraedrus* f. *hercynia* had suffered the loss of the anterior nine somites and regenerated the usual number of five new ones, and the result would be such a worm as we have under discussion. It is the belief of the writer that the specimen originated in some such way. Such an assumption of course raises the question of the number of specimens collected and the possibility of examining others of the same collection.

In reply to a letter asking for further information, Doctor Eisen makes the following statements:

*Tetragonurus pupa*, I found in all, if I remember correctly, three specimens. They all agreed or seemed to agree; and the one you have sectioned should in my opinion,

or so I thought, be the type. The place where I collected the *T. pupa* was on the American side of the falls just below the suspension bridge (Niagara).

In view of the above facts, there seems insufficient reason for regarding this form as entitled to a distinct systematic position.

Subgenus *EISENIA* Malm, 1877.

The location of the spermathecal pores near the mid-dorsal line, or at least dorsad of *d*, separates this subgenus from others except *Eiseniella*; from which it is distinguished by the extent of the gizzard and probably by the position of the oviducal pores, as stated in the description of the subgenus *Eiseniella*.

**HELODRILUS (EISENIA) LÖNNBERGI (Michaelsen).**

*Allolobophora lönnbergi* MICHAELSEN, 1894: 179.

*Eisenia lönnbergi* MICHAELSEN, 1900a: 475.

Length, 9.6 cm. Somites, 138. Color of dorsal and lateral surfaces, brownish violet; the pigment lacking on the lateral surfaces of 8-12. Prostomium, epilobic  $\frac{2}{3}$ . Setae, closely paired and ornamented; those of the ventral pairs on most clitellar somites modified into long slender sexual setae; anteriorly, *dd* is somewhat less than  $\frac{1}{2}$  of the circumference and posteriorly only  $\frac{2}{3}$  of it. Clitellum on 24-30. Tubercula pubertatis on 26- $\frac{1}{4}$ 29. First dorsal pore on 7/8. Spermiducal pores on 15 without definite glandular elevations surrounding them; each is dorsal to *b* and at a distance equal to about *2ab*. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 8/9-10/11, close to the dorsal median line and near the dorsal pores. Septum 12/13, slightly; and septa 13/14 and 14/15, somewhat more strongly thickened. Sperm sacs in 9, 11, and 12. Spermathecae in 9, 10, and 11.

*H. lönnbergi* has been reported from Georgia and North Carolina.

**HELODRILUS (EISENIA) CAROLINENSIS (Michaelsen)**

*Eisenia carolinensis* nomen nudum, MICHAELSEN, 1903: 137.

*Helodrilus (Eisenia) carolinensis* MICHAELSEN, 1910: 15.

Length, 3.5 cm. Somites, 121. Color, more or less reddish, due in part to weak red pigmentation of dorsal surface. Prostomium, epilobic  $\frac{1}{2}$ . Setae, closely paired; posterior to the clitellum, *aa:bc:dd*=4 : 3 : 6; anteriorly *dd*= $\frac{1}{2}$  circumference. Clitellum on 24-31. Tubercula pubertatis on 27-29, slightly dorsad of seta line *b*. Papillae include ventral setae of 10, 16, 17, 24 or 25-31. First dorsal pore on 5/6. Spermiducal pores on 15. Spermathecal pores in 9/10 and 10-11, close beside the mid-dorsal line. Septa of anterior somites including the gizzard region are slightly thickened. Sperm sacs in 9, 11, and 12; those of 9 smaller than the others. Spermathecae in 10 and 11.

One specimen introduced with plants into Hamburg from Fayetteville, North Carolina.

**HELODRILUS (EISENIA) FOETIDUS (Savigny).**

*Enterion fetidum* (COIT. *foetidum*) SAVIGNY, 1826: 182.

*Allolobophora foetida* EISEN, 1874: 50.

*Eisenia foetida* MALM, 1877: 45.

*Helodrilus (Eisenia) foetidus* MICHAELSEN, 1910: 16.

Length, 6–13 cm. Somites, 80–110. Color, conspicuous, due to the transverse purple or brown bands on the middle of the somites alternating with nearly pigmentless intersegmental areas; pigment lacking on the lateral surfaces of 9–11. Prostomium, epilobic  $\frac{1}{2}$ . Setae closely paired. Clitellum on 24, 25, or 26–32. Tubercula pubertatis on 28–30 or 31. First dorsal pore on 4/5. Spermiducal pores on 15, between *b* and *c* and not very near to either. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 9/10 and 10/11, near the mid-dorsal line. Septa of anterior somites not much thickened, those of 7/8–9/10, 13/14, and 14/15 most so but only very moderately. Sperm sacs in 9–12, those of 9 and 10 smaller than the others. Spermathecae more commonly in 9 and 10, but always in close relation to the septa 9/10 and 10/11, and sometimes one or both may lie posterior to them.

*H. foetidus* finds very favorable conditions in manure and compost heaps and is often found in decaying logs. It is abundant throughout Europe and in various parts of the world where Europeans have settled. In North America it is abundant and very widely distributed. It has been collected in most of the States where earthworms have been collected, including those of the Atlantic and Pacific coasts, the Mississippi Valley, the Rocky Mountain region, and the Gulf States.

**HELODRILUS (EISENIA) ROSEUS (Savigny).**

*Enterion roseum* SAVIGNY, 1826: 182.

*Allolobophora rosea* ROSA, 1893: 427.

*Eisenia rosea* MICHAELSEN, 1900a: 478.

*Helodrilus (Eisenia) roseus* MICHAELSEN, 1910: 14.

*Allolobophora mucosa* EISEN, 1874: 47.

Length, 3–8 cm. Somites, 120–150. Color of living specimens, pale red, but the body walls are without definite pigment. Prostomium, epilobic  $\frac{1}{2}$ . Setae closely paired. Clitellum usually includes 25–32 and occasionally involves 24 or 33. Tubercula pubertatis, usually on 29–31, occasionally 30–31. Glandular papillae often include one or more setal bundles of 9, 10, 12, or 13, which may have modified genital setae. First dorsal pore on 4/5. Spermiducal pores on 15 and nearer to *b* than to *c*. Oviducal pores on 14, just dorsad of *b*. Spermathecal pores on 9/10 and 10/11, close

to the mid-dorsal line. Septa 6/7-9/10, considerably thickened; others to 14/15, but slightly. Sperm sacs in 9-12. Spermathecae on dorsal side of 10 and 11 with but short ducts.

*H. roseus* is widely distributed in Europe and in various parts of the world where Europeans have settled. In the United States it has been reported from New York, Georgia, Indiana, Illinois, Louisiana, Arizona, and California. New locality: Maine.

**HELODRILUS (EISENIA) VENETUS var. HORTENSIS.**

*Allolobophora subrubicunda* forma *hortensis* MICHAELSEN, 1890: 180.

*Allolobophora veneta hortensis* ROSA, 1893: 429.

*Eisenia veneta* var. *hortensis* MICHAELSEN, 1900a: 477.

*Helodrilus (Eisenia) venetus* var. *hortensis* MICHAELSEN, 1910: 30.

Length, 3.5-5 cm. Somites, 80-120. Setae, widely paired; posterior to the clitellum, *ab:bc:cd* = 5:9:5. Clitellum on 24 25, 26, or 27-32 or 33. Tubercula pubertatis, two pair on 30 and 31. First dorsal pore on 5/6. Spermiducal pores on 15. Spermathecal pores on 9/10 and 10/11, close to the dorsal median line. Sperm sacs in 9, 11, and 12.

*H. venetus hortensis* has been reported from various parts of Europe and from southern Africa and South America. The only record from North America is that of Michaelsen (1900:12), of specimens collected by Doctor Eisen at San Francisco, California.

Subgenus ALLOLOBOPHORA Eisen, 1874.

Setae more or less closely paired. Sperm sacs, four pairs in 9-12; those of 10 approximately as large as those of 9.

**HELODRILUS (ALLOLOBOPHORA) CALIGINOSUS (Savigny) f. TYPICA and f. TRAPEZOIDES (Dugès).**

*Enterion caliginosum* SAVIGNY, 1826: 180.

*Allolobophora caliginosa* ROSA, 1893: 442.

*Helodrilus (Allolobophora) caliginosus* MICHAELSEN, 1900a: 482.

*Allolobophora turgida* EISEN, 1874: 46.

*Allolobophora turgida* forma *tuberculata* EISEN, 1874a: 43.

*Lumbricus trapezoides* DUGÈS, 1828: 289.

*Helodrilus (Allolobophora) caliginosus trapezoides* MICHAELSEN, 1900a: 483.

Length, very variable, 6-17 cm. Somites, 105-240. Color of antero-dorsal surface, brown-red; very variable in intensity in different specimens. Prostomium, epilobic. Setae very closely paired, especially those of the lateral pairs. Clitellum on 27-34 or 35. Tubercula pubertatis in f. *typica* on 31 and 33 and in f. *trapezoides* on 31-33. (The latter is by far the most common in North America.) Conspicuous glandular papillae surround the ventral setae of 9, 10, and 11 and in the clitellar region are very constantly present on 32-34 and less certainly on 28 and 30. First dorsal pore, usually at 9/10. Spermiducal pores on 15, rather more than half

way from *b* to *c*. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 9/10 and 10/11, in line with dorsal bundles. Septa 6/7–9/10, strongly thickened and 5/6 and 11/12–14/15, a little less so. Longitudinal partitions of the calciferous gland, usually 55–65 in number. Sperm sacs in 9–12. Spermathecae included within the septa 9/10 and 10/11 and not extending freely into the somite cavities.

This is a species of the soil but seems to thrive equally well in the undisturbed soil of woodlands and in that of cultivated fields and gardens. It also abounds in the bottom lands of our rivers.

*H. caliginosus trapezoides* is apparently the most abundantly represented and certainly the most generally distributed of the North American species of earthworms. There is scarcely one of the United States in which collections have been made in which this species is not found abundantly represented.

#### HELODRILUS (ALLOLOBOPHORA) LONGUS (Ude).

*Enterion terrestre* SAVIGNY, 1826: 180.

*Allolobophora terrestris* ROSA, 1893: 444.

*Allolobophora longa* UDE, 1885: 136.

*Helodrilus (Allolobophora) longus* MICHAELSEN, 1900a: 483.

Length, 12–16 cm. Somites, 160–200. Prostomium, epilobic  $\frac{1}{2}$ . Setae closely paired. Clitellum on 27 or 28–35. Tubercula pubertatis on 32–34. First dorsal pore on 12/13. Spermiducal pores on 15, between *b* and *c*. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 9/10 and 10/11, in the seta line *c*. Septa 6/7–8/9 strongly thickened; thickness decreases posteriorly from 8/9. Sperm sacs in 9–12. Spermathecae in 10 and 11, enclosed in sacs between anterior septum and body wall.

*H. longus* has been reported from Grand Manan and from Indiana. It is also found in many parts of Europe.

New localities: Maine and Canada (Toronto).

#### HELODRILUS (ALLOLOBOPHORA) CHLOROTICUS (Savigny).

*Enterion chloroticum* + *E. virescens* SAVIGNY, 1826: 183.

*Allolobophora chlorotica* VEJDOVSKY, 1884: 60.

*Helodrilus (Allolobophora) chloroticus* MICHAELSEN, 1900a: 486.

*Lumbricus riparius* HOFFMEISTER, 1843: 189.

*Allolobophora riparia* EISEN, 1874: 46.

Length, 5–7 cm. Somites, 80–125. Color of American specimens, more or less greenish. Prostomium, epilobic. Setae, closely paired. Clitellum on 29–37. Tubercula pubertatis, three pairs of sucker-like elevations on 31, 33, and 35. First dorsal pore on 4/5. Spermiducal pores on 15, between *b* and *c*. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 8/9–10/11, in line with dorsal bundles. Septa 6/7–13/14, moderately thickened; those from 9/10 diminishing gradually toward the posterior. Sperm sacs in 9–12.

Spermathecae in 9, 10, and 11, extending freely into the somite cavities with ducts of moderate length.

*H. chloroticus* is widely distributed in Europe and in various parts of the world where Europeans have settled. In North America it has been reported from Greenland, North Carolina, Vancouver, California, Mexico, and Guatemala.

New localities: District of Columbia, Indiana, and Colorado.

Subgenus DENDROBAENA (Eisen), 1874.

The following characters are common to the more typical members of this subgenus: Setae, widely paired or separate. Spermathecal pores on 9/10 and 10/11, in the setae lines *c* or *d*. Three pairs of sperm sacs in 9, 11, and 12.

There are species that combine some of these characters with others belonging to other subgenera, and thus break down the dividing lines and make the classification difficult.

HELODRILUS (DENDROBAENA) OCTAEDRUS (Savigny).

*Enterion octaedrum* SAVIGNY, 1826: 183.

*Allolobophora octaedra* ROSA, 1887: 2.

*Helodrilus (Dendrobaena) octaedrus* MICHAELSEN, 1900a: 494.

*Dendrobaena boeckii* EISEN, 1874: 53.

Length, 2.5–4 cm. Somites, 80–95. Color, violet-brown. Prostomium, epilobic. Setal intervals *aa*, *ab*, *bc*, and *cd* approximately equal; *dd* somewhat greater than either. Clitellum on 27, 28, or 29–33 or 34. Tubercula pubertatis on 31–33. First dorsal pore on 4/5. Spermiducal pores on 15, between *b* and *c*. Oviducal pores on 14, slightly dorsad from *b*. Spermathecal pores on 9/10–11/12, in the seta line *d*. Septa all thin with a slight thickening of 13/14 and 14/15. Sperm sacs in 9, 11, and 12. Spermathecae usually in 9, 10, and 11, but occasionally one or more may be found in the somites next posterior.

*H. octaedrus* is known from various parts of Europe, northern Asia, Iceland, and Greenland. In North America it has been reported from Newfoundland and Mexico.

New locality: Colorado (Boulder).

HELODRILUS (DENDROBAENA) SUBRUBICUNDUS (Eisen).

*Allolobophora subrubicunda* EISEN, 1874: 51.

*Helodrilus (Dendrobaena) rubidus*, var. *subrubicunda* MICHAELSEN, 1900a: 490.

*Helodrilus (Dendrobaena) subrubicundus* MICHAELSEN, 1910: 52.

Length, 4–7.5 cm. Somites, 60–110; usually nearer the upper limit. Color of antero-dorsal surface, more or less red. Prostomium, epilobic  $\frac{3}{4}$ . Setae, widely paired; *bc:cd:dd* = 2:1:4; *cd*, is a little greater than *ab*. Clitellum on 26–31, occasionally invading 25 or 32.

Tubercula pubertatis on 28–30. First dorsal pore on 5/6. Spermiducal pores on 15, between *b* and *c*. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 9/10 and 10/11, in the seta line *c*. Septa 7/8 and 8/9 moderately thickened, 6/7, 9/10, 13/14, and 14/15 slightly thickened. Sperm sacs in 9, 11, and 12. Spermathecae in 9 and 10, free in somite cavities, with very short ducts which enter the septa near the body wall.

Specimens collected in Illinois have been found in wet soil more or less subject to sewage contamination.

*H. subrubicundus* is widely distributed in Europe and in various parts of the world where Europeans have settled. It has been reported in North America from Newfoundland and California.

New localities: Illinois, Colorado, and Canada (Niagara).

Subgenus BIMASTUS (H. F. Moore), 1893.

This subgenus includes a group of species, chiefly North American, which have in common the following characters: Tubercula pubertatis are indistinct or more commonly lacking. There are but two pairs of sperm sacs and these are in 11 and 12. Normally developed spermathecae are lacking. In most species the clitellum does not extend posterior to 32.

HELODRILUS (BIMASTUS) PALUSTRIS (H. F. Moore).

*Bimastos* H. F. MOORE, 1893: 333.

*Bimastos palustris* H. F. MOORE, 1895: 473.

*Allolobophora (Bimastos) palustris* MICHAELSEN, 1900: 10.

*Helodrilus (Bimastos) palustris* MICHAELSEN, 1900a: 502.

Length, in life, reaches 7.5 cm. Somites, 80–100. Color, pale red, but not due to pigment. Prostomium, epilobic  $\frac{1}{2}$ . Setae closely paired; posterior to clitellum, *aa:ab:bc:cd:dd* = 18:4:16:3:27; ventral setae of 13 and 16, provided with special glands. Clitellum on 23–28. Tubercula pubertatis, lacking. First dorsal pore on 5/6. Spermiducal pores at summits of large chambers, formed by invaginations of body wall of posterior part of 15, between seta lines *b* and *c*; external openings of these chambers, surrounded by prominent glandular masses. Oviducal pores on 14, slightly dorsad and posteriad of *b*. Septa scarcely thickened. Chambers at anterior end of calciferous gland open into the esophagus in 10; longitudinal partitions of the gland about 45 in number. Sperm sacs in 11 and 12. Spermathecae lacking.

*H. palustris* is found in the wet earth of the shores of rivers and ponds. It has been collected in Pennsylvania, New Jersey, and North Carolina.

## HELODRILUS (BIMASTUS) TUMIDUS (EISEN).

*Allolobophora tumida* EISEN, 1874a: 45.

*Allolobophora (Bimastus) tumida* MICHAELSEN, 1900: 10.

*Helodrilus (Bimastus) tumidus* MICHAELSEN, 1900a: 502.

Length, about 3 cm. Somites, 40–50. Color, reddish-brown. Prostomium, epilobic  $\frac{3}{4}$ . Setae, closely paired. Clitellum on 22–29.\* Tubercula pubertatis on 27 and 28; inconspicuous. Spermiducal pores on 15, with small but definite glandular elevations.

The description of this species by Eisen is in substance as above and is accompanied by four figures (1874a, fig. 5–8) showing, respectively: The dorsal aspect of the worm, natural size; ventral aspect of the clitellar region with the tubercular pubertatis; an outline sketch showing the shape of the body in cross section and the relations of the setae; and a drawing of the superficial aspects of the posterior two somites.

One specimen of the original collection was presented by Eisen to the United States National Museum, and has given an opportunity to study the internal anatomy and to make comparisons with closely related species. There is no indication of the number of specimens collected. In some respects the correspondence of Eisen's figures and description with the museum specimen is so close that it seems fairly probable that they were based, at least in part, on that particular worm.

The specimen is strongly contracted and measures 1.8 cm. in length. Eisen's figure (natural size) shows a length of 2 cm. His statement "longitudo circiter 30 mm." was probably based on living specimens. The maximum diameter is .25 cm. The number of somites is 48, while Eisen gives "circiter 40" in his description and 50 in his table which lists characters of several species. The appearance of the specimen suggests the probability that it is incomplete; and this may account for the fact to which he calls attention—namely, that toward the posterior, from and including the clitellum, the somites gradually increase in length up to the last somite, which is almost twice as long as the one next preceding. It seems to me fairly probable that the last somite is really just at the beginning of regeneration of more somites, but I have no positive evidence to that effect.

The setae are closely paired, but the intervals are not as figured by Eisen. On somite 32,  $aa:ab:bc:cd:dd=18:4:18:4:45$  represents very closely the relative setal distances. Toward the posterior,  $dd$  becomes less and  $ab$  and  $cd$  slightly greater, but nowhere is  $ab$  as small as figured by Eisen, who represents it as distinctly less than  $cd$  and only about  $\frac{1}{7} aa$ . Neither is  $dd$  as small as represented in the figure, where it is scarcely  $\frac{5}{8} aa$ . In the specimen examined,  $dd$  is at least  $2 aa$  and near the clitellum is about  $\frac{5}{2} aa$ .

The clitellum is sharply defined at its anterior and posterior limits on 22 and 29, as described, but it has an uneven development and extends slightly ventrad of two rather thick patches on 27 and 28, which I assume to be the tubercula pubertatis which Eisen described and figured. They seem too far dorsad and too similar to the clitellar mass about them to be homologous with the tubercula pubertatis of typical Lumbricidae. They are dorsad of seta line *b*. The first dorsal pore is on 5/6. The spermiducal pores are on 15; dorsad of *b*, about  $\frac{1}{4}$  *bc*. The oviducal pores are on 14, slightly dorsad of *b*.

The septa 6/7–9/10 are slightly thickened, 8/9 being somewhat thickest, and 13/14 and 14/15 are also slightly thickened and about equal to 8/9. The longitudinal partitions of the calciferous gland are apparently about 40 in number. The exact number can not be ascertained from longitudinal sections of one side. The last pair of hearts is in 11. Spermaries and spermiducal funnels are in 10 and 11 and present no peculiarities. The sperm sacs are in 11 and 12 and have the ordinary appearance and relations. Spermathecae are lacking.

In his general comment on this species, Eisen refers to the peculiar position of the setae which gives a rectangular appearance like that of *H. tetraedrus*, and states that it is very characteristic of this species. The specimen bears out his statement and also his figure, except as to the setal distances *ab* and *dd* mentioned above.

*H. tumidus* was found under moss and leaves in damp woods at Mount Lebanon, New York (New England of Eisen's paper). No other locality has been reported unless it should develop, that the species is identical with *H. gieseleri hempeli* Smith, described below.

HELODRILUS (BIMASTUS) GIESELERI (Ude) forma TYPICA.

*Allolobophora gieseleri* UDE, 1895: 127.

*Allolobophora (Bimastus) gieseleri* MICHAELSEN, 1900: 10.

*Helodrilus (Bimastus) gieseleri* MICHAELSEN, 1900a: 502.

Length, average 5.5 cm. Somites, about 110. Color of anterodorsal part, faint red with bluish iridescence. Prostomium, epilobic  $\frac{1}{3}$  Setae, closely paired; slightly posterior to the clitellum, *aa* : *bc* : *dd* = 10 : 9 : 26. Clitellum on 20– $\frac{1}{2}$  30; saddle form, extending ventrally nearly to *b*. Tubercula pubertatis, lacking. First dorsal pore on 5/6. Spermiducal pores on 15; a little dorsad of *b*. Oviducal pores on 14; slightly dorsad of *b*. Septa 6/7–14/15, slightly thickened. "Hearts" in 7–11. Sperm sacs in 11 and 12. Spermathecae lacking.

The description is taken from Ude's paper which was based on a collection from Georgia. Specimens in the possession of the writer, which he assumes to belong to this species and which were collected in Florida by Mr. A. Hempel, agree very closely in most respects with Ude's description. The length is greater, 6–10 cm., but the

specimens were anesthetized before killing. In some of the specimens, the anterior margin of the clitellum is on 21 while in others it is on 20. *aa* is approximately  $\frac{5}{4}bc$ , and *ab* is greater than *cd*. There are about 40 longitudinal partitions in the calciferous gland.

**HELODRILUS (BIMASTUS) GIESELERI var. HEMPELI Smith.**

*Helodrilus (Bimastus) gieseleri* var. *hempeli* SMITH, 1915: 551.

Length, 5–8 cm. Somites, usually 105–115 in complete specimens. Color, brown-red, distributed fairly uniformly on the dorsal half of the worm; the ventral half is without pigment. Posterior to the clitellum,  $aa : ab : bc : cd : dd = 20 : 4 : 16 : 3 : 52$ , approximately. Clitellum, 22–29 or  $\frac{1}{3}30$ . Septa 6/7, 7/8, and 13/14, slightly thicker than others, none much thickened. Longitudinal partitions of the calciferous gland, about 40 in number. Sperm sacs and spermathecae, as in the typical form.

These worms are ordinarily found under the bark of decaying logs or in the rotten wood. They are present in collections made in Florida (Monticello), Ohio, Illinois, Kansas, and Texas.

A comparison of the above description with that of *H. tumidus* will show their great similarity in most respects. The only significant differences are in the number of somites, the intervals between the setae, and the shape of the body as shown in cross section. We do not know how many specimens Eisen had as a basis for his statements concerning the number of somites in *H. tumidus*; "circiter 40," in the text; and 50, as given in the table. If there were several specimens, we can not safely assume that they were all mutilated and thus explain the presence of less than half the number of somites, normal to *H. gieseleri* and *H. g. hempeli*. The spacing of the setae in the setal bundles, *ab* and *cd*, is subject to much variation in the different bundles in the same worm, and it is quite possible to get formulae from adjacent somites that are materially different. Care is necessary to have the setal formula show average conditions. The specimen of *H. tumidus* shows almost exact equality between *ab* and *cd*, on the average. There is great uniformity in the relation of  $ab = \text{about } \frac{4}{3}cd$  in all of the *H. gieseleri* and *H. g. hempeli* material examined by the writer. The tetragonal form of the body is very noticeable in *H. tumidus*, as stated by Eisen. It is no more noticeable in the other forms under discussion than in the average Lumbricidae. It seems more reasonable to assume that this difference is due to structural conditions rather than to mere differences in methods of preservation. On the whole, it seems safer to await more complete knowledge of the earthworms of the region where *H. tumidus* was collected before uniting it with *H. gieseleri hempeli*. If such union is found desirable, then *H. gieseleri typica* would reasonably be treated as a variety of *H. tumidus*.

## HELODRILUS (BIMASTUS) PARVUS (Eisen).

*Allolobophora parva* EISEN, 1874a: 46.

*Allolobophora (Bimastus) parva* MICHAELSEN, 1900: 10, 14.

*Helodrilus (Bimastus) parvus* MICHAELSEN, 1900a: 502.

Length, 2.5–4 cm. Somites, 85–111. Color of antero-dorsal part, brown-red. Prostomium, epilobic  $\frac{1}{2}$ – $\frac{2}{3}$ . Setae closely paired; a little posterior to the clitellum,  $aa : ab : bc : cd : dd = 18 : 4 : 16 : 3 : 48$ . Clitellum on 24–30. Indefinite ridges (tubercula pubertatis?) on 25–29, occasionally beginning on 26 or reaching 30. First dorsal pore on 5/6. Spermiducal pores on 15, between *b* and *c*. Oviducal pores on 14, slightly dorsad of *b*. Septa 7/8 and 8/9, slightly thickened, others scarcely any. Longitudinal partitions of the calciferous gland, about 40 in number. Sperm sacs in 11 and 12. Spermathecae lacking.

*H. parvus* has been reported from New York, California, Louisiana, Mexico, and Guatemala in North America; and also from China, Japan, and Africa.

New localities: Michigan and Kansas.

## HELODRILUS (BIMASTUS) BEDDARDI (Michaelsen).

*Allolobophora beddardi* MICHAELSEN, 1894: 182.

*Allolobophora (Bimastus) beddardi* MICHAELSEN, 1900: 10, 13.

*Helodrilus (Bimastus) beddardi* MICHAELSEN, 1900a: 502.

Length, 1.7–6.5 cm. Somites, 66–97. Color, reddish antero-dorsally. Prostomium, epilobic  $\frac{1}{2}$ – $\frac{2}{3}$ . Setae, closely paired;  $aa : ab : bc : cd : dd = 26 : 4 : 20 : 3 : 80$ . Clitellum, usually on 24–31, but sometimes begins on 25 and often invades 32. Tubercula pubertatis(?) are indefinite ridges on 24 or 25–30. First dorsal pore on 5/6. Spermiducal pores on 15, between *b* and *c*. Oviducal pores on 14, slightly dorsad of *b*. Septa, all very thin. Longitudinal partitions of calciferous gland, about 40 in number. Sperm sacs in 11 and 12. Spermathecae are lacking.

Specimens of *H. beddardi* in the writer's collection were obtained from wet situations and in decaying logs, stumps, or moss. This species has been reported from Florida, California, and Washington and also from the Hawaiian Islands and Tibet.

New localities: Michigan, Illinois, and Montana.

The close resemblance of *H. parvus* and *H. beddardi* is apparent from the foregoing descriptions, and Michaelsen (1910:64) has expressed doubt of their real distinctness. A careful comparison of the material available to the writer has convinced him that the species are actually distinct. This material consists of specimens of *H. parvus* from three States ranging from Michigan to California and of *H. beddardi* from four States ranging from Florida to Montana. In the latter species, the clitellum uniformly extends a little farther

posteriad; although the length is somewhat greater, the number of somites is less; the setae are more closely paired in the latter species; and there seems to be a constant difference in the shape of the anterior ends. In *H. beddardi*, the anterior somites are comparatively little smaller than the others, and the prostomium is broad and blunt, which all tend to give the anterior end a comparatively broad and blunt appearance. In *H. parvus*, the anterior somites are decidedly more reduced in diameter, and the end seems considerably more pointed. As far as can be judged from my data, *H. parvus* is found in higher and drier situations than is *H. beddardi*.

**HELODRILUS (BIMASTUS) LONGICINCTUS** Smith and Gittins.

*Helodrilus (Bimastus) longicinctus* SMITH and GITTINS, 1915: 548.

Length of well extended specimens, 6.5–9 cm. Somites, 98–122. Color of antero-dorsal part, rose-red; other parts distinctly paler. Prostomium, epilobic  $\frac{1}{2}$ – $\frac{2}{3}$ . Setae, closely paired;  $aa : ab : bc : cd : dd$ , = 10 : 1 :  $7\frac{1}{2}$  :  $\frac{4}{5}$  : 30. This formula represents the approximate relations both anterior and posterior to the clitellum, but some variations are found. Clitellum on 23–32 or 24–33, and the ventral edges extend no farther ventrad than *b*. Tubercula pubertatis are entirely lacking. First dorsal pore on 5/6. Spermiducal pores on 15, slightly dorsad of *b* and surrounded by a rather prominent glandular area which encroaches on 16. Oviducal pores on 14, slightly dorsad of *b*. Septa 6/7 and 14/15, somewhat thickened; and 7/8–13/14, more strongly thickened. Longitudinal partitions of the calciferous gland, about 60 in number. Last hearts in 11 and much smaller than those of 10. Sperm sacs in 11 and 12. Spermathecae are lacking.

*H. longicinctus* occurs abundantly in the soil of lawns, parkings, and near-by woodlands of Urbana, Illinois. This is the only locality from which it is thus far known.

**HELODRILUS WELCHI**, new species.

Length of alcoholic specimen, 13.5 cm. Diameter (maximum), .45 cm., at clitellum. Somites, 116. Color, no pigment except narrow transverse bands of brown flecks in the zone of the setae on each of the somites 5–15. Prostomium, epilobic. Setae, closely paired; on somite 45,  $aa : ab : bc : cd : dd$  = 8 : 1 : 6 :  $\frac{2}{3}$  : 15. Clitellum,  $\frac{2}{3}$  25–35; pale flesh color. Tubercula pubertatis, lacking. First dorsal pore on 5/6. Spermiducal pores on 15, slightly dorsad of *b* and not conspicuous. Septa 8/9–11/12, very strongly thickened; 6/7, 7/8, 12/13, and 13/14, less strongly thickened; and 14/15, scarcely thickened. Longitudinal partitions of the calciferous gland, about 40 in number. Last hearts, in 11 and about equal to those of 10. Sperm sacs in 11 and 12. Spermathecae, lacking.

One specimen, collected near Manhattan, Kansas, by Dr. P. S. Welch April 2, 1914.

*Holotype*.—Cat. No. 16782, U.S.N.M.

The specimen was received in living condition. In normal locomotion it had a length, when extended, of 14 cm. Its diameter, anterior to the clitellum, was 0.5 cm. and posteriorly 0.4 cm. When strongly contracted the length was 8 cm. and the maximum diameter, 0.7 cm. The worm was very pale in color, in comparison with most species of *Bimastus*, and the posterior six somites were almost white from contained matter.

The specimen was not at the height of sexual activity when killed, and the clitellum is not as strongly developed as it might be, but there is a considerable development on the ventral surface of 29–33. The oviducal pores have not been located, as the oviduct, which is very imperfectly developed, can be traced only to the wall and not through it. The gonads and their ducts have the ordinary locations and relations.

This species closely resembles *H. zeteki* in size and the posterior position of the clitellum, but differs from it in several respects. The clitellum is two somites further anterior and is developed on the ventral side of a part of its somites, which is not true of the latter species. The difference in the thickening of the septa is very marked. In *H. zeteki*, septum 14/15 is uniformly one of the two thickest septa of all; while in *H. welchi*, it is very thin. The septa of the latter species which are most strongly thickened, are in *H. zeteki*, only moderately thickened. The difference in the number of longitudinal partitions in the calciferous gland, of which there are 60–64 in *H. zeteki* and in *H. welchi* but about 40, is too great to be a mere individual variation in the same species. Finally there is a marked difference in coloration.

*H. welchi* is a soil species and thus far is known only from the type locality.

**HELODRILUS (BIMASTUS) ZETEKI** Smith and Gittins.

*Helodrilus (Bimastus) zeteki* SMITH and GITTINS, 1915: 545.

Length, 10–14 cm. Maximum diameter, 0.5–0.65 cm, at the clitellum. Color of antero-dorsal part, purplish-brown. Somites, 100–142; in complete specimens, the number usually exceeds 130. Pro-stomium, epilobic  $\frac{1}{3}$ – $\frac{1}{2}$ . Setae, closely paired; anterior to the clitellum,  $aa: ab: bc: cd: dd = 6: 1: 5: 1: 20$ ; posterior to the clitellum,  $bc$  is relatively somewhat greater and  $dd$  somewhat less. Clitellum on 27–37 and extends ventrad far enough to include the ventral setae on 30–36. Tubercula pubertatis are entirely lacking. First dorsal pore on 5/6. Spermiducal pores on 15, slightly dorsad of  $b$ . Oviducal pores on 14, slightly dorsad of  $b$ . Septa 6/7–12/13 are consid-

erably thickened and 13/14 and 14/15 more strongly thickened. Longitudinal partitions of calciferous gland, 60-64 in number. Sperm sacs in 11 and 12. Spermathecae are lacking.

*H. zeteki* is found in the wood and under the bark of decaying logs and sometimes under the logs. It has been collected in considerable numbers in Illinois, Indiana, and Michigan.

**HELODRILUS (BIMASTUS) TENUIS (Eisen).**

*Allolobophora tenuis* EISEN, 1874a:44.

*Helodrilus (Bimastus) tenuis* SMITH, 1914:364.

*Allolobophora constricta* ROSA, 1884:38.

*Allolobophora (Bimastus) constricta* MICHAELSEN, 1900:8.

*Helodrilus (Bimastus) constrictus* MICHAELSEN, 1900a:503.

? *Allolobophora norvegica* EISEN, 1874:48.

Length, 4-8 cm. Somites, 90-105. Color of antero-dorsal surface, rose-red; elsewhere pale. Prostomium, epilobic  $\frac{2}{3}$ . Setae, widely paired;  $aa:ab:bc:cd:dd=12:5:10:7:35$  is an approximation to the relation at a short distance posterior to the clitellum. Clitellum on 26-31. Tubercula pubertatis, indistinct and often lacking; when present, usually on 29 and 30, occasionally invading 31. Ventral setae of 16, usually borne on broad glandular papillae. First dorsal pore on 5/6. Spermiducal pores on 15, between *b* and *c* on prominent glandular elevations. Oviducal pores on 14, slightly dorsad of *b*. Septa but slightly thickened anywhere. Longitudinal partitions of calciferous gland, about 40 in number. Sperm sacs in 11 and 12. Spermathecae, lacking in the typical form; sometimes imperfectly developed.

Three specimens of the original collection, on which Eisen's description of *H. tenuis* was based, were given by him to the United States National Museum; and one of these has been partially sectioned as a basis for the study of the internal anatomy and hence of the relationships of the species.

This specimen is strongly contracted and obviously has lost the posterior end. The length is but 2.2 cm. and the number of somites but 80. On somite 35,  $aa:ab:bc:cd:dd=7:3:6:4:15$ . The clitellum is on 26-31, but not strongly developed, and the specimen was apparently not at the height of sexual activity. Tubercula pubertatis are on 29 and 30 and include setae *b*. Septa 7/8-9/10, 13/14, and 14/15 are very slightly thickened. Longitudinal partitions of the calciferous gland are about 40 in number, but can not be exactly enumerated in the longitudinal sections of one side. The "hearts" are in 7-11, the last pair being about as large as those of 10. There are paired sperm sacs in 11 and 12, and there are no traces of spermathecae.

It is practically certain that this is the species which has been identified as *H. constrictus* in this country, and highly probable that it is the same as the *H. constrictus* of other regions.

The great majority of *H. tenuis* collections examined by the writer have contained only normal specimens; but four collections made in different localities have each contained in close association specimens without spermathecae and others with imperfectly developed spermathecae. The largest of these collections includes 30 or more specimens taken near Burt Lake, Cheboygan County, Michigan, in 1911, from an old manure heap composed of horse manure and sawdust that had been used for bedding. Sections were made from 10 of these specimens. One shows no trace of spermathecae, two show parts of ducts but no sacs, and the others show from one to three sacs with ducts, but never four. They are all at 9/10 and 10/11 in line with setae *c*. A small collection is from a rotten log near Douglas Lake in the same county as above. Sections were made from three specimens. One has a definite duct without sac at 10/11 and no other traces, and the other two specimens show no traces of spermathecae. Two specimens were sectioned from a collection made in a rotten log at Macatawa, Allegan County, Michigan. One specimen shows no traces of spermathecae, and the other one has a sac and duct at 9/10 and a trace of a duct at 10/11 on one side and no traces on the other. A collection was made under a rotting straw stack near Fremont, Steuben County, Indiana, a few miles from the Michigan State line. Two of four specimens sectioned show no traces of spermathecae. Another one shows a sac and duct at 9/10 on one side. The fourth one has a small sac and duct at 10/11 on one side and no traces of others.

The aberrant specimens are indistinguishable in other ways from the normal ones and presumably have come from the same parents or immediate ancestors. They are very similar to *H. norvegicus* of Europe, which Michaelsen has suggested may have arisen through retrogression from *H. constrictus*. I have hesitated to identify the American specimens with *H. norvegicus* since they differ slightly, and I do not know that there is evidence of such close association between the two European forms. *H. norvegicus* is described by both Eisen (1874 : 48) and Michaelsen (1902 : 6) as having the clitellum on 26–32, and the tubercula pubertatis as commonly including 31. In the *H. tenuis* specimens with spermathecae which I have examined, the clitellum very uniformly extends only to the anterior edge of 32, and the tubercula pubertatis includes only 29 and 30. The only exception is a Burt Lake specimen which has not been sectioned but which has the clitellum on 26–32 and the tubercula pubertatis of one side on 30 and 31. None of the *H. tenuis* material from the other parts of North America outside of Michigan and its immediate vicinity are known to develop any traces of spermathecae.

All of the species of the subgenus *Bimastus* found in North America with the exception of *H. tenuis* are presumably indigenous and form

a quite homogeneous group. In addition to the characters mentioned in the definition, they all have closely paired setae, and no traces of spermathecae have been found in them. Since *H. zeteki* has the clitellum extending posteriad as far as 37, the anterior position can no longer be considered as characteristic of the subgenus. In view of the tendency of *H. tenuis* to develop spermathecae, it might simplify matters to place it in a subgenus, as *Dendrobaena*, which normally has spermathecae and leave *H. oculatus* in the subgenus *Eophila*, and thus have a much more homogeneous group in *Bimastus*. Michaelsen is certainly justified in considering the border line between *Bimastus*, *Dendrobaena*, and *Eophila* as one of the most puzzling problems in the system of Lumbricidae.

*H. tenuis* is most commonly found in and under fallen timber and in leaf mold and has been reported as *H. constrictus*, from various places in Europe, Asia, and South America. In North America, it has been listed from Mexico, New York, Illinois, California, Canada, Vancouver, and Alaska.

New localities: Maine, Ohio, Indiana, Michigan, Colorado, Washington, and Bering Island.

#### Genus OCTOLASIUM Örley, emended by Rosa.

Prostomium, usually epilobic, occasionally tanylobic. Sperm sacs, four pairs in 9–12. Spermaries and spermiducal funnels, enclosed in paired sperm vesicles or in narrow chambers. Setae, usually widely paired or separate. Örley (1885 : 13). Rosa (1893 : 424).

#### OCTOLASIUM LACTEUM (Örley).

*Lumbricus terrestris* var. *lacteus* ÖRLEY, 1881: 584.

*Octolasion lacteum* ÖRLEY, 1885: 21.

*Octolasion lacteum* MICHAELSEN, 1900a: 506.

*Allolobophora profuga* ROSA, 1884: 47.

Length, very variable, 5–16 cm. Somites, 100–165. Color of few anterior somites, pale pinkish; posterior end is pale; remainder of body except clitellum is blue-gray when the intestine contains the usual amount of earthy matter. Prostomium, usually epilobic  $\frac{1}{2}$ – $\frac{2}{3}$ ; occasionally tanylobic. Setae anterior to the clitellum, definitely paired, and *ab* less than *bc*; posterior to the clitellum, the setae are scarcely paired, and *ab* is equal to or greater than *bc*; *bc* is greater than *cd*, in general. Clitellum on 30–35. Tubercula pubertatis on 31–34. First dorsal pore on 8/9, 9/10, or 10/11. Spermiducal pores on 15; nearer to *c* than to *b*. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 9/10 and 10/11, in line with *c* or *d*. Septa 6/7–8/9, slightly thickened; and 9/10–13/14, still less thickened. The calciferous gland communicates at its anterior end with the esophagus in 10 and has about 45 longitudinal partitions. Spermaries and spermiducal funnels in 10 and 11, included

in sperm vesicles. Sperm sacs in 9–12; those of 9 and 10 being quite different in form and appearance from those of 11 and 12 which resemble those commonly found in Lumbricidae. The sperm sacs of 9 and 10 are digitiform and have a definite lumen extending through the greater part of the length.

*O. lacteum* is commonly found under logs, leaf mold, and débris of various kinds, and in compost heaps and to some extent in soil. It is widely distributed in Europe and in various parts of the world where Europeans have settled and has been reported from Illinois, California, and Mexico.

New localities: Ohio, Indiana, and Colorado.

#### Genus LUMBRICUS Linnaeus, emended by Eisen.

Prostomium, tanylobic. Sperm sacs, three pairs; in 9, 11, and 12. Spermaries and spermiducal funnels, enclosed in an unpaired median chamber. Setae, closely paired, posteriad of the clitellum. Linnaeus (1758: 647). Eisen (1874: 45).

#### LUMBRICUS RUBELLUS Hoffmeister.

*Lumbricus rubellus* HOFFMEISTER, 1843: 187.

Length, 7–15 cm. Somites, 95–150. Color, reddish-brown or violet; more pronounced on antero-dorsal surface. Prostomium, tanylobic. Setae closely paired;  $aa:ab:bc:cd:dd=5:1:5:\frac{5}{2}:19$ . Clitellum on 27–32, exceptionally beginning on 26. Tubercula pubertatis on 28–31. First dorsal pore on 7/8. Spermiducal pores on 15 and inconspicuous; between *b* and *c*. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 9/10 and 10/11, in line with *cd*. Septa 6/7–8/9, somewhat thickened; others but very little, except in parts adjacent to the attachments of the sperm sacs. Longitudinal partitions of the calciferous gland, about 60 in number. Sperm sacs in 9, 11, and 12. Spermathecae in 9 and 10, in the specimens examined.

*L. rubellus* in the collections of the writer have mostly come from under débris along shores. The species is widely distributed in Europe and Siberia; and in North America has been reported from Newfoundland, California, Oregon, and Washington.

New locality: Michigan (Cheboygan and Gogebic Counties).

#### LUMBRICUS CASTANEUS (Savigny).

*Enterion castaneum* SAVIGNY, 1826: 180, 181.

*Lumbricus castaneus* DUGÈS, 1837: 17, 22.

*Lumbricus purpureus* EISEN, 1871: 956.

Length, 3–5 cm. Somites, about 90. Color dorsally, chestnut brown to brown violet. Prostomium, tanylobic. Setae, closely paired;  $aa:ab:bc:cd:dd=4:1:4:\frac{4}{3}:16$ . Clitellum on 28–33. Tuber-

cula pubertatis on 29-32. First dorsal pore on 6/7. Spermiducal pores on 15; inconspicuous. Oviducal pores on 14; slightly dorsad of *b*. Spermathecal pores on 9/10 and 10/11; in line with *cd*. Septa very thin, in the only specimen examined. Sperm sacs in 9, 11, and 12. Spermathecae in 9 and 10, in one specimen.

*H. castaneus* has been reported from northern and middle Europe and from Canada and New York.

#### LUMBRICUS TERRESTRIS Linnaeus, Müller.

*Lumbricus terrestris* LINNAEUS, (part) 1758:647.

*Lumbricus terrestris* O. F. MÜLLER, (part) 1774:24.

*Enterion herculeum* SAVIGNY, 1826:180.

*Lumbricus herculeus* DUGÈS, 1837:17, 21.

*Lumbricus agricola* HOFFMEISTER, 1842:24.

?*Lumbricus americanus* PERRIER, 1872:44.

Length, 10-30 cm. Somites, 110-180. Color, antero-dorsal surface brownish-violet. Prostomium, tanylobic. Setae, closely paired; posterior to the clitellum,  $aa:ab:bc:cd:dd = 4:1:3\frac{1}{2}:\frac{3}{4}:16$ . Clitellum on 32-37, sometimes beginning on 31. Tubercula pubertatis on 33-36. First dorsal pore on 7/8. Spermiducal pores on 15, between *b* and *c*. Oviducal pores on 14, slightly dorsad of *b*. Spermathecal pores on 9/10 and 10/11, in line with *cd*. Septa 6/7-9/10, strongly and 10/11-14/15, moderately thickened. Longitudinal partitions of the calciferous gland, 70-75 in number. Sperm sacs in 9, 11, and 12. Spermathecae in 9 and 10.

*L. terrestris* is widely distributed in Europe and has been reported in North America from Newfoundland, Massachusetts, Illinois, New York, and Mexico.

New localities: Maine, Connecticut, Maryland, District of Columbia, Ohio, Michigan, Minnesota, Colorado, and California.

#### LUMBRICUS FESTIVUS (Savigny).

Length, 5.5-10 cm. Somites, 100-120. Color, light red brown. Setae, closely paired. Clitellum on 34-39. Tubercula pubertatis on 35-38. First dorsal pore on 5/6. Spermiducal pores on 15, with elevated glandular area.

*L. festivus* has been reported from Scotland, England, and France. It is also reported by Stafford (1902:483) as occurring in Canada.

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