

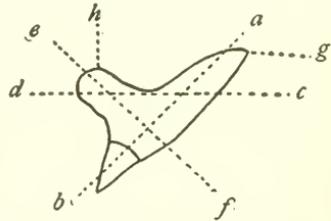
THE BRANCHIOBELLELLID WORMS IN THE COLLECTIONS OF THE UNITED STATES NATIONAL MUSEUM, WITH DESCRIPTIONS OF NEW GENERA AND NEW SPECIES.

By MAX M. ELLIS,

*Of the University of Colorado, Boulder, Colorado.*

The Branchiobdellid worms discussed in this paper include those in the United States National Museum collection and worms from various localities, obtained in many cases through the personal efforts of various collectors. It is a pleasure to thank these collectors and credit the specimens to them under the proper species. The writer is indebted particularly to the United States National Museum for the loan of specimens; to Prof. J. Percy Moore, of the University of Pennsylvania, for valuable material for comparison; to Prof. Frank Smith, of the University of Illinois, for various favors in connection with this work; and to Dr. Walter Faxon, of Harvard University, for the determination of many of the host species of crayfish.

In studying these worms special attention was given to the jaw characters and to the variation in the number of teeth. A sagittal section of either jaw is roughly triangular in outline, so that the jaw may be considered as having three faces. These have been termed the supporting face (fig. 1, portion above *dc*), the anterior face (portion below *ab*), and the dental face (portion below *ef*). When the jaw is in place the supporting face and a considerable portion of the dental face are imbedded in the wall of the pharynx, the teeth are directed caudad down the pharynx, and the anterior face lies parallel to the long axis of the body in the lumen of the pharynx. When the jaw is in use the teeth and part of the dental face are swung into the lumen of the pharynx by a movement of the entire jaw. Of these three faces of the jaw, the anterior is the most regular. The anterior or cephalic margin of the supporting face has been designated the base of the jaw (*g*) and the posterior or caudal



[FIG. 1.—SAGITTAL SECTION THROUGH A TOOTH OF THE "B" ORDER OF THE UPPER JAW OF XIRONOGITON OREGONENSIS OREGONENSIS ELLIS FROM EUGENE, OREGON. PORTION BELOW *ab*—ANTERIOR FACE, PORTION ABOVE *dc*—SUPPORTING FACE, PORTION BELOW *ef*—DENTAL FACE, *g*—BASE OF JAW, *h*—DENTAL RIDGE.

margin the dental ridge (*h*). Unless otherwise specified, the outline drawings of the jaws show the jaw lying on its anterior face—that is, as if viewed from point *e* in figure 1. In this view the entire dental ridge (fig. 2, *h-h*) and the base of the jaw (*g*) may be seen. The dental ridge is usually sinuous in outline, following the bases of the several teeth. The base of the jaw may be regular or deeply emarginate.

In some species of the genus *Cambarincola* the posterior portion of the dental face (fig. 1, *d e*) may be produced caudad in large specimens so that it extends beyond the level of the longest tooth in the jaw, if the jaw is viewed from point *e*. If viewed from the anterior face (point *f*), this produced portion of the dental face forms a hood over the teeth and may be seen lying behind them. In figure 17 a small hood of this sort is shown, although this jaw is viewed from the hood side.

In all of the species examined the jaws, and the dental face in particular, were more or less arcuate. In measuring the jaws this fact should be remembered, as the teeth do not lie in a single plane and the jaw may be perceptibly flattened and thereby widened in an effort to force the teeth into one focal plane.

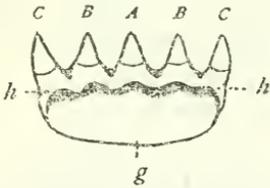


FIG. 2.—HYPOTHETICAL JAW, TYPE I, AS SEEN FROM POINT E IN FIG. 1. A-C=TEETH, G=BASE OF JAW, H-H=DENTAL RIDGE.

The dentition of the jaws has been expressed by two numbers, the first in each case referring to the number of teeth, regardless of size or shape, on the dorsal or upper jaw, and the second to the number of teeth on the ventral or lower jaw. Con-

sidering the relative size and position of the teeth on the jaw several types of jaws were recognized, each of which has been designated by a roman numeral. The primitive type of jaw seems to be one with several, subequal teeth (fig. 2). The modifications of this type have progressed along either or both of two lines, (1) a reduction in number of teeth, and (2) an increase in the size of certain teeth correlated with the reduction in size of certain other teeth. As the arrangement of the teeth on each jaw in species regularly having a dental formula of 5-5 or less could be interpreted in terms of a 5-toothed jaw, the teeth of which are symmetrically placed with reference to the median axis of the jaw, the 5-toothed jaw was chosen as a standard for the description of jaws. Considering the 5-toothed jaw as typical, its teeth have been lettered *C-B-A-B-C* (fig. 2). Capital letters have been used when the teeth were subequal and both capital and small letters when the teeth varied in length, long teeth being denoted by capitals. In the jaws bearing more than five teeth in the occasional individuals of species regularly having a dental formula of 5-5

or less, the extra tooth or teeth were placed asymmetrically, the five principal teeth following the 5-toothed jaw plan. Jaws of species having a dental formula of 6-6 or more approached the primitive jaw type, especially as the teeth of 6-6 and 7-6 jaws were usually more or less subequal. Among the species studied those having such dental formulae possessed other primitive characters. It was also found that the ventral jaw usually bore a smaller number of teeth than the upper, if both jaws did not carry the same number of teeth. For this reason the upper jaw was selected for purposes of comparison when but one jaw was used.

From the sections studied the number and position of the major pharyngeal diverticula and the presence or absence of buttress-like supports of connective tissue attached to the intersegmental partitions were considered to taxonomic value. The major pharyngeal diverticula may be seen to best advantage in sagittal sections (pl. 10, fig. 2), although they may be located in good whole mounts of compressed worms. These pharyngeal diverticula are not to be confused with the slight invaginations of the pharyngeal wall, nor with a fold in the pharyngeal wall near the posterior end of the pharynx (found in many preserved specimens), due to the pushing forward of the esophageal portion of the alimentary canal so that the anterior end of the esophagus partly telescopes the posterior end of the pharynx.

The buttress-like supports of the intersegmental partitions are found easily, if they are present in the specimen, in cross-sections (pl. 10, fig. 1). The supports extend from the lateral portions of the intersegmental partitions like braces, and lie more or less parallel to the long axis of the body, so that in certain cross-sections they appear to divide the cavity of the segment into three or more compartments.

#### XIRONODRILUS, new genus.

Branchiobdellid worms having: Two pairs of testes, one pair in segment V and one pair in segment VI, each nephridium of the anterior pair opening to the outside through a separate pore in the dorsal half of segment III; spermatheca simple, not bifid; no accessory sperm tube; three major pharyngeal diverticula, two dorsal and one ventral; the intersegmental septa in the posterior half of the body with buttress-like supports more or less well developed: segments I to IX, inclusive, distinct, each segment being slightly constricted anteriorly and posteriorly, so that its junctions with the adjoining segments are well defined; at least nine distinct segments visible in a dorsal view; the alimentary canal straight, its maximum enlargement in segments III and IV; a somewhat concave, glandular adhesive disk near each lateral margin of the ventral surface of segments VIII and IX; the anal opening dorsal or dorso-terminal; the caudal sucker ventral; and the body distinctly depressed.

*Type-species.*—*Xironodrilus formosus*, new species.

This genus as here defined includes two species which may be distinguished by the following key.

- a*<sup>1</sup>. Middle tooth of the upper jaw the longest tooth on the jaw if the teeth are odd in number; middle pair of teeth of the upper jaw subequal and longer than the other teeth, if the teeth are even in number; teeth increasing rather regularly in size from the outer edges of the jaw to the middle of the jaw; dental formula 5-4, varying from 4-3 to 6-5. *X. formosus*, new species.
- a*<sup>2</sup>. Middle tooth of the upper jaw distinctly shorter than either of the two teeth adjoining the middle tooth; dental formula 4-4 or 5-4, varying from 3-3 to 5-5. *X. pulcherrimus* (Moore).

**XIRONODRILUS FORMOSUS, new species.**

Plate 11, fig. 2.

*Type.*—Cat. No. 17626, U.S.N.M., body length 2.7 mm., White River, Irondale, near Anderson, Indiana, August, 1915 (M. M. Ellis), on *Cambarus rusticus* Girard (det. Faxon).

*Paratypes.*—Ten, Cat. No. 17627, U.S.N.M., and 10 others, collected with the type.

*Additional specimens.*—500, White River, Irondale, near Anderson, Indiana, summers of 1914-16 (M. M. Ellis), on *Cambarus rusticus* Girard (det. Faxon); six, one=Cat. No. 17628, U.S.N.M., White River, Noblesville, Indiana, June 23, 1915 (M. M. Ellis), on *Cambarus rusticus* Girard; three, Lake Michigan, Charlevoix, Michigan, August 12, 1914 (M. M. Ellis), on *Cambarus propinquus* Girard (det. Faxon); three, Wabash River, Vincennes, Indiana, August, 1913 (M. M. Ellis), on *Cambarus propinquus* Girard; one, between Paoli and Wyandotte, Indiana (O. P. Hay), on *Cambarus rusticus* Girard, Cat. No. 17629, U.S.N.M.

*Description.*—Body rather elongate and distinctly depressed; width of the head approximately equal to that of segment I and less than that of segment II; body segments increasing in width regularly from segment I to segment VII; segment VII usually the widest segment of the body (in strongly contracted specimens and in specimens in which segment VII is not distended with sex cells, segments VII and VIII are usually about the same width, or segment VIII may be slightly wider than segment VII); nine body segments distinct and easily seen in the dorsal view; each segment slightly constricted anteriorly and posteriorly so that the junctions of the segments are evident; segments narrowing regularly and rapidly from the middle of segment VIII to the caudal sucker; diameter of caudal sucker less than or barely equal to the width of the head; head subcylindrical, its anterior third defined by a groove or constriction; lips two, the upper slightly longer than the lower; both upper and lower lips with small but rather definite median emargination, otherwise

entire; margins of the lips bearing a few short, transparent bristles; tooth formula usually 5-4 or 5-5, varying from 4-3 to 6-5; upper jaw usually type V, lower jaw type V or type VI; tooth plan of both jaws *c-B-A-B-c*, upper jaw sometimes *c-B-A-B-c-d*; width of lower jaw 24 micra (in worm 1.4 mm. body length) to 30 micra (in worm 2.8 mm. body length); major pharyngeal diverticula three, two dorsal and one ventral, the ventral diverticulum about midway between the levels of the two dorsal diverticula; anterior nephridia alternating in segments II and III (of 44 specimens examined on this point 25 had the nephridium in segment II on the right side and that in segment III on the left; 17 had the nephridium in segment II on the left side and that in segment III on the right; and two individuals had both nephridia in segment II); anterior nephridia opening to the outside through separate pores on the dorso-lateral surface of segment III; spermatheca in segment V, composed of three parts, a short muscular portion near the spermathecal pore, a middle tubular portion and a dorso-posterior, globose portion; testes in segments V and VI; vasa deferentia from segments V and VI joining the atrium in segment VI; no accessory sperm tube; alimentary canal straight, passing through the body near or along the mesial axis, somewhat expanded in segments I and II, strongly sacculated in segments III and IV, much narrowed in segments V and VI, slightly expanded in segment VII, narrowing from segment VII to the anal opening on the dorsal surface of the anterior half of segment X (in surface view the anus appears to open in the posterior half of segment IX, but sagittal sections show that the anal opening is between segments IX and X and that the rectal portion of the alimentary canal is carried by segment X); caudal sucker ventral; smallest specimen examined 0.8 mm. in length; largest 3.1 mm. (preserved specimens).

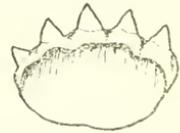


FIG. 3.—UPPER JAW OF TYPE-SPECIMEN OF XIRONODRILLUS FORMOSUS ELLIS, FROM ANDERSON, INDIANA. TYPE V.



FIG. 4.—LOWER JAW OF TYPE-SPECIMEN OF XIRONODRILLUS FORMOSUS ELLIS, FROM ANDERSON, INDIANA. TYPE VI.

A summary of the variations found in the number of teeth in this species is given below:

TABLE 1.

Locality.	Pental formulæ.					
	4-3	4-4	5-4	5-5	6-5	7-5
Irondale, Anderson, Indiana.....	3	4	17	13	4	1
Noblesville, Indiana.....	1	1	4	.....	.....	.....
Charlevoix, Michigan.....	.....	.....	1	.....	2	.....
Vincennes, Indiana.....	.....	.....	2	1	.....	.....
Number of specimens, 54.....	4	5	24	14	6	1

## XIRONODRILUS PULCHERRIMUS (Moore).

Plate 13, fig. 2.

*Branchiobdella pulcherrima* MOORE, Proc. Acad. Nat. Sci. Phila., vol. 45, pp. 423-425, pl. 12, figs. 2a, 2b, 2c, and 2e, 1893 (Watauga County, North Carolina, on *Cambarus bartonii*).—SMALLWOOD, Biol. Bull., vol. 11, No. 2, pp. 100 and 106, fig. 2, 1906 (Lake Clear, Harriets town, Franklin County, New York).

*Specimens*.—Five (3=Cat. No. 17630, U.S.N.M.), Trubies Run, a tributary of Buckhannon River, 7 miles above Buckhannon, West Virginia, August 4, 1899 (U. S. F. C.), on *Cambarus obscurus* Hagen; five (Cat. No. 17631, U.S.N.M.), Right Hand Fork of Chenowith Creek, Queens, West Virginia (U. S. F. C.), on *Cambarus obscurus* Hagen; two (1=Cat. No. 17632, U.S.N.M.), Shavers Fork, of Cheat River, West Virginia (U. S. F. C.), on *Cambarus bartonii carinirostris* Hay; one (Cat. No. 17633, U.S.N.M.), Cheat River, near the Pike, West



FIG. 5.—UPPER JAW OF XIRONODRILUS PULCHERRIMUS (MOORE), FROM QUEENS, WEST VIRGINIA. TYPE II.

Virginia, July 25, 1899 (U. S. F. C.), on *Cambarus bartonii carinirostris* Hay; three (2=Cat. No. 17634, U.S.N.M.), Cheat Bridge, Randolph County, West Virginia, July 24, 1899 (U. S. F. C.), on *Cambarus bartonii carinirostris* Hay; eight (6=Cat. No. 17635, U.S.N.M.), Chenowith Creek, between Beverly and Elkins, West Virginia, July 4, 1899 (U. S. F. C.), on *Cambarus bartonii carinirostris* Hay; eight (6=Cat. No. 17637, U.S.N.M.), Laurel Fork, Cheat River, near Seneca Point, West Virginia, August 31, 1899, on *Cambarus bartonii carinirostris* Hay; one (Cat. No. 17636, U.S.N.M.), Indian Creek, Kanawha County, West Virginia, August 6, 1900, on *Cambarus bartonii veteranus* Faxon; one, near Baileyville, West Virginia, August 15, 1900, on *Cambarus dubius* Faxon; two, Blowing Rock, Watauga County, North Carolina, 1893 (J. P. Moore), on *Cambarus bartonii* (Fabricius); one specimen, Cat. No. 17714, U.S.N.M., on *Cambarus dubius* Faxon, from Rock House River near Baileysville, West Virginia, August 17, 1900, U. S. B. F. (No. 873).



FIG. 6.—LOWER JAW OF XIRONODRILUS PULCHERRIMUS (MOORE). SAME SPECIMEN FIG. 3. TYPE III.

Through the kindness of Prof. J. P. Moore the writer received two specimens of this species collected by Professor Moore at Blowing Rock, North Carolina, in 1893. Both of these specimens have jaws of the 3-3 type, in accord with Moore's original description.<sup>1</sup> In the collections of the United States National Museum, however, 37 specimens were found which have jaws of the 4-4, 5-4, and 5-5 types, although these worms do not appear to differ in other characters

<sup>1</sup> Proc. Acad. Nat. Sci. Phila., vol. 45, 1895, p. 423.

from the North Carolina specimens or the original description of *Branchiobdella pulcherrima* Moore (= *X. pulcherrimus* (Moore)). Thirty of these 37 worms have the dental formula 5-4, and none of the 37 have the dental formula 3-3. In view of the fact that intergrading individuals with dental formula 4-3 may be found in subsequent collections (worms with dental formula 4-3 were found in collections of the closely related species, *X. formosus* Ellis) these 37 worms have been assigned to Moore's species *X. pulcherrimus*, and the dental formula of this species is considered as varying from 3-3 to 5-5. The jaws of the United States National Museum specimens were of types II and III, depending upon the number of teeth present. Moore's figure<sup>1</sup> may be interpreted as a jaw of type II without the teeth of the "c" order. It is possible that the North Carolina worms with the dental formula 3-3 and the West Virginia worms with dental formula 4-4, 5-4, and 5-5 may represent two distinct subspecies. As only two specimens from North Carolina were examined, a complete comparison on this point could not be made. The variations in the number of teeth in the worms studied are tabulated below.

TABLE 2.

Host and locality.	Dental formulæ.				
	3-3	4-3	4-4	5-4	5-5
<i>Cambarus bartonii</i> (Fabricius), Blowing Rock, N. C.	2				
<i>Cambarus bartonii carinirostris</i> Hay:					
Laurel Fork, Cheat River, West Virginia			2	6	
Cheat Bridge, West Virginia				3	
Shavers Fork, West Virginia				1	1
Cheat River near the Pike, West Virginia				1	
Between Berverly and Elkins, West Virginia			1	7	
<i>Cambarus bartonii veteranus</i> Faxon, Indian Creek, West Virginia			1		
<i>Cambarus obscurus</i> Hagen:					
Queens, West Virginia				7	1
Trubies Run, West Virginia			1	4	
<i>Cambarus dubius</i> Faxon, near Baileyville, West Virginia				1	
Number of specimens, 39	2		5	30	2

**XIRONOGITON, new genus.**

Branchiobdellid worms having testes, nephridia, spermatheca, pharyngeal diverticula and intersegmental septa like those of the preceding genus, *Xironodrilus*; a distinct accessory sperm tube joining the atrium in segment VI; segment IX much reduced so that in dorsal view the body appears to be composed of eight or fewer segments; alimentary canal looped once or twice in segment VII, and in mature worms asymmetrically placed in segment VI, where the intestine is pushed to one side by the enlarged reproductive organs;

<sup>1</sup> Proc. Acad. Nat. Sci. Phila., vol. 45, 1893, fig. 2c.

maximum enlargement of the alimentary canal in segment V; anal opening dorsal; caudal sucker ventral; body distinctly depressed; posterior segments wider and flatter than the anterior segments.

*Type-species*—*Xironogiton oregonensis*, new species.

Key to the three species and the two subspecies that have been placed in this genus.

- a*<sup>1</sup>. A somewhat concave, glandular adhesive disk near each lateral margin of the ventral surface of segments VIII and IX; segments I to III constricted anteriorly and posteriorly so that the segmental junctions are well defined; dental formula 6-5. *X. occidentalis*, new species.
- a*<sup>2</sup>. No conspicuous adhesive disks on the ventral surface of segments VIII and IX, although several small glands are usually present; body segments I to IV subequal and well defined, increasing slightly in width caudad; body segments V to VII abruptly expanded and flattened, much wider than the first four body segments; margins of segments V to IX so flattened that the segmental junctions are almost obliterated; general outline of the body and head flask-shaped.
- b*<sup>1</sup>. The two teeth of the longest pair in the upper jaw separated by two teeth; if two long teeth are contiguous the outer one is usually the longer. *X. oregonensis*, new species.
- c*<sup>1</sup>. Dental formula 5-4, varying from 4-4 to 6-5. *X. o. oregonensis*, new subspecies.
- c*<sup>2</sup>. Dental formula 6-6, varying from 6-5 to 7-6. *X. o. pectinatus*, new subspecies.
- b*<sup>2</sup>. The two teeth of the longest pair in the upper jaw separated by but one tooth; if two long teeth are contiguous the inner one is the longer. *X. instabilis* (Moore).

XIRONOGITON OCCIDENTALIS, new species.

Plate 12, fig. 2.

*Type*.—Cat. No. 17639, U.S.N.M., body length, 4.5 mm., Crab Creek, Washington (John T. Nichols), U. S. Bureau of Fisheries, on *Astacus klamathensis* Stimpson.

*Paratype*.—One specimen collected with the type.

*Description*.—Body somewhat elongate and distinctly depressed; body segments I to VIII distinct, each slightly constricted at its anterior and posterior ends giving the segmental junctions sharp definition; segment IX greatly reduced so that the body appears to be composed of but eight segments; segments expanding gradually and regularly in width to segment VII, which is the widest body segment; segment VIII almost as wide as segment VII; segments IX and X so narrow and inconspicuous that the caudal sucker appears to be inserted under the posterior half of segment VIII; head large, its anterior third defined by a groove; lips two, each with a slight median emargination, otherwise entire; a few short transparent bristles on the margins of the lips; major pharyngeal diverticula three, two dorsal and one ventral; the ventral diverticulum about

midway between the levels of the two dorsal diverticula; dental formula 6-6, upper jaw type IV, lower jaw type IV, but with the two teeth of the "a" order unequal in size; tooth plan of upper jaw C-B-a-a-B-C teeth of the "C" order being slightly smaller than those of the "B" order but larger than those of the "a" order, the two "a" teeth unequal; differences in size of teeth slight so that the jaws approach the subequal-toothed jaw type; anterior nephridia alternating in segments II and III, opening to the outside through separate pores on the dorso-lateral surface of segment III; spermatheca simple; testes present in segments V and VI; vasa deferentia from segments V and VI joining the atrium in segment VI; a long accessory sperm tube present; alimentary canal not conspicuously expanded in the first three segments, wider in segment IV, increasing in diameter in segments V and VI, narrowing in segment VII, in which segment the intestine forms a more or less definite "S"-shaped curve; intestine narrowing rapidly in the anterior half of segment VIII and continuing as a somewhat crooked tube to the anal opening on the dorsal surface of the posterior half of segment IX; because of the reduced condition of segment IX, the anal opening is subterminal; adhesive glandular disks on segment VIII prominent, those on segment IX inconspicuous.

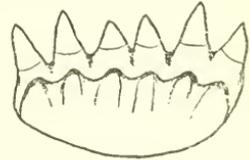


FIG. 7.—UPPER JAW OF TYPE-SPECIMEN OF XIRONOGITON OCCIDENTALIS ELLIS, FROM CRAB REEK WASHINGTON. TYPE IV.

The two specimens from which this species was described measured 4.5 and 5 mm., respectively. *X. occidentalis* resembles a large, much extended specimen of *X. instabilis* (Moore). It is easily separated from that species by the glandular disks on the ventral surface of segments VIII and IX and by the distinct segmental junctions.

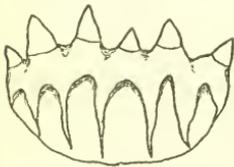


FIG. 8.—LOWER JAW OF TYPE-SPECIMEN OF XIRONOGITON OCCIDENTALIS ELLIS, FROM CRAB CREEK, WASHINGTON.

**XIRONOGITON OREGONENSIS, new species.**

Plate 10, figs. 1, 2; plate 12, fig. 1.

*Type*.—Cat. No. 17639, U.S.N.M., body length 1.3 mm., Eugene, Oregon (J. E. Guthberlet), October, 1914, on *Astacus klamathensis* Stimpson (det. Faxon).

*Paratypes*.—Four, Cat. No. 17640, U.S.N.M., and 10 others, collected with the type.

*Description*.—Body distinctly depressed, general outline of contracted specimens racket—or flask-shaped, extended specimens conspicuously wider in the posterior half of the body than in the anterior; head and body segments I and II subequal and subterete; segment IV distinctly wider than segment III and somewhat depressed; segments V to VIII conspicuously wider than the anterior portion of

the body, rather completely fused at the segmental junctions so that the segmental junctions are not clearly defined as they are in the anterior four segments; maximum width of the body in segment VII; segments V and VIII subequal; segmental margins of segments V to VIII broadly flattened forming a conspicuous shelf beyond the thicker portion of the body; segment IX greatly reduced, not prominent in dorsal view; caudal sucker large, ventral, its width in contracted specimens about equal to that of the head; head large, in contracted specimens exceeding the first two body segments in size; head divided into two rather distinct units, the anterior being slightly shorter than the posterior; lips two, each with a median emargination; dental formula 5-4 or 6-5, varying from 4-4 to 7-6 (see subspecies); major pharyngeal diverticula three, two dorsal and one ventral; each anterior nephridium opening to the outside through a separate pore in segment III; spermatheca in segment V, small and simple, subglobose with a small dorsal tubular portion, not bifid; testes in segments V and VI; vasa deferentia from segments V and VI joining the large atrium in segment VI; accessory sperm tube present and well developed; alimentary canal rather straight in segments I to V, maximum enlargement in segment V, intestine more or less displaced (usually to the right) in segment VI depending upon the state of the enlargement of the reproductive organs in that segment; intestine forming two rather distinct loops in segment VII, decreasing rapidly in diameter from segment VII to the anal opening on the dorsal surface of segment IX; largest specimen examined was strongly contracted and measured 2.0 mm. in length.

The two lots of specimens of this species, from Eugene, Oregon, and Sequallitchew Lake, Washington, form a continuous series through the several types of dental formulae from 4-4 to 7-6, but none of the Washington worms have less than 6-5 teeth and the majority of the Oregon worms have 5-4 teeth, the maximum dentition of this series being 6-5. Correlated with this difference in dental formulae the Oregon specimens have upper jaws in which the two short median teeth of the "a" order are not equal in length, and the Washington worms have upper jaws with subequal "a" teeth. These two lots therefore have been regarded as representing two subspecies, *X. oregonensis oregonensis* and *X. oregonensis pectinatus*. The variation in teeth is shown below.

TABLE 3.

Locality.	Dental formulae.					
	4-4	5-4	5-5	6-5	6-6	7-6
Eugene, Oregon.....	1	8	3	2	.....	.....
Sequallitchew Lake, Washington.....	.....	.....	.....	4	1	3

The jaws of *X. oregonensis* seem to have a 6-tooth plan, the upper jaw having the six teeth symmetrically arranged in the order *c-B-a-a-B-c*, that is a short, a long, two shorts, a long and a short. The majority of the specimens of *X. oregonensis oregonensis* have jaws of the formula 5-4, the teeth of the upper jaw being *c-B-a-a-B*. The short outside tooth "c" suggests the absence of a similar tooth on the opposite side of the jaw to complete the 6-toothed plan. In the 6-6 type of *X. oregonensis pectinatus* the teeth of the upper jaw are symmetrically placed with reference to the median axis of the jaw, being *c-B-a-a-B-c*. In the jaws of this subspecies, however, the two teeth of order "a" are subequal and the "B" teeth, although longer than the teeth of the "c" and "a" orders, are relatively shorter than the "B" teeth in the jaws of *X. oregonensis oregonensis*. For the specimens of *X. oregonensis pectinatus* having the dental formula 7-6 the teeth of the

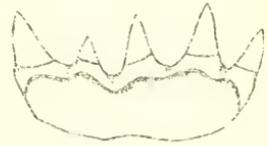


FIG. 9.—UPPER JAW OF TYPE-SPECIMEN OF XIRONOGITON OREGONENSIS OREGONENSIS ELLIS, FROM EUGENE, OREGON.

upper jaw may be represented by the letters *c-B-a-a-B-c-d*. In the jaws of the three worms having 7-6 teeth, the extra tooth of the upper jaw "d" was far enough out of line to show a distinct lack of symmetry with reference to the other teeth of the jaw.

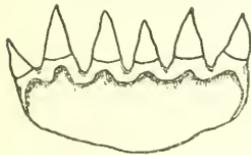


FIG. 10.—UPPER JAW OF TYPE-SPECIMEN OF XIRONOGITON OREGONENSIS PECTINATUS ELLIS, FROM SEQUALLITCHEW LAKE, WASHINGTON.

#### XIRONOGITON OREGONENSIS OREGONENSIS Ellis.

Dental formula 5-4, varying from 4-4 to 6-5; the two small, median teeth of the order "a" separating the two tall teeth of the order "B" of the upper jaw not subequal.

#### XIRONOGITON OREGONENSIS PECTINATUS, new subspecies.

Plate 12, fig. 3.

*Type*.—Cat. No. 17641, U.S.N.M., body length 1.3 mm., Sequallitchew Lake near the creek, Pierce County, Washington, 4 miles south of Steilacoom, April 26, 1904, host not given.

*Paratypes*.—Six Cat. No. 17642, U.S.N.M., and two others, collected with the type.

Dental formula 6-5, varying from 6-5 to 7-6; the two small, median teeth of the order "a" separating the two tall teeth of the order "B" of the upper jaw, subequal; all of the teeth of the upper jaw prominent, the differences in length of teeth small, the teeth of the order "B" not conspicuously longer than the other teeth of the jaw.

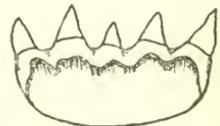


FIG. 11.—LOWER JAW OF TYPE-SPECIMEN OF XIRONOGITON OREGONENSIS PECTINATUS ELLIS, FROM SEQUALLITCHEW LAKE, WASHINGTON.

## XIRONOGITON INSTABILIOUS (Moore).

Plate 13, figs. 1 and 3.

*Branchiobdella instabilia* MOORE, Proc. Acad. Nat. Sci. Phila., vol. 45, pp. 425-427, pl. 12, figs. 3a, 3b, 3c, and 3e, 1893 (Watauga County, North Carolina, and Delaware County, Pennsylvania).—SMALLWOOD, Biol. Bull., vol. 11, No. 2, pp. 100-110, fig. 1, 1906 (Lake Clear, Harrietstown, Franklin County, New York).

*Specimens*.—Twelve (8=Cat. No. 17643, U.S.N.M.), Stoney Man Mountain, Virginia (Palmer and King), on *Cambarus bartonii* (Fabricius); seven (6=Cat. No. 17644, U.S.N.M.), West branch of Glennark Creek, North Rose, New York (A. C. Weed), on *Cambarus bartonii robustus* (Hay); six (5=Cat. No. 17645, U.S.N.M.), Trubies Run, a tributary of the Buckhannon River, 7 miles above Buckhannon, West Virginia, August 4, 1899 (U.S.F.C.), on *Cambarus obscurus* Hagen; six, Blowing Rock, Watauga County, North Carolina, 1893 (J. P. Moore), on *Cambarus bartonii* (Fabricius); three (2=Cat. No. 17646, U.S.N.M.), Chenoweth Creek between Beverly and Elkins, West Virginia, July 4, 1899 (U.S.F.C.), on *Cambarus bartonii carinirostris* Hay; two (Cat. No. 17647, U.S.N.M.), Cheat Bridge, Randolph County, July 24, 1899 (U.S.F.C.), on *Cambarus bartonii carinirostris* Hay; two (Cat. No. 17648, U.S.N.M.), Right Hand Fork of Chenoweth Creek, a tributary of the Cheat River, Queens, West Virginia (U.S.F.C.), on *Cambarus obscurus* Hagen; two (Cat. No. 17649, U.S.N.M.), Elk River at Cogars Mill, West Virginia (U.S.F.C.), on *Cambarus bartonii* subspecies; one (Cat. No. 17650, U.S.N.M.), Cheat River, near the Pike, West Virginia, July 25, 1899 (U.S.F.C.), on *Cambarus bartonii carinirostris* Hay.

The dental formula of this species varies from 4-4 to 5-5 as shown by the table below, compiled from the specimens examined. The teeth of this species as described by Moore are 4-4, the original description stating that, "the dark brown jaws are provided with four strong, curved, conical teeth, which diverge slightly; the outer pair are symmetrical, the left tooth of the middle pair is much larger than the right; this being the case in both jaws in nearly all of the many specimens examined."<sup>1</sup> Through the kindness of Professor Moore the writer received seven specimens of this species collected by him at Blowing Rock, North Carolina, in 1893. The jaws of three of these worms have 4-4 teeth as described by Moore; two other specimens have jaws of the 5-4 type and are similar to many specimens found in the United States National Museum collections; and the teeth of the other two could not be counted.

<sup>1</sup> Proc. Acad. Nat. Sci. Phila., vol. 45, 1893, pp. 425-426.

TABLE 4.

Host and locality.	Dental formulæ.		
	4-4	5-4	5-5
<i>Cambarus bartonii</i> (Fabricius):			
Stoney Man Mountain, Virginia.....	7	2	1
Blowing Rock, North Carolina.....	3	2	.....
<i>Cambarus bartonii carinirostris</i> Hay:			
Cheat River, West Virginia.....	1	.....	1
Cheat River near the Pike, West Virginia.....	.....	.....	1
Chenoweth Creek, West Virginia.....	1	1	.....
<i>Cambarus bartonii robustus</i> (Hay), Glennark Creek, North Rose, New York.....	2	2	3
<i>Cambarus bartonni</i> subspecies, Cogars Mill, West Virginia.....	.....	2	.....
Totals from <i>Cambarus bartonii</i> .....	29	14	9
<i>Cambarus obscurus</i> Hagen:			
Trubies Run, West Virginia.....	1	1	4
Queens, West Virginia.....	1	1	.....
Totals from <i>Cambarus obscurus</i> .....	8	2	2
Grand totals.....	37	16	11
			10

As pointed out in the key to this genus the arrangement of the teeth on the jaws of this species is different from the western species, *X. oregonensis* Ellis. In *X. instabilis* (Moore) the upper jaw, when symmetrical, has five teeth, *c-B-a-B-c*; that is, a short, a long, a short, a long, and a short. If the upper jaw bears but four teeth, as described by Moore and as found in over one-third of the specimens examined, the tooth plan is *c-B-a-B* or *B-a-B-c*. This arrangement may be explained by the loss of one of the "c" teeth. In some of the 4-4 type the upper jaw seemed at first to be composed of a long, a short, and two longs; that is, two long teeth were contiguous on one side of the jaw. By careful measurements it could be shown in every case that the outer of the two contiguous long teeth was shorter than the inner. This type of asymmetrical 4-toothed jaw therefore has been considered a modified type of the 5-toothed jaw. The elongation of the odd outside tooth of the "c" order; that is, the shorter of the two long contiguous teeth, in this type of 4-toothed jaw probably represents a compensatory regulation, as the teeth of a 4-toothed jaw do not have the same alignment with the teeth of the lower jaw as do the teeth of a 5-toothed jaw.

#### Genus PTERODRILUS Moore, 1894.

*Pterodrilus* MOORE, Proc. Acad. Nat. Sci. Phila., p. 449, 1894.

One of the two species described by Moore at the time this genus was designated was found in the collections examined, and two new species have been added. With these additions this genus includes four species which may be distinguished by the following key:

a.<sup>1</sup> Dorsal portions of one or more body segments bearing branched or digitate processes.

- b.*<sup>1</sup> Dorsal processes present on more than one segment.  
*c.*<sup>1</sup> Processes on segments II to VIII, inclusive. *P. distichus* Moore.  
*c.*<sup>2</sup> Processes on segments III, IV, V, and VIII (Moore,<sup>1</sup> not seen). *P. allicornus* Moore.  
*b.*<sup>2</sup> Processes on segment VIII only. *P. mexicanus*, new species.  
*a.*<sup>2</sup> Dorsal portions of several segments elevated; segments VII and VIII, with funnel-shaped enlargements of the dorsal portions; funnel of segment VIII excavated dorsally so that its dorsal margin bears two small "horns." *P. durbini*, new species.

**PTERODRILUS DISTICHUS Moore.**

*Pterodrilus distichus* MOORE, Proc. Acad. Nat. Sci. Phila., pp. 453-454, pl. 13, figs. 2, 2a-2d, 1894 (western New York on *Cambarus bartonii* (Fabricius)).

*Specimens.*—25 (2=Cat. No. 17651, U.S.N.M.), Oxford, Ohio (S. R. Williams), host not given; 20 (10=Cat. No. 17652, U.S.N.M.), Cedar Point, Ohio (S. R. Williams), host not given; 50 (15=Cat. No. 17653, U.S.N.M.), White River, Irondale, near Anderson, Indiana, August, 1915 and 1916 (M. M. Ellis), on *Cambarus rusticus* Girard (det. Faxon); three, White River, Noblesville, June 23, 1915 (M. M. Ellis), on *Cambarus rusticus* Girard.

**PTERODRILUS MEXICANUS, new species.**

*Type.*—Cat. No. 17654, U.S.N.M., body length 1.0 mm., Mirador, State of Vera Cruz, Mexico (Nelson and Goldman), on *Cambarus mexicanus* Erichson.

The type-specimen was unique, and, unfortunately, poorly preserved. Consequently but a brief diagnosis can be given. General body form similar to *Pterodrilus distichus* Moore; no dorsal processes on segments II to VII, inclusive; segment VIII bearing a simple four-horned appendage like that on the same segment of *P. distichus*; dental formula 5-4; upper jaw type IX, lower jaw type X. As far as the internal anatomy could be traced in a whole mount this poorly preserved specimen the organs resembled those of *P. distichus* Moor and *P. durbini*, new species.

**PTERODRILUS DURBINI, new species.**

Plate 11, fig. 1.

*Type.*—Cat. No. 17655, U.S.N.M., body length 1.5 mm., White River, Irondale, near Anderson, Indiana, August, 1916 (M.M. Ellis), on *Cambarus rusticus* Girard (det. Faxon).

*Paratypes.*—Two, Cat. No. 17655, U.S.N.M., and 10 others collected with the type.

*Description.*—Body rather short and thick, size small; width of the head scarcely equaling the width of segment I; body segments increasing rapidly in diameter from segment I to segment VII; seg-

<sup>1</sup> Proc. Acad. Nat. Sci. Phila., 1893, p. 450.

ment VII (sometimes segment VI) the wide segment of the body; at least 10 body segments visible in side view; major and minor annulations of segment I of about the same diameter, the major annulation, however, being about twice the length of the minor annulation; major annulations of segments II, III, and IV conspicuously elevated laterally and dorsally, forming ruffle-like bands around the anterior halves of each of these three segments; minor annulation of segment V almost obliterated, major annulation of segment V elevated dorsally and laterally into a midsegmental crest which almost encircles the segment; major annulation of segment VI low, the minor annulation elevated into an encircling segmental crest; major annulation in segment VII elevated and expanded into a funnel-shaped collar which encircles the segment and stands free from it except at the junction of the segment proper and the collar, the bell of the funnel being directed cephalad; minor annulation of segment VII low; major annulation of segment VIII elevated and expanded into a funnel-shaped collar like that on segment VII, except that the funnel of segment VIII is directed posteriorly, its bell opening caudad and standing free above the low minor annulation of segment VIII; dorsal margin of the funnel-shaped collar of segment VIII excavated in the mid-dorsal line, so that the margin of the funnel shows two distinct "horns" when seen from front or rear; segments IX and X low, small, and regular; head not exceeding the first two body segments in length,

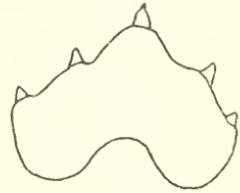


FIG. 12.—UPPER JAW, ANTERIOR FACE VIEW, OF TYPE-SPECIMEN OF PTERODRILUS DURBINI ELLIS, FROM ANDERSON, INDIANA. TYPE IX.



FIG. 13.—LOWER JAW OF TYPE-SPECIMEN OF PTERODRILUS DURBINI ELLIS, FROM ANDERSON, INDIANA. TYPE X.

divided into three rather equal thirds by two indistinct grooves; lips two, the upper the longer, both slightly emarginate in the median line; oral bristles present; dental formula 5-4; upper jaw type IX, lower jaw type X; major pharyngeal diverticula two, one dorsal and one ventral; alimentary canal straight, maximum enlargement in segment IV; testes in segments V and VI; vasa deferentia from segments V and VI meeting in segment VI; no accessory sperm tube; spermatheca simple and tubular; caudal sucker large, termino-ventral; its diameter equalling or exceeding the greatest diameter of the head; largest specimen examined 2.0 mm. in length.

For Mr. D. H. Durbin, whose interest in this work made possible a large number of collections in the White River drainage.

**Genus CAMBARINCOLA Ellis, 1912.**

*Cambarincola* ELLIS, Proc. U. S. Nat. Mus., vol. 42, p. 481, 1912.

Five species have been referred to this genus. Two of these species,

*C. philadelphica* (Leidy) and *C. chirocephala*, new species, have several characters in common with members of the genus *Stephanodrilus* as defined by Pierantoni in his *Monografia dei Discodrilidae*, 1912.<sup>1</sup> One of these characters, "the plurilobate prostomium" is particularly noteworthy in this connection as it is used by Pierantoni to differentiate *Stephanodrilus* in his generic key. The two species *C. philadelphica* and *C. chirocephala* have lobate lips similar to the lips of *Stephanodrilus japonicus* Pierantoni as figured by Pierantoni.<sup>1</sup> Neither *Stephanodrilus koreanus* Pierantoni nor *Stephanodrilus japonicus* Pierantoni, however, are figured with accessory sperm tubes, and the accessory sperm tube is present in species of *Cambarincola*. Pierantoni also figures *Branchiobdella digitata* Pierantoni, a species having but a single pair of testes, (Pierantoni), with a plurilobate prostomium, showing that the lobate lip character occurs in that group of species. No data concerning the pharyngeal diverticula of Pierantoni's species were obtainable.

a<sup>1</sup>. Upper and lower lips entire excepting a small, median emargination; not divided into lobes which may be extended as tentacles; two small lobes present in the median emargination of the upper lip in species with dental formula 3-4.

b<sup>1</sup>. Dental formula 5-4.

c<sup>1</sup>. Middle tooth of the upper jaw long and prominent, the lateral teeth of the "c" and "b" orders, small. *C. macrodonta* Ellis.

c<sup>2</sup>. Middle tooth of the upper jaw longer than the other four teeth, but small enough so that all five teeth may be considered as almost subequal; lateral teeth of the "c" and "b" orders from one-half to three-fourths as long as the middle "A" tooth. *C. vitrea*, new species.

b<sup>2</sup>. Dental formula 3-4; middle tooth of the upper jaw long and prominent, lateral teeth small; teeth of the "c" order wanting. *C. inversa*, new species.

a<sup>2</sup>. Upper lip composed of four subequal lobes, which may be extended as digitiform tentacles; lower lip composed of two subequal lobes which may be extended also; a small lateral lobe on each side at the junction of the upper and lower lips.

d<sup>1</sup>. Dental formula 5-4, middle tooth of the upper jaw long and prominent; lateral teeth of the "c" and "b" orders small, one-half the length of the middle tooth or less; jaws subequal, the upper slightly larger than the lower. *C. philadelphica* (Leidy).

d<sup>2</sup>. Dental formula apparently 1-4, but actually 5-4; middle tooth of the upper jaw long and prominent, lateral teeth of the "c" and "b" orders very small, not exceeding one-sixth the length of the middle "A" tooth; upper jaw much larger than the lower, from one and three-quarters to three times as wide as the lower jaw. *C. chirocephala*, new species.

<sup>1</sup> Annuario del Museo Zool. della R. Univ. Napoli, n. s., vol. 3, num. 24, Feb. 29, 1912, pp. 1-28, pl. 5.

## CAMBARINCOLA MACRODONTA Ellis.

*Cambarincola macrodonta* ELLIS, Proc. U. S. Nat. Mus., vol. 42, pp. 481-486, figs. 1-5, 1912 (Boulder, Colorado, on *Cambarus diogenes* Girard).

*Specimens*.—Nine (7-Cat. No. 17656, U.S.N.M.), Fort Clark, Texas (E. A. Mearns), on *Cambarus clarkii*; one (Cat. No. 17657, U.S.N.M.), New Orleans, Louisiana (R. W. Shufeldt), on *Cambarus diogenes ludovicianus* Faxon; two (1-Cat. No. 17658, U.S.N.M.) Sims Bayou, Houston, Texas (B. W. Evermann), on *Cambarus blandingii acutus* Faxon (host determination uncertain); one (Cat. No. 17659, U.S.N.M.), Lake Lapoudre, Morgan City, Louisiana, on *Cambarus clarkii*; five (3-Cat. No. 17660, U.S.N.M.), Frierson, Louisiana, on *Cambarus blandingii acutus* Faxon; two (one-Cat. No. 17661, U.S.N.M.), Las Vegas, New Mexico (T. D. A. Cockerell), on *Cambarus gallinas* Cockerell and Porter; 15 (10-Cat. No. 17663, U.S.N.M.), Muldon, Mississippi (W. H. Baker), on *Cambarus hagenianus* Faxon; 25 (10-Cat. No. 17665, U.S.N.M.), Agricultural College, Mississippi (Earl Wilson); three (Cat. No. 17662, U.S.N.M.), Fort Collins, Colorado (L. C. Bragg), on *Cambarus diogenes* Girard; 25 (10-Cat. No. 17664, U.S.N.M.), Black Wolf Creek, near Beecher's Island, Colorado (B. Jaffa), October, 1915, on *Cambarus diogenes* Girard; 10 (5-Cat. No. 17666, U.S.N.M.), Arikaree River, near Beecher's Island, Colorado (G. C. Roe), October, 1915, on *Cambarus diogenes* Girard; 25 (10-Cat. No. 17667, U.S.N.M.), Boulder, Colorado (M. M. Ellis), September, 1916, on *Cambarus diogenes* Girard.

## CAMBARINCOLA VITREA, new species.

Plate 10, fig. 3.

*Type*.—Cat. No. 17668 U.S.N.M., body length 3.0 mm., Douglas Lake, Michigan, July, 1915 (M. M. Ellis), on *Cambarus virilis* Hagen (det. Faxon).

*Paratypes*.—Three, Cat. No. 17668 U.S.N.M., and 15 others, collected with the type.

*Additional specimens*.—Twenty-five (5-Cat. No. 17669, U.S.N.M.), Rhineland, Wisconsin, October, 1915, (G. Hansen) on *Cambarus virilis* Hagen (det. Faxon); 25 (5-Cat. No. 17670, U.S.N.M.), St. Vrain, Colorado, May, 1915 (M. M. Ellis), on *Cambarus immunis* Hagen; 10 (2-Cat. No. 17671, U.S.N.M.), Rolla, Missouri, October, 1915 (J. Barley), on *Cambarus virilis* Hagen (det. Faxon); 50 (5-Cat. No. 17672, U.S.N.M.), Maple River, Douglas Lake, Michigan, summers of 1915 and 1916, on *Cambarus propinquus* Girard (det. Faxon); 25 (2-Cat. No. 17673, U.S.N.M.), Lake Huron, Cheboygan, Michigan, August, 1915 (M. M. Ellis), on *Cambarus propinquus* Girard and *Cambarus virilis* Hagen; 50, (3-Cat. No. 17674, U.S.N.M.),

Grapevine Point, Douglas Lake, Michigan, summers of 1914, 1915, and 1916 (M. M. Ellis), on *Cambarus propinquus* Girard; 10 (2-Cat. No. 17675, U.S.N.M.), Wellington, Illinois, September, 1914 (A. T. Evans), on *Cambarus virilis* Hagen (det. Faxon); 15 (3-Cat. No. 17676, U.S.N.M.), Urbana, Illinois (Frank Smith), on *Cambarus virilis* Hagen; 20 (2-Cat. No. 17677, U.S.N.M.), Arikaree River, near Beecher's Island, Colorado, October, 1915 (B. Jaffa), on *Cambarus virilis* Hagen; three (2-Cat. No. 17678, U.S.N.M.), St. Marys River, Fort Wayne, Indiana (host not given); two (1-Cat. No. 17679, U.S.N.M.), mouth of Carp River, St. Martins Bay, near Straits of Mackinac (J. T. Scovell), on *Cambarus virilis* Hagen.

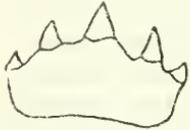


FIG. 14.—UPPER JAW OF TYPE-SPECIMEN OF *CAMBARINCOLA VITREA* ELLIS, FROM DOUGLAS LAKE, MICHIGAN, ANTERIOR FACE VIEW.

*Description.*—Body and head subterete, little if at all depressed; diameter of the head approximately equal to that of segment II, usually slightly greater than that of segment I; body segments II to VIII subequal, segments V, VI, and VII when distended with sex cells slightly wider than seg-

ments III and IV; segments posterior to VIII narrowing rather rapidly to the caudal sucker, the diameter of which is less than of the head; all body segments easily visible in side view; major annulations distinct, but very slightly elevated above the minor annulations; head divided into three subequal parts, the anterior being the most distinct of the three; lips two, subequal, each with a small, median emargination; major pharyngeal diverticula two, the dorsal slightly anterior to the ventral; a few short bristles present on each lip; dental formula 5-4, upper jaw between types V and VII, lower jaw of general plan of type VIII but with all four teeth almost subequal; alimentary canal straight, following the mesial line of the body, maximum enlargement in segment IV; anterior nephridia opening to the outside through a common pulsatile pore on the dorsal surface of the major annulation of segment III; spermatheca simple and tubular; testes present in segments V and VI vasa deferentia from segments V and VI, meeting the atrium in segment VI; accessory sperm tube present; largest specimen examined, 4.7 mm.

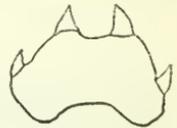


FIG. 15.—LOWER JAW OF TYPE-SPECIMEN OF *CAMBARINCOLA VITREA* ELLIS, FROM DOUGLAS LAKE, MICHIGAN, ANTERIOR FACE VIEW.

This species superficially resembles *Xironodrilus formosus* Ellis, both in body form and type of jaws. In addition to the several generic characters by which these two species may be separated, it may be noted that the jaws, although having the same number of teeth and the same general form, are quite different. (See figures.)

## CAMBARINCOLA INVERSA, new species.

Plate 11, fig. 3.

*Type*.—Cat. No. 17680, U.S.N.M., body length 2 mm., Eugene, Oregon (J. E. Gutberlet), on *Astacus klamathensis* Stimpson (det. Faxon).

*Paratypes*.—Five, Cat. No. 17680, U.S.N.M., and 15 others collected with the type.

*Description*.—Body rather elongate and more or less terete; width of the head approximately equal to that of segment I; body segments increasing in width regularly and gradually from segment I to segment VI, which is the widest segment of the body; segments VII and VIII slightly narrower than segment VI; body posterior to segment VIII narrowing rapidly to the caudal sucker; all 11 body segments visible in side view and 9 or more visible in dorsal view; caudal sucker termino-ventral, its diameter less than that of the head; each segment, slightly constricted anteriorly and posteriorly, so that the segmental junctions are distinct; head subcylindrical, its anterior third defined by a groove or constriction; length of the head in moderately expanded specimens slightly less than the length of the first two body segments; lips, two, the upper slightly longer than the lower; the lower lip with a distinct median emargination; upper lip like the lower, but with two small lobes in the base of the emargination; oral bristles present; dental formula 3-4, varying 3-3 to 5-4 (see table); upper jaw with three large teeth, of which the middle one is the longest, all three directed forward—that is, away from the base of the jaw; dental ridge of the upper jaw usually with a small tubercle in the position of the teeth of the "c" order—that is, if the jaw were five-toothed (teeth were found on these tubercles in two specimens, the tooth point in each case being very small); lower jaw with two large teeth and two small lateral teeth; upper jaw 20 micra wide, lower jaw 17 micra wide



FIG. 16.—UPPER JAW OF CAMBARINCOLA INVERSA ELLIS, FROM EUGENE, OREGON.



FIG. 17.—LOWER JAW OF CAMBARINCOLA INVERSA ELLIS, FROM EUGENE, OREGON.

in an expanded worm measuring 3.6 mm.; major pharyngeal diverticula two, one dorsal and one ventral; anterior nephridia alternating in segments II and III, opening to the outside in segment III through a common pore in the dorsal surface of the major annulation of segment III; spermatheca simple, long, and tubular, not bifid; testes present in segments V and VI, vasa deferentia from segments V and VI meeting in the atrium in segment VI; alimentary canal straight, increasing in diameter in segment I, much expanded in segments II, III, and IV, in which segments it forms an almost continuous pouch; intestine narrowing

in the posterior half of segment IV; alimentary canal following the mesial line of the body through segments V to IX, swinging dorsad through segment IX to anal opening on the dorsal surface of segment X.

The variation in the number of teeth of 20 specimens of this species is shown in the following table:

TABLE 5.

Locality.	Dental formulae.		
	3-3	3-4	5-4
Eugene, Oregon.....	1	17	2

CAMBARINCOLA PHILADELPHICA (Leidy).

*Astacobdella philadelphica* LEIDY, Proc. Acad. Nat. Sci. Phila., p. 209, 1851, on *Astacus bartonii* Fabricius.

*Branchiobdella philadelphica* (Leidy) MOORE, Proc. Acad. Nat. Sci. Phila., pp. 427-428, pl. 12, figs. 4a-4e, 1893.

*Specimens*.—Five (three=Cat. No. 17861, U.S.N.M.), Cheat Bridge, West Virginia (U.S.F.C.), on *Cambarus bartonii carinirostris* Hay; four (1=Cat. No. 17682, U.S.N.M.), Chenoweth Creek, between Beverly and Elkins, West Virginia (U.S.F.C.), on *Cambarus bartonii carinirostris* Hay; two (Cat. No. 17683, U.S.N.M.), Laurel Fork of Cheat River, near Seneca Point, West Virginia, on *Cambarus bartonii carinirostris* Hay; four (Cat. No. 17684, U.S.N.M.), Right Hand Fork at Queens, West Virginia (U.S.F.C.), on *Cambarus obscurus* Hagen; five (Cat. No. 17685, U.S.N.M.), Rock House River, near Baileyville, West Virginia, on *Cambarus dubius* Faxon; one (Cat. No. 17686, U.S.N.M.), Bangers Springs, Hilton, West Virginia, on *Cambarus bartonii* (Fabricius); one (Cat. No. 17687, U.S.N.M.), Crane Creek, West Virginia, on *Cambarus bartonii veteranus* Faxon; five (3=Cat. No. 17688, U.S.N.M.), Elk River at Cogar's Mill, West Virginia (U.S.F.C.), on *Cambarus bartonii* subspecies; two (Cat. No. 17689, U.S.N.M.), Cheat River near the Pike, West Virginia (U.S.F.C.), on *Cambarus bartonii carinirostris* Hay; two (one=Cat. No. 17690, U.S.N.M.), Tilhance Creek, Black Creek Valley, West Virginia (E. L. G.); one (Cat. No. 17691, U.S.N.M.), Indian Creek, tributary of the Elk River in Kanawha County, West Virginia on *Cambarus bartonii veteranus* Faxon; three (one=Cat. No. 17692, U.S.N.M.), Stone Coal Creek, between Buckhannon and Weston, West Virginia (U.S.F.C.), on *Cambarus obscurus* Hagen; one (Cat. No. 17693, U.S.N.M.), War Creek, headwaters of the Big Sandy in McDowell County, West Virginia, on *Cambarus dubius* Faxon; five (3=Cat. No. 17694, U.S.N.M.), Coney

Creek, Bainbridge, Pennsylvania (B. A. Bean), on *Cambarus bartonii* (Fabricius); 14 (7=Cat. No. 17695, U.S.N.M.), Stoney Man Mountain, Virginia (Palmer and King), on *Cambarus bartonii* (Fabricius); ten (7=Cat. No. 17696, U.S.N.M.), North Fork of Blackwater, Courtland, West Virginia (U.S.F.C.), on *Cambarus bartonii carinirostris* Hay; ten (2=Cat. No. 17697, U.S.N.M.), Raleigh, North Carolina (C. S. Brimley), May, 1915, on *Cambarus bartonii acuminatus* Faxon and *Cambarus latimanus* LeConte (det. Faxon); one (Cat. No. 17698, U.S.N.M.), Wytheville, Virginia (M. McDonald), on *Cambarus bartonii* (Fabricius); one (Cat. No. 17699, U.S.N.M.), Cabin John, Maryland (McAtee and Wood), on *Cambarus bartonii* (Fabricius); one (Cat. No. 17700, U.S.N.M.) Schlarie Creek, Green County, Catskills, New York (E. A. Mearns), on *Cambarus bartonii* (Fabricius); two (one=Cat. No. 17701, U.S.N.M.), Spring Branch, 3 miles east of Mammoth Cave, Kentucky (W. P. Hay), on *Cambarus bartonii tenebrosus* Hay; two (Cat. No. 17702, U. S. N. M.), Left Hand fork of Middle Fork of Valley, Cassiday, West Virginia (U.S.F.C.), on *Cambarus obscurus* Hagen; two (one=Cat. No. 17705, U.S.N.M.), East River, West Virginia, on *Cambarus bartonii* (Fabricius); four (Cat. No. 17703, U.S.N.M.), Trubies Run, West Virginia (U.S.F.C.), on *Cambarus obscurus* Hagen; two (one=Cat. No. 17704, U.S.N.M.), between Paoli and Wyandotte, Indiana (O. P. Hay), on *Cambarus rusticus* Girard; two (Cat. No. 17706, U.S.N.M.), St. Marys River, Fort Wayne, Indiana; five (2=Cat. No. 17707, U.S.N.M.), Bluffton, Indiana (E. B. Williamson), on *Cambarus rusticus* Girard; 10, Rhinelander, Wisconsin (G. Hansen), on *Cambarus diogenes* Girard (det. Faxon); 50 (4=Cat. No. 17708, U.S.N.M.), Maple River, Douglas Lake, Michigan, summers of 1914, 1915, and 1916 (M. M. Ellis) on *Cambarus propinquus* Girard and *Cambarus virilis* Hagen (det. Faxon); 25 (4=Cat. No. 17709, U.S.N.M.), Bloomington, Indiana (Will Scott), May, 1915, on *Cambarus propinquus* Girard (det. Faxon); 200 (10=Cat. No. 17710, U.S.N.M.), White River, Irondale, Anderson, Indiana, summers of 1914, 1915, and 1916 (M. M. Ellis) on *Cambarus rusticus* Girard (det. Faxon); 10 (4=Cat. No. 17711, U.S.N.M.), Oxford, Ohio (S. R. Williams); 10 (2=Cat. No. 17712, U.S.N.M.), North Judson, Indiana (P. S. Welch).

In the original description of this species Leidy<sup>1</sup> gives the following: "Head campanulate, terminated by a circular or elliptical crenated lip, fringed with very minute stiff hairs; dental plates brown, nearly equal, forming an isocetes triangle, with the base longest and attached. apex of superior plate ending in a sharp conical point with several minute denticulations on each side; apex of inferior

<sup>1</sup> Proc. Acad. Nat. Sci. Phila., 1851, p. 209.

plate bifurcated into two points, with two minute denticulations on each side." From this description the lower jaw may be regarded as a six-toothed jaw, having two large apical teeth and two small teeth on each side. The upper jaw is not so easily understood. The upper jaw bears " $x$ " teeth, if  $x=1$  plus  $y$ , in which statement " $y$ " is more than two (*several minute denticulations*, according to Leidy). This interpretation of the upper jaw would give it a minimum of seven teeth; that is, one large tooth plus at least three teeth on each side.

Moore<sup>1</sup> figures a specimen which he assigns to Leidy's species, having jaws of the dental formula 7-10. The upper jaw as figured has one large apical tooth, and three small denticles on each side, and the lower jaw has two large teeth, and four small denticles on each side. Moore's figure of the head of this worm shows the upper lip to be composed of four distinct but small lobes, and the lower lip of two large subequal lobes. At the junction of the upper and lower lips on each side is a small intermediate lobe. These six lobes are small enough to fall in Leidy's description of a "circular or elliptical, crenated lip."

From the examination of a large series of specimens and a study of many living individuals at Douglas Lake, Michigan, the usual dental formula of this species seems to be 5-4. The upper jaw has one large tooth with two small denticles on each side and the lower two large teeth with two small denticles. The variation in the number of teeth figured and described may be accounted for by the fact that the sides of both upper and lower jaws of this species often bear small tubercles below the small denticles—that is, toward the base of the jaw—and these small tubercles could easily be confused with teeth. As understood in this paper, a tooth or denticle is a tubercle on the dental face bearing a distinct tooth cap. These tooth caps are lighter in color than the dental ridge, have 5 definite points and definite form. Two specimens from Tilhance Creek, West Virginia, one from Indian Creek, West Virginia, and one from Douglas Lake, Michigan, had jaws with more teeth—that is, definite teeth with tooth caps—than the regular 5-4 type, showing that some variation does occur.

The plurilobate condition of the prostomium is regular and definite, the upper lip having four subequal lobes, the lower, two large, subequal lobes with a small, often inconspicuous, lobe present at the junction of the upper and lower lip on each side of the mouth. In the living worms it was observed that the four lobes of the upper lip and, to a less extent, the two lobes of the lower lip could be extended to form distinct tentacles on the lips. Several specimens from

<sup>1</sup> Proc. Acad. Nat. Sci. Phila. 1893, pl. 12.

various localities were found in the collections, killed with these tentacles fully extended. Most of the preserved specimens examined showed these tentacles, the lobes of the lips being extended beyond the level of the lips so that the tentacles, although small, were distinct. It was also found that worms of this species could flatten the entire lip, so that the lobes were scarcely visible. Preserved specimens which had been killed with the lips in this flattened condition were separated often with difficulty from individuals of the first group of species of this genus, but close examination in nearly every case showed the regular emarginations marking the location of lobes of lips. The lobes were easily seen in a young worm less than three hours old which was examined in water. This worm extended and contracted the lobes in the same manner as an adult. *Cambarincola philadelphia* was the most variable species studied.

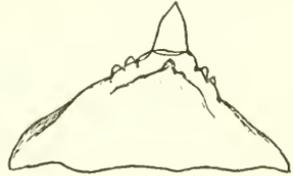


FIG. 18.—UPPER JAW OF TYPE-SPECIMEN OF *CAMBARINCOLA CHIROCEPHALA* ELLIS, FROM ROLLA, MISSOURI. TYPE VII.

**CAMBARINCOLA CHIROCEPHALA, new species.**

*Type*.—Cat. No. 17713, U.S.N.M., body length 2 mm., Rolla, Missouri (J. Barley), on *Cambarus virilis* Hagen (det. Faxon).

*Paratypes*.—One, Cat. No. 17713, U.S.N.M., and three others, collected with the type.

*Description*.—General body form that of *Cambarincola philadelphia* (Leidy); body segments evident, major annulations of segments especially in contracted specimens, distinctly and visibly elevated above the minor annulations; body segments increasing regularly and gradually in diameter from segment I to segment VI or VII, and decreasing slightly from segment VIII to the caudal sucker; body terete; head large, equalling the first two body segments in length and exceeding the first segment in width; lips two, upper composed of four subequal lobes which may be extended into four



FIG. 19.—L O W E R JAW OF TYPE-SPECIMEN OF *CAMBARINCOLA CHIROCEPHALA* ELLIS, FROM ROLLA, MISSOURI. TYPE VIII.

distinct digitiform tentacles, or may be so flattened as to give the lip an almost entire outline; lower lips of two larger, subequal lobes which are usually somewhat extended; a very small intermediate lobe at the junction of the upper and lower lip on each side of the mouth; major pharyngeal diverticula two, a dorsal and a ventral, the dorsal diverticulum being slightly cephalad of the ventral; dental formula 5-4; upper jaw very large, its width two or three times that of the lower jaw, teeth of the "c" and "b" orders on each side very small, less than one-sixth the height of tooth "A," the jaw

appearing to have but one large tooth when examined under low magnification; lower jaw of type VIII, teeth of the usual proportions for that type; anterior nephridia opening to the outside through a common pore in segment III; spermatheca simple, bulbous; testes in segments V and VI, vasa deferentia from segments V and VI meeting in segment VI.

TABLE 6.—Distribution of *Branchiobdellids* examined according to host.

Host species of crayfish.	Xironodrilus.		Xironogiton.			Pterodrilus.		Cambarincola.					Total.		
	formosus.	pulcherrimus.	occidentalis.	o. oregonensis.	o. pectinatus.	instabilis.	distichus.	mexicanus.	durbinii.	macrodonta.	vitrea.	inversa.		philedephica.	chirocephala.
A. klamathensis.....			*	*	?						*				3
C. bartonii.....	*					*									3
C. bartonii acuminatus.....													*		1
C. bartonii carinrostris.....	*												*		3
C. bartonii robustus.....					*								*		1
C. bartonii tenebrosus.....													*		2
C. bartonii veteranus.....	*												*		1
C. blandingsi acutus.....															1
C. clarkii.....										*					1
C. diogenes.....										*			*		2
C. diogenes ludovicianus.....										*					1
C. dubius.....		*								*			*		2
C. gallinas.....										*					1
C. hagenius.....										*					1
C. immunis.....										*					1
C. latimanus.....													*		1
C. mexicanus.....								*							1
C. obscurus.....		*				*									2
C. pellucidus.....													*		1
C. propinquus.....	*									*			*		3
C. rusticus.....	*						*		*				*		4
C. virilis.....										*			*	*	3
Total, 22.....	2	5	1	1	1	4	1	1	1	7	2	1	12	1	...

#### EXPLANATION OF PLATES.

##### PLATE 10.

FIG. 1.—Cross section of body of *Xironogiton oregonensis oregonensis* Ellis, in segment V, showing the buttress-like supports of the intersegmental partition. The positions of these structures are indicated by the dotted lines. AC=allimentary canal.

2.—Sagittal section of the head of *Xironogiton oregonensis oregonensis* Ellis, from Eugene, Oregon.

a=first dorsal pharyngeal diverticulum.

b=second dorsal pharyngeal diverticulum.

c=ventral pharyngeal diverticulum.

d=lumen of the pharynx.

e=false diverticulum formed by the contraction of the specimen during fixation.

3.—Side view of type-specimen of *Cambarincola vitrea* Ellis, from Douglas Lake, Michigan.

## PLATE 11.

- FIG. 1.—Side view of type-specimen of *Pterodrilus durbini* Ellis, from White River, Irondale, near Anderson, Indiana.
- 2.—Dorsal view of type-specimen of *Xironodrilus formosus* Ellis, from White River, Irondale, near Anderson, Indiana.
- 3.—Side view of type-specimen of *Cambarincola inversa* Ellis, from Eugene, Oregon.

## PLATE 12.

- FIG. 1.—Ventral view of type-specimen of *Xironogiton oregonensis oregonensis* Ellis, from Eugene, Oregon.
- 2.—Dorsal view of type-specimen of *Xironogiton occidentalis* Ellis, from Crab Creek, Washington.
- 3.—Ventral view of type-specimen of *Xironogiton oregonensis pectinatus* Ellis, from Sequallitchew Lake, Washington.

## PLATE 13.

- FIG. 1.—Ventral view of *Xironogiton instabilis* (Moore) from Queens, West Virginia. Contracted specimen.
- 2.—Dorsal view of *Xironodrilus pulcherrimus* (Moore), from Right Hand Fork of Chenowith Creek, Queens, West Virginia.
- 3.—Ventral view of *Xironogiton instabilis* (Moore), from Queens, West Virginia. Partly expanded specimen.

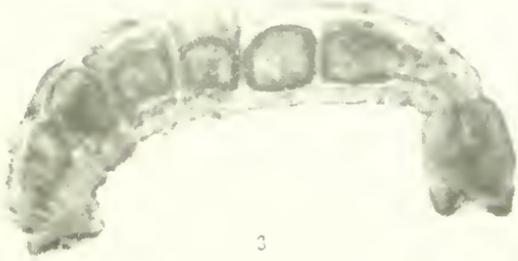




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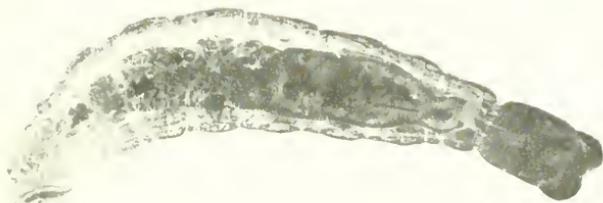


3

NEW SPECIES OF BRANCHIOBELLELLID WORMS.

FOR EXPLANATION OF PLATE SEE PAGE 261.

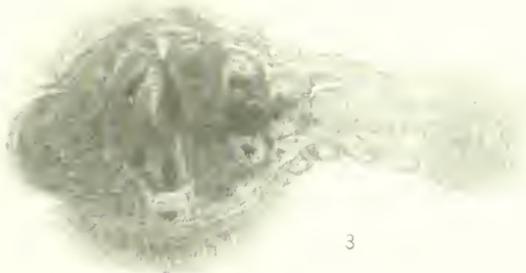
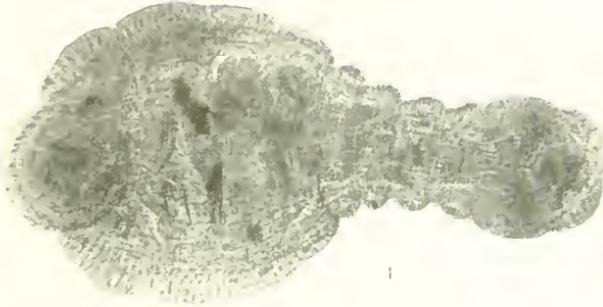




NEW SPECIES OF BRANCHIOBELLID WORMS.

FOR EXPLANATION OF PLATE SEE PAGE 265.

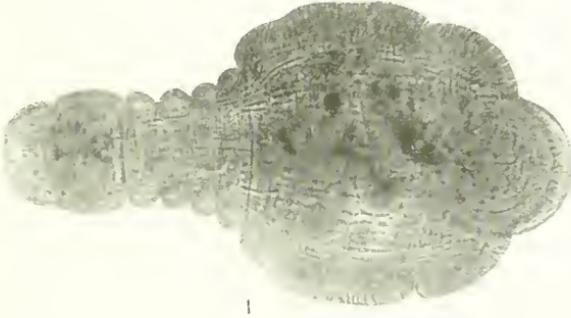




NEW SPECIES OF BRANCHIOBELLID WORMS.

FOR EXPLANATION OF PLATE SEE PAGE 265.





1



2



3

NEW SPECIES OF BRANCHIOBELLID WORMS.

FOR EXPLANATION OF PLATE SEE PAGE 265.

