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DESCRIPTION OF A NEW SPECIES OF LAMPREY
OF THE GENUS ICHTHYOMYZON.

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Lampreys representing the apparently new species described below were first observed and collected on May 23, 1905, spawning in Mill Creek, a tributary of the Huron River west of Ann Arbor, Michigan. Other specimens were later taken in the Huron River, near Ann Arbor. The type material is in the Museum of Zoology, University of Michigan.

Ichthyomyzon fossor, new species.

Diagnosis: Maximum length about 150 mm.; larvae at transformation with maximum adult length; buccal funnel small; disc teeth small and blunt, occasionally obsolete; supra-oral lamina with two small, blunt, well separated cusps; ante-

rior lingual lamina with a single transverse element, provided with minute rounded denticles; anal fin well developed, particularly in the female.

Habitat: Southern Michigan.

Type Specimen: Cat. No. 48377, Museum of Zoology, University of Michigan; Mill Creek, Washtenaw County, Michigan; May, 1905; Jacob Reighard, collector.

Description of Type Specimen:¹ (Pl. I, fig. 1.) Length, 121 mm.; tip of snout to vent, 67.76; tip of snout to anterior margin of dorsal, 45.59; last gill opening to vent, 47.11; last gill opening to anterior margin of dorsal, 28.92; tip of snout to first gill opening, 9.92; tip of snout to last gill opening, 20.66; width of body immediately behind branchial basket, 5.78; depth of body immediately behind branchial basket, 7.44; diameter of eye, 1.24; tip of snout to anterior margin of orbit, 5.78; tip of snout to nasal pit, 4.55; antero-posterior diameter of buccal funnel, 5.6; transverse diameter of buccal funnel, 5.5. Muscular impressions between last gill opening and vent, 49. Disc bordered by fimbriae arranged in a single row except anteriorly, where they tend to form a double row; anterior ones (Pl. II, fig. 2) simple or biramous, with an increase in size and number of lobes posteriorly; extremities of lobes blunt; lobes of adjacent fimbriae sometimes fused. A prominent lip-like fold within fimbriae forming outer boundary of disc. Extraorals (Pl. II, fig. 1) 5 on right side and 4 on left, larger than disc teeth, low, blunt, borne on papillae with distinct boundaries. Disc teeth low, blunt, arranged in radiating lines; each line composed of three teeth except posteriorly, two; those in posterior portion of disc and the marginal ones anteriorly and laterally nearly obsolete. Supraoral lamina narrow, well imbedded within the

¹ Throughout this description the proportions are indicated in hundredths of the total length, which includes the caudal fin.

fleshy suproaral papilla, with two cusps, one in the center of each half of supraoral papilla; cusps low, blunt, of about same size as extraorals. Infraoral lamina crescentic, bearing 9 rounded cusps of unequal size. Anterior lingual lamina a single bi-crescentic plate, with an anterior median prominence; minutely denticulated; the anterior element as found in more typical members of the genus either lacking or so nearly obsolete as to be overlooked. Anterior and posterior fins united, with a notch in front of vent; posterior dorsal continuous with caudal. Tip of snout to middle of dorsal notch, 66.12; tip of snout to middle of dorsal-caudal notch, 92.97; greatest height of anterior dorsal, 2.48; height of dorsal at middle of notch, 2.07; greatest height of posterior dorsal, 4.14. Anal fin continuous with caudal, greatest height, 1.24. Sensory papillae indistinct; one series above each eye, directed postero-dorsally; a series beneath eye, curving upward and directed anteriorly; a series continuing as a broken line below end of last to tip of snout; none distinguishable on ventral surface of body. Urinogenital papilla prominent. Color in life uniform grayish-brown over entire surface posterior to vent, two-thirds the distance down sides between vent and last gill opening, and half way down in region of gill openings and snout; elsewhere light yellowish-brown except for a narrow line of grayish brown connecting gill openings; fins grayish-brown, lighter than body color.

Notes on Paratypes: Besides the type fifteen adults have been examined as follows, eleven females and three males from Mill Creek, May, 1905, and one female from the Huron River, near Ann Arbor, April 23, 1912. (Cat. Nos. 4368-48376, 48378-48383, Museum of Zoology, University of Michigan.) There are some variations in the material. The extraorals vary in number from 4 to 6; a noteworthy fact is the frequent lack of

bilateral symmetry—a different number on the two sides, as in the type. In several specimens extraorals are indistinguishable. Disc teeth vary in size and number; in specimens where they are prominent four teeth may be made out within each radiating series over entire surface of disc. Where the dentition is less strong three, two, or only one may constitute a series posteriorly; but always with three in each series anteriorly and laterally. In several specimens no disc teeth can be made out.² It is needless to say that weak disc dentition is associated with weak extraorals, supraorals, etc. Infraoral lamina has 8 to 10 cusps, always more or less irregular, as in the type. The anal fin in females (Pl. I, fig. 3) is higher and more convex in outline than in males. Females possess a fin-like swelling anterior to vent. The urinogenital papilla in females does not protrude from the vent. Pronounced individual variation in proportions of the body occurs here, as in other lampreys. These variations, as well as differences in the number of muscular impressions, are presented in the following table:

²The teeth are much more readily seen if stained yellow by immersing the oral disc for five minutes in a saturated solution of picric acid in 70% alcohol. The specimen may then be placed in 70% alcohol, in which the color is but slowly extracted.

MEASUREMENTS OF SIXTEEN ADULTS EXPRESSED IN HUNDREDTHS OF THEIR TOTAL LENGTHS.

Catalog Number	48368	48369	48370	48371	48372	48373	48374	48375	48376	48377	48378	48379	48380	48381	48382	48383
Total length in millimeters...	149	137	133	132	131	130	129	126	125	121	121	121	119	116	113	112
Sex	female	female	female	male	female	female	male	female	female	male	female	female	female	female	female	male
Tip of snout to vent.....	69.07	71.53	72.18	70.45	69.28	68.46	70.54	69.44	69.60	67.76	71.49	68.59	71.01	68.97	70.79	67.85
Tip of snout to anterior margin of dorsal	44.30	47.44	42.48	43.93	40.46	46.92	46.51	46.43	40.00	49.59	47.93	44.63	49.16	44.83	42.92	41.07
Last gill opening to vent.....	52.29	52.55	52.63	51.51	57.44	49.23	51.07	50.00	50.80	47.11	51.65	49.58	51.93	49.14	53.98	46.41
Last gill opening to anterior margin of dorsal	27.52	28.46	22.93	24.99	21.75	27.69	27.13	26.99	21.20	28.92	27.68	25.62	30.08	25.00	26.11	19.63
Tip of snout to 1st gill opening	7.72	8.76	9.02	8.71	8.40	9.23	9.30	9.52	8.80	9.92	9.09	9.51	8.82	9.92	7.52	10.72
Tip of snout to last gill opening	16.78	18.98	19.55	18.94	19.46	19.23	19.38	19.44	18.80	20.66	20.25	19.01	19.08	19.83	16.81	21.44
Tip of snout to middle of dorsal notch	59.79	64.96	63.91	..*..	62.98	61.92	62.79	64.29	61.60	66.12	68.59	63.63	65.96	..*..	64.60	64.28
Tip of snout to middle of dorsal-caudal notch	90.61	..?..	93.23	..?..	90.08	92.69	92.25	92.06	91.20	92.97	..?..	91.73	92.01	90.52	91.15	92.41
Height of anterior dorsal.....	1.34	1.46	1.51	1.52	1.91	1.92	1.94	1.98	1.60	2.48	2.07	1.66	2.10	2.16	2.66	2.68
Height of dorsal at notch.....	0.67	1.10	1.13	..*..	1.52	1.54	1.36	1.59	1.20	2.07	1.65	1.24	1.68	..*..	1.33	2.24
Height of posterior dorsal ...	2.01	2.55	2.26	2.28	3.05	3.08	3.49	3.57	2.40	4.14	2.48	3.32	2.52	3.02	3.98	4.47
Height of anal fin.....	0.67	1.10	1.51	1.52	2.30	1.54	0.78	1.59	1.20	1.24	1.24	1.66	1.68	1.30	1.77	1.79
Width of body just behind branchial basket	4.36	5.11	3.75	..†..	4.20	3.46	5.05	4.37	..†..	5.78	..†..	6.20	3.78	6.04	3.54	4.91
Depth of body just behind branchial basket	6.05	7.30	6.77	..†..	6.49	5.39	7.75	5.56	..†..	7.44	..†..	8.27	5.88	8.63	6.20	8.04
Diameter of eye	1.00	1.10	1.32	1.14	1.15	1.35	1.36	1.19	1.20	1.24	1.16	1.24	1.26	1.08	1.11	1.34
Tip of snout to anterior margin of orbit.....	4.70	5.11	5.08	4.92	4.96	5.19	6.20	5.16	5.20	5.78	5.38	4.96	4.62	6.04	3.98	6.70
Tip of snout to nasal pit.. ..	3.36	3.30	3.36	3.79	3.05	4.23	5.05	3.37	4.00	4.55	3.97	4.14	3.36	4.74	3.54	4.47
Muscular impressions between last gill opening and vent	53	53	50	50	51	52	51	51	52	49	52	50	52	51	51	54

† Much shrunken.

* No notch.

Description of Larva: Eight larvae have been examined (Cat. Nos. 48384-48391, Museum of Zoology, University of Michigan), six from Mill Creek and two from the Huron River near Ann Arbor. The following description is based on specimen number 48386 taken in Mill Creek, Washtenaw County, Michigan, May 21, 1916.

With the usual ammocoetes facies. Length, 135 mm.; tip of snout to vent, 70.37; tip of snout to anterior margin of dorsal, 50.37; last gill opening to vent, 51.85; last gill opening to anterior margin of dorsal, 31.85; tip of snout to last gill opening, 18.52; tip of snout to first gill opening, 8.15; width immediately behind branchial basket, 5.19; depth immediately behind branchial basket, 6.67. Muscular impressions between last gill opening and vent, 51. Shape of mouth and form of oral villi as in *Entosphenus wilderi*. Dorsal fin (Pl. I, fig. 4) continuous, not separated into anterior and posterior dorsals, increasing gradually in height posteriorly to reach its maximum height behind the vent; height in its anterior portion, .56. Posterior portion slightly convex in outline; greatest height, 1.48; continuous with caudal, the junction indicated by a shallow notch. No anal fin.

The larval characters seem to be more constant than those of adults. There are, however, slight variations in proportions as may be seen in the following table:

MEASUREMENTS OF EIGHT LARVAE EXPRESSED IN HUNDREDTHS
OF THEIR TOTAL LENGTHS.

Catalog Number	48384	48385	48386	48387	48388	48389	48390	48391
Total length in millimeters	158	150	135	130	124	95	94	80
Tip of snout to vent	72.47	69.67	70.37	69.24	68.55	73.68	73.41	74.38
Tip of snout to anterior margin of dorsal	50.32	46.67	50.37	48.47	47.59	54.21	49.47	51.88
Last gill opening to vent	53.48	52.00	51.85	50.77	50.00	53.68	53.19	53.13
Last gill opening to anterior margin of dorsal	31.33	29.00	31.85	30.00	29.04	34.21	29.25	30.63
Tip of snout to first gill opening	7.60	7.33	8.15	8.08	8.06	8.42	8.52	8.13
Tip of snout to last gill opening	18.99	17.67	18.52	18.47	18.55	20.00	20.22	21.25
Tip of snout to middle of dorsal-caudal notch	94.34	89.67	91.85	93.46	92.74	80.47	90.43	91.25
Height of anterior dorsal	0.44	0.50	0.56	0.54	0.61	0.74	0.64	0.63
Height of posterior dorsal	0.95	1.33	1.48	1.54	1.61	1.58	1.07	1.25
Width of body just behind branchial basket	4.75	5.00	5.19	5.00	4.84	5.27	5.32	5.31
Depth of body just behind branchial basket	5.70	6.00	6.67	6.16	6.05	6.32	6.65	7.19
Length of oral opening	3.64	3.17	4.26	3.85	3.63	3.16	3.73	4.38
Muscular impressions between last gill opening and vent	51	51	51	50	50	50	51	51

Habits of Larvae: In Mill Creek, larvae occur most abundantly where eddies have deposited silt in concavities of the stream bed, and where the current is slow. An admixture of silt and sand seems to produce the most favorable situation, although larvae were collected in small numbers from gravelly and pure sand bottoms. None were found in stiff muck. An idea of their abundance in a very favorable locality may be obtained from the fact that in an hour's dredging sixty-one were collected from an area not larger than 5 x 10 feet. When earth containing larvae is thrown from the dredge net to the bank, individuals almost immediately wriggle to the surface.

The same activity follows if the stream level lowers rapidly, so that their haunts are exposed. For instance, in 1913, when the Huron River level was lowered during the construction of a dam, many larvae emerged to the surface of the mud flats thus uncovered.

When a larva is liberated in an aquarium or in the stream it swims a short distance, then erects the body almost vertically, head downward, and burrows with a rapid vibratory movement. It does not continue straight down, but turns horizontally, then upward, forming a burrow in the shape of a flattened **U**. The dorsal surface of the body is kept uppermost throughout this process. If the aquarium floor is covered with but a thin layer of sand the burrow is much more flattened; under these conditions the tail frequently protrudes, but we have never seen the head exposed. When disturbed, the animal leaves its burrow and swims vigorously. When placed in an aquarium with no sand or other material the larva alternately swims about and lies on its side—either right or left. As yet we have not determined the duration of larval life or time of metamorphosis. It is to be noted that the habits, as above described, are identical with those of the larvae of *Entosphenus wilderi*.

*Habits of Adults:*³ The spawning activities of 1905 were first observed on May 23, and they continued until May 27; the last adult seen in that year was a weakened individual noted June 2. For two or three days following May 27 the water was so muddy that no observations were possible. Spawning may have continued during that period. All the adults were observed within a radius of twenty-five feet, on a bottom of coarse gravel and shingle which contained stones from one to

³ The writers are indebted to Prof. F. E. Wood for the use of his notes on the spawning habits of this lamprey.

six inches in diameter, and in water from eight to eighteen inches deep. The stream at this point is not more than thirty feet wide, with a strong current. Adults have been seen or collected only during the spawning season.

They are rarely seen to swim free even for a few feet, but are often found progressing or wriggling between stones. They are usually so hidden among or beneath stones of three to six inches diameter that only the tip of the tail is visible. The animals take possession of chinks beneath such stones as may be lodged loosely, and extend the natural cavities by removing sand and gravel. In enlarging the cavity the lamprey attaches itself by the mouth to pebbles, and tosses them up and out from between the larger stones. Active lashing of the body at the same time serves to stir up the sand, which is swept away by the current. On rare occasions an individual may attempt to remove a larger stone by attaching himself to it, loosening the stone by wriggling the body and then allowing the current to carry himself and burden downstream—as is the common habit in *Entosphenus wilderi*. Like the brook lamprey, this species has the habit of attaching the mouth to large stones and throwing the body into vigorous vibrations. However, the habit differs from that of the brook lamprey in that the axis of the body is often nearly vertical, and whatever inclination there may be toward the horizontal is quite as likely to be upstream as downstream. The vibrations occur when the animal is partially hidden among stones as well as when it is in the open. The brook lamprey lies with the body nearly horizontal and with the head directed upstream during these vibrations. When placed in a bacteria dish in bright light the animal becomes restless and moves continually until the dish is covered. Although not so sensitive to current as the brook lamprey, *Ichthyomyzon fossor* does exhibit a tendency

to avoid remaining in a very strong current. When confined in an aquarium containing a pile of smooth glass objects the lamprey shows little or no inclination to retreat among them, but it will at once hide among stones. If a number of them are placed in bright light in a dish one-half of which is covered with ruby glass, they are at first active but soon collect in the area of red light and come to rest. It seems then that the preference for weak light determines the burrowing habit.

The spawning nests are very ill-defined; they are little more than areas on the stony bottom where the sand and pebbles have been cleared away from between or beneath larger stones. Other nests three or four inches in diameter and of about the same depth are sometimes excavated in sand or gravel. During the excavation of such a nest the lamprey's body is nearly vertical, with no tendency to incline in a particular direction with respect to current. The pebbles are thrown out in any direction. Although the excavation of nests is prosecuted with great vigor, with sometimes as many as seven or eight individuals present, attempts at spawning in them are rarely seen. On the contrary, the spawning act takes place almost invariably when the animals are more or less hidden among stones. Consequently it has been difficult to determine the exact details of the act. Apparently the male attaches himself by the buccal funnel either to a stone close to where the female is likewise attached, or to the body of the female near her head. Then the bodies of both are thrown into spasmodic vibration. At the same time the eggs may be seen to escape. Some of them are carried down by the current. The male, so far as our observations go, seldom winds his tail about the female. Infrequently an individual may wind his tail about the head of another, vibrating his body at the same time, or may seize another near the branchial region, wind his tail around

the body, and vibrate feebly. But in such cases no emission of eggs or milt is discernible. In the confined space where spawning usually occurs there would seem to be no room for the enwrapping of the female by the male, and it is doubtful if it occurs with any regularity. Spawning seldom takes place when the water is below 18°C., and is most vigorous at 20 to 22°C.

Affinities of the Species: Since adults have been taken only in the spawning season and are not found attached to fish, and since our sections show that the alimentary canal of the adult is degenerated, there seems to be no ground to doubt that all adults die soon after spawning. *I. fossor* is then analogous to *Entosphenus wilderi* in which the adult parasitic life has been lost. It is interesting to note that in both species the non-parasitic condition is associated with a size small for the group and with life in small bodies of water. *Ichthyomyzon fossor* thus bears the same relation to members of its genus that *Entosphenus wilderi* bears to its congeners, *E. tridentatus*, *E. spadiceus*, etc.

This species may be readily separated from other North American *Ichthyomyzons* by the following characters:

<i>Ichthyomyzon fossor</i>	Other species of <i>Ichthyomyzon</i>
Maximum length about 150 mm.	Maximum length about 300 mm.
Larvae at transformation equal in length to maximum adults.	Larvae at transformation much smaller than maximum adults.
Buccal funnel small.	Buccal funnel large. (In an immature <i>I. concolor</i> it is about twice as large as in a mature <i>I. fossor</i> of the same length.)
Disc teeth small and blunt—some even obsolete.	Disc teeth large and sharp.
Supraoral lamina with two small, blunt, well separated cusps.	Supraoral lamina with two or more large, sharp, closely appressed cusps.

Anterior lingual lamina with a single transverse element, which is provided with minute rounded denticles.	Anterior lingual lamina with anterior and posterior transverse elements, each provided with prominent sharp denticles.
Anal fin well developed, particularly in females.	Anal fin usually lacking; when present it is low and not prominent. ⁴

No specific larval characters have been worked out.

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⁴ Girard's generic diagnosis of *Ichthyomyzon* definitely states that there is no anal fin, and his type specimens do not exhibit this structure. But the junior author has examined, in the U. S. National Museum, individuals which have the anal fin. Its presence or absence cannot then be considered a generic character. Very likely it is of seasonal appearance in the typical *Ichthyomyzons*.

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PLATES

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PLATE I.

Figure 1. Male, taken during spawning. $\times\frac{3}{4}$. (Photographed in life.)

Figure 2. Female, dorsal surface. $\times\frac{3}{4}$. (Photographed in life.)
Note that the expanded buccal disc is not greater in diameter than the width of body.

Figure 3. Female, taken during spawning. $\times\frac{3}{4}$. (Photographed in life.)

Figure 4. Posterior portion of a larva, to show fin outline. $\times 1$.



1



2



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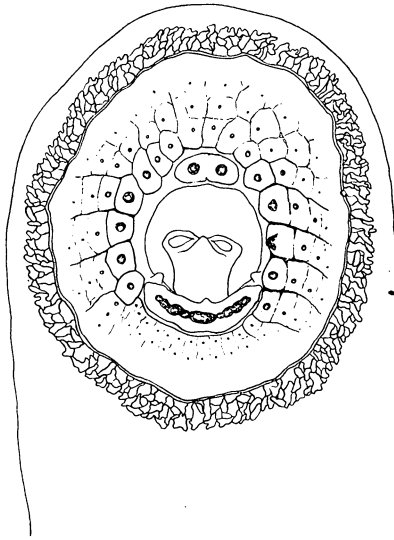


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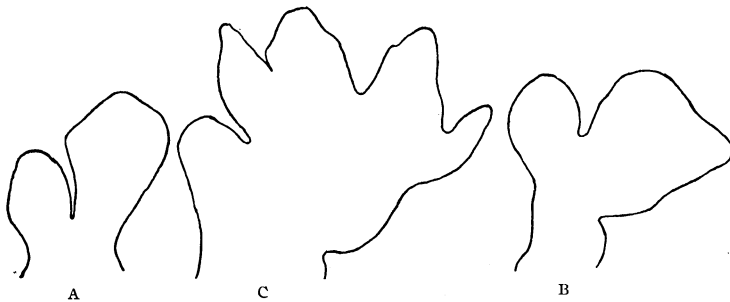
PLATE II.

Figure 1. Sketch of mouth. x10.

Figure 2. Oral fimbriae. a, middle anterior; b, middle lateral;
c, middle posterior. x50.



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