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Description of larval pirate perch, Aphredoderus sayanus (Gilliams) from the Savannah River.

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INTRODUCTION

The pirate perch, Aphredoderus sayanus is the only living member of the family Aphredoderidae, one of three families in the North American order Percopsiformes. It occurs in the southern portions of the Great Lakes drainage, the Mississippi Valley and the lowlands of the Gulf and Atlantic slopes from Texas through New York (Eddy and Underhill 1974; Lee et al. 1980). Western and eastern subspecies, A. s. gibbosus and A. s. sayanus, respectively, are recognized by some authors and questioned by others (Bailey et al. 1954; Smith 1979; and Lee et al. 1980). The pirate perch is nocturnal in behavior and typically inhabits marshes, swamps, estuaries, bottomland lakes, overflow ponds and quiet springs, pools, backwaters, and oxbows of low-gradient streams with an abundance of vegetation, organic debris, or other cover (Abbott 1861; Jordan and Evermann 1896; Becker 1923; and Becker 1983).

One of the more unusual features of adult pirate perch is the jugular position of the vent. Mansueti (1963) documented the migration of the vent from a more typical abdominal position (just anterior to the anal fin) in metalarvae to its adult position beneath the heart in specimens over 60 mm total tength (TL).

Aside from Mansueti's (1963) well illustrated description of metalarvae and juveniles, the only published information on pirate perch larvae originated with Martin and Hubbs (1973), Hogue et al. (1976) and Hardy (1978), and was summarized by Hardy (1978), Wang and Kernehan (1979), and Auer (1982). Martin and Hubbs (1973) described aspects of the development from fertilized egg through a few days after hatching, but provided neither illustrations nor size data for the larvae; they did, however, note that fertilized eggs were about 1.0 mm in diameter with single oil globules under 0.4 mm in diameter. Hardy (1978) included supplemental notes by Martin and drawings of a fertilized egg and three recently hatched protolarvae based on photographs. Again, the lengths of the larvae illustrated were not recorded and, unfortunately, the specimens are not available (F.D. Martin personal communication). Hogue et al. (1976) provided a photograph of an 8 mm TL specimen and some descriptive notes based on three Tennessee River larvae. Some of the information summarized by Auer (1982) appears to be mistakenly attributed to specimens about 4 mm TL.

The following account is intended to partially fill the gap in our knowledge of pirate perch larvae, especially mesolarvae, and provide a basis for distinguishing them from the larvae of other species. Unfortunately, information on the protolarvae and recently transformed mesolarvae remains incomplete.

MATERIALS AND METHODS

Pirate perch larvae were collected during an ichthyoplankton survey in the Savannah River (South Carolina and Georgia) between River Mile 157.3 near the Department of Energy's Savannah River Plant and River Mile 44.8 near Ebenezer Creek.

Ichthyoplankton samples were collected with paired 0.5 m, 505 µ, conical nets, preserved in buffered 5 % formalin and stained with Eosin B and Biebrich scarlet to facilitate sorting. After sorting, specimens were stored in 70 % ethanol. Shrinkage due to alcohol preservation must be considered when comparing our results with living, freshly killed or formalin-preserved specimens. A series of 33 larval specimens from 5.8 mm TL to 14.7 mm TL were collected during March, April and May 1983.

Selected measurements, fin ray counts, myomere counts, and developmental terminology followed Snyder (1981). Measurements used in this account are defined in Table 1. Specimens were examined and analyzed under a stereomicroscope fitted with polarizing filters (useful for myomere and fin ray counts) and a calibrated ocular micrometer. Morphometrics were expressed as percent standard length to avoid erroneous data based on damaged caudal rays and the allometric influence of the caudal fin on total length. All standard length measures were made to the posterior margin of the hypural plate. Some developmental data for stages earlier than those examined were extracted from previous published accounts and a personal

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Table 1. Selected morphometric data expressed as percent standard length (%SL) for mesolarvae and metalarvae of Aphredoderus sayanus from the Savannah River.

Parameter	Mesolarvae x + SD	Range	N	Metalarvae x + SD	Range	N
Size, mm						
Total Length	6.6 ± 0.6	5.8 - 7.7	14	10.8 ± 2.0	8.2 - 14.7	19
Standard Length	5.6 ± 0.4	5.1 - 6.4	14	8.7 ± 1.5	6.7 - 11.8	19

Parameter	Mesolarvae x + SD	Range	N	Metalarvae x + SD	Range	N
Length, % SL						
Anterior margin of snout (AS) to:						
Anterior margin of eye (AE)	6 ± 1	5 - 8	14	9 ± 1	7 - 11	19
Posterior margin of the eye (PE)	14 ± 2	12 - 17	14	18 ± 1	17 - 20	19
Origin of pectoral fin (OP1)	28 ± 2	25 - 33	14	33 ± 2	30 - 36	19
Posterior margin of operculum (PO)	30 ± 3	26 - 34	14	37 ± 2	33 - 39	19
Origin at pelvic fin (OP2)	-	-	-	42 ± 2	37 - 44	19
Origin of preanal finfold (OPAF)	44 ± 5	31 - 51	13	50 ± 6	31 - 57	17
Origin of dorsal finfold (ODF)	35 ± 4	28 - 44	14	42 ± 2	32 - 45	18
Origin of dorsal fin (OD)	45 ± 2	42 - 47	13	47 ± 1	44 - 49	19
Insertion at dorsal fin (ID)	64 ± 4	61 - 69	4	69 ± 2	65 - 72	19
Posterior margin of vent (PV)	55 ± 2	51 - 59	14	60 ± 2	57 - 62	19
Origin of anal fin (OA)	62 ± 1	60 - 64	12	64 ± 2	62 - 67	19
Insertion of anal fin (IA)	72 ± 2	71 - 75	4	76 ± 3	71 - 81	19
Posterior margin of caudal fin (PC)	117 ± 4	109 - 122	14	124 ± 2	119 - 127	19
Pectoral fin (PI)	18 ± 3	14 - 23	14	22 ± 2	17 - 24	19
Pelvic fin (P2)	-	-	-	6 ± 4	1 - 14	19
Dorsal fin (D)	21 ± 2	20 - 23	4	29 ± 3	23 - 34	18
Anal fin (A)	12 ± 1	12 - 13	4	18 ± 4	11 - 24	18
Depths, % SL at						
Posterior margin of eye (BPE)	22 ± 2	18 - 25	14	27 ± 1	25 - 29	19
Origin of pectoral fin (OP1)	23 ± 2	20 - 28	14	29 ± 2	25 - 31	19
Origin of dorsal fin (OD)	19 ± 3	15 - 23	14	26 ± 2	20 - 29	19
Posterior margin of vent (BPV)	10 ± 2	7 - 15	14	17 ± 4	11 - 22	19
Origin of anal fin (OA)	9 ± 1	7 - 11	14	16 ± 3	11 - 20	19
Anterior margin of posterior myomere (AMPM)	6 ± 1	5 - 8	14	10 ± 1	8 - 13	19
Widths, % SL at						
Posterior margin of eye (BPE)[a]	20 ± 2	17 - 24	14	23 ± 2	19 - 28	19
Origin of pectoral fin (OP1)[a]	13 ± 1	11 - 16	14	16 ± 1	14 - 18	19
Origin of pectoral fin (OP1)[b]	20 ± 3	13 - 23	14	23 ± 2	20 - 29	19
Origin of dorsal fin (OD)	9 ± 3	6 - 12	14	14 ± 1	11 - 16	19
Posterior margin of vent (BPV)	6 ± 1	5 - 7	14	9 ± 2	6 - 11	19
Origin of anal fin (OA)	6 ± 1	5 - 7	14	8 ± 2	6 - 9	19
Anterior margin of posterior myomere (AMPM)	4 ± 1	3 - 5	14	4 ± 1	3 - 5	19

[a] Exclusive of opercula.

[b] Inclusive of opercula.

communication (see Table 2). Illustrations were initially traced from photographs to assure accurate proportions and structure location. Details and pigmentation were completed while examining the photographed specimen and additional, similar sized larvae.

Table 2. Size (mm standard length/mm total length) at the apparent onset of selected developmental events for Aphredoderus sayanus. Referenced structures are observable under low power magnification. Rare or questionable extremes are enclosed in parentheses. Question marks indicate extracted or otherwise unverified data.

Hatching	? 2-3/(2)3[a]
Eyes pigmented	? (2)3/(2)3[a]
P1 bud formation	? 3/3(4)[a,b]
P2 bud formation	(6)7/8
Yolk completely absorbed	? (3)4/4(5)[b]
Finfold completely absorbed	12/15-16
Gut coil or loop formation, as evidenced by at least a 90° bend	? ≤4(5)/≤5
Segmentation evident in the principal rays of all fins	9-10/12-13

Fin rays	First observed	Adult complement
Principal C	? 3-4/4[a,b]	? (4)5/5-6[b]
Secondary C	7/(8)9	9/(11)12
Principal D	(5)6/(6)7	6-7/(7)8
Principal A	6/7	6-7/(7)8
P1	5/6	6-7/(7)8
P2	8/10	11-12/14

Scales	
initial appearance	10/ 12-13
full coverage	? ≥20/≥24[c]

[a] Based on drawings of recently hatched specimens illustrated in Hardy (1978); sizes were approximated by extrapolation from size of yolk and oil in an illustrated egg assumed to be about 1.0 mm in diameter.

[b] Based, at least in part, on state of development reported for a 4.3 mm specimen which possesses little yolk, pectoral fin buds and a few caudal rays (D. Lowery, personal communication).

[c] Based on visual examination under the microscope of specimens not stained for this purpose.

RESULTS

Morphometrics, developmental state relative to size and myomere counts are summarized in Tables 1, 2 and 3, respectively. Body form and pigmentation are illustrated in Figures 1, 2 and 3. Pirate perch larvae are distinguished by a relatively short preanal length, the triangular shape of the gut region, anterior air bladder position, relative position of dorsal and anal fin, 14-17 postanal myomeres (Table 3), 18 principal caudal rays and very distinct pigmentation. Large stellate melanophores are concentrated on top of the head, laterally in the gut region and a few mid-laterally on the body. Suborbital bar pigment exists in all of our larval specimens.

Our smallest mesolarvae (5.8 mm TL) has a full complement of principal caudal rays (although some are poorly defined), pectoral fins without rays, an air bladder, dorsal and anal fin folds with a few dorsal fin pterygiophores forming, a fairly large head and large stellate melanophores, especially over the head and gut region (Figure 1). A distinct crescent of melanophores at the base of the caudal fin is present in some later mesolarvae. Mesolarvae have well developed median fins by 8 mm TL (Table 2). Transformation to metalarval phase occurs at about 8 mm TL with the acquisition of the adult complement of principal rays in the median fins and the appearance of pelvic fin buds.

As pirate perch larvae increase in size, their body proportions change considerably relative to standard length (Table 1). Head length (OP1) increased from a mesolarva mean of 28 percent SL to a metalarva mean of 33 percent SL (30 to 37% SL based on PO). Preanal length (PV) increased from 55 to 60 percent SL (Table 1). Body depth and body

width increased at all points measured, except width at AMPM (Table 1). Other changes, except for the morphogenesis of the fins, are less pronounced. There is an increase in small melanophores scattered over the body until the body attains a dusky coloration early in the juvenile period. The suborbital bar is very distinct on metalarvae (Figure 3). The pelvic fin buds are present by 8 mm TL and develop a full complement of fin rays by about 13.5 mm TL (Table 2). The anus commences its anterior migration around 9 mm TL (Hardy 1978); however, very little anal migration occurs during the metalarval phase. Most of the migration occurs during the juvenile period (Mansueti 1963). The preanal finfold persists to about 15 - 16 mm TL (Table 2). Specimens 15 mm TL are considered to be juveniles with the attainment of a full complement of fin rays, segmentation apparent in median fin rays and the absence of finfolds. Hardy (1978) describes a juvenile as having a minimum length of 14 mm TL.

Table 3. Frequency distribution of myomere counts for pirate perch mesolarvae (N=14) and metalarvae (N=19), from the Savannah River. See Snyder 1981 for count criteria.

	Myomere count	No. of larvae: Meta-larvae	No. of larvae: Meso-larvae
Preanal (to posterior margin of vent)	12	4	5
	13	5	7
	14	11	2
Postanal	14	4	2
	15	12	5
	16	3	6
	17	0	1
Total	27	3	3
	28	5	4
	29	10	7

DISCUSSION

The later mesolarvae and metalarvae of pirate perch from the Savannah River are very similar to the larvae described by Hogue et al. (1976) and Mansueti (1963). However, pigmentation differences between Savannah River specimens and the 8 mm TL Tennessee River specimen illustrated by Hogue et al. (1976) are notable. In contrast to Savannah River specimens (Figure 3), the Tennessee River specimen exhibited melanophores distributed more evenly over the head and body. Also, in Hogue's specimens the range of preanal and postanal myomeres differ by one from our specimens. Our pirate perch have their adult complement of median fin rays by 12 mm TL. Hogue et al. (1976) reports this event to occur at 13 mm TL. The differences may reflect differences in preservation, collection from different environments or genetic differences between populations or subspecies.

Several genera of the Centrarchidae may be difficult to distinguish from pirate perch. Larvae of an Elassoma species taken in Savannah River ichthyoplankton collections were found to be very similar to pirate perch in appearance, developmental state relative to size and total myomeres. The most obvious difference between Aphredoderus and Elassoma is in pigment. The Elassoma larvae have small melanophores scattered rather uniformly over much of the head and body as well as a broad ovoid midventral band anterior to the vent with a very dense spot at the anterior apex of the band. However, since distribution of melanin in melanophores depends in many cases on the larva's environment, the appearance could vary with habitat. Less obvious and definitive criteria noted in preliminary comparisons include slightly higher postanal myomere counts of 17 or 18 and earlier pelvic bud formation at about 6 mm SL or 7 mm TL for Elassoma. Once the adult complement of principal caudal rays are present, in the mesolarvae phase, counts of 18 for pirate perch and 16 or fewer for Elassoma species (Conner 1979) serve as good criteria for diagnosis. Metalarvae are readily segregated on the basis of fin meristics and position (e.g., dorsal fin insertion well anterior to anal fin insertion in pirate perch, but over the anal fin insertion in Elassoma).

The higher postanal myomere count (19 - 23 postanal myomeres), air bladder development and position of dorsal and anal fin readily separates Centrarchus and Pomoxis larvae from pirate perch larvae. Unlike pirate perch, the Centrarchus and Pomoxis larvae develop an air bladder which extends posteriorly to or beyond the anus (Conner 1979).

The protolarvae and mesolarvae of Enneacanthus and possibly Acantharchus might also prove to be quite similar to pirate perch. Unfortunately, we are not aware of descriptions of Enneacanthus mesolarvae or any larval phase of Acantharchus, and, as mentioned earlier, our knowledge of pirate perch protolarvae is inadequate.

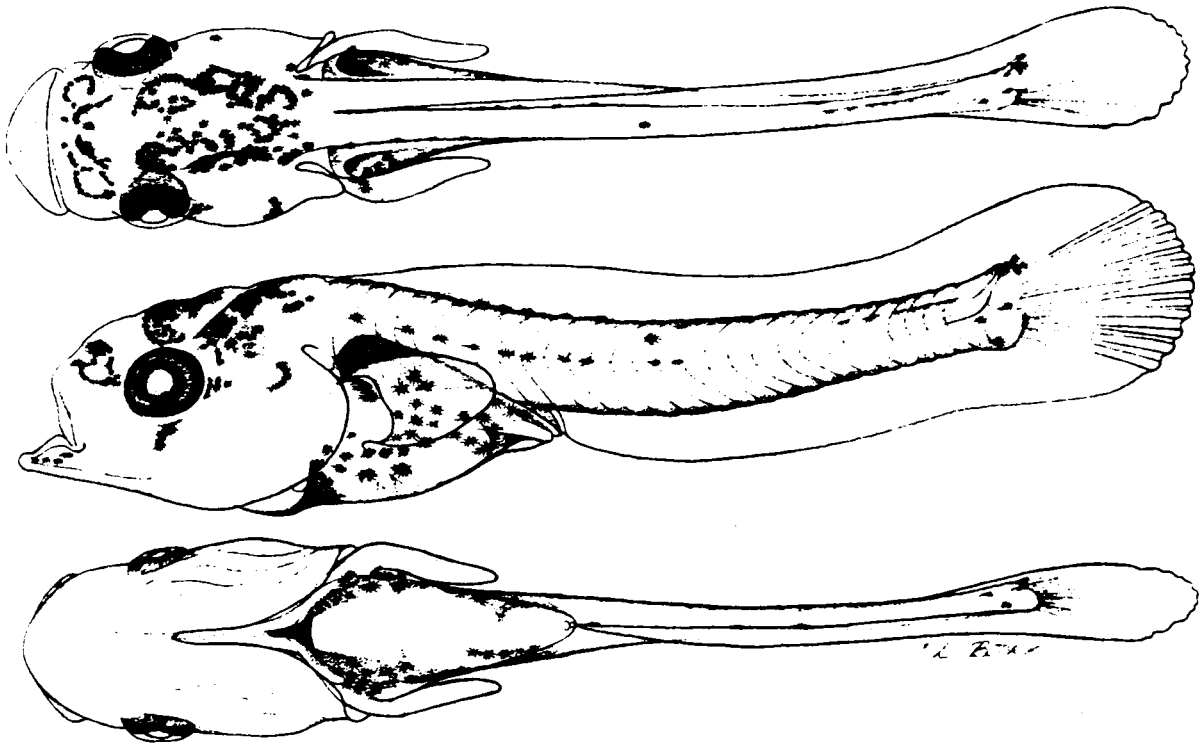

Figure 1. Pirate perch (Aphredoderus sayanus) mesolarvae; dorsal, lateral and ventral views; 5.8 mm TL, 5.1 mm SL. Collected from the Savannah River, South Carolina.

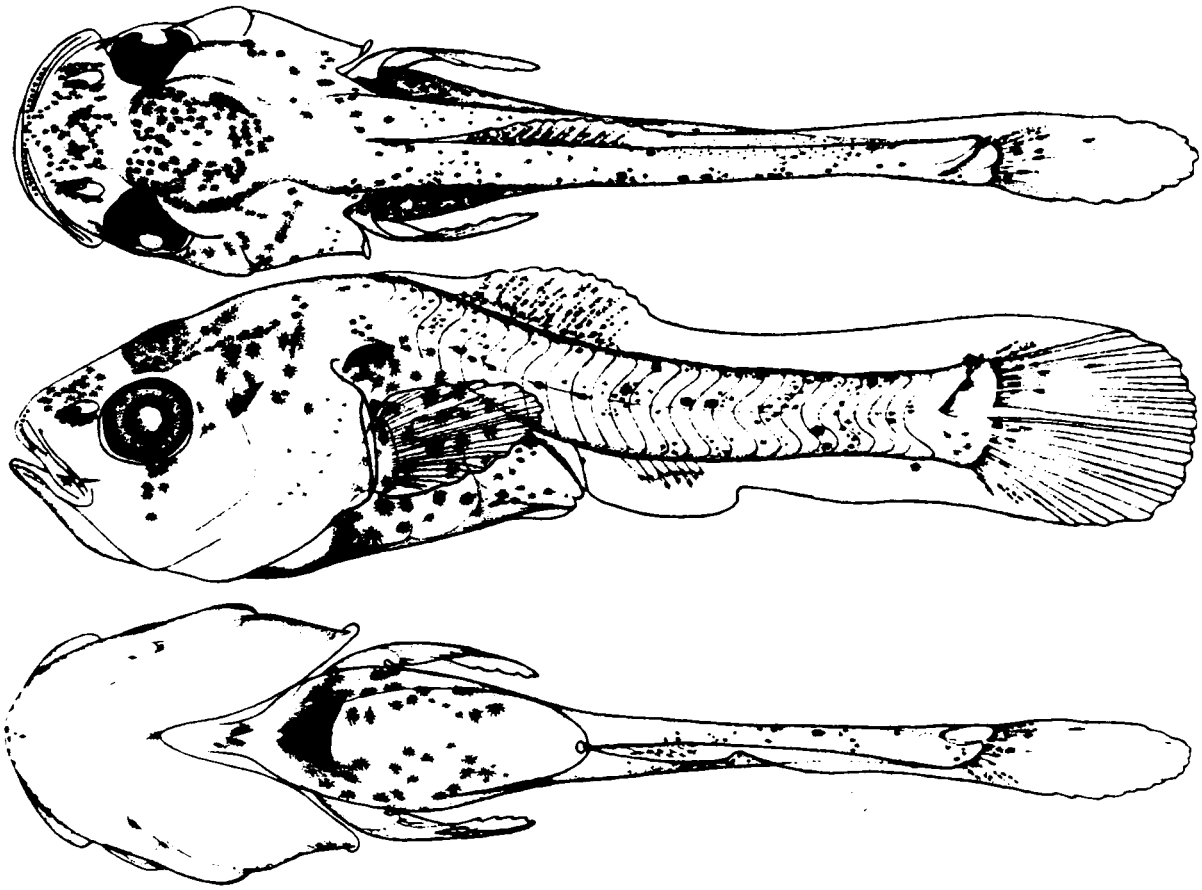

Figure 2. Pirate perch (Aphredoderus sayanus) mesolarvae; dorsal, lateral and ventral views; 7.5 mm TL, 6.2 mm SL. Collected from the Savannah River, South Carolina.

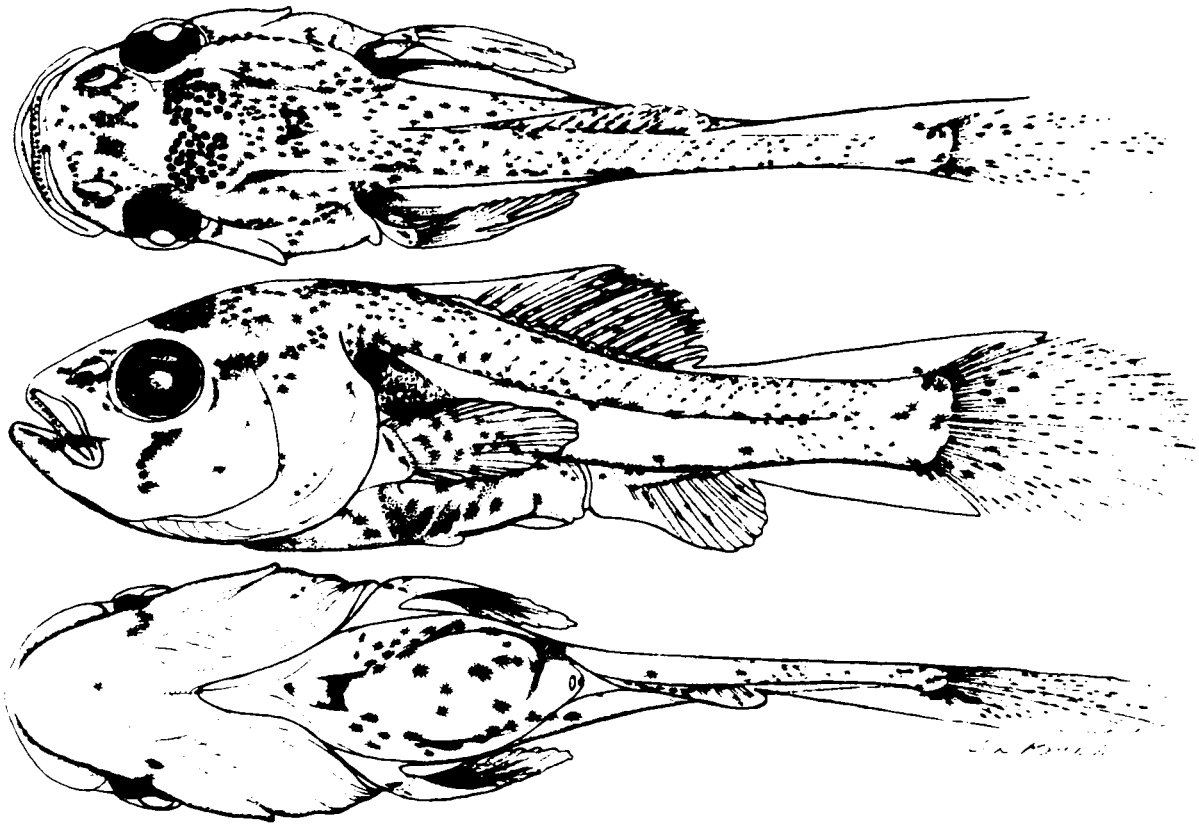

Figure 3. Pirate perch (Aphredoderus sayanus) metalarvae; dorsal, lateral and ventral views; 9.1 mm TL, 7.3 mm SL. Collected from the Savannah River, South Caroina.

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