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Description of the larval stages of the Shield Darter, *Percina peltata* (Pisces: Percidae), in New York

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Abstract

A series of larvae of *Percina peltata* (Pisces: Percidae) was collected from the Neversink River, a Delaware River tributary, in spring of 2001 and 2002. We provide descriptions and illustrations of yolk sac larvae and post yolk sac larvae through the end of larval development. The larval morphology of *P. peltata* is plesiomorphic for the clade of the Etheostomatinae which we correlate with the plesiomorphic position afforded *P. peltata* in other studies. We do not consider the larval morphology of this species to be an adaptation to its environment.

Key words: early life history, post yolk sac larvae, taxonomy, yolk sac larvae

Introduction

The shield darter, *Percina peltata* (Stauffer 1864), is a small freshwater percid distributed on the Atlantic coastal plain and Piedmont from the Hudson, Delaware, and Susquehanna Rivers in New York, south to the Neuse River in North Carolina (Page 1983, Smith 1985). Three subspecies have been recognized (Page 1983). The nominal form ranges from the James River, Virginia, northward (Page 1983, Jenkins & Burkhead 1994). *P. nevisense*, from rivers in Virginia and North Carolina, has been elevated to species (Goodin *et al.* 1998) and the third form from the upper Roanoke remains undescribed (Jenkins & Burkhead 1994).

Percid larvae are well known and readily distinguishable in North America (e.g. Auer 1982, Wallis *et al.* 1990). Descriptions of larvae of *Perca*, *Sander*, and several species of *Etheostoma* have been published (Auer 1982, Hardy 1978, Paine 1984). Descriptions of larvae of the genera *Percina* and *Ammocrypta* are scarce and poorly illustrated, except for

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Percina caprodes (Auer 1982, Cooper 1978, Fish 1932). The purpose of this paper is to provide descriptions of the larval stages of *Percina peltata* and to discuss some systematic implications.

Methods

During drift net sampling in the Neversink River, Orange County, New York, in spring of 2001 and 2002, we collected a series of percid larvae that did not fit the characteristics of the described larval percids known from the area. The percid fauna of the Neversink River includes *Etheostoma olmstedi*, *Perca flavescens*, *Sander vitreus*, and *Percina peltata* (Smith 1985). Since all but *P. peltata* larvae are well described (Auer 1982) and the larvae collected did not fit any of those descriptions, by process of elimination, the larvae collected are *Percina peltata*.

Material examined: All specimens are from the Neversink River, Orange County, New York, and catalogued in the New York State Museum (NYSM). NYSM 52620: Above dam in Cuddebackville, May 16, 2001, 2 specimens, 8–10 mm TL. NYSM 52623: Bridge on Neversink Drive, Huguenot, May 16, 2001, 2 specimens, 5.5–9 mm TL. NYSM 52722: Above dam in Cuddebackville, May 31, 2001, 1 specimen, 14 mm TL. NYSM 52905: Above dam in Cuddebackville, June 7, 2001, 1 specimen, 16 mm TL. NYSM 52907: Bridge on Guymard Turnpike, Myers Grove, June 7, 2001, 1 specimen, 15 mm TL. NYSM 53072: Bridge on Neversink Drive, Huguenot, June 14, 2001, 1 specimen, 7 mm TL. NYSM 53076: Bridge on Guymard Turnpike, Myers Grove, June 14, 2001, 3 specimens, 18–20 mm TL. NYSM 53128: Above dam in Cuddebackville, June 7, 2001, 1 specimen, 19 mm TL. NYSM 53344: Bridge on Neversink Drive, Huguenot, July 5, 2001, 1 specimen, 16 mm TL. NYSM 54562: Bridge on Guymard Turnpike, Myers Grove, June 13, 2002, 1 specimen, 10 mm TL.

Meristic characters were observed under a stereomicroscope following Auer (1982). Morphometric measurements were made with a ocular micrometer.

Results

Percid yolk sac larvae are distinguished from other North American families by having the vent near midbody, a large anterior oil droplet in the yolk sac, usually well developed pectoral fins at hatching, and relatively numerous thin myomeres (Auer 1982, Wallis *et al.* 1990). Also, in post yolk sac larvae, the spinous dorsal fin is separate from the soft dorsal fin (Wallis *et al.* 1990). Development of *Perca* and *Sander* is well described (Craig 1987). Early developmental stages of most other percids have been poorly studied, but they appear to be very similar in morphology (Auer 1982). The following descriptions are based on 14 specimens, 5.9–18.3 mm total length (TL).

Yolk sac larvae–

The yolk sac is present in larvae from 5.9 mm TL to 7.9 mm TL. In the smallest specimen, the length of the yolk sac is 42% of the total length of the larva (Figure 1A). The anterior oil globule is small with the maximum length at 19% of the length of the yolk sac. The anus is slightly posterior of midbody (54% of TL) but the preanal myomere number equals the postanal (Table 1). Pectoral fin buds are present and large, situated dorsally but have no visible fin rays. The dorsal fin fold begins at about myomere 18 and extends around the caudal to the anus. Four small fin ray precursors are visible in the posterior part of the dorsal fin fold. These rays can only be seen with strong lighting and careful manipulation of the larvae under high power. Pigment consists of small melanophores scattered over the lateral and ventral surfaces of the yolk sac and in a thin line on the ventral surface of the myomeres from about myomere 19 to 35. Larger and darker melanophores are situated on several of the myosepta.

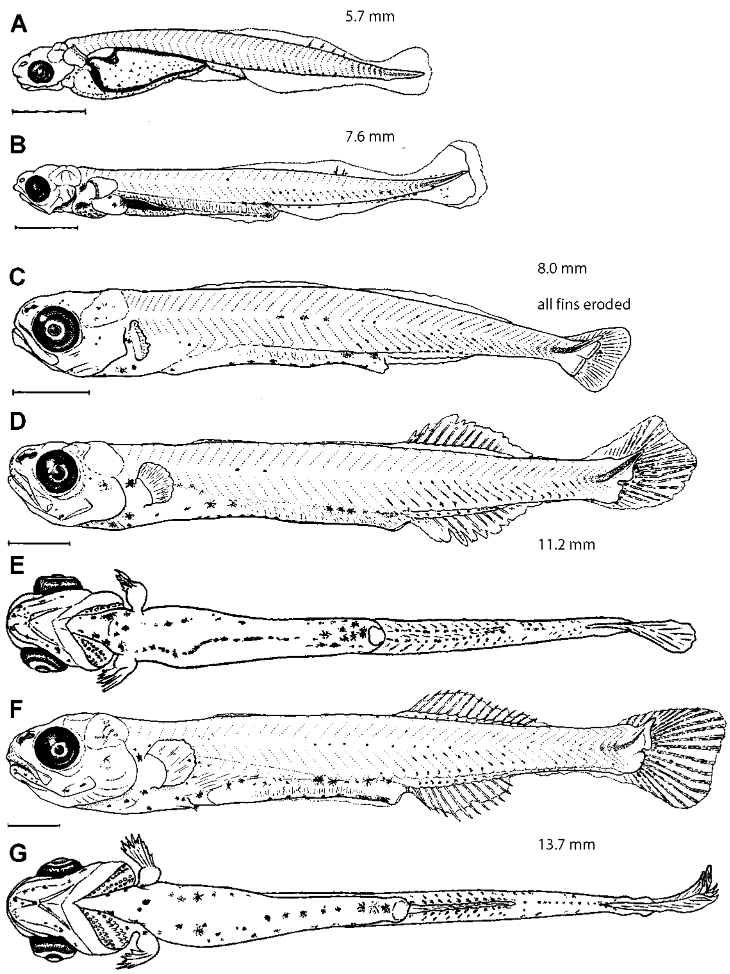

FIGURE 1. Larvae of *Percina peltata*. A. Yolk sac larva. B. Larva at the end of yolk absorption. C. Larva at the beginning of caudal flexion. D. Early post yolk sac larva. E. Ventral view of early post yolk sac larva. F. Late post yolk sac larva. G. Ventral view of late post yolk sac larva.

In the largest specimen with remnants of yolk (7.6 mm SL, Fig. 1B), pigmentation becomes more extensive. Melanophores are crowded on the breast and enlarged and two very large melanophores are located dorsally and ventrally, respectively, to the pectoral fin base. Scattered fine melanophores are present along the ventral surface of the yolk sac. Pigment along the ventral surface is about the same as in the smaller larva (Fig. 1A). Pigment on the myosepta of the hypaxial muscles is more extensive, however, beginning on the myomere behind the anus and extending to the caudal peduncle.

TABLE 1. Meristics and morphometrics of *Percina peltata* larvae from the Neversink River, New York. TL is total length in mm. The following morphometrics are in percent of TL: standard length (SL), preanal length (PA), head length (HD), snout length (ST), eye diameter (EY), and body depth (BD). The meristics are: preanal myomeres (M1), postanal myomeres (M2), first dorsal spines (D1), second dorsal rays (D2), anal fin rays (AN), and pectoral fin rays (PT).

TL	SL%	PA%	HD%	ST%	EY%	BD%	M1	M2	D1	D2	AN	PT
5.9	97.2	54.9	13.4	2.8	6.3	16.9	21	21				
7.1	96.5	56.5	20	2.4	5.9	15.3	19	21				
7.5	97.8	57.8	16.7	3.3	6.7	12.2	20	22				
7.9	97.9	55.8	12.6	3.2	5.8	10.5	20	21				
8.5	91.2	58.8	23.5	3.9	6.9	14.7	20	20				
8.8	95.2	60	19	3.8	5.7	13.3	18	21				
12.3	90.5	56.8	20.3	4.1	6.8	13.5	21	19				
13.3	83.8	51.3	22.5	3.8	6.3	15	17	21	8	11	11	–
14	92.9	58.3	19	3.6	7.1	13.1	20	22	–	13	11	13
14.2	84.7	58.8	22.4	4.7	6.5	12.9	20	21	8	12	12	15
16.3	87.8	56.1	19.4	5.1	6.1	12.2	20	22	12	13	11	–
17	87.3	53.9	25.5	4.9	6.9	12.7	20	21	10	11	11	16
17.8	87.9	55.1	20.6	4.7	5.9	15	20	21	12	13	12	–
18.3	85.5	56.4	18.2	4.1	5.7	11.8	20	21	12	13	11	–

Post yolk sac larvae–

Flexion begins about 8 mm SL (Fig. 1C). Principal caudal rays and some accessory rays are visible as well as rays in the pectoral fin. The fin fold delineating the spinous dorsal is visible and separate from the posterior dorsal fin fold. The second dorsal and anal fin folds are separated from the caudal, as well. Pigmentation is similar in distribution to the late yolk sac larvae (Fig. 1B).

At about 11 mm SL (Fig. 1D), rays are visible in the second dorsal and anal fins. Pigmentation on the anterior body is the same as described above, but pigmentation posterior to the anus has increased. Dark melanophores on the hypaxial myosepta are more continuous and provide an easily observed color pattern that distinguishes shield darter from the other percids in the Neversink drainage. Ventral pigmentation (Fig. 1E) is essentially a median line of melanophores on the anterior gut (deflected in the specimens illustrated) with a line on either side of the isthmus. There is a line of melanophores on either side of the anal fin, each of which is in line with the myoseptal pigmentation. There is a single median line posterior to the anal fin.

The pigmentation patterns described in the previous paragraph remain the same in larger larvae (~13 mm SL, Figs. 1F&G). Dorsal fin spines become apparent and second dorsal and anal fins have the adult complement of rays (Table 1). Pelvic fins begin to develop. The adult complement of fin elements is present in individuals at about 16 mm SL, therefore they are technically juveniles.

The hypaxial myoseptal pigmentation gives shield darter larvae a very distinctive appearance. Under low power magnification, the pigment appears as relatively bold stripes angled posteriorly over and slightly posterior to the anal fin. This pigmentation distinguishes shield darter larvae from all the other percids in the Neversink River. We have not seen any percid larvae with this pigmentation, but so few have been illustrated that we are unsure of whether this color pattern is unique to the shield darter.

Discussion

Near (2002) placed *P. peltata*, along with three other Atlantic slope species, into a monophyletic clade that is the sister group to all other *Percina* species. Too little is known about the larvae of this genus to use larval characteristics to analyze intrageneric relationships. However, shield darter larvae have characteristics that we consider plesiomorphic: they are elongate, possess numerous small myomeres, and have a large oil droplet in the anterior yolk sac. *Perca* and *Sander* larvae have the same morphology and those two genera are plesiomorphic within the Percidae (Near *et al.* 2000, Wiley 1992). *Perca*, *Sander*, and *Percina* larvae also lack the derived characteristics found in *Etheostoma* larvae, which are typically “bullheaded” and have a large anterior yolk sac with the oil droplet surrounded and obscured by yolk making it difficult to see (see illustrations of percid early larvae in Balon *et al.* 1977).

Paine (1984) suggested that these larval differences are related to the necessity for *Percina* larvae to drift to feeding locations and for *Etheostoma* larvae to remain in place in streams. Too few larvae of either genus have been described to assume that this generality is valid and an alternative assessment is that larval type may be an evolutionary characteristic, independent of life history, behavior, or ecology.

Percina is plesiomorphic compared to *Etheostoma* (Wiley 1992) in the monophyletic Etheostomatinae (Page 1985, Coburn & Gaglione 1992, Wiley 1992). Page (1974) and Bailey & Etnier (1988) regarded *Percina* as the plesiomorphic darters because they generally lack breeding colors and nuptial tubercles, have high meristic counts, are relatively large, and are hyperbenthic. Near (2002), however, said that there was "no cladistic basis to presume that *Percina* is the sister taxon to all other darter species." In fact, Near *et al.* (2000) suggested that the relationship among etheostomine genera requires further study.

Our observations on the morphology of larval *P. peltata* suggest that this species possesses several ancestral characteristics and that its larvae are very similar to those of *Perca* and *Sander*. Our conclusion, then, is that *P. peltata* larvae are plesiomorphic. Interestingly, adult *P. peltata* do not possess the traits, listed in Page (1983), that have been identified as plesiomorphic. Adult shield darters are demersal, live in riffles and are not fusiform. Aspects of the natural history of shield darter also suggest that ability for larvae to drift is unimportant. Shield darter spawns in riffles and leaves its eggs unguarded, buried in gravel (New 1966). Furthermore, "place holding" morphology does not mean necessarily that a larval darter does not drift. Yolk sac larvae of *Etheostoma olmstedi*, which possess derived characteristics (Auer 1992), are frequently taken in drift samples in Hudson River tributaries (Schmidt & Lake *In press*). The combination of ancestral and derived traits within *P. peltata* suggests strongly that the ability to drift did not originate in *Percina*. We propose that larval drift is not an adaptation, as intimated by Paine (1984), but is, instead, a retained characteristic unassociated with behavior or ecology.

The larvae of *P. peltata* possess plesiomorphic traits. If shield darter fry are representative of *Percina* fry in general, then *Percina* may be the ancestral darter genus. Alternatively, Near (2002) placed shield darter in the ancestral *Percina peltata* clade, sister group to all other *Percina* species. Traits found in shield darter may not be shared by species in other clades, which would support the contention that *P. peltata* is ancestral within the genus, but would not add significantly to assessing the status of the genus in relation to other genera within the family. Examination of larval characteristics of additional species could be revealing.

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