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Description of Eggs and Larvae of Fantail *(Etheostoma flabellare)* and Rainbow *(E. caeruleum)* darters from Lake Erie Tributaries[1]

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Abstract

Fantail and rainbow darter eggs and larvae were reared through the juvenile phase. Fantail darter eggs ranged from 2.5 to 2.9 mm in diameter and were amber in color. Rainbow darter eggs ranged from 1.7 to 1.9 mm in diameter and were clear with a yellow yolk.

Fantail darter protolarvae hatched at 5.8 to 6.5 mm total length and rainbow darter protolarvae hatched at 6.0 to 6.2 mm total length. The yolk sac was larger in the fantail darter and fin-ray formation was more rapid than that reported for other darter species in Lake Erie tributaries. Growth rate of the rainbow darter was similar to that of the greenside darter (*Etheostoma blennioides*).

Fantail darter eggs were spawned on the undersides of rocks, similar only to the johnny darter (*E. nigrum*). Larvae of the fantail and rainbow darters can be separated from other percids in Lake Erie tributaries by length at yolk absorption, length at fin-ray formation, and pigmentation patterns.

The fantail darter *Etheostoma flabellare,* and the rainbow darter *Etheostoma caeruleum,* are common in the stream tributaries of Lake Erie, but little is known of their egg and larval phases. Hankinson (1932) and Lake (1936) presented photographs of fantail darter eggs, and a few larvae were illustrated by Lake (1936). The eggs and larvae of the rainbow darter have not been described but reproductive habits of this species have been studied by Reeves (1907) and Winn (1957, 1958). The present study describes and illustrates egg and larval phases of the fantail and rainbow darters.

The spawning season of the fantail darter begins in late March and early April and continues to the end of June (Lake 1936). The males migrate from riffles to slow, shallow water (30–50 cm depth) where the nesting sites are prepared. Migration was observed by Lake (1936) when water temperature was 7–15 C in New York. A 15–25-mm cavity, located under a rock, is selected by the male as the nest site. The male cleans the underside of the rock with his dorsal fins. Ripe females migrate into the nesting area during the latter part of April and May and are attracted to the nest site by the male who performs a series of rapid movements into and out of the cavity. Eggs are deposited and fertilized singly on the underside of the rock (Lake 1936). Average egg diameter is 2.2–2.3 mm (Lake 1936; Winn 1958).

Water temperature at spawning is 18–24 C (Greeley 1927) and eggs hatch after 30 to 35 days at 17–20 C; 21 days at 21–22 C; and 14 to 16 days at 23.5 C (Lake 1936). Hatching length is 7.0 mm and yolk absorption is complete 7–10 days after hatching (Lake 1936).

The spawning season of the rainbow darter has been reported as April to May (Winn 1958) and March to June (Reeves 1907). Spawning occurs in rubble and gravel, generally in riffles (Winn 1958). The male attracts the female by performing a series of trembles and nudges and displaying the opercles and pectoral fins. During spawning, the female is partly concealed in the gravel with the male above her. The male initiates the spawning act by vibrating his head; both fish then vibrate and the eggs and sperm are released (Reeves 1907). Fertilized eggs are 1.5 mm in diameter, pale yellow in color with one oil globule (Reeves 1907). Winn (1958) reported egg diameter as 1.6–1.8 mm and the embryos hatched after 10 to 11.5 days at 17–18.5 C.

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TABLE 1.—*Meristic counts from larval and juvenile fantail darters. Each couplet gives the mode and range. Counts, other than myomeres, were not made on larvae smaller than 6.51 mm.*

Size range (total length) mm	N	Spines and rays[a]							Myomeres[b]		
		Branchiostegal	Pectoral	Pelvic	Spiny dorsal	Second dorsal	Anal	Caudal	Preanal	Postanal	Total
									15	21	36
5.7–6.5	8								15–15	19–21	34–36
7.2–7.5	3		10		6	12	10	13	15	21	36
			10–10		6–6	12–13	10–10	13–14	15–15	21–21	36–36
7.7–8.4	4	3	10		6	13	10	14	15	20	35
		3–3	10–11		6–7	12–13	9–10	13–15	15–15	20–21	35–36
8.5–9.4	11	4	11	3	7	13	10	16	15	21	36
		3–6	11–12	3–4	7–8	12–14	9–11	15–16	15–15	19–21	34–36
9.5–10.2	4	6	11	4	8	13	I,9	16	15	21	36
		5–7	11–13	3–5	8–8	12–13	0,10–II,8	16–16	15–15	21–21	36–36
10.7–11.5	7	6	12	5	8	14	II,8	16			
		6–6	12–12	5–6	7–8	12–14	I,9–II,8	14–19			
11.6–12.5	7	6	12	6	7	14	II,8	16			
		6–6	11–12	5–6	7–8	12–14	I,9–II,8	16–18			
12.8–14.0	6	6	12	6	VIII	14	II,8	18			
		6–6	12–12	6–6	VII–VIII	12–14	I,9–II,8	14–18			
18.7	1	6	12	6	VIII	14	II,8	18			
19.0	1	6	12	6	VIII	14	II,8	21			

[a] Roman numerals designate spines.
[b] Myomeres were not counted in fish larger than 10.5 mm.

Nine additional darter species have been reported from Lake Erie tributaries (Trautman 1957; Hubbs and Lagler 1974): eastern sand darter (*Ammocrypta pellucida*); greenside darter (*Etheostoma blennioides*); Iowa darter (*E. exile*); least darter (*E. microperca*); johnny darter (*E. nigrum*); logperch (*Percina caprodes*); channel darter (*P. copelandi*); blackside darter (*P. maculata*); and river darter (*P. shumardi*).

Descriptions of eggs and larvae for these species have been given for greenside darter (Fahy 1954); johnny darter (Fish 1932; Speare 1965); logperch (Fish 1932; May and Gasaway 1967; Cooper 1978); channel darter (Fish 1932; Winn 1958); and blackside darter (Petravicz 1938). Descriptions of eggs of Iowa darter were given by Winn (1958) and for least darter by Petravicz (1936) . Eggs and larvae of the eastern sand darter and river darter and larvae of Iowa darter and least darter are undescribed.

Egg and larva descriptions of three other Lake Erie percids, yellow perch (*Perca flavescens*), walleye (*Stizostedion vitreum*), and sauger (*S. canadense*), can be found in Norden (1961), Mansueti (1964), Olson (1966), May and Gasaway (1967), and Nelson (1968).

Methods

Eggs of the fantail darter were collected in Elk Creek, Pennsylvania, in 1975, and in the Greenbrier River, West Virginia, in 1978. Rainbow darter eggs were collected in Elk Creek in 1976. No attempt was made to artificially spawn eggs. Collected eggs were transferred to aquaria filled with aerated creek water. Egg samples were taken at the time of collection and then every 8 hours until hatching.

Larvae were sampled every 5 hours for the first 15 hours and then every 12 hours to the juvenile phase. Additional larval samples were collected by dip net. All samples were preserved in 10% formalin. Average aquarium water temperature was 14 C (range: 13.5–16.5) in 1975 and 21 C (range: 18–22) in 1976 and 1978.

Descriptions of fantail darter eggs and larvae were based on stock reared in 1975. Anatomical measurements were made to the nearest 0.1 mm. Body lengths given are total lengths. Il-

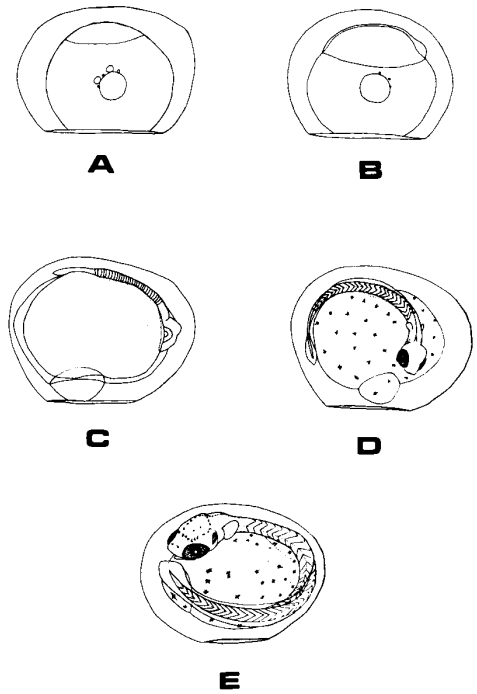

FIGURE 1.—*Developing eggs of the fantail darter, inverted from life. (A) morula; (B) embryonic axis; (C) tail-bud embryo; (D) free-tail embryo; (E) late embryo prior to hatching (2.7 mm diameter).*

TABLE 2.—*Selected measurements of larval and juvenile fantail darters expressed as means of percent total length with one standard deviation in parentheses.*

Size range (total length) mm	*N*	Standard length	Snout-vent length	Head length	Eye diameter
5.51–6.50	8	96 (1.2)	52 (1.9)	19 (0.7)	10 (0.7)
6.51–7.50	3	90 (0.6)	49 (1.5)	19 (1.5)	8 (0.6)
7.51–8.50	4	87 (2.5)	48 (1.3)	19 (0.8)	8 (0)
8.51–9.50	11	85 (1.5)	48 (1.6)	19 (1.7)	7 (0.5)
9.51–10.50	4	83 (0.9)	49 (0.5)	20 (0.9)	8 (0.8)
10.51–11.50	7	84 (1.3)	50 (1.3)	24 (0.6)	8 (0)
11.51–12.50	7	84 (0.5)	50 (0.6)	24 (0.6)	8 (0.4)
12.51–14.00	6	83 (0.5)	52 (0.8)	23 (1.1)	8 (0)
18.7	1	83	51	24	6
19.0	1	80	49	25	6

lustrations of larvae were drawn freehand at 10× magnification and each is to scale based on the respective recently hatched larva. Terms used for descriptions and measurements are from Mansueti and Hardy (1967); numeration of myomeres follows Fuiman and Loos (1977). Terminology of larva phases follows Snyder et al. (1977).

Developmental Morphology

Fantail Darter

Morphometric data for the fantail darter are given in Tables 1 and 2.

Eggs and Embryos

Fertilized eggs were oval-shaped due to the proximity of other eggs and the contours of the rock. The average egg diameter (N = 25) was 2.7 mm (range: 2.5–2.9 mm) which was larger than that reported by Lake (1936: 2.3 mm) and Winn (1958: 2.2 mm). The perivitelline space averaged 0.3 mm (range: 0.1–0.3 mm). A single amber oil globule (0.7–0.8 mm diameter) was present in each egg; occasionally several small globules were also present. The yolk was 2.0 mm in diameter and pale yellow in color (opaque after preservation in some). The yolk and oil globule gave the egg an amber color.

The least developed egg stage collected (Fig. 1A) had passed through cleavage and had no distinct blastomeres. The blastocoel could not be detected. The developing area covered 20% of the yolk surface. The embryonic axis (Fig. 1B) developed with no measurable change in yolk or egg diameters. The head region was slightly enlarged and the developing area covered one-third of the yolk.

In tail-bud embryos (Fig. 1C), the somites had developed and ranged in number from 25 to 30. The lens placodes were present and the head was pointed on the dorsal surface. Melanophores were present along the body-yolk juncture at nearly every somite and scattered over the yolk membrane.

In the free-tail stage (Fig. 1D), the pectoral fin buds were present and the eyes were pigmented. Distinct myomeres and otic vesicles

could be seen. Several scattered melanophores were present on the yolk membrane. The fin fold extended from the third myomere posteriorly around the tail, then anteriorly to the vent.

The mouth was formed prior to hatching (Fig. 1E). A circular series of melanophores outlined the dorsal surface of the head, occasionally with large melanophores within the outline. Melanophores had developed on the dorsal and ventral surfaces of the tail and near the vent. The average yolk diameter had decreased to 1.7 mm.

Protolarvae

Protolarvae hatched at an average length of 6.2 mm (N = 6; range: 5.8–6.5 mm) similar to that reported by Greeley (1927: 6.4 mm) but less than that given by Lake (1936: 7.0 mm). The yolk sac was large, 31% of total length in 6.2-mm larvae, which differed from the small yolk sac reported by Greeley (1927). The gills and rudimentary opercles had formed. The oil globule was flattened in the anterior part of the yolk sac (Fig. 2A, 2B).

Mesolarvae

Nine hours after hatching, fin-ray development was evident in the caudal, second dorsal, anal, and pectoral fins (Table 1), and the tip of the notochord had turned upward. The average length of seven mesolarvae was 7.2 mm at 9 hours and 7.8 mm at 11 hours. Rudimentary spine formation began in the spiny dorsal fin 11 hours after hatching and the jaws were well developed but lacked teeth (Fig. 2C). A series of melanophores was present along the dorsal and ventral surface of the body and along the horizontal septum.

Metalarvae

Metalarvae were 8.8 mm in length 15 hours after hatching (Fig. 2D). The pelvic fin buds were present just posterior to the oil globule (Fig. 2E). A single line of melanophores was present from the snout posteriorly to the opercle, extending around the posterior edge of the head. Melanophores were present on the vent and along the base of the anal fin.

Six days after hatching, the metalarvae averaged 9.5 mm in length and possessed the full complement of spines in the spiny dorsal and principal rays in the pectoral fins (Fig. 3A).

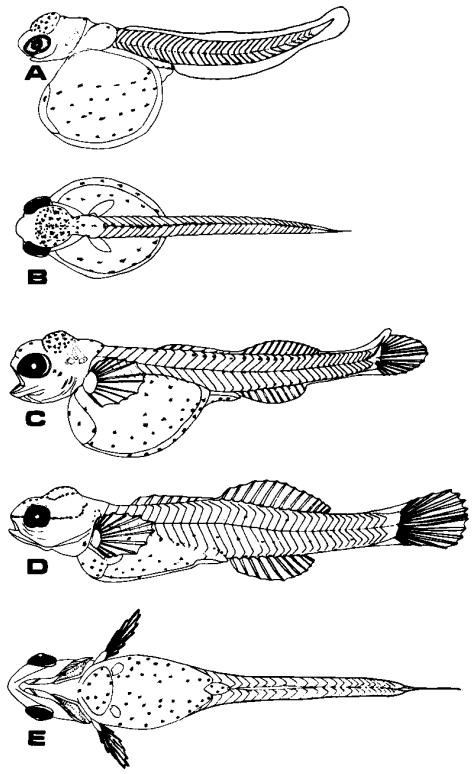

FIGURE 2.—*Larvae of the fantail darter. (A) recently hatched protolarva, 6.2 mm total length; (B) protolarva, 6.2 mm, dorsal view; (C) mesolarva, 7.8 mm; (D) metalarva, 8.8 mm; (E) metalarva, 8.8 mm, ventral view.*

Yolk absorption was complete 8 to 10 days after hatching at 9 to 10 mm total length.

Melanophores in square patterns had formed along the dorsal surface of the body in 9.5-mm metalarvae. Pigmentation on the head consisted of the snout-to-opercle melanophore series and a stellate pattern on the dorsal surface (Fig. 3B).

In 11.5-mm metalarvae (12 days after hatching), the melanophore series from the snout to the opercle had become more of a band (Fig. 3C). Melanophores were present along the rays of the second dorsal and caudal fins and along the spines of the spiny dorsal fin. Each ray had a melanophore at its base. A few larvae had melanophores along the pectoral fin rays. Twelve to 14 melanophore patches had developed along the horizontal septum. Internal melanophores were located on the dorsal surface of the gut cavity near the vent and under

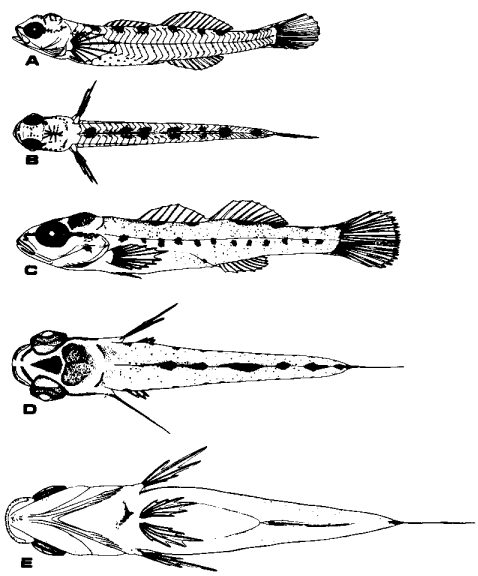

FIGURE 3.—*Larvae of the fantail darter. (A) metalarva, 9.5 mm; (B) metalarva, 9.5 mm, dorsal view; (C) metalarva, 11.5 mm; (D) metalarva, 11.5 mm, dorsal view; (E) metalarva, 14 mm, ventral view.*

the opercles. Melanophores were also present on the outer margin of the upper jaw and on the dorsal surface of the head (Fig. 3D).

Scale formation had begun in 13.0-mm metalarvae (14 to 15 days after hatching) at the caudal fin base and extended to the posterior base of the second dorsal fin. At 14.0 mm, the pelvic fin rays were complete. Pigmentation had developed along the outer edge of the lower jaw and ventrally anterior to the pelvic fins (Fig. 3E).

TABLE 4.—*Selected measurements of larval and juvenile rainbow darters expressed as a means of percent total length with one standard deviation in parentheses.*

Size range (total length) mm	*N*	Standard length	Snout-vent length	Head length	Eye diameter
6.0–7.5	8	96 (1.5)	48 (1.4)	13 (1.2)	6. (0.6)
7.6–9.5	3	95 (2.3)	51 (0.6)	20 (2.1)	7 (1.0)
9.6–11.5	1	86	53	24	7
11.6–15.5	3	85 (2.1)	50 (0.7)	23 (0)	7 (0)
18.0	1	83	50	22	5

Juveniles

Teeth were present around the margins of both jaws in 19.0-mm fish, 24 to 28 days after hatching. Melanophores on the snout, opercles, and lateral line were more concentrated than at 13.0 mm (Fig. 4). Scales had formed to the opercles but were lacking on the dorsal surface near the spiny dorsal fin. Segmentation of the principle rays in the median fins was present in specimens 18.5 mm and larger.

Rainbow Darter

Morphometric data for the rainbow darter are given in Tables 3 and 4.

TABLE 3.—*Meristic counts from larval and juvenile rainbow darters. Each couplet gives the mode and range.*

Size range (total length) mm	*N*	Spines and rays[a]							Myomeres[b]		
		Branchiostegal	Pectoral	Pelvic	Spiny dorsal	Second dorsal	Anal	Caudal	Preanal	Postanal	Total
6.0–7.5	8								17 16–18	18 18–19	35 35–36
7.6–9.5	3	5 4–6	12 11–13		8 8–9	7 6–9	6 4–9	14 6–15	16 16–17	19 18–20	35 35–36
10.5	1	6	12	6	11	12	I,9	15			
11.6–15.5	3	6 6–6	12 12–12	6 6–6	11 10–11	12 12–12	II,8 I,9–II,8	16 15–16			
18.0	1	6	13	6	X	12	II,7	18			

[a] Roman numerals designate spines.
[b] Myomeres were not counted in fish larger than 10.0 mm.

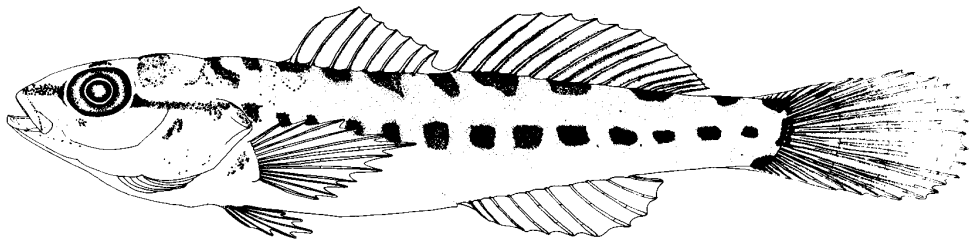

FIGURE 4.—*Juvenile fantail darter, 19 mm total length.*

Eggs and Embryos

Fertilized eggs were spherical and averaged 1.8 mm in diameter (range: 1.7–1.9; $N = 15$). The chorion was clear and contained a yellow, translucent yolk with one translucent oil globule. The surface of the chorion and the yolk were finely reticulated. The eggs were adhesive when spawned and had discs on the chorion where they had adhered to other eggs (illustrated as a flat section). Sand grains were frequently attached to the chorion.

The morula (Fig. 5A) had no distinct blastomeres and the blastocoel had not formed. A single oil globule was located near the developing area of the egg. The embryonic axis (Fig. 5B) extended two-thirds around the yolk. The optic vesicles and 10 to 20 somites were present. The yolk was constricted inward where it met the body.

Pigmentation had developed around the eye margins, on the yolk, and on the ventral edge of the tail in the free-tail stage (Fig. 5C). The lens placodes and otic vesicles were present and the major ventricles of the brain had developed.

The eyes were pigmented and the pectoral fin buds were present prior to hatching (Fig. 5D). The dorsal fin fold extended posteriorly from the fifth myomere around the tail and then anteriorly to the yolk sac. Minute granules were present in the otic placodes.

Protolarvae

The larvae hatched as protolarvae at an average length of 6.0 mm (range: 6.0–6.2 mm; $N = 5$). The oil globule was placed anteriorly in the yolk (Fig. 6A). The mouth had formed but teeth were not evident. There were 17 preanal and 19 postanal myomeres in two specimens. Large melanophores covered the underside of the yolk sac (Fig. 6B).

One day after hatching, the protolarvae were 6.8 mm in length (Fig. 6C). The yolk was reduced which brought the yolk sac melanophores closer together. The gills and rudimentary opercles had formed.

Mesolarvae

Two to 5 days after hatching, incipient rays were present in the caudal, anal, second dorsal, and pectoral fins (Fig. 6D). Mesolarvae ranged from 7.8 to 8.2 mm during this period. Those larger than 8.0 mm had incipient spines in the spiny dorsal fin. Five branchiostegal rays had formed and the jaws were well developed. Meristic counts are summarized in Table 3. A solid band of pigmentation had formed on the anterior dorsal surface of the gut, becoming less dense posteriorly. Melanophores were scat-

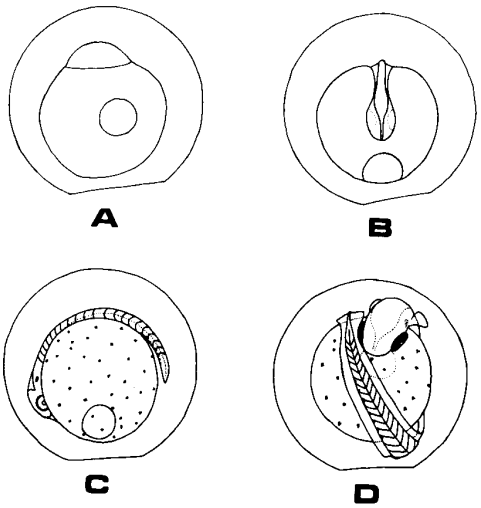

FIGURE 5.—*Developing eggs of the rainbow darter. (A) morula; (B) embryonic axis; (C) free-tail embryo; (D) late embryo prior to hatching (1.8 mm diameter).*

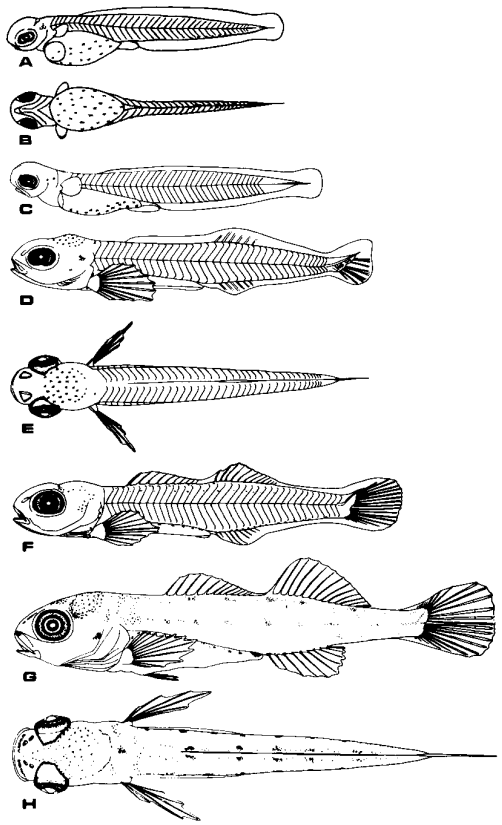

FIGURE 6.—*Larvae of the rainbow darter. (A) recently hatched protolarva, 6.0 mm total length; (B) protolarva, 6.0 mm, ventral view; (C) protolarva, 6.8 mm; (D) mesolarva, 8.0 mm; (E) mesolarva, 8.0 mm, dorsal view; (F) metalarva, 8.5 mm; (G) metalarva, 10.5 mm; (H) metalarva, 10.5 mm, dorsal view.*

tered on the dorsal surface of the head (Fig. 6E).

Metalarvae

The pelvic buds formed 15 days after hatching and were located just posterior to the base of the pectoral fins. The metalarvae ranged from 8.5 to 9.4 mm in length. Fin rays were jointed in the caudal and pectoral fins (Fig. 6F). The snout was rounded and the jaws had minute teeth. Preanal myomeres ranged from 16 to 17 and postanal myomeres from 18 to 20 (N = 5). A series of melanophores outlined both sides of the gut, becoming less dense posteriorly. Pigmentation was present along the ventral aspect of the body from the anal fin to the caudal fin and under the dorsal fins. A small concentration of melanophores was present on the preopercles and head.

Metalarvae were 10.5 mm in length (Fig. 6G) 27 days after hatching. The pelvic fins had become posterior to the bases of the pectoral fins. Myomeres were indistinguishable. Pigmentation was present on the snout, dorsal surface of the head, under the dorsal fins, and along the horizontal septum (Fig. 6H). Melanophores were concentrated at the base of the anal fin rays. Internal pigmentation was present anterior to the pelvic fins and along the rays of the spiny dorsal fin.

Juveniles

The metalarva phase ended approximately 47 days after hatching. At 13.0 mm, fin rays were segmented (Fig. 7) and scales had formed at the base of the caudal fin and extended to the spiny dorsal fin. Specimens were fully scaled at 15 mm.

A horizontal band of melanophores was present anterior and posterior to the eye. Dense pigmentation was present on the dorsal surface of the head and patches had formed under the dorsal fins and on the lateral line. The lateral line patches were elongated vertically. In specimens 17 to 18 mm, two bands of pigment were present on the spiny dorsal fin, similar to adult pigmentation.

Comparative Development

Development of fin rays was rapid in the fantail darter. Ray formation was present in all fins when larvae were only 2 mm longer than at hatching and anal spine formation occurred with a further increase of 2 mm in total length. This was faster than for the yellow perch (Mansueti 1964), walleye and sauger (Nelson 1968), and logperch (Cooper 1978) in which fin-ray formation began after an increase of at least 7 mm from length at hatching. Fin-ray development occurred earlier in the fantail darter than in the rainbow darter: the full complement of principal median rays was obtained in 12 days in the fantail darter and in 27 days in the rainbow darter. Pelvic buds appeared 15 hours after hatching in the fantail darter and 15 days after hatching in the rainbow darter.

Completion of yolk absorption occurred after fin ray development began in the fantail darter, a sequence unlike that of the rainbow darter;

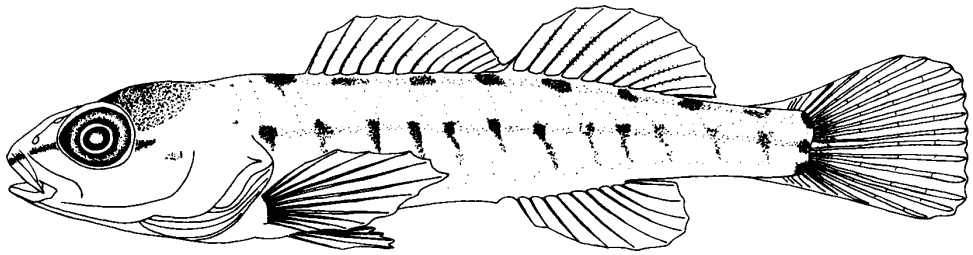

FIGURE 7.—*Juvenile rainbow darter, 15 mm total length.*

johnny darter (Fish 1932); greenside darter (Fahy 1954); logperch (Cooper 1978); yellow perch (Mansueti 1964); walleye and sauger (Nelson 1968); and possibly the blackside darter, although specific information was not given (Petravicz 1938).

The juvenile phase was reached 24 days after hatching in the fantail darter and 47 days in the rainbow darter. Growth of the rainbow darter was similar to early growth of the greenside darter; both species reached 8.0 to 8.5 mm in length after 15 to 16 days (Fahy 1954).

Dimensional changes, as a percentage of total length, were different in the fantail darter than in yellow perch or logperch. Standard length of the fantail darter decreased 12% in the interval 5.5 to 12.5 mm (Table 2) but only 2% in yellow perch (Mansueti 1964) and 5% in log-

TABLE 5.—*Egg characteristics of Lake Erie percids.*

Species	Egg diameter	Yolk/oil color	Spawning site	Source
Etheostoma blennioides	1.8	orange or yellow oil globule	algae, swift water	Fahy 1954 Winn 1958
E. caeruleum	1.5–1.8	pale yellow yolk	sand riffles: 0.1–0.2 m depth	author Winn 1958
E. exile	1.1	orange or yellow oil globule	fibrous material, undercut banks	Jaffa 1917 Winn 1958
E. flabellare	2.3–2.7	yellow yolk, amber oil globule	underside rocks, 0.2–0.3 m depth	author Lake 1936
E. microperca	0.7–1.0	orange or yellow oil globule	vegetation, quiet water	Petravicz 1936 Winn 1958
E. nigrum	1.5	yellow yolk	underside rocks, 0.2–0.4 m depth	author Winn 1958 Speare 1965
Perca flavescens	1.8–4.5	amber yolk	shallow water, often entangled in vegetation	Mansueti 1964
Percina caprodes	1.3	amber yolk	riffles: 0.1–0.2 m depth	Winn 1958 Cooper 1978
P. copelandi	1.4	orange oil globule	behind rocks: 0.6–0.9 m depth	Winn 1953
P. maculata	2.0	unknown	fine gravel, sand 0.3 m depth	Petravicz 1938
Stizostedion canadense	1.4–1.8 (embryo) 1.0–1.5 (egg)	unknown	quiet water: 0.6–3.6 m depth	Nelson 1968 Priegel 1969 Scott and Crossman 1973
S. vitreum	1.9–2.3 (embryo)	unknown	shallow water	Nelson 1968 Scott and Crossman 1973

TABLE 6.—*Total lengths (mm) at hatching, yolk absorption, and first appearance of fin-ray formation in Lake Erie percids.*

Species	Hatching[a]	Yolk absorption	Spiny dorsal fin	Second dorsal fin	Anal fin	Pelvic fin	Pectoral fin	Source
Etheostoma blennioides	6.7–7.5	7.5–8.0	unknown	8.0	8.0	8.0	8.0	Fahy 1954
E. caeruleum	6.0–6.2	8.0	>8.0	7.8–8.2	7.8–8.2	9.0	7.8–8.2	author
E. flabellare	5.8–6.5	9–10	7.8	7.2	7.2	9.0	7.2	author Lake 1936
E. nigrum	5.0	5.6–7.1	<9	<9	<9	<9	7.1	Fish 1932
Perca flavescens	5.5–6.0	7.0	<13	>12	>12	>15	>14	Norden 1961 Mansueti 1964
Percina caprodes	4.5	6.3–6.9	15.6	12	13	15.5	15.6	May and Gasaway 1967 Cooper 1978
Stizostedion canadense	4.6–5.1	>10	>10	>12	>12	>15	>14	Nelson 1968
S. vitreum	6.1–6.8	>10	>10	>12	>12	>15	>14	Nelson 1968

[a] Hatching length of *Etheostoma exile* is 3.4 mm (Jaffa 1917); of *E. microperca*, 3.0 mm (Petravicz 1936); of *Percina maculata*, 5.7 mm (Petravicz 1938). Other information for these three species is unknown.

perch (Cooper 1978). Head length remained 3 to 6% less in logperch than in the fantail darter or yellow perch, and snout-to-vent length decreased 2% in the fantail darter but increased 3% in yellow perch and 1% in logperch. The rainbow darter was similar in proportional changes to the fantail darter (Table 4).

Identification

Many of the characteristics presented have been summarized from the literature and are not adequate for all Lake Erie percids. There is no information concerning the eggs and larvae of the eastern sand darter and river darter nor for larval phases of the blackside, least, or Iowa darters.

Eggs

Only the fantail and johnny darters are reported to deposit eggs on the undersides of rocks (Fahy 1954; Winn 1958). Fantail darter eggs are nearly twice the diameter of johnny darter eggs and are more pigmented at hatching. The eggs of the rainbow darter are spawned in riffles as are the eggs of the logperch. Rainbow darter eggs are larger than logperch eggs and have a clear chorion and pale yellow yolk; logperch egg yolks are amber. Egg characteristics of Lake Erie percids are summarized in Table 5.

Saugers and walleyes spawn earlier than other percids, generally when the ice breaks up in lakes or streams (Scott and Crossman 1973). The egg strands of the yellow perch are not likely to be confused with eggs of other percids (Mansueti 1964).

Larvae

Separation of fantail and rainbow darter larvae from other percids in Lake Erie can be accomplished by segregating specimens into those with yolk and those without. Fantail darter larvae have a large yolk which is retained through advanced fin-ray formation. No other percid from Lake Erie has been reported to exhibit this characteristic. The total length of specimens at the time of yolk absorption and of fin-ray formation in the second dorsal and pectoral fins will separate rainbow and fantail darters from most other percids (Table 6).

Pigmentation patterns differ among the rainbow darter, greenside darter, and yellow perch only on the vent. The rainbow darter lacks vent pigmentation until after yolk absorption while the greenside darter and yellow perch have heavy pigmentation prior to yolk absorption. Walleye larvae with yolk exhibit a dense melanophore pattern on the dorsal surface of the vent and along the ventral surface of the tail (Nelson 1968; author, unpublished data). Sauger larvae have little pigmentation above the vent and several melanophores on the ventral part of the yolk sac (Nelson 1968).

Logperch may or may not have melano-

phores on the yolk sac. Cooper (1978) reported laboratory-reared larvae with melanophores on the yolk sac and field-collected larvae without. More recent collections from Lake Erie indicate that this characteristic is variable (Jeanne E. McAfee, Aquatic Ecology Associates, personal communication).

Fish (1932) has indicated recently hatched johnny darters with no pigment on the yolk sac or body. Specimens collected in Elk Creek and those received on loan (John Dorr, University of Michigan) had melanophores on the yolk sac and on the ventral surface of the tail. Johnny darter yolk sacs are more rounded than those of the rainbow darter and the body is more slender.

Pigmentation on the snout and opercle appears as a thin band in the fantail darter at approximately 9 mm, and increases in width at 9.5 to 11.5 mm. This pattern is similar in rainbow darter larvae at 12 mm, extending just posterior to the eyes, whereas in the fantail darter it extends to the posterior edge of the opercles. Johnny darter, yellow perch, logperch, sauger, and walleye larvae do not have this pigment pattern.

The pigmentation on the horizontal septum is not useful for separating larvae of the fantail darter, rainbow darter, and johnny darter. Each has a similar pattern that forms at 10 to 11 mm total length. The Iowa darter has a similar pattern as a juvenile and could be expected to have it as a larva.

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