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Eggs and Larvae of the Logperch, Percina caprodes (Rafinesque)[1]

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ABSTRACT: Eggs and larvae of the logperch, *Percina caprodes* (Rafinesque), were reared in the laboratory to recently hatched larvae. More advanced stages were collected by plankton net from Lake Erie. Developmental stages were sampled; changes in morphology and gross characteristics are described and illustrated.

Manually stripped eggs were extruded as a mass but did not remain physically attached to each other. The eggs were adhesive, demersal and amber in color with a granular yolk. Average egg diam after water hardening was 1.12 mm. Eggs hatched 200 hr after fertilization at an average water temperature of 16.5 C. Average hatching length was 4.47 mm.

The yolk sac was completely absorbed at 6.28 mm in most individuals. Fin ray development began at 7.80 to 10.00 mm with the caudal fin. The soft dorsal fin rays and anal fin rays began to develop at 12.00 mm and all fin rays were nearly complete at 22.5 mm.

Staining techniques for meristic analysis used in the present study may account for the higher number of myomeres found, compared with a previous report where staining was not used to make these counts.

INTRODUCTION

Larval stages of the logperch have been described and illustrated (Fish, 1932; May and Gasaway, 1967), but no illustrations are available for logperch eggs. The present study was initiated to provide information on identification of logperch eggs and comparative data for larvae.

Logperch are distributed from the St. Lawrence River in eastern Quebec westward through the Great Lakes and into Saskatchewan and southward through the Mississippi River system to the Rio Grande River in southern Texas. Logperch were introduced into California waters in 1953 (Scott and Crossman, 1973).

Logperch were found spawning in large numbers in Crooked Creek, a stream tributary to Lake Erie in Erie Co., Pennsylvania, on 27 April 1975. Spawning logperch were found as far as 1200 m upstream from the mouth of Crooked Creek with the greatest numbers

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in swift currents over sand and gravel substrate. Few were found in slow water or in areas with slate substrate with either fast or slow water. Spawning occurred most frequently less than 10 m from the lake. Spawning was generally restricted to areas just above the swiftest water, although an occasional pair would spawn in the swifter water.

More males than females were observed in the creek. Ripe females entered the creek when ready to spawn, swimming through the schooling males. One or more males would follow the female, one of which would clasp the female with its pelvic fins. Both fish vibrated with their tails pressed together, working their tails into the underlying sand and gravel where the eggs were extruded, fertilized and buried. Females were observed to spawn with more than one male. These observations follow Reighard's (1913) description of spawning logperch.

Eggs that were not buried completely were eaten by other logperch. This was also reported by Winn (1958) in his detailed description of spawning in Douglas Lake, Michigan. In the present study, logperch were also observed eating eggs of a redhorse sucker, *Moxostoma* sp., even during actual spawning.

MATERIALS AND METHODS

Three female and six male logperch were collected by seining from Crooked Creek on 30 May 1975. The seine was held parallel with the creek bottom and lifted as the fish swam over it. Attempts to catch fish with normal seining techniques were unproductive because the fish were able to escape under the lead line. Captured fish were transported to the laboratory and artificially spawned in pairs by stripping the eggs and milt into a shallow dish filled with creek water. The water was agitated and then poured into a 40-liter aquarium filled with filtered creek water. The aquarium water was continuously filtered and aerated using a charcoal-cotton filter. Filtering was discontinued when the first larva hatched. Water temperature was measured at each sampling. Water temperature ranged from 15-18 C during the study and averaged 16.5 C. No type of temperature control was attempted. The aquarium was in a cool basement which prevented wide water temperature fluctuations. The aquarium water temperature remained lower than the water temperature in Crooked Creek.

Egg samples were taken before and immediately after fertilization and then every 6 hr until the eggs reached the tail-free stage. Sampling was continued after this at 12-hr intervals until all surviving eggs hatched. Sampling times were dictated by other commitments and did not allow for collecting early cleavage stages. These early stages are not included in the discussion. Egg samples were examined and then preserved in 4% buffered formalin. Dead eggs were removed at each sampling time.

The specimens illustrated came from two sources: eggs and recently hatched larvae were from laboratory-reared stock (Figs. 1a-h, 2a-c); the remaining larvae (Figs. 3a-c, 4a-e) were from plankton collections

made in Lake Erie during June and July 1974. Plankton collections were made with a 1-m plankton sled and net (505 μ mesh).

Eggs and larvae were measured with an ocular micrometer to the nearest 0.01 mm. All larvae were stained with Alizarin Red S to highlight the myomeres. The larvae examined for ossification were cleared and stained using trypsin and Alizarin Red S (Taylor, 1967). This allowed a comparison of myomeres and vertebrae counts and served as a check of fin ray counts. Terms used in the descriptions and measurements follow Lippson and Moran (1974). Fish sizes referred to in the text are total lengths.

Attempts to feed the larvae were made without success using a mixed collection of zooplankton and phytoplankton. Concentrated volumes were added to the aquarium before the larvae hatched and at irregular intervals afterward.

RESULTS

Three pairs of fish were stripped, resulting in approximately 300 eggs from each pair. This was less than the reported fecundity of 1065 to 3085 (Reighard, 1913; Winn, 1958), but no internal examination was made; thus many eggs may have been overlooked. When females were manually stripped, the eggs were extruded as a mass but did not remain physically attached to each other like the eggs of the yellow perch. Separation of the eggs occurred when the water was agitated with the introduction of sperm. In nature, separation would probably result from water currents. The eggs were demersal, amber in color, with a granular yolk containing one large oil globule and numerous small ones. The chorion was strong and had a rough surface with an attachment disc. The disc was formed by contact with other eggs. The eggs were adhesive when spawned but lost some adhesiveness after water hardening.

Before fertilization (Fig. 1a).—The eggs were irregular in shape (mean diam, 1.03 mm) but became spherical after fertilization as the chorion swelled. The average diam of 25 eggs after fertilization was 1.12 mm (range: 1.09-1.15 mm).

Early development (Fig. 1b, 5 min after fertilization).—Evidence of fertilization could be detected opposite the oil globule as protoplasm began to accumulate at the animal pole. The perivitelline space increased to 0.16 mm and the yolk became spherical. The oil globule was forced against the yolk membrane and created tension lines on the yolk surface. Early stages of cleavage were not obtained in this study.

Six-hr stage (Fig. 1c).— The blastomeres had undergone several divisions resulting in the blastula. The blastoderm covered approximately one-fourth of the yolk. The mean (n = 5) egg diam was 1.20 mm, yolk diam was 0.77 mm, and the oil globule diam was 0.43 mm.

18-hr stage (Fig. 1d).—The gastrula had formed and covered almost one-third of the yolk. There were no dimensional changes in the yolk or oil globule. The attachment disc was less distinct than in pre-

vious stages because of reduction in thickness of the egg membrane (Mansueti, 1964).

36-hr stage (Fig. 1e).—Neural fold development had become visible under low (10X) magnification. The perivitelline space decreased to 0.15 mm. Egg, yolk and oil globule diameters remained unchanged. The oil globule protruded from the yolk membrane.

48-hr stage (Fig. 1f).—The embryo nearly encircled the yolk and

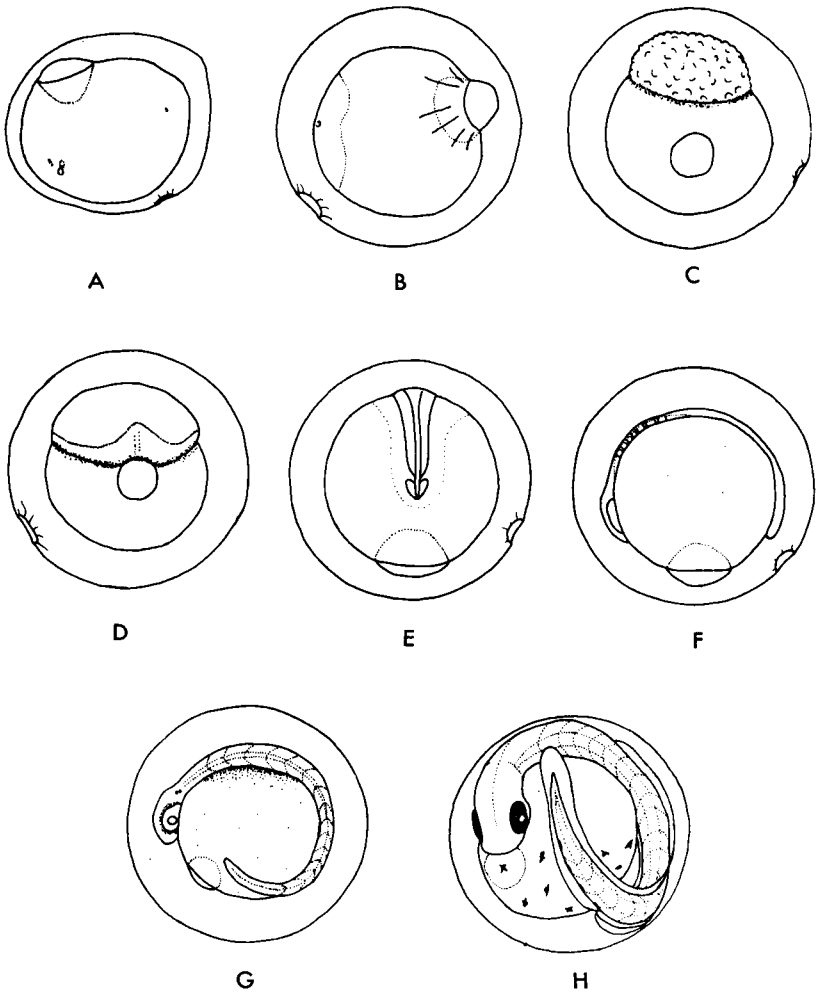

Fig. 1.—Developing eggs of the logperch. (A) unfertilized; (B) 5 min after fertilization; (C) blastula (6 hr); (D) gastrula (18 hr); (E) early embryonic development (36 hr); (F) tail-bud stage (48 hr); (G) tail-free embryo (72 hr); (H) embryo (96 hr)

the tail was beginning to bud. Somites had developed and some development of the optic vesicles was apparent. Pigmentation was first noticed on the yolk surface at this stage and consisted of small, scattered melanophores. The egg diam had increased slightly to 1.27 mm, yolk diam was 0.89 mm, and the oil globule diam was 0.44 mm.

72-hr stage (Fig. 1g).— The embryo had reached the tail-free stage. Myomeres were visible extending nearly to the end of the tail. The lens placodes were partially developed but the eyes remained unpigmented. The otic vesicles could be seen. Pigmentation had increased on the yolk surface near the embryo and was also present around the eyes.

96-hr stage (Fig. 1h).—The embryo had greatly increased in size compared to the 72-hr stage. Perivitelline space had decreased to 0.13 mm. The yolk diam was 0.76 mm and the oil globule diam was 0. 38 mm. A line of small melanophores extended from the caudal region anteriorly to the vent but were absent from the embryo-yolk margin as shown in Figure 1g. The eyes were pigmented.

200-hr stage (Fig. 2a).—The majority of eggs hatched at 200 hr after fertilization (average water temperature, 16.5 C) and all eggs had

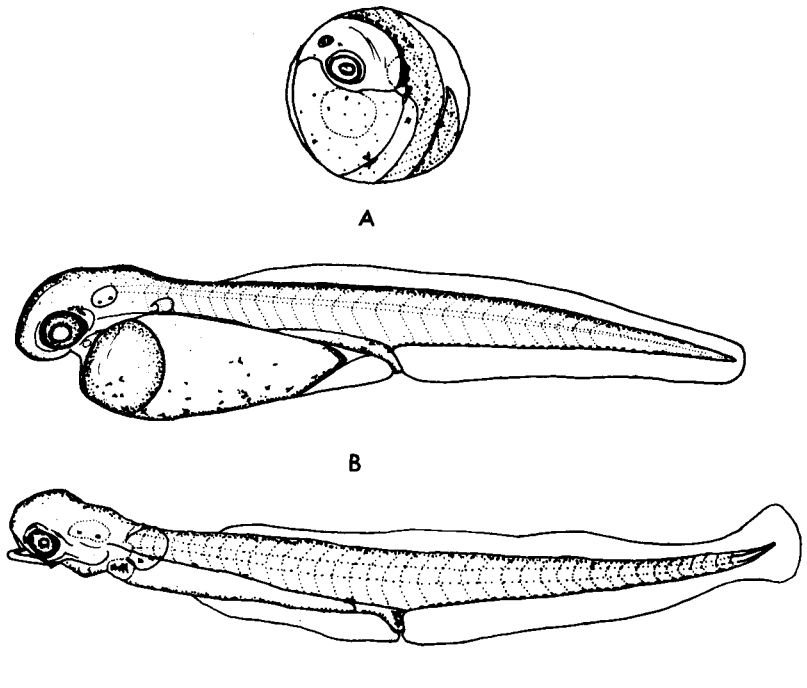

Fig. 2.—Developing logperch. (A) just before hatching (200 hr); (B) recently hatched larva (4.47 mm); (C) late yolk-sac larva (5.59 mm)

hatched by 205 hr. At the time of hatching, the egg diam was 1.27 mm and the embryo had completely filled the egg leaving no perivitelline space. The pectoral fin buds were partially formed and the mouth had not developed. The embryo was quite active, broke the chorion with its tail, and emerged tail-first from the egg.

The average total length at hatching (Fig. 2b) was 4.47 mm (n = 5). Average measurements were: diam of eye, 0.26 mm; head to vent length, 2.49 mm; length of yolk, 1.46 mm and oil globule diam, 0.43 mm. These measurements were taken before preservation.

231-hr stage (Fig. 2c).—The mouth was forming. The yolk was the same size as in the 200-hr stage; however, the oil globule diam decreased to 0.34 mm. Pectoral fins were developed further; greatest pectoral fin length was 0.43 mm. Total length of the larva was 5.59 mm.

302-hr stage.—The yolk sac was completely absorbed at 6.28 mm although some yolk material was present in a few individuals at 6.90 mm (Fig. 3a).

Attempts to feed the laboratory-reared larvae proved fruitless. Feeding was not evident in any fish after the mouth was formed. Food offered consisted of concentrated algae, rotifers and copepods. Four days after hatching, the larvae became thinner and some mortality had occurred. Three days later mortality was 100% and the study was ended.

The remaining descriptions were based on the larvae from the plankton collections.

6.90-7.00-mm larvae.—A small amount of yolk material was present in 6.90-mm larvae but none was found in 7.00-mm larvae. The pectoral fin membrane was distinct but no fin rays had formed. The finfold was quite extensive. Pigmentation was nearly the same as observed in the laboratory-reared larvae.

7.50-mm larvae (Fig. 3b).—The jaws were well developed with teeth evident in stained specimens, and the olfactory buds were developing. There was no change in pigmentation.

7.80-10.0-mm larvae (Fig. 3c-d).—The first visible fin rays in the caudal fin had formed. At 10.0-mm the head was more pointed than in earlier stages. Pigmentation had decreased, especially on the head and ventral surface of the tail.

11.0-12.0-mm larvae (Fig. 3c).—The urostyle was turned upward at 11.0 mm and the caudal fin rays were well formed by the time the larvae reached 12.0 mm. The latter size also had developed fin rays in the dorsal and anal fins.

13.0-14.0-mm larvae (Fig. 4a-b).—The pelvic fin rays were forming. The dorsal and anal fin rays were well formed at 14.0 mm with very little finfold remaining.

15.0-22.5-mm larvae (Fig. 4c-e).—All fin rays except the spiny dorsal and pelvic were formed at 15.0 mm. Some finfold remained along the ventral edge of the body and tail. At 22.5 mm, the fin rays were nearly complete and the general body shape resembled the adult.

Larvae of sizes larger than 22.5 mm were not available. Mean morphometric data are summarized in Table 1.

Larvae were stained with Alizarin Red S to provide more accurate fin ray counts. Many of the fin rays counted at various stages otherwise could not be seen and would not be included in total counts. This was especially true of the spiny dorsal where many fin rays were present but were under the flesh. Staining was also useful in determining the size range at which the rudimentary anal fin ray transforms into a spine. A single spine and 11 fin rays were found in fish in the 15.5-17.5-mm range and two spines and 10 fin rays after the 19.5-mm size. The first anal fin ray had transformed into a spine between 17.5 and 19.5 mm. This transformation was described by Mansueti (1964) for the yellow perch and was similar in the logperch.

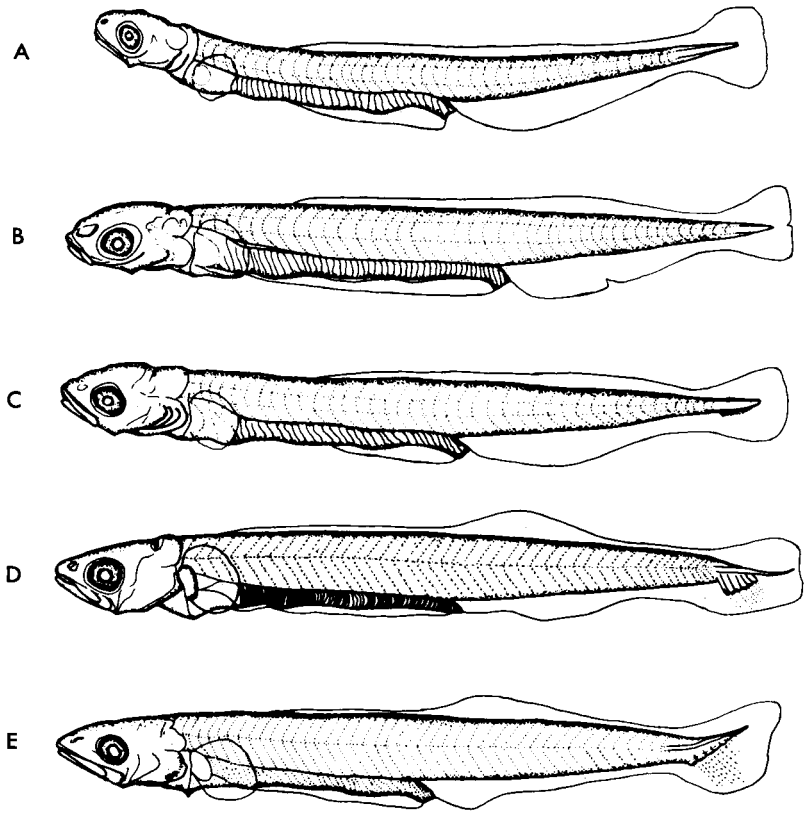

Fig. 3.—Postyolk-sac-stage logperch. (A) 6.9 mm; (B) 7.5 mm; (C) 7.8 mm; (D) 10.0 mm; (E) 11.0 mm

Several specimens were cleared and stained to reveal the extent of ossification. The only specimen illustrated (21.0 mm., Fig. 5) showed the most advanced ossification. Ossification began in fish 10.0 mm in length and first occurred in the cleithrum and jaws. At 12.5 mm, the jaw, cleithrum and branchiostegal rays were completely ossified. Partial ossification was present in the gill rakers, vertebrae, hemal and neural spines, and the fin rays of the caudal, anal and second dorsal fins. Teeth were partially developed.

All fin rays, except those in the pectoral fin, were complete at 21.0 mm. The vertebrae, gill rakers and teeth were complete and most of the head had ossified. The anterior ribs were partially ossified. Fish larger than 22.5 mm were not available, thus the time of complete ossification was not determined.

Meristic counts were not attempted on larvae smaller than 11.5 mm total length. Many features were not distinguishable in small larvae even with staining.

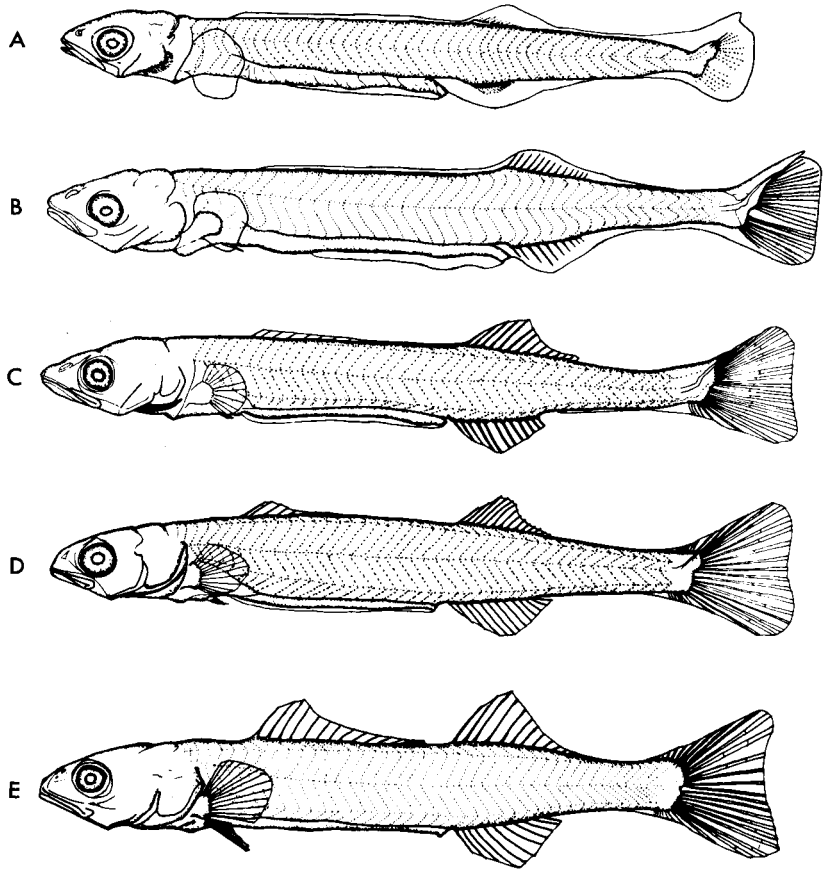

Fig. 4.—Postyolk-sac-stage logperch. (A) 13.0 mm; (B) 14.0 mm; (C) 15.6 mm; (D) 17.1 mm; (E) 22.5 mm

TABLE 1.—Mean measurements (mm) of larval logperch. One standard deviation is given in parentheses

Size range (Total length)	N	Total length	Standard length	Head	Diam of eye	Body depth	Snout-vent length
5.50- 6.50	27	5.98(0.18)	5.78(1.11)	0.91(0.07)	0.28(0.04)	0.56(0.01)	3.28(0.03)
6.51- 7.50	10	6.87(0.32)	6.53(0.46)	1.07(0.09)	0.30(0.06)	0.72(0.06)	3.85(0.33)
7.51- 9.50	4	8.30(0.45)	7.88(0.46)	1.46(0.32)	0.43(0.08)	0.90(0.14)	4.88(0.48)
9.51-11.50	3	10.48(0.84)	10.23(0.74)	1.86(0.19)	0.56(0.10)	1.18(0.27)	6.08(0.66)
11.51-12.50	2	12.37(0.14)	11.44(0.14)	2.24(0.26)	0.65(0)	1.54(0.10)	7.25(0)
12.51-13.50	6	13.14(0.22)	12.15(0.42)	2.57(0.21)	0.77(0.10)	1.58(0.16)	7.50(0.44)
13.51-15.50	24	14.46(0.52)	12.97(0.49)	2.66(0.29)	0.81(0.10)	1.88(0.45)	8.11(0.41)
15.51-16.50	9	15.89(0.19)	14.09(0.36)	3.12(0.29)	0.94(0.07)	2.10(0.10)	8.85(0.32)
16.51-17.50	7	16.90(0.39)	14.67(0.90)	3.40(0.35)	0.95(0.07)	2.06(0.20)	9.25(0.37)
17.51-18.50	4	17.86(0.15)	15.86(0.41)	3.58(0.41)	1.09(0.05)	2.42(0.15)	10.09(0.28)
18.51-19.50	5	18.82(0.24)	16.44(0.62)	3.76(0.28)	1.18(0.08)	2.86(0.39)	10.38(0.28)
19.72	1	19.72	17.11	3.91	1.12	2.42	10.42
22.32	1	22.32	17.86	4.09	1.30	2.42	11.16

Vertebral counts and myomere counts were nearly equal in 10 fish counted. Vertebrae counts were frequently 41 and 42 but ranged from 39-44. Total myomere counts were usually 41-43. Preanal myomere counts were most often 23 or 24; postanal myomere counts were 18 or 19. Counts of postanal myomeres were subject to more error than preanal counts. Postanal myomeres were found closer together, especially near the caudal region, and were difficult to distinguish. Thus the total count may be too low in some individuals.

Gill rakers were counted on the first arch only (Table 2). Specimens were cleared and stained to provide easier and more accurate counts. Branchiostegal rays were very distinct when stained. Very little variation in number occurred within size ranges probably due to the ease in counting the rays.

Pigmentation was very distinct in the laboratory-reared larvae but not in field-collected larvae. Melanophores were found near the vent and in the lower jaw of all size groups in the reared larvae but were often absent in field-collected larvae. The longer preservation time of the field-collected larvae may have resulted in some bleaching of melanophores. Pigmentation as a tool for identification of these larvae would be unreliable.

The last living laboratory-reared specimens were compared to field-collected larvae in the same size range. The reared larvae were considerably less developed than those in the field collections. This could be partially attributed to lower temperatures in the aquarium than in Lake Erie. The aquarium location resulted in the water temperature decreasing from 20.0 C to 15.5 C at the start of the study and slowly increasing to 17.0 C near the end. The lake temperature increased from 20.0 C at the start of the study to 26.0 C near the end. The aquarium water temperature may have been below the critical level needed for feeding. This may have caused the deaths of the raised larvae. Hubbs (1961) and Hubbs and Strawn (1963) reported higher percentages of survival of larval logperch from Texas and Arkansas at 21-25 C than at 16-20 C.

This study agreed, in general, with the descriptions presented by Fish (1932) although eggs were not described by Fish. Meristic values, except myomere number, were in close agreement with Fish. Fish reported 20-22 preanal myomeres and 16-20 postanal myomeres com-

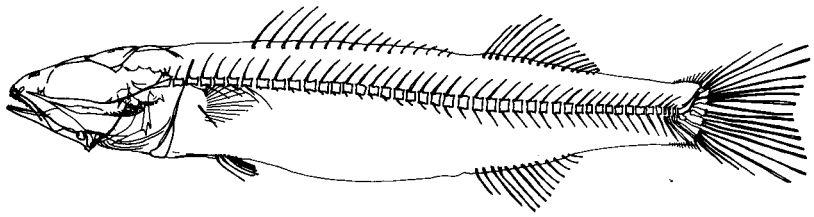

Fig. 5.—Ossification in a logperch at 21.0 mm

TABLE 2.—Mean meristic counts of larval logperch. One standard deviation is given in parentheses. No counts were made on larvae smaller than 11.50 mm

		Rays								Myomeres	
Size range (Total length)	N	Branchiostegal	Pectoral	Pelvic	Spiny dorsal	Soft dorsal	Anal	Caudal	Gill rakers	Preanal	Postanal
11.51-12.50	2	4	....	..	....	11.5	10.5	19.0	....	23.0	17.0
		(0)				(0.7)	(0.7)	(0)		(0)	(0)
12.51-13.50	6	5	....	..	....	7.8	8.2	19.2	6.5	23.0	17.0
		(0)				(2.9)	(2.9)	(2.4)	(2.3)	(0)	(0)
13.51-15.50	24	5.6	9.5	..	9.7	12.6	11.1	21.3	7.1	23.0	18.0
		(0.6)	(3.2)		(3.7)	(2.5)	(1.6)	(2.9)	(1.1)	(0.9)	(0.8)
15.51-16.50	9	6	13.4	3.9	13.6	14.1	I[1]-11.9	25.6	8.6	22.8	19.0
		(0)	(1.5)	(0.6)	(2.1)	(0.8)	(1.1)	(2.6)	(0.5)	(0.8)	(1.0)
16.51-17.50	7	6	14.3	I-4.6	14.1	13.9	I -11.4	30.9	10.0	23.6	18.1
		(0)	(1.5)	(0.9)	(1.5)	(0.9)	(1.3)	(3.5)	(1.0)	(0.5)	(0.4)
17.51-18.50	4	6	14.8	I-4.5	14.5	14.0	I -11.0	33.0	8.8	23.3	18.8
		(0)	(0.5)	(0.6)	(0.6)	(1.4)	(0.8)	(1.4)	(0.5)	(1.0)	(1.0)
18.51-19.50	5	6	15.0	I-5.6	13.8	14.0	II -10.6	37.8	12.0	24.0	18.0
		(0)	(0)	(0.6)	(1.3)	(1.0)	(0.9)	(2.9)	(1.6)	(0)	(0)
19.72	1	6	15	I-5	15	15	II -10	39	11	24	19
22.32	1	6	15	I-5	15	16	II -11	38	11	24	20

[1] Roman numerals refer to the number of spines in the anal and pelvic fins

pared to counts of 22-23 and 18-20, respectively, in this study (n = 59). Fish used staining techniques for vertebrae but did not state if staining was used for myomere counts. The differences in the two studies might have been fewer if the same staining techniques had been used. Pigmentation patterns are like those described by Fish; however, in the present study, less pigment was found in larger specimens.

May and Gasaway (1967) presented a key which included larval logperch from Oklahoma. The larvae described in the present study closely followed the key although there were minor variations in general appearance. Larvae at 12.0 mm in the present study had more pointed snouts than illustrated in the key. This may be due to geographical variation. The swim bladder noted in the key was not distinct in larvae in the present study. This may have been due to preservation and staining in the present study before the larvae were examined. There were many fine reticulations along the gut in larvae 6.9 mm through 13.0 mm (Figs. 3a-e, 4a) in the present study, but no granular appearance was seen as described by May and Gasaway.

Larval logperch are quite similar to larval walleye, yellow perch and darters. There is little information concerning larval darters and separation of these from logperch would depend partly upon collecting locality and season. The pectoral fins in darters are larger in successive developmental stages when compared to logperch (Lippson and Moran, 1974).

Several studies have been made of yellow perch and walleye development (Mansueti, 1964; Nelson, 1968; Norden, 1961). Certain differences exist in larval morphology between logperch and these two species. The yolk sac is retained in larvae up to 7.0 mm and 8.5 mm in yellow perch and walleye, respectively, compared to less than 6.0 mm in logperch. The relative size of the yolk sac in logperch is larger than in yellow perch or walleye. Preanal myomere counts in logperch larvae (23-24) are higher than yellow perch (19-20) but overlap those in walleye up to 10 mm. Walleye larger than 10 mm have more postanal myomeres (20-26) than logperch (17-20) at any size. Larval logperch are more slender than larval yellow perch or larval walleye and generally have a shorter head length.

Identification of logperch eggs and larvae can be accomplished using the description presented in this study. Logperch eggs are 1.27 mm in diam after water-hardening and have a granular yolk. The eggs contain numerous small oil globules and one large oil globule which coalesce during early development. There is no perivitelline space at hatching.

Hatching length of the larvae is 4.47 mm and yolk absorption is complete at 6.0 mm. Fin ray development begins at 11.5-12.5 mm and is complete at 22.0 mm. Logperch have 41-43 total myomeres. Morphological variations may occur in larvae from different areas, but most larvae will exhibit the characteristics described in this study.

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