DESCRIPTION OF REARED EGGS AND YOUNG LARVAE OF THE SPOTTED SEATROUT, *CYNOSCION NEBULOSUS*

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ABSTRACT

Adult spotted seatrout, *Cynoscion nebulosus*, were induced to spawn in the laboratory by controlling temperature and photoperiod. Development of eggs and larvae, reared at 25°C, is described to 15 days after hatching. The pelagic, spherical eggs have a mean diameter of 0.77 mm, and usually contain one oil globule averaging 0.22 mm in diameter. Hatching occurs about 18 h after fertilization. Standard length at hatching is between 1.30 and 1.56 mm. Spotted seatrout average 4.4 mm standard length at notochord flexion. The larvae, which were fed the rotifer, *Brachionis plicatilis*, and nauplii of *Artemia* sp., grew to about 4.5 mm standard length in 15 days.

The spotted seatrout, *Cynoscion nebulosus*, is one of the most important fishes to both recreational and commercial fishermen in the Gulf of Mexico and southeastern United States. In the Gulf it ranks first in weight landed by sports anglers (Deuel 1973) and seventh by weight taken commercially (U.S. Department of Commerce 1975). Despite its value, the eggs and youngest larval stages have not been adequately described in previous literature.

Four early works (Welsh and Breder 1923; Hildebrand and Schroeder 1928; Pearson 1929; Hildebrand and Cable 1934) provided descriptions of spotted seatrout development. Welsh and Breder (1923) described juvenile *C. nebulosus* as small as 28 mm, collected from North Carolina and Chesapeake Bay waters. Hildebrand and Schroeder (1928) illustrated a spotted seatrout presumably 120 mm long, apparently from Chesapeake Bay. Spotted seatrout from Texas as small as 7.8 mm were described by Pearson (1929). The most complete description of young spotted seatrout was by Hildebrand and Cable (1934). The smallest seatrout described by them was 1.8 mm long and was taken off North Carolina. The only other illustrations of larval spotted seatrout were of 3.0 and 5.0 mm SL fish from south Florida by Jannke (1971).

The first description of *C. nebulosus* eggs was by Miles (1950, 1951). He stated that eggs measured from 0.70 to 0.98 mm in diameter and contained one to four small oil globules. Later, Tabb (1966) stated that eggs were spherical and normally had one oil droplet, but sometimes two or three.

In this paper, we provide detailed descriptions of eggs and young larvae of spotted seatrout, based on laboratory spawned and reared specimens.

PROCEDURES

Adult spotted seatrout were caught by hook and line at Port Aransas, Tex., in August 1973. Eleven fish (seven males and four females) were brought into the laboratory and maintained in a 30,000-l seawater tank. The tank was constructed of fiber glass and measured 6 × 3 × 1.5 m. It contained seawater which was recirculated through a shell-and-gravel filter.

The fish were fed shrimp and fish, both live and dead. Temperature and photoperiod in the laboratory were adjusted to simulate spring and, subsequently, summer conditions. Spawning began 1 mo after conditions were stabilized at 15 h of light, 9 h of dark, and 26°C. Details of the methods to induce spawning by spotted seatrout are described by Arnold et al. (in press). In a 1-yr period, the spotted seatrout have spawned during each month for a total of 82 times. On several occasions more than one female spawned.

Eggs described in this paper were spawned by a single female on 8 September 1975. They were preserved hourly in 3% buffered Formalin[2] from

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the time of spawning until hatching. Larvae described in this report were from eggs spawned on 7 October 1975 and were transferred to rearing aquaria. Samples of larvae were preserved daily in 5% Formalin for 15 days.

Larvae were reared in 57-l aquaria which were filled with algae and rotifer culture water 2 days prior to the introduction of fish. Algal growth was enhanced by a constant light source above the aquaria. Seatrout were fed the rotifer, *Brachionis plicatilis,* daily at a rate of at least 20/ml of water for 4 days. On the fifth day rotifers and brine shrimp, *Artemia* sp., nauplii (3-5/ml) were both introduced. This combination was fed until larvae were 8 days old, then brine shrimp were used as the only food source. Temperatures in the aquaria were maintained at 24.0° to 26.0°C.

Eggs and larva were measured using an ocular micrometer in a dissecting microscope. Measurements included total length, standard length, snout to anus length, snout length, head length, eye diameter, and body depth. Illustrations are of preserved specimens. In discussing seatrout eggs, the three stages described by Ahlstrom and Ball (1954) are used.

EMBRYONIC DEVELOPMENT

Spotted seatrout eggs are pelagic and spherical, the chorion is clear and unsculptured, and the yolk is homogeneous. The perivitelline space in live eggs is narrow, occupying approximately 4% of the egg diameter. One hundred live eggs and 100 Formalin-preserved eggs were measured at various stages of development. No differences in diameters of eggs or oil globules were noted at different stages of development. Diameters of both live and preserved eggs averaged 0.77 mm. The diameter of live eggs ranged from 0.73 to 0.82 mm while diameters of preserved eggs ranged from 0.70 to 0.85 mm.

The eggs usually contain one yellow oil globule, but some eggs (2%) have two or three globules. Oil globules in preserved eggs range from 0.18 to 0.26 mm in diameter, with a mean of 0.22 mm. Oil globules in live eggs range from 0.22 to 0.27 mm in diameter, with a mean of 0.23 mm. When more than one globule is present, sizes vary greatly.

Early Stage Eggs

Duration of the early stage is about 8 h. Eggs preserved in Formalin have yellowish oil globules, opaque cells, and, in this early stage, a shrunken and disorganized yolk (possibly due to poor preservation). Eggs float with the oil globule(s) on top and the developing cells on the bottom.

Development proceeds as follows: 1½ h, 16- or 32-cell stage; 2 h, morula stage; 3 h, blastula stage; 4 h, gastrulation begins; 6 h, gastrula encircles two-thirds of the yolk and primitive streak is evident; 8 h, blastopore closure. At the onset of gastrulation, numerous small droplets form around the oil globule. By blastopore closure, optic vesicles are visible in most eggs and the notochord can be seen in some. Myomeres are not discernable and no pigmentation is present on the egg or embryo.

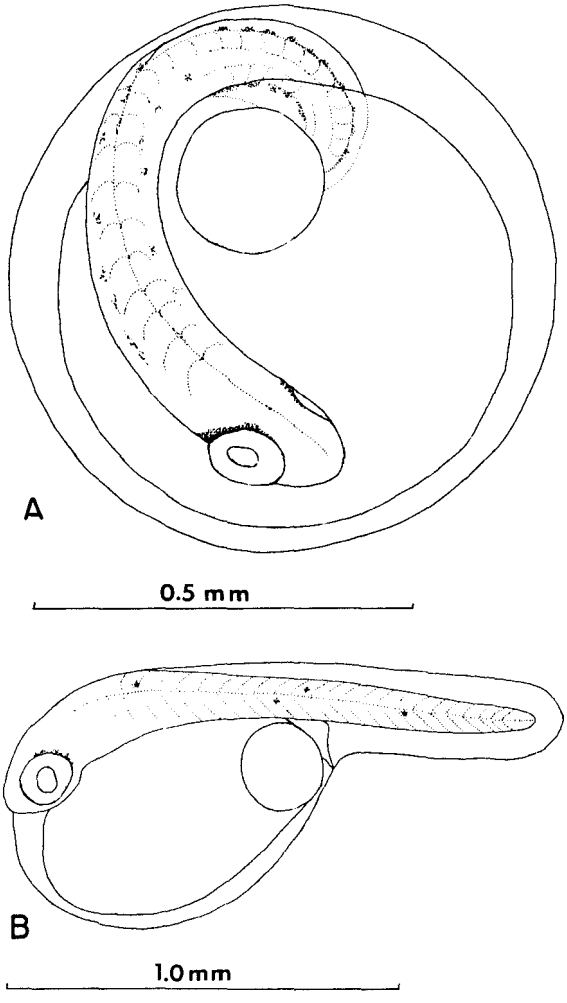


FIGURE 1.—Spotted seatrout embryos: A) 15 h after fertilization; B) at hatching (SL 1.46 mm).

Middle Stage Eggs

Duration of the middle stage is about 4 h. At 9 h after fertilization, the notochord develops further and the forebrain begins to develop. Small melanophores are present for the first time around the optic vesicles and in no apparent pattern along the body. In the 10th hour, six to eight myomeres can be seen with difficulty on the posterior one-third of the embryo. By the 12th hour, the embryo extends over about one-half the circumference of the egg.

Late Stage Eggs

The tip of the tail of the embryo has separated from the yolk and the finfold is evident on both the posterior dorsal and ventral caudal regions at 13 h. Eighteen to 20 myomeres are present. Melanophores, which are present over the entire body of the embryo, are concentrated around the dorsal surfaces of the eyes, on either side of the notochord, and along the base of the finfold. At 15 h (Figure 1A), the tail of the embryo is well past the oil globule and has developed a marked curve. The finfold surrounds the posterior half of the embryo and 24 to 25 myomeres can be counted. Internal organs show some differentiation, while anteriorly the eyes are pronounced and the hindbrain is developing. One hour later, the embryo occupies three-fourths of the circumference of the egg. Twenty-five myomeres are apparent.

Hatching occurs 16 to 20 h after fertilization, when incubation temperatures are approximately 25°C. In other experiments, hatching occurred in 15 h at 27°C and in 21 h at 23°C.

LARVAL DEVELOPMENT

Hatching (Figure 1B)

Standard lengths of 20 newly hatched larvae ranged from 1.30 to 1.56 mm and averaged 1.46 mm. At hatching the oil globule is located at the posterior end of the yolk sac. Some scattered melanophores like those in the embryos are still found, but most are indistinct, especially those along the finfold. No pigment is visible in the yolk or on the oil globule.

Sixteen Hours Posthatching (Figure 2A)

At 16 h, larval standard lengths ranged from 1.89 to 2.10 mm and averaged 2.03 mm. The finfold is large and clear with no fin differentiation. The mouth is undeveloped, only a little yolk remains, and the oil globule is still in a posterior position. Otocysts are faintly visible within the otic capsule. Pectoral fin buds are evident for the first time. The alimentary canal is straight, terminating at the anus in the anterior half of the body.

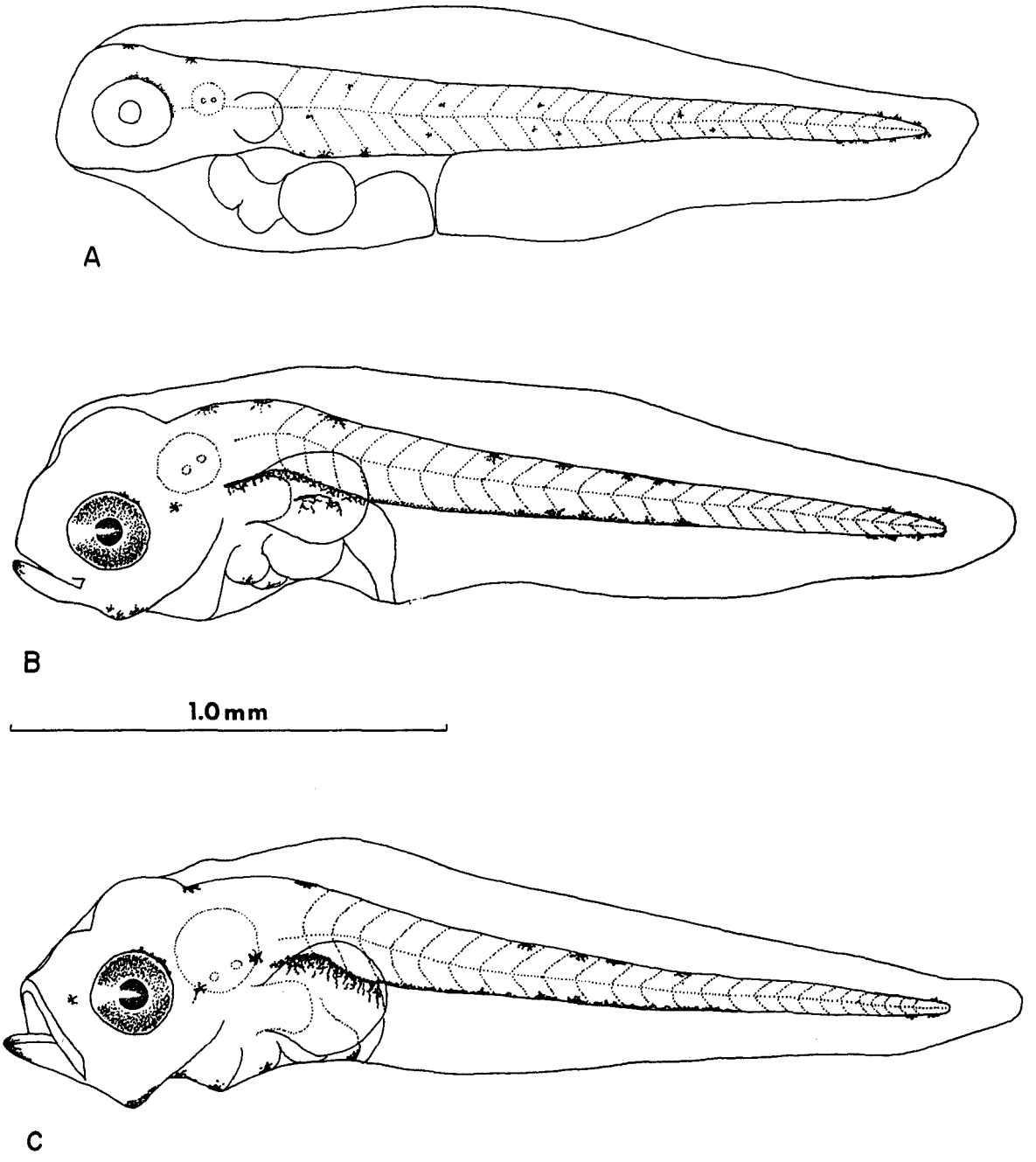
Body pigments are in four vertical bands located above the abdomen, above the anus, and one-third and two-thirds of the distance from the anus to the tip of the notochord. Small melanophores are concentrated in these bands, but many disappear with preservation. The most prominent of the bands is located one-third of the way from the anus to the notochord tip. Pigmentation in preserved specimens is most distinctive in the head region. Several small dendritic melanophores are located above and behind the eye. Two dendritic melanophores are located on the dorsomedial surface of the head. Some slight black pigmentation is visible above the abdomen where the first pigment band is located. Numerous granular melanophores are also found on the finfold at the dorsal and ventral body margins at the notochord tip.

Forty Hours Posthatching

At 40 h, the larvae average 2.10 mm SL, the mouth is formed, and the yolk sac is almost completely gone. The head has grown very deep, and the brain appears dorsally over the eyes. In preserved fish the eye is totally black, and pectoral fins stand out from the sides. Internal organs are increasing in size and complexity, but the alimentary canal is still straight, although thicker than at hour 16.

Pigmentation undergoes distinctive changes prior to 40 h of age. The four vertical bands which occur on the 16-h larva are absent, and only one wide, diffuse band is found just forward of the half-way point between the anus and the tip of the notochord. Melanophores are intensifying along the dorsal and ventral body margins within the band and anteriorly over the abdomen. The granular melanophores on the finfold at the tip of the notochord are somewhat fewer in number. Dendritic melanophores are on the dorsal surface of the abdomen. Pigmentation on the lower jaw is heaviest at the angle and posteriorly. A few small melanophores are anterior to this and at the tip of the lower jaw.

The pigment which remains least distinct and disappears after a short period in Formalin is that



around the eye and dorsal surface of the head. Concentrations of small amber chromatophores are found ventral and posterior to the eye, while several larger yellow chromatophores are found above the eye. Several amber chromatophores are also located medially on the dorsal surface of the head.

Sixty-Four Hours Posthatching (Figure 2B)

Larvae at 64 h past hatching range from 2.06 to 2.15 mm SL and average 2.12 mm SL. The yolk is completely absorbed, the gut has become convoluted, and the intestine is very thick.

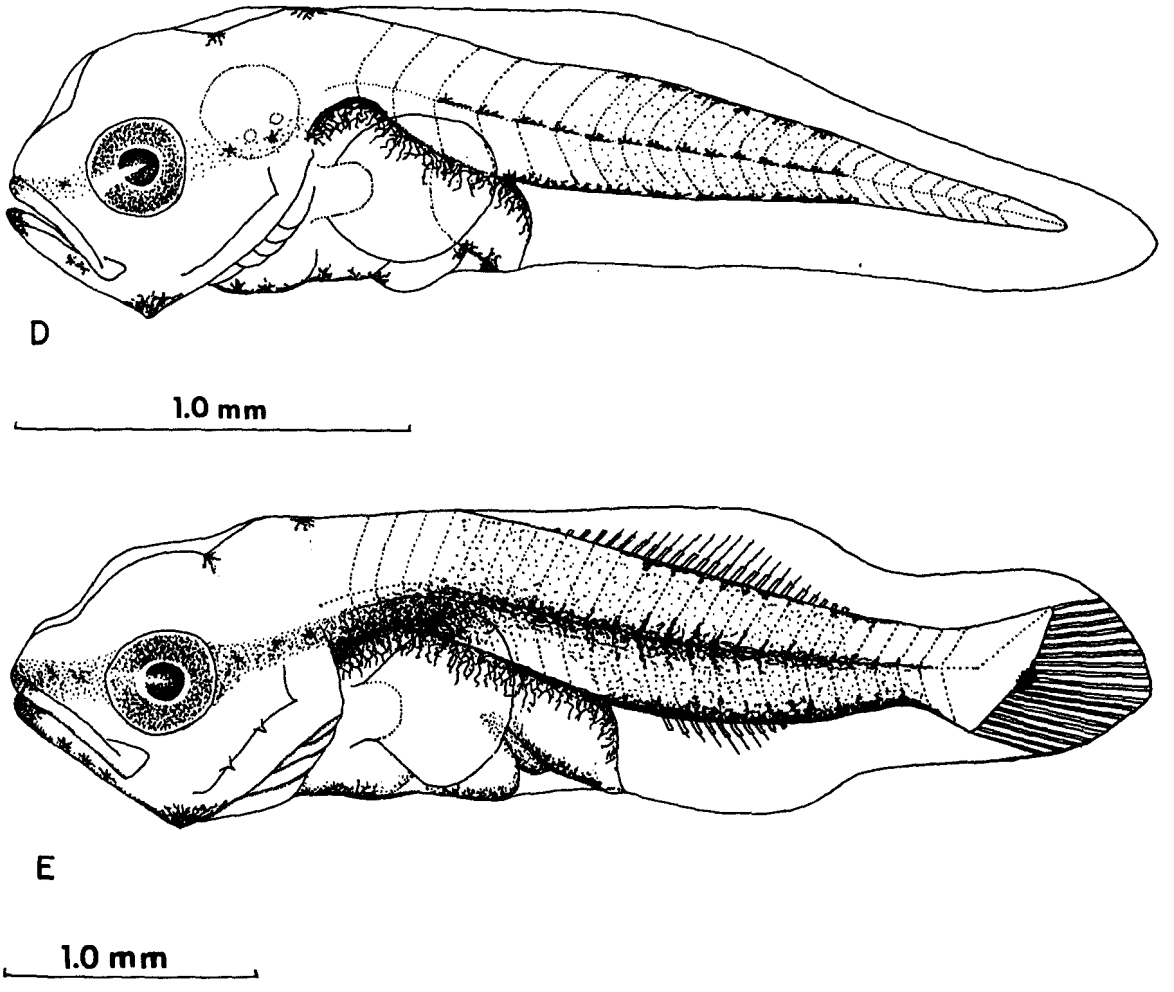


FIGURE 2.—Spotted seatrout larva: A) 16 h posthatching (SL 2.03 mm); B) 64 h posthatching (SL 2.12 mm); C) 112 h posthatching (SL 2.12 mm); D) 232 h posthatching (SL 2.71 mm); E) 328 h posthatching (SL 4.21 mm).

Eye pigmentation is complete and very reflective. The diffuse band found in 40-h fish is still present but is indistinct. Basic pigment patterns and melanophore placement remain similar to 40-h fish except in the following cases. Pigment is increasing along the dorsal surface of the abdomen, and anteriorly towards the eye. The melanophores on the tip of the lower jaw are more distinct. Some pigment is also present on the ventral surface of the abdomen.

Four and Five Days Posthatching (Figure 2C)

In a typical spotted seatrout 112 h old, standard lengths vary from 2.04 to 2.15 mm and average 2.12 mm. The mouth is well-developed and the maxillary is prominent.

Dendritic melanophores are found from the upper surface of the abdomen posteriorly to two-thirds of the length of the tail along the ventral midline. They radiate ventrally over the outer abdominal surface. Melanophores on the tail radiate dorsally from the ventral margin and ventrally from the dorsal margin. Large dark melanophores are present on the preserved larvae at this age but are somewhat variable. One is found immediately ahead of the anus (an important characteristic in sciaenid larvae), and two to three more occur anteriorly below the abdomen. Another is located at the angle of the lower jaw. One or two are on the

dorsal surface of the body above the abdomen. Melanophores on the finfold at the tail vary greatly; they are found both on the dorsal and ventral body margins in varying numbers. A single dendritic melanophore is present anterior to the eye, and two or three more are posterior to the eye.

Six Through Eight Days Posthatching

At this age, there is little difference in body form and structure from that in Figure 2c. Standard lengths at 160 h average 2.06 mm and range between 1.80 and 2.23 mm. The preopercle can be seen on some larger specimens.

Pigmentation has become more intense and is expanding. Principal changes in the dendritic pigments involve the ventral expansion of melanophores on the upper surface of the abdomen, and the coalescence of tail pigmentation into dark stripes. Indistinct pigment occurs from the eye to the tip of the snout. Melanophores are still found anterior to the anus and have increased in number below the abdomen. A melanophore spot is still found on the tip of the lower jaw.

Nine Through Eleven Days Posthatching (Figure 2D)

During this 3-day period the larvae begin to grow appreciably in length. By 11 days, standard lengths average 2.92 mm and range from 2.37 to 3.48 mm. Six small teeth are present on the upper jaw and four on the lower jaw at this age. The preopercle is more evident and a small spine can be seen. Branchiostegal rays are present for the first time. The pectoral fin is still membraneous. Some larvae have a presumptive hypural plate below the notochord tip, but no notochord flexion is observed.

Pigmentation undergoes only minor changes in this period. Principal body pigment gives the appearance of a dark stripe from snout to tail. Melanophores are now evident on the lateral line giving the impression of a series of dashes. Tiny melanophores are present on the midlateral tail region and both ahead of and behind the eye within the pigment stripe.

Twelve Through Fifteen Days Posthatching (Figure 2E)

Standard lengths at 12 days average 3.35 mm, and increase to 4.59 mm at 15 days. The preopercular spine is prominent, and on the larger specimens second and third spines are visible below the first. By the 14th day (at a size of 4.4 mm SL) notochord flexion has occurred in all specimens. As many as 18 caudal rays are first seen at 13 days (4.0 mm SL), and by 15 days (4.4 mm SL), 25 dorsal rays and 10 anal rays are evident. Teeth are found on both jaws (10 on the upper and 6 on the lower).

At this age, the pigmentation still gives the appearance of a stripe from the snout through the eye to the upper abdomen, and on the lateral line and ventral tail surface. Melanophores are still located at the tip and posterior to the angle of the lower jaw, on the tip of the upper jaw, and along the ventral margin of the abdomen. The spot anterior to the anus is indistinct. Pigmentation around the eye is localized in an anterior and posterior position within the pigment stripe. The dendritic melanophores on the upper abdominal surface are still large and distinct. Dendritic melanophores are heavily concentrated along the lateral line and also along the ventral margin of the tail. The dorsal tail margin has less pigmentation. A single large dendritic melanophore is found on the base of the caudal fin. Other pigmentation is widely scattered over the entire tail. Seatrout preserved for long periods seem to lose the melanophore on the caudal fin but other body melanophores remain visible.

GROWTH

Larval spotted seatrout grew from about 1.5 mm SL at hatching to about 4.5 mm SL in 15 days. A. K. Taniguchi (pers. commun.) at the University of Miami has observed faster growth of larval spotted seatrout. He raised larvae at various temperatures and fed them copepods. At 2 wk of age, we noted cannibalism in our seatrout larvae even though ample food of appropriate size appeared to be present.

Measurements were made of preserved larvae. The data were tabulated according to size and age (Table 1). Standard lengths of larvae were consistently 93 to 95% of the total length until flexion of the notochord occurred at 14 or 15 days; then the standard length decreased to 88% of total length.

Preanal lengths at 1 day posthatching were 44% SL, 36% SL at 5 days, and 54% SL at 15 days. This indicated that the preliminary decrease in gut length appeared to be associated with yolk absorption. After 5 days, the gut length steadily in-

TABLE 1.—Average age (hours) and measurements (millimeters) of preserved larval spotted seatrout of known size.

Standard length range	Age	Number of specimens	Snout to anus length	Snout length	Head length	Eye diameter	Body depth
1.70-1.89	118	4	0.79	0.09	0.43	0.21	0.50
1.90-2.09	92	32	0.85	0.10	0.44	0.22	0.53
2.10-2.29	122	52	0.91	0.12	0.49	0.23	0.54
2.30-2.49	216	6	1.22	0.17	0.69	0.28	0.65
2.50-2.69	248	3	1.38	0.21	0.83	0.30	0.75
2.70-2.89	244	4	1.41	0.20	0.82	0.31	0.77
2.90-3.09	253	7	1.47	0.21	0.88	0.32	0.80
3.10-3.29	274	8	1.60	0.26	1.01	0.34	0.90
3.30-3.49	290	7	1.72	0.29	1.06	0.35	0.91
3.50-3.69	304	3	1.78	0.27	1.08	0.35	0.96
3.70-3.89	316	4	1.95	0.35	1.20	0.40	1.01
3.90-4.09	323	5	2.06	0.34	1.29	0.42	1.07
4.10-4.29	323	5	2.20	0.40	1.37	0.38	1.13
4.30-4.49	344	3	2.46	0.41	1.50	0.45	1.24
4.50-4.69	—	0	—	—	—	—	—
4.70-4.89	352	1	2.56	0.43	1.63	0.48	1.35
4.90-5.09	342	5	2.68	0.45	1.68	0.48	1.36
5.10-5.29	—	0	—	—	—	—	—
5.30-5.49	352	1	3.05	0.47	1.84	0.52	1.48

creased relative to standard length. Snout length increased relative to standard length from 3% at 1 day to 9% at 15 days. Similarly, head length increased relatively from 19-20% SL to 34% SL. Both these changes were due to rapid development of the mouth and head. Eye diameter and body depth varied only slightly during development. Eye diameter was between 9 and 11% SL at all stages, while body depth varied from 22 to 28% SL at all ages.

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