TAXONOMIC DATA ON THE EARLY LIFE HISTORY STAGES OF SCIAENIDAE OF THE SOUTH ATLANTIC BIGHT OF THE UNITED STATES[1]

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Introduction

The perciform family Sciaenidae is represented in waters of the South Atlantic Bight of the United States by 18 species in 11 genera (Table 1) (Bailey et al., 1970; Hildebrand and Schroeder, 1928; Anderson, 1968; Dahlberg, 1972; Welsh and Breder, 1923; Marine Resources Research Institute - Marine Resources Monitoring, Assessment and Prediction (MRRI-MARMAP) Trawl Survey Data). All inhabit coastal and/or estuarine waters except for the four Equetus species, which inhabit hard or "live" bottom areas of the continental shelf (MRRI-MARMAP Trawl Data); several coastal species (including Leiostomus xanthurus and Micropogon undulatus) migrate seasonally to continental shelf waters to spawn.

The sciaenids are abundant fishes of coastal waters of the Bight and are important components of sport fisheries and catches incidental to shrimp trawling. Leiostomus xanthurus, Micropogon undulatus, Pogonias cromis, Sciaenops ocellata, and the species of Cynoscion and Menticirrhus are sought-after sport fishes; data on sports catches are limited but significant catches of all these fishes are taken by sport fishermen in the region. The Sciaenidae are the major component of the finfish catch of shrimp trawlers, making up 73% numerically of the incidental catch throughout the Bight (Anderson, 1968) and 60% of the incidental catch off South Carolina (Keiser, 1976). Leiostomus xanthurus, Micropogon undulatus, and Stellifer lanceolatus numerically account for most of the incidental sciaenid catch, with species of Cynoscion and Menticirrhus also taken in significant numbers. Species whose maximum size is too small for sports or commercial fishery exploitation are abundant in estuaries and coastal waters of the region; Stellifer lanceolatus and Bairdiella chrysura are extremely abundant in trawl catches in these habitats in South Carolina and Georgia, while Larimus fasciatus is also present (Dahlberg, 1972; Shealy et al., 1974).

Larval and juvenile sciaenids are a significant component of the ichthyoplankton of South Atlantic Bight waters. Although Fahay (1975) found sciaenids to be a minor component of surface net catches in continental shelf waters, Powles and Stender (1976) found fishes of the family (primarily Leiostomus xanthurus and Micropogon undulatus) to account for some 67% of winter neuston catches, while young Menticirrhus and Cynoscion were present in smaller numbers in spring and fall neuston and bongo net catches. Williams and Deubler (1968) found Sciaenidae to be important in the ichthyoplankton of Pamlico Sound, North Carolina, and unpublished data (South Carolina Estuarine Survey Program) indicate that young sciaenids are common in the plankton of South Carolina estuaries.

Early life histories of the Sciaenidae have been intensively studied since the beginning of the present century (Table 2). For only one South Atlantic Bight species (Umbrina coroides) is no published early life history information available. Developmental series from eggs to juveniles have been described for five species, from early larvae (post yolk-sac absorption but without developed fin rays) onwards for six species, and from late larvae (those with the full dorsal and anal fin ray complements) onwards for two species (Table 2; complete series of Equetus larvae not available). Several summary works on identification and ecology of sciaenid early life history stages are available. Hildebrand and Cable (1934) produced a key for identification of larvae and juveniles; this comprehensive work, with their earlier paper (1930), provides a basis for sciaenid early life history studies, but contains inaccuracies (see individual species sections). Scotton et al. (1973) summarized published information on seven species occurring in the Delaware Bay. Lippson and Moran (1974) summarized available identification and ecological information for nine species found in the Potomac River Estuary. Johnson (1978) summarizes available information on early life history stages of Sciaenidae of the mid-Atlantic Bight. Keys for identification of adults have been published by several authors, the most recent and complete being that of Chao (1976).

The quality of the many published studies on early life history stages is uneven. Pigmentation in many published illustrations does not agree with that in fresh material we have seen, suggesting that specimens on which the published descriptions were based had cleared in preservative. Several published illustrations are based on damaged or deformed specimens, suggesting that the descriptions may have been based on limited material; in many published studies, number of specimens studied are not given. Some published series are of mixed species. Finally, most of the published descriptions lack the detailed developmental morphometric and meristic data necessary for separation of larvae which are superficially very similar. For these reasons it seemed useful to critically evaluate the existing literature and add descriptive data from the material available at our laboratory.

We do not claim that this study is complete, but believe that it permits definition of areas where further study is required and a preliminary overview of developmental stages of the family as represented in our area. Material on some species is incomplete. The lack of illustrations (noted by all our reviewers and regretted by us) resulted from a conscious decision on our part; due to limited resources, both drawings and detailed taxonomic data could not be provided in the time available, and we opted for the data, having seen too many inaccurate, unsupported drawings in the literature. We plan to provide illustrated publications on selected species in the future. We hope that this study will encourage other studies of larvae of this diverse family and provide a point of comparison with such studies. It is our particular hope that further studies of larval Sciaenidae (and other speciose families) will emphasize characters for differentiating larvae of closely-related species, for it is in this area that past descriptions of larval sciaenids have been most lacking.

Methods and Materials

Specimens for this study were collected with the following types of gear:

A. South Carolina estuaries:

1. Conical nets of 1/2 m mouth diameter, mesh opening 571 microns, towed at surface or bottom for 10 minutes at 1.3 - 1.5 m/s (2.5 - 3.0 knots) (Estuarine Survey Program).

2. A 6-m (20-ft), semiballoon otter trawl towed against a flooding tide in daylight at 1.3 - 1.5 m/s (2.5 - 3.0 kt) (Estuarine Survey Program).

3. A 4.9-m (16-ft) balloon try-net (Oyster Program).

B. South Carolina tidal passes: Conical nets of 1-m mouth diameter, mesh opening 571 microns, moored to bridges or piers and fished near bottom for 1 hour at early or middle flood tide (Crustacean Management Program, Office of Conservation and Management).

C. Continental shelf waters, South Atlantic Bight:

1. Bongo samplers of mouth diameter 60 cm, mesh opening 505 microns, towed in double oblique pattern from surface to 2 m off bottom or 200-m depth and to surface, at 0.8 m/sec (1.5 knots) (MRRI-MARMAP Program).

2. Neuston samplers of mouth opening 1 m high by 2 m wide, mesh opening 947 microns, towed at surface at 2.6 m/sec (5 knots) for 10 minutes (MRRI-MARMAP Program).

D. Cape Fear River estuary: Conical nets of 1 m mouth diameter, mesh opening 760 microns, towed at 0.5 m/sec (1 knot) (specimens loaned by Dr. Ronald Hodson, North Carolina State University).

Plankton samples from South Carolina collections were preserved in 10% formalin or in 5% formalin neutralized with borax. Samples from continental shelf waters were initially fixed by immersing the codend of the plankton net (after washing down) in 20% formalin for 1-2 minutes. Specimens from 10% formalin were transferred to 5% neutral formalin within a year of initial collection. Samples from the Cape Fear River were preserved in 5% formalin.

Counts were made on specimens which had not been cleared and stained. All fin elements of which any part was present were counted, following Hubbs and Lagler (1958). Measurements were made with ocular micrometers on Wild M-5 binocular microscopes. All measurements were made along or perpendicular to the body midline. All measurements and counts of paired fins were made on the left side. Specimens undergoing notochord flexion are indicated between dashed lines in the meristics table for each species. Procurrent caudal rays are given as dorsal, ventral counts in the meristics tables. All internal and external pigment was recorded for each specimen on worksheets, on which meristic and morphometric data were also recorded. All specimen lengths referred to in our descriptions are either notochord length (before notochord flexion) or standard length (during and after flexion). Definitions of measurements and abbreviations for these as used in tables are as follows:

Notochord length (NL): symphysis of upper jaw to tip of notochord (measured in pre-flexion larvae)

Standard length (SL): symphysis of upper jaw to posterior edge of hypurals (measured in larvae undergoing notochord flexion and post-flexion larvae)

Snout length (SnL): symphysis of upper jaw to anterior margin of eye

Eye diameter (ED): horizontal diameter of eye

Head length (HL): symphysis of upper jaw to posterior margin of opercular membrane

Preanus length (PAnL): symphysis of upper jaw to posterior margin of anus

Snout to origin of first dorsal (IDo): symphysis of upper jaw to first developed dorsal spine base

Snout to origin of second dorsal (IIDo): symphysis of upper jaw to anterior margin of first developed dorsal ray base

Snout to dorsal fin termination (IIDt): symphysis of upper jaw to posterior margin of last developed dorsal ray base

Snout to anal fin origin (Ao): symphysis of upper jaw to anterior margin of first developed anal element base

Snout to anal fin termination (At): symphysis of upper jaw to posterior margin of last developed anal ray base

Anus-anal fin gap (Gap): posterior margin of anus to anterior margin of first developed anal element base

Snout to pelvic fin insertion (P_2i): symphysis of upper jaw to anterior margin of pelvic fin base

Depth at cleithral symphysis (BDc): vertical distance between dorsal body margin and ventral symphysis of cleithra

Depth at caudal peduncle (CpD): least vertical depth between the dorsal and ventral body margins in the area posterior to the terminal dorsal and anal fin rays and anterior to the hypural plates of the caudal fin

First dorsal count (ID)

Second dorsal count (IID)

Anal count (A)

Pectoral count (P_1)

Table 1. Reported meristics of South Atlantic Bight Sciaenidae. Counts in parentheses occur infrequently, dash indicates range, and semicolon indicates two fins.

Species	Source	Dorsal spines	Dorsal rays	Anal spines	Anal rays	Vertebrae	Gill Rakers upper	Gill Rakers lower
Bairdiella chrysura	1	X;I	19-23	II	8-10, usually 9	12+13	7-8	14-16
	4	XI-XII	19-21	II	9-10			14-16
	5	XI;I	22	II	10		8	16
	7	XII	19-22	II	8-10	11+14		
Cynoscion nebulosus	1	IX-X	25-28	II	10-11	(12) 13+12 (13)	2-3	7-9
	3		25		10-12	25		8
	4	X(XI);I	24-26	II	10-11			8
	5	X;I	25-27	II	10		4	7
	7	XI-XII	24-27	II	10-11	13+12		
	9		25-27		9-10		4	6-8
	10		24-27		10-11	25-26		
Cynoscion nothus	1	X;I	26-30		8-10	15+12	3-4	8-10
	2		27-30(31)		8-9 (10)	27 (26)		12-14 (15), usually 13
	3		24-28		8-10			12-14
	4	X;I	28-29	II	9			9
	5	X;I	27-29	II	9-10		4	9
	7	XI	28-30	II	9	14+13		
	9		26-29		9-11			
Cynoscion regalis	1	X;I	26-29		11-13	(12) 13+12 (13)	4-5	10-13
	4	X;I	25-28	II	11-12			11-13
	5	X;I	26-29	II	11-13		5	11
	6	X-XI;I	24-29	II	10-12	14-15+10		
	7	XI	24-28	II	10-12	13+12		
Equetus acuminatus	1	VIII-IX;I	37-41	II	7-8	10+15	5-6	9-14
	5	X;I	38-40	II	7		6	9
	7	X-XI	36-40	II	6-8	10+15		
	8	IX-X;I	37-40					

Table 1. continued

Species	Source	Dorsal spines	Dorsal rays	Anal spines	Anal rays	Vertebrae	Gill Rakers upper	Gill Rakers lower
Equetus lanceolatus	1	XII-XIII;I	47-55	II	6	10+15	5-6	10-13
	5	XIV-XVI;I	53	II	5		6	9
	7	XIII-XIV	46-50	II	6	10+15		
	8	XIII-XIV	49-55					
Equetus punctatus	1	XI-XII;I	45-47	II	6-8	10+15	5	10-13
	5	XI-XII;I	46	II	6-7		6	11
	7	XIII	44-49	II	7-8	10+15		
	8	XI-XII;I	45-47					
Equetus umbrosus	1	X-XI;I	38-40	II	7	10+15	4-6	10-12
	5	X;I	40	II	7			
	7	IX-XI	38-39	II	7	10+15		
Larimus fasciatus	1	X;I	24-27			11+14	11-13	22-25
	4	X;I	24-27	II	6-8			23-25
	5	X;I	24-26	II	5-6		12	24
	7	XI-XII	25-27	II	6	10+15		
Leiostomus xanthurus	1	IX;I	29-35	II	12-13	10+15	8-12	20-23
	4	X;I	30-34	II	12-13			22-23
	5	X;I	31	II	12		8	22
	7	XI-XII	29-32	II	12-13	10+15		
Menticirrhus americanus	1	X:I	20-26	I	6-8, usually 7	10+15	2-3	0-7
	4	X;I	24-27	I	7-8, usually 7			-6
	5	X;I	24-25	I	7			
	7	XI	24-26	II	7-8	10+15		
Menticirrhus littoralis	1	X-XI	19-26			10+15	3-5	0-8
	4	X;I	24-26	I	7			-7-8
	5	X;I	23-25	I	7			7
	7	XI	24-25	II	7	10+15		

Table 1. continued

Species	Source	Dorsal spines	Dorsal rays	Anal spines	Anal rays	Vertebrae	Gill Rakers upper	Gill Rakers lower
Menticirrhus saxatilis	1	X;I	22-27	I	7-9, usually 8,	10+15	3-5	0-7
	4	X;I	24-26	I	8-9, usually 8			-6
	5	X;I	26-27	I	8			
	7	XI	23-25	II	7-8	10+15		
Micropogon undulatus	1	X;I	27-30	II	8-9	10+15	8-10	14-18
	4	X;I	28-29	II	8			14-16
	5	X;I	28-29	II	7		7	16
	7	XI	28-29	II	8	10+15		
Pogonias cromis	1	X;I	19-21	II	5-6	10+14	4-6	12-16
	4	X;I	20-22	II	6-7			14-16
	5	X;I	21	II	5-6		4	12
	7	XI	21-23	II	6	10+14		
Sciaenops ocellata	1	X;I	23-25	II	8-9	10+15	4-5	7-9
	4	X;I	23-25	II	8			8-9
	5	X;I	24	II	8		5	7
	7	XI	23-25	II	7-8	10+15		
Stellifer lanceolatus	1	XI-XII;I	20-24			11+14	10-13	22-23
	5	XI;I	20-23	II	7-8		13	22
	7	XII-XIII	21-24	II	7-9	10+15		
Umbrina coroides	1	X;I	26-31	II	6	11+14	5-7	7-10
	4	X;I	29	II	6			11
	5	X;I	27-28	II	6-7		5	9

Sources:

1. Chao, 1976
2. Ginsburg, 1929
3. Hildebrand and Cable, 1934
4. Hildebrand and Schroeder, 1928
5. Jordan and Evermann, 1896
6. Lippson and Moran, 1974
7. Miller and Jorgensen, 1973
8. Randall, 1968
9. Welsh and Breder, 1923
10. Daniels, 1977

Table 2. Published information on identification of early life history stages of South Atlantic Bight Sciaenidae.

Species	Eggs	Yolk sac larvae	Early larvae	Late larvae	Juveniles	Recapitulation
Bairdiella chrysura	8,14	8,14	6,8,14	6,8,14	8,14	3,9,13,14,17
Cynoscion nebulosus	1		4,6	4,11	4,5,11,14	1,9,17
Cynoscion nothus				4	4,14	17
Cynoscion regalis	2,10,14	14	4,12,13,14	4,12,13,14	4,12,14	5,9,13,17
Equetus spp.			15	15		
Larimus fasciatus			4	4	4	17
Leiostomus xanthurus			3,9,11,16	3,6,9,11,14	3,11,14	9,13,17
Menticirrhus americanus			4,6	4,6	4,14	9,13,17
Menticirrhus littoralis				4	4,14	17
Menticirrhus saxatilis	14	14	6,13	4,6	4,14	9,13,17
Micropogon undulatus			3,9,11,14,16	3,9,11,16	3,11,14	9,13,17
Pogonias cromis	7	7	6,7,11	11	11	9,13,17
Sciaenops ocellata			6,11	6,11	11,14	9,17
Stellifer lanceolatus			4	4	4,14	17
Umbrina coroides						

Sources:

1. Guest and Gordon, 1958
2. Harmic, 1958
3. Hildebrand and Cable, 1930
4. Hildebrand and Cable, 1934
5. Hildebrand and Schroeder, 1928
6. Jannke, 1971
7. Joseph et al., 1964
8. Kuntz, 1914
9. Lippson and Moran, 1974
10. Merriner, 1976
11. Pearson, 1929
12. Pearson, 1941
13. Scotton et al., 1973
14. Welsh and Breder, 1923
15. Powles and Burgess, 1978
16. Fruge, 1977
17. Johnson, 1978

Pelvic count (P_2)

Principal caudal rays (C)

Procurrent caudal rays (pC)

Preopercular spines (Preoperc)

Opercular spines (Operc)

Subopercular spines (Suboperc)

Posttemporal spines (Posttemp)

Finfold (ff)

Not developed (N)

Scientific and common names used in this report follow Bailey et al. (1970). Recent changes in nomenclature (Chao, 1976) are given in parentheses at the head of species accounts. For preopercular spines, we use the terms "lateral" and "marginal" of Aprieto (1974). The lateral row consists of relatively small spines which project laterally from the surface of the preoperculum, the marginal row of relatively larger spines which project posteriorly and ventrally from the margin of the preoperculum. In most species spines of these two rows have been counted and differentiated in the meristic tables (lateral/marginal).

We define "larvae" to include specimens from the time of hatching to the time of complete development of all fin elements and onset of scale formation and "juvenile" to include specimens from the end of the larval period to the onset of sexual maturity. We have used the term "early" to indicate larvae between yolk-sac absorption and complete development of second dorsal and anal fin complements and "late" to indicate larvae with complete development of elements of these fins. "Yolk-sac" larvae would indicate larvae with unabsorbed yolk; however, we have not identified yolk-sac larvae of Sciaenidae from our collections. By using these terms, we do not want to complicate the field of larval stage terminology; however, we consider the distinction important since identification follows different groups of characters in larvae whose dorsal and anal elements can be counted than in less advanced larvae.

Previous works by Pearson (1929, 1941), and Welsh and Breder (1923) did not specify the kind of lengths (SL, TL, NL) taken on their specimens. For this reason, when referring to these earlier studies, we do not specify the kind of length taken although some authors (Lippson and Moran, 1974) have assumed this to be TL in most cases.

Bairdiella chrysura

Bairdiella chrysura (Bairdiella chrysoura of Chao, 1976) - Silver perch

Range - Massachusetts to Texas (Hildebrand and Cable, 1930)

Spawning Season -

Delaware Bay - May to July (Thomas, 1971)

Chesapeake Bay - May to July (Hildebrand and Schroeder, 1928; Joseph et al., 1964)

Beaufort, North Carolina - late April to August (Kuntz, 1914; Hildebrand and Cable, 1930). Spawning peaks in late June and early July (Kuntz, 1914), in late May and early June (Hildebrand and Cable, 1930)

South Carolina - smallest juveniles (33-52 mm TL) taken in July (Shealy et al., 1974)

Georgia - April and May (Dahlberg, 1972)

South Florida - April to September (Jannke, 1971)

Louisiana - April to September (Sabins, 1973; Frank Truesdale, pers. comm.)

Spawning Area

Spawning apparently occurs in estuarine and coastal waters. Hildebrand and Cable (1930) took larvae in estuaries, in Beaufort Harbor, and in coastal waters to 22-28 km (12-15 miles) offshore. Jannke (1971) suggested that spawning occurs both inside estuaries and in coastal waters, while Sabins (1973) caught small postlarvae in a tidal pass, suggesting spawning nearby in estuarine or coastal waters.

Early Life History

Eggs require about 18 hours to hatch at 27°C, 40-50 hours at 19-21°C; spawning occurs in early evening, before 8 p.m. (Kuntz, 1914). Larvae are said to become demersal at about 5 mm (Pearson, 1941); larvae were more abundant and more frequently caught in bottom than in surface hauls by Hildebrand and Cable (1930). Truesdale and Birdsong (Frank Truesdale, pers. comm.) collected more specimens in bottom than in surface hauls, more at night than by day, and more on flooding tides than at other tide stages in a tidal pass in South Louisiana. Hildebrand and Schroeder (1928) reported that fish mature at 130-160 mm, at an age of 1 year; this conclusion agrees with that of Hildebrand and Cable (1930). Welsh and Breder (1923), however, reported first spawning to occur at 150-210 mm, at age 2.

Description of our Material

The following description is based on 21 specimens 3.1-8.8 mm, and one 24.1 mm juvenile, from South Carolina estuaries and tidal passes.

Body form (Table 3). Body proportions change gradually during the early and late larval stages. Preanus length, 40.0-47.6% NL in larvae of 3.0-3.9 mm, increases steadily to 53.3-58.5% SL in larvae 7.0-8.9 mm and 65.1% SL at 24.1 mm. Body depth changes little with development, being some 30.8-39.3% SL throughout the series available. Distance between the anus and the anal fin origin is relatively great (15.4-21.7% SL) in larvae less than 5.0 mm, and decreases to 7.6-11.9% SL in larvae 7.0-8.8 mm and to 8.3% SL at 24.1 mm.

Fin development (Table 4). In the caudal region notochord flexion occurs between 3.8 mm and 4.8 mm. Principal caudal fin rays are first seen at 3.5 mm; the adult complement of 9 + 8 principal rays is present in specimens ≥ 5.0 mm. Procurrent caudal rays begin to develop at 5.7 mm, and reach a count of 6 dorsal and 5 ventral by 8.8 mm.

Bases of the second dorsal and anal fins are present consistently in specimens ≥ 4.3 mm. Development of elements in these fins is complete by 5.7 mm, and at this length the full complement of first dorsal spines is also present.

The pelvic fin buds first appear in our series at 5.7 mm; however, Peter Berrien (pers. comm.) has observed pelvic buds at 5.2 mm in specimens from Georgia. By 7.0 mm the adult complement of I,5 is present. The pectoral fins are present, with no differentiated rays, in the earliest larvae available; development of rays begins at 5.7 mm. Sixteen pectoral rays are present at 8.8 mm and at 24.1 mm.

Pigmentation. A striking swath of pigment, from the dorsal midline to the ventral midline, roughly parallelling the cleithrum, is characteristic of larval B. chrysura. Melanophores in several areas constitute this swath: in the musculature dorsal to the visceral mass, both above the notochord and on the dorsal and ventral surfaces of the notochord; on the dorsal, anterior, posterior and anteriolateral surfaces of the airbladder and visceral mass; internally, ventral to the brain and in the hyoid area; on the ventral body surface anterior to the cleithrum; and on the ventral surface of the visceral mass. In most specimens of our series, expanded melanophores are present in these areas, so that a continuous dark pigment swath is formed. In a few specimens (two of the 13) in the length range 3.1-4.9 mm, melanophores in these areas are contracted, so a continuous swath of pigment is not developed; however, in these specimens melanophores are present in the separate areas listed. At ≥ 5.0 mm these melanophores are more frequently contracted than in smaller specimens, and thickening of the body wall begins to obscure the internal pigment areas; thus, the pigment swath is somewhat less evident in larger larvae. Pigment in some of these areas is found in larvae of most other sciaenid species we have seen; however, pigment in this area is most extensive and continuous in B. chrysura. This pigment swath can be variable; Peter G. Berrien (pers. comm.) states that the swath may not be very striking in some specimens, although melanophores are generally present in the locations noted. These specimens were 3 years old and alcohol-preserved, so lack of pigment may have been due to age and preservation.

Pigment in the tail region, posterior to the anus, is also of value in identifying larvae of B. chrysura. A row of some 10 melanophores is present in the ventral midline at 3.1-3.8 mm; one of these, located some 2/3 of the distance from anus to notochord tip, is larger than the others. By 4.3 mm the base of the anal fin is well developed, and melanophores of the ventral row are placed as follows: one or two anterior to the anal base, one at the anterior end of the anal base, one (the largest of the row) at the posterior end of the anal base, and three or four between the anal base and the developing caudal fin. This arrangement persists until 5.7 mm. After 7.0 mm, the melanophore(s) anterior to the anal base are no longer visible, and melanophores begin to appear along the anal base in addition to anterior and posterior ones. Otherwise, pigmentation along the ventral body margin remains rather constant with development to 8.8 mm. A single melanophore is present in the caudal fin membrane near the caudal base throughout the series; in specimens larger than 3.8 mm, in which the caudal fin has differentiated into dorsal and ventral lobes, this melanophore is at the base of the ventral lobe.

In the head region (in addition to the melanophores of the vertical pigment swath), a melanophore is present at the angle of the lower jaw, throughout the series available. A melanophore is present laterally on the dentary at 3.1-4.3 mm; between 4.4 and 7.0 mm a melanophore is occasionally present in this area, and at ≥ 7.5 mm the lateral surface of the dentary consistently shows one melanophore or several. Pigment is present at the tip of the premaxillary at ≥ 5.7 mm and at the tip of the lower jaw at ≥ 7.5 mm. Melanophores are present above the eye (over the anterior surface of the midbrain) and internally on the surface of the midbrain at its junction to the hindbrain at ≥ 7.0 mm. Melanophores on the dorsal surface of the forebrain are present at ≥ 7.7 mm.

Pigmentation of the visceral mass region (in addition to that described above), includes two melanophores in the midventral line; one midway between the cleithral symphysis and the anus (between the pelvic fin bases when these are developed) is present at ≥ 3.3 mm, while the other, on the anteroventral surface of the anus, is present in specimens of 3.1-5.0 mm. A third melanophore, located midway between these, is present in some specimens 3.5-4.7 mm and in all specimens ≥ 4.8 mm. A small patch of melanophores may also be present midway between the cleithral symphysis and the pelvic bases (Peter Berrien, pers. comm.). On the posterior surface of the visceral mass, above the anus, a melanophore is present at ≥ 4.9 mm; this melanophore becomes increasingly branched and dark at ≥ 5.7 mm.

Further pigment on the body surface begins to appear in late larvae, at ≥ 7.0 mm, and includes a cluster of melanophores in the dorsal midline anterior to the first dorsal fin, a group of melanophores ventral to this cluster, and a series of melanophores in the midlateral line between the anus and the caudal peduncle. Numbers of melanophores in these areas increase with growth. Melanophores on the dorsal surface of the head, above the forebrain and midbrain, and on the lateral surface

Table 3. Development of body proportions of Bairdiella chrysura.

NL/SL	3.0-3.4	3.5-3.9	4.0-4.9	5.0-5.9	7.0-7.9	8.0-8.9	24.1
n	2	6	6	3	4	1	1
SnL	7.1-8.7	6.3-10.6	7.2-10.6	8.6-8.6	7.0-10.9	9.3	10.1
ED	10.0-13.1	9.5-12.8	10.3-12.4	10.9-11.4	10.6-11.6	11.2	9.1
HL	30.0-32.1	27.3-34.4	30.3-37.3	35.2-35.7	35.8-38.3	36.4	37.9
PAnL	42.5-47.6	40.0-46.7	44.6-48.7	48.6-51.4	53.3-58.5	56.1	65.1
IDo	N	N-41.1	N,38.9-42.5	37.1-39.9	37.2-43.6	39.3	41.7
IIDo	N-54.8	N-58.9	47.0-61.9	57.8-60.0	57.6-59.8	59.8	62.0
IIDt	N-77.4	N-80.0	76.2-83.2	82.9-83.6	81.5-83.7	85.0	83.5
Gap	N-16.7	N-20.0	15.4-21.7	10.4-17.9	7.6-11.9	8.4	8.3
Ao	N-64.3	N-66.7	62.2-66.4	62.8-67.1	63.0-68.1	64.5	73.4
At	N-76.2	N-78.9	73.7-81.4	80.0-81.4	78.3-80.8	79.5	83.5
P_2i	N	N	N-35.7	35.7-37.1	35.8-40.4	39.3	52.5
BDc	35.0-39.3	30.8-37.8	33.6-37.2	36.7-37.1	35.8-37.2	36.4	32.2
CpD	N-8.1	N-7.2	6.5-10.3	10.1-11.4	8.7-11.9	10.3	10.1

Table 4. Development of meristic characters of Bairdiella chrysura.

NL/SL	ID	IID	A	P_1	P_2	C	pC	Preoperc	Posttemp
3.1	ff	ff	ff	bud	N	ff	0	2/3	0
3.3	ff	15	7	bud	N	ff	0	0/3	0
3.5	ff	ff	ff	bud	N	ff	0	1/2	0
3.5	ff	14	7	bud	N	8 + 6	0	2/3	0
3.6	ff	ff	ff	bud	N	ff	0	3/5	0
3.7	ff	ff	ff	bud	N	ff	0	2/2	0
3.7	ff	ff	ff	bud	N	ff	0	1/2	0
3.8	ff	ff	ff	bud	N	ff	0	0/2	0
4.3	ff	14	6	bud	N	7 + 6	0	2/3	0
4.4	ff	15	8	bud	N	7 + 7	0	2/3	0
4.4	ff	18	6	bud	N	7 + 7	0	2/4	0
4.8	ff	20	10	bud	N	8 + 7	0	2/3	0
4.9	ff	19	I,9	bud	N	9 + 8	0	4/3	1
5.0	ff	I,21	I,9	bud	N	9 + 8	0	5/4	1
5.7	XI	21	II,9	bud	3	9 + 8	3,1	4/4	2
5.7	XI	I,21	II,9	6	I,2	9 + 8	0	4/4	1
7.0	XI	I,21	II,9	11	I,5	9 + 8	4,3	5/4	1
7.5	XI	I,21	II,9	12	I,5	9 + 8	5,4	5/4	1
7.5	XI	I,22	II,9	8	I,5	9 + 8	4,4	5/4	1
7.7	XI	I,21	II,9	12	I,5	9 + 8	5,4	5/4	1
8.8	XI	I,22	II,9	16	I,5	9 + 8	6,5	5/4	2
24.1	XI	I,22	II,9	16	I,5	9 + 8	0	7/9	3

of the visceral mass also become more numerous with growth after 7.0 mm. By 24.1 mm, most of the head and body are covered with small melanophores. These are spaced most closely anterodorsal to the eye and on the dorsal and ventral surfaces of the caudal peduncle. Melanophores are present in the membranes of the spinous dorsal, soft dorsal, anal, caudal and pectoral fins.

Other Structures. Lateral and marginal preopercular spines are present throughout the series (Table 4). Spines become more numerous with growth; 5 lateral and 4 marginal are present in larvae 7.0-8.8 mm. The marginal spines are larger than the lateral and are quite large at all sizes. Spination on the posttemporal is present consistently at $\geq$ 5.0 mm (Table 4) as a single spine in all specimens to 7.7 mm and 2 spines at 8.8 mm. A 3-spined scale bone is present at 24.1 mm.

Published Developmental Descriptions

A complete series, from eggs to a 30-mm juvenile, was described and illustrated by Kuntz (1914). Kuntz's work has been widely cited in later studies of larval B. chrysura. Our observations agree substantially with his description and illustrations, and it is certain that his series is B. chrysura. The characteristic swath of pigment from nape to ventral head and visceral mass is well shown by Kuntz. However, a melanophore in the dorsal midline posterior to the position of the anus shown by him in specimens up to 7.5 mm is not present in specimens larger than 3.7 mm NL in our material. (Peter Berrien, pers. comm.) has observed this melanophore in specimens as large as 5.2 mm.) Dorsal, anal, pelvic and caudal fins develop at smaller sizes in our material than in that of Kuntz; for example, in his 5-mm specimen the second dorsal and anal fins are undeveloped and caudal flexion has scarcely begun, while in our series most second dorsal and anal fin elements are present and caudal flexion is complete at 5.0 mm. Such discrepancies may have been due to the fact that Kuntz used living or freshly dead rather than preserved material; our specimens have been formalin preserved, most for at least a year, which may have caused some shrinkage and pigment changes.

Jannke (1971) illustrated B. chrysura of standard lengths 2.0 and 5.0 mm. The smaller specimen is smaller than any of ours so we cannot comment on its identity. The larger specimen agrees with our B. chrysura in fin development, preopercular spination, and fin element counts. Neither specimen has the conspicuous vertical swath of pigment in the area posterior to the head, although both have contracted melanophores in some areas making up the swath. The larger specimen lacks many melanophores of the midventral line seen in our specimens; only those at the anterior and posterior ends of the anal fin base are shown, and this specimen thus resembles S. lanceolatus in pigmentation in this area.

Cynoscion nebulosus

Cynoscion nebulosus - Spotted seatrout

Range - Cape Cod, Massachusetts - Gulf of Campeche, Mexico (Mahood, 1974)

Spawning Season -

Chesapeake Bay - May to July or August (Lippson and Moran, 1974)

North Carolina - April to August, mainly April and May (Hildebrand and Cable, 1934)

South Carolina - April to August (collections of small larvae in South Carolina estuaries and tidal passes)

Georgia - April to August, peak in May (Mahood et al., 1974; Mahood, 1974)

Florida, east coast - mid-April to late July (Tabb, 1961)

Florida, Everglades - year round, mostly April to October, peak April to June (Jannke, 1971)

Florida, northwest coast - late April through September (Klima and Tabb, 1959)

Louisiana - April to August, peaks in May and August (Frank Truesdale, pers. comm.)

Texas - March to October, mainly April and May (Pearson, 1929)

Spawning Area -

Virginia - offshore on shelf and near mouth of Chesapeake Bay (Lippson and Moran, 1974); within Chesapeake Bay (Welsh and Breder, 1923)

North Carolina - inside and outside waters, North Carolina not an important spawning area (Hildebrand and Cable, 1934)

South Carolina - lower estuaries and inlets, possibly just off inlets (early larval collections in South Carolina estuaries and tidal passes)

Georgia - in 1-3 m (3-10 foot) depths in tidal creeks, rivers, sounds, and beaches near inlets (Mahood, 1974)

Florida, east coast - in deeper holes and channels of lagoons (Tabb, 1961)

Florida, Everglades - outside estuaries and in high salinity bays (Jannke, 1971)

Florida, northwest coast - probably inshore over grassy areas (Moody, 1950)

Louisiana - in and near coastal passes, possibly in drifting detrital masses (Sabins, 1973)

Texas - large or entirely within bays and lagoons in 3-5 m (10-15 foot) depths (Pearson, 1929)

Early Life History

Off North Carolina, most young larvae (< 5 mm) occurred in offshore, surface tows with larger ones in inshore bottom tows (Hildebrand and Cable, 1934). Pearson (1929) stated that the eggs hatched over grassy bottom shallows off Texas, and Guest and Gunter (1958) reported the young develop in these beds. Sabins (1973) found postlarval speckled trout associated with drifting detrital masses in areas where grass beds did not occur. Young remain in grass beds until winter when they move into deeper waters (Moody, 1950). Fable et al. (1978) found that reared eggs hatched in 16-20 hr at 25°C at 1.30-1.56 mm and grew to 4.59 mm in 15 days when maintained at 24-26°C. Pearson (1929) determined that the young reached 130 mm at their first winter. Jannke (1971) caught larvae in salinities of 23.5-37.4 °/oo, with most in greater than 36 °/oo, and in temperatures 24-30°C. Joseph and Yerger (1956) in northwestern Florida reported 30-mm young throughout the summer in open waters and in tidal streams.

Klima and Tabb (1959) found that females matured at age I at 250 mm TL and males matured at age II at 270 mm TL. Miles (1950 and 1951, cited in Guest and Gunter, 1958) found 10% of Cynoscion nebulosus to be mature at age I at 164 mm TL (most of the 10% being males) and 50% to be mature at age II at 250 mm TL. Most spawners in Miles's studies were ages II-IV at 250-450 mm TL; females had 100,000 to 560,000 ova, one third of which were ready for spawning. His age VIII females bore 1,500,000 ova. Pearson (1929) found a 480 mm TL female with 427,819 ova and 620 mm TL one with 1,118,000 ova.

Description of our Material

This study is based on 25 specimens (1.9-32.2 mm) from South Carolina estuaries and inlets.

Body form (Table 5). Several body proportions change with growth. The anus-anal fin gap rapidly decreases from 20.0% NL at 3.0 mm to 7.8% SL at 3.9 mm, continues to decrease rapidly to 0.9% SL at 8.0-8.9 mm, and gradually increases to 5.9% SL in juvenile fish at 32.2 mm. Head length, preanus distance, snout length, and depth at caudal peduncle increase rapidly during early development (1.0-3.0 mm for first two measurements; 1.0-4.0 mm for last two) and then stabilize. Eye diameter decreases consistently, but gradually, over the entire series of specimens examined. All other morphometrics change little through the series examined.

Fin development (Table 6). The dorsal, caudal, and anal finfolds are continuous in the smallest specimens; the pectoral bud is present. Hypural plates begin forming at 3.0 mm with notochord flexion occurring from 3.5-4.8 mm. Pterygiophores are sufficiently developed to permit some enumeration in the anal fin at 3.5 mm and dorsal fin at 3.8 mm. The pelvic bud is first visible at 4.8 mm. Pectoral fin rays are first countable at 6.6 mm. The size for each fin at which elements are completely developed is 4.8 mm for the caudal (principal rays only), 6.6 mm for the anal, 7.6 mm for the dorsal, and 8.4 mm for the pectoral and pelvic fins.

Pigmentation. At the smallest sizes (1.9 mm), internal pigment is distinguishable on the ventral surface of the hindbrain from posterior to the eye to anterior to the first vertebra. This pigment is present in all specimens examined although its extent is variable. At 3.5 mm, an internal melanophore appears on the anterior surface of the midbrain. By 4.8 mm, this midbrain pigment has increased to three branching melanophores on the anterior, dorsal, and posterior surfaces; these are present in 7 of 8 specimens longer than 4.8 mm. At 6.6 mm, an external melanophore is present dorsal to the midbrain. From 6.6 to 32.2 mm, external pigmentation generally increases to cover the dorsal half of the head with dense, branching melanophores. At $\geq$ 8.4 mm, an internal pigment spot is present on the anterior portion of the forebrain. The eyes are pigmented at all sizes examined. Internal pigment on the ventral surface of the palatines is present throughout the series. External pigment on the snout is present at $\geq$ 8.4 mm; by 32.2 mm, the snout is covered with dense, branching melanophores continuous with the external pigment on the dorsal surface of the head.

At 5.2 mm, two subsurface pigment spots are present on the internal surface of the operculum posterior to the eye. These spots persist (except on a 5.5 mm specimen) to about 12.7 mm when 5 spots appear on the external surface posterior to the position of the internal ones. By 32.2 mm, these external spots form a dense blotch on the upper operculum that is continuous with the dorsal head pigment.

One melanophore is present at the premaxillary symphysis at 3.5 mm; pigmentation increases until it covers the anterior half of the upper jaw at 7.4 mm. Internal pigment on the premaxillary, present at 4.8 mm, is found on most (7 of 8) larger specimens.

A melanophore is first present on the lower jaw (external on the anterior tip of the dentary) at 3.3 mm; melanophores increase in number to cover the anterior half of the lower jaw at $\geq$ 7.6 mm. Pigment on the ventral midline of the lower jaw is present externally on 10 of the 25 specimens. One or two spots are present at the angle of the lower jaw in about half of the specimens examined.

External pigmentation on the ventral midline of the visceral mass is present on most specimens (20 of 25). Twelve, all larger than 3.3 mm, have a spot anterior to the cleithrum. Sixteen have 1-3 spots on the midline of the visceral mass and 12

have a small melanophore just anterior to the anus. Internal pigment is present on the anterior, dorsal, and posterior surfaces of the visceral mass at all sizes. The single anterior melanophore is small at all sizes. The dorsal surface is lined with small, discrete, branching melanophores which, at 4.2 mm, are found as a continuous row with a second row below its posterior portion. At less than 4.2 mm, the posterior spot is well separated from the dorsal line but is continuous with the dorsal pigment at $\geq$ 4.2 mm.

A gradual increase occurs in the number of external spots along the base of the dorsal fin from 1-4 posteriorly placed spots in larvae less than 3.0 mm to a continuous row at 6.6-12.7 mm. By 32.2 mm along the base of the dorsal, a blotch of dense, branching melanophores is continuous from the dorsal head pigment to below the spinous dorsal fin, and discontinuous blotches continue posteriorly to the base of the caudal fin. A varying number of internal melanophores constitutes this dorsal row in specimens > 6.6 mm.

Midlateral body pigment, particularly characteristic of Cynoscion nebulosus larvae, is present at all sizes. In larvae < 4.2 mm, a series of dashes on the external surface along the midlateral line extends from above the middle of the visceral mass to 2/3 or 3/4 of the way along the caudal portion of the body. Between 4.2 and 8.4 mm, these melanophores become close-set and branching and are paired in a band from above the midgut to the middle of the caudal peduncle; melanophores are more widely spaced at the anterior end. With further development, this band becomes continuous from the operculum to the caudal base. Between 7.4 and 32.2 mm, the number of spots scattered above and below this band increases.

In 2.7 mm larvae, dashes of internal pigment form a row parallel to the external, midlateral dashes. Additional dashes are present internally above and below the notochord in this same region. The series below the notochord is composed of fewer spots placed more posteriorly than the dorsal series. By 4.8 mm, a row of internal spots forms midway along successive neural spines over the length of the vertebral column except for 1 or 2 vertebrae at either end. By this size, the series below the vertebrae is continuous with the lateral series. A few melanophores are scattered internally along the hemal spines. By 12.0 mm, additional, scattered, internal melanophores are present above and below the midlateral series; the 32.2 mm specimen was too opaque to observe this internal pigment.

Along the ventral body margin, there is an internal series of melanophores generally continuous from the visceral mass to below the midlateral series. This series is present up to 12.7 mm when it becomes less continuous overall and darker above the anal fin base. There are a few external melanophores along the ventral margin at < 7.4 mm. At 7.4-8.4 mm, the external pigment becomes more continuous, with the 12.7 mm larva having a band from the anus to the caudal fin base. By 32.2 mm, this band is composed of more scattered spots from along the anal to the caudal fin base.

A spot is present at the posterior tip of the notochord or in the middle of the primitive caudal base in 3 of 13 specimens < 3.8 mm. From 3.8-6.4 mm, all larvae have a spot at the base of the inferior lobe of the caudal fin. The number of spots at the caudal base increases to 5 by 8.4 mm. At 12.7 mm, there is a blotch of branching melanophores at the base of the inferior lobe of the caudal, and by 32.2 mm, there is a blotch on the anterior half of the caudal fin and 3 smaller blotches posteriorly on the inferior lobe of the fin extending toward the tip.

The only other fin pigment is on the dorsal fin at 32.2 mm. The pigment is in the membrane between the dorsal fin elements, giving the impression of a row of vertically-oriented lines.

Other Structures. Teeth are present on the upper and lower jaws in all specimens examined. Opercular spination is first apparent on a 3.8 mm larva, and all specimens > 4.2 mm had 1 or 2 spines on the operculum. A single marginal preopercular spine is apparent at 3.0 mm; spines increase with size to 6 + 11 on the 32.2 mm specimen. This largest specimen has a 4-toothed projection at the posttemporal. The 8.4 mm specimen has 1 posttemporal spine. Three of the 7 specimens larger than 5.2 mm have 2 small spines developed on lateral surface of the subopercular.

Published Developmental Descriptions

Welsh and Breder (1923) described and illustrated fish from 28-240 mm. Pearson (1929) described fish of 7.8 and 15-35 mm and illustrated 7.8, 13, 41, and 120 mm. Hildebrand and Cable (1934) gave descriptions and illustration of specimens from 1.8-100 mm. Jannke (1971) illustrated 3.0 and 5.0 mm larvae. Lippson and Moran (1974) and Johnson (1978) recapitulated the above works. Daniels (1977) described and illustrated larvae from 1.8-11.3 mm SL. Fable et al. (1978) gave illustrations and descriptions of reared larvae 1.3-4.6 mm.

Morphometrics of our specimens roughly agree (± 5% SL) with those reported by Hildebrand and Cable (1934), Daniels (1977), Fable et al. (1978), and Welsh and Breder (1923) for similar-sized specimens. However, the ratio of depth posterior to the anus to eye diameter was less in our specimens than reported by Hildebrand and Cable (1934) for small larvae (1.8 and 2.5 mm). Also, morphometrics reported by Fable et al. (1978) were somewhat lower than we found on similar sized specimens, but this is probably due to greater shrinkage in our larvae which were generally preserved for a longer period of time.

In general body form, the smallest larvae (1.89-2.10 mm) in the series by

Table 5. Development of body proportions of Cynoscion nebulosus.

NL/SL	1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.6	7.0-7.9	8.4	12.7	32.2
n	2	3	10	2	2	1	2	1	1	1
SnL	5.1-5.2	5.7-8.2	3.8-11.0	10.1-10.6	10.6-12.0	9.3	10.7-12.5	12.5	10.1	9.3
ED	11.5-12.2	10.9-11.4	10.7-11.8	11.3-13.4	9.8-9.9	10.0	8.7-9.3	8.8	8.3	7.7
HL	21.9-22.4	27.1-29.0	29.7-37.0	37.0-38.2	36.3-43.7	36.0	38.5-38.8	38.9	40.4	38.5
PAnL	40.8-41.7	51.8-53.4	51.0-58.5	55.5-61.8	62.1-63.4	62.6	63.3-65.6	68.5	69.0	67.3
IDo	N	N	42.2-43.8	42.5-44.7	42.2.-43.9	46.6	40.8-45.8	43.5	44.0	37.8
IIDo	N	N	50.0-60.0	54.6-65.0	57.8-60.6	61.3	57.1-62.5	60.2	59.5	57.4
IIDt	N	N	72.3-86.7	74.0-89.4	84.8-87.3	90.6	87.5-88.8	88.0	89.2	87.2
Gap	N	N	7.8-20.0	5.6-8.1	5.6-9.1	5.3	3.1-4.1	0.9	3.6	5.9
Ao	N	N	63.2-68.0	64.8-69.9	69.0-71.2	68.0	67.4-68.7	69.4	72.6	73.2
At	N	N	71.1-77.6	75.0-83.7	83.3-84.5	82.6	80.2-81.6	84.3	84.5	83.8
P_2I	N	N	N	38.2	37.8-38.0	38.6	38.8-39.5	38.0	44.0	46.8
BDc	28.6-30.2	25.7-31.5	26.1-36.7	30.5-31.7	28.7-28.9	29.3	27.6-29.1	26.8	27.3	25.1
CpD	3.1-4.2	3.6-5.7	3.8-8.9	6.4-7.3	7.5-8.4	8.5	9.0-9.2	9.3	8.3	8.6

Table 6. Development of meristic characters of Cynoscion nebulosus.

NL/SL	ID	IID	A	P_1	P_2	C	Preoperc	Operc	Subopere	Posttemp
1.9	ff	ff	ff	bud	N	ff	0/0	0	0	0
1.9	ff	ff	ff	bud	N	ff	0/0	0	0	0
2.1	ff	ff	ff	bud	N	ff	0/0	0	0	0
2.7	ff	ff	ff	bud	N	ff	0/0	0	0	0
2.7	ff	ff	ff	bud	N	ff	0/0	0	0	0
3.0	ff	ff	ff	bud	N	ff	0/1	0	0	0
3.0	ff	ff	ff	bud	N	ff	1/2	0	0	0
3.1	ff	ff	ff	bud	N	ff	1/2	0	0	0
3.3	ff	ff	ff	bud	N	ff	2/3	0	0	0
3.3	ff	ff	ff	bud	N	ff	1/2	0	0	0
3.5	ff	ff	ff	bud	N	7 + 6	1/2	0	0	0
3.5	ff	ff	6	bud	N	3 + 3	2/3	0	0	0
3.7	ff	ff	ff	bud	N	ff	2/3	0	0	0
3.8	ff	14	ff	bud	N	5 + 4	3/4	1	0	0
3.9	ff	ff	ff	bud	N	8 + 8	3/4	0	0	0
4.2	ff	15	9	bud	N	8 + 6	2/3	0	0	0
4.8	ff	22	9	bud	bud	8 + 7	4/3	1	0	0
5.2	III	20	10	bud	N	9 + 8	2/3	1	0	0
5.5	X	25	11	bud	bud	9 + 8	3/3	1	2	0
6.6	XI	24	II,10	16?	5	9 + 8	6/3	2	0	0
7.4	XI	24	II,10	10	I,4	9 + 8	4/3	2	0	0
7.6	XI	26	I,10	bud	bud	9 + 8	5/3	2	2	0
8.4	XI	26	II,11	15	I,5	9 + 8	5/4	2	2	1
12.7	XI	28	II,11	14?	I,5	9 + 8	7/5	2	0	0
32.2	XI	25	II,10	16	I,5	9 + 8	6/11	2	0	4

Fable et al. (1978) were less developed in eye pigmentation and differentiation of the gut and mouth parts than our smallest specimens (1.9 mm). This may also reflect varying shrinkage rates.

The sizes at which fin counts can be made (Table 8) are similar to those reported in the literature, except that no anal finfold is found in specimens 7.4-7.6 mm as found in Pearson's (1929) 7.8 mm larvae and that pelvic fin buds are first apparent at 4.8 mm rather than 7.0 mm in Hildebrand and Cable (1934). Dorsal, anal and caudal counts were obtainable at earlier sizes (4.2, 3.5, and 3.5 mm SL, respectively) than those reported by Daniels (1977); however, this may be a result of our counting pterygiophores. Notochord flexion takes place at 3.5-4.8 mm, similar to sizes 3.0-3.6 mm reported by Hildebrand and Cable (1934) and 3.5-4.4 mm reported by Fable et al. (1978).

Opercular spination is found earlier (5.2 mm) than Hildebrand and Cable's (1934) 20-mm specimen, while preopercular spination (found at 3.0 mm) is developed earlier than on their 7.0-mm larva.

The prominent spot anterior to the anus in 1.8 and 2.5 mm larvae (Hildebrand and Cable, 1934) is present as a small external melanophore on 1 of 3 specimens less than 2.7 mm. The band on the snout (actually, on the ventral surface of the palatines) is recognizable at an earlier size (1.9 mm) than reported by Hildebrand and Cable (1934) (3.0 mm), and the prominent stripe along the dorsal body margin appears earlier (4.8 mm) than in the series of Hildebrand and Cable (1934) (7.0 mm) and of Pearson (1929) (7.8 mm). Daniels (1977) reported that pigment along the dorsal midline disappears in larvae > 5 mm; however, it develops into a continuous row in our specimens from 6.6-12.7 mm. The lack of pigment in her 7.0 mm larva may be due to blanching of pigment in older specimens. A significant problem is encountered in comparing pigment with reported literature because the distinction was not made in previous works between internal and external pigment. Daniels (1977) did note some internal pigment about the caudal vertebrae, but this is visible in our specimens at larger sizes (≤ 12.7 mm) than she reported (≤ 6 mm).

Comparison of the pigment in our wild-caught specimens with those reared by Fable et al. (1978) yielded several differences. Their larvae had more pigment along the dorsal margin of the body and along the ventral surface of the visceral mass. The mid-lateral stripe on the tail and band on the snout occurred at earlier sizes (≥ 1.9 mm) in our series than in theirs (2.37-3.48 mm and 2.04-2.15 mm, respectively). The vertical bars in their 1.89-2.10 mm larvae were not observed by us. Internal pigment on the ventral surface of the hindbrain and on the anterior margin of the gut occurred at larger sizes or was absent in their series.

Cynoscion nothus

Cynoscion nothus - Silver seatrout

Range - Chesapeake Bay - southwestern Texas (Mahood, 1974)

Spawning Season -

North Carolina - May or June through August (Hildebrand and Cable, 1934)

South Carolina - apparently spawn in late August through November (MRRI-MARMAP plankton samples, young 2.7-9.7 mm caught in November)

Georgia - spring and August to October (Mahood, 1974)

Florida, east coast - fall (Fahay, 1975)

Gulf of Mexico - fall (Welsh and Breder, 1923)

Texas - August to November inferred from catches of small fish (43-108 mm TL) only in October and November and a single ripe male taken on 30 August, 1941 (Gunter, 1950)

Spawning Area -

North Carolina - at sea (Hildebrand and Cable, 1934)

South Carolina - continental shelf to the south of South Carolina, in waters deeper than 60 m depth (MRRI-MARMAP plankton studies)

Georgia - about 18.5 km (10 miles) offshore, in spring and closer inshore in fall (Mahood, 1974)

Florida, east coast - offshore, 5 larvae (15.1-17.9 mm FL) captured 57 km (31 nautical miles) off Jacksonville, Florida (Fahay, 1975)

Gulf of Mexico - offshore, probably in deep water (Guest and Gunter, 1958)

Early Life History

Hildebrand and Cable (1934) stated that young were not regular inhabitants off Beaufort Inlet, North Carolina, and that the larger young inhabited the same grounds as the adults. Mahood (1974) found that the smallest specimens were most abundant in outside waters from April through June. The maximum juvenile mortality occurred in May when shrimpers fished off Georgia for large roe shrimp. Of 817 fish, 34.4% were males, and 65.6% were females, with 13 having advanced stages of gonadal development (9 females, 4 males) (Mahood, 1974). Gunter (1950) obtained a ripe male 208 mm TL off Texas.

Description of our Material

This study is based on 38 specimens, 2.7-9.7 mm, taken in continental shelf waters of the South Atlantic Bight and on

one specimen 55.7 mm from a South Carolina estuary.

Body form (Table 7). Body proportions vary greatly with increasing length, the amount of variation obscuring any patterns except for three proportions. Eye diameter decreases with increasing size, from 13.2-13.6% NL at 2.7-2.8 mm to 7.8% SL in the 55.7 mm specimen. Preanus length increases from 54.7-57.3% NL at 2.7-2.8 mm to 69.5% SL at 55.7 mm. The depth of the caudal peduncle increases from 5.4-5.8% NL at 2.7-2.8 mm to 7.9-11.4% SL at 5.3-5.7 mm and remains reasonably constant thereafter.

The anterior outline of the gut has an anteriorly-directed ventral hump in 22 of 35 specimens less than 6.9 mm. In the three largest specimens, the anterior profile of the gut is more evenly contoured.

Fin development (Table 8). The dorsal, caudal, and anal finfolds are continuous in our smallest specimen (2.7 mm). Hypural formation begins by 3.0 mm with notochord flexion occurring at 3.3-5.3 mm. The pectoral fin bud is present on the smallest larva. Pterygiophores or elements are developed sufficiently to allow at least partial counts of the dorsal and caudal fins in a 3.8 mm specimen, of the anal and pelvic by 4.1 mm, and of the pectoral by 6.6 mm. The sizes at which complete complements of elements are present in the fins are 6.2 mm for the dorsal, 6.6 mm for the pelvic, 6.9 mm for the anal and caudal (principal rays only), and between 9.7 and 55.7 mm for the pectoral.

Pigmentation. Internal pigment is occasionally present on the ventral surface of the hindbrain (in 9 of 38 specimens 2.7-9.7 mm). External pigment on the head is present in the 55.7 mm fish as small, scattered melanophores over the dorsal surface in no particular pattern. The eyes are pigmented at all sizes examined. Pigment on the snout is present on the largest specimen as scattered external melanophores.

Opercular pigmentation appears on two specimens: on a 3.0-mm specimen, as a single small melanophore on the posterior margin dorsally on the right operculum, and on the 55.7 mm specimen, as scattered melanophores on the upper operculum with those on the posterior half being larger, more compact, and forming a darkened blotch.

A single melanophore at the symphysis of the upper jaw is present on the 9.7 mm specimen; on the 55.7 mm specimen, melanophores cover the anterior half of the upper jaw. An external melanophore is present on the tip of each lower jaw ramus at 6.9 and 9.7 mm; by 55.7 mm, several melanophores cover the anterior half of the lower jaw. Most specimens (33 of 39) have 1-3 external melanophores along the ventral midline of the head. In half the specimens, there are 1 or 2 melanophores on the midlateral surface of each ramus either externally or internally. Internal pigment is present on the anterior half of the dentary and scattered over the tongue on the 55.7 mm specimen. Rarely is there no pigment at all on the lower jaw (3 of 39). A vertically expanded melanophore is present externally at the angle of the lower jaw in most specimens (37 of 39).

Pigment is present at the nape in all 39 specimens: internally buried in the musculature in 21, externally on the dorsal surface in 2, both internally and externally in 15. In specimens < 3.9, the pigment typically consists of an external melanophore on the dorsal surface with an adjacent, underlying internal one in the musculature. At 3.9 mm, the internal pigment area is generally found deeper in the musculature near the vertebral column and is more branched. Internal pigment on the dorsal surface of the first 1 or 2 vertebrae is rarely found and only in specimens < 6.1 mm. Nape pigment on the 55.7 mm specimen consists of small melanophores outlining the posterior margins of scales.

All specimens except the largest (too opaque) have internal pigment on the anterior, dorsal, and posterior surfaces of the visceral mass. The anterior and posterior pigment areas each consist of a prominent, branching melanophore; the dorsal area appears as a line of pigment. In specimens < 4.3 mm, the anterior gut spot is somewhat larger than the posterior. At ≥ 4.3 mm, anterior and posterior melanophores are equal or the posterior is somewhat larger. External pigment is present on the ventral midline anterior to the cleithrum in all specimens, beneath the anterior part of the gut in 32, and anterior to the anus in 32. There are 1-3 melanophores on the lateral surface of the gut. The largest specimen has scattered external melanophores over the lateral surface of the visceral mass. A small, branched melanophore may be present on the dorsal surface of the axil of the pectoral fin or anteriorly on the base of the pectoral. The largest specimen has many small melanophores externally on the anterior base of the pectoral.

Pigment along the dorsal body margin occurs only in the largest specimen. This specimen has the posterior margins of all scales outlined with small melanophores.

Midlateral pigment occurs in the 9.7 mm larva as an internal melanophore lateral to the urostyle and on the 55.7 mm as small melanophores outlining the posterior margins of the scales.

An internal melanophore is buried in the musculature between the anus and the anal fin origin (or comparable position in small specimens) in most specimens (34 of 39). In larvae < 3.8 mm, this is followed by a series of 5-8 internal or external melanophores extending to the caudal peduncle. At ≥ 3.8 mm (24 fish), this series consists of an internal (13 of 24) or external (11 of 24) melanophore at the anterior end of the anal fin base and 1-3 melanophores at the posterior end of the anal base that are internal, external, or both. This series is followed by 0-3 (2

Table 7. Development of body proportions of Cynoscion nothus.

NL/SL	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	9.7	55.7
n	2	18	6	7	4	1	1
SnL	10.2-11.7	7.5-12.5	9.6-11.1	10.0-11.7	10.2-11.3	8.8	7.8
ED	13.2-13.6	10.1-14.9	12.0-14.2	10.0-13.6	10.2-11.6	9.2	8.6
HL	32.3-34.2	28.6-38.6	36.6-40.3	32.4-40.6	36.2-41.0	39.5	33.7
PAnL	54.7-57.3	45.9-60.2	55.9-63.9	52.5-60.2	57.5-64.1	58.0	69.5
IDo	N	38.3-45.4	39.6-49.5	38.2-51.5	40.4-46.5	43.5	34.4
IIDo	N	51.1-59.2	53.7-62.0	51.8-62.6	55.1-57.5	57.2	53.6
IIDt	N	70.1-73.8	81.6-95.4	78.4-89.7	85.0-88.6	87.9	90.2
Gap	N	10.3-12.2	8.2-15.6	9.0-15.7	7.7-14.8	12.9	4.6
Ao	N	68.7-70.1	70.4-76.1	65.5-73.5	70.0-75.0	70.9	74.1
At	N	78.1-78.3	80.7-83.4	74.8-83.8	81.2-85.2	83.0	83.0
P_2i	N	N	38.0-46.7	35.2-45.5	38.0-47.4	41.1	36.4
BDc	38.3-39.7	28.6-41.3	36.4-40.9	33.0-38.5	34.0-42.3	31.8	26.8
CpD	5.4-5.8	4.4-8.0	7.4-10.4	7.9-11.4	9.0-10.4	9.6	10.0

Table 8. Development of meristic characters of Cynoscion nothus.

NL/SL	ID	IID	A	P_1	P_2	C	Preoperc	Operc	Suboperc	Posttemp
2.7	ff	ff	ff	bud	N	ff	1/2	1	0	0
2.8	ff	ff	ff	bud	N	ff	2/3	0	0	0
3.0	ff	ff	ff	bud	N	ff	2/3	0	0	0
3.1	ff	ff	ff	bud	N	ff	1/3	0	0	0
3.1	ff	ff	ff	bud	N	ff	2/3	1	0	0
3.3	ff	ff	ff	bud	N	ff	1/3	0	0	0
3.4	ff	ff	ff	bud	N	ff	2/3	0	0	0
3.4	ff	ff	ff	bud	N	ff	2/3	1	0	0
3.4	ff	ff	ff	bud	N	6 + 6	2/3	1	1	1
3.4	ff	ff	ff	bud	N	ff	2/4	0	0	0
3.4	ff	ff	ff	bud	N	ff	2/3	1	0	0
3.6	ff	ff	ff	bud	N	ff	2/3	1	0	0
3.6	ff	ff	ff	bud	N	ff	1/3	0	0	0
3.6	ff	ff	ff	bud	N	ff	2/3	0	0	0
3.7	ff	ff	ff	bud	N	ff	3/4	0	0	0
3.8	ff	ff	ff	bud	N	ff	2/3	0	0	0
3.8	ff	ff	ff	bud	N	ff	1/3	1	0	0
3.8	ff	ff	ff	bud	N	ff	3/3	1	0	0
3.8	ff	15	ff	bud	N	7 + 7	3/3	1	1	0
3.9	ff	16	ff	bud	N	7 + 6	3/3	1	1	0
4.1	VI	22	8	bud	bud	9 + 6	3/3	1	2	1
4.2	VII	15	N	bud	N	9 + 7	3/3	1	0	0
4.3	ff	ff	ff	bud	bud	7 + 5	3/3	1	2	2
4.3	VI	23	I,8	bud	N	7 + 7	2/3	1	0	1
4.7	XI	23	9	bud	bud	9 + 8	3/3	2	2	0
4.8	VIII	29	I,9	bud	bud	8 + 7	3/3	1	1	0
5.0	IX	22	I,9	bud	N	8 + 7	4/3	1	2	1
5.1	IX	28	9	bud	bud	9 + 7	3/3	2	2	0
5.2	X	26	8	bud	bud	9 + 8	4/3	2	2	1
5.3	IX	18	*	bud	bud	8 + 7	4/3	2	2	2
5.4	IX	29	II,9	bud	bud	9 + 7	2/3	2	2	0
5.5	X	29	6	bud	bud	9 + 8	3/4	1	2	1
5.7	X	24	I,9	bud	bud	9 + 8	4/3	1	2	1
6.1	XI	26	I,9	bud	bud	8 + 7	4/3	1	2	1
6.2	X	27	II,9	bud	N	9 + 8	4/3	1	2	1
6.6	XI	27	I,10	18	I,5	8 + 7	3/3	1	2	1
6.9	XI	29	II,9	12	I,5	9 + 8	4/4	2	2	1
9.7	X	30	II,9	14	I,5	9 + 8	6/7	2	2	2
55.7	XI	28	II,9	19	I,5	9 + 8	3/2	2	0	5

* damaged

in 10 of 24 specimens) internal or external melanophores along the ventral margin of the caudal peduncle. In 28 of the 39 specimens, the internal melanophore between the anus and the anal fin origin and the one at the posterior end of the anal base are of equal size and larger than the rest of the ventral series.

Most specimens ≥ 3.0 mm (34 of 36) have 1-4 spots at the base of the ventral lobe of the caudal fin base. In the largest specimen, pigment on the caudal fin consists of melanophores in horizontal rows along the caudal rays.

No pigment is present on the dorsal and anal fins until 55.7 mm where melanophores occur in rows along the spinous and soft rays of the dorsal fin and as a few, small, scattered melanophores on the anal fin. The pectoral and pelvic fins are unpigmented throughout the series.

Other Structures. Teeth are present on all specimens examined. Most larvae have a single opercular spine, although in small larvae (< 3.8 mm) this may be absent and in large larvae (> 4.3 mm) there may be two spines.

Preopercular spines are present on all specimens and generally increase from 1 + 2 at 2.7 mm to 6 + 7 at 9.7 mm. The largest specimen has a preopercular count of 3 + 2.

Spines are present on the subopercu-lum at 3.4 mm (1 spine), at 3.8 mm. A subopercular spine is first apparent on a 3.4 mm larva, and the number increases to 2 in most specimens 3.9-9.7 mm; however, the largest specimen has none.

In 30 specimens < 5.5 mm, 7 have 1 or 2 spines projecting from the posttemporal. In 6 specimens 5.5-6.9 mm, there is one spine on the posttemporal. Two spinous projections are present at 9.7 mm and 5 at 55.7 mm.

Published Developmental Descriptions

Welsh and Breder (1923) gave characters distinguishing Cynoscion nothus from Cynoscion regalis young (110-190 mm). Hildebrand and Cable (1934) described and illustrated specimens 9.5-77 mm. Johnson (1978) recapitulated the above works. Specimens less than 9.5 mm have not been described.

Comparison of our 9.7 mm larva with Hildebrand and Cable's (1934) description of 9.5-11.0 mm shows agreement in all described or illustrated morphometrics, meristics, pigmentation, and other structures, with three exceptions. On our specimen, the soft dorsal count is 1 element higher, the posterior end of the maxillary is beneath the anterior margin of the eye, and there is no pigment along the base of the dorsal fin. Our 55.7-mm specimen differs from Hildebrand and Cable's (1934) description of a 40-46 mm specimen in lacking lateral and dorsal blotches of pigment and is in agreement with Welsh and Breder's (1923) description of 110-190 mm juveniles. Because of agreement with earlier work in these comparisons and in all other aspects and the continuity of characters in our series, we feel that our identifications are correct.

Cynoscion regalis

Cynoscion regalis - weakfish

Range - Bay of Fundy, Nova Scotia to eastern Florida (Thomas, 1971)

Spawning Season -

Delaware Bay - late May to early August (Daiber, 1957; Harmic, 1958)

Chesapeake Bay - May to September, mainly May to July (Hildebrand and Schroeder, 1928)

North Carolina - March through August or October, peak April through July (Merriner, 1976)

South Carolina - May to August (Shealy et al., 1974)

Georgia - March through August, peak March to May (Mahood, 1974)

Spawning Area -

Delaware - in eastern Delaware Bay in 5.5-8.2 m (3-5 fm) over mud and sand (Welsh and Breder, 1923); in southwestern bay but not in tributary rivers nor tidal streams (Harmic, 1958)

Virginia - in lower Chesapeake Bay and along Atlantic coast (Lippson and Moran, 1974)

North Carolina - primarily at sea (Hildebrand and Cable, 1934); in or near inlets and in Pamlico Sound (Merriner, 1976)

South Carolina - probably coastal waters (MRRI collections of early larvae in South Carolina estuaries and tidal passes)

Georgia - in deeper sounds of estuaries and off beaches (Mahood, 1974)

Early Life History Ecology

The planktonic eggs have been reported to hatch in 36-40 hr at 20-21°C (Welsh and Breder, 1923), 40 hr at 20.0-21.0°C (Merriner, 1976), and 50 hr at 17.8°C (Daiber, 1957). Greatest hatching success was at 18-24°C and was independent of salinity in the range of 10-33 °/oo (Harmic, 1958). Harmic (1958) suggested that, since mechanical disturbances increased the number of injured specimens, there could be an increase in larval mortality resulting from storms during larval development. Reported lengths at hatching were 1.75 mm NL (Welsh and Breder, 1923) and 1.8 mm NL (Merriner, 1976).

Off North Carolina the larvae assumed a demersal existence early; most larvae

1.5-10 mm TL were found on the bottom (Hildebrand and Cable, 1934). Off Virginia larvae 1.5-7 mm were planktonic and less abundant inshore while larvae > 8 mm adopted a demersal existence (Pearson, 1941). Young C. regalis moved into the Delaware River in deeper waters and then dispersed to the shallows of the upper river in low-salinity waters. Movement into fresh water was blocked by low oxygen content (1.0-2.3 ppm). Young (13-129 mm TL) occurred in tidal creeks up to 10 miles from the mouths in marginal habitats, but most inhabited deeper waters; young remained very sensitive to fresh water floods (Thomas, 1971). Chao (1976) found young more abundant in the York River Channel, Virginia, and showed Cynoscion regalis to be morphologically adapted for a pelagic existence. In winter, the young moved offshore and south into warmer waters off Virginia and North Carolina, from which they dispersed in the spring (Thomas, 1971; Chao, 1976).

One month old fish averaged 30 mm, and 5-6 month old averaged 102-180 mm (Welsh and Breder, 1923 and Bigelow and Schroeder, 1953). The annual mortality for Cynoscion regalis was 50-75% (Nesbit, 1954).

Maturing males (210-280 mm TL) along the middle Atlantic coast spawned at ages 2-3 years and females (280-330 mm TL) at 3-4 years, but the bulk of spawning at Cape May, New Jersey, was by 5 year old fish (360 mm TL) (Welsh and Breder, 1923). Off Morehead City, North Carolina, 50% of the males were mature at 130 mm SL while 50% of the females were mature at 145 mm SL; in Pamlico Sound, 50% of the males were mature at 150 mm SL and of the females at 190 mm SL. Ova counts in youngest females (age 0) were 45,000, and in older ones (age IV) were 1,726,000 (Merriner, 1976). Merriner (1973 in Chao, 1976) reported multiple spawning in females within a spawning season.

Description of our Material

This study is based on 33 specimens (2.7-12.2 mm) from South Carolina estuaries and 1 specimen (25.5 mm) from surface waters 90 km southeast of Charleston, South Carolina.

Body form (Table 9). Most body proportions remain fairly constant with an increase in length or do not follow particular patterns. Preanus length generally increases (45.6% NL at 2.7 mm to 68.4% SL at 25.5 mm) with increasing length. The postanus-preanal gap remains reasonably stable at 10.6-20.3% SL from 3.0-8.3 mm and regularly decreases thereafter from 14.7% SL at 8.5 mm to 3.6% SL at 25.5 mm.

The gut has the characteristic, posterior hump (as drawn by Pearson, 1941, for 8.2 and 10.5 mm larvae) just anterodorsal to the anus in 23 of the 33 specimens of 2.7-12.2 mm.

Fin development (Table 10). In the smallest larva (2.7 mm), the dorsal, caudal, and anal finfolds are continuous, and the pectoral fin bud is present. Enumeration of dorsal and anal fin pterygiophores is first possible at 3.5 mm; fin rays and dorsal spines develop at 4.4 mm. Hypurals and caudal rays begin forming at 3.5 mm, with notochord flexion taking place from 4.0-4.3 mm. The pelvic fin bud is first observed at 4.3 mm, and both the pelvic and pectoral fins have countable elements at 6.7 mm. Complete complements of elements are present at 5.9 mm for the anal fin, 6.7 mm for the caudal (principal rays only), 7.4 mm for the dorsal, 9.2 mm for the pelvic, and 10.1 mm for the pectoral.

Pigmentation. Pigment on the ventral surface of the hindbrain is present in the smallest specimen (2.7 mm) and remains on half of the specimens examined. Pigment on the anterior surfaces of the forebrain and midbrain is present on 11 and 12, respectively, of 17 specimens 4.8 mm and larger. External head pigment begins as four branched melanophores on each side over the dorsal surface of the midbrain at 10.1 mm and persists in all larger specimens, expanding to a patch of scattered melanophores over the midbrain and hindbrain and a triangular patch of larger, branching melanophores on the posterior surface of the head at 25.5 mm. The eyes are pigmented at all sizes examined. External pigment on the snout is present on the two largest specimens, at 12.2 mm as three melanophores and at 25.5 mm as a small patch on the anterodorsal surface of the snout.

One or two melanophores are present on the internal surface of the operculum posterior to the eye on most specimens 7.4-10.1 mm. At 10.3 mm, 2-4 melanophores are present externally in the same area, and, at 25.5 mm, scattered spots are present on the upper part of the operculum and along the posterior margin of the preoperculum.

Pigment on the upper jaw is present at $\geq$ 5.9 mm and increases from a single melanophore at the tip to a series covering the anterior half of the premaxillary. Pigment is present on the lower jaw in most of the specimens (24 of 34). Characteristically, at all sizes, there are 1-4 small melanophores along the ventral midline. Two melanophores (1 on each side) appear on the anterior tip of the lower jaw in the 5.9 mm specimen; these increase to a series covering the anterior half of the lower jaw at 25.5 mm. Rarely (in 5 of 24 with lower jaw pigment), pigment is also present midlaterally on the ventral surface of each ramus. A melanophore is present in most specimens at the angle of the lower jaw.

Pigment is present internally in the musculature of the nape in all but the 3 largest specimens. External pigment is present on the dorsal surface of the nape above the internal pigment on half of the specimens, appearing as a single melanophore at 2.7 mm increasing to a triangular patch of branching melanophores at 25.5 mm.

Internal pigment is also present on the dorsal surface of the anterior 1 or 2 vertebrae (or similar position when vertebrae are not developed) and sometimes has branches connecting to the internal pigment in the nape musculature.

Internal pigment is present on the anterior, dorsal, and posterior surfaces of the visceral mass in most specimens. In general, the dorsal pigment consists of a band of dense melanophores, while the anterior and posterior pigment areas are each composed of a single branching melanophore, the two of approximately equal intensity. At 7.4 mm, the number of melanophores in dorsal and posterior areas increases to form a continuous band of pigment, while the anterior spot reduces in intensity. At 11.2 mm, a row of branching melanophores begins to form on the lateral surface of the visceral mass just anterior to the posterior pigment area and expands anteriorly to form a row of spots below the dorsal pigment area on larger specimens.

Single, branching melanophores on the ventral surface of the visceral mass are present in most specimens in 5 positions - at the cleithrum, below anterior portion of the visceral mass, anterior to the anus on the ventral midline, and on each side of both the spot beneath the anterior part of the visceral mass and the one anterior to the anus. A small branching melanophore is present near the dorsal end of the pectoral fin axil at 2.7-2.9 mm or on the cleithrum anterior to the latter position at 3.5-8.5 mm in about half of the specimens. At 10.3-11.2 mm, this spot is replaced by one on the lateral surface of visceral mass medial to the pectoral fin.

Pigment is present on the dorsal midline at the dorsal fin termination (or a comparable position in specimens without a completely developed dorsal fin) in most specimens (30 of 34). At 9.4 mm, 1 or 2 short horizontal rows of 2 or 3 branching melanophores are present in this position; they may extend onto the pterygiophores of the dorsal fin. At 6.7 mm, external spots develop on each side of the spinous dorsal base and are present on all but 2 of 13 larger specimens. These gradually form 1 or 2 horizontal rows of 5 or 6 melanophores by 25.5 mm. At 9.2 mm, an external melanophore appears below the anterior part of the soft dorsal base (present in only 1 smaller specimen at 6.7 mm) and develops into 1 or 2 horizontal rows of 3 or 4 melanophores by 10.1 mm. The rows in these 3 areas become the dorsal part of 3 saddle-shaped blotches at 25.5 mm. At 25.5 mm, there also is present a row of external melanophores along the dorsal surface of the caudal peduncle and a short row between the anterior and posterior blotches of the soft dorsal.

No midlateral line pigment is present on small larvae (< 5.9 mm). At 5.9 mm, pigment in this area consists of 1 or 2 external spots above the midanal base and another few below the spinous dorsal. At 7.4-8.3 mm, external pigment appears on the lateral line below the anterior part of the soft dorsal fin. At 10.1 mm, a melanophore appears externally lateral to the urostyle. Pigment in these 4 areas has spread dorsally and ventrally from the midlateral line by 25.5 mm, forming three saddles extending from the dorsal midline to below the midlateral line and a midlateral blotch on the caudal peduncle (not connected with the dorsal pigment on the caudal peduncle). Internal pigment on the dorsal surfaces of the vertebrae expands posteriorly from the anterior vertebrae to a few more of the anterior abdominal vertebrae at 5.9 mm and to all of the vertebrae anterior to that above the anal fin termination at 12.2 mm; the 25.5 mm specimen is too opaque to distinguish the internal pigment. At 9.2 mm, an internal melanophore develops on the lateral surface of the urostyle and is visible at all larger sizes except 25.5 mm.

In the smallest larva (2.7 mm), a row of 7 evenly spaced internal melanophores is present along the ventral midline from the anus to the midcaudal region, where a spot consisting of both internal and external melanophores slightly larger than the other melanophores of this series, is found. Posterior to this spot is a series of 4 melanophores composed of internal and external pigment. By 3.5-4.0 mm, the anterior series is replaced by one prominent melanophore buried in the musculature between the anus and the anal fin origin; this spot is present in all but 4 larger specimens (4.8, 6.7, 10.3, and 25.5 mm). The melanophore midway along the anal fin base is internal and prominent at 3.5-4.0 mm, and a series of 0-3 internal or external melanophores is present posterior to this spot along the ventral midline of the caudal peduncle. At 9.2 mm, 2 internal melanophores, one behind the other, are placed midway along the anal base. At 9.4 mm, an external spot develops at the anterior end of the base of the anal fin. Melanophores along the anal fin base are more numerous at 10.1 mm. At 25.5 mm, a row of melanophores is present along the midventral body margin above the anal fin base and along the caudal peduncle.

All fins except the caudal are unpigmented in our series. At 3.5 mm, a melanophore is present posteroventral to the developing hypural plates on the ventral half of the caudal finfold. This spot is present at the base of the ventral lobe of the caudal fin on all larger specimens, except for 1 at 6.7 mm. At 11.2 mm, 2 vertically-expanded melanophores appear at the bases of the dorsal and ventral lobes of the caudal. A vertical bar composed of several melanophores is present at the base of the caudal fin in the 25.5 mm specimen. At 25.5 mm, rows of pigment overlying the caudal rays are present on the ventral lobe of the caudal fin.

Other Structures. Teeth are present in both jaws in all specimens examined. One or two opercular spines are present throughout the series. Preopercular spines are present throughout the series, increasing from 1 + 1 at 2.7 mm to 7 + 8

Table 9. Development of body proportions of Cynoscion regalis.

NL/SL	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9
n	2	2	14	2	2	2
SnL	7.5-9.7	8.2-11.0	6.5-11.2	9.4-10.6	9.8-10.3	9.5-10.5
ED	11.8-12.7	9.7-9.9	9.6-12.4	10.2-10.6	7.5-10.9	7.4-7.4
HL	32.2-34.3	30.6-36.8	32.4-36.8	34.4-39.7	33.3-40.2	33.6-33.7
PAnL	45.6-49.2	42.9-52.8	44.4-57.3	50.0-59.6	54.0-58.6	52.6-52.6
IDo	N	N	36.8-42.3	39.1-41.1	37.9-44.8	36.8-39.0
IIDo	N	N-49.4	50.0-57.4	54.7-58.3	54.0	53.7-55.8
IIDt	N	N-65.9	76.9-88.7	85.9-87.4	83.9-89.6	84.2-86.3
Gap	N	N-13.2	11.6-22.6	10.6-20.3	10.7-14.9	14.7-16.8
Ao	N	N-65.9	58.9-69.9	70.2-70.3	69.0-69.3	67.4-69.5
At	N	N-74.7	71.8-83.7	82.8-84.8	83.9-86.2	82.1-83.2
P_2l	N	N	32.3-33.3	35.9	40.2-41.3	34.7-35.8
BDc	30.9-32.1	N-35.2	30.8-38.0	34.4-38.4	29.3-33.3	31.6-31.6
Cpd	5.2-5.4	N-6.6	5.6-9.7	8.6-10.6	6.9-10.3	8.4-9.5

Table 9. continued

8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.2	25.5
2	2	2	2	1	1
9.4-11.0	10.2-10.7	7.8-8.8	8.1-8.8	9.4	7.7
7.3-8.4	9.1-10.6	8.8-9.8	9.5-9.5	9.4	10.1
29.9-33.9	33.9-42.0	31.6-32.4	38.1-40.5	37.5	36.3
53.2-57.9	58.7-61.0	58.6-60.3	59.9-60.8	60.6	68.4
38.3-39.4	40.7-41.3	40.4-42.1	37.8-38.1	37.5	38.6
55.0-56.1	57.6-57.8	57.1-57.4	55.4-55.8	56.2	55.3
84.4-86.9	85.6-86.8	87.2-88.2	85.7-86.5	85.0	84.5
10.8-14.7	8.5-9.9	5.9-7.5	6.8-6.8	6.2	3.6
67.9-68.7	68.6-69.5	66.2-66.2	66.7-67.6	66.2	72.0
81.6-82.2	84.3-84.8	80.9-82.7	81.6-82.4	81.2	85.7
35.8-36.4	36.4-39.8	35.3-37.6	35.1-36.7	36.2	36.9
30.3-32.7	33.1-43.2	33.1-35.3	32.4-33.3	32.5	26.1
8.3-10.3	10.2-10.3	7.4-10.3	10.8-10.9	10.0	8.9

Table 10. Development of meristic characters of Cynoscion regalis.

NL/SL	ID	IID	A	P_1	P_2	C	Preoperc	Operc	Suboperc	Posttemp
2.7	ff	ff	ff	bud	N	ff	1/1	0	0	0
2.9	ff	ff	ff	bud	N	ff	1/1	1	0	0
3.5	ff	11	5	bud	N	3 + 4	3/3	1	0	0
3.8	ff	ff	ff	bud	N	ff	1/3	1	0	0
4.0	ff	24	9	bud	N	9 + 8	2/3	1	1	0
4.0	ff	20	9	bud	N	9 + 7	1/3	0	0	0
4.1	ff	20	8	bud	N	7 + 6	2/3	1	0	0
4.2	ff	25	10	bud	N	8 + 6	3/3	1	0	0
4.2	IV	25	9	bud	N	9 + 6	2/3	1	0	0
4.2	ff	23	11	bud	N	8 + 7	3/3	1	1	0
4.2	ff	23	7	bud	N	6 + 5	1/3	0	0	0
4.3	ff	26	10	bud	bud	9 + 7	2/3	1	0	0
4.4	II	23	10	bud	N	7 + 7	3/3	2	0	0
4.6	IX	24	10	bud	N	8 + 6	2/3	1	0	0
4.8	II	28	12	bud	N	8 + 7	3/3	2	1	1
4.8	II	20	II,8	bud	N	9 + 8	4/4	1	1	1
4.8	I	27	10	bud	N	8 + 6	2/3	0	0	0
4.8	VI	24	ff	bud	N	9 + 6	4/3	1	0	0
5.0	ff	26	13	bud	bud	9 + 8	2/3	2	0	0
5.9	XII	26	II,11	bud	bud	9 + 8	3/3	2	2	1
6.7	XI	25	II,14	12	I,5	9 + 8	2/3	0	0	0
6.8	IX	27	II,10	bud	bud	9 + 8	3/3	2	0	0
7.4	XI	26	II,10	15	bud	9 + 8	3/3	2	2	0
7.4	XII	28	II,10	bud	bud	9 + 8	3/3	2	1	0
8.3	XI	26	II,11	15	I,3	9 + 8	5/3	2	2	1
8.5	XI	28	II,10	18	3	9 + 8	3/4	2	1	1
9.2	XI	26	II,11	16	I,5	9 + 8	5/4	2	2	1
9.4	XI	27	II,12	14	I,5	9 + 8	4/4	1	2	2
10.1	XI	26	II,11	18	I,5	9 + 8	5/4	2	1	1
10.3	XI	25	II,11	16	I,5	9 + 8	5/3	2	0	1
11.2	XI	27	II,11	17	I,5	9 + 8	7/4	2	1	4
11.2	XI	27	II,12	18	I,5	9 + 8	8/4	2	2	4
12.2	XI	26	II,12	18	I,5	9 + 8	4/4	2	2	2
25.5	XI	25	II,11	18	I,5	9 + 8	7/8	2	0	4

at 25.5 mm. Spination on the posttemporal is present on most (13 of 20) specimens 4.8 mm and larger, the number of spinous projections increasing from 1 at 4.8 mm to 4 at 25.5 mm. One or two spines on the suboperculum are present in 15 of 30 specimens 4.0 mm and larger. The two specimens at 11.2 mm have 2 spines on the epiotic but these are not apparent at any other sizes and may represent an artifact of preservation

Published Developmental Descriptions

Welsh and Breder (1923) described and illustrated specimens 1.75-32 mm. Their 6.5 and 12.5 mm illustrations and description were taken from Tracy (1908). Pearson (1941) described and illustrated specimens at 1.8-32 mm. Hildebrand and Cable (1934) included information on Cynoscion regalis larvae and juveniles in their keys for Sciaenidae for sizes 1.7-35 mm. Scotton et al. (1973) summarized the above descriptions, published Pearson's (1941) illustrations of 1.8 and 8.2 mm larvae, and supplied original drawings of 3.8, 4.6, and 10.5 mm larvae.

Body depths and preanus distances of our specimens are in general agreement with the limited information given by Hildebrand and Cable (1934) and Pearson (1941), with the exception that the increase in body depth from 1.8 to 17 mm and decrease thereafter (Pearson, 1941) was not found.

The sizes at which fin enumerations could be made in our specimens were generally consistent with literature reports with exceptions in three fins. Complete counts were obtained in the dorsal and anal fins as early as 5.9 mm as opposed to 8-10 mm in Hildebrand and Cable (1934), 10.5 mm in Scotton et al. (1973), and 8.2 mm in Pearson (1941). The pelvic fin was frist present as a bud at 4.3 mm and contained coutable elements at 6.7 and 8.3 mm in our specimens as opposed to first appearing and countable at 10.5 mm in Pearson (1941) and Scotton et al. (1973) and at 6.5 mm in Welsh and Breder (1923). The pelvic fin complement was complete at a size similar to reported sizes. Notochord flexion occurred between 4.0 and 4.3 mm and was complete earlier than pictured in Pearson (1941) and Scotton et al. (1973).

Teeth were present on our smallest specimen (2.7 mm), agreeing with the descriptions of Pearson (1941) and Scotton et al. (1973) but earlier than the report of Welsh and Breder (1923) where teeth were first present at 6.5 mm.

Opercular (1) and preopercular spines (1 + 1) were present as early as 2.9 mm. These appeared earlier than depicted in any of the published illustrations.

Pigmentation observed was in general agreement with the published descriptions with the following exceptions. Some pigment was on or buried in the musculature of the nape and below the position of the dorsal fin termination at all sizes examined but has been reported or depicted only for larvae larger than 6.5 mm in Welsh and Breder (1923) and 10.5 mm in Pearson (1941). In Scotton et al. (1973), pigment was indicated on the nape for all sizes except 4.6 and 8.2 mm and below the dorsal fin termination only for sizes greater than 10 mm. Pigment at the base of the dorsal fin shown in a 12.5 mm specimen by Welsh and Breder (1923) and Tracy (1908) was not observed in our series. Pigment on the midlateral line in our series was less widespread than that shown by those authors and occurred internally along the vertebral column. Their 12.5 mm C. regalis resembles our C. nebulosus larva at 12.7 mm and thus may be misidentified; however, this cannot be stated with certainty. Once again, the extent of internal pigmentation has not been clearly defined in previous works.

A comparison of our C. regalis larvae with larval C. arenarius of Daniels (1977) showed the head length of C. arenarius to be smaller. Pigmentation showed similarities and differences; however, further comparisons of the species will be necessary to ensure accurate identification of these species in Gulf of Mexico waters.

Equetus acuminatus

Equetus acuminatus (Pareques acuminatus of Chao, 1976) - High-hat

Range - Bahamas and Florida through Lesser Antilles (Bohlke and Chaplin, 1968); South Atlantic Bight (MRRI-MARMAP trawl data)

Spawning Season - No information

Spawning Area - Presumably the adult habitat - in the South Atlantic Bight, hard or "live" bottom areas

Early Life History - See notes on Equetus spp. below

Equetus lanceolatus

Equetus lanceolatus - Jacknife fish

Range - Bermuda, Carolinas and Bahamas to Brazil, including Gulf of Mexico (Bohlke and Chaplin, 1968)

Spawning Season - No published information. Specimens 18-25 cm TL taken off Georgia in September, 1975, in MRRI-MARMAP trawl tows, had ripening ovaries and testes

Spawning Area - Presumably the adult habitat; in the South Atlantic Bight, "live" bottom areas

Early Life History - See notes on Equetus spp. below

Equetus punctatus

Equetus punctatus - Spotted drum

Range - Bahamas (Bohlke and Chaplin, 1968), Florida, the Antilles, Panama to Brazil (Chao, 1976); South Atlantic Bight (MRRI-MARMAP trawl tows)

Spawning Season - No information

Spawning Area - Presumably the adult habitat; in the South Atlantic Bight, "live" bottom areas

Early Life History - See notes on Equetus spp. below

Equetus umbrosus

Equetus umbrosus (Pareques umbrosus of Chao, 1976) - Cubbyu

Range - Charleston, S. C. to Pensacola, Florida (Jordan and Evermann, 1896)

Spawning Season - No information

Spawning Area - Presumably the adult habitat; in the South Atlantic Bight, "live" bottom areas

Early Life History - See notes on Equetus spp. below

Equetus spp.

E. acuminatus and E. umbrosus have been referred to the genus Pareques by Chao (1976), but we follow Bailey et al. (1970) in retaining Equetus for all four species. Additional undescribed species may be present in our area (Chao, 1976). Unlike the other sciaenids of our area these are year-round inhabitants of continental shelf waters, found chiefly in "live-bottom" areas (hard substrate areas with high invertebrate and fish diversity) in the South Atlantic Bight and in and around coral reef areas in the tropical western Atlantic.

Little is known of the early life history of Equetus species. The long filamentous first dorsal, pelvic, and caudal fins characteristic of the juveniles were described by Longley and Hildebrand (1941), Bohlke and Chaplin (1968) and Randall (1968). Three larval Equetus, 4.4-7.6 mm SL, unidentifiable to species, from the Caribbean have been described and illustrated by Powles and Burgess (1978 as Paraques. The larvae had a distinct gap (6.9-13.1% SL) between the anus and anal fin origin and had the long second dorsal and short anal fin characteristic of the Sciaenidae. Dorsal fin elements were incompletely developed in 4.4 mm and 6.3 mm specimens, but enough elements were present to identify the larvae as Equetus; dorsal fin elements were completely developed in the 7.6 mm specimen. The larvae were heavily pigmented. Anal fin elements were complete at 6.3 and 7.6 mm. All three were captured by divers and were actively orienting to features of the bottom (rocks or a sea urchin); thus, larval Equetus appear to take on a benthic mode of life early in development. No identifiable Equetus larvae have been taken on our surveys in the South Atlantic Bight.

Larimus fasciatus

Larimus fasciatus - Banded drum

Range - Cape Cod, Massachusetts to Texas (Hildebrand and Cable, 1934)

Spawning Season -

Beaufort, N. C. - May to October (Hildebrand and Cable, 1934). South Atlantic Bight - small larvae have been taken on MRRI-MARMAP cruises in April-May and in August- September

Louisiana - March and May to August (Frank Truesdale, pers. comm.)

Spawning Area

Apparently outside estuaries, in coastal or shelf waters. Larvae were taken from shore to 22 km (12 miles) off by Hildebrand and Cable (1934). Larvae have been taken in continental shelf waters on MRRI-MARMAP cruises and have not been identified from plankton tows in South Carolina estuaries. However, Frank Truesdale (pers. comm.) reports taking small larvae (2.4-3.7 mm) in Caminada Pass, a tidal pass in South Louisiana.

Early Life History

Hildebrand and Cable (1934) took larvae only in bottom plankton hauls, not at the surface. However, we have taken the larvae in both neuston tows and oblique bongo sampler tows.

Description of our Material

The following description is based on 21 larvae, 3.0-5.9 mm, from neuston and bongo tows over the South Atlantic Bight continental shelf.

Body form (Table 11). Larval L. fasciatus are deep-bodied, and preanus length is greater than 50% SL, throughout the size range available. The gap between the anus and anal fin origin is less than 10% SL in almost all specimens, shorter than in some other deep-bodied sciaenid larvae. The dorsal fin base is notably longer than the anal base in specimens 4.0 mm and larger.

Fin development (Table 12). The notochord is undergoing flexion in the caudal region in specimens 3.6-3.8 mm. Principal caudal rays are first seen at 3.6 mm, and the adult complement is consistently present at $\geq$ 4.9 mm. Procurrent caudal rays are first present at 5.5 mm; 1 dorsal and 2 ventral rays are present in the largest specimen available.

The soft dorsal and anal fin bases with developing pterygiophores are present first at 3.6 mm. The adult complements of elements in these fins are consistently present from 4.9 mm. The spinous dorsal

Table 11. Development of body proportions of Larimus fasciatus.

NL/SL	3.0-3.4	3.5-3.9	4.0-4.4	4.5-4.9	5.0-5.4	5.5-5.9
n	2	3	4	3	2	6
SnL	9.6-10.4	9.2-10.9	7.3-10.1	8.1-10.3	9.4-9.4	7.5-12.5
ED	10.4-12.0	12.2-14.1	11.9-13.8	13.2-14.3	13.3-15.0	12.7-14.9
HL	33.8-36.1	34.7-39.1	36.7-40.4	36.8-41.5	38.3-40.2	35.8-44.8
PAnL	53.0-53.2	49.0-60.9	54.1-58.4	54.4-65.0	58.3-60.2	59.3-67.2
IDo	N	N,41.3-44.6	36.7-43.4	40.4-41.5	39.4-42.2	32.8-44.4
IIDo	N-50.6	N,53.3,57.6	50.5-58.4	49.1-58.5	55.1-56.3	55.2-59.7
IIDt	N-68.8	N,76.1-87.0	81.7-89.4	86.0-87.3	84.4-87.4	87.3-94.0
Gap	N	4.3-10.2	3.6-8.9	0.8-9.6	4.6-4.7	1.4-5.6
Ao	N	59.2-65.2	59.6-67.3	62.7-69.1	63.0-64.8	62.0-67.2
At	N	70.4-75.0	71.6-75.2	76.3-78.9	75.6-78.1	74.6-82.1
P_2i	N	N,39.1-39.1	35.8-39.1	36.0-40.4	34.4-39.4	36.4-43.3
BDc	39.8-50.6	33.7-43.5	36.3-40.9	37.7-44.4	43.0-46.5	43.1-45.1
Cpd	6.5-7.2	6.1-9.8	8.2-10.6	8.8-10.6	10.9-11.0	9.7-11.9

Table 12. Development of meristic characters of Larimus fasciatus.

NL/SL	ID	IID	A	P_1	P_2	C	pC	Preoperc	Posttemp
3.0	ff	ff	ff	bud	N	ff	0	1/2	0
3.2	ff	ff	ff	bud	N	ff	0	0/3	0
3.6	ff	16	5	bud	bud	6 + 5	0	0/3	0
3.8	ff	10	ff	bud	N	3 + 3	0	2/3	0
4.0	ff	19	6	bud	bud	9 + 8	0	3/3	0
3.6	ff	20	5	7	bud	7 + 6	0	0/3	0
4.2	ff	16	7	bud	bud	8 + 6	0	2/3	0
4.3	ff	15	6	7	bud	4 + 5	0	0/3	0
4.3	ff	20	7	6	bud	8 + 7	0	2/3	0
4.4	IX	27	II,6	11	I,4	9 + 8	0	4/3	0
4.5	III	22	7	10	bud	8 + 6	0	2/3	0
4.8	X	25	6	10	bud	9 + 7	0	3/3	0
4.9	X	27	II,6	12	I,3	9 + 8	0	5/3	0
5.0	X	26	II,6	10	I,1	9 + 8	0	5/3	0
5.0	IX	25	II,6	9	I	9 + 8	0	5/3	0
5.5	X	27	II,6	15	I,5	9 + 8	0,1	5/3	1
5.5	IX	26	II,6	14	I,2	9 + 8	1,2	8/3	1
5.5	IX	27	II,6	12	I,1	9 + 8	0,1	6/3	0
5.7	X	27	II,6	14	I,4	9 + 8	0,1	6/4	0
5.8	XI	26	II,6	16	I,5	9 + 8	1,2	6/4	2
5.9	IX	27	II,6	15	I,5	9 + 7	2,2	6/4	0

fin develops later than the soft dorsal; adult spine counts are present at ≥ 4.8 mm.

Pelvic fin buds are present at ≥ 3.6 mm; elements begin to develop at 4.4 mm, and the adult complement of I,5 is consistently present in large larvae, 5.8-5.9 mm. Pectoral fins are present throughout our series; rays begin to develop early (relative to other larval sciaenids), at 3.6 mm, but pectoral ray complements are not complete in the largest larvae available.

Pigmentation. Larval L. fasciatus of the sizes available are heavily and characteristically pigmented; particularly useful for identification of early larvae are the pigmented areas of the brain and of the pectoral fin.

Melanin is present on the anterior surface of the forebrain, the anterior and posterior surfaces of the midbrain, the posterodorsal surface of the hindbrain, and the ventral surface of the brain posterior to the eye, throughout the series available. The pectoral fin base and membrane are heavily pigmented throughout the series. Pigment in the membrane, diffuse in small larvae, is found between the fin rays in specimens of ≥ 3.6 mm. An expanded melanophore is present on the visceral mass just ventral to the pectoral fin base throughout the series; two or more melanophores may be present here at 4.2 mm and larger.

In the midventral line of the head, between the lower jaw rami, a line of three melanophores is present between the tip of the lower jaw and the level of the posterior margin of the eye throughout the series (two or four may be present). A melanophore appears at the posterior margin of the preoperculum, ventral and posterior to the eye, at ≥ 4.0 mm. Additional melanophores appear posterior to the eye on the preoperculum and operculum after 4.0 mm. A melanophore is present at the angle of the lower jaw and another anterior to the cleithral symphysis throughout the series.

Internally in the visceral mass area, the dorsal surface of the airbladder and the anterior and posterior surfaces of the visceral mass are pigmented throughout the series. In the ventral midline, three melanophores are present in early larvae, one posterior to the cleithral symphysis (between the pelvic fin bases when these are developed), one midway between the cleithral symphysis and the anus, and one on the anteroventral surface of the anus. At ≥ 3.6 onward, no melanophore is present here. At > 4.5 mm, two or three melanophores may be present at each of the other two locations. At ≥ 5.0 mm melanophores begin to appear and to increase in numbers on the lateral surface of the visceral mass, and the visceral mass is rather heavily pigmented in the largest larvae available.

In the ventral midline posterior to the anus, a row of 6 melanophores is present at 3.0 mm; the 5th of these, about midway between the anus and the notochord tip, is larger than the others. At ≥ 3.2 mm, only two melanophores are present in the midventral line, one at the position of the large melanophore of the original series, and one anterior to this. In larvae with the anal base developed, the larger, posterior melanophore is placed at the posterior end of the anal fin base and the anterior, smaller one, just posterior to the anterior end of the anal base; both are present throughout the remainder of the series. One melanophore is present at the base of the ventral lobe of the caudal fin throughout the series.

In the dorsal midline of the body, one melanophore is present on the body surface anterior to the origin of the finfold or first dorsal fin at ≥ 3.8 mm; two or three melanophores may be present here at ≥ 4.5 mm. Two melanophores, one on either side of the midline, are present on the body surface midway along the spinous dorsal base at ≥ 4.8 mm. A similar pair of melanophores is present about two-thirds of the way along the soft dorsal base in the 5.9 mm specimen.

On the lateral surface of the body, between the spinous dorsal fin base and the visceral mass, one or two melanophores are present at 4.4 mm. By 5.0 mm, a row of four melanophores is present here; at 5.5 mm, two such rows, one above the other, are present. Melanophores in these rows increase in number with further growth until 7 are present in each row by 5.9 mm.

Other Structures. Preopercular spines are present in all larvae available (Table 12). Lateral spines are very small and in early larvae are often absent; they increase in number until, by 5.5 mm, the margin of the preoperculum is serrated. Marginal spines are larger than lateral spines but are not so well developed as in, for example, Bairdiella chrysura or Stellifer lanceolatus. One or two small posttemporal spines are present in some larvae of ≥ 5.5 mm. A low, spinous supraorbital ridge is present in larvae of ≥ 5.5 mm.

Published Developmental Descriptions

Hildebrand and Cable (1934) described and illustrated a series from 1.9-65 mm. Their larval illustrations and descriptions agree with our material in body proportions, fin development, and some important aspects of pigmentation, particularly the heavily pigmented pectoral fin and pigment in the ventral midline posterior to the anus. We have, however, observed additional areas of pigment not noted by them.

Leiostomus xanthurus

Leiostomus xanthurus - Spot

Range - Massachusetts - Texas (Welsh and Breder, 1923)

Spawning Season -

Chesapeake Bay - late autumn and early

winter (Hildebrand and Schroeder, 1928), possibly continuing to March and April (Joseph et al., 1964)

Beaufort, N. C. - December to May (Hildebrand and Cable, 1930)

South Carolina - ripe fish taken October-February, spent fish in February (Dawson, 1958)

South Florida - December to late March (Jannke, 1971)

Louisiana - December-April, peaking in December (Sabins, 1973)

Texas - December-March, peaking in January and February (Pearson, 1929)

Spawning Area

Winter spawning migrations from estuaries offshore have been reported by many authors (e.g., Hildebrand and Schroeder, 1928), and Hildebrand and Cable (1930) and Jannke (1971) believed spawning to be outside estuaries on the basis of size of larvae in estuaries. Dawson (1958) found ripe fish in depths to at least 82 m (45 fm) in winter off South Carolina. Fruge (1977) found small larvae to be most abundant 60-80 km offshore off Louisiana, and mean length of larvae increased with decreasing distance from the shore. Pearson (1929) believed spawning to occur at the mouths of tidal passes, but the other evidence cited would appear to contradict this.

Early Life History

Spawning first occurs at the end of the second year of life (Hildebrand and Cable, 1930; Pearson, 1929) at a minimum length of 200-220 mm (Hildebrand and Cable, 1930). Ova counts of two females, standard lengths in the interval 158-187 mm, were 78,000 and 84,000 (Dawson, 1958). Ova are of several size classes (Hildebrand and Cable, 1930), so all eggs are probably not spawned at once. Larvae were reported to be more abundant in bottom than in surface tows (Hildebrand and Cable, 1930); however, MRRI-MARMAP neuston tows in continental shelf waters have taken many larval and juvenile specimens. Young may be found as far upstream as freshwater (Dawson, 1958). Populations of L. xanthurus fluctuate dramatically from year to year; since year-class strength is determined before young enter estuaries, it is probably determined by factors affecting planktonic stages offshore (Joseph, 1972).

Description of our Material

This description is based on 34 specimens, 4.0-39.0 mm, from South Carolina estuaries and from continental shelf waters off the southeastern United States.

Body form (Table 13). Body proportions of L. xanthurus change gradually with development. Body depth is relatively small, less than 32.5% SL in all specimens and less than 29.3% at $\geq$ 7.0 mm. Preanus distance, less than 50.0% SL from 4.0-15.5 mm, increases to greater than 48.4% SL at $\geq$ 16.0 mm. The anus-anal fin gap, 7.1-17.0% SL at less than 16.0 mm, decreases to 7.0% SL or less in specimens $\geq$ 16.0 mm.

Fin development (Table 14). Notochord flexion begins at 4.4 mm and is complete by 4.7 mm. Principal caudal rays begin to develop at 4.5 mm; the adult complement is present in most larvae of $\geq$ 5.8 mm, in all specimens $\geq$ 7.2 mm. Procurrent caudal rays first appear in a 6.2 mm specimen; counts stabilize at 7 dorsal and 6-7 ventral at 15.5 mm. The truncate caudal is evident in larvae of $\geq$ 9.3 mm. Caudal rays may be broken.

Soft dorsal and anal fin pterygiophores are first apparent as notochord flexion begins, at 4.4 mm; the soft dorsal has more elements than the anal in all specimens in which counts can be made. Soft dorsal and anal fin rays are present in specimens $\geq$ 7.2 mm. Adult complements of I,29-30 soft dorsal elements and II,12-13 anal elements are generally present from 9.3 mm; anal ray or pterygiophore counts of 12 or 13, characteristic of L. xanthurus, are present from 6.2 mm. Dorsal fin spines are first present at 7.2 mm; adult complements of X or XI are consistently present from 14.1 mm, although smaller specimens may have the adult complement.

Pelvic fin buds first appear at 5.2 mm. Elements of these fins appear at 8.0 mm, and adult counts are present from 10.7 mm. Pectoral fins are present in all specimens. Elements are first developed at 10.7 mm, and counts, apparently stabilized, of 19-21 are present at $\geq$ 16.8 mm.

Pigmentation. In the head region, a melanophore is present at the angle of the lower jaw, and one is present anterior to the ventral symphysis of the cleithra, from 4.0 mm (the smallest specimen available) throughout the series. A melanophore is present on the ventral surface of the hindbrain in some specimens 4.7-12.8 mm, and one is present internally just posterior to the hindbrain from 6.2-12.8 mm. A melanophore is present on the posterior surface of the midbrain from 11.1-19.7 mm. On the dorsal surface of the head, above the midbrain, a melanophore is present in specimens $\geq$ 12.9 mm; from 15.5 mm melanophores increase in number in this area until it is fairly heavily pigmented by 39.0 mm. Pigment appears in other areas of the head at 15.1 mm and increases in extent through the early juvenile stages on the tip of the upper and lower jaws and along the anterior half of the surface of the dentary, on the preoperculum posteroventral to the eye, and on the dorsal surface of the head above the hindbrain. Pigment in all these areas is well developed at 19.7 mm and 39.0 mm.

On the ventral surface of the visceral mass, a left-right pair of melanophores is present midway between the cleithral symphysis and the anus in all specimens; each of these is placed at the base of each pelvic fin when these are present.

One melanophore is present in the ventral midline just anterior to the anus from 4.0-15.3 mm. An internal melanophore is placed on the anterior surface of the visceral mass, between the cleithra, from 4.0-15.5 mm, and an internal melanophore is present on the posterodorsal surface of the intestine dorsal to the anus from 4.0-17.5 mm. Melanophores are present on the dorsal surface of the airbladder in all specimens. A pigment spot is present internally in the musculature of the nape from 6.2-13.8 mm; in larger specimens the thickening of the body wall and musculature may prevent seeing this spot.

Pigmentation in the ventral midline posterior to the anus is rather constant over a large part of the developmental series. In the smallest specimen, 4.0 mm, 15 small melanophores are present between the anus and notochord tip. By 4.4 mm, when the anal fin base has begun to develop, this row of spots has taken the following form: one spot is placed anterior to the anal fin origin, two are present along the anal base, one is placed at the posterior end of the anal base, and three are placed between the termination of the anal fin and the developing caudal fin. This pattern remains rather constant until 19.7 mm. One to three melanophores (occasionally as many as five) are present along the anal base, and four or five (occasionally as many as seven) are placed posterior to the anal base, in addition to the single melanophore anterior to the anal base and that at the posterior end of the anal base. By 39.0 mm this row of melanophores is no longer present or has been obscured by development of diffuse pigmentation laterally and ventrally on the body surface.

Pigmentation in the dorsal body midline and on the lateral surface of the body develops at $\geq$ 15.1 mm. An external melanophore is present at the posterior end of the first dorsal fin base at 15.1 mm; one or two melanophores are present here from 15.5-19.7 mm. Along the soft dorsal base, two melanophores are present at 15.1 and 15.5 mm; six are present from 16.8-19.7 mm. At $\geq$ 15.5 mm two or more melanophores are present on the body surface anterior to the first dorsal origin, and a large melanophore is present on the dorsal surface of the caudal peduncle, posterior to the second dorsal fin. In the midlateral line, four melanophores are placed on the body surface between the anal fin origin and the caudal fin base at 15.5 mm; by 19.7 mm 6 clusters of small melanophores are present in the midlateral line between the opercular margin and the caudal base. By 39.0 mm much of the dorsal, lateral and ventral body surfaces are covered with small melanophores, with some concentration of these along myosepta so that the myomeres are outlined; the clusters of melanophores in the midlateral line are still present at this length.

A single melanophore is present at the base of the developing caudal fin at 4.4 mm; by 6.6 mm two such spots, one in the dorsal lobe and one in the ventral, are present. By 9.3 mm three melanophores are present at the base of the ventral lobe, outlining the fin base; by 14.1 mm two melanophores are present in the dorsal lobe, so that the entire caudal fin base is more or less outlined. Small melanophores are placed throughout the caudal fin membrane at 19.7 and 39.0 mm. A few small melanophores are present in the first dorsal and anal fin membranes at 15.5 mm. Their numbers have increased, and melanophores are present on the second dorsal membrane, by 16.8 mm; at 19.7 and 39.0 mm the dorsal and anal membranes are largely covered with small melanophores.

Other Structures. Lateral and marginal preopercular spines are present in all specimens except the largest (39.0 mm) (Table 14), in which these spines have apparently been overgrown by the developing preoperculum. A small posttemporal spine is present from 14.6-16.8 mm and in two smaller specimens (Table 14). Teeth are present in all specimens, in both upper and lower jaws. Scales, including the pored scales of the lateral line, are developed in the 39.0-mm specimen.

Published Developmental Descriptions

Welsh and Breder (1923) illustrated juveniles of lengths 29 mm and 164 mm. Pearson (1929) illustrated specimens of 10.5 mm and 13.5 mm, briefly described specimens 7.0-50 mm, and reprinted the earlier drawings of juveniles. Fin development and general body form were shown fairly well by Pearson, but much important pigment was not shown by him. Hildebrand and Cable (1930) described and illustrated a developmental series from 1.5-50.0 mm. Early larvae illustrated by them were apparently distorted; body form of specimens up to 7 mm is unlike that in larvae we have seen. Although the pigmentation shown and described is generally accurate (e.g. that of the ventral midline behind the anus), much important pigment (e.g. that of the ventral visceral mass) was not shown or referred to in the description. Development of the caudal and other fins is similar to that observed by us. In general, this description is not suitable for separation of L. xanthurus from many other sciaenid and non-sciaenid species. Jannke (1971) illustrated a specimen of 11 mm. This illustration is accurate in body form and fin development, and the dorsal and anal fin counts are those of L. xanthurus; pigment, however, as shown in his figure does not agree with what we have observed.

Scotton et al. (1973) reprinted Hildebrand and Cable's (1930) figures and provided a condensed version of the earlier descriptions. Lippson and Moran (1974) repeated Hildebrand and Cable's (1930) description and illustrations of early larvae and early juveniles; however, they included original illustrations and a description of late larvae by Peter Berrien, which are far better than previous work on the species. Based on this work, larval L. xanthurus can be separated from other species.

Fruge (1977) described and

Table 13. Development of body proportions of Leiostomus xanthurus.

NL/SL	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.7	11.0-11.9	12.0-12.9
n	5	4	2	3	2	2	1	2	2
SnL	7.8-9.6	9.0-10.6	8.8-10.5	6.8-10.3	8.2-8.6	8.0-8.0	6.2	7.5-7.6	7.9-9.1
ED	10.4-11.7	9.9-11.9	10.5-11.2	9.1-10.2	9.5-10.2	8.8-9.7	8.6	7.5-9.1	7.8-9.2
HL	29.1-36.0	32.1-33.3	33.8-34.2	28.4-33.0	29.5-30.6	28.3-31.0	28.1	30.3-31.3	28.6-30.3
PAnL	42.7-48.3	43.9-45.1	48.8-50.0	39.8-48.3	44.8-45.9	46.0-46.9	45.3	45.5-46.3	46.8-47.4
IDo	N	N	39.5-40.4	31.8-36.8	32.7-33.3	32.7-33.6	31.2	33.3-35.8	35.1-35.5
IIDo	N,50.9-56.5	52.1-54.5	51.3-52.5	52.3-54.0	49.5-51.0	48.7-51.3	46.9	44.8-47.0	49.4-51.3
IIDt	N,74.6-82.5	76.1-81.7	84.2-88.8	81.2-84.1	85.7-86.7	85.0-86.7	85.9	84.8-86.6	85.7-86.8
Gap	N,10.0-12.3	11.9-13.9	7.9-8.7	10.3-17.0	9.2-11.4	7.1-10.6	7.8	8.9-9.0	9.0-9.2
Ao	N,56.5-60.5	56.7-59.2	57.5-57.9	56.8-58.6	55.1-56.2	54.0-56.6	53.1	54.5-55.2	55.8-56.6
At	N,73.0-75.4	74.2-76.1	77.6-78.8	77.3-78.2	77.6-78.1	77.0-77.0	73.4	75.8-76.1	77.6-77.9
P_2i	N	33.3-36.6	35.0-38.2	36.4-41.4	34.3-35.7	34.5-38.1	31.2	33.3-35.8	32.9-35.1
BDc	27.2-32.5	28.4-30.6	27.5-30.3	25.0-27.3	25.5-25.7	24.8-26.5	23.4	23.9-24.2	23.4-23.7
CpD	4.8-9.2	8.5-9.1	8.8-9.2	9.1-10.2	9.2-10.5	8.8-9.7	9.4	9.1-10.4	7.8-7.9

Table 13. continued

NL/SL	13.8	14.0-14.9	15.0-15.9	16.0-16.9	17.5	19.7	39.0
n	1	2	3	2	1	1	1
SnL	7.3	8.0-8.3	7.6-8.8	7.4-9.0	9.6	10.3	6.5
ED	7.3	6.9-7.1	7.6-7.8	8.4-9.0	7.7	8.6	9.5
HL	28.0	29.8-29.9	27.2-31.1	29.5-32.0	30.8	35.9	31.0
PAnL	45.1	47.6-49.4	47.8-49.4	48.4-57.0	52.9	54.7	62.5
IDo	32.9	34.5-35.7	33.3-35.2	33.7-35.0	35.6	35.9	35.8
IIDo	50.0	48.3-48.8	46.7-50.6	48.4-50.1	51.9	53.0	53.9
IIDt	86.6	86.2-86.9	85.6-86.8	85.3-88.0	86.5	88.0	91.0
Gap	9.8	9.2-9.5	7.6-10.0	5.7-7.0	5.7	4.3	2.6
A	54.9	57.1-58.6	55.4-58.2	54.7-59.0	58.6	59.0	65.1
At	75.6	77.0-77.4	75.0-79.1	74.4-80.0	76.9	77.8	79.7
P_2i	32.9	33.3-34.5	32.2-35.2	31.6-36.0	34.6	34.2	35.3
BDc	23.2	23.0-23.8	22.2-23.1	24.2-26.0	24.0	27.4	29.3
CpD	8.5	8.0-8.3	8.7-8.9	9.0-9.5	9.6	9.4	9.5

Table 14. Development of meristic characters of Leiostomus xanthurus.

NL/SL	ID	IID	A	P_1	P_2	C	pC	Preoperc	Posttemp
4.0	ff	ff	ff	bud	N	ff	0	0/2	0
4.5	ff	ff	ff	bud	N	5 + 5	0	2/1	0
4.4	ff	15	7	bud	N	6 + 6	0	2/2	0
4.5	ff	13	10	bud	N	7 + 7	0	3/3	0
4.7	ff	20	10	bud	N	9 + 8	0	2/3	0
5.2	ff	18	9	bud	bud	9 + 7	0	2/3	0
5.4	ff	10	10	bud	bud	8 + 7	0	2/3	0
5.5	ff	16	7	bud	bud	8 + 8	0	2/3	0
5.8	ff	20	10	bud	bud	9 + 8		2/3	0
6.2	ff	21	12	bud	bud	9 + 8	1,1	3/3	0
6.6	ff	27	I,13	bud	bud	9 + 8		3/3	0
7.1	ff	26	13	bud	bud	9 + 7	0	3/3	0
7.2	ff	22	I,12	bud	N	9 + 8	0,1	3/3	0
7.2	IX	25	I,12	bud	bud	9 + 8	1,1	2/3	0
8.0	X	24	II,12	bud	2	9 + 8	1,1	2/4	0
8.6	III	24	I,13	bud	4	9 + 8	1,1	4/4	0
9.3	X	30	II,12	bud	4	9 + 8	1,3	4/4	0
9.3	X	I,30	II,12	bud	3	9 + 8	2,2	4/3	0
10.7	X	I,28	II,12	9	I,5	9 + 8	3,4	4/4	1
11.1	XI	I,30	II,13	10	I,5	9 + 8	3,3	4/4	0
11.3	XI	I,29	II,13	11	I,5	9 + 8	5,4	4/4	1
12.8	V	30	II,12	11	I,5	9 + 8	4,4	4/4	0
12.9	IX	I,30	II,12	10	I,5	9 + 8	5,4	3/3	0
13.8	VI	I,29	II,12	15	I,5	9 + 8	5,5	4/5	0
14.1	X	I,31	II,12	14	I,5	9 + 8	6,5	4/4	0
14.6	X	I,31	II,12	18	I,5	9 + 8	6,5	4/3	1
15.1	X	I,31	II,12	17	I,5	9 + 8	6,6	3/3	1
15.3	X	I,31	II,12	20	I,5	9 + 8		4/4	1
15.5	X	I,30	II,12	19	I,5	9 + 8	7,6	4/4	1
16.0	X	I,31	II,13	17	I,5	9 + 8	7,7	4/4	1
16.8	X	I,30	II,13	20	I,5	9 + 8	7,6	4/3	1
17.5	X	I,31	II,12	19	I,5	9 + 8	7,6	4/5	
19.7	X	I,30	II,12	20	I,5	9 + 8	7,6	4/3	
39.0	X	I,33	II,13	21	I,5	9 + 8	7,7	0	0

illustrated a series 1.6-10.7 m SL. His description is quite similar to our material, with some differences in fin development stages (e.g. earlier development of caudal rays in Fruge's material). Fruge (1977) noted that eye diameter and preanus distance could be used to separate L. xanthurus from Micropogon undulatus larvae, and provided useful comparative data on pigment of the ventral surface of the visceral mass in these two species.

Menticirrhus americanus

Menticirrhus americanus - Southern kingfish

Range - New York to Argentina, most abundant from Chesapeake Bay southward (Hildebrand and Cable, 1934; Chao, 1976)

Spawning Season -

Mid-Atlantic region - May to June (Joseph et al., 1964) and August (Welsh and Breder, 1923)

Beaufort, North Carolina - April to August and possibly early September, peak in June to August (Hildebrand and Cable, 1934)

South Carolina - May to September, peak in June to July (Bearden, 1963)

Georgia - April to August (Dahlberg, 1972)

South Florida - year-round (Jannke, 1971)

Gulf of Mexico - June or July to September (Pearson, 1941); April to August, peak in July to August (Sabins, 1973)

Spawning Area

Spawning occurs outside estuaries (Dahlberg, 1972; Bearden, 1963; Jannke, 1971), probably in coastal waters nearshore (Hildebrand and Cable, 1934).

Early Life History

Small specimens (less than 20 mm) were more abundant outside Beaufort Inlet than inside; larvae were taken more often in bottom than in surface tows (Hildebrand and Cable, 1934). Smallest juveniles were found furthest upstream in South Carolina estuaries, with progressively larger specimens found closer to the sea (Bearden, 1963).

Description of our Material

See below, Menticirrhus sp.

Menticirrhus littoralis

Menticirrhus littoralis - Gulf kingfish

Range - Virginia to Brazil, most abundant south of Cape Hatteras (Hildebrand and Cable, 1938; Chao, 1976)

Spawning Season -

Beaufort, North Carolina - May to August, on the basis of limited data (Hildebrand and Cable, 1934).

South Carolina - smallest specimens taken in fall, implying summer spawning (Bearden, 1963)

Georgia - April to September (Dahlberg, 1972)

Spawning Area

Spawning probably occurs outside estuaries in open waters (Hildebrand and Cable, 1934).

Description of our Material

See below, Menticirrhus sp.

Menticirrhus saxatilis

Menticirrhus saxatilis - Northern kingfish

Range - Cape Cod to Mexico, stragglers to Maine; most abundant from Chesapeake Bay northward (Hildebrand and Cable, 1938; Chao, 1976)

Spawning Season -

Mid-Atlantic region - May to September (Welsh and Breder, 1923; Joseph et al., 1964; Schaefer, 1965)

Beaufort, North Carolina - April to May at least (Hildebrand and Cable, 1934)

South Florida - fall and winter, based on limited data (Jannke, 1971)

Spawning Area

Spawning occurs outside estuaries (Jannke, 1971; Thomas, 1971), perhaps in open coastal waters (Hildebrand and Cable, 1934).

Early Life History

Eggs hatch in 46-50 hours at 20.0-21.1°C (68-70 F) (Welsh and Breder, 1923). Males mature at age 2, females at age 3 (Hildebrand and Cable, 1934).

Description of our Material

See below, Menticirrhus sp.

Menticirrhus sp.

Identification of larval Menticirrhus poses a problem, because of our limited material and the sketchiness of the literature. For this reason we have limited ourselves to a discussion of identification information available, description of a series identified to the genus level, and a summary of developmental descriptions in the literature. Further work is needed on larvae of the three South Atlantic Bight Menticirrhus species.

Identification of Menticirrhus to the genus level is straightforward from early larvae to adult stages. In juveniles and adults, the single barbel and the single anal spine are unique in sciaenids of our area (Chao, 1976). In early and late larvae the heavy body pigmentation should differentiate Menticirrhus from all other sciaenids except Cynoscion nebulosus

(assuming that larval M. littoralis will have heavy body pigment), which can be separated from Menticirrhus by characters given in the summary of this report.

Identification of young Menticirrhus to species is somewhat more difficult. Field identification of juveniles is "difficult and time-consuming" (Dahlberg, 1975). Identification in the larval stages, probably a difficult task, has been complicated by published studies through mixing of species other than Menticirrhus into developmental series (Hildebrand and Cable, 1934), use of incomplete series (Scotton et al., 1973), and an apparent lack of extensive comparative material, which shows up in earlier authors' failure to give definitive reasons for naming their larval series and for differentiation from the other species. The two larval types in the literature, (M. americanus of Hildebrand and Cable, 1934 and M. saxatilis of Scotton et al., 1973) differ primarily in pigmentation, which we feel has been uncritically treated in many studies of sciaenid larvae. The spawning seasons of all three species overlap, as do their ranges in the areas where descriptive studies have been done, so it is possible that larvae of all species could have been present in samples of the earlier workers.

Characters for adult species identification are chest scale size (scales fully developed by 40 mm in all three species according to Welsh and Breder, 1923 and in one 19.3 mm SL M. americanus in our collection) and anal fin counts (developed by 6 mm, from Jannke, 1971, and our observations). Chest scales are smaller than scales on sides in M. littoralis, not in the other two species; anal counts are I,8 (rarely I,9) in M. saxatilis, and I,7 (rarely I,8) in M. americanus (Hildebrand and Cable, 1934; Dahlberg, 1975; Chao, 1976). Fin pigmentation is a useful character in identifying juveniles (Hildebrand and Cable, 1934; Dahlberg, 1975). Construction of good size series downward from early juveniles identified by these characters through larvae, or from rearing studies, would be necessary for unequivocal separation of the larvae.

In our larval series, the largest specimen (19.3 mm) is identifiable as M. americanus; late larvae have 7 anal fin rays, but we have insufficient material to link these with the largest specimen. Larvae of our series resemble M. americanus of Hildebrand and Cable (1934). It is possible that we have a mixed series, although morphometric, meristic and pigment characters of specimens develop without abrupt changes. In any case we have insufficient material to state unequivocally that the series is M. americanus, and so treat it as Menticirrhus sp. This description is based on 23 specimens 2.5 to 19.3 mm from continental shelf waters of the South Atlantic Bight and from the Cape Fear River estuary.

Body form (Table 15). Menticirrhus sp. are fairly deep-bodied as early larvae (depth 35.5-38.5% SL at less than 4.0 mm), with body depth decreasing to the late larval and juvenile stages. The gap between the anus and anal fin is short, none being present in many specimens and the maximum value being 5.0% SL. Relative lengths of the soft dorsal and anal fins are established by 3.6 mm, permitting early identification to the family level. The anus is posterior to mid-body, at 53.1-63.5% SL. Apart from body depth, body proportions change little with development.

Fin development (Table 16). Notochord flexion in the caudal region occurs between 3.6 and 4.1 mm. Caudal rays are first present in a pre-flexion specimen of 3.6 mm, and the adult complement of principal rays is present at and after 6.4 mm. Elements of the dorsal fin are first present at 4.1 mm; adult dorsal fin complements of X-I, 24-27 are present at $\geq$ 6.6 mm. Anal fin elements are first present at 4.1 mm and are complete (I,7) at $\geq$ 5.2 mm. Pectoral fin elements are present at $\geq$ 6.8 mm; 21 are present in the two largest specimens of 10.1 and 19.3 mm. The pelvic fin appears as a bud in a specimen of 4.1 mm; the adult complement of I,5 elements is present at $\geq$ 6.8 mm.

Pigmentation. Menticirrhus sp. larvae are heavily pigmented in all stages represented in our series.

In the head region, a melanophore is present at the angle of the lower jaw throughout our series. Unlike most other sciaenids, melanin is absent from the area anterior to the cleithral symphysis in the ventral midline. A melanophore is present at the tip of each premaxillary from 2.5-10.1 mm, while another is placed on the lateral surface of each dentary halfway along its length in specimens 4.6-10.1 mm. A patch of melanin is present on the roof of the mouth from 2.5-10.1 mm. In the ventral midline between the lower jaw rami, 2-3 melanophores are present in line from 2.5-3.6 mm, 4 or more in larger larvae; a pair of spots, one at the anterior tip of each lower jaw ramus, is present at $\geq$ 4.1 mm. At $\geq$ 6.1 mm these melanophores are often expanded. On the brain, a melanophore is present on the posterior surface of the midbrain from 3.6 mm, one on the dorsal surface of the hindbrain at $\geq$ 4.6 mm, one on each side of the anterior surface of the midbrain (above the eye) at $\geq$ 4.6 mm. At $\geq$ 6.1 mm, melanophores are present on the dorsal surface of the head above the midbrain, and from 6.8-10.1 mm number of melanophores here increases until the dorsal surface of the head is well pigmented by 10.1 mm. On the lateral surface of the head, a melanophore is present posterior to the eye medial to the preoperculum at $\geq$ 2.5 mm. One is present posterior to this on the branchiostegal membrane at $\geq$ 3.6 mm, and one is present ventral to the eye at $\geq$ 4.7 mm. Number of melanophores posterior and ventral to the eye increases at $\geq$ 6.8 mm.

In the visceral mass area, pigment is present on the dorsal surface of the airbladder and on the anterior surface of the visceral mass between the cleithra throughout the series. On the ventral

surface of the visceral mass, many small melanophores are present in all specimens. From the time of appearance of the pelvic fins (4.1 mm), these spots are localized into a group on the anterior part of the visceral mass, a group on the anteroventral surface of the anus, and one melanophore at the base of each pelvic fin. On the posterior surface of the visceral mass dorsal to the anus, one or several melanophores, usually expanded, are present at ≥ 3.6 mm. A melanophore is placed at the dorsal end of the axil of the pectoral fin at ≥ 3.6 mm.

In the dorsal body midline, 1 to 3 small melanophores are present anterior to the origin of the finfold from 2.8-3.6 mm, while one is present in larger specimens. Several melanophores are placed along the soft dorsal base at ≥ 3.4 mm. Melanophores are placed along the spinous dorsal base at ≥ 6.1 mm; thus, at this size and larger, the dorsal midline has a series of melanophores almost its whole length. In the midlateral line, a series of melanophores, each extending into the body musculature, is present in all specimens; at ≥ 2.5 mm, this series extends from above the anus about halfway to the notochord tip, and at ≥ 3.4 mm, the series extends further posteriorly, almost to the caudal peduncle. In the ventral midline a row of melanophores is placed between the anus and the notochord tip at ≥ 2.8 mm. From the time of appearance of the anal fin base (3.4 mm), this row extends from the anal origin posteriorly, the melanophores being larger along the anal base than posterior to it. At 4.6 mm, one large melanophore is present midway along the anal base, four large melanophores posterior to the anal base, and one to three smaller melanophores posterior to these four. At ≥ 6.8 mm, large melanophores are placed in series along and posterior to the anal base, extending almost to the caudal peduncle.

Melanophores on the lateral surface of the body, above and below the midlateral line series, appear at 4.6 mm in the area between the anus and the caudal peduncle. Melanophores on the lateral body surface increase in number and size with growth, but the caudal peduncle remains unpigmented until 10.1 mm. Melanophores appear dorsal and lateral to the visceral mass at 6.1 mm, and become more numerous with growth. By 10.1 mm, the whole lateral surface of the body is heavily pigmented, and a cluster of melanophores appears over the hypurals.

One or two small melanophores are present at the base of the ventral lobe of the caudal in about half the specimens at ≥ 4.1 mm. At ≥ 6.8 mm, the spinous dorsal and anal membranes are covered with melanophores, while a few small melanophores are placed in the pelvic membrane at 10.1 mm.

Other Structures. Small marginal preopercular spines are present at 3.6 mm and increase in number from 3 to a maximum of 4-5 at 4.6-10.1 mm (Table 16). Lateral preopercular spines appear at 4.1 mm and increase in number to a maximum of 6 at 7.0-10.0 mm. Preopercular spines are overgrown with bone in the 19.3 mm specimen.

A small posttemporal spine is first seen at 6.6 mm, and at ≥ 7.8 mm a well-developed scale bone is present (Table 16). Scales are present along the lateral line from the opercular margin to the level of the anus at 10.1 mm and are sufficiently developed at 19.3 mm to determine that chest scales are not reduced, permitting identification of this specimen as M. americanus. The single mental barbel is present at ≥ 9.2 mm.

Published Developmental Descriptions

Welsh and Breder (1923) illustrated a 26-mm juvenile M. americanus. Hildebrand and Cable (1934) described and illustrated a series identified as M. americanus. lengths 1.7-59 mm. Their description of large larvae (≥ 8 mm) agrees fairly well with our Menticirrhus material in body form, fin development, and some aspects of pigment. Their illustrations of specimens 1.7, 2.9 and 3.8 mm are insufficiently detailed to be definitely identified as M. americanus and are not in agreement with our material in proportions. Their 5.8 mm specimen (Fig. 4, p. 57) is not Menticirrhus; it is probably a sciaenid, but its characters do not fit any of our sciaenid material (it is closest to Stellifer lanceolatus). Jannke (1971) illustrated three Menticirrhus larvae identified as M. americanus. He cited Hildebrand and Cable's (1934) erroneous 5.8 mm specimen in making the identification. Anal fin ray counts (7) of two of his larvae, both 6 mm, were those usually found in M. americanus and M. littoralis. He did not give reasons for identification of his 2.5 mm larva as M. americanus. Scotton et al. (1973) reprinted Hildebrand and Cable's (1934) drawings and main points of their description. They included Welsh and Breder's (1923) figure of a 2.7 mm M. saxatilis with the M. americanus series because of an error in the caption of Welsh and Breder's (1923) original paper (Figure 52, page 193). Lippson and Moran (1974) recapitulated the Hildebrand and Cable material, but pointed out that the 5.8 mm specimen illustrated in the earlier work is not M. americanus.

Welsh and Breder (1923) noted features of three 38-51 mm M. littoralis distinguishing them from M. americanus and M. saxatilis, and illustrated a 50 mm fish. Hildebrand and Cable (1934) described and illustrated M. littoralis of 10-60 mm.

Eggs and yolk-sac larvae of M. saxatilis were described and illustrated by Welsh and Breder (1923), as was a juvenile of 39 mm. Hildebrand and Cable (1934) described and illustrated late larvae and juveniles 10-60 mm and recapitulated Welsh and Breder's (1923) work. Jannke (1971) illustrated 2 specimens, 5.0 and 8.0 mm, presumably identified by the characteristic anal fin ray count of 8. Scotton et al. (1973) reprinted Welsh and Breder's drawings of 2.2 and 2.5 mm and Hildebrand and Cable's drawings of 10.0,

Table 15. Development of body proportions of Menticirrhus sp.

NL/SL	2.0-2.9	3.0-3.9	4.0-4.9	5.2	6.0-6.9	7.0-7.9	10.1	19.3
n	2	5	6	1	4	3	1	1
SnL	5.5-7.7	6.4-8.6	6.9-10.0	9.4	6.8-7.7	5.3-8.2	8.1	7.8
ED	12.3-15.1	9.7-12.9	9.6-11.8	10.9	9.6-10.8	10.1-10.6	10.6	8.7
HL	30.1-30.8	32.3-35.9	30.4-37.5	37.3	31.3-33.7	33.7-36.4	34.1	30.4
PAnL	53.4-55.4	53.1-63.0	55.8-62.5	60.9	56.6-60.2	57.9-63.5	63.4	57.4
IDo	N	39.7-43.5	39.2-46.6	43.7	37.3-42.3	36.0-40.0	40.7	33.9
IIDo	N	52.1-58.1	50.0-60.5	56.2	52.7-59.4	53.7-56.5	56.1	53.0
IIDt	N	73.5-81.7	79.7-89.1	87.5	87.3-89.2	78.9-89.9	89.4	87.0
Gap	N	2.1-5.0	1.0-3.0	1.6	1.2-2.6	N	1.6	3.5
A	N	57.0-63.0	57.7-64.1	62.5	57.8-62.8	57.8-63.5	65.0	60.9
At	N	66.7-71.7	69.3-76.6	75.0	72.3-75.6	73.0-75.3	76.4	72.2
P_2i	N	N	39.1-42.5	39.0	33.7-38.7	34.8-40.0	39.8	34.8
BDc	34.2-38.5	30.6-37.5	30.7-36.3	32.8	27.7-31.1	27.4-29.2	27.6	24.3
CpD		6.5-7.5	6.9-10.1	9.4	8.4-10.2	9.0-11.6	8.9	8.7

Table 16. Development of meristic characters of Menticirrhus sp.

NL/SL	ID	II D	A	P_1	P_2	C	Preoperc	Posttemp
2.5	ff	ff	ff	bud	N	ff	N	0
2.8	ff	ff	ff	bud	N	ff	N	0
3.4	ff	ff	ff	bud	N	ff	N	0
3.6	ff	ff	ff	bud	N	ff	0/3	0
3.6	ff	ff	ff	bud	N	4 + 4	0/3	0
3.6	ff	ff	ff	bud	N	5 + 4	0/2	0
3.8	ff	ff	ff	bud	N	3 + 2	0/2	0
4.1	ff	ff	ff	bud	bud	5 + 3	0/4	0
4.1	ff	23	9	bud	bud	7 + 5	1/2	0
4.4	ff	19	5	bud	bud	7 + 4	1/3	0
4.6	ff	24	7	bud	bud	9 + 7	2/4	0
4.7	ff	26	7	bud	bud	8 + 7	3/4	0
5.2	X	26	I,7	bud	bud	7 + 6	4/3	0
6.1	X	27	I,7	bud	bud	8 + 7	2/5	0
6.4	X	25	I,7	bud	bud	9 + 8	2/5	0
6.6	X	I,24	I,7	bud	bud	9 + 8	5/4	1
6.8	X	I,25	I,7	21	I,5	9 + 8	2/5	0
7.0	X	I,25	I,7	17	I,5	9 + 8	6/5	2
7.3	X	26	I,7		I,5	9 + 8	6/4	several
7.8	X	I,26	I,7	18	I,5	9 + 8	6/5	3
9.2	X	I,25	I,7		I,5	9 + 8	0/2	several
10.1	X	I,25	I,7	21	I,5	9 + 8	6/5	5
19.3	X	I,24	I,7	21	I,5	9 + 8	3/2	2

20.0 and 30.0 mm fish; Scotton et al. (1973) also added original drawings of 3.7 and 4.5 mm specimens identified as M. saxatilis. The basis for this identification was not given by them and fin elements were incompletely developed in these specimens. Presumably the identification was based on the facts that these larvae were sciaenids, were probably Menticirrhus (because of the heavy body pigmentation, similar to M. americanus of earlier writers), but were not M. americanus since the details of pigment pattern were different. Scotton et al. (1973) also provided a brief description based on their illustrations and the earlier studies. Lippson and Moran (1974) reprinted the figures of Welsh and Breder (1923), Scotton et al. (1973), and Hildebrand and Cable (1934) and provided brief descriptions based on these earlier works.

Micropogon undulatus

Micropogon undulatus (Micropogonias undulatus of Chao, 1976) - Atlantic croaker

Range - Massachusetts - Brazil (Hildebrand and Schroeder, 1928; Chao, 1976)

Spawning Season -

Chesapeake Bay - September to November, possibly to January and February (Hildebrand and Schroeder, 1928; Joseph et al., 1964)

Beaufort, North Carolina - September to May, peaking October to March (Hildebrand and Cable, 1930)

South Carolina - October to January (Bearden, 1964)

Georgia - September to April (Dahlberg, 1972)

Gulf of Mexico - October to April, peaking in November (Pearson, 1929; Sabins, 1973)

Spawning Area

Most authors and our data suggest spawning in continental shelf waters some distance from shore, although Pearson (1929) believed spawning occurred at the mouths of tidal passes. Bearden (1964) and Hoese (1965) stated that spawning occurs offshore. Bearden (1964) found ripe adults 5-50 km (3-30 mi) offshore off South Carolina, and found no early larvae nearshore, although 8-15 mm larvae were captured here. Hildebrand and Cable (1930) suggested that spawning occurred 22-56 km (12-30 mi) offshore. Minimum length of larvae in the harbor at Beaufort, North Carolina, was 3 mm, while 10-25 mm specimens were more numerous in Beaufort Harbor than offshore (Hildebrand and Cable, 1930). Fruge (1977) found small larvae most abundant 60-80 km offshore, while larger larvae became more abundant with decreasing distance from shore. Small larvae ($\leq$ 10.0 mm SL) are present in MRRI-MARMAP bongo and neuston tows in shelf waters, and are absent from South Carolina Estuarine Survey plankton tows.

Early Life History

Mean length at maturity is 220 mm, minimum length 140 mm; growth in the first year is 150 mm, in the second to 200 mm (Pearson, 1929). A 395 mm female contained 180,000 eggs, and all ova were of uniform size (Hildebrand and Schroeder, 1928). Young may use deep estuarine currents to move upbay; larvae were more common in bottom than in surface tows off Beaufort, North Carolina (Hildebrand and Cable, 1930), and have been taken in deep (33-53 m) waters of Chesapeake Bay (Welsh and Breder, 1923; Haven, 1957). In continental shelf waters, however, larvae are frequently taken in neuston tows (MRRI-MARMAP unpublished data).

Description of our Material

The following description is based on 67 specimens, 3.1-41.0 mm, from continental shelf waters of the South Atlantic Bight and from South Carolina estuaries.

Body form (Table 17). Larval M. undulatus are relatively slender, depth < 30% SL throughout our series except for 1 specimen in the 3.0-3.9 mm range. The relative lengths of the soft dorsal and anal fins are established in larvae 5.0-5.9 mm. The gap between the anus and anal fin origin is relatively short (4.6-16.0% SL at 3.1-6.9 mm, 0-8.3% SL in larger specimens). Preanus length is < 50% NL in the smallest larvae available and increases steadily to 55-60% SL in large larvae and small juveniles.

Fin development (Table 18). Caudal flexion occurs between 4.0 and 4.4 mm. Principal caudal rays have begun to differentiate in one pre-flexion specimen and are consistently present in specimens $\geq$ 4.3 mm; the adult complement of 9 + 8 principal caudal rays is present in specimens $\geq$ 6.8 mm. Procurrent caudal rays are first seen at 7.1 mm; counts stabilize at 7-9 dorsal and 7-8 ventral at 17.5 mm.

The soft dorsal and anal bases are first visible at 3.9 mm. Elements of these fins appear at 4.4 mm. Adult anal fin complements of II, 7-8 are present at $\geq$ 6.8 mm; adult soft dorsal counts of I, 27-30 are present at $\geq$ 10.1 mm. Dorsal fin spines are countable at 7.4 mm, and adult counts (X spines) are consistently present at $\geq$ 8.4 mm.

The pelvic fin appears late in development, compared with other larval sciaenids, the bud first being present at 8.4 mm. Pelvic elements begin to appear at 9.4 mm, with the spine developing first and the rays developing from the spine mediad; the adult complement of I, 5 elements is present at $\geq$ 11.8 mm. Pectoral fin rays appear at 7.8 mm.

Pigmentation. In the head region, melanophores are present at the angle of the lower jaw and anterior to the cleithral symphysis throughout the series. Other head pigment appears late in development.

The ventral surface of the hindbrain is pigmented at ≥ 7.4 mm. The tip of the lower jaw has a melanophore in a few specimens 8.3-10.1 mm and in all specimens > 10.1 mm. A melanophore at the tip of the premaxillary and another on the ramus of the lower jaw below the eye appear at 11.8 mm. Two melanophores appear posterior to the eye at 11.8 mm. Melanophores appear on the dorsal surface of the head, dorsal to the forebrain and midbrain, at 12.9 mm. Melanophores on the jaws, dorsal to the brain, and posterior to the eye increase in numbers with growth, and all these areas are rather heavily pigmented at ≥ 15.8 mm.

Throughout the series, melanin is present on the dorsal surface of the airbladder, and one or two melanophores are present on the posterior surface of the visceral mass dorsal to the anus. Unlike many other larval sciaenids, no pigment is present on the anterior surface of the visceral mass between the cleithra. In the ventral midline in the visceral mass area, a melanophore is present just posterior to the cleithral symphysis and another on the anteroventral surface of the anus at ≥ 3.1 mm. At ≥ 4.9 mm, a third melanophore is present about midway between these; this melanophore is between the pelvic fin bases at ≥ 7.4 mm when the pelvic is present. Often two melanophores, one on each side of the midline, are present here. Two melanophores appear on the lateral surface of the visceral mass posterior to the pectoral fin base at 15.8 mm; two-three are present here through the rest of the series.

In the dorsal midline of the body, a single melanophore is present on the body surface anterior to the origin of the finfold from 3.1-3.9 mm. Subsequently, no dorsal midline pigment is present until 11.8 mm, when a pair of melanophores, one each side of the midline, appears anterior to the origin of the first dorsal. Two or three melanophores appear along the second dorsal base at 11.8 mm. Numbers of melanophores in this sequence increase until 5-6 are present at 21.5-33.8 mm. A large melanophore at the posterior end of the first dorsal base is first seen at ≥ 12.9 mm. In the largest specimens of the series, pigment in the dorsal midline consists of a sequence of 8-10 clumps of small melanophores, evenly spaced from anterior to the first dorsal to the posterior end of the second dorsal.

In the midlateral line of the body, three melanophores are first seen on the body surface at 11.8 mm, one above the anus, one above the anal fin base, and one below the termination of the soft dorsal fin. Numbers of melanophores in the midlateral line increase, and the line of melanophores extends posteriorly to the caudal peduncle and anteriorly to above the visceral mass with further development. At ≥ 21.5 mm 10 melanophores are placed in this sequence. A line of 5 melanophores appears on the body surface between the first dorsal fin base and the midlateral line at 13.4 mm; 3-5 melanophores are placed in this line in specimens 13.4-24.4 mm. At ≥ 33.8 mm about 10 melanophores are present between the dorsal fin base and the midlateral line. At ≥ 33.8 mm, the melanophores in the three lengthwise lines (at the dorsal base, in the midlateral line, and between these) increase in numbers and spread dorsally and ventrally until, in the largest specimens, 10 vertical bars of pigment are formed.

In the ventral midline, 12 melanophores are placed in a row from the anus to the notochord tip at 3.1 mm; two of these, midway along the row, are larger and more expanded than the others. Twelve-fifteen such melanophores, usually with one expanded (2/3 of the way between anus and notochord tip), are present from 3.1-3.5 mm. By 3.9 mm, with the anal base developing, a large melanophore is present at the origin and one at the termination of the anal base, and no melanophores are present along the rest of the base. From 4.3-7.1 mm, there is one melanophore anterior to the anal base, one just posterior to the anal origin (at the base of the second anal ray when this is developed), one at the posterior end of the anal base, and three-six posterior to the anal fin. At ≥ 7.1 mm, the melanophore anterior to the anal fin is not present and the number of melanophores posterior to the anal fin is reduced to two-four. The gap in the midventral pigment along the anal base separates Micropogon undulatus from Leiostomus xanthurus. At ≥ 15.8 mm, 2-5 melanophores are arranged in sequence along the anterior half of the anal fin base; at ≥ 24.4 mm melanophores are found along the whole length of the anal fin base.

Pigment appears in all the median fins during development. One or two melanophores are present at the base of the ventral lobe of the caudal fin throughout the series; two melanophores are present at the base of the dorsal lobe at ≥ 11.8 mm. Small melanophores appear in the spinous dorsal, anal, and caudal membranes at 15.2 mm and in the soft dorsal membrane at 17.5 mm.

Other Structures. One or two small posttemporal spines are present from 8.3-10.2 mm (Table 18). Number of posttemporal spines increases to 5 by 21.5 mm, and a well-developed scale bone is present at ≥ 21.5 mm.

Preopercular spines are present in all specimens (Table 18). Numbers of lateral and marginal spines increase to a maximum at 13.4 mm, and numbers subsequently decrease slightly as the smaller lateral spines are resorbed and the marginal spines are overgrown by the developing operculum.

Barbels are first seen at 21.5 mm. Three or four short barbels on each lower jaw ramus are developed in specimens ≥ 21.5 mm. Scales are present at ≥ 21.5 mm.

Published Developmental Descriptions

Welsh and Breder (1923) illustrated

Table 17. Development of body proportions of Micropogon undulatus.

NL/SL	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9
n	8	12	6	9	4	6	4	3
SnL	6.2-8.4	5.9-9.2	4.8-9.2	6.2-8.2	6.9-8.4	5.9-8.9	5.0-8.3	4.8-7.8
ED	8.2-11.9	8.3-9.8	7.2-10.1	6.6-8.2	6.9-8.0	5.8-7.3	6.7-7.8	5.8-7.3
HL	26.8-31.6	30.3-34.8	26.1-36.9	28.9-32.9	31.6-33.3	30.1-33.3	28.6-30.2	26.7-31.5
PAnL	41.2-47.0	42.7-54.5	42.0-56.9	46.7-52.5	50.6-53.3	49.0-54.5	47.9-54.3	51.7-57.8
IDo	N	N-40.0	N	34.2-39.5	34.5-36.8	32.4-35.9	30.5-31.9	33.3-35.9
IIDo	N-49.5	46.9-53.2	46.4-55.1	49.3-53.2	50.6-51.7	48.5-51.5	46.2-50.0	50.0-53.1
IIDt	N-75.2	70.6-86.7	80.6-85.5	82.9-88.9	85.6-87.4	84.2-87.4	79.8-86.7	84.7-88.3
Cap	N-10.9	7.0-15.5	4.6-16.0	5.0-11.0	3.2-6.9	2.9-8.3	N-4.2	2.4-3.3
Ao	N-57.4	54.5-61.8	58.0-61.5	56.6-61.0	55.8-60.0	54.9-60.2	52.1-56.3	55.0-60.9
At	N-65.3	67.3-78.2	72.5 -78.5	70.9-79.2	72.4-74.7	70.6-74.8	67.2-73.3	71.8-76.6
$P_2$1	N	N	N	N	29.5-35.6	31.4-33.0	28.6-33.0	29.0-35.0
BDc	25.6-30.5	27.4-29.8	24.6-29.3	23.7-27.4	26.3-28.9	24.8-27.2	25.2-27.6	25.0-28.1
Cpd	4.4-6.7	6.4-9.1	8.1-10.1	7.9-10.4	8.0-9.2	8.3-9.8	8.3-9.5	7.8-10.1

Table 17. continued

NL/SL	11.0-11.9	12.9	13.4	14.1	15.0-15.9	17.5	21.0-21.9	24.4	33.8	41.0
n	3	1	1	1	2	1	3	1	1	1
SnL	8.5-10.0	9.1	7.5	8.3	7.8-8.5	8.7	7.8-10.2	8.3	8.5	9.4
ED	7.0-8.5	7.8	7.5	7.1	7.4-7.8	6.7	7.8-8.5	7.6	9.0	10.8
HL	31.0-32.9	35.1	31.2	32.1	32.2-34.0	36.5	32.3-35.2	35.2	35.3	33.6
PAnL	49.3-57.1	57.1	56.2	56.0	54.4-56.4	56.7	58.5-59.4	57.9	59.7	61.5
IDo	33.8-37.1	35.1	32.5	36.9	34.4-35.1	35.6	34.4-39.1	35.2	35.3	36.5
IIDo	36.6-53.9	51.9	51.2	54.2	50.0-53.2	50.0	50.0-55.5	53.8	58.2	56.6
IIDt	85.9-87.3	88.3	86.2	86.9	85.6-89.4	86.5	83.6-86.7	85.5	85.1	87.7
Gap	2.8-5.6	2.6	1.3	2.3	1.2-2.1	2.9	N-3.9	2.8	2.5	3.3
Ao	54.9-60.0	59.7	57.5	58.3	55.6-58.5	59.6	58.6-62.5	60.7	62.2	64.8
Ai	71.8-74.3	74.0	73.8	73.8	71.1-72.3	73.1	70.3-75.8	73.1	73.1	75.8
P_2i	32.4-35.7	33.8	33.8	35.7	34.0-34.4	34.6	32.0-39.1	35.9	34.8	36.1
BDc	26.8-29.7	28.6	28.8	29.8	27.8-28.7	27.9	25.0-28.1	29.0	27.4	28.3
CpD	7.1-9.9	9.1	8.8	8.3	8.5-8.9	7.7	7.8-8.5	8.3	8.0	8.2

Table 18. Development of meristic characters of Micropogon undulatus.

NL/SL	ID	IID	A	P_1	P_2	C	pC	Preoperc	Posttemp
3.1	ff	ff	ff	bud	N	ff	0	0/1	0
3.5	ff	ff	ff	bud	N	ff	0	0.1	0
3.7	ff	ff	ff	bud	N	ff	0	2/2	0
4.8	ff	ff	ff	bud	N	1 + 2	0	2/2	0
4.0	ff	ff	ff	bud	N	ff	0	2/2	0
4.3	ff	ff	ff	bud	N	1 + 3	0	2/2	0
4.3	ff	ff	ff	bud	N	1 + 2	0	1/2	0
4.4	ff	23	8	bud	N	7 + 6	0	2/2	0
4.8	ff	ff	ff	bud	N	9 + 5	0		0
5.3	ff	21	I,8	bud	N	8 + 7	0		0
5.7	ff	20	7	bud	N	8 + 7	0	3/3	0
6.0	ff	23	8	bud	N	9 + 8	0	2/3	0
6.2	ff	27	II,7	bud	N	9 + 8	0	4/3	0
6.5	ff	24	8	bud	N	8 + 7	0	3/3	0
6.8	ff	27	II,7	bud	N	9 + 8	0	4/3	0
7.1	ff	26	II,8	bud	N	9 + 8	1,0	3/4	0
7.4	ff	27	II,8	bud	N	9 + 8	0	3/3	0
7.4	X	26	II,8	bud	N	9 + 8	0		0
7.8	IX	28	II,8	2	N	9 + 8	1,1	3/4	0
8.3	IX	28	II,8	3	N	9 + 8	3,3		1
8.4	X	I,28	II,8	bud	bud	9 + 8	0	3/4	1
8.9	X	30	II,8	bud	bud	9 + 8	3,2		2
9.4	X	28	II,7	5	I,1	9 + 8	4,5		2
10.1	X	I,29	II,8	5	I,3	9 + 8	5,4	4/4	1
10.2	X	I,30	II,8	6	I,3	9 + 8	5,3	4/3	1
11.8	X	I,29	II,8	14	I,5	9 + 8	5,3	4/5	3
11.9	X	I,28	II,8	16	I,5	9 + 8	4,4	5/5	3
13.4	X	I,29	II,8	16	I,5	9 + 8	N	6/5	4
15.8	X	I,29	II,8	17	I,5	9 + 8	6,5	5/5	3
17.5	X	I,30	II,8	16	I,5	9 + 8	8,7	5/5	3
21.5	X	I,29	II,8	17	I,5	9 + 8	8,7	4/6	5
21.8	X	I,28	II,8	17	I,5	9 + 8	9,7	4/5	5
24.0	X	I,27	II,8	18	I,5	9 + 8	8,8	3/4	several
33.0	X	I,27	II,8	18	I,5	9 + 8	7,7	3/4	several
42.5	X	I,29	II,8	18	I,5	9 + 8	8,8	3/4	several

and briefly described late larvae (11-12 mm) and juveniles (30-80 mm). Pearson (1929) described and illustrated a 6.5 mm larva and repeated Welsh and Breder's earlier information on the later stages. Hildebrand and Cable (1930) illustrated and described a series from 2.5 mm larvae to 110 mm juveniles. Their illustrations and descriptions are fairly accurate for specimens 4 mm and larger, in terms of body form, fin development, and pigmentation; however, their smallest specimen (2.5 mm) is distorted, and the details (particularly pigmentation) given for early larvae are not sufficient for separation of the larvae from those of L. xanthurus. Lippson and Moran (1974) repeated Hildebrand and Cable's (1930) illustrations and characters for early larvae and juveniles, but included accurate original illustrations (5.3, 7.7, 12.2 mm SL) by Peter Berrien which represent the best available for the species. Lippson and Moran also include characters for separation of larval M. undulatus from L. xanthurus. Fruge (1977) described and illustrated a series 1.7-10.5 m SL. His description matches our material quite closely except for some differences in fin development stages (earlier development of caudal fin rays in Fruge's description, most notably). Fruge (1977) gives useful comparative data on ventral visceral mass pigment in M. undulatus and Leiostomus xanthurus.

Pogonias cromis

Pogonias cromis - Black drum

Range - Gulf of Maine - Brazil (Chao, 1976)

Spawning Season -

Delaware Bay - April and May, possibly a second spawning in September (Thomas, 1971)

Chesapeake Bay - April and May (Joseph et al., 1964)

South Florida - November to March (Jannke, 1971)

Louisiana - March and April (Frank Truesdale, pers. comm.)

Texas - February to May, possibly a second spawning July to November (Pearson, 1929)

Spawning Area

Spawning occurs in coastal waters nearshore and possibly inside estuaries (Pearson, 1929; Joseph et al., 1964; Jannke, 1971). Jannke (1971) cited evidence of estuarine spawning from the literature but believed P. cromis to spawn outside estuaries of the Everglades. Pearson (1929) reported spawning at the seaward side of tidal passes, and Joseph et al. (1964) reported spawning in lower Chesapeake Bay. Truesdale and Birdsong took small larvae (2.6-5.8 mm) in a tidal pass in Louisiana (Frank Truesdale, pers. comm.).

Early Life History

Average size at maturity is about 350 mm, minimum 270 mm (Pearson, 1929). P. cromis reach about 320 mm after 2 years' growth (Simmons and Breuder, 1962). A female of 1100 mm total length contained 6,000,000 eggs (Pearson, 1929). Eggs, of diameter 0.8-1.0 mm in the plankton, take less than 24 hours to hatch at about 20°C (Joseph et al., 1964).

No larval P. cromis were taken by Joseph et al. (1964) in plankton hauls despite extensive collections at times and in areas of suspected spawning. Young specimens (8-15 mm SL) were taken in ditches and creeks of the Delaware Bay area by Thomas (1971), and were not found in deeper areas sampled by trawl. Juveniles (30-50 mm total length) were taken at seine stations along river edges, and minimum total length in trawl stations was 60 mm (Thomas, 1971). Frisbie (1961) also suggests that shallow estuarine waters are the nursery ground for young P. cromis.

Description of our Material

The following description is based on 5 specimens, 3.9-4.6 mm, from the Cape Fear River estuary and South Carolina estuaries. This limited material is identified as P. cromis because the specimens are Sciaenidae, are not other species, and agree with published descriptions (Pearson, 1929; Joseph et al., 1964).

Body form (Table 19). The larvae are slender for sciaenids, depth less than 25% SL. The dorsal fin base is longer than the anal fin base in larvae where these structures are present (4.4-4.6 mm), and a marked gap (10-12% SL) exists between the anus and anal fin origin, both characters suggesting that these larvae are Sciaenidae.

Fin development. Notochord flexion in the caudal region has begun in one of the two 4.6 mm specimens. The bases of the second dorsal and anal fins are present at 4.4-4.6 mm, but no fin elements are countable. The pectoral fin is present, with no differentiated rays, in all specimens. First dorsal and pelvic fins are not present.

Pigmentation. P. cromis larvae are extensively pigmented, much of their pigmentation being in large, stellate, branching melanophores.

In the head region, one melanophore is present at the tip of the lower jaw, and another on the interior surface of each lower jaw ramus. One melanophore is present in the ventral midline below the anterior margin of the eye at 4.6 mm, and at this size, a melanophore is present laterally on the premaxillary at about its midpoint. A large area of melanin is present on the ventral surface of the brain, posterior to the eye, in all specimens. Two melanophores are present on the preoperculum behind the eye in one 4.6 mm specimen. A melanophore is present at the angle of each lower jaw and one is present

Table 19. Development of body proportions of Pogonias cromis

NL/SL	3.9	3.9	4.4	4.6	4.6
n	1	1	1	1	1
SnL	7.0	5.0	4.4	8.5	7.7
ED	8.0	8.9	8.0	7.6	8.5
HL	26.0	27.7	28.3	28.0	N
PAnL	46.0	46.5	47.8	47.5	47.9
IDo	N	N	N	N	N
IIDo	N	N	44.2	46.6	49.6
IIDt	N	N	61.9	67.8	70.9
Gap	N	N	11.5	11.0	10.2
Ao	N	N	59.3	58.5	58.1
At	N	N	65.5	66.1	66.7
P_2l	N	N	N	N	N
BDc	23.0	24.8	24.8	23.7	24.8
CpD		4.0	4.4		5.1

anterior to the cleithral symphysis, in all specimens.

Diffuse melanin is present on the dorsal surface of the airbladder, and a large branching melanophore is present on the posterior surface of the visceral mass, dorsal to the anus. A large melanophore is present on the anterior surface of the visceral mass. In the ventral midline, two melanophores, one behind the other, are present posterior to the cleithral symphysis in all specimens but one of 3.9 mm; the anterior of the two is the larger. A melanophore is present on the anteroventral surface of the anus in all specimens.

In the dorsal midline of the body, one internal melanophore is present in the nape in all specimens. One or two large, branching melanophores are placed on the dorsal midline about halfway between the position of the anus and the notochord tip in all specimens but one of 3.9 mm; these melanophores are located along the posterior part of the second dorsal base in specimens in which this is developing.

In the midlateral line, three expanded stellate melanophores are placed in longitudinal sequence from just anterior to just posterior of the anus. One 3.9 mm specimen has two further stellate melanophores behind these three, while the other has no stellate melanophores in the midlateral line.

In the ventral midline, a series of about 5 large melanophores is located between the anus and the developing caudal fin. Some of these are stellate, branching dorsally almost to the midlateral line. A single melanophore is placed at the base of the ventral lobe of the developing caudal fin in all specimens.

Other Structures. Teeth are present in both jaws in all specimens except one of 3.9 mm. All specimens have preopercular spines, counts ranging from 1/0 (lateral, marginal) at 3.9 mm to 1/2-3 at 4.6 mm.

Published Developmental Descriptions

Pearson (1929) described and illustrated a series from 4.5 mm larvae to adults. Joseph et al. (1964) described and illustrated eggs, yolk-sac larvae, and later larval stages to 8.0 mm TL. Jannke (1971) illustrated larvae of 3.5 and 5.5 mm. The descriptions of Pearson (1929) and of Joseph et al. (1964) agreed with respect to fin development, body form, and pigment. Jannke's (1971) 5.5 mm specimen was somewhat more advanced with respect to fin development than specimens of the other authors at similar lengths, and although Jannke (1971) showed pigment in the same areas as Pearson (1929) and Joseph et al. (1964), he did not illustrate the branching nature of the melanophores characteristic of P. cromis in the other descriptions and our material.

Sciaenops ocellata

Sciaenops ocellata - Red drum

Range - Massachusetts to Texas (Hildebrand and Schroeder, 1928; Chao, 1976)

Spawning Season -

East coast United States - late fall and early winter (Welsh and Breder, 1923)

Chesapeake Bay - August to November, possibly somewhat later (Hildebrand and Schroeder, 1928; Mansueti, 1960; Joseph et al., 1964)

South Florida - September to February (Jannke, 1971)

Louisiana - September to November (Sabins, 1973)

Texas - September to November (Pearson, 1929)

Spawning Area

Spawning occurs outside estuaries in coastal waters nearshore (Pearson, 1929; Mansueti, 1960; Jannke, 1971).

Early Life History

Late larvae and early juveniles are found in grassy areas of estuaries, seldom over bare sand bottoms; minimum and mean sizes of young increase with distance from the sea within estuaries. At 50-150 mm, young fish move from the grassy areas to deeper estuarine areas. Size at maturity is about 800 mm. A female of 900 mm total length had 3,500,000 eggs (Pearson, 1929).

Description of our Material

The following description is based on nine specimens from the Cape Fear River estuary and from South Carolina estuaries, 4.1-7.9 mm. This material is relatively limited, so the description may not include all variations which may occur in the larvae.

Body form (Table 20). Larval S. ocellata of the sizes available are slim-bodied, body depth less than 32% SL. The second dorsal fin base is longer than the anal base in all specimens available, facilitating identification to the family Sciaenidae. The gap between anus and anal fin, 10.2-12.3% SL in larvae of 4.1 and 5.2 mm, decreases to 5.1-7.1% SL in larvae 6.5-7.9 mm. Other body proportions remain rather constant over the size range available.

Fin development (Table 21). Notochord flexion, occurring at 4.1 mm, is complete by 5.2 mm. Principal caudal rays are present in all specimens available and are complete (9 + 8 rays) at $\geq$ 6.5 mm. Procurrent caudal rays (4 dorsal, 1 ventral) are first seen in the largest specimen, 7.9 mm.

Table 20. Development of body proportions Sciaenops ocellata.

NL/SL	4.1	5.2	6.1	6.2	6.2	6.5	6.5	7.0	7.9
n									
SnL	10.4	7.8	8.8	9.2	6.7	8.9	8.9	10.6	8.9
ED	9.4	9.4	8.8	9.2	9.3	10.1	10.1	8.2	9.4
HL	33.0	29.7	33.8	*	33.3	34.2	34.2	32.9	34.4
PAnL	51.9	50.0	54.1	53.9	52.0	53.2	54.4	54.1	55.2
IDo	N	37.5	37.8	38.2	40.0	39.2	38.0	38.8	36.5
IIDo	53.8	50.0	54.1	53.9	53.3	53.2	55.7	54.1	53.1
IIDt	75.5	81.3	85.1	84.2	86.7	84.8	83.5	84.7	85.4
Gap	12.3	10.2	6.7	7.9	10.7	7.6	5.1	7.1	5.2
Ao	64.2	60.2	60.8	61.8	62.7	60.8	59.5	61.2	60.4
At	73.6	75.0	74.3	75.0	70.0	74.7	74.7	75.3	75.0
P_2i	N	32.8	33.8	34.2	34.7	39.2	32.9	35.3	35.4
BDc	31.1	29.7	28.4	28.3	26.7	29.1	29.1	26.5	28.1
Cpd	7.5	7.8	8.9	7.9	8.0	8.9	8.9	8.2	9.4

Table 21. Development of meristic characters of Sciaenops ocellata.

NL/SL	ID	IID	A	P_1	P_2	C	pC	Preoperc
4.1	ff	14	5	bud	N	8 + 6	0	2/1
5.2	ff	-22	7	bud	bud	7 + 6	0	2/2
6.1	VI	I,25	II,8	bud	bud	8 + 8	0	3/3
6.2	IX	I,24	II,8	bud	bud	8 + 6	0	2/3
6.2	V	I,24	I,8	bud	bud	9 + 7	0	3/3
6.5	VIII	I,25	II,8	bud	bud	9 + 7	0	3/3
6.5	IX	I,22	II,8	bud	bud	9 + 8	0	4/4
7.0	X	I,25	II,8	bud	bud	9 + 8	0	4/4
7.9	X	I,25	II,8	6	bud	9 + 8	4,1	4/5

Soft dorsal and anal fin bases with fin elements are developed in all specimens (Table 20). The adult second dorsal and anal complements are complete by 6.1 mm (except for one 6.5 mm specimen with 22 second dorsal rays and a 6.2 mm specimen with one anal spine). First dorsal spine counts are complete at 7.0 mm. The pelvic fin first appears at 5.2 mm; no fin elements are developed in this fin through 7.9 mm. The pectoral fin, present in all specimens, first has developed elements (6) at 7.9 mm.

Pigmentation. S. ocellata larvae are extensively pigmented. Particularly notable in all specimens is a series of about 10 internal melanophores associated with the dorsal surface of the developing vertebral column. These melanophores are placed one per myomere and extend from the position of the anus to the caudal peduncle.

In the ventral midline, a melanophore is present between the anus and the anal fin origin in all specimens except that of 7.9 mm. Specimens $\geq$ 5.2 mm have one or two melanophores along the anal fin base. All specimens have one or two melanophores at the posterior end of the anal base; these frequently branch dorsally to the midlateral line. Between the anal base and the caudal fin base, two melanophores are present throughout the series. A single melanophore is present at the base of the ventral lobe of the caudal fin throughout the series. In the dorsal midline, a pigment spot is present at the origin of the second dorsal and another above the position of the anal fin termination in all specimens; these spots are made up of both internal and external pigment. An exterior melanophore is placed on the nape in all specimens in which the spinous dorsal fin is present ($\geq$ 5.2 mm). In the midlateral line, a branching melanophore is present on the body surface above the position of the anus in most larvae; this is usually present at < 6.5 mm and always present at $\geq$ 6.5 mm.

On the premaxillary, one melanophore at the symphysis and one on the lateral surface are present in all specimens. The maxillary has one melanophore, below the anterior margin of the eye, in specimens $\geq$ 5.2 mm. One melanophore is placed in the ventral midline, between the lower jaw rami, in all specimens.

The ventral surface of the brain, posterior to the eye, has a large patch of melanin in all specimens. One or two melanophores are present on the lateral surface of the brain, at the midbrain-hindbrain junction, at $\geq$ 7.0 mm. Above the eye, on the surface of the head, one melanophore is present in about half our specimens, and posterior to the eye, medial to the surface of the preoperculum, one or two melanophores are present in all specimens $\geq$ 5.2 mm. A melanophore is present at the angle of the lower jaw and another anterior to the cleithral symphysis in all specimens.

Diffuse melanin is present internally on the dorsal and posterior surfaces of the airbladder and on the posterior surface of the visceral mass in all specimens. One internal melanophore is placed on the anterior surface of the visceral mass between the cleithra throughout the series. In the ventral midline, all specimens have a melanophore at the position of the pelvic fin insertion and one on the anteroventral surface of the anus.

Other Structures. Small lateral and marginal preopercular spines are present in all specimens (Table 21). These increase in number with growth, 4/4-5 (lateral/marginal) being present in the three largest larvae available. The marginal spines are larger than the lateral; these are not, however, as large as in B. chrysura or S. lanceolatus. Small teeth are present on the premaxillary and dentary throughout the series.

Published Developmental Descriptions

Pearson (1929) described and illustrated larvae and juveniles from 4.0 mm to 42 mm. His specimens of 4.5 mm and 7.0 mm agree fairly well with our material in median fin development. However, he showed no pelvic fins at 7.0 mm, and a rudiment of broken branchiostegal rays in his illustration might be interpreted as a jugular pelvic fin. Body proportions in his figures indicate distortion. Pigmentation on the body surface shown by Pearson (1929) is similar to that in our specimens, and his description is adequate for separation of S. ocellata larvae from other sciaenid larvae on this character. However, he did not show the internal pigment associated with the notochord which is very evident in our material. Head and visceral mass pigment and preopercular spination observed by us were not shown or specifically described by Pearson.

Jannke (1971) illustrated larvae of 3.5 mm and 6.5 mm. Jannke's (1971) illustrations agree with our specimens in body proportions, preopercular spination, and fin development. He illustrated 10 + 8 principal caudal rays, 7 anal rays, and 22 dorsal rays; these counts appear from the drawing to be complete, but they are not characteristic of adult S. ocellata (Table 1). Melanophores associated with the vertebral column are shown in both of Jannke's illustrations, as is pigmentation at the posterior end of the anal fin base, but much pigmentation on the body surface, visceral mass, and head seen in our specimens is not shown by Jannke (1971). Thus, the illustrations of Jannke (1971) and of Pearson (1929) are not in agreement, but show characters in common with our material which permit confirmation of their identifications as S. ocellata.

Stellifer lanceolatus

Stellifer lanceolatus - Star drum

Range - Chesapeake Bay to Texas, possibly to Mexico (Hildebrand and Cable, 1934)

Spawning Season -

Chesapeake Bay - late spring and early

summer (Hildebrand and Schroeder, 1928)

Beaufort, North Carolina - May or June to August (Hildebrand and Cable, 1934)

South Carolina - smallest juveniles caught July to October (Shealy et al., 1974)

Georgia - May and June to September (Dahlberg, 1972)

Louisiana - May to June, August and October (Frank Truesdale, pers. comm.)

Spawning Area

Most larvae were taken between the coast and 13-22 km (7-12 miles) offshore, few in estuaries by Hildebrand and Cable (1934). Small larvae are, however, frequently taken in estuaries of South Carolina (Estuarine Survey unpublished data). Small specimens (minimum 2.4 mm) were taken in a tidal pass in Louisiana (Frank Truesdale, pers. comm.).

Early Life History

Larvae were taken only in bottom plankton tows, not in surface tows, by Hildebrand and Cable (1934); however, larvae have been taken in both surface and bottom hauls in South Carolina estuaries (Estuarine Survey unpublished data). S. lanceolatus first mature at age 1 year, at a length of 80 mm (Welsh and Breder, 1923).

Description of our Material

The following description is based on 26 specimens, 2.8-15.1 mm, from South Carolina estuaries and tidal passes.

Body form (Table 22). Body proportions change slowly with development. Depth at the cleithral symphysis decreases gradually from 35.0-41.2% SL at 2.9-3.9 mm to 33.3-35.8% SL at 13.0-15.1 mm. Preanus length increases slightly, from 41.2-47.1% SL at 2.9-3.9 mm to 54.2-57.8% SL at 13.0-15.1 mm. Distance from the anus to the anal fin origin, 13.3-21.5% SL in larvae of 2.9-3.9 mm, also decreases gradually with growth to 12-16% SL at 4.0-6.9 mm and to 6.5-9.7% SL at 13.0-15.9 mm.

Fin development (Table 23). Bases of the second dorsal and anal fins are visible in all specimens. Pterygiophores in the second dorsal are countable (10) at 3.1 mm, and the adult complement of 20-24 rays is present at $\geq$ 5.5 mm. Anal fin pterygiophores are countable (8) at 3.3 mm; adult complements of II, 8-9 elements are present in specimens of $\geq$ 4.5 mm. The spinous dorsal fin is first visible at 4.1 mm, and adult spine counts of XII are consistently present at $\geq$ 6.9 mm.

The notochord flexes at 3.3-4.3 mm. The full principal ray complement (9 + 8) is present at $\geq$ 4.5 mm. Procurrent caudal rays first appear at 5.1 mm and the adult complement is present at $\geq$ 10.2 mm.

The pelvic fin bud first appears in a specimen of 4.5 mm and is consistently present at $\geq$ 5.8 mm. The adult count (I,5) is present in specimens $\geq$ 7.4 mm. The pectoral fin is present in all specimens; rays are first seen at 6.9 mm with the ray complement complete in specimens of $\geq$ 14.0 mm.

Pigmentation. In the smallest larvae available, $\leq$ 3.1 mm, a row of five melanophores is present in the ventral midline between the anus and the notochord tip; one or two melanophores two-thirds of the way from anus to notochord tip are expanded laterally. In all specimens > 3.1 mm a large melanophore is present at the posterior end of the anal fin base. This melanophore branches dorsally in most specimens, often as far as the midlateral line. In most specimens > 3.1 mm a melanophore is also placed at the anterior end of the anal base. One to three melanophores are present posterior to the anal base in most specimens 3.3-6.2 mm; no pigment is present in this area at 6.2-10.2 mm, and at > 10.2 mm, three or four melanophores are again present here. An external melanophore is present in the dorsal midline dorsal to the melanophore at the posterior end of the anal base in most specimens 2.9-6.2 mm. A small, faint pigment spot is present in the midlateral line above the melanophore at the posterior end of the anal base in some specimens 3.1-5.5 mm. A single melanophore is present at the base of the inferior lobe of the caudal fin at $\geq$ 3.1 mm.

A large, internal melanophore is present on the anterior surface of the visceral mass, between the cleithra, throughout development. A similar large melanophore is present internally on the posterior surface of the visceral mass, dorsal to the anus, at $\geq$ 4.1 mm; this melanophore becomes extensively branched at $\geq$ 6.9 mm, and additional, branched, internal melanophores appear anterodorsal and posteroventral to this one, on the posterior surface of the visceral mass, at $\geq$ 10.2 mm. On the ventral surface of the visceral mass, a melanophore is present midway from the cleithral symphysis to the anus at 2.9-6.2 mm (between pelvic fin bases at sizes where the pelvics are present), and a second melanophore is present on the anteroventral surface of the anus at 2.9-5.8 mm.

In small larvae ($\leq$ 3.8 mm) pigment is also present externally in the dorsal midline and internally (associated with the notochord) above the visceral mass. In specimens < 5.5 mm a melanophore is placed on the body surface at its junction with the dorsal edge of the pectoral fin. Pigment is found at the angle of the lower jaw in specimens smaller than 6.2 mm and anterior to the cleithral symphysis throughout our series. A characteristic internal area of pigment at the upper end of the operculum, in the otic region, is present in all specimens $\geq$ 7.4 mm. This area appears to roof a cavity between the body wall and the hindbrain (possibly the otic capsule).

Table 22. Development of body proportions of Stellifer lanceolatus.

NL/SL	2.8-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	10.2	13.0-13.9	14.0	15.1
n	2	6	4	4	2	3	1	2	1	1
SnL	8.2-9.3	5.9-9.0	7.5-8.7	7.0-9.7	8.0-8.3	7.4-10.0	8.8	9.3-10.6	9.0	10.1
ED	10.7-11.0	9.3-12.9	9.5 - 11.8	10.4-14.1	8.0-9.5	8.6-10.6	9.6	7.2-9.0	9.0	8.9
HL	30.1-33.3	27.8-36.8	31.1-34.7	31.0-35.5	32.0-34.5	32.6-37.8	38.4	38.5-39.7	37.3	38.9
PAnL	45.2-45.3	41.2-47.1	42.9-48.7	43.3-48.4	45.2-46.7	45.3-54.4	55.2	54.2-57.6	55.4	57.8
IDo	N	N	N,35.7-39.6	32.8-35.5	34.7-36.9	35.8-41.1	40.0	38.5-38.5	36.2	36.7
IIDo	N-50.6	N,49.4-61.2	53.6-57.4	49.3-56.4	54.7-54.7	53.6-56.7	59.2	58.9-59.0	54.1	55.5
IIDt	N-66.7	N,70.1-90.5	81.8-86.8	80.6-90.0	82.1-82.7	83.2-86.0	85.6	85.5-85.9	85.5	84.5
Gap	N-13.3	N,13.8-21.5	12.1-19.0	11.9-15.5	12.0-14.3	8.9-12.6	8.8	6.5-9.7	8.4	7.7
Ao	N - 58.6	N,58.8-65.8	60.4-61.8	58.2-61.3	58.7-59.5	59.1-63.3	64.0	63.9-64.1	63.8	65.5
At	N-69.3	N,73.2-84.7	77.3-80.2	76.1-79.1	76.0-76.2	76.3-79.0	79.2	78.2-78.3	78.3	77.7
P_2i	N	N	N,30.2-37.4	N-35.5	29.7-32.0	30.5-31.1	38.4	36.1-39.7	38.5	38.9
BDc	37.0-37.3	35.0-41.2	36.5-40.8	32.4-38.7	33.3-36.0	34.4-37.8	36.0	33.7-35.8	33.7	33.3
CpD	6.7-6.8	6.2-10.1	8.7-11.3	8.5-9.7	9.3-9.5	9.5-10.0	5.6	9.0-9.6	9.6	8.9

Table 23. Development of meristic characters of Stellifer lanceolatus.

NL/SL	ID	IID	A	P_1	P_2	C	pC	Preoperc	Posttemp
2.8	ff	ff	ff	bud	N	ff	0	1/3	0
2.9	ff	ff	ff	bud	N	ff	0	2/3	0
3.1	ff	10	ff	bud	N	2 + 2	0	3/3	0
3.1	ff	ff	ff	bud	N	ff	0	2/3	0
3.3	ff	15	8	bud	N	6 + 6	0	3/3	0
3.4	ff	19	7	bud	N	4 + 5	0	3/3	0
3.5	ff	ff	ff	bud	N	8 + 7	0	2/3	0
3.8	ff	18	8	bud	N	8 + 7	0	2/3	0
4.1	ff	17	I,8	bud	N	8 + 7	0	4/4	0
4.3	ff	19	8	bud	N	8 + 6	0	3/3	0
4.5	II	21	II,8	bud	N	9 + 8	0	4/4	1
4.9	ff	20	I,8	bud	bud	9 + 7	0	3/4	1
5.1	V	19	II,8	bud	N	9 + 8	1,1	4/4	1
5.5	ff	19	I,8	bud	N	8 + 7	0	3/3	1
5.5	ff	22	II,9	bud	N	9 + 8	1,1	4/4	1
5.8	ff	22	II,8	bud	N	9 + 8	0	3/4	0
6.2	VII	22	II,8	bud	bud	9 + 8	2,2	4/4	1
6.9	XII	22	II,8	7	I,4	9 + 8	4,3	4/4	1
7.4	XII	23	II,8	13	I,5	9 + 8	4,4	4/4	1
7.6	XII	22	II,8	7	1,3	9 + 8	5,4	4/4	1
7.8	XI	22	II,8	13	1,5	9 + 8	6,4	5/4	1
10.2	XI	I,23	II,8	19	1,5	9 + 8	8,8	6/5	4
13.1	XI	1,22	II,8	19	1,5	9 + 8	9,8	7/5	4
13.9	XI	I,22	II,8	15	1,5	9 + 8	9,8	6/4	4
14.0	XI	I,23	II,8	19	1,5	9 + 8	9,8	7/4	4
15.1	XI	I,21	II,8	20	1,5	9 + 8	9,8	8/5	4

Further external and internal pigment develops in the head region, laterally on the body surface, and in the fin membranes in specimens larger than 10.2 mm. A row of 4-8 melanophores is present on the surface of the body between the first dorsal base and the visceral mass at 13.1-14.0 mm, and by 15.1 mm this area has many small scattered melanophores. Four clusters of small melanophores are present in the dorsal midline at 13.1 mm and persist through 15.1 mm; one is placed anterior to the first dorsal origin, one midway along the first dorsal base, one at the second dorsal origin, and one midway along the second dorsal base. A few small melanophores appear in the first dorsal membrane at 13.1 mm and in the second dorsal membrane at 15.1 mm. Small melanophores at the tip of the caudal fin appear at 13.1 mm. At 14.0 mm, a few internal melanophores appear scattered around the midlateral line dorsal to the anal fin base. By 15.1 mm, pigmentation is not particularly heavy and is localized in the areas described above.

Other Structures. Lateral and marginal preopercular spines are present throughout development. The marginal spines, numbering 3-4 at 2.9-7.8 mm, are larger than the lateral and are rather well-developed at all sizes. Teeth are present on the premaxillary and dentary at all sizes. A posttemporal spine appears at 5.1 mm and is present until 7.8 mm. A gap exists in our series between 7.8 and 10.2 mm; in specimens 10.2 mm and larger a "scale bone" with 4 spinous points is present in the posttemporal region.

Published Developmental Descriptions

Hildebrand and Cable (1934) described and illustrated a series 1.8-85 mm, including Welsh and Breder's (1923) figures of 29 mm and 164 mm juveniles, with their original illustrations of specimens 1.8-13.0 mm. The early larvae (lengths 1.8-3.5 mm) described by Hildebrand and Cable (1934) as S. lanceolatus have pigment of the brain and pectoral fin, and early developing pectoral rays characteristic of Larimus fasciatus; the body proportions given by these authors correspond more closely to our L. fasciatus than to our S. lanceolatus. Their illustrations of larvae 1.8, 2.5 and 3.3 mm do not correspond to their description in terms of pigment, and represent neither L. fasciatus nor S. lanceolatus as we know them. Hildebrand and Cable's (1934) description of later larvae corresponds fairly well to our observations with respect to body proportions, preopercular spination, and development of fins. The description includes most of the pigment we have seen in our material, with the exception of an external melanophore in the dorsal midline, dorsal to a prominent spot at the posterior end of the anal fin. This is present in almost all our specimens below 7.0 mm but was rarely present in those of Hildebrand and Cable (1934). Their illustrations of late larvae correspond somewhat better to their description than do those of the small larvae.

Umbrina coroides

Umbrina coroides - Sand drum

Range - Florida and the Bahamas to Brazil, including Gulf of Mexico (Bohlke and Chaplin, 1968; Chao, 1976). One specimen recorded from Chesapeake Bay (Hildebrand and Schroeder, 1928)

Spawning Season - No information

Spawning Area - No information

Early Life History

No information. This species is probably rare in the South Atlantic Bight; we know of no records north of Florida except the Chesapeake Bay specimen noted above. U. coroides inhabits shallow waters along sand beaches (Bohlke and Chaplin, 1968). We have identified no larval, juvenile or adult specimens in any of our collections.

Summary and Discussion

Published information on spawning seasons, based on both observations of gonad condition and of presence of eggs and larvae, is available for all but five species of South Atlantic Bight sciaenids (four species of Equetus and Umbrina coroides). Most sciaenids of the area can be characterized as winter or summer spawners (Table 24). Two species are winter spawners; nine are summer spawners. Of the nine summer spawners, eight have spawning seasons starting in late spring. Two species cannot be characterized as summer or winter spawners: Sciaenops ocellata spawns in fall, and Pogonias cromis has been reported to spawn at various times throughout the year.

Published information on egg and larval distributions and on migrations of adults before the spawning season indicates that spawning of sciaenids may occur in estuarine, coastal, and continental shelf waters (Table 25). Four species spawn in estuarine and coastal waters. Five species are reported to spawn outside estuaries, probably in coastal waters. Eight species are supposed to spawn some distance from shore in continental shelf waters. For Leiostomus xanthurus and Micropogon undulatus the supposition is well supported. Small larvae (< 5 mm SL) of Cynoscion nothus and Larimus fasciatus have been taken in shelf waters in MRRI-MARMAP bongo and neuston tows. Equetus spp. are permanent inhabitants of shelf waters in the South Atlantic Bight and thus almost certainly spawn there.

All species for which eggs are known spawn planktonic eggs, and, from fecundity data and the absence of reports of demersal spawning, it is to be expected that this spawning pattern is characteristic of the family. Larvae are planktonic in all sciaenids in which the larvae are known, except for Equetus; the three larval Equetus known were collected on the bottom. In many species, larvae are reported to be more abundant in water near bottom than in

Table 24. Spawning seasons of South Atlantic Bight Sciaenidae

WINTER SPAWNERS -		
	Fall - Winter:	*Micropogon undulatus*
	Winter:	*Leiostomus xanthurus*
SUMMER SPAWNERS -		
	Spring - Summer:	*Bairdiella chrysura*
		Cynoscion nebulosus
		Cynoscion regalis
		Menticirrhus americanus
		Menticirrhus littoralis
		Menticirrhus saxatilis
		Stellifer lanceolatus
	Summer - Fall:	*Larimus fasciatus*
	Spring - Summer - Fall:	*Cynoscion nothus*
FALL SPAWNERS -		
	Fall:	*Sciaenops ocellata*
QUESTIONABLE -		*Pogonias cromis*
NO DATA -		*Equetus* spp.
		Umbrina coroides

Table 25. Spawning areas of South Atlantic Bight Sciaenidae

ESTUARINE AND COASTAL -	Bairdiella chrysura
	Cynoscion nebulosus
	Cynoscion regalis
	Pogonias cromis
COASTAL -	Menticirrhus americanus
	Menticirrhus littoralis
	Menticirrhus saxatilis
	Sciaenops ocellata
	Stellifer lanceolatus
CONTINENTAL SHELF -	Cynoscion nothus
	Equetus spp.
	Larimus fasciatus
	Leiostomus xanthurus
	Micropogon undulatus
NO DATA -	Umbrina coroides

surface waters, and it has been hypothesized (e.g. Mansueti, 1960) that presence of larvae in bottom water accounts for upstream transport in estuarine bottom currents. Larvae of offshore-spawning species, however, have been found in large numbers in MRRI-MARMAP neuston tows in continental shelf waters.

Family Characters of Larvae

Larval sciaenids can be characterized as unspecialized perciform larvae, with myomere counts of 24-27. They lack the specialized larval characters (e.g. highly developed head and fin spines and exotic body shape) found in many other perciform and non-perciform larvae. Thus, identification of larvae to the family level may be to a considerable extent a matter of elimination of non-sciaenid larvae.

Body proportions are sufficiently similar in larvae of all species to be of limited usefulness in separating genera and species. Body depth is rather similar in the early stages (depth at cleithral symphysis ca. 30% SL at < 3.5 mm) but in later stages larvae fall roughly into a deep-bodied group (depth at cleithral symphysis greater than 32% SL in Bairdiella chrysura, Cynoscion nothus, Larimus fasciatus and Stellifer lanceolatus) and a shallow-bodied group (depth at cleithral symphysis less than 32% SL in Cynoscion nebulosus, Leiostomus xanthurus, Micropogon undulatus, Pogonias cromis, and Sciaenops ocellata); body depths of Cynoscion regalis are intermediate between those of the two groups.

Fins develop early, with the full complement of dorsal and anal soft rays present before 10 mm in all species we have seen. Fin development sequence is that of most larval teleosts, with full complements of elements developing usually in the following sequence - anal and dorsal rays, principal caudal rays, dorsal spines, pelvic spine and rays, pectoral rays, procurrent caudal rays. In Equetus the spinous dorsal and the pelvic fins develop early and are well-developed at the time of notochord flexion. In Larimus fasciatus, pectoral ray development begins relatively early, simultaneously with notochord flexion. In all species, bases of the soft dorsal and anal begin development early (< 5 mm). In adults, the soft dorsal base is at least twice as long as the anal base and the soft dorsal base has at least twice as many rays as the anal. In all larvae in which bases of these fins are developed, the soft dorsal base is noticeably longer than the anal, and this represents a good character for family-level identification. Presence of one or two anal spines, an adult character, is not a good larval character since in larvae of many perciform families with three anal spines the third spine develops from a ray in the late larval stages. In larvae of most sciaenids we have seen (except Menticirrhus sp. and Cynoscion nebulosus), there is a marked gap between the anus and anal fin origin; this gap is found in larvae of few other perciform families (e.g. Gerreidae, Scombridae).

Preopercular spines are present in all species we have seen, but in many the spines are small and in none are they as well developed as in, for example, larval Carangidae and Lutjanidae.

Pigmentation ranges from sparse to moderately heavy and extensive. Early sciaenid larvae (< 3.5-4.0 mm) have, like many other larvae, a row of melanophores in the ventral midline from the anus to the caudal finfold; with development, melanophores of this row become less numerous and form characteristic sequences in relation to the anal fin base which are useful in separating genera and species. Pigment characters common to most larvae of the family are shared with larvae of other families and include melanophores at the angle of the lower jaw and anterior to the ventral symphysis of the cleithra; on the dorsal, posterior and ventral surfaces of the visceral mass; on the ventral surface of the brain; and at the base of the ventral lobe of the caudal fin. Pigment on the anterior surface of the visceral mass and internally in the musculature of the nape is somewhat better developed in sciaenid larvae than in other larval fishes of our area. Although pigment, which degrades with storage, is not generally the most reliable character for separation of larval fishes, it is necessary to rely to a considerable extent on pigment for generic and specific identifications in larval sciaenids of our area. Thus, sorting samples of larval Sciaenidae should be performed as soon after collection as possible.

Families whose larvae may be confused with those of the Sciaenidae include the Apogonidae, Gerreidae, Pomacentridae, Sparidae and Stromateidae. Apogonid, pomacentrid, and stromateid larvae might be confused with sciaenid larvae in the early stages. Myomere counts are higher (> 30) in stromateids of our region than in the sciaenids. Apogonid larvae develop dorsal and anal fins early (ca. 5 mm); the two dorsal fins are separated, length of the second dorsal fin base is short, and second dorsal counts are low (≤ 10) in apogonids of our region. Pomacentrid larvae also develop second dorsal and anal fins early (ca. 5 mm); lengths and counts of these fins are approximately equal, in contrast to the sciaenids. Sparid and gerreid larvae of our area are somewhat slimmer-bodied than the deeper-bodied sciaenid larvae but might be confused with slender-bodied sciaenids in the later stages; however, fin element counts and the space between successive rays should separate the families in these stages. Gerreid larvae have distinct melanophores in the dorsal midline posterior to the second dorsal fin which we have not observed in larval sciaenids. Sparid larvae have a shorter anus-anal fin gap than most sciaenid larvae and many we have seen lack the melanophore at the angle of the lower jaw characteristic of larval sciaenids.

Synopsis of Generic and Specific Characters

Characters used in this synopsis are

derived from our observations rather than literature descriptions, except for fin counts and a few exceptions noted. We emphasize characters for separation of early larvae (those without complete dorsal and anal ray counts), since identification of late larvae is facilitated by fin counts. Species are placed in this synopsis in approximate order of decreasing body depth. Lengths of specimens seen by us are given in parentheses following the species name. The term "tail" refers to that part of the body posterior to the anus.

Equetus spp. (4.4, 6.3, 7.6 mm)

Spinous dorsal and pelvic fins develop precociously (well-developed at 4.4 mm); dorsal ray pterygiophores > 35 at ≥ 4.4 mm. Pigment anterior to eye, on operculum, on spinous dorsal and pelvic fins well-developed at ≥ 4.4 mm. Known specimens collected in benthic, not planktonic, habitat. Dorsal rays complete at 7.6 mm; anal rays complete at 6.3 mm. BDc 37.7-42.7% SL; dorsal rays 36-55, anal rays 5-8.

Resemble no other larval Sciaenidae of our area.

Larimus fasciatus (3.0-5.9 mm)

Melanophores on anterior and posterior surfaces of midbrain (encircling the midbrain), anterior surface of forebrain, and dorsal surface of hindbrain very pronounced at all sizes. Pectoral fin pigmented at all sizes. Rows of melanophores present on body surface between first dorsal fin base and visceral mass at ≥ 4.4 mm. Melanophore at anterior end and one at posterior end of anal base at ≥ 3.2 mm. Soft dorsal and anal rays complete at 4.9 mm; pelvic fins first present at 3.6 mm, pectoral rays first present at 3.6 mm (earlier than all other species). BDc 33.7-50.6% SL; dorsal rays 24-27, anal rays 5-8.

Resembles no other larval Sciaenidae of our area.

Bairdiella chrysura (3.1-8.8 mm, 24.1 mm)

Swath of internal and external pigment from nape to cleithral symphysis present in all specimens, more pronounced in those ≤ 4.9 mm since melanophores of the swath more expanded at these sizes and thickening body wall obscures internal pigment in larger larvae; nape pigment tends to outline several myomeres. Pigment of ventral midline consists of a row of 10 melanophores at ≤ 3.8 mm; a melanophore at the anterior end and one at the posterior end of the anal fin base in all specimens ≥ 4.3 mm; a melanophore in the anus-anal fin gap at 4.3-5.7 mm; additional melanophores along the anal base at > 7.0 mm. Second dorsal and anal rays complete at 5.7 mm; pelvic buds first present at 5.7 mm; pectoral rays first present at 5.7 mm. BDc (larvae) 30.8-39.3% SL; dorsal rays 19-23, anal rays 8-10.

Resembles Stellifer lanceolatus, Cynoscion nothus, Cynoscion regalis; differentiated from these by presence of pigment swath and by pigment of ventral midline of tail.

Stellifer lanceolatus (2.9-15.1 mm)

Pigment in ventral midline of tail consists of a prominent melanophore at the posterior end of the anal base, usually branching dorsally, often to the midlateral line; a smaller melanophore at the anterior end of the anal base; and 1-3 small melanophores posterior to anal base; no melanophore in the anus-anal fin gap. Melanophore in dorsal midline above prominent anal-fin spot present in most specimens 2.9-6.9 mm; no spot in this position 7.4-13.1 mm; pigment again present here in larger specimens. Pigment in midlateral line (faint external branches from prominent melanophore at posterior end of anal base) present in many. Internal pigment area at dorsal junction of operculum with body wall at ≥ 7.4 mm. Internal spots along notochord above anal fin base present at ≥ 14.0 mm. Anal rays complete at 4.5 mm, dorsal rays at 5.5 mm; pelvic buds first present at 4.5 mm, consistently from 5.8 mm; pectoral rays first present at 6.9 mm. BDc 32.4-41.2% SL; dorsal rays 20-24, anal rays 7-9.

Resembles Bairdiella chrysura, Cynoscion nothus, Cynoscion regalis; differentiated by pigment of ventral midline of tail and absence of swath of pigment at the nape.

Cynoscion regalis (2.7-12.2, 25.5 mm)

Pigment in ventral midline (> 3.5 mm) consists of a melanophore in the anus-anal fin gap in specimens ≤ 4.7 mm, a melanophore midway along the anal base, 0-3 small melanophores posterior to the anal base, and (≥ 9.4 mm) a melanophore at the anterior end of the anal base. Melanophore in dorsal midline at second dorsal fin termination present at all sizes. External pigment in midlateral line at ≥ 5.9 mm; internal pigment dorsal to anteriormost vertebrae at < 5.9 mm, dorsal to all abdominal vertebrae at ≥ 5.9 mm, dorsal to all but vertebrae of caudal peduncle at ≥ 12.2 mm. Posterodorsal outline of visceral mass with a posterior hump dorsal to the anus. Dorsal rays complete 4.8 mm, anal rays 5.0 mm; pelvic buds first present 4.3 mm, consistently from 5.0 mm; pectoral rays first present 6.7 mm, consistently from 8.3 mm. BDc 29.3-43.2% SL; dorsal rays 24-29, anal rays 10-13.

Resembles Bairdiella chrysura, Cynoscion nothus, Stellifer lanceolatus; differentiated by pigment of tail and

absence of pigment swath at nape.

Cynoscion nothus (2.7-9.7, 55.7 mm)

Pigment in ventral midline posterior to anus (≥ 3.8 mm) consists of a melanophore in the anus-anal fin gap, one at anterior end of anal base, 1-2 at posterior end of anal base, none-three posterior to anal base. Pigment in midlateral line and in dorsal midline along second dorsal fin present at ≥ 9.7 mm. Anteroventral outline of visceral mass with a pronounced anterior hump. Dorsal rays complete 5.4 mm, anal rays 5.7 mm; pelvic buds first present at 4.1 mm, consistently from 5.1 mm; pectoral rays first present at 6.6 mm. BDc 28.6-42.3% SL; dorsal rays 24-31, anal rays 8-11.

Resembles Bairdiella chrysura, Cynoscion regalis, Stellifer lanceolatus; differentiated by pigment of tail and absence of pigment swath at nape.

Menticirrhus sp. (2.5-19.3 mm)

Heavily pigmented. Row of external melanophores with inward extensions on lateral midline of tail, row in ventral midline at ≥ 2.8 mm, row in dorsal midline continuous at ≥ 6.1 mm. Anus-anal fin gap short, ≤ 5% SL in all specimens. At > 8 mm, pigment of body surface consists of well-branched melanophores, giving uniform dusky appearance; no discrete pigment lines. No melanophore in ventral midline anterior to cleithral symphysis; 1-4 well-defined melanophores on nape at ≤ 3.6 mm, one at > 3.6 mm; well-defined melanophore on or near cleithrum at dorsal end of pectoral axil in > 75% of specimens; no pigment in ventral midline in anus-anal fin gap in most specimens ≥ 3.4 mm, pigment present here at < 3.4 mm; melanophores in ventral midline discrete; BDc usually > 30% SL at < 4 mm. Dorsal rays complete 4.4 mm, anal rays 4.6 mm; pelvic buds first present 4.1 mm; pectoral rays first present 6.8 mm. BDc 27.4-38.5% SL; dorsal rays 19-27, anal rays 6-9.

Closely resembles Cynoscion nebulosus in body form and pigment; differentiated by pigment characters described.

Cynoscion nebulosus (1.9-32.2 mm)

Heavily pigmented. External row of melanophores on midlateral line of the tail; internal pigment dorsal, lateral and ventral to notochord at ≥ 2.7 mm; row of internal and external melanophores in ventral midline of tail, this row continuous at < 12.7 mm; row of melanophores in dorsal midline continuous at ≥ 6.6 mm. Anus-anal fin gap short, < 10% SL at all sizes (except where anal origin ill defined). Dorsal, midlateral, ventral pigment lines still discrete at > 8 mm, dorsal and midlateral lines broad. Posterodorsal outline of gut sloping gently from airbladder to anus, no hump. Melanophore anterior to cleithral symphysis in ventral midline present in about 33% of specimens < 3.5 mm, in about 66% of specimens ≥ 3.5 mm. Pigment usually absent from exterior surface of nape, although faint diffuse spot present in 20% of specimens > 3.6 mm; no well-defined spot at dorsal end of pectoral axil, although other pigment (of visceral mass) may be present in this area; BDc usually < 32% SL at < 4 mm. Dorsal rays complete 5.5 mm, anal rays complete 4.2 mm; pelvic buds first present 4.8 mm, pectoral rays first present 6.6 mm. BDc 25.7-36.7% SL; dorsal rays 24-27, anal rays 9-12.

Closely resembles Menticirrhus sp. in body form and pigment; differentiated by pigment characters described.

Sciaenops ocellata (4.1-7.9 mm)

Internal melanophores, expanded and prominent, present along dorsal surface of notochord or vertebrae of the tail. One or two large melanophores at posterior end of anal base, in most specimens branching dorsally to midlateral line; one melanophore at soft dorsal origin and one partway along soft dorsal base at all sizes; often a stellate melanophore in midlateral line above anus. Anal rays complete 5.2 mm, dorsal rays usually complete at ≥ 6.1 mm; pelvic buds first present 5.2 mm, pectoral rays first present 7.9 mm. BDc 26.5-31.1% SL; dorsal rays 23-25, anal rays 7-9.

Resembles Pogonias cromis; differentiated by presence of internal pigment along notochord in tail, pigment of dorsal, lateral and ventral midlines of tail.

Pogonias cromis (3.9-4.6 mm; Pearson, 1929; Joseph et al., 1964)

Melanophores of tail region very stellate, branching. Two to five branching melanophores in ventral midline of tail at < 6 mm; one or two along soft dorsal base (no melanophore at soft dorsal origin in our specimens or description of Joseph et al., 1964; Pearson, 1929, shows one at 4.5 mm, none in later larvae); three in midlateral line above anus in our specimens. Dorsal and anal rays complete at > 4.6 mm (ca. 6 mm from Pearson, 1929 and Joseph et al., 1964); pelvic buds first present ca. 8 mm (Pearson, 1929; Joseph et al., 1964). BDc 23.0-24.8% SL; dorsal rays 19-23, anal rays 5-7.

Resembles Sciaenops ocellata; differentiated by absence of internal notochord pigment in tail region, absence of melanophore at soft dorsal origin.

Leiostomus xanthurus (4.0-19.7, 39.0 mm)

No pigment in dorsal midline of tail or lateral surface of tail at < 15.1 mm.

Pigment in ventral midline of tail a more or less continuous row of discrete melanophores; at ≤ 4.3 mm, about 15 such melanophores; at > 4.3 mm, one melanophore in anus-anal fin gap, one to five along anal base, one at posterior end of anal base, 4-5 (occasionally more) posterior to anal base. Pair of melanophores, one at each pelvic fin base or in these positions before pelvics develop, and melanophore anterior to anus form triangular pattern when viewed from ventral; pigment patch present on anterior surface of visceral mass, between the cleithra. Anal rays complete 6.2 mm, dorsal rays complete 9.3 mm; pelvic buds first present 5.2 mm, pectoral rays first present 10.7 mm. BDc 22.2-32.5% SL; dorsal rays 29-35, anal rays 12-13.

Resembles Micropogon undulatus; differentiated by pigment along anal fin base, pigment pattern on ventral surface of gut (not always reliable since M. undulatus may have a triangular pattern similar to that of L. xanthurus), presence of pigment on anterior surface of visceral mass, between cleithra.

Micropogon undulatus (3.1-41.0 mm)

No pigment in dorsal midline of tail or lateral surface of tail at < 11.8 mm. Pigment of ventral midline of tail with a break along the middle of the anal fin base; at ≤ 3.5 mm about 12 melanophores from anus to caudal region; at ≥ 4.3 mm a melanophore in anus-anal fin gap, one at second anal ray base, one at posterior end of anal base, 3-6 posterior to anal base. A melanophore just posterior to the cleithral symphysis and one just anterior to the anus in the ventral midline at all sizes; at ≥ 4.9 mm SL a single melanophore midway between these two or between pelvic fin bases when pelvics are present (occasionally paired, usually paired at ≥ 9.8 mm SL). No pigment on anterior surface of visceral mass between cleithra. Anal rays complete 5.3 mm, dorsal rays complete at ≥ 7.8 mm; pelvic buds first present 8.4 mm, pectoral rays first present 7.8 mm. BDc 23.7-30.5% SL; dorsal rays 27-30, anal rays 7-9.

Closely resembles Leiostomus xanthurus in body form and pigmentation; differentiated by gap in pigment row of ventral midline of tail along anal fin base, by absence of pigment on anterior surface of visceral mass between cleithra, and by pigment pattern on ventral surface of visceral mass (occasionally misleading since M. undulatus may have a triangular, Leiostomus-like pattern).

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