DESCRIPTIONS OF LARVAL SILVER PERCH, *BAIRDIELLA CHRYSOURA*, BANDED DRUM, *LARIMUS FASCIATUS*, AND STAR DRUM, *STELLIFER LANCEOLATUS* (SCIAENIDAE)[1, 2]

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ABSTRACT

This paper presents descriptions and illustrations of larval *Bairdiella chrysoura* (3.1-8.8 mm standard length), *Larimus fasciatus* (3.0-5.9 mm standard length), and *Stellifer lanceolatus* (2.8-15.1 mm standard length). *Larimus fasciatus* larvae are characterized by brain pigment, pectoral fin pigment, and early-developing pectoral fin rays. Larval *B. chrysoura* resemble *S. lanceolatus*, but *B. chrysoura* have a swath of expanded melanophores from nape to cleithral symphysis. These two species also can be differentiated by the sequence of melanophores in the midventral line posterior to the anus. Off the southeastern United States, *L. fasciatus* spawn in continental shelf waters from May to October, and *B. chrysoura* and *S. lanceolatus* spawn in coastal and estuarine waters during late spring and summer.

The perciform family Sciaenidae is represented by 18 species off the southeastern United States (Table 1). Taxonomy of adult Sciaenidae of the western North Atlantic has recently been revised by Chao (1978); nomenclature in the present paper follows Chao (1978) rather than Bailey et al. (1970). Studies of larval sciaenids of the east coast of the United States have been numerous; these have recently been summarized in several publications (Scotton et al. 1973; Johnson 1978; Powles and Stender 1978; Lippson and Moran[4].) Despite the number of larval studies, their quality has been uneven; for example, larval series now known to consist of more than one species have been described as single species (*Menticirrhus americanus* and *Stellifer lanceolatus* of Hildebrand and Cable 1934), damaged or distorted specimens have been illustrated and described (*Sciaenops ocellata* of Pearson 1929; *Leiostomus xanthurus* of Hildebrand and Cable 1930), and illustrations have differed from descriptions of larvae of the same species in the same publication (early *Stellifer lanceolatus* of Hildebrand and Cable 1934). Further, few detailed developmental series of morphometric, meristic, and pigmentation data have been published, making separation of larvae to species impossible in the early stages before complete development of fin elements. Thus, both description of undescribed or incompletely described larvae and redescription of larvae which have been poorly described in the literature are necessary to specific identification of sciaenid larvae.

The three species whose larvae are treated in this paper are generally similar in habitat and probably in ecology. They are small fishes (maximum total lengths 20-23 cm) of coastal and estuarine waters (Hildebrand and Schroeder 1928; Hoese and Moore 1977). None are important commercial or sport fish, but all are abundant in estuaries (Dahlberg 1972; Shealy et al. 1974) and on coastal shrimp grounds (Anderson 1968; Keiser 1976). Because of their abundance and small size, all may be important prey items for larger, predacious fishes.

Descriptions of larvae of all three species have been published. Kuntz (1915) described eggs and yolk-sac larvae of *Bairdiella chrysoura* from eggs obtained from a ripe female and further described larvae and early juveniles from plankton collections. Since he examined live or fresh material rather than Formalin-preserved[5] material, it is to be expected that body proportions and pigment characters of his series might differ from those in

[1]South Carolina Marine Resources Center Contribution No. 94.

[2]MARMAP Contribution No. 164.

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[4]Lippson, A. J., and R. L. Moran. 1974. Manual for identification of early developmental stages of fishes of the Potomac River estuary. Md. Dep. Nat. Resour., Power Plant Siting Program, PPSP-MP-13:1-282.

[5]Reference to trade name does not imply endorsement by the National Marine Fisheries Service, NOAA.

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larvae from preserved series. His description was cited by later authors (Hildebrand and Cable 1934; Scotton et al. 1973; Johnson 1978; Lippson and Moran see footnote 4) in compilations of larval

TABLE 1.—Reported meristics of South Atlantic Bight Sciaenidae. Counts in parentheses occur infrequently and semicolon indicates separate dorsal fins.

		Dorsal		Anal				Gill rakers	
Species	Source[1]	Spines	Rays	Spines	Rays	Caudal procurrent	Vertebrae[2]	Upper	Lower
Bairdiella chrysoura	1	X;I	19-23	II	8-10		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	8-9, 5-8	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	6-9, 5-7		4	6-8
C. 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)
	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	7-8, 6-8			
C. 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	7-9, 5-7	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			7-8, 6-7			
E. 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			7-8, 6-7			
E. 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			7, 5-7			
E. 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	7-8, 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	6-7, 4-7	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	6-8, 6-8	10+15		
Menticirrhus americanus	1	X;I	20-26	I	6-8		10+15	2-3	0-7
	4	X;I	24-27	I	7-8				6
	5	X;I	24-25	I	7				
	7	XI	24-26	II	7-8	8-9, 7	10+15		
M. 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	7-8, 6	10+15		
M. saxatilis	1	X;I	22-27	I	7-9		10+15	3-5	0-7
	4	X;I	24-26	I	8-9				6
	5	X;I	26-27	I	8				
	7	XI	23-25	II	7-8	6-8, 6	10+15		
Micropogonias 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	8-9, 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	8-9, 7	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	8-10, 7-9	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	7-9, 6-9	10+15		

TABLE 1.—Continued.

Species	Source[1]	Dorsal Spines	Dorsal Rays	Anal Spines	Anal Rays	Caudal procurrent	Vertebrae	Gill rakers Upper	Gill rakers Lower
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

[1]Sources:
1. Chao 1978
2. Ginsburg 1929
3. Hildebrand and Cable 1934
4. Hildebrand and Schroeder 1928
5. Jordan and Evermann 1896
6. Lippson and Moran (see text footnote 4)
7. Miller and Jorgensen 1973
8. Randall 1968
9. Welsh and Breder 1923.

[2]Includes urostyle.

sciaenids. Jannke[6] illustrated *B. chrysoura* of 2.0 and 5.0 mm SL (standard length). Hildebrand and Cable (1934) described a series identified as *Larimus fasciatus*. Although there is some disagreement between illustrations and descriptions of early larvae in this work, the series appears to represent a single species and to be correctly identified. Hildebrand and Cable also described larvae and juveniles identified as *Stellifer lanceolatus*. Their early larvae represent a mixed series; larvae <4 mm long had pectoral fin pigment and developed pectoral rays, but larvae >4.5 mm long had no pectoral pigment and pectoral rays that developed at ≥5.6 mm. Body proportions also changed between 4.0 and 4.5 mm. Their series appears coherent and correctly identified at lengths ≥5.6 mm. There were also some discrepancies between drawings and descriptions of early stages in their paper.

The purpose of the present paper is to redescribe larvae of these three species and to summarize characters for differentiating between the three species. In addition, notes are given on time and place of larval collections and on separation of larvae of these three species from those of other marine sciaenids of the southeastern United States.

METHODS

Approximately 50 specimens of each species were examined. Descriptions are based on the following numbers of specimens: silver perch, *Bairdiella chrysoura*, 21; banded drum, *Larimus fasciatus*, 21; star drum, *Stellifer lanceolatus*, 26.

Specimens on which descriptions were based were collected from continental shelf waters of the South Atlantic Bight, estuaries and tidal passes of South Carolina, and the Cape Fear River estuary of North Carolina. Those from continental shelf waters were collected with Boothbay neuston nets (mouth 1 m high × 2 m wide, mesh size 0.947 mm, tow velocity 2.6 m/s), MARMAP neuston nets (mouth 0.5 × 1.0 m, mesh size 0.505 mm, tow velocity 1.0 m/s), and 60 cm bongo nets (mesh size 0.505 mm, towing velocity 0.8 m/s) towed in a double oblique pattern between surface and bottom or 200 m depth. Specimens from South Carolina estuaries were collected with 0.5 m diameter conical nets (mesh size 0.571 mm, towing velocity 1.3-1.5 m/s) towed at surface or bottom. South Carolina tidal passes were sampled with 1.0 m mouth diameter plankton nets (mesh size 0.571 mm) moored to bridges or piers and fished near bottom for 1 h at early or middle flood tide. Specimens from the Cape Fear River estuary were collected with 1.0 m mouth diameter conical nets (mesh size 0.760 mm) towed at surface at 0.5 m/s. The number of samples available from each area except the Cape Fear River estuary by month (Table 2) provides an estimate of seasonal and areal effort distribution for comparison with data on time and place of capture of larvae. Tidal pass sampling was not carried out from August to January, and estuarine samples from August to December were not available. All specimens were preserved in 2% formaldehyde buffered by saturating with borax. Specimens from continen-

[6]Jannke, T. E. 1971. Abundance of young sciaenid fishes in Everglades National Park, Fla., in relation to season and other variables. Univ. Miami Sea Grant Tech. Bull. 11:1-128.

TABLE 2.—Numbers of plankton samples from South Carolina estuaries (1974), South Carolina tidal passes (1976), and the South Atlantic Bight continental shelf (1973-76) that were sorted for larval Sciaenidae.

Month	Estuaries Surface	Estuaries Bottom	Tidal passes	Continental shelf Neuston	Continental shelf Bongo
Jan.	33	30	—	30	30
Feb.	17	14	2	30	30
Mar.	17	14	1	47	47
Apr.	33	28	1	52	38
May	19	17	2	48	48
June	17	17	5	—	—
July	16	16	8	—	—
Aug.	—	—	—	40	37
Sept.	—	—	—	39	1
Oct.	—	—	—	10	11
Nov.	—	—	—	31	16

tal shelf waters were initially fixed by immersing net cod ends in 8% formaldehyde for 2 min immediately following net washdown.

Measurements were made on the left side of the body, by ocular micrometer on a dissecting microscope. All measurements were made along or perpendicular to the body midline. Measurements are defined as follows:

Notochord length (NL) — symphysis of upper jaw to tip of notochord (measured in preflexion larvae).

Standard length (SL) — symphysis of upper jaw to posterior edge of hypurals (measured in larvae undergoing notochord flexion and in postflexion larvae).

Snout length — symphysis of upper jaw to anterior margin of eye.

Eye diameter — horizontal diameter of eye.

Head length — symphysis of upper jaw to posterior margin of opercular membrane.

Preanus length — symphysis of upper jaw to posterior margin of anus.

Snout to origin of spinous dorsal fin — symphysis of upper jaw to anterior margin of first developed dorsal spine base.

Snout to origin of soft dorsal fin — symphysis of upper jaw to anterior margin of first developed dorsal ray base.

Snout to dorsal fin termination — symphysis of upper jaw to posterior margin of last developed dorsal ray base.

Snout to anal fin origin — symphysis of upper jaw to anterior margin of first developed anal element base.

Snout to anal fin termination — symphysis of upper jaw to posterior margin of last developed anal ray base.

Anus to anal fin — posterior margin of anus to first developed anal element base.

Snout to pelvic fin insertion — symphysis of upper jaw to anterior margin of base of pelvic fin.

Depth at cleithral symphysis — vertical distance between dorsal margin of body and ventral symphysis of cleithra.

Depth at caudal peduncle — least vertical distance between dorsal and ventral margins of body in the area posterior to the terminal dorsal and anal fin rays and anterior to the hypural bones.

Fin counts include all elements of which any part (including pterygiophore) was developed. Counts were made in unstained specimens since the primary purpose of the study was to permit identification of specimens from field collections. Unless otherwise stated, lengths referred to in this paper are standard lengths.

Data on occurrences of larval *Larimus fasciatus* in plankton tows from continental shelf waters between Martha's Vineyard, Mass., and Palm Beach, Fla., were provided by Peter Berrien (Fisheries Biologist, Northeast Fisheries Center Sandy Hook Laboratory, National Marine Fisheries Service, NOAA, Highlands, NJ 07732). Collection methods and station distribution are given in Clark et al. (1969, 1970).

RESULTS

Bairdiella chrysoura

Morphology. Body proportions change gradually during larval development (Table 3). Body depth at the cleithral symphysis increases slightly with growth and is >30% SL in all specimens examined. Caudal peduncle depth remains constant through development. Preanus length increases from 40-45% SL in preflexion and flexion larvae to >50% SL at ≥5.7 mm. Positions of the dorsal, anal, and pelvic fins remain quite constant as the fins develop, whereas the decrease in length of the anus-anal fin gap corresponds to the increase in preanus length. Snout length and eye diameter change little during development, whereas head length increases from 27-31% NL or SL in preflexion and flexion larvae to 35% SL in larvae 4.9 mm.

Lateral and marginal preopercular spines are present throughout the series, becoming more numerous with growth until a maximum of five lateral and four marginal spines are present at 7.0-8.8 mm. A single posttemporal spine is present at 5.0-7.7 mm, and two such spines are present at 8.8 mm.

Fin development. The pectoral fin is present in all specimens examined; ray development begins at 5.7 mm and 16 rays are present by 8.8 mm (Table 4). Notochord flexion occurs at 4.1-4.4 mm SL. Development of caudal rays begins at the same time as notochord flexion. The full complement of principal rays is developed soon after completion of notochord flexion. Procurrent caudal rays begin to form at 5.7 mm and an incomplete procurrent ray count is present at 8.8 mm. The soft dorsal and anal fins begin ray development at the start of

TABLE 3.—Body proportions (percentage of NL or SL) of larval *Bairdiella chrysoura*. Specimens between dashed lines undergoing notochord flexion; lengths are NL above upper dashed line, SL below.

NL or SL (mm)	Snout length	Eye diameter	Head length	Preanus length	Snout to spinous dorsal origin	Snout to soft dorsal origin	Snout to soft dorsal termination	Anus to anal fin	Snout to anal fin origin	Snout to anal fin termination	Snout to pelvic fin insertion	Body depth at cleithrum	Caudal peduncle depth
3.1	8.7	10.0	30.0	42.5	–	–	–	–	–	–	–	35.0	–
3.5	6.8	10.3	31.0	41.3	–	–	–	–	–	–	–	31.0	–
3.6	7.4	9.8	27.6	40.4	–	–	–	–	–	–	–	30.8	–
3.7	7.4	10.6	30.8	41.4	–	–	–	–	–	–	–	31.9	–
3.7	6.3	10.5	27.3	40.0	–	–	–	–	–	–	–	32.1	–
3.8	7.4	9.5	28.7	44.6	–	–	–	–	–	–	–	32.9	–
4.1	7.2	11.7	31.5	46.8	–	54.1	77.5	15.4	62.2	74.8	–	35.1	8.1
4.4	10.6	12.4	37.2	48.7	42.5	61.9	83.2	17.7	66.4	81.4	–	37.2	9.7
4.4	8.9	11.1	30.3	44.6	40.1	57.1	76.7	21.7	66.3	80.3	–	33.9	7.1
4.8	9.8	11.4	31.1	45.9	39.3	57.3	78.6	16.3	62.2	73.7	–	33.6	6.5
4.9	7.9	10.3	37.3	48.4	38.9	57.1	82.5	16.7	65.1	80.2	35.7	36.5	10.3
5.0	8.6	10.9	35.2	49.2	39.9	57.8	83.6	17.9	67.1	80.5	35.9	36.7	10.1
5.7	8.6	11.4	35.7	48.6	38.6	60.0	82.9	17.1	65.7	80.0	35.7	37.1	11.4
5.7	8.6	11.4	35.7	51.4	37.1	58.6	82.8	11.4	62.8	81.4	37.1	37.1	11.4
7.0	7.0	11.6	37.2	57.0	37.2	59.3	82.5	8.1	65.1	80.2	38.4	37.2	11.6
7.5	10.9	10.9	35.8	55.4	38.1	59.8	81.5	7.6	63.0	78.3	35.8	35.8	10.9
7.5	8.7	10.9	36.9	53.3	39.1	57.6	83.7	11.9	65.2	79.3	35.8	35.8	8.7
7.7	10.6	10.6	38.3	58.5	43.6	59.6	82.9	9.6	68.1	80.8	40.4	37.2	10.6
8.8	9.3	11.2	36.4	56.1	39.3	59.8	85.0	8.4	64.5	79.5	39.3	36.4	10.3

TABLE 4.—Fin element counts of larval *Bairdiella chrysoura*. Specimens between dashed lines undergoing notochord flexion; lengths are NL above upper dashed line, SL below.

NL or SL (mm)	Spinous dorsal	Soft dorsal	Anal	Pectoral[1]	Pelvic	Caudal principal	Caudal procurrent
3.1	–	–	–	+	–	–	–
3.5	–	–	–	+	–	–	–
3.6	–	–	–	+	–	–	–
3.7	–	–	–	+	–	–	–
3.7	–	–	–	+	–	–	–
3.8	–	–	–	+	–	–	–
4.1	–	14	6	+	–	7+6	–
4.4	–	15	8	+	–	7+7	–
4.4	–	18	6	+	–	7+7	–
4.8	–	20	10	+	–	8+7	–
4.9	–	19	I,9	+	–	9+8	–
5.0	–	I,21	I,9	+	–	9+8	–
5.7	XI	21	II,9	+	3	9+8	3,1
5.7	XI	I,21	II,9	6	I,2	9+8	–
7.0	XI	I,21	II,9	11	I,5	9+8	4,3
7.5	XI	I,21	II,9	12	I,5	9+8	5,4
7.5	XI	I,22	II,9	8	I,5	9+8	4,4
7.7	XI	I,21	II,9	12	I,5	9+8	5,4
8.8	XI	I,22	II,9	16	I,5	9+8	6,5

[1] + = fin present, no developed elements.

notochord flexion and attain adult complements at ≥4.8 mm. The spinous dorsal begins development between 5.0 and 5.7 mm; spine development is rapid, with the adult complement present at 5.7 mm. Pelvic fins are first present at 5.7 mm and adult element complements are present at ≥7.0 mm.

Pigmentation. Larvae are characterized by an oblique swath of internal and external pigment, paralleling the cleithrum, from nape to cleithral symphysis (Figure 1). Melanophores of several areas constitute this swath: in the musculature of the nape, on the anterior and dorsal surfaces of the visceral mass, ventral to the brain, and on the ventral body surface. In small larvae (<5.0 mm), melanophores in these areas are usually expanded, so that a continuous swath of pigment is formed. Occasionally melanophores may be contracted, but are always present in the areas listed. In large larvae (≥5.0 mm), melanophores of these areas are more frequently contracted than in smaller larvae, and thickening of the body wall begins to obscure some of the swath pigment.

Pigment of the ventral midline of the tail begins as a continuous row of small melanophores in the smallest larvae and develops into a characteristic sequence of melanophores with growth. About 10 melanophores are present at 3.1-3.8 mm; one of these (two-thirds of the distance from anus to notochord tip) is larger than the others. In the dorsal midline of the tail, a few specimens ≤3.5 mm NL have a small melanophore dorsal to the large melanophore of the ventral midline. At ≥4.1 mm, melanophores of the ventral row are placed as follows: one or two anterior to the anal base, one at the origin of the anal fin, one at its termination, and three or four posterior to the anal fin. In most specimens ≥7.0 mm, no pigment is present anterior to the anal base, but the rest of the sequence remains, and small melanophores begin to appear at the bases of individual rays.

Other head and visceral mass pigmentation characterizes these larvae. A melanophore is present at the angle of the lower jaw throughout the series. Pigment is present at the tip of the

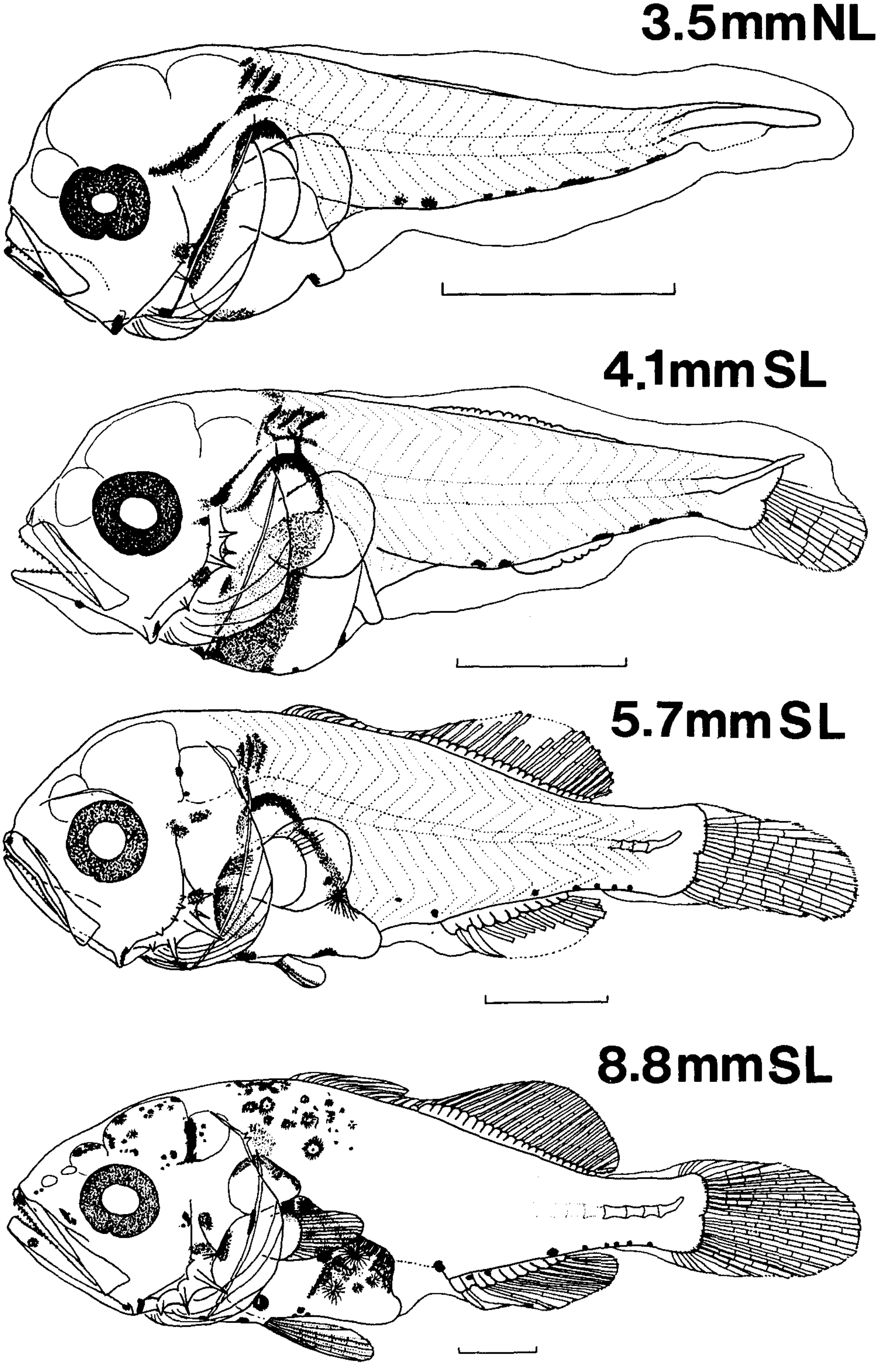

FIGURE 1.—Larval *Bairdiella chrysoura*. Scale equals 1 mm.

premaxillary at ≥5.7 mm and at the tip of the lower jaw at ≥7.5 mm. A melanophore is usually present on the medial surface of each dentary at 3.1-7.0 mm, while at ≥7.5 mm, one or several melanophores consistently occur in this position. Melanophores are present above the anterior part of the midbrain, and above the eye, at ≥7.0 mm. Melanophores are present on the surface of the midbrain at its junction with the hindbrain at ≥5.7 mm, and on the dorsal surface of the forebrain at ≥7.7 mm. Two melanophores occur in the midventral line on the ventral surface of the visceral mass: one midway between the cleithral symphysis and the anus (between the pelvic fin bases when these are developed), present at ≥3.3 mm, and another on the anterioventral surface of the anus, present at 3.1-5.0 mm. A melanophore midway between these is occasionally present at 3.5-4.7 mm and always present at ≥4.8 mm. 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.

Body surface pigment increases in extent in late larvae (≥7.0 mm). This includes a cluster of melanophores in the dorsal midline anterior to the spinous dorsal fin, a group of melanophores ventral to this cluster, a group on the dorsal surface of the head, and a group on the lateral surface of the visceral mass.

Identification of the series. This series was identified as *B. chrysoura* by fin ray counts, pigmentation, caudal fin shape, and similarity to a published description. Fin ray counts (dorsal 21-22, anal 9) of late larvae in the series could have been attributed to *Menticirrhus americanus, M. saxatilis*, or *Stellifer lanceolatus* as well as *B. chrysoura*. A series of *Menticirrhus* larvae (identified by presence of a single mental barbel at ≥9.2 mm, tentatively as *M. americanus*), which I have examined, is characterized by heavy and extensive body pigment, and the absence of such pigment in larvae of the series described here indicated that it was *B. chrysoura* rather than *M. americanus*. Heavy body pigmentation has been described for *M. americanus* (Hildebrand and Cable 1934) and *M. saxatilis* (Scotton et al. 1973). Although species identifications in those descriptions may not be accurate, heavy body pigmentation is probably characteristic of larvae of the genus *Menticirrhus*. Caudal fin shape distinguished larvae of the series here described from larval *S. lanceolatus*. Late larvae of this series have the broadly rounded caudal fin characteristic of *B. chrysoura* (Hildebrand and Schroeder 1928; Dahlberg 1975) while late larvae of *S. lanceolatus* have the lanceolate caudal fin characteristic of the adult. Finally, larvae of my series are similar in major characters (the swath of pigment between head and visceral mass, midventral pigment posterior to the anus) to the larvae described by Kuntz (1915), which were apparently correctly identified.

Spawning season and area. Larval *B. chrysoura* occurred in six surface and six bottom tows in May and in five surface and five bottom tows in June 1974 in South Carolina estuaries. None occurred between January and April or in July. In South Carolina tidal passes, larvae occurred in two May samples, one June sample, and one July sample, and did not occur between February and April. A single specimen was taken in continental shelf waters, in a bongo net tow made in 31 m on 8 April 1974 (Figure 2). Thus spawning appears to occur primarily in coastal and estuarine waters of the southeastern United States, at least from April through July. Spawning may occur later in the year, but no samples after July from coastal and estuarine waters were examined.

Larimus fasciatus

Morphology. Body proportions change little during development (Table 5). The larvae are deep bodied (depth at cleithral symphysis >35% SL, except for a 3.8 mm specimen). Preanus length is >50% SL in all specimens but one. Positions of the fins change little during development. Anus to anal fin distance is variable in length, <6% SL in most larvae but with a maximum value of 10.2% SL. Caudal peduncle depth increases with development, from <9% SL at ≤4.2 mm to >9% SL in most larger specimens.

Preopercular spines are present in all larvae. Lateral spines are smaller than marginal spines, and numbers in both series increase with growth. One or two small posttemporal spines and a low, spinous supraorbital ridge are present at ≥5.5 mm.

Fin development. The pectoral fins are present throughout development (Table 6). Pectoral elements are first present at ≥4.0 mm; elements are incomplete at 5.9 mm, the largest larva available

TABLE 5.—Body proportions (percentage of NL or SL) of larval *Larimus fasciatus*. Specimens between dashed lines are undergoing notochord flexion. Lengths are NL above upper dashed line, SL below.

NL or SL (mm)	Snout length	Eye diameter	Head length	Preanus length	Snout to spinous dorsal origin	Snout to soft dorsal origin	Snout to soft dorsal termination	Anus to anal fin	Snout to anal fin origin	Snout to anal fin termination	Snout to pelvic fin insertion	Body depth at cleithrum	Caudal peduncle depth
3.0	10.4	10.4	33.8	53.2	–	50.6	68.8	–	–	–	–	50.6	6.5
3.2	9.6	12.0	36.1	53.0	–	–	–	–	–	–	–	39.8	7.2
3.6	10.9	13.0	35.9	55.4	41.3	53.3	76.1	4.4	59.8	71.7	39.1	39.1	8.7
3.8	9.2	12.2	34.7	49.0	–	–	–	10.2	59.2	70.4	–	33.7	6.1
4.0	10.8	12.8	38.8	56.8	–	52.0	76.8	4.0	60.8	74.4	35.6	39.6	9.2
4.2	7.3	11.9	36.7	54.1	36.7	50.5	81.7	5.5	59.6	71.6	37.6	37.6	8.3
4.3	10.1	13.8	40.4	57.8	39.4	55.0	81.7	5.5	63.3	74.3	35.8	40.4	9.2
4.3	8.2	12.7	38.2	57.3	41.8	54.5	85.5	3.6	60.9	71.8	39.1	40.9	8.2
4.4	9.7	13.3	38.1	58.4	43.4	58.4	89.4	8.9	67.3	75.2	36.3	42.5	10.6
4.5	9.6	13.2	36.8	54.4	40.4	49.1	86.0	9.6	64.0	76.3	36.0	37.7	8.8
4.8	8.1	13.8	41.5	65.0	41.5	58.5	87.0	4.1	69.1	78.9	40.7	41.5	10.6
4.9	10.3	14.3	37.3	61.9	40.5	57.1	87.3	0.8	62.7	77.0	39.7	44.4	10.3
5.0	9.4	15.0	40.2	58.3	39.4	55.1	87.4	4.7	63.0	75.6	39.4	46.5	11.0
5.5	7.5	13.4	35.8	59.7	41.8	56.7	89.6	4.5	64.2	77.6	37.3	44.8	11.9
5.7	10.3	14.5	37.9	60.0	38.6	57.9	89.0	5.5	65.5	79.3	37.2	44.1	11.0
5.8	9.9	12.7	38.0	60.6	42.3	59.2	87.3	1.6	62.0	74.6	39.4	45.1	11.3
5.9	12.5	13.9	40.3	59.7	44.4	59.7	87.5	5.6	65.3	76.4	37.5	43.1	9.7

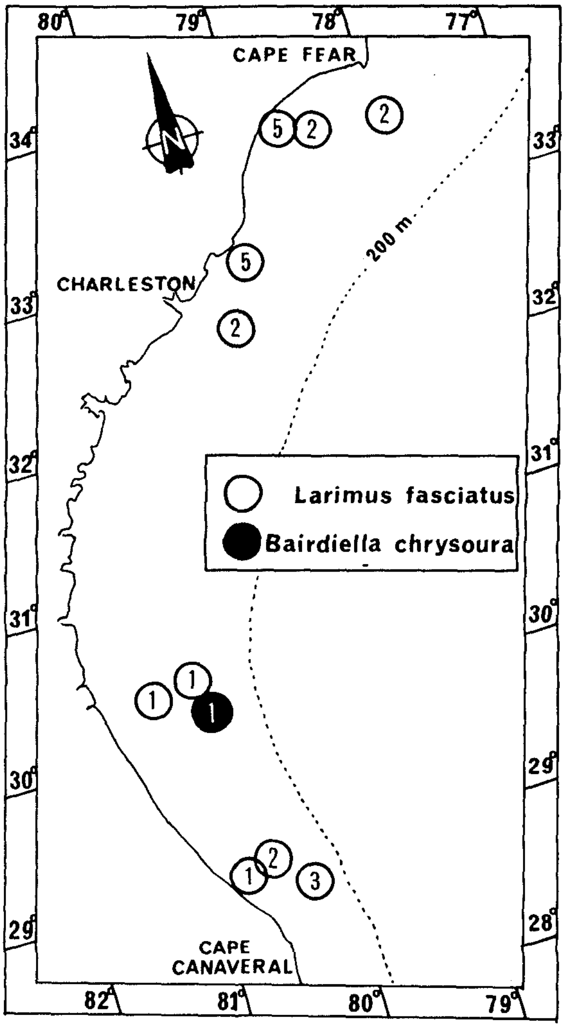

FIGURE 2.—Occurrence of larval *Bairdiella chrysoura* and *Larimus fasciatus* in South Carolina-MARMAP plankton tows in continental shelf waters of the South Atlantic Bight. Numbers indicate numbers of larvae at stations.

TABLE 6.—Fin element counts in larval *Larimus fasciatus*. Specimens between dashed lines are undergoing notochord flexion. Lengths are above upper dashed line, SL below.

NL or SL (mm)	Spinous dorsal	Soft dorsal	Anal	Pectoral[1]	Pelvic[1]	Caudal principal	Caudal procurrent
3.0	–	–	–	+	–	–	–
3.2	–	–	–	+	–	–	–
3.6	–	16	5	+	+	6+5	–
3.8	–	18	–	+	–	3+3	–
4.0	–	19	7	10	+	9+8	–
4.2	–	16	7	+	+	8+6	–
4.3	–	15	6	7	+	4+5	–
4.3	–	20	7	6	+	8+7	–
4.4	IX	27	II,6	11	I,4	9+8	–
4.5	III	22	7	10	+	8+6	–
4.8	X	25	6	10	+	9+7	–
4.9	X	27	II,6	12	I,3	9+8	–
5.0	X	26	II,6	10	I,1	9+8	–
5.5	X	27	II,6	15	I,5	9+8	0,1
5.7	X	27	II,6	14	I,4	9+8	0,1
5.8	XI	26	II,6	16	I,5	9+8	1,2
5.9	IX	27	II,6	15	I,5	9+8	2,2

[1] + = fin present, no developed elements.

(adult complement 17 in nine adults, 16 in one, all from South Carolina waters). Caudal flexion is occurring in specimens of 3.6-4.0 mm. Principal caudal rays are first seen in flexion specimens and are usually complete after 4.9 mm. Procurrent caudal rays appear at 5.5 mm and are incomplete in the largest specimen available. The soft dorsal fin base is present in the smallest larva, with no discernible elements; pterygiophores are countable at 3.6 mm and rays are consistently complete at ≥4.8 mm. Dorsal spines first appear at 4.4 mm and are complete in one specimen at 5.8 mm. The anal fin is first present at 3.6 mm; the complete anal ray complement is present at ≥4.0 mm and anal spines are complete consistently at 4.9 mm. The pelvic fin bud is first present at 3.6 mm, and the complete element complement consistently present at ≥5.8 mm.

Pigmentation. Characteristic pigment patterns of the brain and pectoral fin are useful for identifying larval *L. fasciatus* (Figure 3). Melanophores are 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 available series. The midbrain pigment appears to ring the midbrain when viewed from dorsally. The pectoral fin base and membrane are heavily pigmented throughout the series. Pigment in the membrane, diffuse in small larvae, is present between the rays when these are developed (≥4.3 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 occur here at ≥4.2 mm.

Other head pigment includes two to four melanophores on the gular isthmus between the lower jaw rami, melanophores on the preoperculum posterior to the eye, a melanophore at the angle of the lower jaw, and one anterior to the cleithral symphysis.

In the ventral midline of the visceral mass, early larvae have three melanophores: one posterior to the cleithral symphysis (between pelvic fin bases when present), one midway between cleithral symphysis and anus, and one on the anteroventral surface of the anus. At ≥3.6 mm, the anus melanophore is absent, and at ≥4.5 mm, two or three melanophores may occur at the other two ventral midline locations. The anterior, dorsal, and posterior surfaces of the visceral mass are pigmented throughout the series, and at ≥5.0 mm, melanophores appear and increase in numbers on the lateral surface of the visceral mass.

In the ventral midline posterior to the anus, a row of six melanophores is present in the smallest larva (3.0 mm), the fifth of which, midway between the anus and notochord tip, is larger than the others. At ≥3.2 mm, two melanophores occur in the ventral midline, one at the position of the large melanophore of the original series (at the posterior end of the anal base when developed) and one anterior to this (just posterior to the anterior end of the anal base when developed).

In the dorsal midline, a melanophore is present anterior to the origin of the finfold or spinous dorsal 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 midway along the spinous dorsal base at ≥4.8 mm, and a similar pair of melanophores is present two-thirds of the distance along the soft dorsal base at ≥5.9 mm.

On the lateral surface of the body, between the spinous dorsal base and the visceral mass, melanophores appear at 4.4 mm and increase in number with growth.

Identification of the series. This larval series was identified as *L. fasciatus* by dorsal and anal fin ray counts, pigmentation, and by correspondence with a published description of late larval and early juvenile stages. Fin ray counts (dorsal 26-27, anal 6) observed in late larvae of this series could only have been of *L. fasciatus* or *M. americanus* (Table 1). The absence of heavy, extensive body pigmentation characteristic of *Menticirrhus* larvae indicated that the series described here was *L. fasciatus* rather than *M. americanus*. The pectoral fin pigment of the series here described is similar to that of *L. fasciatus* late larvae and early juveniles described by Hildebrand and Cable (1934). Although descriptions of early larvae in that paper are inadequate, late larvae (≥10.5 mm) and juveniles represent a coherent series apparently correctly identified.

Spawning season and area. No larval *L. fasciatus* were present in samples from South Carolina estuaries or tidal passes throughout the months sampled, January-July. In MARMAP tows in shelf waters, larvae were taken in April-May 1974, August-September 1974, and September 1975; larvae were most frequently taken on the inner two-thirds of the continental shelf and occurred from Cape Canaveral to Cape Fear (Figure 2). Information from plankton collections made by personnel of Northeast Fisheries Center Sandy Hook Laboratory (Figure 4) shows larval *L. fasciatus* to have been distributed across the width of the continental shelf and as far south as lat. 27°43′ N. Large collections of larvae (6-18 specimens) were common off northern Florida and southern Georgia. Larval *L. fasciatus* were taken in cruises made during May, July, and October off

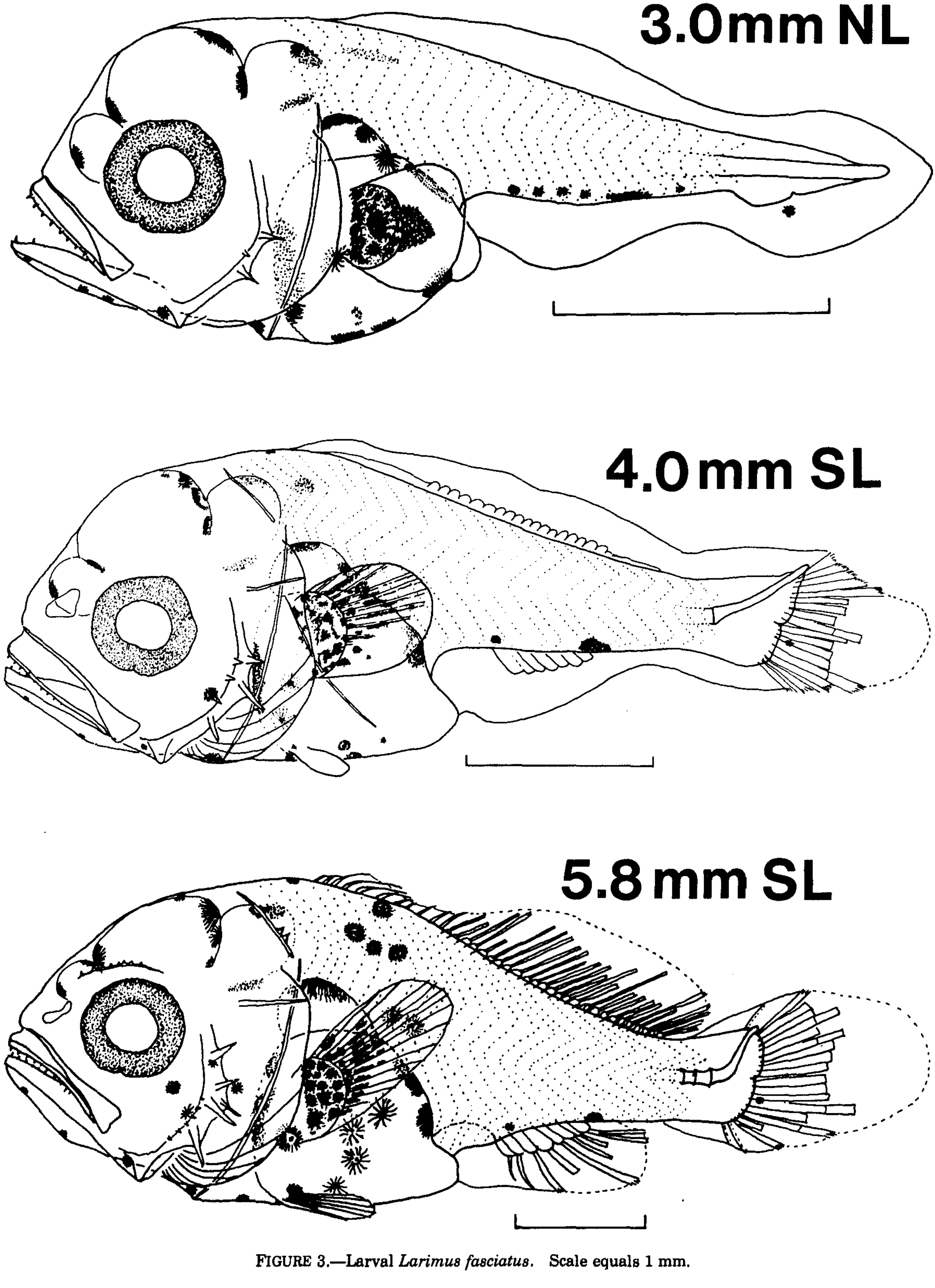

FIGURE 3.—Larval *Larimus fasciatus*. Scale equals 1 mm.

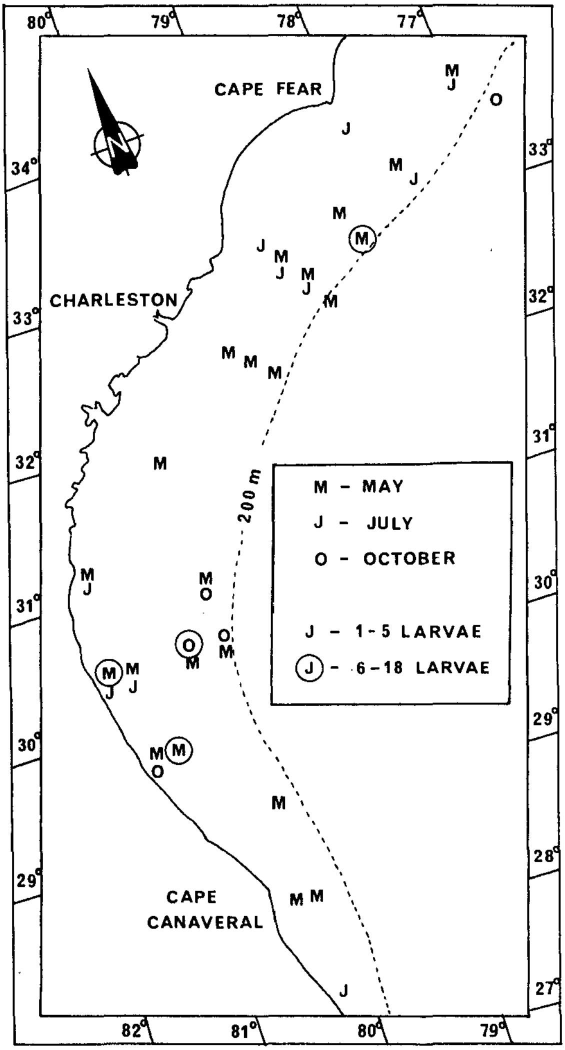

FIGURE 4.—Distribution of captures of larval *Larimus fasciatus* during plankton tows conducted by personnel of Northeast Fisheries Center Sandy Hook Laboratory off the southeastern United States (data supplied by Peter Berrien, Fishery Biologist, Northeast Fisheries Center Sandy Hook Laboratory, NMFS, NOAA, Highlands, NJ 07732).

the southeast United States; larvae were absent from the cruises made in January-February. On cruises made north of Cape Lookout, N.C., by Northeast Fisheries Center Sandy Hook Laboratory personnel, larval *L. fasciatus* were found as far north as lat. 36°22′ N (just south of the mouth of Chesapeake Bay); larvae were approximately as widely distributed and as abundant in continental shelf waters between Cape Lookout and Chesapeake Bay as off the southeastern United States (Berrien[7]). Larval *L. fasciatus* were collected in April to June and August to October on these "northern section" cruises.

Stellifer lanceolatus

Morphology. Body proportions change little during larval development (Table 7). The body is fairly deep (depth at cleithral symphysis 34-41% SL in most specimens). Preanus length, 40-50% SL through most of the series, increases to 55% SL in most late larvae (≥10.2 mm SL). Fins develop at the adult positions. The anus-anal fin gap, 12-20% SL in most specimens <8 mm, decreases with an increase in preanus length in larvae >10 mm. Head length increases slightly with development to the late larval stages; snout length and eye diameter change little over the size range available. Depth of the caudal peduncle increases slightly before and during notochord flexion and remains constant after flexion is complete.

Small lateral and large marginal preopercular spines are present throughout the series, as are premaxillary and dentary teeth. A posttemporal spine is present at 5.1-7.8 mm; at ≥10.2 mm a "scale bone" with four spinous projections is present in the posttemporal region.

Fin development. The pectoral fin, present throughout the series, first has elements at 6.9 mm and has the complete ray complement consistently at ≥14.0 mm, although the complete ray complement may be present in smaller larvae (Table 8). Notochord flexion occurs between 3.3 and 4.3 mm. Principal caudal rays are present in one preflexion larva and are consistently present during and after flexion; the adult complement is present at ≥5.5 mm. Procurrent caudal rays first appear at 5.1 mm and are complete at ≥10.2 mm. Bases of the soft dorsal and anal fins are present, with no discernible elements, in two preflexion specimens, and are consistently present with developed pterygiophores in flexion and postflexion specimens. Complete anal ray counts occur at ≥3.3 mm, and complete anal spine complements at ≥5.5 mm. Dorsal ray complements are consistently complete at ≥5.5 mm although complete counts may occur at 4.5 mm. Dorsal spines are occasionally seen at 4.5-5.8 mm and are consis-

[7]Peter L. Berrien, Fishery Biologist, Northeast Fisheries Center Sandy Hook Laboratory, National Marine Fisheries Service, NOAA, Highlands, NJ 07732, pers. commun. June 1979.

TABLE 7.—Body proportions (percentage of NL or SL) of larval and juvenile *Stellifer lanceolatus*. Specimens between dashed lines are undergoing notochord flexion. Lengths are NL above upper dashed line, SL below.

NL or SL (mm)	Snout length	Eye diameter	Head length	Preanus length	Snout to spinous dorsal origin	Snout to soft dorsal origin	Snout to soft dorsal termination	Anus to anal fin	Snout to anal fin origin	Snout to anal fin termination	Snout to pelvic fin insertion	Body depth at cleithrum	Caudal peduncle depth
2.8	8.2	11.0	30.1	45.2	–	–	–	–	–	–	–	37.0	6.8
2.9	9.3	10.7	33.3	45.3	–	50.6	66.7	13.3	58.6	69.3	–	37.3	6.7
3.1	8.8	11.4	32.9	41.7	–	48.0	69.6	21.5	63.2	74.6	–	38.0	7.6
3.1	8.9	11.4	35.4	41.8	–	–	–	–	–	–	–	35.4	7.6
3.5	6.6	11.0	27.4	39.5	–	–	–	–	–	–	–	34.1	6.6
3.3	5.9	12.9	34.1	47.1	–	61.2	90.5	18.7	65.8	84.7	–	41.2	9.4
3.4	6.9	11.5	36.8	46.0	–	51.7	77.0	13.8	59.8	74.7	–	40.3	8.1
3.8	7.2	9.3	27.8	41.2	–	49.4	70.1	17.6	58.8	73.2	–	35.0	6.2
4.1	7.5	11.3	31.1	45.3	39.6	54.7	86.8	15.1	60.4	79.2	–	39.6	10.4
4.3	8.2	11.8	31.8	45.5	–	53.6	81.8	16.3	61.8	78.2	–	38.2	10.9
4.5	8.7	11.3	34.7	48.7	35.7	57.4	86.1	12.1	60.8	77.3	37.4	40.8	11.3
4.9	8.7	9.5	32.5	42.9	36.5	55.6	83.3	19.0	61.9	80.2	30.2	36.5	8.7
5.1	9.7	12.9	35.5	48.4	35.5	56.4	87.1	12.9	61.3	77.4	35.5	38.7	9.7
5.5	7.5	10.4	32.8	43.3	32.8	49.3	80.6	14.9	58.2	76.1	–	35.8	9.0
5.5	9.0	10.4	31.3	47.8	34.3	52.2	90.0	11.9	59.7	79.1	–	37.3	9.0
5.8	7.0	14.1	31.0	43.7	35.2	50.7	84.5	15.5	59.2	76.1	32.4	32.4	8.5
6.2	8.0	8.0	32.0	46.7	34.7	54.7	82.7	12.0	58.7	76.0	32.0	36.0	9.3
6.9	8.3	9.5	34.5	45.2	36.9	54.7	82.1	14.3	59.5	76.2	29.7	33.3	9.5
7.4	10.0	10.0	37.8	54.4	41.1	56.7	84.4	8.9	63.3	77.8	41.1	37.8	10.0
7.6	8.6	8.6	35.4	47.3	37.6	55.9	86.0	11.8	59.1	76.3	31.1	34.4	9.7
7.8	7.4	9.5	32.6	45.3	35.8	53.6	83.2	12.6	57.9	79.0	30.5	35.8	9.5
10.2	8.8	9.6	38.4	55.2	40.0	59.2	85.6	8.8	64.0	79.2	38.4	36.0	5.6
13.1	10.3	9.0	38.5	57.6	38.5	58.9	85.9	6.5	64.1	78.2	39.7	35.8	9.0
13.9	9.6	7.2	39.7	54.2	38.5	59.0	85.5	9.7	63.9	78.3	36.1	33.7	9.6
14.0	9.0	9.0	37.3	55.4	36.2	54.1	85.5	8.4	63.8	78.3	38.5	33.7	9.6
15.1	10.0	8.9	38.9	57.8	36.7	55.5	84.5	7.7	65.5	77.7	38.9	33.3	8.9

tently present at 6.2 mm; the adult complement is consistently present at ≥10.2 mm. The pelvic fin bud is first present at 4.9 mm and is consistently present at ≥6.2 mm; adult element complements are present at ≥6.9 mm.

Pigmentation. Pigmentation of the body posterior to the anus is of particular value in identification of larval *S. lanceolatus* (Figure 5). In the ventral midline, small larvae (≤3.1 mm) have a row of five or six melanophores between the anus and the notochord tip; one or two of these, two-thirds of the distance from anus to notochord tip, are larger than the others. In larger specimens, an expanded melanophore is present two-thirds of the distance from anus to notochord tip (at the posterior end of the anal base when developed); this melanophore branches dorsally, often as far as the midlateral line. In some specimens (as shown, Figure 5) two expanded, branching melanophores are present at the posterior end of the anal fin base. In most specimens ≥3.1 mm, a melanophore is present (at the anterior end of the anal base when developed) anterior to this expanded melanophore. One to three small melanophores are present posterior to the anal base in most specimens 3.3-6.2 mm; none are present at 6.9-10.2 mm, and at >10.2 mm three or four melanophores are present here. 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, often connected to

TABLE 8.—Fin element counts in larval and juvenile *Stellifer lanceolatus*. Specimens between dashed lines are undergoing notochord flexion. Lengths are NL above upper dashed line, SL below.

NL or SL (mm)	Spinous dorsal	Soft dorsal	Anal	Pectoral[1]	Pelvic[1]	Caudal principal	Caudal procurrent
2.8	–	–	–	+	–	–	–
2.9	–	–	–	+	–	–	–
3.1	–	–	–	+	–	–	–
3.1	–	–	–	+	–	2+2	–
3.5	–	–	–	+	–	–	–
3.3	–	15	8	+	–	6+6	–
3.4	–	19	7	+	–	4+5	–
3.8	–	18	8	+	–	8+7	–
4.1	–	17	I,8	+	–	8+7	–
4.3	–	19	8	+	–	8+6	–
4.5	II	21	II,8	+	–	9+8	–
4.9	–	20	I,8	+	+	9+7	–
5.1	V	19	II,8	+	–	9+8	1,1
5.5	–	19	I,8	+	–	8+7	–
5.5	–	22	II,9	+	–	9+8	1,1
5.8	–	22	II,8	+	–	9+8	–
6.2	VII	22	II,8	+	+	9+8	2,2
6.9	XI	I,22	II,8	7	I,4	9+8	4,3
7.4	XI	I,23	II,8	13	I,5	9+8	4,4
7.6	XI	I,22	II,8	7	I,3	9+8	5,4
7.8	XI	22	II,8	13	I,5	9+8	6,4
10.2	XI	I,23	II,8	19	I,5	9+8	3,8
13.1	XI	I,22	II,8	19	I,5	9+8	9,8
13.9	XI	I,22	II,8	15	I,5	9+8	9,8
14.0	XI	I,23	II,8	19	I,5	9+8	9,8
15.1	XI	I,21	II,8	20	I,5	9+8	9,8

[1] + = fin present, no developed elements.

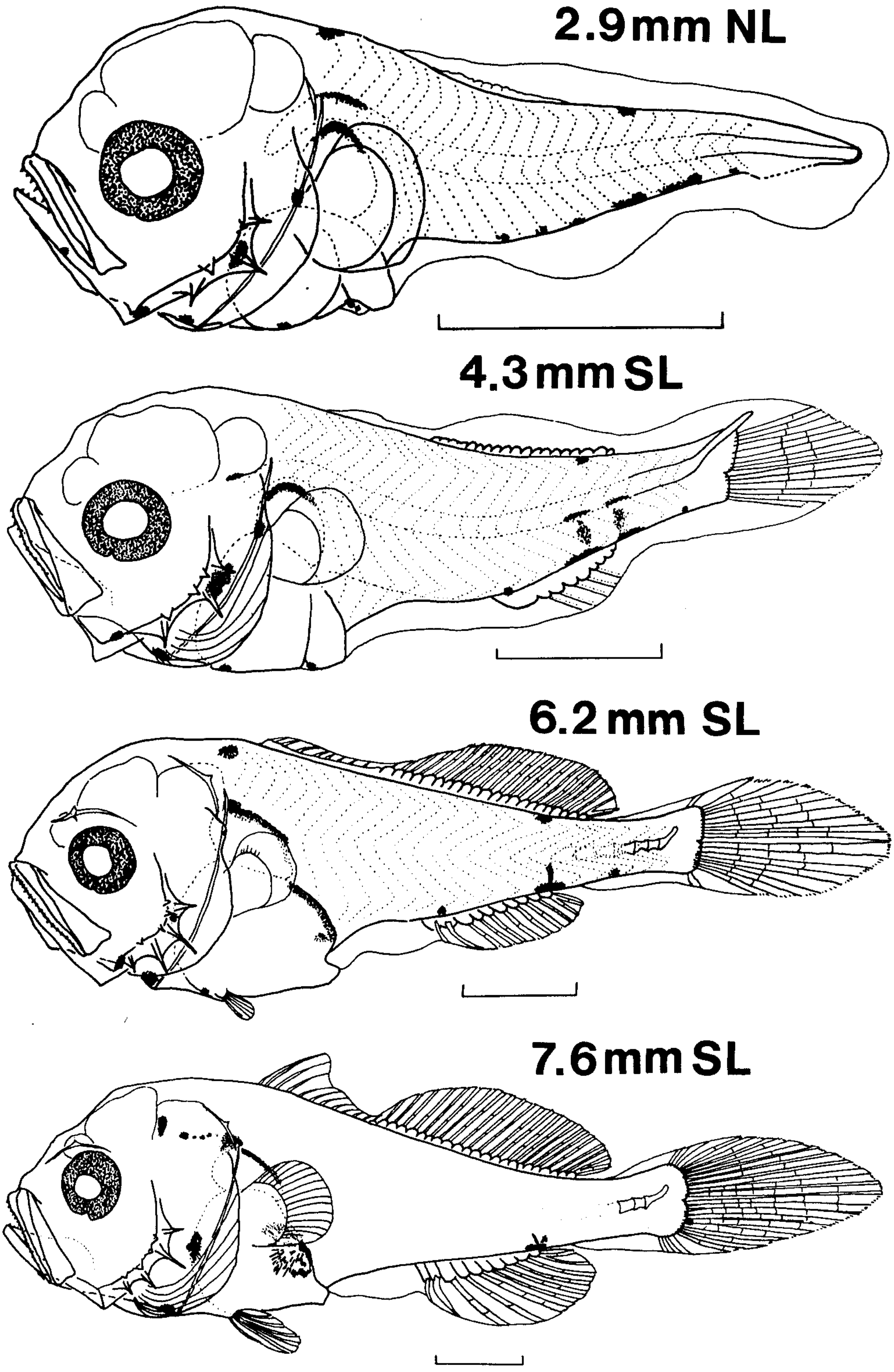

FIGURE 5.—Larval *Stellifer lanceolatus*. Scale equals 1 mm.

the dorsal branches of the expanded melanophore. A melanophore is present in the dorsal midline dorsal to the melanophore at the anal fin termination in most specimens 2.9-6.2 mm.

Head and visceral mass pigment is also useful in identifying larval *S. lanceolatus*. A large melanophore is present on the anterior surface of the visceral mass, between the cleithra, throughout development. A similar melanophore appears on the posterior surface of the visceral mass at ≥4.1 mm; this melanophore becomes extensively branched at ≥6.9 mm, and additional expanded melanophores appear dorsal and ventral to this one at ≥10.2 mm. In the ventral midline of the visceral mass a melanophore is present midway from cleithral symphysis to anus at 2.9-6.2 mm (between pelvic fin bases when present), and a second melanophore occurs on the anteroventral surface of the anus at 2.9-5.8 mm. In small larvae (≤3.8 mm), pigment is present in the dorsal midline and internally, on both sides of the notochord, above the visceral mass. A characteristic pigment area at the dorsal end of the operculum, which appears to roof a cavity in this area, is present at ≥7.4 mm. Pigment occurs at the angle of the lower jaw at <6.2 mm and anterior to the cleithral symphysis throughout the development.

Further pigment develops in late larvae (>10.2 mm). On the body surface, this includes a scattering of melanophores between the spinous dorsal and the visceral mass, four clusters of small melanophores in the dorsal midline along the dorsal fin base, and a few internal melanophores in the midlateral line above the anal base. Small melanophores appear in the spinous dorsal membrane and at the tip of the caudal fin at 13.1 mm, and in the soft dorsal membrane at 15.1 mm. Even in late larvae, pigmentation is not particularly heavy.

Identification of the series. The series was identified as *S. lanceolatus* by fin ray counts, pigmentation, caudal fin shape, and similarity to a published description of late larvae and juveniles. Fin ray counts of late larvae in this series (dorsal 21-23, anal 8) could be those of *B. chrysoura, M. americanus, M. saxatilis,* or *S. lanceolatus* (Table 1). Lack of heavy extensive body pigment indicates that the series is not *Menticirrhus*. The late larvae of the series have a lanceolate caudal fin, characteristic of *S. lanceolatus* but not of *B. chrysoura* (Hildebrand and Schroeder 1928; Dalhlberg 1975). Late larvae (≥9 mm) and early juveniles of *S. lanceolatus* described by Hildebrand and Cable (1934) represent a coherent series leading to a correctly identified young adult; late larvae of the series described here are similar to the late larvae of Hildebrand and Cable (1934), notably in the presence of an area of pigment at the upper end of the operculum, which appears to roof a cavity in this area.

Spawning season and area. Larval *S. lanceolatus* occurred in two South Carolina estuary samples in June and in one in July 1974; all three samples came from bottom rather than surface tows. Tidal pass sampling yielded five samples containing larvae in June and five with larvae in July; no larvae were taken from February to May. No *S. lanceolatus* larvae were taken in continental shelf tows. Thus, spawning appears to occur in estuarine and coastal waters, and not in shelf waters. Spawning occurs in early summer and may continue later into the year.

DISCUSSION

Comparisons with earlier descriptions

Bairdiella chrysoura

My material is in agreement with the description of Kuntz (1915), except that fin development occurs at larger sizes in Kuntz's description than in my material, and some pigment details are different. Kuntz's 5 mm specimen had a flexing notochord, 13 caudal rays, a developing dorsal fin base, and no anal base; these characters are found in my larvae of 4.3-4.4 mm. His 7.5 mm specimen is equivalent to my specimens of about 5.0 mm, having about 25 dorsal fin elements, 11 anal elements, no pelvic fin buds, and the full complement of caudal rays. Kuntz's larvae of ≤7.5 mm had a melanophore in the dorsal midline above the large melanophore of the ventral midline, present in only a few specimens ≤3.5 mm SL in my series, and a melanophore anterior to the dorsal fin origin, present in none of my specimens. These discrepancies may be due to Kuntz's use of fresh material while I used formaldehyde-preserved material. Shrinkage of formaldehyde-preserved larvae could account for the developmental differences, and melanophores may be contracted during preservation or degraded with storage in formaldehyde. Kuntz probably used total lengths rather than standard lengths which might partially account for development rate discrepancies.

Jannke (see footnote 6) illustrated 2.0 mm and 5.0 mm larvae identified as *B. chrysoura*. The 2.0 mm specimen, smaller than my smallest larva, does not resemble Kuntz's larvae at similar sizes nor my earliest specimen in pigmentation. Jannke's 5.0 mm specimen is probably correctly identified: it has the fin counts and the characteristic cleithral pigment swath of *B. chrysoura* but lacks characteristic pigment of the ventral midline.

Larimus fasciatus

My material agrees fairly well with the only published description, that of Hildebrand and Cable (1934). The pigmented pectoral fin, emphasized by Hildebrand and Cable (1934), would appear to confirm identification of all specimens of their series. The drawings are not in good agreement with the description in their text; for example, their drawing of a 4.5 mm specimen shows none of the pigment described. The pigment of the brain which I have found characteristic of *L. fasciatus* larvae was not mentioned by Hildebrand and Cable; perhaps fading due to preservation was responsible. The few body proportions given by Hildebrand and Cable (particularly the position of the anus at >50% SL) are characteristic of *L. fasciatus*.

Stellifer lanceolatus

Hildebrand and Cable's (1934) description of a series identified as *S. lanceolatus* was based on a mixture of that species and *L. fasciatus*. Early larvae (≤3.5 mm SL) had pigmented pectoral fins and developing pectoral rays characteristic of *L. fasciatus*. Later larvae (≥4.5 mm SL) lacked pectoral fin and brain pigment and showed pectoral ray development only at >5.6 mm. Body depth and preanus length values of the early larvae are closer to those of *L. fasciatus* than of *S. lanceolatus*. Characters given by Hildebrand and Cable (1934) for separating early *L. fasciatus* and *S. lanceolatus* were preopercular spination, mouth shape, maxillary length, and amount of space around the brain. However, my observations indicate that none of these characteristics are suitable for separating these species.

As with *L. fasciatus*, there are discrepancies between text and illustrations in the description of Hildebrand and Cable (1934), particularly in the early stages. My material agrees fairly well with that of Hildebrand and Cable (1934) at ≥4.5 mm SL, although I observed a dorsal midline melanophore dorsal to the termination of the anal fin in specimens ≤7.0 mm SL, which was not indicated by those authors.

Spawning Seasons and Areas

Bairdiella chrysoura

Spawning is reported by various authors to occur in late spring and summer on the east coast of the United States and the Gulf of Mexico, and year-round in South Florida. The season appears to begin later and to be shorter at higher latitudes: June to August off New Jersey (Welsh and Breder 1923), May to July in Delaware Bay (Thomas 1971) and Chesapeake Bay (Hildebrand and Schroeder 1928; Joseph et al. 1964), April to August at Beaufort, N.C. (Kuntz 1915), April to May off Georgia (Dahlberg 1972), and April to September off Louisiana (Sabins 1973). Year-round spawning with peaks in January to February and April to June is reported in South Florida (Jannke see footnote 6). Spawning occurs at least April to July in South Carolina waters, according to data presented in the present study.

Spawning reportedly occurs primarily in estuarine and coastal waters, and this is indicated by my data also. Hildebrand and Cable (1930) reported captures of eggs and early larvae in estuaries and to 19-24 km offshore off Beaufort, N.C., but the reliability of their identifications is uncertain. Their descriptions of eggs and early larvae of *B. chrysoura* are insufficiently detailed to ensure separation from those of other sciaenid and perciform fishes. Jannke (see footnote 6) and Sabins (1973) judged from the small size of larvae caught in tidal passes that spawning must have occurred nearby in estuarine or coastal waters. Specimens I examined were mostly taken in South Carolina estuaries and tidal passes, with only one specimen coming from continental shelf waters.

Larimus fasciatus

The information I have presented and the limited literature reports available indicate a long spawning period, extending at least from May to October, for *L. fasciatus*. Although larvae were more abundant in MARMAP tows made from August to September than tows made from April to May, larvae were abundant in NMFS Sandy Hook

Laboratory plankton tows made in May and in July. Hildebrand and Cable (1934) took specimens of length <5 mm from July to October off Beaufort, but presence of small juveniles in these months indicated spawning began in May. Larvae were taken from April to October in plankton tows between Chesapeake Bay and Cape Lookout, N.C. (Berrien et al. 1978).

Spawning apparently occurs in continental shelf waters. I obtained no larvae from South Carolina estuaries, but larvae were abundant in continental shelf plankton tows. Hildebrand and Cable (1934) took larvae from the coast to 22 km offshore. Larvae were common in plankton tows in continental shelf waters between Chesapeake Bay and Cape Lookout (Berrien et al. 1978).

Stellifer lanceolatus

My data point to spawning at least in June and July in South Carolina waters; later spawning may occur but no samples were available from the second half of the year. Hildebrand and Cable (1934) reported presence of small larvae from July to September, but their small "*S. lanceolatus*" were probably *L. fasciatus* so this report may not be accurate. Welsh and Breder (1923) reported spawning in late spring and early summer on the U.S. east coast, and Dahlberg (1972) reported May to September spawning off Georgia. Fahay (1975) reported a 28.2 mm SL specimen taken in October off Florida.

Spawning in coastal and estuarine waters rather than continental shelf waters was indicated by my observations. Hildebrand and Cable (1934) reported small larvae from the coast to 22 km offshore, but again these larvae may have been misidentified. Larvae have been taken in Georgia estuaries (Berrien[8]). Fahay's (1975) single specimen was from inshore 7.5 km south of Cape Canaveral; being relatively large, this specimen could have originated in another spawning area.

Comparisons With Other Larval Sciaenidae

Larimus fasciatus

Although superficially similar to larvae of several other marine sciaenids, of the southeast United States, *L. fasciatus* larvae are easily separated from all others by pigmentation, fin development sequence, and preanus distance. Forebrain pigment and pectoral fin pigment are not present in early larvae (larvae with dorsal and anal fin rays undeveloped or incompletely developed) of other sciaenids of the area, and pigment on the anterior surface of the midbrain appears earlier than in other sciaenids of the area. Pectoral fin rays begin development earlier than in other sciaenids of the area, in fact earlier than in larvae of most known teleosts. The preanus distance of >50% SL is greater than in other sciaenid larvae of the area.

Bairdiella chrysoura and *Stellifer lanceolatus*

These species are treated together because they are quite similar as larvae, and resemble larvae of other species, notably *Cynoscion regalis* (Pearson 1941) and *Cynoscion nothus* (Stender[9]). Typical larvae of *B. chrysoura* have a well-developed swath of pigment from nape to cleithral symphysis, which is not found in larvae of the other species; however, melanophores of the swath may be contracted or faded by preservation. Pigment of the ventral midline posterior to the anus is the most reliable character for separation of *B. chrysoura* from *S. lanceolatus* larvae. Both have a melanophore at the posterior end of the anal fin base; however, *B. chrysoura* has a melanophore anterior to the anal fin base (at 4.1-7.0 mm SL) and a melanophore at the anterior end of the anal base, while *S. lanceolatus* has no melanophore anterior to the anal base but has a melanophore just posterior to the anterior end of the anal base (at the base of the second anal spine when this is developed).

Larvae of the two *Cynoscion* species mentioned can be separated from larval *B. chrysoura* and *S. lanceolatus* by careful attention to pigment of the midventral line (Stender see footnote 9; pers. observ.). Identification of small larvae with undeveloped anal fin bases may be difficult, since the characteristic pigment sequences develop (from a row of small melanophores) at about the same time as anal-base development. Presence of a melanophore in the dorsal midline, above the posterior end of the anal base, in most *S. lan-*

[8]Peter L. Berrien, Fishery Biologist, Northeast Fisheries Center Sandy Hook Laboratory, National Marine Fisheries Service, NOAA, Highlands, NJ 07732, pers. commun. May 1975.

[9]Bruce W. Stender, Biologist, South Carolina Wildlife and Marine Resource Division, P.O. Box 12559, Charleston, SC 29412, pers. commun. February 1978.

ceolatus 2.9-6.9 mm SL may also assist in separating the species; such a melanophore is present in only a few *B. chrysoura* at ≤3.5 mm SL.

Cynoscion regalis has a single melanophore in the dorsal midline above the anal fin throughout development.

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