UNITED STATES DEPARTMENT OF THE INTERIOR
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FISH AND WILDLIFE SERVICE
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Fishery Bulletin 36

THE YOUNG OF SOME MARINE FISHES TAKEN IN LOWER CHESAPEAKE BAY, VIRGINIA, WITH SPECIAL REFERENCE TO THE GRAY SEA TROUT *Cynoscion regalis* (BLOCH)

By JOHN C. PEARSON

From FISHERY BULLETIN OF THE FISH AND WILDLIFE SERVICE
Volume 50

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1941

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - - - - - - - - Price 10 cents

ABSTRACT

Plankton collections made at the mouth of Chesapeake Bay, Va., yielded specimens of 45 species of marine fishes that were recognized. As a result of these weekly collections during the summer and biweekly collections during the winter, from May to October 1929, from April to December 1930, and during January and March 1931, sufficient data were acquired to provide distributional and descriptive data on 31 of the 45 species recognized.

Larval and postlarval stages of the gray sea trout, or weakfish, *Cynoscion regalis;* the bluefish, *Pomatomus saltatrix;* the butterfish, *Poronotus triacanthus;* the harvestfish, *Peprilus alepidotus;* and the stargazer, *Astroscopus guttatus*, are described and illustrated.

Collections of juvenile gray sea trout by seine and trawl indicate that this food fish attains an average total length of 16 to 20 cm. at the end of its first year of growth in lower Chesapeake Bay.

THE YOUNG OF SOME MARINE FISHES TAKEN IN LOWER CHESAPEAKE BAY, VIRGINIA, WITH SPECIAL REFERENCE TO THE GRAY SEA TROUT *Cynoscion regalis* (BLOCH)

By JOHN C. PEARSON, *Aquatic Biologist, Fish and Wildlife Service*

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INTRODUCTION

Our knowledge concerning seasonal and geographic distributions of the planktonic young of most inshore marine fishes of the Atlantic coast is meager. This is especially true of certain common food fishes such as the weakfish, or gray sea trout, *Cynoscion regalis*, which provides the most valuable inshore fishery along the Middle Atlantic

seaboard. The importance of such information concerning our marine food fishes has been brought out by Bowman (1914), who asked

> Are the chief spawning places such that when the bulk of the larvae appear from the egg they find themselves in the immediate neighborhood of a locality suitable for development? To what extent do the prevailing physical conditions assist the passive eggs and helpless larvae in securing a suitable habitat for further development?

It is of considerable import to the annual success of the American fisheries that there should be an intimate connection between the spawning grounds of a species and the localities suitable for growth.

The present paper presents additional distributional and descriptive data on the young of a number of marine fishes regularly occurring in lower Chesapeake Bay. These data should help to increase our knowledge of the spawning season and spawning habitat of these fishes.[1]

METHODS

The area of Chesapeake Bay included in this study is bounded roughly by Cape Henry and Cape Charles on the east, Lynnhaven Roads on the south, Old Point Comfort on the west, and Back River Light on the north (fig. 1).

Plankton collections were made at weekly or biweekly intervals at definite points within this area with a meter ringnet towed by powerboat. All except two of the collecting stations were permanently marked with navigation buoys and nearly all plankton was taken at definite localities over the entire period of collection—extending from May to October 1929, from April to December 1930, and during January and March 1931. The period of each tow was standardized at 15 minutes, the tow usually being with the tide and at as constant a rate of speed as conditions permitted.[2] Collections were usually taken from 10:30 a. m. to 2:00 p. m. Both surface and subsurface tows were frequently made at each station. Subsurface tows were made from 10 to 20 feet below the surface of the water—the depth of water at no station exceeding 30 feet.

PLANKTONIC FISHES

Over 7,400 young fishes, representing 45 species, were taken in the plankton collections in lower Chesapeake Bay during 1929–30. Of the total number, 7,380 fishes were identified and separated into 31 recognizable species, while 50 fishes were separated into 14 unknown species. The planktonic young of the sea trout, *Cynoscion regalis*, constituted over 50 percent of the total number of fish identified; followed in abundance by the young of the common anchovy, *Anchoviella mitchilli;* the sea robin, *Prionotus* sp.; and the blenny, *Hypsoblennius hentz*.[3] The numerical seasonal relationship of the various species of larval and postlarval fishes in the plankton given by the month and year is presented in table 1.

The planktonic fishes, usually in larval or postlarval stages, were secured princi-

[1] Acknowledgment is due the War Department for extended use of laboratory space at Old Point Comfort, Va., and to the many fish dealers and fishermen about Hampton Roads for valued information and assistance. Special mention is due Miss Louella E. Cable for the original drawings (figs. 2 to 9, 12 to 21, 24, and 25) in this report.

[2] The length of the net was approximately 4 meters (13 feet), the upper 1½ meters of No. 0 silk bolting cloth (38 meshes to the inch), the lower 3 meters of No. 2 silk cloth (54 meshes to the inch), and a detachable cap of No. 12 silk cloth (150 meshes to the inch.

[3] Numerically the young of *A. mitchilli* were far more abundant in the plankton than the young of *C. regalis* but, owing to the labor involved, only a small proportion of young *mitchilli* was removed from the plankton, while all the young of *C. regalis* as well as all other species were removed and identified.

pally from April 1 to November 1.[4] The months from May to August yielded the most abundant catches, as well as the largest variety of species. While certain species, such as the blenny, *Hypsoblennius hentz*, and the common pipefish, *Syrictes fuscus*, were generally found widely distributed in the plankton from early spring until late fall, other species, such as the bluefish, *Pomatomus saltatrix*, occurred only once.

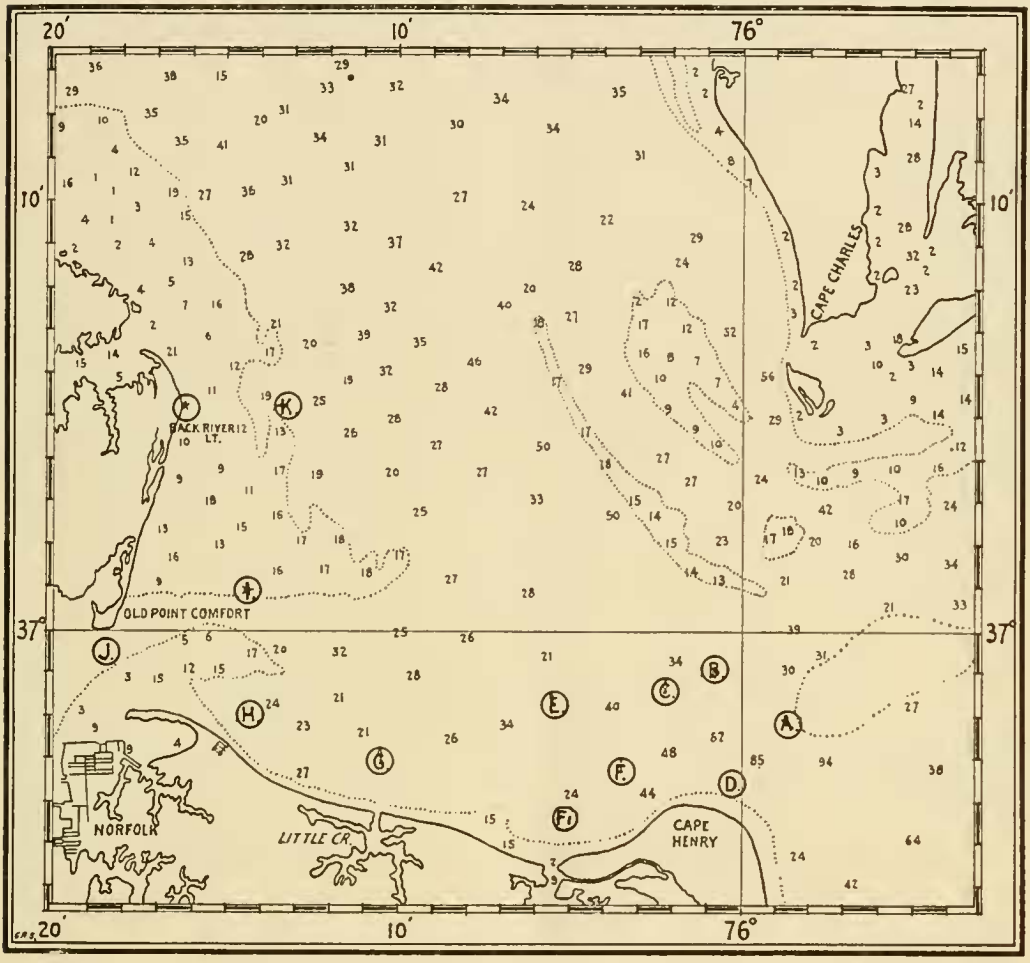

FIGURE 1.—Entrance to Chesapeake Bay, Va. Circled letters indicate plankton-collecting stations. Depth is given in feet.

Subsurface collections generally yielded a larger number of fishes than surface tows. Certain species, such as *Gobiesox strumosus*, however, were taken proportionately more often in surface than in subsurface hauls. Many investigators have found that the surface layers contain few larval fish during the day. Clark (1914), in a study of the larval and postlarval fishes in the vicinity of Plymouth, England, found that night

[4] The term "larval" as used in this paper refers to the growth stages of a fish from the time of hatching to the point where the fin rays appear differentiated and the young fish have considerable power of movement. The term "postlarval" refers to the growth stages following the development of the fin rays to a size where all traces of the larval fin fold have disappeared. The terms "larval" and "postlarval" fill a need for differentiating the more or less helpless young of many marine fishes from the juvenile young which have more or less complete control of their movements.

hauls yielded a much larger percentage of young forms from the surface layers than did day hauls. Possibly the same condition might have occurred if night collections had been made in Chesapeake Bay (table 2).

TABLE 1.—*Seasonal distribution of young fishes in the plankton, Chesapeake Bay, 1929–30. Nearly all fishes were taken in larval or early postlarval stages*

Species	April 1930	May		June 1929	July		August		September		October 1930	November 1930
		1929	1930		1929	1930	1929	1930	1929	1930		
Achirus fasciatus					34		34	45		1		
Anchoviella mitchilli			24	79	120	11	87	44	13	19		
Ancyclopsetta sp.					2							
Astroscopus guttatus					1	1						
Bairdiella chrysura				6	1							
Brevoortia tyrannus	2	1										
Centropristes striatus				1	55	2						
Conger conger	1											
Cynoscion regalis		9	8	2,468	1,540	268		5				
Etropus sp.				1	108	1						
Gobiesox strumosus		13	55	13	4		1	1				
Gobiosoma sp.				18	87	23	99	29	7	31	11	
Hippocampus hudsonius				6	3	2	2	2	1			
Hypsoblennius hentz		5	2	117	98	47	72	26	33	26	38	1
Lophius piscatorius			12									
Lophopsetta maculata	55	2	118									
Menidia menidia		7	12									
Menticirrhus americanus				30	34	73	23	4	10	1		
Microgobius thalassinus					11			1	1	12		
Micropogon undulatus						9		11	48	26	17	
Paralichthys sp.												1
Peprilus alepidotus					17	2	53	1				
Pomatomus saltatrix						4						
Poronotus triacanthus		5	4	82	75	32	26			8		
Prionotus sp.				138	223	63						
Rissola marginata					3	2	1		3	1	2	
Symphurus plagiusa					2							
Syngnathus floridae			2	3		1	1		1			
Syrictes fuscus		5	15	26	12	4	4	1	2	8	3	3
Tautoga onitis			10									
Sphoeroides maculatus			22	58	14	3	2			1		

TABLE 2.—*The surface and subsurface distribution of planktonic fishes in Chesapeake Bay, expressed as the percentage of hauls in which the various species occurred*

[108 surface and 140 subsurface hauls were made from May to October, 1929, and 111 surface and 168 subsurface hauls from April to December, 1930, omitting June. No fishes were obtained in 24 surface hauls and 47 subsurface hauls made in January and March, 1931]

Species	Percent of hauls, 1929		Percent of hauls, 1930		Species	Percent of hauls, 1929		Percent of hauls, 1930	
	Surface	Subsurface	Surface	Subsurface		Surface	Subsurface	Surface	Subsurface
Achirus fasciatus	3	14		3	*Lophopsetta maculata*	1	1	20	22
Anchoviella mitchilli	5	18	9	12	*Menidia menidia*	4		6	4
Ancyclopsetta sp.			1		*Menticirrhus americanus*	8	22	3	6
Astroscopus guttatus		1		1	*Microgobius thalassinus*	1	1		2
Bairdiella chrysura		4			*Micropogon undulatus*		3	5	12
Brevoortia tyrannus	2	1			*Paralichthys* sp.			1	
Centropristes striotus	1	5		2	*Peprilus alepidotus*	6	16	1	2
Conger conger				1	*Pomatomus saltatrix*				1
Cynoscion regalis	12	40	9	9	*Poronotus triacanthus*	12	25	2	10
Etropus sp.	3	9		1	*Prionotus* sp.	3	16	3	4
Gobiesox strumosus	10	8	11	6	*Rissola marginata*	1	5	1	2
Gobiosoma sp.	4	24	5	7	*Symphurus plagiusa*		1		
Hippocampus hudsonius	2	6	1	2	*Syngnathus floridae*	1	3	2	1
Hypsoblemius hentz	17	43	17	16	*Syrictes fuscus*	7	16	12	11
Lophius piscatorius			7	5	*Sphoeroides maculatus*	6	21	9	8
					Tautoga onitis	10	9		

BREVOORTIA TYRANNUS (Latrobe). Menhaden; Fatback

Distribution.—Young menhaden were taken four times during May 1929 and April 1930 near Old Point Comfort. The scarcity of young indicates that spawning probably occurs outside of the area of collection, although a limited number of menhaden eggs were taken during late summer. The occurrence of these young fish in early spring indicates that some spawning occurs during the winter months, as suggested by Hildebrand and Schroeder (1927).

Description.—The young menhaden were from 20 to 24 mm. in length. The young of the species have been described by Kuntz and Radcliffe (1918).

ANCHOVIELLA MITCHILLI (Cuvier and Valenciennes). Anchovy

Distribution.—Young anchovies were taken from July 6 to Sept. 13, 1929, and from May 16 to Sept. 13, 1930. The larval and postlarval young were the most numerous of all species of fishes in the plankton. The separation of *A. mitchilli* from its relative, *A. epsetus*, is difficult if not impossible for young under 5 mm. Consequently, numbers of young *A. epsetus* may be represented in the collections of *A. mitchilli*. According to the relative abundance of eggs and adults of the two species in lower Chesapeake Bay, however, *mitchilli* far outnumbers *epsetus*.

Description.—The size range of the young extended from 2.5 to 20.0 mm. The young of *A. mitchilli* have been described by Kuntz (1914) and the young of *A. epsetus* by Hildebrand and Cable (1930).

CONGER CONGER (Linnaeus). Conger eel

Distribution.—A leptocephalus, probably that of *C. conger*, was taken on Apr. 18, 1930, at Station J.

Description.—The larva measured 100 mm. in length and possessed 150+ myomeres.

LOPHOPSETTA MACULATA (Mitchell). Windowpane

Distribution.—The young of the windowpane flounder were taken during April and May 1930, at stations nearest the sea. The appearance of young only during April and May suggests an early spring spawning season in the region of Chesapeake Bay.

Description.—The young ranged from 2 to 10 mm. in length. They are quite distinctive in appearance. Several stages of the young have been described by Bigelow and Welsh (1925).

ETROPUS sp. Etrope

Distribution.—Planktonic young of this small flatfish were taken principally in July 1929.

Description.—This fish ranged in length from 2.5 to 13 mm. Although the correct generic identification of the young was possible through counts of fin rays of the larger specimens, doubt exists as to the specific identity owing to the probable presence of two species of the genus in the Chesapeake Bay area—namely, *E. crossotus* and *E. microstomus*.

PARALICHTHYS sp. Flounder

Distribution.—A fish, perhaps referable to the summer flounder, *P. dentatus*, was taken on Nov. 28, 1930, at Station B.

Description.—The fin rays of this fish, measuring 10 mm. in length, were differentiated, but the eye had not completed transition. Pigmentation consisted of three parallel rows of weak chromatophores lying along the dorsal, median, and ventral sides of the body. Each row contained eight distinct chromatophores. The specimen was too badly damaged to permit accurate fin-ray count, although the latter fell within the known range of *P. dentatus*.

ANCYLOPSETTA sp. Flounder

Distribution.—Two planktonic young taken on July 12, 1929, at Station B are probably referable to this genus of flatfishes.

Description.—The young measured 5 and 6 mm. in length. The most characteristic features of the two fish are the pronounced elongation of the first two dorsal rays, the latter reaching nearly a quarter the length of the body, and the elongation of one of the ventral fins into a filament extending to the vent. The other ventral fin is not evident and apparently is undifferentiated.

The pigmentation consists of a series of six chromatophores along the upper side of the body; a single chromatophore along the median line on the posterior part of the body; a thin, black, continuous line along the ventral edge of the body; and many branching chromatophores on the ventral surface of the abdominal cavity. The fishes are symmetrical in shape.

ACHIRUS FASCIATUS (Lacépède.) American sole; Hog choker

Distribution.—The planktonic young of this flatfish were taken during July 1929, August 1929–30, and September 1930. Most young were obtained during July 1929 and August 1929–30. This seasonal distribution indicates that the species spawns largely in midsummer. The greatest abundance of young was found about 1 mile off Little Creek, Virginia, near Station G. The latter estuary contains many adult and young fish during the summer months, and may constitute a spawning area.

Description.—The length range of planktonic young extended from 1.5 to 4 mm. At 4 mm. the fin rays are clearly differentiated and identification is easily determined. The close resemblance of larval fish at 1.5 mm. to larger sizes permits ready identification. A strikingly heavy black pigmentation is characteristic of all young *Achirus*. The latter at 4 mm. in length still retain a symmetrical shape with an eye on each side of the head.

The young have been described by Hildebrand and Cable (1938).

SYMPHURUS PLAGIUSA (Linnaeus). Tonguefish

Distribution.—Several larval tonguefish were secured at Station A on July 9, 1929.

Description.—The fish ranged from 5 to 6 mm. in length. The young of this species has been described by Hildebrand and Cable (1930) and is readily identified.

SYNGNATHUS FLORIDAE (Jordan and Gilbert). Pipefish

Distribution.—The young of this species were taken during June, August, and September 1929, and during May and July 1930, at many localities.

Description.—The young pipefish ranged in length from 14 to 48 mm. Identification was based on body and tail ring counts.

SYRICTES FUSCUS (Storer). Common pipefish

Distribution.—The young of this species were taken from May 11 to Sept. 16, 1929, and from May 6 to Nov. 22, 1930.

Description.—The length of the young ranged from 9 to 50 mm. Identification was based on body and tail ring counts.

HIPPOCAMPUS HUDSONIUS De Kay. Seahorse

Distribution.—The young of the seahorse, *Hippocampus hudsonius*, were taken in plankton from June 6 to Sept. 13, 1929, and from July 7 to Sept. 12, 1930. Although spawning may occur within the bay, the young seahorses were generally taken in masses of floating sea vegetation and probably had drifted in from open sea.

Description.—The young fish ranged from 6 to 33 mm., which included the distance from the tip of the snout (head flexed) to the end of the caudal fin. The young of the species has been described by Ryder (1881).

MENIDIA MENIDIA (Linnaeus). Silverside

Distribution.—The young of the silverside were taken in plankton during May 1929–30. Most young were secured at stations well within the bay. Hildebrand and Schroeder (1928) stated that the largest number of ripe adult *Menidia* occurred in April and May.

Description.—The length range of the young extended from 5 to 9 mm. The various developmental stages have been described by Kuntz and Radcliffe (1917) for the northern form, *M. menidia notata*, and by Hildebrand (1922) for the southern, or typical form, *M. menidia*.

PEPRILUS ALEPIDOTUS (Linnaeus). Harvestfish

Distribution.—The young of this important food fish were taken in the plankton during July and August, 1929–30, at all stations.

The appearance of the young fish accompanied the incursion of large numbers of the coelenterates, *Dactylometra* and *Cyanea*. The long tentacles of these stinging "jellyfish" appear to act as a shelter and possibly as a food provider for the young harvestfish, for young fish were frequently observed hovering under the coelenterates.

Description.—The lengths of the young fish ranged from 1.5 to 32 mm. The young harvestfish at 1.8 mm. in length has the larval yolksac absent and the larval fin fold entire. The larval gut is elongate, reaching about half the length of the body. A lateral pigmentation occurs as a scattering of black chromatophores on the body (fig. 2).

At 2.5 mm. the young fish possesses the lateral chromatophores in a more pronounced and characteristic pattern. One series of pigment cells follows the median line of the body from the pectoral fin to about half way the length of the body, while another, more regular series, lies along the lower side of the body dorsal to the gut. Scattering anastomosed chromatophores are found above the opercle and along the

posterior sides of the abdominal cavity. The fin fold remains entire. A reduction in the length of the gut occurs at 2.5 mm. and what appears to be a secondary, or true vent is developed anterior to the gut. Several young at this length showed this peculiar structure, the exact nature of which has not been determined (fig. 3).

FIGURE 2.—*Peprilus alepidotus*. From a specimen 1.8 mm. long.

The harvestfish at 3.5 mm. is more compressed, the gut has become greatly reduced and only one vent is evident. The location of the chromatophores becomes

FIGURE 3.—*Peprilus alepidotus*. From a specimen 2.5 mm. long.

more elevated. The fin rays are slightly differentiated, although the fin fold remains entire (fig. 4).

The young fish can be easily recognized at 7 mm. for the fin rays are fully differentiated. A further deepening of the body takes place and the chromatophores

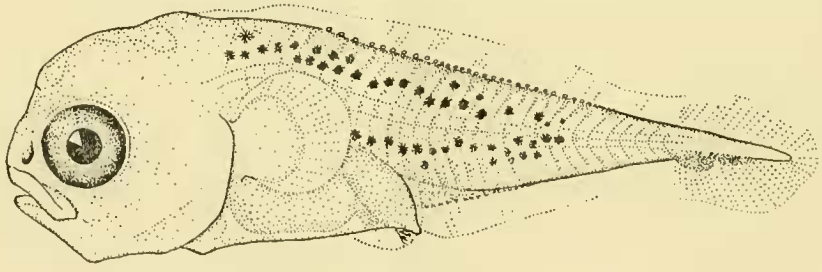

FIGURE 4.—*Peprilus alepidotus*. From a specimen 3.5 mm. long.

become more scattered, enlarged, and anastomosed. The pigmentation is confined to the forward part of the body (fig. 5).

The young fish becomes still further compressed at 9 mm. The pigmentation is darker and a considerable reduction in the size of each chromatophore occurs (fig. 6).

The fish has assumed a characteristic adult shape at a length of 62 mm. The body has become strongly compressed, deep, and oval. The caudal fin has become forked, while the dorsal and anal fins are similar in shape and notably elevated ante-

riorly. The body chromatophores have disappeared and their place is taken by a thick peppering of black dots over the sides. The tips of the elevated dorsal and anal fins are heavily pigmented with black (fig. 7).

PORONOTUS TRIACANTHUS (Peck). Butterfish

Distribution.—Young butterfish were taken abundantly in plankton from May 25 to Aug. 19, 1929, and from May 28 to Sept. 12, 1930. The young fish, similar to

FIGURE 5.—*Peprilus alepidotus*. From a specimen 7 mm. long.

Peprilus, were generally found in association with the coelenterates, *Dactylometra* and *Cyanea*. Butterfish 6 mm. long were secured from May 25 to July 23, indicating a late spring and early summer spawning season. The young were taken at all collecting points.

Description.—The young butterfish ranged from 1.8 to 57 mm. in length. On the basis of an extensive series of butterfish from Chesapeake Bay, the writer believes

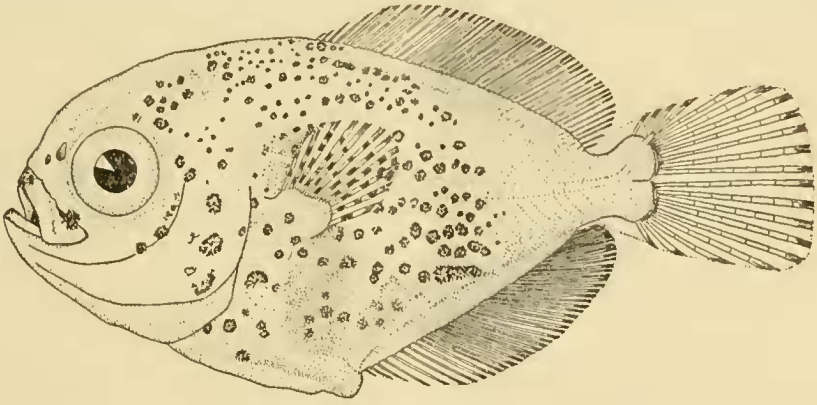

FIGURE 6.—*Peprilus alepidotus*. From a specimen 9 mm. long.

the fish represented in figures 62, 63, 64, and 65 (Kuntz and Radcliffe 1918) are not the young of the butterfish, *Poronotus triacanthus*, but most probably the young of a hake, *Urophycis*. Several fish obtained in Chesapeake Bay in 1929 are herein described as larval butterfish. Several figures of larger butterfish from Kuntz and Radcliffe (1918) are reproduced to show the gradual transformation to the adult shape.

The smallest butterfish taken in the plankton measured 1.8 mm. A fish at this length has lost the yolksac but has the larval fin fold entire. The pectorals are faintly outlined, and a few rays of the caudal are discernable. A series of anastomosed

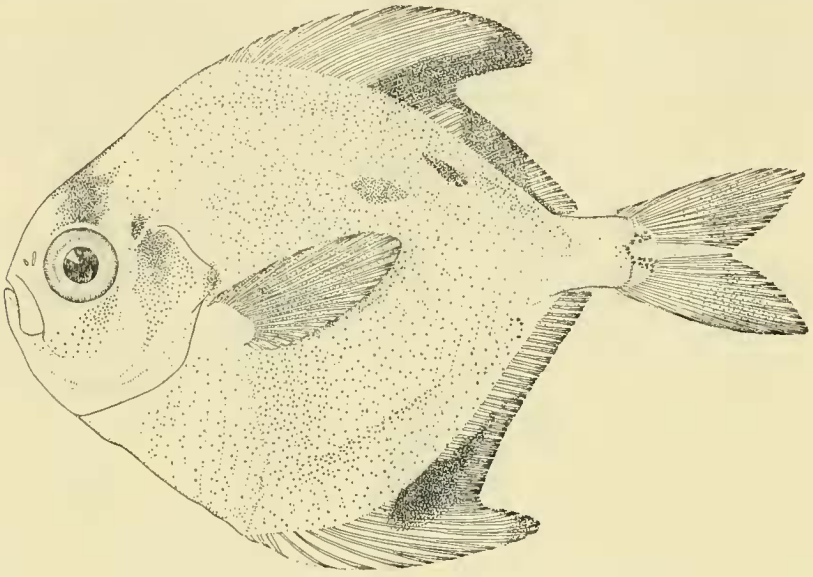

FIGURE 7.—*Peprilus alepidotus*. From a specimen 62 mm. long.

chromatophores lies along the dorsal region of the abdominal cavity. The ventral edge of the abdominal cavity and the body is sharply bordered with a solid narrow black line (fig. 8).

The young possesses a deeper body at 3.7 mm. The fin fold is still entire, although the rays of the caudal are becoming differentiated. The same arrangement

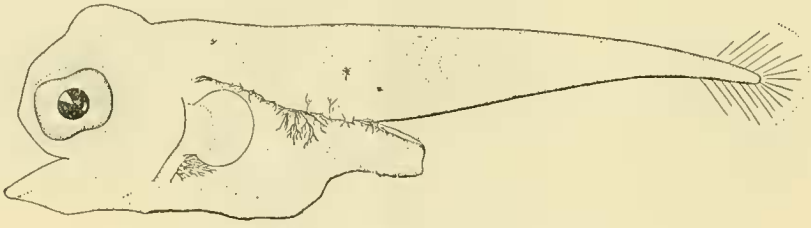

FIGURE 8.—*Poronotus triacanthus*. From a specimen 1.8 mm. long.

of chromatophores exists as in smaller fish, but an additional series of markings are now found along the ventral edge of the body from the gut to the caudal fin. Scattered chromatophores may appear at random along the sides, although never abundantly or in any definite arrangement as in young *Peprilus* (fig. 9).

Succeeding stages of development have been described by Kuntz and Radcliffe.[5] (figs. 10 and 11).

[5] Perlmutter (1939) has also recognized the erroneous descriptions by Kuntz and Radcliffe (1918) and has given figures of young butterfish 2.8 mm. and 3.5 mm. length.

POMATOMUS SALTATRIX (Linnaeus). Bluefish

Distribution.—One plankton tow on July 24, 1930 at Station B yielded four specimens of young bluefish.

Description.—The young ranged from 4 to 7 mm. in length. The bluefish at 4.3 mm. has the larval fin fold entire, although the dorsal, anal, and caudal fin rays

FIGURE 9.—*Poronotus triacanthus*. From a specimen 3.7 mm. long.

FIGURE 10.—*Poronotus triacanthus*. From a specimen 6 mm. long. From Kuntz and Radcliffe (1918).

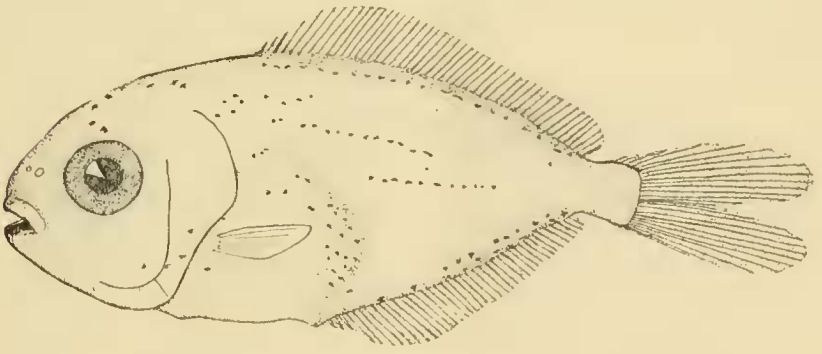

FIGURE 11.—*Poronotus triacanthus*. From a specimen 15 mm. long. From Kuntz and Radcliffe (1918).

are slightly differentiated. The yolksac is absent. Three distinctive series of black dashes occur laterally on the body; one along the dorsal ridge, another along the median line, and the other along the ventral edge. Other chromatophores occur above the abdominal cavity and on the top of the head. The teeth are well developed and appear quite diagnostic. The writer is unfamiliar with any other local fish in which the teeth are so strongly developed at such an early age (fig. 12).

At 7.3 mm. the fish has lost its larval fin fold and the fin rays are clearly differentiated. The pigmentation remains essentially the same, but the lateral markings have become more pronounced and the dashes are now joined to form narrow black

FIGURE 12.—*Pomatomus saltatrix.* From a specimen 4.3 mm. long.

bands. The number of chromatophores on the head and on the abdominal cavity also increases (fig. 13).

A later stage at 26 mm. no longer possesses the lateral bands but the entire body

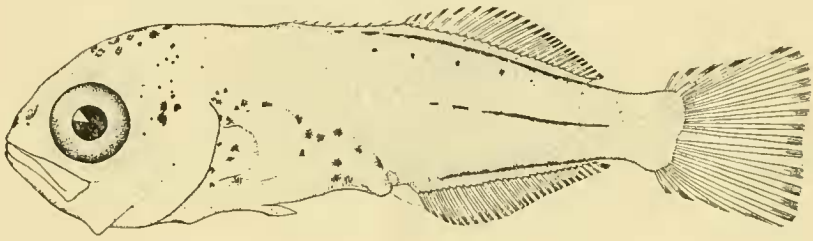

FIGURE 13.—*Pomatomus saltatrix.* From a specimen 7.3 mm. long.

is covered with fine black dots. The caudal fin has become forked and the fins, particularly the spinous dorsal, have become further developed (fig. 14).

At 72 mm. the young bluefish closely resemble the adult, except that the young fish has a silvery sheen in life and in preservation appears thickly peppered with fine

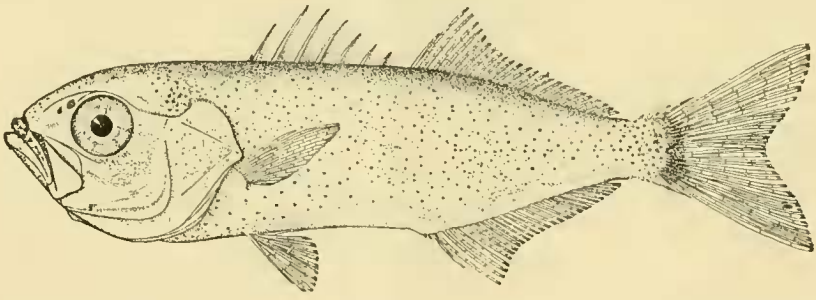

FIGURE 14.—*Pomatomus saltatrix.* From a specimen 26 mm. long.

dots (fig. 15). Both figures 14 and 15 were furnished to the writer by Samuel F. Hildebrand and Louella E. Cable. The bluefish represented in these illustrations were taken off the coast of North Carolina, near Beaufort.

CENTROPRISTES STRIATUS (Linnaeus). Sea bass; Blackfish

Distribution.—Larval and early postlarval sea bass were secured during June 1929 and July 1929–30. Most young were taken in July 1929 at Station A.

Description.—The length range of the young extended from 2.5 to 9 mm. Young sea bass remain undescribed but comparison with a series of known sea bass from southern New England waters establishes the identity of the Chesapeake fish. Fin rays may be counted when the young reach 9 mm. in length. A distinctive type of pigmentation along the ventral edge of the body is characteristic of the larvae.

BAIRDIELLA CHRYSURA (Lacépède). Sand perch

Distribution.—The young of *Bairdiella chrysura* apparently are hatched largely outside of the area of collection, for only seven larval and postlarval fish were taken in the plankton. The young were secured from June 7 to July 1, 1929, principally at Stations A and B. Young fish ranging from 6 to 28 mm. were commonly taken by trawl on the muddy bottom in Little Creek in July 1930.

Description.—The planktonic fish were from 2.5 to 5 mm. in length. Larval and postlarval sand perch are recognized by two vertical bands, the first behind the head

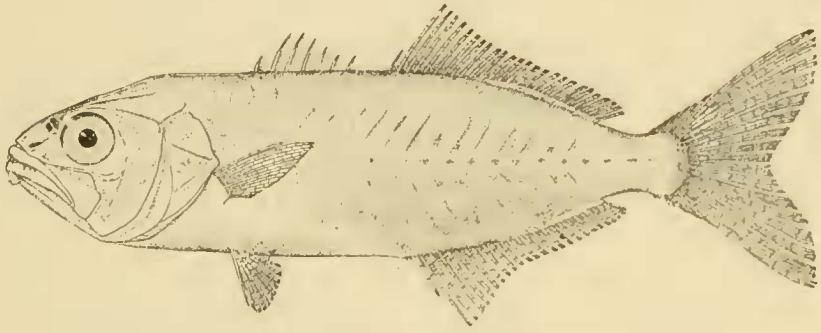

FIGURE 15.—*Pomatomus saltatrix*. From a specimen 72 mm. long.

and the second, less pronounced, about two-thirds the distance from the vent to the tip of the tail. The band nearest the tail is often weak and indistinct. Kuntz (1914) described the eggs and the young of the species.

MICROPOGON UNDULATUS (Linnaeus). Croaker

Distribution.—Notwithstanding a great abundance of juvenile croakers within lower Chesapeake Bay throughout the year, a relatively small number of larval and postlarval fish were taken in the plankton. Young fish were taken on Sept. 13, 1929, and from July 29 to Oct. 17, 1930. Practically all catches were made at stations nearest the sea.

An extended spawning period for croakers noted by Hildebrand and Cable (1930) in North Carolina evidently occurs also in the region of Chesapeake Bay.

Description.—The young croakers ranged from 1.5 to 15 mm. in length. Larval croakers and larval gray sea trout appeared together in the plankton on several occasions in late July 1930. The two species closely resemble each other when newly hatched. The young croaker at 2 mm. in length, however, possesses a much deeper body than the sea trout at the same size. The croaker usually has a dark, crescent-shaped area above the abdominal cavity, while this marking is usually not as distinct in young sea trout. The pronounced chromatophore at the base of the anal fin, found on all young sea trout, is not especially pronounced on young croakers, although

the latter do have a series of ventral chromatophores that greatly resemble comparable markings on the sea trout. The ventral chromatophores on the croaker are more numerous, however, and more evenly spaced than on the young sea trout. A perceptible difference in the shape of the head and snout is also evident in the two species. Larval and young croakers have been described by Welsh and Breder (1923), Pearson (1929), and Hildebrand and Cable (1930).

MENTICIRRHUS AMERICANUS (Linnaeus). Kingfish; Whiting

Distribution.—The young of *Menticirrhus americanus* were secured abundantly from June 12 to Sept. 13, 1929, and from July 21 to Sept. 2, 1930. The largest collections were made at Stations A, B, and C.

Description.—The length-range of young extended from 1.5 to 7 mm. Young fish, 3 to 7 mm. long, are characterized by profuse jet-black chromatophores scattered over the entire body. Under 3 mm. pigmentation is restricted to an area along the median line of the body. The jaws at all sizes are tipped with black. Fin-ray counts are possible at 5 mm.

The young of *M. americanus* may be confused with the young of *M. saxatilus*, a closely related species. However, a comparison with a description of young *saxatilus* by Welsh and Breder (1923) and of *americanus* by Hildebrand and Cable (1934) indicates that the fish from Chesapeake Bay most probably represent the young of *americanus*.

CYNOSCION REGALIS (Bloch and Schneider). Gray sea trout; Weakfish; Squeteague

Distribution.—Over 4,000 young gray sea trout were taken in plankton hauls from May 25 to July 25, 1929. The majority of fish were secured at Stations A, B, C, and D during the latter half of June 1929. In 1930 planktonic sea trout were taken from May 21 to Aug. 1. The seasonal distribution of the young sea trout thus corresponds closely for 2 successive years (table 1 and fig. 23).

The young of the gray sea trout were taken in 55 subsurface tows, with an average of 67 fish to a tow, and occurred in 13 surface tows, with an average of 25 fish to a tow. While more subsurface than surface tows were made, a comparison of simultaneous surface and subsurface hauls at the same station indicates that in most instances the subsurface tow contained far more young fish than the surface tow.

The planktonic sea trout decreased in abundance at those stations farther within the bay, compared with localities nearer to the sea. However, protected coves and creeks in the vicinity of Lynnhaven Roads yielded large quantities of young fish (8 mm. and over) just leaving the planktonic existence for a semidemersal life. The young fish were found on the bottom, where they were readily obtainable by trawl and seine. Various creeks from Lynnhaven Roads to the York River also had their complement of young sea trout during early summer, all young probably originating on spawning grounds off the entrance to the bay.

Description.—The planktonic sea trout ranged from 1.5 to 7 mm. in length. At a length of 1.8 mm. they are characterized by a very elongated slender body and by a large eye covering most of the side of the head (fig. 16). The larval fin fold is entire but the pectorals are differentiated, although indistinct. The greatest depth of the body is contained 4.0 to 4.5 times in the length to the end of the notochord. A

series of small black chromatophores is present along the ventral edge of the body extending from the vent to the tail. A chromatophore at midcaudal length, or at the primitive base of the anal, is consistently more pronounced than the rest. Several small chromatophores are found along the ventral edge of the abdomen. No other color markings are evident. The yolksac has been absorbed at 1.8 mm., although Welsh and Breder (1923) found a yolksac present on young of 2.2 mm. length taken in Delaware Bay.[6]

The young sea trout at 3 mm. has the body depth proportionately increased. The only color marking is the series of chromatophores along the ventral edge of the

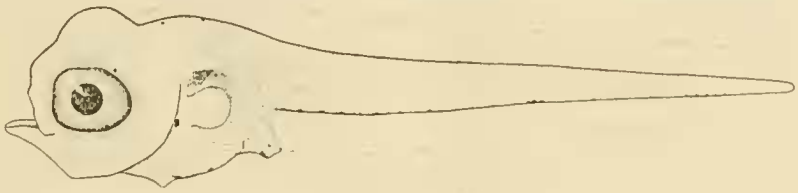

FIGURE 16.—*Cynoscion regalis*. From a specimen 1.8 mm. long.

body. All chromatophores become more pronounced, particularly the one at midcaudal length. The fin fold remains entire. Minute teeth, usually evident at this length, help to distinguish the young sea trout from some related Sciaenidae such as the sand perch, *Bairdiella chrysura*, and the croaker, *Micropogon undulatus* (fig. 17).

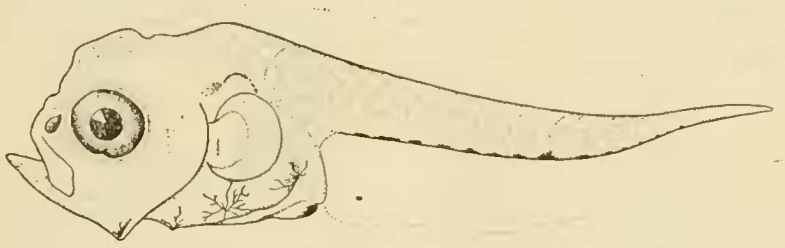

FIGURE 17.—*Cynoscion regalis*. From a specimen 3 mm. long.

The young sea trout at a length of 4.6 mm. has the caudal fin rays evident and shows a slight differentiation of the anal and dorsal fin rays. The fin fold remains entire. The greatest depth of the body is contained 2.7 to 3.0 times in the length to the end of the notochord. The series of ventral chromatophores has largely disappeared, with the exception of the spot at the base of the anal which appears enlarged and anastomosed. This anal spot is significant for it apparently distinguishes the young of *C. regalis* from both *C. nebulosus* and *C. nothus*. Markings on the abdominal cavity are also pronounced. The mouth is more oblique and the teeth further developed (fig. 18).

The young fish is quite readily identified at 8.2 mm. for the anal fin rays are usually distinct, while the soft dorsal rays are almost fully differentiated. The fin fold remains entire to the caudal fin. The greatest depth of the body is now contained about 2.8 times in the standard length. The snout is quite blunt, the lower jaw

[6] All length measurements in this paper are referable to preserved specimens and denote total length.

projecting but little. The chromatophore at the base of the anal is extremely pronounced, while the markings on the abdominal cavity are somewhat reduced in size and intensity (fig. 19).

At 10.5 mm. the young have usually passed out of a planktonic existence and have adopted a semibottom habitat in quiet, muddy coves and creeks. Lateral chroma-

FIGURE 18.—*Cynoscion regalis.* From a specimen 4.6 mm. long.

tophores now profusely appear, although the spot at the base of the anal still persists. The fin fold has nearly disappeared, while the caudal fin has changed to a symmetrically pointed shape (fig. 20).

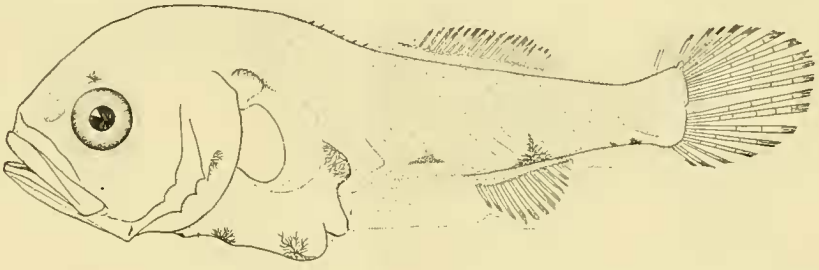

FIGURE 19.—*Cynoscion regalis.* From a specimen 8.2 mm. long.

At 17 mm. in length the young are characterized by the presence of heavy lateral chromatophores arranged in four indistinct vertical bands or saddles. The chromatophore at the base of the anal has now disappeared. The amount and intensity of

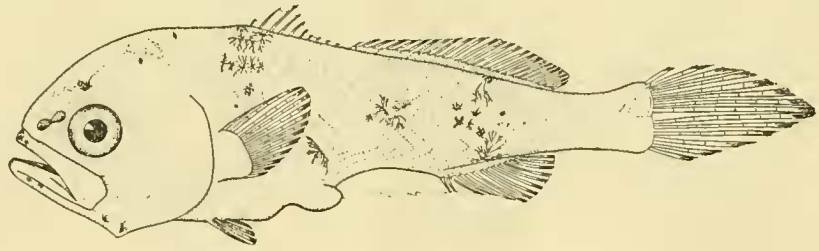

FIGURE 20.—*Cynoscion regalis.* From a specimen 10.5 mm. long.

pigmentation along the sides of the body seem to depend largely on the type of environment in which the fish is found. Young taken on sandy and light bottom do not have as much pigmentation as fish secured on a muddy, or dark bottom. Tracy (1908), for instance, found several young gray sea trout in sunken canvas bags off Rhode Island

which at 6.5 and 12.5 mm. in length possessed more extensive pigmentation than fish of corresponding sizes taken in Chesapeake Bay. The greatest depth of the body is contained about 3.3 to 3.4 times in the standard length. In both larval and postlarval stages of the gray sea trout the body continues to increase in proportionate depth until at about 17 mm. it commences to decrease. In other words, the body becomes

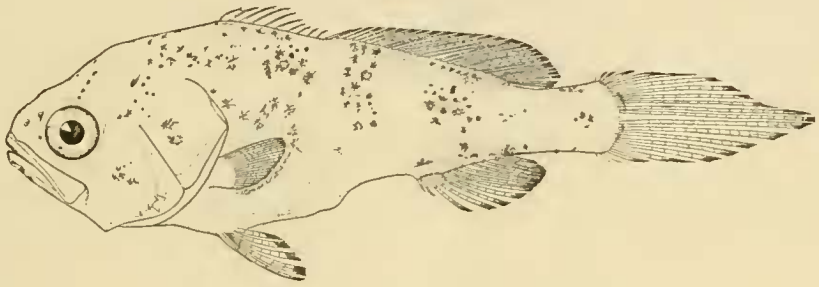

FIGURE 21.—*Cynoscion regalis*. From a specimen 17 mm. long.

progressively stouter and shorter in proportion to length from the slender, newly hatched fish up to about 17 mm. in length, while after 17 mm. is reached the body tends to become more slender and elongate (fig. 21).

Young sea trout over 17 mm. in length are characterized largely by four distinct saddles on the body. Both Eigenmann (1901) and Breder and Welch (1922) have described various stages of the young sea trout (fig. 22).

Growth.—Juvenile sea trout were found to grow rapidly during their first summer. Planktonic young ranging from 8 to 10 mm. soon settle to the bottom after entering

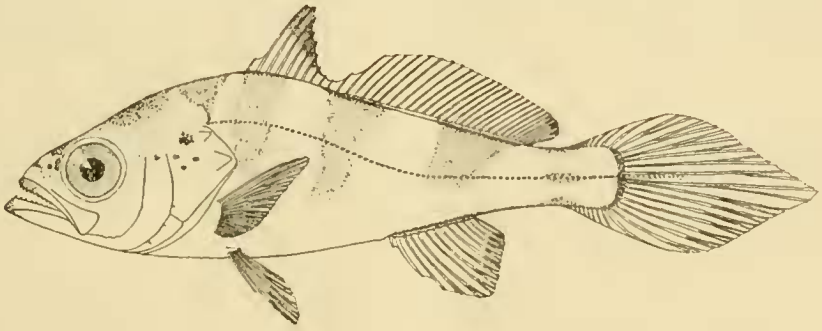

FIGURE 22.—*Cynoscion regalis*. From a specimen 32 mm. long. From Welsh and Breder (1923).

Chesapeake Bay. Brackish creeks and coves are favorite shelters for the young. Collections of fish at varying intervals during 1929–30 indicate that the young attain an average length of 16 to 20 cm. (6.3 to 7.8 in.) by the end of the first year. A growth diagram of young sea trout collected during their first summer and following spring is shown in figure 23.

The length-range of young fish taken during the summer of 1930 is considerably less than for fish secured in 1929. This difference appears largely due to size selection by the type of fishing gear employed. Seines were used exclusively during 1929 and allowed a greater escapement of the smaller fish than occurred in 1930, when fine-meshed trawls were employed. Similarly, year-old fish taken during the spring

of 1930 by commercial pound nets were larger than fish of the same approximate age taken during June 1930 by experimental trawl. Unfortunately, larger series of young collected at regular intervals at various localities and with all types of gear could not be obtained in order to show the selectivity of the gear and the effect of environment on the size distribution of the young fish.

Notwithstanding limitations in the sampling of the juvenile sea trout population, it is believed that the average growth during the first year of life in lower Chesapeake Bay is reliably shown by figure 23. The young sea trout evidently have a length range of at least 10 cm. at the end of the first year of growth. Any clear-cut growth curve must involve large collections of young from diverse localities and by varied types of collecting gear.

Eigenmann (1901) stated that juvenile sea trout (squeteague) doubled their length during July and August. This observation appears substantiated for Chesa-

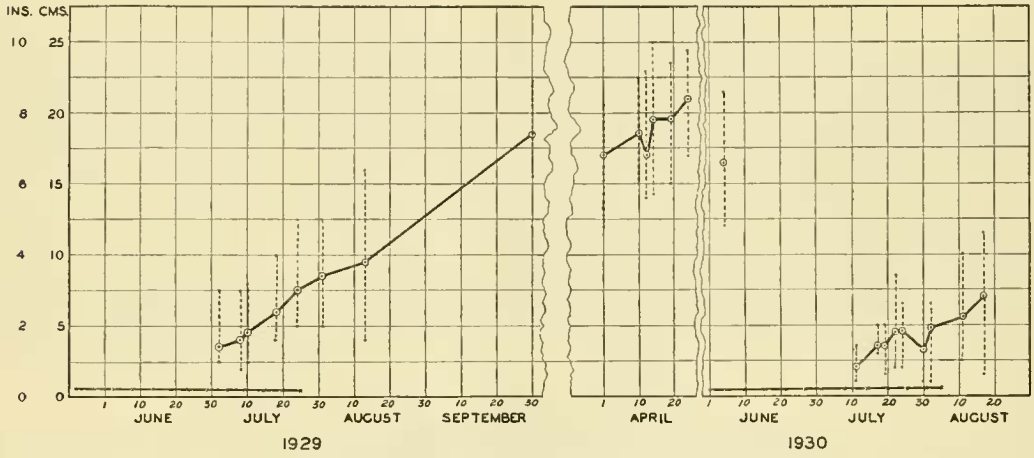

FIGURE 23.—Spawning period and juvenile growth of gray sea trout, *Cynoscion regalis*, in lower Chesapeake Bay. A circle is placed at the mean length of the frequency distribution represented by the vertical dotted line. The horizontal solid line at the half-centimeter unit shows the approximate spawning period as indicated by collections of larval fish under 6 mm. in length. Young fish taken in April 1930 were secured by commercial pound net. All other fish were captured with experimental gear.

peake Bay fish taken on July 2, 1929, having an average length of 3.5 cm. Apparently these fish reached an average length of 8 to 9 cm. by the end of the month. Young fish in all instances were secured at the same locality and by the same fishing gear.

Welsh and Breder (1923), on the basis of length-frequency distributions from Delaware Bay, reached the conclusion that sea trout, averaging 3 cm. on July 1, should be 17 cm. in length on October 1. Such growth also appears substantiated by the collections in lower Chesapeake Bay.

Young sea trout appear to gather in schools in autumn at various places along the coast for departure to their winter habitat. For a brief period before departure they frequently appear in considerable numbers in pound nets. In table 3 are listed the lengths of young sea trout secured by R. A. Nesbit from pound-net catches in various localities.

Many juvenile sea trout remain in lower Chesapeake Bay during the greater part of their first year of life. Juvenile fish were obtained by the writer in the bay from

March to October, while Hildebrand and Schroeder (1928) found young in November and December. Although some fish may remain in the deeper waters throughout the winter, most young seek the warmer offshore oceanic water. Trawlers operating off the Virginia and North Carolina coasts during the winter of 1930–31 secured many juvenile sea trout from 13 to 17 cm. in length (Pearson, 1931).

Hildebrand and Cable (1934) have presented extensive data on the growth of gray sea trout at Beaufort, N. C.

TABLE 3.—*Length-frequency distributions of gray sea trout,* Cynoscion regalis, *secured from pound nets at various localities along the Atlantic coast by R. A. Nesbit*

Length in centimeters	North Carolina	Chesapeake Bay		Exmore		Wildwood			Beach Haven		Northern New Jersey					Fire Island				Montauk				
	1933	1931	1933	1934	1933	1934	1930	1932	1934	1930	1931	1928	1929	1930	1931	1934	1928	1929	1930	1931	1929	1930	1931	1932	1934
9.0	1																								
10.5	3																								
11.0	2																								
11.5	1																								
13.0					1																				
13.5	1																	1			1		1		
14.0	1																				2	1			
14.5	1																	4			5	1	1		
15.0	1				2													12			2	2	1		
15.5	9				2				1									14			11	2			
16.0	9			1	1				1									27			10	3	1		
16.5	13	2		3	5				6					1		3		31			11	7			2
17.0	15			3	14	1			8					2		6		48	1		8	11	2		10
17.5	8	2			17	2			9		1	1		8		3	2	100	1	1	13	10	1	2	19
18.0	12	1		3	25	4			18			5		4		8		156	2		7	16	6	9	30
18.5	11	5		9	44	9			26			11	1	7	1	12	1	136	3	2	17	20	2	11	44
19.0	15	6		7	57	26			28			16	1	9		20	3	172	4	1	22	21	4	23	49
19.5	4	8		9	71	24	2	3	25			9		9		30	1	175	3	1	26	16	8	25	54
20.0	3	6	1	15	56	21	1	4	30	1		39		9	1	32	3	208	3	3	12	27	7	20	30
20.5	3	5		11	65	11	5	9	24			32		13		42	6	158	8	4	9	15	7	12	29
21.0	2	4		2	51	9	5	13	29			21		13	2	49	2	89	3	1	11	28	9	5	9
21.5	1	9		3	46	3	4	5	31			22		17	2	41	4	91	14	4	3	6	12	6	4
22.0	2	6			16	2	6	4	24	2		18	1	17	4	26	4	98	8	4	6	12	14	5	4
22.5		4			17	1	4	2	7	1		6	1	18	6	22	1	46	11	10	2	7	9	4	2
23.0		1			7	1	5	3	5			6		5	3	14		33	12	4	2	11	18	2	1
23.5		1			2		6	3	2	1		3		5	6	8		35	9	9		3	16	2	
24.0					3		4	1	1			4		7	6	1		15	6	12		2	16	1	
24.5							4		3			4	1	1	2	1		5	3	4	1	2	12		
25.0									2	1		1		1	7			7	1	4		1	10	1	
25.5									1													1	4		
26.0																							2		
26.5																							1		
27.0																							3		
27.5																							1		
Total	118	60	1	3	66	502	114	46	47	281	6	1	198	5	146	40	318	27	1,661	92	64	181	225	168	128	287

PRIONOTUS sp. Sea robin

Distribution.—The young of the genus, *Prionotus*, were taken abundantly from June 19 to July 29, 1929, and from July 21 to July 29, 1930, principally at points adjacent to the sea.

Description.—The lengths of the young ranged from 1.5 to 11 mm. Positive specific identification of these young *Prionotus* could not be made. On the basis of descriptions of *P. carolinus* by Kuntz and Radcliffe (1917), the writer is inclined to believe that the Chesapeake Bay fish may belong to the closely related species, *P. evolans*. The larval stages of both species are perhaps quite similar and separation may prove impossible.

TAUTOGA ONITIS (Linnaeus). Tautog

Distribution.—A few larvae of the tautog were secured at several localities from May 6 to May 23, 1930.

Description.—The lengths of the larvae ranged from 2 to 3.5 mm. Various stages of the young tautog have been described by Kuntz and Radcliffe (1918). Careful examination of larval tautogs is essential in order not to confuse the species with the young of the oysterfish, *Gobiesox strumosus*, which it strongly resembles.

MICROGOBIUS THALASSINUS (Jordan and Gilbert). Scaled goby

Distribution.—The young of this goby occurred in the plankton during July and September 1929, and August and September, 1930. Postlarval and juvenile fish from 9 to 36 mm. in length were taken by trawl in Little Creek during the summer. All gobies were secured at stations well within the bay.

Description.—The young ranged from 4.5 to 9 mm. in length. They can be distinguished by a series of 14 to 16 solid black dots along the edge of the anal fin. These dots are also evident along the ventral edge of the body prior to the formation of the anal fin. The union of the ventral fins to form the ventral disk occurs at about 10 mm.

The young have been described by Hildebrand and Cable (1938) under the name of *Microgobius holmesi.*

GOBIOSOMA sp. Naked goby

Distribution.—The young of this genus of gobies occurred abundantly in the plankton from June 6 to Sept. 9, 1929, and from July 29 to Oct. 3, 1930, at all localities. The period of maximum abundance was in July and August. Hildebrand and Schroeder (1927), on the basis of adult fish collections, observed that spawning of *G. bosci* takes place from June to October, and that the height of the spawning period probably occurred in July.

Description.—The length-range of the young extended from 2 to 14 mm. Kuntz (1916) and Hildebrand and Cable (1938) have described the young of the genus. The transparency of young fish is quite characteristic.

ASTROSCOPUS GUTTATUS (Abbott). Stargazer

Distribution.—Several pelagic young of this fish were taken in July 1929 and 1930 at Station A. Larger young were taken by seine during summer along sandy beaches within the lower bay.

Description.—The fish ranged from 2.5 to 5 mm. in length. The young stargazer at 4.9 mm. has the eyes laterally placed, as contrasted with the dorsally situated eyes of the adult. A heavy pigmentation covers the body from the origin of the pectorals to the vent. The soft dorsal, anal, and caudal fins are slightly differentiated at this size, although the larval fin fold remains entire (fig. 24).

A marked change in the general shape and pigmentation of the body occurs at a length of 23 mm. The eyes have slowly migrated dorsally; the mouth becomes more vertical; the lips fringed; and the pigmentation more scattered. The fin rays become fully differentiated and the pectorals much enlarged. Two bony processes, apparently originating from the frontal bones of the skull, project from the surface of the skull (fig. 25). The migration of the eyes to a dorsal position is completed soon after 25 millimeters is reached (fig. 26).

HYPSOBLENNIUS HENTZ (Le Sueur). Blenny

Distribution.—The planktonic young were found widely distributed from May 8 to Sept. 13, 1929, and from May 16 to Nov. 22, 1930. The greatest abundance was noted during June and July. This young blenny occurred in more plankton hauls than any other species, but the number taken in any one tow was never large.

Description.—The length-range of the young extended from 2 to 8 mm. The larvae may be distinguished by the elongated black pectoral fins and the series of

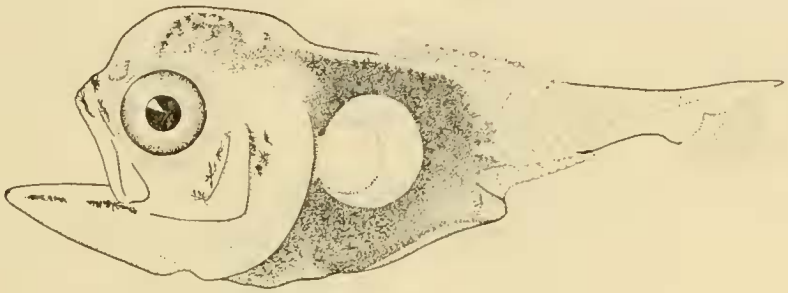

FIGURE 24.—*Astroscopus guttatus*. From a specimen 4.9 mm. long.

black dots along the ventral edge of the body posterior to the vent. Fin-ray counts are not definite until the fish reaches 8 mm. in length.

The young have been described by Hildebrand and Cable (1938).

RISSOLA MARGINATA (De Kay). Cusk eel

Distribution.—The young of the cusk eel were taken from July 1 to Sept. 13, 1929, and from July 21 to Oct. 3, 1930.

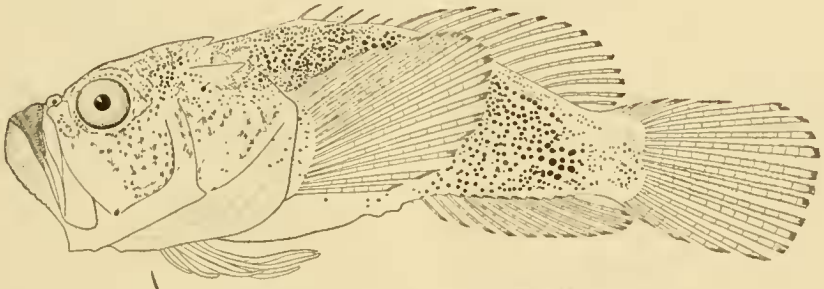

FIGURE 25.—*Astroscopus guttatus*. From a specimen 23 mm. long.

Description.—The length range of young extended from 2 to 7.5 mm. The young are undescribed but can be distinguished by an extremely elongated body that possesses two narrow, parallel black lines along the ventral edge.

GOBIESOX STRUMOSUS Cope. Oysterfish; Clingfish

Distribution.—The spawning of the oysterfish occurs principally in the spring. Young fish were taken from May 2 to Aug. 1, 1929, and from May 6 to Aug. 29, 1930. The largest collections were obtained during May. Hildebrand and Schroeder (1928) recorded adult fish with well developed gonads during April and May in Chesapeake Bay.

Apparently the young oysterfish soon adopt the characteristic bottom habitat, for no fish over 45 mm. were obtained in the plankton. The young were taken largely over oyster reefs, where spawning probably occurs.

Description.—The young ranged from 2 to 4.5 mm. in length. They are rather broad, anteriorly depressed and posteriorly compressed, somewhat similar to the adult. The body pigmentation is heavy, consisting of diffuse chromatophores very similar in arrangement to those on the young tautog (*Tautoga onitis*). The posterior caudal region of both species remains free from pigment.

Larval *Gobiesox* resembles larval *Tautoga* closely. Care is essential in distinguishing the larval fish of these two species, which are at times found to occur simultaneously in the plankton. Young *Gobiesox* possesses a less distinctive chromato-

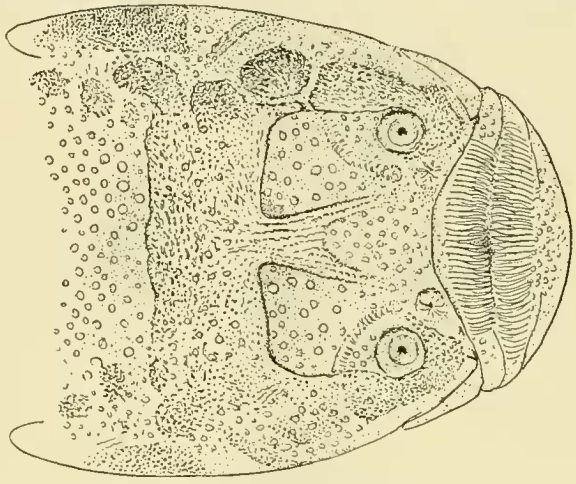

FIGURE 26.—*Astroscopus guttatus*. Dorsal surface of head; from a specimen 235 mm. long. From Hildebrand and Schroeder (1928).

phore pattern and the pigmentation does not extend so far back on the body as in *Tautoga*. *Gobiesox* also has a shorter gut and lacks the black-tipped upper jaw most characteristic of young *Tautoga*.

SPHOEROIDES MACULATUS (Bloch and Schneider). Puffer

Distribution.—The young of the puffer were taken from June 5 to Aug. 15, 1929, and from May 9 to Sept. 2, 1930.

Description.—The lengths of the fish ranged from 1.5 to 4 mm. The early stages of the puffer have been described by Welsh and Breder (1922).

LOPHIUS PISCATORIUS Linnaeus. Goosefish

Distribution.—The young of this species were taken in small numbers during May 1930 at Stations A, B, and C. Since the adult fish are rarely taken within the bay, spawning probably occurs offshore. Hildebrand and Schroeder (1927) secured newly hatched young on June 10, 1916, in the lower bay.

Description.—The young ranged from 3 to 5.5 mm. in length. Bigelow and Welsh (1925) have described the larvae of the species.

SUMMARY

1. The area of study is located at the mouth of Chesapeake Bay and is bounded roughly by Cape Charles and Cape Henry on the east, Lynnhaven Roads on the south, Old Point Comfort on the west, and Back River Light on the north.

2. A series of collecting stations was visited, usually weekly in summer and biweekly in winter, to determine the seasonal and geographic distribution and variation of the marine plankton. The present paper deals only with the young fishes taken in this plankton.

3. Forty-five species of fishes were recognized in the plankton. Thirty-one species were identified and 14 remain unidentified. Larval and postlarval stages of the gray sea trout, or weakfish, *Cynoscion regalis;* the bluefish, *Pomatomus saltatrix;* the harvestfish, *Peprilus alepidotus;* the butterfish, *Poronotus triacanthus;* and the stargazer, *Astroscopus guttatus*, are described and figured.

4. Collections of juvenile gray sea trout by seine and trawl indicate that this food fish attains an average total length of 16 to 20 cm. (6.3 to 7.8 in.) at the end of its first year of growth in lower Chesapeake Bay.

5. Brief distributional and descriptive records for the planktonic young of 31 species of marine fishes are given.

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