Spawning apparently takes place in the spring. During May, 1915, we took several large fish, with ripe roe, at Beaufort, N. C. The ovary in this species, as in the other members of garfishes, is single, and when fully distended with eggs it is fully one-third the total length of the body. The ripe ova are large, measuring about 3 millimeters in diameter.

This gar attains a length of at least 3 feet. It is not common in Chesapeake Bay, but is occasionally seen in pound nets (in the meshes of which it becomes entangled by means of its long snout, large mouth, and sharp teeth) in the southern sections of the bay. This fish is of no commercial importance.

Habitat.—Massachusetts to Brazil.

Chesapeake localities.—(*a*) Previous records: None. (*b*) Specimens in collection or observed in field: Buckroe Beach, June 21, 1921; Cape Charles, September 23, 1921.

Family XXXIV.—SCOMBERESOCIDÆ. The sauries

Body long, slender, compressed; both jaws prolonged in the adult, forming a slender beak; maxillary and premaxillary united; teeth feeble; gill rakers numerous, long, and slender; scales small, thin, deciduous; dorsal and anal low, similar, each with 4 to 6 detached finlets, as in the mackerels. A single genus and species comes within the scope of the present work.

50. Genus SCOMBERESOX Lacépède. Sauries; Skippers

Both jaws produced, forming a slender beak, the lower jaw the longer, the jaws short in the young; air bladder large; lateral line near ventral edge of body; scales small, partly covering the opercle.

68. Scomberesox saurus (Walbaum). Skipper; "Northern billfish"; Saury.

Esox saurus Walbaum, Artedi Genera Piscium, III, 1792, p. 93; Cornwall.
Scomberesox scutellatus Uhler and Lugger, 1776, ed. I, p. 144; ed. II, p. 123.
Scomberesox saurus Jordan and Evermann, 1896–1900, p. 725, Pl. CXVII, fig. 314.

Head 3.5; depth 9 to 13; D. 10 or 11–V; A. 12 or 13–VI; scales about 115. Body elongate, compressed; head broad above, narrow below, tapering gradually to the very slender beak; snout longer than rest of head, proportionately shorter in young; lower jaw longer; eye about 3 in postorbital part of head; air bladder large; scales small, about eight rows on upper part of opercle; dorsal and anal fins similar, small, and mainly opposite each other, each followed by five or six detached finlets; caudal fin forked; ventral fins small, inserted about equidistant from eye and base of caudal; pectoral fins shorter than postorbital part of eye.

Color greenish brown above, sides and belly silvery; sides with a silvery lateral band about width of eye, bounding the darker color of the back.

This species does not occur in the present collection. It is included in the present work on the basis of a record by Uhler and Lugger (1876, ed. I, p. 144, and ed. II, p. 123), who state that this fish is found very rarely near the entrance to Chesapeake Bay. The foregoing description is compiled from published accounts.

The skipper is primarily a fish of the open sea, where it travels in large schools and is preyed upon by mackerel, pollock, tunny, and other fish. It is a warm-water fish, and in the western Atlantic it probably lives largely between the latitudes of 11° and 40° N., in which region the young are very numerous. (Bigelow and Welsh, 1925, p. 166.) Its appearance along our immediate shores during the summer is very erratic, and in places where large catches may be made one year none at all will be taken the succeeding year. Although the skipper evidently occurs in the subtropical part of the open Atlantic it has not been reported south of Beaufort, N. C. Its center of abundance along our coast appears to be around Provincetown, Cape Cod, north and south of which it is uncommon. It is strictly pelagic, living exclusively at the surface.

The skipper feeds on small pelagic Crustacea. Doctor Linton listed annelids, fragments of fish, vegetable débris, copepods, and crustacean larvæ as the food of one specimen examined at Woods Hole.

Spawning occurs in the open sea, probably at the surface. "The most interesting phase in the development of the skipper is that the jaws do not commence to elongate until the fry have

attained a length of about 40 millimeters, and that the lower outstrips the upper at first, so that fry of 100 to 150 millimeters look more like halfbeaks (Hemiramphus stage) than like their own parents." (Bigelow and Welsh, 1925, p. 166.)

The skipper attains a length of 18 inches, the usual size being 12 to 16 inches.

Habitat.—Temperate parts of the Atlantic Ocean, on both the European and American coasts; Mediterranean Sea; New Zealand. On the western Atlantic coast, ranging from Nova Scotia to Beaufort, N. C.; rare south of Cape Cod.

Chesapeake localities.—(*a*) Previous records: Entrance of Chesapeake Bay (Uhler and Lugger, 1876). (*b*) Specimens in collection: None.

Family XXXV.—HEMIRAMPHIDÆ. The balaos (halfbeaks)

Body elongate, more or less compressed; upper jaw short; lower jaw various (much produced in the specimens included in the present work, the "beak" projecting beyond the upper jaw, being nearly or quite equal to the length of the rest of the head); lateral line placed low on side; scales in regular rows, cycloid; dorsal and anal fins small, placed posteriorly; caudal fin rounded or forked, if forked the lower lobe is the larger. This is a family of rather small, surface-swimming, warm-water shore fishes. A single species is common in Chesapeake Bay, where it has no commercial value.

KEY TO THE GENERA

a. Air bladder simple, not divided into compartments; sides of body not quite vertical, more or less convex; dorsal and anal fins opposite each other, the last ray of dorsal not produced; ventral fins placed about equidistant from gill opening and base of caudal.....Hyporhamphus, p. 152

aa. Air bladder divided into compartments, cellular; sides of body vertical; dorsal fin beginning in advance of anal, its last ray somewhat produced; ventral fins placed much nearer base of caudal than gill opening.....Hemiramphus, p. 153

51. Genus HYPORHAMPHUS Gill. Halfbeaks

Body long and slender; sides not quite vertical and usually more or less convex; lower jaw much produced, the produced portion never much shorter than the rest of head; air bladder simple, not divided into compartments; dorsal and anal fins similar and opposite each other, the last ray of dorsal not produced; ventral fins inserted about equidistant from gill opening and base of caudal.

69. Hyporhamphus unifasciatus (Ranzani). Halfbeak; "Skipjack."

Hemirhamphus unifasciatus Ranzani, Novi. Comment. Ac. Sci. Bonon, V, 1840, 326; Brazil. Lugger, 1877, p. 83.
Hemirhamphus roberti Uhler and Lugger, 1876, ed. I, p. 143; ed. II, p. 122; Bean, 1891, p. 92.
Hyporhamphus roberti Jordan and Evermann, 1896–1900, p. 721, Pl. CXVII, fig. 312.

Head[9] 4.1 to 4.8; depth 6 to 10; D. 13 to 15; A. 15 to 17. Body long, compressed, becoming deeper with age; head low, somewhat depressed above, the sides nearly straight; mandible much produced, except in very young (10 millimeters), developed in somewhat older specimens (25 millimeters), proportionately shorter in large examples than in smaller ones, its length from tip of upper jaw equal to rest of head in specimens about 150 millimeters in length; snout 2.5 to 4 in head; eye 3.2 to 4.8; interorbital space 4 to 4.5; teeth in the jaws in villiform bands; gill rakers rather short and blunt, 23 to 26 on the lower limb of the anterior arch; scales rather firm, cycloid; dorsal and anal similar, placed opposite each other, each scaled at base; caudal forked, the lower lobe much the longer; ventral fins small, inserted nearer base of caudal than eye; pectoral fins rather short, 1.25 to 2 in head.

Color largely silvery, with more or less greenish above; sides with a plumbeous band; middle of back with three dark lines; upper surface of head and mandible dark, the latter with a red tip in life; fins mostly plain translucent.

This species is represented by numerous specimens ranging from very small (larvæ) to 290 millimeters (11½ inches, without mandible) in length. This halfbeak is common in Chesapeake Bay but it is of no commercial importance.

[9] Head and body are measured from tip of upper jaw.

The alimentary canal is almost a straight tube, without a definite differentiation between the stomach and intestine. The food of the adult, according to the contents of eight stomachs, consists of small crustaceans, mollusks, and vegetable matter.

The ovary is single. Spawning takes place during summer, and the mature egg, when it is first laid, is approximately 2 millimeters in diameter, almost transparent, and semibuoyant. The very young have no "beak," but in specimens 15 millimeters in length its development has definitely begun. Specimens 100 to 200 millimeters in length have a proportionately longer beak than larger ones.

The youngest specimen (3 millimeters long), taken with a bottom net (July 8), had recently been hatched. Specimens taken with townets (June 10–11 and July 8–9) were 15 to 19 millimeters in length, measured from upper jaw. By the end of July many fish 24 to 49 millimeters long were taken with collecting seines.

The halfbeaks are commonly seen swimming near the surface. Their movements are often sudden and quick, making them rather difficult to capture, and because of their slenderness they pass through all except the smallest meshed nets. The greatest length attained is little in excess of 1 foot.

Habitat.—Cape Cod to Brazil, rarely straying to Maine; most common from Chesapeake Bay southward; on the Pacific coast from the Gulf of California to the Galapagos Islands.

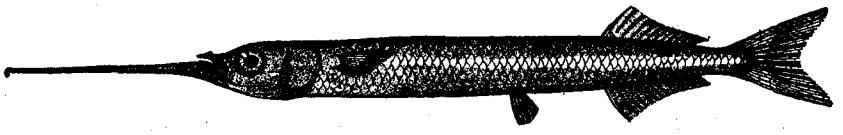

FIG. 81.—*Hyporhamphus unifasciatus*

Chesapeake localities.—(*a*) Previous records: St. Marys County, "southern part of Chesapeake Bay," and Cape Charles city. (*b*) Specimens in collection: From many points from Baltimore, Md., south to Cape Charles and Ocean View, Va., generally common; also taken in brackish water in the lower courses of streams.

52. Genus HEMIRAMPHUS Cuvier. Halfbeaks

Body more robust than in Hyporhamphus; sides nearly vertical and parallel; lower jaw much produced, usually longer than rest of head; air bladder divided into many compartments, cellular; dorsal fin a little longer than the anal and its origin a little farther forward, its last ray slightly produced; ventral fins inserted far backward, much nearer base of caudal than gill opening.

70. Hemiramphus brasiliensis (Linnæus).

Esox brasiliensis Linnæus, Syst. Nat., ed. X, 1758, 314; Jamaica.
Hemirhamphus pleei Bean, 1891, p. 92.
Hemiramphus brasiliensis Jordan and Evermann, 1896–1900, p. 722, Pl. CXVII, fig. 313; Fowler, 1912, p. 54.

Head 4.3 to 4.6; depth 5.4 to 6.3; D. 13 or 14; A. 11 to 13; scales 53 to 57. Body elongate, compressed, the sides vertical; head rather low; mandible much produced, its length from tip of upper jaw 3.3 to 3.9 in length of body; snout 2.8 to 3.5 in head; eye 3.6 to 4.1; teeth in jaws short, mostly in three series; gill rakers very short, 21 to 24 on lower limb of first arch; dorsal fin placed posteriorly, the last ray slightly produced; caudal fin forked, the lower lobe much the larger; anal fin small, beginning under middle of base of dorsal; ventral fins small, inserted about half as far from base of caudal as tip of upper jaw; pectorals 5.9 to 6.8 in body.

Color dusky brown above; sides and below bright silvery; median part of back with an indistinct dark streak, with a black line on each side; an inconspicuous dark streak extending from upper angle of gill opening to base of caudal; dorsal, caudal, and pectoral with more or less dusky; other fins pale. (The caudal fin is said to be orange in life.)

This fish does not occur in the present collection. It was reported from Cape Charles city by Bean (1891, p. 92), under the name *H. pleei*, as more common than *H. unifasciatus*. Jordan and Evermann (1896–1900, p. 722) record a specimen from Hungers Wharf, Va., and Fowler

(1912, p. 54) purchased one in the Baltimore fish market, "said to have been taken in Chesapeake Bay." It is probable that this fish occasionally enters Chesapeake Bay in some numbers, but it quite certainly is not a regular resident there, or it would have been secured during the extensive collecting done in connection with the present investigation. The foregoing description was compiled from published accounts.

Virtually nothing seems to be known of its life history and habits. The greatest length attained is about 15 inches.

Habitat.—Chesapeake Bay to Bahia, Brazil; also recorded from Angola, West Africa.

Chesapeake localities.—(*a*) Previous records: "Chesapeake Bay," Hungers Wharf, Va., and Cape Charles city, Va. (*b*) Specimens in collection: None.

Family XXXVI.—EXOCŒTIDÆ. The flying fishes

Body elongate; head with more or less vertical sides; mouth terminal, or the lower jaw projecting, the latter not produced in the adult; premaxillaries not protractile; maxillary short, slipping under preorbital; nostrils double, near the eye; teeth various, small or weak; lateral line running low, along edge of belly; scales cycloid, more or less deciduous, extending forward on head; dorsal fin without spines, placed on posterior part of body; caudal fin forked, the lower lobe the longer; anal fin opposite the dorsal and more or less similar to it; ventral fins abdominal, sometimes more or less enlarged; pectoral fins inserted high, usually greatly enlarged, serving as organs of flight.

53. Genus EXOCŒTUS Linnæus. Flying fishes

Body elongate; sides flattened; head rather short; snout blunt; eyes large; mouth small; jaws very short, about equal; scales large, deciduous; caudal fin broadly forked, the lower lobe the longer; pectoral fins very long and large, reaching nearly or sometimes quite to the base of the caudal. The species of this genus are inhabitants of the warm seas, many of them being largely cosmopolitan in their distribution, and they may at times work their way into Chesapeake Bay. A single species of flying fish, however, so far has been recorded from this body of water.

71. Exocœtus heterurus Rafinesque. Flying fish.

Exocœtus heterurus Rafinesque, Caratteri di Alauni Nouvi Generi, etc., 1810, p. 58; Palermo. Jordan and Evermann, 1896-1900, p. 735.

? *Exocœtus mesogaster* Uhler and Lugger, 1876, ed. I, p. 143; ed. II, p. 122.

Head 4.66; depth 5.33; D. 14; A. 9; scales 58. Body moderately robust; snout 3.75; eye 3.2; scales moderate, 33 before dorsal, 26 before ventrals, 7 rows between dorsal and lateral line; anal fin short, its origin behind that of the dorsal, base of anal 1.66 in base of dorsal; ventral fins inserted about equidistant from pupil and base of caudal, their length about 2.75 in body; pectorals about 1.45 in body, reaching last ray of dorsal. Dorsal and anal plain; ventrals white, their axils scarcely dusky; pectorals with an oblique white band across lower half of fin.

This species does not occur in the present collection and it is not certain that it definitely belongs to the Chesapeake Bay fauna. Uhler and Lugger (1876), however, record a species of flying fish under the name *Exocœtus mesogaster*, which may have been *Parexocœtus mesogaster*. The description is very inadequate, but it seems to suit *E. heterurus* rather better than *P. mesogaster*. The species is said to reach a length of about 15 inches.

Habitat.—Atlantic Ocean, common southward on both the European and American coasts, straying northward to Newfoundland and England.

Chesapeake localities.—(*a*) Previous records: Mouth of Potomac River and southern part of Chesapeake Bay (Uhler and Lugger, 1876). (*b*) Specimens in collection: None.

Order ANACANTHINI

Family XXXVII.—GADIDÆ. The codfishes

Body more or less elongate; the caudal region moderately long; mouth large, usually terminal; chin with a barbel more or less developed; gill openings very wide; gill membranes separate or somewhat united, usually free from the isthmus; gills 4, a slit behind the fourth; fins without spines; dorsal fins, 1, 2, or 3, extending almost over the length of the back; caudal fin separate or confluent with the dorsal and anal; anal fin long, single or divided; ventral fins jugular, with one to eight rays. Three genera of this rather large family come within the scope of the present work.

KEY TO THE GENERA

a. Dorsal fin divided into three separate parts; anal fin divided into two parts; ventral fins expanded, with about seven short rays.
  b. Lower jaw projecting; caudal fin forked; vent under first dorsal ..... Pollachius, p. 155
  bb. Upper jaw projecting; caudal fin nearly square; vent under second dorsal ..... Gadus, p. 156
aa. Dorsal fin divided into two separate parts; anal fin long, undivided; ventral fins with two or three filamentous rays ..... Urophycis, p. 158

54. Genus POLLACHIUS Nilsson. Pollocks

Body rather elongate; mouth moderate or large; lower jaw projecting; teeth in the jaws equal or the outer ones slightly enlarged; pointed teeth on vomer; none on palatines; gill membranes more or less united; barbel at chin small or obsolete; scales numerous; dorsal fins three; anal fins two; caudal fin lunate or forked; vent under first dorsal.

72. Pollachius virens (Linnæus). Pollock.

Gadus virens Linnæus, Syst. Nat., ed. X, 1758, p. 253; seas of Europe.
Pollachius virens Jordan and Evermann, 1896–1900, p. 2534, Pl. CCCLIX, fig. 886.

Head 3.68 to 3.88; depth 4.53; D. 13 or 14–21–19 or 20; A. 24 to 28–20 or 21; scales 154 to 156; body rather elongate, somewhat compressed, tapering posteriorly; head conical; snout 2.84 to 3 in head; eye 5.73 to 6.35; interorbital convex 3.28 to 3.80; mouth oblique; lower jaw projecting; maxillary scarcely reaching anterior margin of eye, 2.90 to 3.19 in head; teeth small, pointed, cardiform, present on jaws and vomer, none of them notably enlarged; gill rakers rather long, slender, equal to diameter of pupil, 28 to 30 on lower limb of first arch; scales very small, cycloid; dorsal fins separate, first and second of about equal height, outer margin of first convex, margins of second and third nearly straight, the fins tapering posteriorly; caudal moderately forked; anal fins separate, outer margins gently rounded; ventrals small, inserted below posterior margin of gill cover, slightly in advance of pectorals, 3 to 3.37 in head; pectorals moderate, 2 to 2.31 in head.

Color dark green above, silvery to silvery gray below; lateral line pale; dorsals and caudal dark green, anals bluish white; pectorals pale, ventrals white.

This species was not observed by us in the field. The above description is based on three specimens, 450 to 460 millimeters (about 18 inches) in length, caught off Gay Head, Mass. Small pollock, below 15 inches in length are usually brownish green, while large pollock are dark green, with some dusky on the fins, particularly the caudal. Published accounts give the following range in the fin counts: First dorsal, 12 to 14; second dorsal 19 to 24; third dorsal 19 to 22; first anal 23 to 27; second anal 20 to 23.

This species was not secured during the present investigation. It is included here through the courtesy of Dr. William C. Kendall, who kindly permitted us to use his unpublished notes bearing upon certain investigations made in the vicinity of Hampton, Va., in 1894. We find a note, dated March 26, reporting the capture of a pollock 12 inches in length in a pound net. This fish is recognized by its projecting lower jaw, small ventrals, and forked caudal. It is also distinguished from all other species known from the Chesapeake (except the cod) by its three separate dorsal fins.

The food of the pollock is reported to consist chiefly of small fish and of pelagic crustaceans.

Spawning takes place late in the fall and early in the winter along the New England coast. The eggs are reported (Bigelow and Welsh, 1925, p. 405)[10] to be numerous, as many as 4,000,000 from a fish weighing 23½ pounds, about 1.15 millimeters in diameter, and bouyant, hatching in nine days at a temperature of 43° F. The newly hatched larvæ are about 3.4 to 3.8 millimeters in length. Young fish from 25 to 30 millimeters in length show most of the characters of the adult.

Young hatched in the winter in the Gulf of Maine attain a length of 1 to 2 inches by spring and 3 to 5 inches by late fall. The second spring, or when they are a little more than 1 year old, they are 5 to 6 inches long. At Provincetown, on June 26, 1925, we secured numerous young 125 to 140 millimeters (5 to 5½ inches) in length, apparently about 1½ years old.

On our side of the Atlantic pollock are most abundant from Woods Hole, Mass., to Cape Breton, and within this region about 40,000,000 pounds are caught and marketed annually. From eastern Long Island to New Jersey it occurs in small numbers, but below Cape May apparently it is only a straggler.

A pollock 44 inches in length and weighing 36 pounds, taken in the Gulf of Maine by the junior author, is the largest of which we have record. The average length, however, is from 2 to 3 feet, with a weight of 4 to 15 pounds, few exceeding a length of 40 inches or a weight of 30 pounds. The pollock is an active swimmer, occupying any or all levels between the surface and the bottom, and sometimes it schools. A small part of the catch is salted, and in that state the pollock is said to be as good as or better than cod.

Habitat.—Both sides of the North Atlantic; on the American coast from Hudson Bay and Davis Straits to Cape Lookout, N. C., chiefly between Narragansett Bay and the Gulf of St. Lawrence. Dr. Russell J. Coles (in Copeia, No. 151, Feb. 25, 1926) reports the capture of a 10-inch pollock at Cape Lookout, N. C., on February 13, 1925. This establishes the most southerly record for the species.

Chesapeake localities.—(*a*) Previous records: None. (*b*) Specimens in collection: None; a single 12-inch individual is mentioned in the unpublished notes of Dr. W. C. Kendall, this specimen having been taken in a pound on March 26, 1894, at Buckroe Beach, Va.

55. Genus GADUS Linnæus. Cods

Body moderately elongate, compressed posteriorly, and tapering to the rather slender peduncle; head large, becoming narrower anteriorly; mouth large; upper jaw projecting; teeth on jaws and vomer; a barbel on chin; lateral line pale; scales very small; dorsal fins 3; anal fins 2; ventral fins with seven rays.

73. Gadus callarias Linnæus. Cod.

Gadus callarias Linnæus, Syst. Nat., ed. X, 1758, p. 252; European seas. Jordan and Evermann, 1896–1900, p. 2541, Pl. CCCLXI, fig. 891.

Head 3.53 to 3.76; depth 4.74 to 5.14; D. 13 or 14—19 to 22—18 or 19; A. 20 to 22—17; scales 150 to 170. Body elongate, slightly compressed, tapering posteriorly; head conical; snout 2.70 to 2.90 in head; eye 5 to 5.76; interorbital convex, 3.67 to 4.28 in head; mouth horizontal; upper jaw and snout projecting; maxillary reaching anterior third of eye, 2.32 to 2.52 in head; teeth small, pointed, cardiform, in bands, present on jaws and vomer, those of outer row of upper jaw and inner row of lower jaw somewhat enlarged; chin barbel about equal to diameter of eye; gill rakers moderate, length less than diameter of pupil, 15 or 16 on lower limb of first arch (excluding rudiments); scales very small, cycloid; dorsal fins separate, the first the highest, outer margin convex; second and third tapering gradually posteriorly, outer margins nearly straight; caudal truncate or slightly emarginate; anal fins separate, tapering posteriorly, outer margins nearly straight; ventrals inserted below posterior margin of gill cover, slightly in advance of pectorals, the first ray slightly filamentous, the second ray more so, 2.40 to 2.95 in head, without filament; pectorals moderate, 1.86 to 2 in head.[11]

[10] For a detailed account of the pollock, see Bigelow and Welsh, 1925, pp. 396–406.

[11] For an account of the cod see Bigelow and Welsh (1925, pp. 409–430).

Color green to red brown above and on sides; pale below; sides and back with green, brown, or reddish irregular spots, usually of one color on any one fish; spots sometimes extending on dorsal fins; lateral line pale; fins usually the same as ground color.

This species was not seen by us in the field. The above description is based on five specimens, 350 to 497 millimeters (about 14 to 20 inches) in length, caught off Gay Head, Mass. The color of the cod is very variable. Out of 25,000 cod observed by the junior author during fish-tagging operations, the colors ranged from pale green to deep red brown and bright red. The greenish cod have dark green or reddish spots, while the reddish cod usually have dark brown spots. We have seen several specimens, as large as 30 inches, that were colored bright red everywhere on body, head, and fins, including the lower parts.

The fin rays vary in number. A large series of Gulf of Maine fish examined by Welsh gave the following variation: First dorsal, 13 to 16; second dorsal, 19 to 24; third dorsal, 18 to 21; first anal, 20 to 24; second anal, 17 to 22. (Bigelow and Welsh, 1925 p. 410.) The cod is distinguished by its three dorsal fins, two anal fins, barbel at the chin, projecting upper jaw, nearly square tail, vent under the beginning of the second dorsal, and by the pale (not black) lateral line.

The cod is typically a bottom feeder but at times rises to the surface in pursuit of schools of small fish and squid. The cod is omnivorous, including in its diet many species of fish, mollusks, crustaceans, worms, echinoderms (chiefly brittle stars), as well as hydroids and algæ. Many foreign

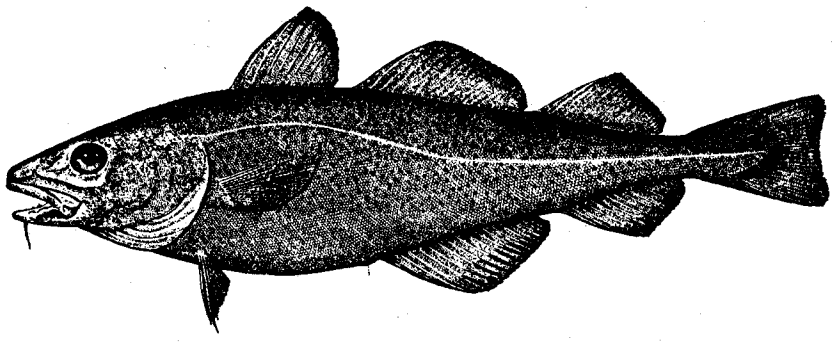

FIG. 82.—*Gadus callarias*. From a specimen 18¾ inches long

objects have been recorded from cod stomachs, including pieces of metal, gravel, wood, rope, and rubber, and fragments of clothing. Aboard the *Halcyon* in 1925, fishing 35 miles from shore, we were surprised to find an empty cigarette container in a cod stomach. It probably had been thrown from a vessel and was seized by the cod because of the bright tinfoil with which it was wrapped. However, the cod does have a preference for certain foods, among which are rock crabs (Cancer), hermit crabs, sea clams (Mactra), cockles (Lunatia), lobsters, brittle stars, blood worms (Nereis), sand launces (Ammodytes), and young herring (Clupea). The chief baits used in the western Atlantic for catching cod are fresh or frozen herring, squid, cockles, and clams (*Mya arenaria*).

The scales of cod form a good index for determining age, but this study is rendered complex because of the protracted spawning season (fall to spring) and because of the fish's wide distribution, wherein growth is more rapid in some localities than in others European cod average 5, 8.3, and 12.2 inches in length for the first, second, and third years, respectively. Bay of Fundy cod average 5.7, 14.2, and 19.6 inches, and we find the size of Nantucket Shoals cod to be about 8, 15, and 23 inches for the first, second, and third years, respectively.

Spawning takes place along our coast from October to June, the height of the season, however, occurring during the winter. Spawning begins earlier in the southern part of the range than farther north and also ends correspondingly earlier. An inshore migration of spawning fish has been noticed. The eggs of the cod are buoyant, transparent, 1.16 to 1.82 millimeters in diameter (Bigelow and Welsh, 1925, p. 428), and the incubation period extends over about 10 to 11 days at 47° F. Lower temperatures lengthen this period and higher ones shorten it. The newly-hatched larvæ are about 4 millimeters in length. When the cod first hatch they float about helplessly on their backs. An upright position is acquired in a few days, however. The dorsal and anal fin

rays begin to appear when the young have attained a length of 10 to 13 millimeters, and when 30 millimeters long many of the adult characters, including the spotted color pattern and scales, have developed.

Young cod live at the surface but descend to the bottom when about 2 or 3 months old, or at a length of about 1 to 1½ inches, and thereafter they are chiefly bottom dwellers, coming to the surface only occasionally, as indicated elsewhere.

The cod was not seen during the present investigation, nor do we find any published record of its occurrence in Chesapeake Bay. Some years, however, a few stragglers pass the capes and are taken in pound nets between Cape Henry and Ocean View. A set of two-pound nets in Lynnhaven Roads caught one cod on March 4, 1919, in the first day's fishing, but no more were caught during that year. The same nets were set on March 12 in 1923, and, on March 16, 16 cod, the only ones caught that year, were taken. The number of fish caught on this occasion illustrates the schooling habit of the cod.

The few cod caught in the lower Chesapeake are taken in March only. It is well known that cod appear yearly in November each year off the coast of New Jersey, from Seabright to a few miles southeast of Cape Henlopen, Del., and fair quantities are caught by hand lines until well into December. No doubt some cod continue down the coast late in the fall as far as North Carolina (where it has been reported by Smith (1907, p. 382)), but none are caught in November in the Chesapeake. A few fish are present on the New Jersey coast throughout the winter, but in March and early April fair-sized schools appear, and for a short period good hand-line fishing is had from Capes Henlopen and May to Atlantic City and Seabright. It is during the beginning of this run that a few stragglers are sometimes taken in the Chesapeake, and it seems probable that such fish belong to small schools that are migrating from North Carolina to the New England coast, their summer home. Recent cod-tagging experiments made by the Bureau of Fisheries have proven conclusively that cod migrate in the fall from Nantucket Shoals, Mass., at least to Cape Henlopen. No tagging has been done in southern waters, but the return of the cod from there to New England in the spring follows as a natural sequence. Virtually no fishing is done in the open Atlantic during the winter from Cape Henlopen to North Carolina, consequently the rarity of cod records within that region can be attributed largely to nonfishing.

At times cod attain an enormous size; the largest specimen recorded weighed 211¼ pounds and was more than 6 feet long. This size, however, is very exceptional, as individuals of more than 75 pounds are rare. Fish of 50 to 60 pounds are not unusual. The cod is too rare in Chesapeake Bay to be of economic importance, as apparently only occasionally a straggler passes between the capes. The cod is one of the most highly prized and among the most valuable commercial food fishes in the North Atlantic Ocean. It is found in depths as great as 250 fathoms, but most of the commercial fishing is done between 10 and 75 fathoms.

Habitat.—Both sides of the North Atlantic; on the American coast from Greenland and Hudson Straits southward to North Carolina; not taken in commercial numbers south of Delaware.

Chesapeake localities.—(*a*) Previous records: None. (*b*) Specimens in collection: None; listed in the invoice of the Buchanan Bros. fishery, in Lynnhaven Roads, Va., on March 4, 1919, and March 16, 1923.

56. Genus UROPHYCIS Gill. Codlings; Hakes

Body rather elongate; head subconic; mouth rather large; maxillary reaching below eye; lower jaw included; unequal teeth on jaws and vomer, none on palatines; chin with a small barbel; dorsal fins 2, the first one short, the second long and similar to the anal; ventral fins far apart, each consisting of 3 slender rays, closely joined, appearing like a bifed filament.

KEY TO THE SPECIES

a. First dorsal with a produced filamentous ray, its color uniform dusky; dorsal fins with 9 to 11—56 to 61 rays; anal 52 to 56; scales about 104 to 112 ..... *chuss*, p. 159

aa. First dorsal low, without a produced ray, its color distally jet black margined with white; dorsal fins with 8 or 9—46 to 51 rays; anal 43 to 49; scales about 89 to 97 ..... *regius*, p. 160

74. Urophycis chuss (Walbaum). Squirrel hake; "Ling."

Blennius chuss Walbaum, Artedi, Gen. Piscium, III, 1792, p. 186; New York.
Urophycis chuss Jordan and Evermann, 1896-1900, p. 2555, Pl. CCCLXV, fig. 902; Evermann and Hildebrand, 1910, p. 163.

Head: 4.25 to 4.5; depth, 4.8 to 5.05; D. 9 to 11—56 to 61; A. 52 to 56; scales about 104 to 112. Body elongate, compressed; head somewhat depressed; snout tapering, 2.95 to 3.6 in head; eye, 2.55 to 3.54; interorbital, 5.05 to 6.8; mouth horizontal; upper jaw and snout projecting; maxillary scarcely reaching opposite posterior margin of eye, 1.9 to 2.05 in head; teeth small, pointed, present on jaws and vomer, those in lower jaw in a very irregular series, those of the upper jaw more or less definitely in two series; gill rakers short, slender, 12 or 13 on lower limb of first arch; scales very small, cycloid; dorsal fins separate; the third ray of first dorsal produced, filamentous; second dorsal long, of nearly uniform height throughout; caudal fin round; anal fin long and low; ventral fins composed of two filamentous rays, inserted on margin of gill opening; pectoral fins rather narrow, 1.2 to 1.35 in head.

Color brownish above; lower part of sides more or less silvery; white, gray, or yellowish underneath; ventrals and pectorals pale; the other fins with dusky punctulations.

Many specimens of this species, ranging in length from 80 to 205 millimeters (3¼ to 8⅛ inches), were preserved. This ling is recognized by its produced, filamentous ray in the first dorsal fin, by the numerous rays in the dorsal and anal fins, and by the number of oblique rows of scales on the sides. It differs, with respect to the scales, from *U. regius* in having more numerous oblique rows and from *U. tenuis* (a northern species that has been recorded from the coast of Maryland

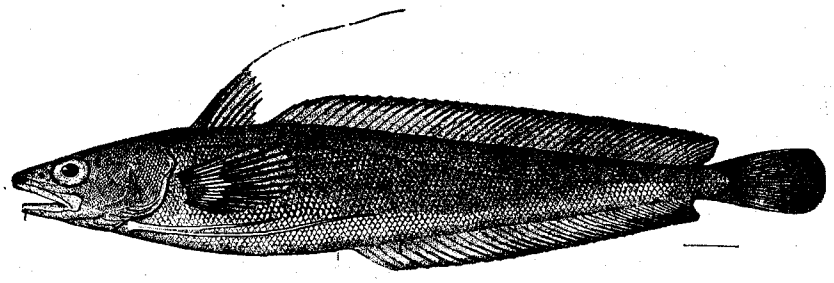

FIG. 83.—*Urophycis chuss*

and also reported from North Carolina, although not yet taken in Chesapeake Bay) in having fewer oblique rows of scales on the sides. *U. regius* has about 88 to 97 oblique rows, *U. chuss* has approximately 104 to 112, and *U. tenuis* has about 140.

The food in eight stomachs examined consisted wholly of crustaceans, principally shrimp. Squids, the smaller sizes of many species of fish, prawns, shrimps, and amphipods have been recorded by various investigators. However, it is said to seldom take mollusks of any kind (excepting squid) or the larger crustaceans, such as cod feed upon (Bigelow and Welsh, 1925, p. 450). As with many other species of fish, the sand launce (Ammodytes) is a favorite food of the ling. We have observed ling caught off Sandy Hook, N. J., gorged with launce, in some cases the tails extending into their mouths because their stomachs could hold no more.

With respect to the spawning of this ling, Bigelow and Welsh (1925, p. 452) state that they trawled fish with running spawn and milt in Ipswich Bay in July. The height of the spawning season falls in the early summer in the Massachusetts Bay region and begins in June south of Cape Cod. It is quite certain that the ling spawns at least as far south as New Jersey, for we have observed large schools of fish in April and May off Rockaway, N. Y., and Sandy Hook, which were distended with spawn. No ripe fish were observed in Chesapeake Bay. However, one individual, taken April 15, 1922, had the ovaries somewhat developed and contained eggs plainly visible under a low-power hand lens.

The eggs are buoyant, 0.72 to 0.76 millimeter in diameter. The fry attain a length of 27 to 70 millimeters in late summer and autumn off the New England coast. (Bigelow and Welsh, 1925, p. 452.) The fry are greenish on the back and silvery on the sides. According to Bigelow

and Welsh (1925, p. 449), the young fish are pelagic until 2 to 4 inches long, individuals as small as 2 inches having been taken on the bottom and as large as 4 inches on the surface.

The ling is found on muddy or sandy bottom (rarely in rocky places), at all depths down to the deepest parts in the Gulf of Maine. During the summer it is taken in moderate and deep water, but in the fall it moves inshore. Whether there is a north and south migration is not known, but it is certain that along the New Jersey coast ling are almost entirely absent during the summer, appearing in vast numbers in November, however. Throughout New York Bay they are caught from docks and small boats anchored a few hundred feet from shore. They disappear from the immediate shores during the winter, but reappear in April, when they are distended with spawn. They remain close inshore only a short period, but are caught 2 to 6 miles off at least until late May. On the Cholera Bank, 12 miles south from Long Beach, Long Island, ling are sometimes abundant in July at a time when they have virtually forsaken the shore waters. The evidence seems to indicate that the migration is an inland-offshore one, particularly in the southern parts of its range, where the shore waters no doubt become uncomfortably warm during the summer.

It is of interest to note that all ling that we have seen in the Chesapeake have been taken either with offshore pound nets or with the beam trawls of the *Fish Hawk* and *Albatross* from Cape Henry to Bloody Point, off Annapolis, and not one specimen has been taken along the shores. A few fish 12 inches or less in length are mentioned in our field notes as occurring in catches of pound nets at Ocean View between November 15 and December 5, 1921. However, all fish taken in the beam trawl were caught between March 7 and May 23 of various years, and none of these fish exceeded 12 inches in length. It is reasonably certain, therefore, that the ling does not spawn in Chesapeake Bay, that adult fish are uncommon, and that young from 2 or 3 to 8 or 9 inches long enter the bay late in the fall or in the spring and leave for offshore waters by early June.

Assuming that the ling spawns off the coasts of Maryland and New Jersey as early or somewhat earlier than off Woods Hole, Mass., the larvæ living nearest Chesapeake Bay begin their existence in June or July. Young trawled in Chesapeake Bay were 97 to 134 millimeters (3.8 to 5.2 inches) in March, 81 to 126 millimeters (3.2 to 5 inches) in April, and 111 to 169 millimeters (4.3 to 6.6 inches) in May. At this rate of growth they would probably reach the length of 6 to 7 inches given for yearlings by Bigelow and Welsh (1925, p. 457).

Ling of marketable size are too scarce to be of commercial importance in the Chesapeake, and the very small catch is utilized by the fishermen themselves. From New Jersey northward this ling is an important market fish; and in the Gulf of Maine, where it is taken together and marketed with the white hake (both the ling and white hake are called "hake" in New England and are not separated), an annual catch of 20,000,000 to 35,000,000 pounds for the past 25 years is reported by Bigelow and Welsh (1925, p. 449).

The extreme length of the ling is given as 30 inches, with a weight of 8 pounds. The usual run of fish is from 1 to 4 pounds, and individuals over 5 pounds are uncommon.

Chesapeake localities.—(*a*) Previous record: Off Cape Henry, Va. (*b*) Specimens in the collection: From many deep-water stations from Bloody Point, Md., to the mouth of the bay.

75. Urophycis regius (Walbaum). Spotted hake; "Cod."

Blennius regius Walbaum, Artedi, Gen. Piscium, III, 1792, p. 186; New York.
Urophycis regius Lugger, 1877, p. 67; Jordan and Evermann, 1896-1900, p. 2553, Pl. CCCLXIV, fig. 898.

Head 3.85 to 4.4; depth 3.9 to 5.05; D. 8 or 9—46 to 51; A. 43 to 49; scales 89 to 97. Body elongate, compressed; head rather small, somewhat depressed; snout tapering, 3.4 to 4 in head; eye 2.9 to 4.6; interorbital 4.9 to 6.25; mouth large, horizontal; upper jaw and snout projecting; maxillary reaching well beyond eye, 1.75 to 2.08 in head; teeth present on jaws and vomer, those in the jaws pointed, irregular in size, those of upper jaw mostly in a single irregular series, those of lower jaw in two irregular series; gill rakers rather short, 13 or 14 on lower limb of first arch; scales rather small, thin, cycloid; dorsal fins 2, the first not elevated, scarcely higher than the second, none of the rays produced; second dorsal long and rather low, enveloped in scaly skin at base; caudal fin round; anal fin long and low, similar to second dorsal but not quite as long; ventral fins inserted on margin of gill opening, consisting of two long filaments; pectoral fins rather long, 1.1 to 1.35 in head.

Color in life of a specimen 153 millimeters (6 inches) in length, brownish above, darkest on back; white below; a row of white spots, connected by black lines, situated on lateral line; a vertical row of two to four small black spots on head back of eye; two similar spots about an eye's diameter behind the first row; first dorsal dusky, edged with white, with a prominent jet black spot; second dorsal and caudal uniformly dark; caudal dusky; anal white or pinkish at base, bluish along center, edged with black; ventrals white; pectorals pale dusky edged with light yellow. After death the body and fins become suddenly pale, the black spot on first dorsal remains, and the second dorsal and anal are edged with black; the caudal is dusky only at edges; the black spots on head become almost obscure.

Many specimens of this hake, ranging in length from 50 to 310 millimeters (2 to 12¼ inches), were preserved and were before us when the foregoing description was prepared. This hake differs from *U. chuss* chiefly in the low first dorsal fin, which has no produced ray, in the fewer rays in the dorsal and anal fins, and in having somewhat larger scales. A good field mark is the color of the first dorsal fin, which is distally black and margined with white, whereas in *U. chuss* this fin is uniform dusky. The row of white spots along lateral line in *U. regius* is absent in *U. chuss*.

Dr. Edwin Linton examined for us 141 specimens for food and found over 95 per cent of the stomach contents to consist of crustaceans. Nearly 82 per cent consisted of Mysis alone. Shrimp, crabs, amphipods, and isopods also were included. Negligible amounts of fish, annelids, leeches, sponges, and hydroids also had been eaten. Bigelow and Welsh (1925, p. 455), basing their conclusions on stomach examinations made at Woods Hole, Mass., by Vinal N. Edwards, state that this hake is more of a fish eater than the other hakes. Doctor Linton's examinations appear to show that in Chesapeake Bay, at least, this hake is quite as much of a crustacean eater as the other species.

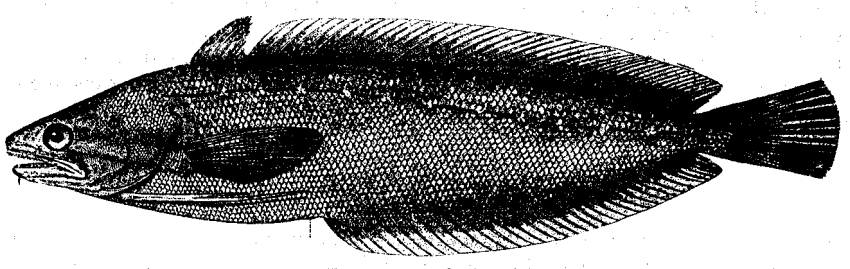

FIG. 84.— *Urophycis regius*

Comparatively little is known of the spawning habits of this hake. Welsh, working on the *Albatross*, took spawning fish off the Carolinas in December, 1919 (Bigelow and Welsh, 1925, p. 455), which indicates that the species spawns during the winter. There is no indication that this hake spawns in Chesapeake Bay, for not only are adult fish scarce there, but no young are found until they have attained a length of about 3 inches and presumably are a year old. It is quite likely that this species, like *U. chuss*, spawns outside the bay, and that, like most of the hakes, the larvæ are pelagic for from one to several months. The following table gives the sizes and apparent rate of growth of spotted hake taken in Chesapeake Bay.

Date	Number of fish caught	Range in length	Average length
		Inches	*Inches*
Jan. 22	1	3	3
Mar. 30–31	2	2.7–3.7	3.2
Apr. 10–15	64	3.5–5.5	4.5
Apr. 19–29	170	3.3–6.0	4.7
May 11–20	28	3.7–7.2	5.5

The total catch (except for January 22, when one large fish 11.4 inches in length was taken) is shown for each date given in the foregoing table. Although only three small specimens were

taken during the winter months, their size fits in so well with the subsequent collections that it seems safe to assume that all the fish listed in the foregoing table belong to the same year class. Assuming, then, that Welsh's discovery of spawning fish in December may be interpreted as restricting the spawning period to the winter, it seems reasonable to conclude that 1-year-old fish have a length of approximately 3 inches.

This hake, unlike *U. chuss*, was taken twice (between April 10 and 24, 1922) alongshore off Buckroe Beach and the lower York River in collecting seines. It was taken in the trawl at a depth of 38 to 144 feet, as follows: Two fish in January, two in March, many in April, and several in May. During other months it did not appear in the collections. This fish was present in collections made from Cape Henry to Bloody Point, near Annapolis. The majority of the fish, however, were taken south of the mouth of the Potomac River.

It appears, therefore, that most of the young (yearlings) enter the bay by the end of March or early in April, probably depending on the water temperature, and that they leave toward the end of May when the water begins to get warm. Larger fish over 8 inches in length are very scarce in the bay, and only occasionally one is taken either in the late fall or the spring in pound nets set in the lower part of the bay.

This fish is nowhere abundant (in comparison with other hakes), and this, together with its small size, makes it of very slight commercial importance. Certainly in Chesapeake Bay its value is negligible, although in some localities it serves as a source of food supply for other fishes.

The largest size attained by the spotted hake is about 16 inches, but the largest observed in the Chesapeake was only 12¼ inches long.

Habitat.—Nova Scotia to South Carolina; rare north of Cape Cod and south of Virginia.

Chesapeake localities.—(*a*) Previous record: Off Kent Island, Md. (*b*) Specimens in collection: From many localities, from Annapolis to the mouth of the bay, mostly taken at depths of 38 to 144 feet; occasional along the immediate shores.

Family XXXVIII.—MERLUCCIIDÆ. The hakes

Body moderately elongate; head elongate, depressed, shaped as in the pikes, its upper surface with a triangular excavated area; no barbels; suborbital bones moderate; dorsal fins 2, the first one short, the second long, consisting of soft rays only; tail isocercal; ventral fins subjugular, well developed. This family consists of a single genus with about four species, a single one of which comes within the scope of the present work.

57. Genus MERLUCCIUS Rafinesque. Hakes

Body elongate; head slender, its upper surface with well-defined ridges, converging backward into a low occipital crest; snout long, depressed; eye rather large; edge of opercle free; mouth large, oblique; maxillary reaching opposite eye; lower jaw projecting; sharp teeth present on the jaws and vomer; branchiostegals 7; gill membranes not united; scales small, deciduous; two well-separated dorsal fins, the first short, the second deeply emarginate; anal similar to the second dorsal; ventral fins normal, well developed.

76. Merluccius bilinearis (Mitchill). Silver hake; Whiting; "Winter trout."

Stomodon bilinearis Mitchill, Rept., Fishes, New York, 1814, p. 7; New York.
Merluccius bilinearis Jordan and Evermann, 1896-1900, p. 2530.

Head 3.55 to 3.65; depth 4.6 to 5.45; D. 12 to 14—40 or 41; scales about 105. Body elongate, compressed; caudal peduncle slender; head rather long and low, flat above, with rather prominent ridges; snout moderately broad, 2.65 to 3 in head; eye, 3.35 to 4.7; interorbital 3.85 to 4.2; mouth large, slightly oblique; maxillary reaching to or a little beyond middle of eye, 1.8 to 2 in head; teeth in the jaws sharp, recurved, in 2 or 3 irregular series, similar teeth present on the vomer; gill rakers slender, about 12 on lower limb of first arch; lateral line distinct; scales rather larger than in related species, deciduous; dorsal fins 2, well separated, composed of soft rays only, the base of the first contained about 3.5 times in the base of the second, its origin over base of pectorals; the second dorsal with longer rays anteriorly and posteriorly than in middle portion of its length; caudal fin nearly straight in the young, somewhat emarginate in the adult; anal fin similar to the second dorsal

and placed opposite it; ventral fins well developed, inserted under and slightly in advance of pectorals, 1.45 to 1.6 in head; pectorals narrow, 1.25 to 1.4 in head.

Color in life, dark gray to brownish above, sides and belly silvery, highly iridescent. The iridescence fades soon after death and the color becomes dull silvery on sides and below.

This northern fish is represented in the present collection by three specimens, ranging in length from 105 to 460 millimeters (4⅛ to 18⅛ inches). The silver hake is readily distinguished from the true hakes (Urophycis) by the presence of well-developed ventrals, instead of feelerlike ventrals, by two well-developed dorsals, the second of which, and the anal, are emarginate instead of straight, and by the absence of a chin barbel.

The food of the silver hake, according to Bigelow and Welsh (1925, p. 389), consists principally of fish of suitable size, regardless of the species. Squids and occasionally crabs and other crustaceans also are eaten.

Spawning takes place along the New England coast from June to October, the principal months being July and August. Most of the ripe fish have been taken at depths of 50 fathoms or less, but others have been taken at 300 fathoms off southern New England (Goode and Bean, 1896, p. 387). Spawning, therefore, not only is protracted, but covers a wide range of depths. No ripe silver hakes have been observed in Chesapeake Bay, and it is so rare that we do not hesitate to eliminate this region as a probable spawning ground.

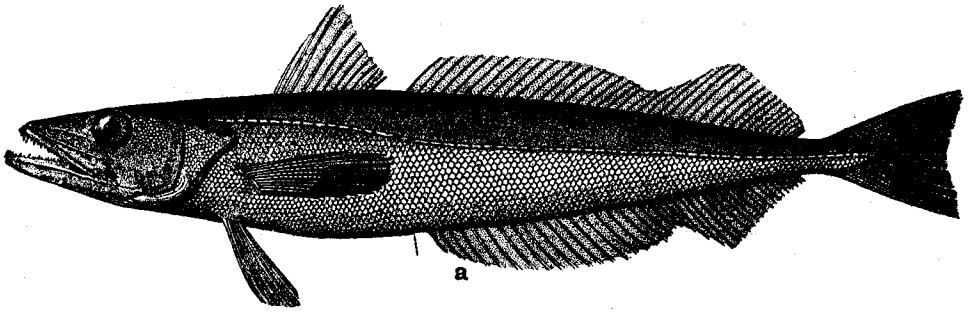

FIG. 85.—*Merluccius bilinearis*. From a specimen 18 inches long

The eggs float at the surface and are about 0.88 to 0.95 millimeters in diameter.[12] Incubation is fairly rapid, being about 48 hours at Woods Hole, Mass., but no doubt somewhat longer in the cooler waters of its natural breeding grounds. Bigelow and Welsh (1925, p. 394) believe that temperatures of 55° to 60° F. are the most suitable for normal incubation. Recently hatched larvæ are 2.8 millimeters in length, and many of the adult characters have been assumed at 20 to 25 millimeters. Newly hatched silver hake are pelagic but take to the bottom the first autumn at a length of 1 or 1½ inches. Little is known about the rate of growth.

In the Chesapeake the silver hake is taken only in the spring and only in the lower sections of the bay, not far from the capes. Its appearance from year to year is very erratic; in some years none are taken, in others only stragglers are caught, and occasionally, as in 1920, a fair catch is made. In a set of two pound nets, operated in Lynnhaven Roads from 1908 to 1923, catches of about 10 pounds or more on any one day were taken only in 1918 and 1920. In 1918 the silver hake was taken on only two days in these nets—100 pounds on May 3 and about 200 pounds on May 4. The year 1920 was exceptional, for this hake was caught from April 28 to May 17 in quantities of 10 to 150 pounds daily, the aggregate catch being about 1,000 pounds. The small local catch is easily disposed of in the Norfolk markets, where the fish is known as winter trout.

The silver hake is an important market fish in New England, but its value has only recently been realized. Bigelow and Welsh (1925, p. 396) point out that only 37,000 pounds were saved in Massachusetts and Maine in 1895, but that 14,000,000 pounds were marketed in 1919. It is exceedingly abundant at Provincetown, where it is taken in mackerel wiers in the spring and summer. There it is frozen, and a large market for it has been developed in the Middle West. Oddly enough,

[12] For an account of the embryology of this fish see Kuntz and Radcliffe, 1918, pp. 109–112.

large fish are discarded by the freezers, who state that the western demand is only for "pan size" fish of about 8 to 14 ounces. So abundant is the silver hake at Provincetown that the mackerel freezers will accept only 35 barrels a day from each fishing crew (who usually operate 3 to 6 wiers); and when cold-storage space becomes scarce no more are accepted. The surplus silver hake are allowed to escape through a hole cut in the trap near the surface, an operation we saw repeatedly in June, 1925. The flesh of the silver hake is very sweet when fresh but it softens quickly, which greatly lessens its value.

The maximum size is said to be 8 pounds, but fish over 4 pounds are rare. The usual length of adults is 14 to 24 inches.

Habitat.—Off Newfoundland to the Bahama Islands; most common between Cape Sable and Cape Cod; not recorded from the coast south of Virginia; taken off the New England coast from the shore line to a depth of about 300 fathoms, off Chincoteague, Va., in 90 and 190 fathoms, and only in deep water in the vicinity of the Bahama Islands.

Chesapeake localities.—(*a*) Previous records: None. Once recorded from Cedar Island, Va., which is on the eastern shore of the peninsula. (*b*) Specimens in the collection or observed in the field; Off Barren Island, Md., Ocean View, Lynnhaven Roads, and off Cape Henry Lighthouse, Va.

Order HETEROSOMATA. The flat fishes

Family XXXIX.—PLEURONECTIDÆ.[13] The flounders

Body much compressed, deep, and more or less oval in shape; eyes and color on one side, the skull being twisted, the fish swimming in the water horizontally, with the blind side down; premaxillary protractile; gills 4; pseudobranchiæ present; preopercular margin more or less distinct and not concealed by skin; air bladder wanting; vent close behind the head; lateral line rarely absent, extending on caudal fin when present; scales various, usually small; dorsal fin long, beginning on head, composed of soft rays only; anal similar but shorter; caudal fin sometimes continuous with dorsal and anal; ventral fins small, one of them sometimes wanting; pectoral fins rarely absent, placed rather high on the sides. The family is composed of many genera and numerous species. Some of them are important food fishes. Only two of the seven species from Chesapeake Bay, discussed in the following pages, are locally of economic importance.

KEY TO THE GENERA

a. Ventral fins similar in position and shape, or at least lateral; neither on the ridge of the abdomen.
  b. Mouth large; maxillary reaching beyond lower eye; eyes and color on the left side, Paralichthys, p. 165
  bb. Mouth small; maxillary about reaching lower eye; eyes and color on the right side.
    c. Lateral line anteriorly with a distinct arch; body thin.....Limanda, p. 167
    cc. Lateral line not arched; body notably thicker.....Pseudopleuronectes, p. 168
aa. Ventral fins dissimilar in position and shape, the one of the eyed side being longer and inserted on the ridge of the abdomen.
  d. Lateral line strongly arched anteriorly; anterior rays of dorsal fin rather high and distally free and branched.....Lophopsetta, p. 171
  dd. Lateral line nearly straight; anterior rays of dorsal fin not elevated, not free and not evidently branched.
    e. Body oval, with the eyes and color on the left side.....Etropus, p. 172
    ee. Body quite elongate, with the eyes and color on the right side, Neoetropus gen. nov., p. 174

[13] We have examined the recent works of Regan (1910, pp. 484 to 496) and Jordan (1923, pp. 166 to 169), in which these authors subdivide the large family, Pleuronectidæ, as previously understood, into several smaller families. However, we prefer to leave the large family intact until more information relative to the merits of the characters upon which the separations are made is available and until the families can be described more adequately.

58. Genus PARALICHTHYS Girard. Summer flounders

Body oblong; eyes and color normally on left side; mouth large, oblique; jaws with a single row of sharp teeth; no teeth on vomer or palatines; gill rakers rather long; lateral line simple, with a strong curve anteriorly; scales small, cycloid or ctenoid; dorsal fin beginning before eye, its anterior rays produced; caudal fin double concave or double truncate; no anal spine; both ventral fins lateral. A single species of this large genus is included in the Chesapeake fauna.

77. Paralichthys dentatus (Linnæus). Flounder; Summer flounder; Fluke; Plaice.

Pleuronectes dentatus Linnæus, Syst. Nat., ed. XII, 1766, p. 458.
Chænopsetta ocellaris Uhler and Lugger, 1876, ed. I, p. 96; ed. II, p. 80.
Paralichthys dentatus Bean, 1891, p. 85; Smith, 1892, p. 72; Jordan and Evermann, 1896–1900, p. 2629, Pl. CCCLXXIII, fig. 922; Evermann and Hildebrand, 1910, p. 163; Fowler, 1918, p. 19.

Head 3 to 3.95; depth 2.15 to 2.45; D. 85 to 94; A. 60 to 73; scales 92 to 105. Body moderately elongate; dorsal and ventral outlines about evenly convex; head rather large; snout pointed, 4.05 to 5 in head; eye 3.35 to 5.7; interorbital varying greatly in width with age, narrower than pupil in very young, about three-fourths width of eye in large examples; mouth large, oblique; the jaws somewhat curved; maxillary reaching beyond eye in specimens ranging upward of 180 millimeters, not reaching posterior margin of eye in young, 2 to 2.6 in head; teeth rather prominent, pointed, in a

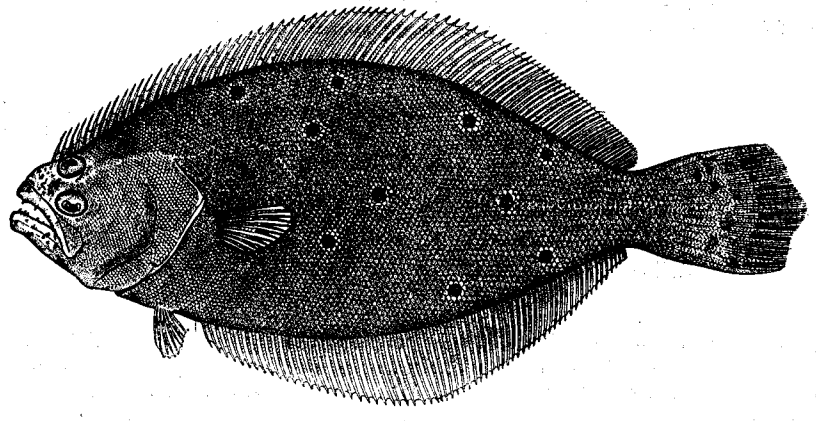

FIG. 86.—*Paralichthys dentatus*. From a specimen 6⅛ inches long

single series in each jaw; gill rakers rather long and slender, 14 to 18 on lower limb of first arch; lateral line anteriorly with a short, prominent arch; scales rather small, cycloid; origin of dorsal over or more usually slightly in advance of upper eye; caudal fin round in young, slightly double-concave in adult; origin of anal under base of pectorals; ventral fins symmetrically placed, inserted under and behind margin of preopercle; pectoral fins moderate, the one on eyed side somewhat more strongly developed, 1.8 to 2.1 in head.

Color brownish, variable, some specimens being much darker than others; most specimens marked with dark ocellated spots, the most prominent of these situated on posterior part of body, three of these forming a triangle with the apex directed forward, the anterior spot being situated on the lateral line, one of the posterior ones over posterior part of base of anal and the other under posterior portion of base of dorsal, these spots often extending on head; fins mostly uniform, sometimes more or less spotted with brown, pale, and dusky specks and bars.

Numerous specimens of this species, ranging in length from 20 to 445 millimeters (⅘ to 17¾ inches), were preserved. The smallest specimen at hand already has the eyes well on one side, and it has essentially the form of the adult. The summer flounder resembles the winter flounder in its outlines. It differs, however, in having the eyes and color on the left instead of the right side. It also has a much larger mouth than the winter flounder, and the lateral line has a distinct arch anteriorly. The rather distinct dark spots on the body of the summer flounder usually are convenient for identification in the field. The three most posterior ones form a triangle, the anterior

spot situated on the lateral line being at the apex. This character, together with the more numerous gill rakers, readily separates the summer flounder from its relative and associate in more southern waters, *Paralichthys albiguttus*.

The food of the summer flounder, as shown by 41 specimens examined for us by Dr. Edwin Linton, consists mainly of fish. Squids, shrimp, crabs, and Mysis also were eaten. This is the same general diet reported in published accounts. One author, at least, adds to this list small shelled mollusks, worms, and sand dollars. This fish is frequently seen on sandy shores, partly buried in the sand. Its movements, however, are rapid when in pursuit of bait. Color adaptation is developed to a very high degree, as it is able to assimilate to a very remarkable extent the color of the bottom that it inhabits. For an account of its color adaptation see Mast (1916, pp. 177 to 238, pls. XIX to XXXII).

Comparatively little is known of the spawning habits of the summer flounder. The eggs quite certainly are deposited during the winter. Specimens taken in Chesapeake Bay during October had comparatively large gonads. The large individuals appeared to be more advanced in this respect than the smaller ones. The senior author, working at Beaufort, N. C., has given considerable attention to the spawning of this flounder and during the fall and early winter has found numerous individuals with partly developed gonads, but never any that were even nearly ready for spawning. By March and April the fish appear to be fully spent. It seems probable that this flounder may go to deep water to spawn. Further evidence that this flounder is a winter spawner is given in the following table enumerating the young caught in Chesapeake Bay in collecting seines:

Date	Locality	Number of specimens	Inches
May 21	Cape Charles (beach)	1	0.9
May 20	Lynnhaven Bay (creek)	3	.9–1.1
June 24	Buckroe Beach (creek)	2	2.0–2.4
June 25	Back River (creek)	1	2.4
July 1	Willoughby Point (beach)	3	1.9–4.1
July 10	Lower York River (sandy flats)	8	2.5–4.3
July 26	Lower Rappahannock River	2	3.0–5.0

A study of length frequencies of young fish indicates that by December and January following hatching, or at about the age of one year, the flounder has attained a length of 12 to 18 centimenters (4.7 to 7.1 inches); that by the next October, when about 1¾ years old, the length ranges from about 20 to 26 centimeters (7.9 to 10.2 inches); and that by May, or at a little over 2 years of age, the length centers around 27 and 28 centimeters (10.6 to 11 inches). During December and January no fish smaller than 12 centimeters or larger than 18 centimeters were caught, and there was a complete absence of fish below 20 centimeters in the seine catches from May to November.

The summer flounder is a valuable food fish in Chesapeake Bay. During 1920, among the food fishes of the bay this species ranked twelfth in quantity and eleventh in value, the catch being 285,100 pounds, valued at $13,763.

In Maryland it ranked twelfth in quantity and thirteenth in value, the catch being 26,746 pounds, worth $1,150. About 60 per cent of this amount was caught in pound nets, 38 per cent in fyke nets, and 2 per cent with haul seines. The counties leading with the largest catch were Somerset, 9,118 pounds; Dorchester, 5,520 pounds; and Talbot, 4,411 pounds.

In Virginia it ranked tenth in quantity and eleventh in value, the catch being 258,354 pounds, valued at $12,613. About 77 per cent of this amount was caught in pound nets; 9 per cent in fyke nets; 8 per cent with haul seines, and 6 per cent with lines. The counties having the largest catch were Norfolk, 51,200 pounds; Warwick, 36,230 pounds; and Accomac, 34,080 pounds.

The summer flounder is caught in the Chesapeake throughout the fishing season, from March until November. In the lower part of the bay, pound nets are set for shad early in March. Beginning about the middle of that month stray flounders are taken, generally one or two in the catch of one net or a set of nets. During the first week or two of April the daily catch per net generally varies from one to six flounders. For the last half of April, however, the daily catch may vary from 25 to 500 pounds per set of two or three nets. The largest catches of this flounder through-

out the bay are made during May, October, and November. The bulk of the catch often is taken during November. The summer flounder can be taken during December, but nearly all fishing in the bay, except for small fyke nets, ceases the latter part of November. The most productive flounder fishing remembered by Chesapeake Bay fishermen occurred during 1921. In one set of two pound nets located at Lynnhaven Roads, Va., 25,605 pounds were caught during 22 fishing days in November. This amount was equivalent to the total catch of flounders made by these two nets during the entire fishing seasons of the years 1916 to 1919, inclusive. In a set of two pound nets at Ocean View, Va., a total of 4,000 pounds of flounders was taken on November 25 and 26, constituting the largest two-day catch ever known in this locality.

The greater part of the catch of summer flounders in the Chesapeake is taken below the Potomac River, particularly from Mobjack Bay to the Capes. However, it is taken in commercial quantities, at least, as far north as Love Point, Md. The summer flounder is rarely taken north of Baltimore. It takes the hook freely and offers good resistance. Sport fishermen catch many flounders from Annapolis, Md., southward, of which no record is made.

The summer flounder is a well-flavored fish, although the meat is rather dry. Its good flavor is best brought out when baked. A large part of the catch is shipped to markets located principally between Washington and New York. Comparatively good prices are frequently obtained, particularly during the heavy November run when fresh fish of other species are not plentiful in northern markets. During 1921 and 1922, the wholesale price usually ranged from 4 to 10 cents a pound.

The name "summer flounder," which is used in the northern part of the range of the present species, doubtless originated from its occurrence in those waters only during the summer. This name distinguished it from the winter flounder, which is most abundant during cold weather. The present species is nearly always simply called "flounder" on Chesapeake Bay. The winter flounder, *Pseudopleuronectes americanus*, is rarely referred to as flounder, for it is known there as "halibut" or "holibut." The summer flounder is the same fish that is called "fluke" or "plaice" in New York.

This species is reported to reach a maximum length of 3 feet and a weight of 10 to 25 pounds. The usual size of the fish seen in the markets of the Chesapeake, however, range from ½ to 6 pounds in weight, and only occasionally one weighing 8 or 9 pounds is seen.

Habitat.—Shore waters from Maine to South Carolina and probably to Florida.

Chesapeake localities.—(*a*) Previous records: St. George Island, Md., Hampton Creek and Cape Charles City, Va., and entrance of Chesapeake Bay. (*b*) Specimens in collection: From many localities from Annapolis, Md., to the Capes; taken chiefly in shallow water during the summer; many small specimens also were taken by the *Fish Hawk* during the winter months in water measuring as much as 25 fathoms in depth.

Comparison of lengths and weights of P. dentatus

Length, in millimeters	Number of specimens	Average length, in inches	Average weight, in ounces	Length, in millimeters	Number of specimens	Average length, in inches	Average weight, in ounces
189	1	7.4	2.3	340–359	3	13.7	14.2
200–219	15	8.3	3.0	360–379	6	14.6	17.7
220–239	17	9.0	3.8	380–399	3	15.3	21.2
240–259	20	9.7	4.7	400–439	3	16.3	25.7
260–279	23	10.6	5.9	440–459	3	17.7	32.8
280–299	14	11.4	7.9	465	1	18.2	35.3
300–319	6	12.2	9.4	497	1	19.5	41.3
320–339	5	13.2	11.9				

59. Genus LIMANDA Gottsche. Mud dabs

Teeth chiefly uniserial; lateral line with a distinct arch in front and without an accessory dorsal branch; scales imbricate, strongly ctenoid. The single species of this genus is reported from Chesapeake Bay.

78. Limanda ferruginea (Storer). Sand dab; Rusty dab.

Platessa ferruginea Storer, Rept., Fish., Mass., 1839, p. 141, Pl. II; Cape Ann, Mass.
Myzopsetta ferruginea Uhler and Lugger, 1876, ed. I, p. 95; ed. II, p. 79.
Limanda ferruginea Jordan and Evermann, 1896-1900, p. 2644, Pl. CCCLXXVII, fig. 929.

"Head 4 in length; depth 2⅕; D. 85; A. 62; scales 100. Body ovate-elliptical, strongly compressed; teeth small, conical, close set, in a single series on each side in each jaw, about 11+30 in the lower jaw; snout projecting, forming a strong angle above upper eye, with the descending profile; gill rakers of moderate length, very weak, not toothed; eyes moderate, 4½ in head, the lower slightly in advance of upper, separated by a high, very narrow ridge, which is scaled posteriorly and is continued backward as an inconspicuous but rough ridge to the beginning of the lateral line; scales imbricate, nearly uniform, those on right side rough, ctenoid, those on left side nearly or quite smooth; scales on body rougher than on cheeks; caudal peduncle short, higher than long; dorsal inserted over middle of eye, its middle rays highest; pectoral less than two-fifths length of head; caudal fin rounded; anal spine present; lateral line simple, with a rather low arch in front, the depth of which is barely two-fifths the length; a concealed spine behind ventrals; ventral of colored side partly lateral, the other wholly so; anal spine strong. Brownish olive, with numerous irregular reddish spots; fins similarly marked; left side with caudal fin, caudal peduncle, and margins of dorsal and anal fins lemon yellow." (Jordan and Evermann.) The fin counts given by other authors show a range for the dorsal of 76 to 85 rays and for the anal 57 to 63 rays.

This species was not seen during the present investigation. It is known from Chesapeake Bay only from a record by Uhler and Lugger (1876), who state that it occurs occasionally in the southern part of the bay. The rusty dab is distinguished from the other flounders of Chesapeake Bay by having its eyes and color on the right side, together with a small mouth and an arched lateral line.

The food of the rusty dab, according to Bigelow and Welsh (1925, p. 498), consists chiefly of the smaller crustaceans, such as amphipods, shrimps, schizopods, etc., and likewise of the smaller shellfish, both univalves and bivalves, and of worms. It is also known to eat small fish.

Spawning is reported to take place on the New England coast all summer, a single female spawning over a considerable period of time, as only a small part of the eggs ripen simultaneously in any one fish. The eggs are spherical, buoyant, transparent, and from 0.87 to 0.94 millimeter in diameter. Incubation extends over a period of about five days at a temperature of 50° to 52° F. Metamorphosis—i. e., the twisting of the skull and the migration of the left eye to the right side, which becomes the colored side—is reported to be completed at a length of about 14 millimeters.

The maximum size reported for this species is 21¾ inches. This northern species is of commercial value from New York northward. However, it is considered less valuable, because of its thin body, than the winter flounder. It evidently is an extremely rare species in Chesapeake Bay if, in fact, it occurs there at all at the present time.

Habitat.—Northern shores of the Gulf of St. Lawrence; northern Newfoundland to Virginia; apparently rare south of New York.

Chesapeake localities.—(*a*) Previous record: "Occasional in the southern part of Chesapeake Bay." (Uhler and Lugger, 1876.) (*b*) Specimens in collection: None.

60. Genus PSEUDOPLEURONECTES Bleeker. Winter flounders

Body oblong, with firm flesh; mouth small; teeth in a single series, close-set; lateral line nearly straight; scales strongly ctenoid on eyed side, firm and regularly imbricated; fin rays with scales.

79. Pseudopleuronectes americanus (Walbaum). Winter flounder; "Halibut"; "Holibut."

Pleuronectes americanus Walbaum, Artedi, Piscium III, 1792, p. 113; New York.
Pseudopleuronectes americanus Uhler and Lugger, 1876, ed. I, p. 94; ed. II, p. 79; Jordan and Evermann, 1896-1900, p. 2647 Pl. CCCLXXIX, fig. 933.

Head 3.4 to 4.4; depth 1.75 to 2.55; D. 62 to 69; A. 46 to 53; scales 77 to 83. Body eliptical, varying greatly in depth; dorsal and ventral outlines about evenly curved; head rather small; snout pointed, 4.6 to 5.2 in head; eye 3.05 to 4.9; mouth small; the jaws unsymmetrical; maxillary on the right side reaching anterior margin of the lower eye, 3.45 to 4.45 in head; teeth small, present only on the left side of each jaw; gill rakers rather short, about eight on lower limb of first arch; lateral

line scarcely arched anteriorly; scales rather small, strongly ctenoid on right side, extending on the fin rays, less strongly ctenoid to nearly smooth on left side; origin of dorsal over anterior part of upper eye; caudal fin round; origin of anal about an eye's diameter behind base of pectorals; ventral fins small, inserted under base of pectorals, reaching to or somewhat beyond origin of anal; pectoral fins rather small, the one on right side slightly the longer, 1.45 to 2.6 in head.

Color in life of a Chesapeake Bay specimen 12 inches long, eyed side, olive green, reddish brown spots of various sizes, irregularly placed, everywhere on head and body; lips pale pinkish; fins reddish brown with darker blotches, dorsal and anal pink along edges; underneath white; dorsal and anal grayish blue, anteriorly pink; pectoral pink. Considerable color variation exists in this flounder, depending largely upon the locality where it is caught and somewhat upon size. The ground color may vary from light to dark; the spots may be prominent, obscure, or almost absent. Underneath it sometimes has areas of dark coloration. Young of 18 to about 50 millimeters (¾ to 2 inches) in length are paler than the adults and more distinctly spotted. Like the summer flounder, this species is able to bring about color changes adaptable to the bottom.

Many specimens of this species, ranging from 18 to 280 millimeters (¾ to 11 inches) in length, were preserved. The principal characters distinguishing this fish are the colored right side, the

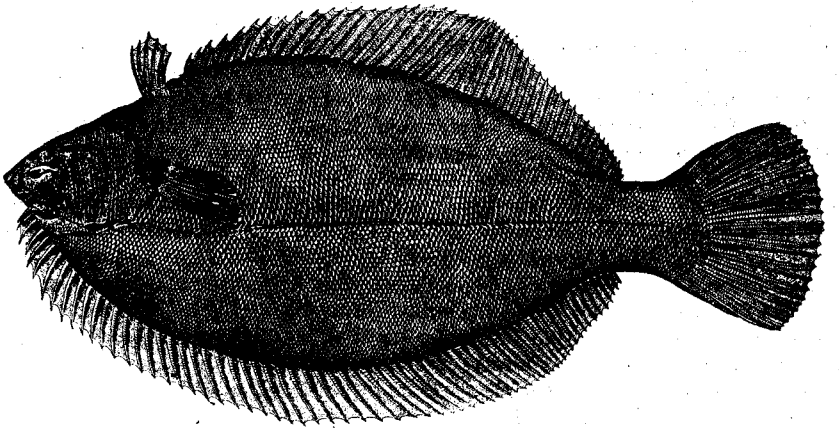

FIG. 87.—*Pseudopleuronectes americanus*. From a specimen 16¼ inches long

nearly straight lateral line, the strongly ctenoid scales of the colored side, and the scaly fin rays. The young do not differ greatly from the adults except in color, as stated in the description.

The food of the winter flounder consists of many kinds of animal life, mostly of small size, for its small mouth restricts the size of the prey that can be taken. Small crustaceans appear to supply the principal food. Worms, small mollusks, and small fish also enter into the food. The first food taken by the larvæ is said to consist of diatoms.

Spawning takes place along sandy shores during the winter and early spring, the season beginning somewhat earlier in the southern part of the range of the species than farther north. The eggs are heavier than sea water and sink to the bottom in clusters. They are from 0.74 to 0.85 millimeter in diameter. The period of incubation occupies 15 to 18 days at a water temperature of 37° to 38° F. The newly hatched fish is about 3 to 3.5 millimeters in length. Metamorphosis—i. e., the twisting of the skull and the migration of the left eye to the right side, which becomes the colored side—is said to be completed when the fish is only 8 to 9 millimeters in length.

Many young were collected in Chesapeake Bay, as follows: April 24–26, Coan River, Lewisetta, length 18 to 28 millimeters (0.7 to 1.1 inches); Love Point, Oxford, and Crisfield, seined along beach and trawled in deep holes, May 11 to 16, length 24 to 44 millimeters (1 to 1.73 inches); mouth of Potomac River, June 11, 2 specimens 50 and 58 millimeters (2 to 2.3 inches) in length.

Flounders trawled in Chesapeake Bay during December and January, at about one year of age, ranged from 4¼ to 7 inches in length, agreeing very well with the 4 to 6 inch fish recorded by Bigelow and Welsh (1925, p. 504) for southern New England during January and February.

This flounder is a valuable food fish in Chesapeake Bay, and its importance is greatly increased because it occurs in the bay during the winter, when other fish are scarce. In 1920 it ranked sixteenth in quantity and seventeenth in value, the catch being 53,719 pounds, worth $5,372.

In Maryland it ranked ninth in quantity and eighth in value, the catch amounting to 40,119 pounds, worth $4,012. About 60 per cent of the quantity taken was caught in pound nets and 40 per cent in fyke nets. The counties having the largest catches were Kent, with 11,960 pounds; Somerset, with 8,117 pounds; and Dorchester, with 6,780 pounds.

In Virginia it ranked twenty-first in quantity and twentieth in value, the catch amounting to 13,600 pounds, worth $1,360. About 75 per cent of this amount was taken in pound nets and 25 per cent in fyke nets. The counties having the largest catches were Accomac, with 2,300 pounds; Gloucester, with 1,400 pounds; and Warwick, with 1,300 pounds.

The winter flounder is caught in the Chesapeake from November to April and a few stragglers in May. Nearly all the pound nets in the bay are taken up by December and reset in March. The winter flounders taken with this apparatus, therefore, are nearly all caught in November and April and a few in May. Fyke nets, being small and easily fished by one man, are used throughout the winter, and the winter flounder is one of the principal species caught. This flounder takes the baited hook. However, very little hook-and-line fishing is done in the Chesapeake during the winter months.

Unlike most of the salt-water species of the bay, the winter flounder appears to be more common in Maryland waters than in the lower sections of the bay. Around Norfolk the principal catch is taken with pound nets in November and early December. At Cape Charles it is taken in pound nets in late fall and early spring, and in Cherrystone Inlet it is taken during the winter with fyke nets. In the lower York River the winter flounder is one of the principal fish taken with fyke nets during the winter. At Lewisetta, Va., and Crisfield, Md., it is taken in November, December, March, and April in pound nets and fyke nets. At Solomons a few are taken in the spring, but the principal season is late fall. At Annapolis the winter flounder is one of the chief fish taken in the late fall and early spring. In the vicinity of Love Point it is considered an important winter fish. Few, however, are taken northward of this locality. The best catch of winter flounders made at Love Point by a set of two pound nets on one day during the spring of 1922 was 400 pounds.

As this flounder is caught during the colder months, when other species of fish are comparatively scarce in the bay, a market is always available and a good price generally is obtained. A large part of the catch is sold in Norfolk, Portsmouth, Washington, and Baltimore. The price received by the fishermen in 1921 and 1922 ranged around 10 cents a pound.

As a food fish this species is considered somewhat superior to the summer flounder. It is an important fish in the fall and early spring along the entire middle Atlantic and New England coasts, where in places it is quite abundant. In the vicinity of New York and elsewhere this is a favorite fish of anglers, who catch large numbers with hook and line. The name most used for this species in the Chesapeake is "holibut" or "halibut."

The maximum size recorded for the winter flounder is 21 inches. Individuals over 18 inches in length and over 3½ pounds in weight are unusual. The usual size of fish seen in the markets on the Chesapeake range from one-half to 2 pounds, and only occasionally are larger ones seen.

Habitat.—Northern Labrador to Georgia, not taken in commercial numbers south of Chesapeake Bay; entering brackish to nearly fresh water.

Chesapeake localities.—(*a*) Previous records: Southern part of Chesapeake Bay, Potomac River, and coast of St. Marys County, Md. (*b*) Specimens in collection: From many localities from Robins Point, on the Susquehanna River, where the water was fresh enough to drink, to the mouth of the bay; taken both in shallow and deep water, ranging from a foot or two to 29 fathoms in depth, and nearly all catches having been made between November 1 and June 1.

Comparison of lengths and weights of P. americanus

Length, in millimeters	Number of specimens	Average length, in inches	Average weight, in ounces	Length, in millimeters	Number of specimens	Average length, in inches	Average weight, in ounces
110–129	14	4.7	0.6	265	1	10.2	7.7
130–149	10	5.5	1.0	290	1	11.0	10.2
150–169	12	6.3	1.5	305	1	11.8	13.8
170–189	2	7.1	2.4	370	1	15.0	20.0
220	1	8.6	5.0				

61. Genus LOPHOPSETTA Gill. Sand flounders

Body broad, much compressed, translucent; eyes and color on the left side; mouth large; maxillary reaching opposite the pupil; lateral line with a high arch anteriorly; scales small, cycloid; dorsal fin beginning in front of eye, the anterior rays long, distally free and branched; ventral fins dissimilar in shape and position, broad at base, the left one inserted on ridge of abdomen. This genus consists of a single species.

80. Lophopsetta maculata (Mitchill). Sand flounder; Window-pane; Spotted flounder; Sand dab.

Pleuronectes maculatus Mitchill, Rept., Fish., New York, 1814, p. 9; New York.
Lophopsetta maculata Jordan and Evermann, 1896–1900, p. 2660, Pl. CCCLXXXII, fig. 938.
Bothus maculatus Bean, 1891, p. 85.

Head 2.9 to 4.05; depth 1.45 to 1.8; D. 63 to 69; A. 46 to 52; scales 92 to 102. Body rhomboid, very strongly compressed; head rather small; snout short, 3.7 to 4.45 in head; eye 2.7 to 3.95; interorbital narrower than eye, proportionately much broader in adult than in young, 1.8 to 3.5 in eye; mouth nearly vertical; lower jaw projecting, with a bony knob at chin; maxillary broad, reaching below middle of lower eye, 2 to 2.45 in head; teeth in jaws small, in a single series laterally, in a band anteriorly; gill rakers slender, 24 to 26 on lower limb of first arch; lateral line with a prominent arch anteriorly, shorter than head; scales small, scarcely imbricate; origin of dorsal nearer tip of snout than eye, the anterior rays distally free and branched; caudal fin round; origin of anal between base of ventrals; ventral fins small with broad bases, the left one nearly on ridge of abdomen; pectoral fins moderate, the left one somewhat larger than the right, 1.25 to 1.65 in head.

Color light brown mottled with numerous lighter brown and black spots, these spots extending on the vertical fins, where they sometimes become elongate; white below. Some specimens are much darker than others but the pattern is about the same.

Many specimens, ranging in length from 40 to 260 millimeters (1⅗ to 10¼ inches), were preserved. The young do not differ greatly from the adults. The sand flounder is recognized by the ventral fins, which are broad at the base and dissimilar in shape and position. These characters, in combination with the strongly arched lateral line and the free and branched rays forming the anterior part of the dorsal fin, distinguish this flounder from all others known from Chesapeake Bay.

We have nothing new to add concerning the food of this flounder. It is known to feed freely on fish of suitable size and on crustaceans, certain mollusks, annelids, and ascidians.

Spawning, according to Bigelow and Welsh (1925, p. 520), takes place in late spring and summer in the Gulf of Maine. It seems probable that spawning takes place much earlier in Chesapeake Bay, as fish with fairly well developed gonads were taken as early as the latter part of September. The larval development is said to be rapid. Tracy (1910, p. 166) gives a length of 2 to 3 inches for the young in July and 4 inches or more by December in Rhode Island waters.

The eggs are spherical, transparent, buoyant, and 1 to 1.08 millimeters in diameter. Incubation requires about eight days at 51° to 56° (Bigelow and Welsh, 1925, p. 520). The development of the larvæ is rapid, and at 10 millimeters the migration of the eye is completed and the fry are ready to take to the bottom (Williams, 1902, p. 2).

The following young fish were caught in Chesapeake Bay:

Date	Number of specimens	Total length, inches	Date	Number of specimens	Total length, inches
Feb. 19	6	1.6–2.3	Apr. 12	13	2.2–3.6
Mar. 7	1	2.6	Apr. 13	8	4.1
Mar. 31	1	2.1	Apr. 14	1	
Apr. 10	26	2.3–3.4	Apr. 15	4	2.7–3.0
Apr. 11	2	2.2–3.5	May 20	10	3.0–4.5

The sand flounder is fairly common in Chesapeake Bay, but, owing to the small size attained and the extreme thinness of its body, it has no commercial value. The common name "window-pane" has reference to the extremely thin body, which in some places is almost transparent.

A maximum length of 18 inches is reported for the sand flounder. Such a length, however, must be very exceptional. It would appear from published accounts that the species grows larger in the northern part of its range than farther south. A fish as much as 10 inches long is exceptional both in Chesapeake Bay and at Beaufort, N. C., whereas Bigelow and Welsh (1925, p. 517) report a usual length of 10 to 12 inches for adult fish. A fish 6¼ inches long weighs about 1.7 ounces; 7½ inches, 3 ounces; and 8½ inches, 4.7 ounces.

Habitat.—Shallow water from the Gulf of St. Lawrence to South Carolina.

Chesapeake localities.—(*a*) Previous record: Cape Charles City, Va. (*b*) Specimens in collection: From many localities from Bloody Point, Md., to the entrance of the bay, common chiefly in the southern sections of the bay; taken both in the shallow and deeper waters, ranging up to 25 fathoms, and principally from September to June.

62. Genus ETROPUS Jordan and Gilbert

Body oval; eyes and color on left side; head small; eyes small, separated by a narrow ridge; mouth very small; teeth small, pointed, in a single series, few or none in upper jaw of colored side; vomer toothless; scales thin, ctenoid on left side; smooth on right side; lateral line simple, nearly straight; origin of dorsal over upper eye; anal without a spine; left ventral on ridge of abdomen.

KEY TO THE SPECIES

a. Body somewhat elongate, the depth somewhat less than half the length in the adults; gill rakers about 13 on lower limb of first arch ..... *microstomus*, p. 172

aa. Body more ovate, the depth equal to or greater than half the length in the adult; gill rakers about 8 on lower limb of first arch ..... *crossotus*, p. 173

81. Etropus microstomus (Gill).

Citharichthys microstomus Gill, Proc., Ac. Nat. Sci., Phila., 1864, p. 223; Bean, 1891, p. 84.
Etropus microstomus Jordan and Evermann, 1896–1900, p. 2687.

"Body ovate. The depth of the body is contained two and one-tenth times in its length, which is three and one-half times the length of the head. Mouth small, very oblique, the gape curved; maxillary two and two-thirds times in length of head, reaching beyond middle of orbit; snout projecting; eyes small, even, shorter than snout, about six in head, separated by a narrow ridge, which is concave and scaleless anteriorly; teeth all small, front teeth of upper jaw wide set, much larger than posterior, which are close together and very small, teeth of lower jaw few, wide apart; gill rakers short and strong, 13 below angle; pectorals short, less than half length of head; scales large, those on middle of sides posteriorly largest. D. 80; A. 61; Lat. 1. 45. Individuals from Great Egg Harbor Bay have D. 74; A. 55; scales 41 to 42.

"Olive brownish, usually with large blotches of darker; a series of distinct, obscure, blackish blotches along the basal portions of the anal and dorsal fins. Size small. Tropical America, north to Long Island occasionally in summer." (Bean, 1903, p. 725.)

No specimens of this species were obtained during the present investigation. The species, however, has been recorded from Chesapeake Bay and we also find a reference to it in Dr. William

C. Kendall's field notes of 1894, based on investigations made in Chesapeake Bay, in which he lists the capture of a few specimens during March. This flounder is a rather obscure species and its relationship is not well known. It apparently differs from *E. crossotus* principally in having a more slender body, the depth being less than half the length. Nothing is known concerning its habits and life history. Its length probably seldom exceeds 4⅓ inches.

Habitat.—Long Island, N. Y., to Virginia, and probably southward.

Chesapeake localities.—(*a*) Previous records: Cape Charles City, Va. Also recorded in Dr. William C. Kendall's unpublished notes in 1894 from off Lynnhaven Roads and off Cape Henry, Va. (*b*) Specimens in collection: None.

82. Etropus crossotus Jordan and Gilbert.

Etropus crossotus Jordan and Gilbert, Proc., U. S. Nat. Mus., IV, 1881, p. 364; Mazatlan, Mexico. Jordan and Evermann, 1896-1900, p. 2689, Pl. CCCLXXXVI, fig. 946.

Head 4 to 4.85; depth 1.75 to 2.55; D. 75 to 81; A. 55 to 64; scales 41 to 44. Body elliptical, very strongly compressed; dorsal and ventral outlines about evenly convex; head short; snout very short, 5 to 7 in head; eye 3.05 to 3.8; interorbital very narrow, a mere ridge; mouth small, strongly oblique; maxillary reaching anterior margin of lower eye, 3.5 to 3.9 in head; teeth in jaws small, in a single series, greatly reduced or wanting in upper jaw on eyed side; gill rakers 7 to 9

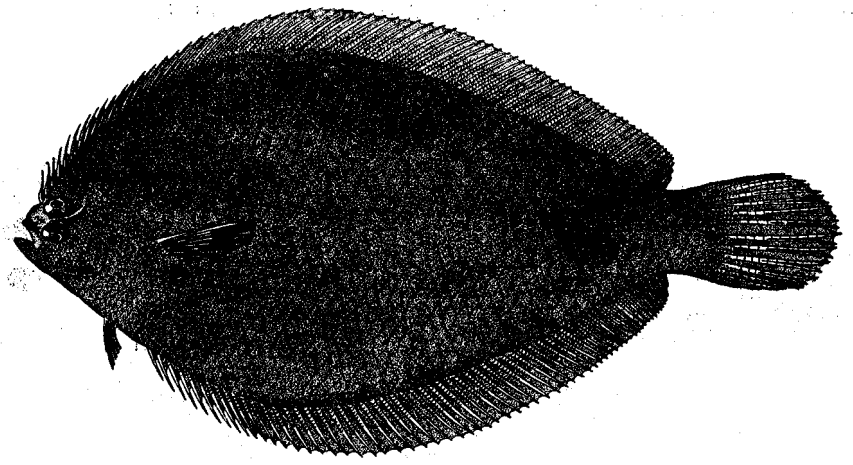

FIG. 88.—*Etropus crossotus*. From a specimen 4¾ inches long

on lower limb of first arch; lateral line nearly straight; scales rather large, ctenoid on eyed side, cycloid on blind side, with small accessory scales at base; origin of dorsal a little in advance of upper eye; caudal fin round; origin of anal a little behind vertical from base of pectorals; ventral fins small, the left one on the ridge of the abdomen; pectoral fins moderate, the one on the eyed side notably longer than the one on the blind side, 1.15 to 1.4 in head.

Color in alcohol brownish, more or less spotted with dusky markings, occasionally with a series of dark blotches along the side on the lateral line; fins pale, with dark specks.

This species is represented in the present collection by 20 specimens, ranging from 50 to 115 millimeters (2 to 4½ inches) in length. This small flounder is recognized by its extreme thinness and its deep body, which in the adult is quite half as deep as long, whereas in *E. microstomus* the depth is less than half the length. The small number of scales (41 to 44) in a lateral series also at once separates it from all other flounders of Chesapeake Bay.

The life history and habits of this little flounder are but little known. It is chiefly a fish of the American Tropics, occurring only as a straggler as far north as Chesapeake Bay. It is most frequently taken along sandy shores and is too small to be of commercial value, as it probably does not exceed a length of 6 inches.

Habitat.—Both coasts of tropical America; on the Pacific from Lower California to Panama, and on the Atlantic from Virginia to Rio de Janeiro, Brazil.

Chesapeake localities.—(*a*) Previous records: None. (*b*) Specimens in collection: All taken in the southern sections of the bay, from somewhat north of Cape Charles City, Va., to the mouth of the bay. Some were seined in shallow water; others were taken by the *Fish Hawk* in water 22 fathoms in depth. Catches were made during the months of July, September, October, and December.

63. NEOETROPUS gen. nov.

Type *Neoetropus macrops* sp. nov.

This genus has the eyes and color on the right side, as in the winter flounders, Pseudopleuronectes. However, it has the unsymmetrical ventral fins (the one of the right side being on the ridge of the abdomen), the small mouth, and very narrow interorbital of the small flounders, Etropus, the members of which have the eyes and color on the left side. It differs from both these genera in the elongate body (depth about 3 in length). The teeth are pointed, in a single series, present on both sides of the jaws, and apparently wanting on the vomer. The scales are rather large and deciduous.

83. Neoetropus macrops sp. nov.

Type No. 87653, U.S.N.M.; length 55 millimeters; off Smiths Point, Va.

Head 4.1; depth 3.2; D. 83; A. 67; scales about 40. Body elongate, strongly compressed; dorsal and ventral profiles evenly rounded; head small; snout short, 5.25 in head; eyes large,

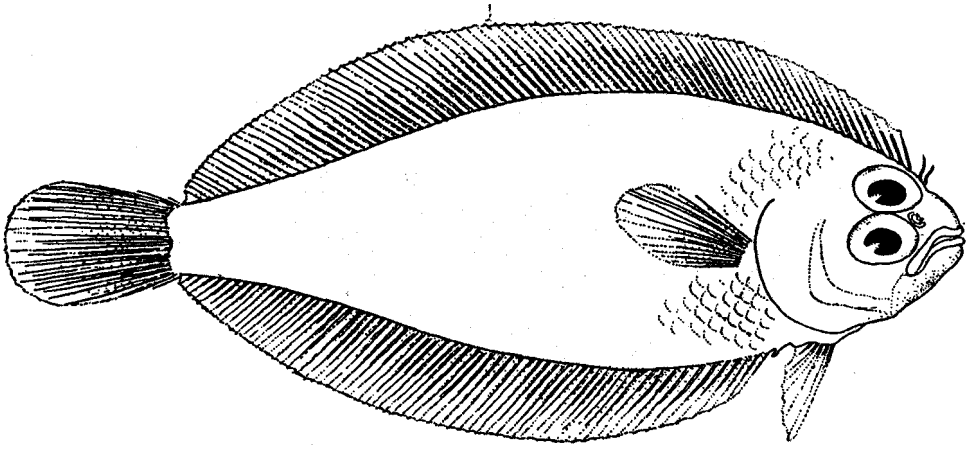

FIG. 89.—*Neoetropus macrops*. From the type 2½ inches long

the lower one scarcely in advance of the upper, interorbital space extremely narrow, 3.2 in head; mouth very small, oblique; maxillary reaching slightly past anterior margin of eye, 3.5 in head; teeth in the jaws pointed, in a single series, not quite as strongly developed on the eyed side as on the blind side; vomer apparently toothless; preopercular margin free; gill rakers rather short and blunt, placed far apart, six on lower limb of first arch; lateral line without an arch; scales deciduous (all lost from the specimen in hand), large (as shown by the marks on the body); origin of dorsal over snout, somewhat in advance of eye; dorsal and anal similar, both well separated from the caudal; caudal fin somewhat injured in the specimen at hand, apparently round or pointed; ventral fins unsymmetrical, the one of the blind side on ridge of abdomen in advance of origin of anal; pectoral fins moderately developed on both sides, about 1.9 in head.

Color of preserved specimen uniform pale, the eyed side being nearly as pale as the blind one.

A single specimen, 55 millimeters in length, is at hand. We are unable to place this specimen in any known genus or species. It has the eyes and color on the right side, as in the winter flounders, Pseudopleuronectes. On the other hand, it has the very small mouth, narrow interorbital, and the unsymmetrical ventral fins of the small flounders of the genus Etropus. Apparently it differs from all the known forms of both genera with which it has characters in common in the elongate body and the large eyes. The specimen might be considered an aberrant individual of Etropus, with

the eyes and color on the reverse side, were it not for the fact that when so considered there is still no species known in that genus with which the specimen in hand may be identified. No other course seems open to us, therefore, than to set up a new genus and species, a matter that is nearly always highly unsatisfactory when only a single specimen happens to be at hand.

Chesapeake localities.—Off Smiths Point, Va., somewhat below the mouth of the Potomac River, taken by the *Fish Hawk* in an 8-foot beam trawl at a depth of 25 fathoms on February 21, 1914.

Family XL.—ACHIRIDÆ. The broad soles

Body oblong or ovate; eyes and color dextral (i. e., on the right side); eyes moderate or small, separated by a distinct bony ridge, upper eye usually more or less in advance of lower; mouth small, more or less twisted toward the blind side; teeth little developed, in villiform bands if present; edge of preopercle adnate, usually concealed by scales; gill openings more or less narrowed; gill membranes adnate to shoulder girdle above; scales usually ctenoid, rarely wanting; blind side of head usually with fringes; lateral line single, straight; caudal fin free from the dorsal and anal; right ventral on the ridge of the abdomen and continuous with the anal fin; one or both pectorals often absent.

64. Genus ACHIRUS Lacépède. Hog chokers; American soles

Body ovate, bluntly rounded anteriorly; head small; eyes small, separated by a bony ridge; mouth small, somewhat turned toward the colored side; gill openings narrow, not confluent below; teeth minute or wanting; color and eyes on the right side; scales very strongly ctenoid, similar on both sides; lateral line simple, nearly straight; origin of dorsal over snout; anal spine wanting; caudal fin free, the peduncle very short; ventral fins both present, the one of colored side often nearly continuous with the anal; pectoral fin of blind side wanting, the one on eyed side small or obsolete.

84. Achirus fasciatus Lacépède. Hog choker; Sole.

Achirus fasciatus Lacépède, Hist. Nat. Poiss., IV, 1803, pp. 659, 662; Jordan and Evermann, 1896–1900, p. 2700, Pl. CCCLXXXVII, fig. 948; Smith and Bean, 1899, p. 187; Evermann and Hildebrand, 1910, p. 163; Fowler, 1923, p. 14.

Achirus lineatus Uhler and Lugger, 1876, ed. I, p. 93; ed. II, p. 78; Bean, 1883, p. 365; Bean, 1891, p. 84.

Head 3.45 to 4; depth 1.6 to 1.95; D. 50 to 56; A. 36 to 42; scales 66 to 75. Body broad; dorsal and ventral outlines about evenly convex; head short; snout blunt, 2.85 to 3.7 in head; eye small, 5.2 to 7.5; interorbital never broader than eye, notably narrower than eye in young; mouth rather small, terminal; the jaws considerably curved; maxillary reaching under lower eye, 2.5 to 2.9 in head; teeth in the jaws in villiform bands, present only on blind side; lateral line indicated by a narrow stripe, but without pores; scales small, strongly serrate on both sides of fish; blind side of head with numerous tentacles, extending backward and somewhat on the dorsal and anal fins; origin of dorsal over snout; caudal fin round, separate from dorsal and anal; origin of anal under margin of opercle; ventral fins moderately developed, the one of the eyed side on ridge of abdomen, somewhat continuous with anal fin; pectoral fins wanting.

Color of eyed side brownish to dusky; some specimens much darker than others; usually with about seven or eight black vertical lines; sometimes much mottled with pale markings, these marks occasionally suggesting reticulations; blind side sometimes plain white, more usually with more or less brownish pigment and variously spotted with black, the spots varying in size from very small to larger than the eye, sometimes covering the entire side, sometimes present only posteriorly; fins with pale and dark streaks or spots.

Numerous specimens of this common sole, ranging from 38 to 202 millimeters (1½ to 8 inches) in length, are in the Chesapeake collection. The young appear to be somewhat more elongate than the adults, but in other respects they are similar. The hog choker is at once distinguished from all other flat fishes of Chesapeake Bay by the deep, round body, the fringed scales on the blind side of the head, and, when present, by the black crossbars extending across the body. Both species of soles known from Chesapeake Bay have no pectoral fins and, unlike in the flounders, the upper instead of the lower jaw is the longer.