

trawled on the southern part of the Newfoundland Bank in bottom water as cold as 33° F. (0.6° C.), while others reported from Bay Bulls, on the east coast of Newfoundland and from Cut-throat Harbor on the outer coast of Labrador (p. 254) doubtless were in water equally cold.

At the opposite extreme, it has been found that only a few halibut are taken in the parts of the North Sea where the bottom water is warmer than 46°-47° (8° C.), none at all where it is warmer than 59° F. (15° C.). And there is no reason to suppose that halibut ever were plentiful anywhere in the western side of the Atlantic in temperatures much higher than about 46°-47°, for while the bottom water warms locally to 50°-52° on Georges Bank in summer, and to 52°-59° on Nantucket Shoals, it was only during the winter and spring that there ever was any regular fishing for halibut on either of these grounds.

On the other hand, the halibut that summer on banks where the bottom chills below about 36° in winter have been described repeatedly as withdrawing to deeper (i. e., to warmer) water for the coldest part of the year. Perhaps the best known example is off west Greenland. Here the halibut work in over the banks regularly in summer, from the deeper waters of Davis Strait, as the temperature rises, but work out again, and deeper, in autumn, as the water cools again.²⁹ Thus it was only deeper than 350 fathoms that long liners, fishing there in 1926-28³⁰ found halibut in paying quantities at the beginning of June, when the bottom temperature on the banks was about 33°-37°. But good catches were made as shoal as 200 fathoms by the middle of the month when the temperature had risen to 35°-38°. And there was good fishing as shoal as 70 fathoms by mid-July, when the banks had warmed to 37°-39°, though many of the halibut were in deeper water still.

Halibut have been described as shifting ground in the same way in the coastal belt of the Gulf of Maine (p. 257) from season to season. On the other hand, we suspect that halibut finding themselves in water shoaler than 30 fathoms or so in the southernmost part of the range of the species, on the American side, at the onset of summer may

withdraw to slightly deeper water for the time being, but definite information is lacking.

The seasonal movement of halibut in onto the Greenland Banks as early in the summer as temperature allows seems to be in search of food, as Jensen points out, for a much richer supply of small fish is available to them on these shoaler bottoms than deeper down the Davis Strait slope, where they must depend chiefly on large shrimps (p. 252). And we suspect that the food supply is equally important in influencing the seasonal movements of halibut in our Gulf.³¹

If the prevalent view is correct, the Atlantic halibut resort to rather definite and circumscribed ground to spawn, much as the Pacific halibut do.

Halibut have also been credited with extensive wanderings from bank to bank, for no evident reason. And recent tagging experiments carried out off Nova Scotia by the Fisheries Research Board of Canada,³² have proved that some of them certainly do so, in American waters. Thus fish that were marked on German and Browns Banks have been recaptured as far to the eastward as Western Bank and in the general vicinity of Sable Island, while one that was tagged at Anticosti was recaptured at Seven Islands more than 100 miles to the westward. But most of the recaptures were made within a few miles of the places where the fish had been tagged. And available evidence as to halibut migrations in the Gulf of Maine and in Nova Scotian waters is so contradictory, and so greatly complicated by the local effects of hard fishing, that it is not worth while to attempt any further discussion here.

Food.—The halibut is very voracious, preying chiefly on other fishes, a long list of which have been reported from their stomachs, including cod, cusk, haddock, rosefish, sculpins, grenadiers, silver hake, herring, launce on which they often gorge in northern seas,³³ capelin, flounders of various sorts (these seem to be their main dependence), skates, wolffish, and mackerel. Halibut are also known to eat crabs, lobsters, clams, and mussels;

²⁹ For a further discussion of the range and movements of the halibut in relation to temperature, with references, see Thompson and VanCleve, Rept. Internat. Fish. Comm. No. 9, 1936, pp. 22-38.

³⁰ Martin and McCracken, Fish. Res. Board Canada, Progress Rept., Atlantic Coast Station, No. 50, 1950, pp. 3-8.

³¹ Capt. Baldersheim described halibut off west Greenland as sometimes in schools, preying on launce (Rapp. Proc. Verb. Conseil Internat. Explor. Mer., vol. 56, 1929, p. 25).

³² Jensen (Meddelelser, Dansk Komm. Havunders., Ser. Fiskeri vol. 7, No. 7, 1925, pp. 17-18) seems to have been the first to bring this to scientific attention.

³³ Baldersheim, Rapp. Proc. Verb. Conseil Internat. Explor. Mer., vol. 56, 1929, pp. 25-28.

even sea birds have been found in them.³⁴ Fishermen have reported finding in halibut the heads and backbones of cod thrown overboard, and a variety of indigestible objects such as pieces of wood or iron, and even fragments of drift ice.

The diet of the halibut in any particular locality depends chiefly on what other ground fish are most easily available. Thus they are reported as feeding chiefly on flatfish on Georges Bank, but on cod, haddock, cusk, and sculpins on other grounds.

Halibut, like other flounders, must be nearly invisible as they lie on bottom, capturing any fish that passes within reach by a sudden rush. On one occasion a halibut of about 70 pounds was seen at the surface trying to kill a small cod with blows of its tail. "We hove out a dory and two men went in her taking with them a pair of gaff hooks. They soon returned bringing not only the halibut but the cod."³⁵ And halibut are very destructive to smaller fish. We read, indeed, of half a bushel of flatfish taken from one halibut. And fishermen said the appearance of a school of halibut soon drove away the cod and haddock, in the days when halibut were still plentiful on the shoaler banks.

It appears that halibut do not eat many invertebrates at least in the Gulf of Maine, or in Nova Scotian waters. But a case is on record when 6 lobsters, 6 inches long, were found in the stomach of one. And Jensen found that halibut caught in deep water off west Greenland had fed chiefly on large shrimps (*Pandalus borealis*).³⁶

According to fishermen who have watched them in clear shallow water, "The halibut will advance to the bait . . . then retreat 4 or 5 feet from it . . . after repeating this performance several times—generally three or four—the fish seems to make up its mind to eat the bait, and, suddenly darting toward it, swallows it down at a gulp."³⁷

Halibut, in their own turn, fall prey to seals, and especially to the Greenland shark, for which they are a staple article of diet.

³⁴ Smitt (Scandinavian Fishes, vol. 1, 1892, p. 414) speaks of a halibut that had eaten a razor-billed auk; Good and Collins (Fish. Ind. U. S., Sect. 5, vol. 1, 1887, p. 35) record an "ice bird" (probably a dovekie) as taken from a halibut caught on Georges Bank; and Scudder (Fish. Ind. U. S., Sect. 5, vol. 1, 1887, p. 119) reports finding the skeleton of a gull in the stomach of another.

³⁵ Goode, Fish. Ind. U. S., Sect. 1, 1884, p. 196.

³⁶ Meddelelser, Dansk. Komm. Havunders., Ser. Fisk., vol. 7, No. 7, 1925, p. 18.

³⁷ Goode and Collins, Fish. Ind. U. S., Sect. 5, vol. 1, 1887, p. 17.

Large halibut are very prolific, the ovaries of an Atlantic female of about 200 pounds having been estimated as containing 2,182,773 eggs, while a female of the Pacific form of "140 pounds may have as many as 2,700,000."³⁸

Very little is known about the breeding of the Atlantic halibut. In the eastern Atlantic halibut spawn chiefly in March, April, and May with the chief production of eggs in April, while a few females may ripen as early as the end of January, and some not until June.³⁹ Off west Greenland they spawn late in spring.⁴⁰ Off the American coast it seems that the spawning season continues through the summer, for fishermen have reported ripe fish, both male and female, in April, May, June, July, August, and early September at various localities from Georges Bank to the Grand Banks;⁴¹ while the report that part of the eggs in the ovaries of a fish examined on Banquereau by representatives of the Bureau of Fisheries on September 13, 1878, were ripe, but others immature, is evidence (if correct) that individual halibut may spawn over a considerable period.

Presumably they spawn on bottom, like other flat-fishes, but definite information is lacking. The Pacific halibut is known to spawn at depths of 150 fathoms to about 225 fathoms;⁴² and European students, generally, have believed that the Atlantic fish spawns deeper still, perhaps even outside the 400-500 fathom line; evidence is that naturally spawned eggs have been taken only where the depth was greater than about 550 fathoms (1000 meters), the drifting larvae less than 19 mm. long only over depths greater than about 220 fathoms (400 meters).⁴³ On the other hand, halibut spawn regularly in the aquarium at Trondhjem, Norway, where the eggs have been fertilized artificially and hatched successfully.⁴⁴ This, with fishermen reports of ripe fish, both females and males, on the slopes of all the offshore Banks east of Cape Cod and, with Cox's report of

³⁸ Clemens and Wilby, Bull. No. 68, Fisheries Res. Board Canada, 1946, p. 312.

³⁹ For a general survey of available information, see Tåning, Meddelelser Komm. Danmarks Fisk. Havunders., Ser. Fisk., vol. 10, No. 4, 1939, p. 14.

⁴⁰ A larva 14.75 mm. long taken on June 19 and another 21 mm. long taken on July 7 is recorded by Jensen (Rapp. Proc. Verb. Cons. Intern. Explor. Mer, vol. 39, p. 96, 1926).

⁴¹ Goode (Fish and Fishery Industr. U. S., Sec. 1, 1884, pp. 196-197), mentions reports to this effect.

⁴² Clemens and Wilby, Bull. 68, Fish. Res. Bd. Canada, 1946, p. 312.

⁴³ Tåning, Meddel. Komm. Danmarks Fisk. Havunders., Ser. Fiskertf., vol. 10, No. 4, 1936, p. 8.

⁴⁴ Rollesen, Kgl. Norske Vidensk. Selsk. Trondhjem, Forhand., vol. 7, No. 7, 1934.

two larval halibut, 20 and 21.5 mm. long, taken close in to the southern coast of Nova Scotia in shoal water,⁴⁵ suggests that the American fish may spawn at least as shoal as the Pacific fish does, and perhaps even shoaler.

The eggs are buoyant, drifting suspended in the water at depths greater than 30 to 50 fathoms, not at the surface. Usually they are 3 to 3.8 mm. in diameter, and they do not have any oil globule.⁴⁶

The only other buoyant fish eggs equally large that are likely to be found in the Gulf of Maine are those of the Argentine (p. 140), but these have a large oil globule, so there is no danger of mistaking them for halibut eggs. The buoyant eggs of the Greenland halibut (p. 258) are larger still.⁴⁷

In the Trondhjem aquarium the incubation of artificially fertilized eggs occupied 16 days at a temperature of about 43° (6° C.). The larvae were 6.5 to 7 mm. long at hatching, with very large yolk sac and no pigment, growing to about 8.5 mm. by the sixth day, and developing pigment by the 10th day.⁴⁸

The smallest naturally hatched Atlantic halibut yet seen⁴⁹ was 13.5 mm. long, with the vertical fin rays appearing. The dorsal and anal fins are developed and the ventral fins are visible at about 22 mm. (fig. 125), by which time the left eye has moved upward until its margin is just visible above the contour of the head, forecasting that the fish is to be a right-handed flatfish. Fish of this size also show the large mouth characteristic of the species. Up to this stage there is little pigment. About one-fourth of the eye appears above the profile when the little halibut is about 27 mm. long, but even at 34 mm. (the largest pelagic stage yet found) the eye has not entirely completed its migration (fig. 126), though the pigmentation is

stronger on the right side than on the left, and the caudal fin (previously rounded) has become square tipped.

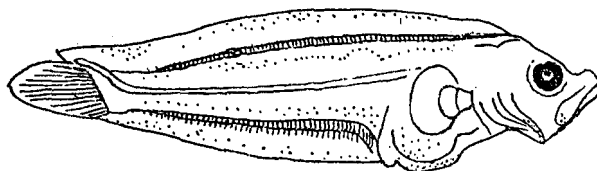


FIGURE 124.—Larva, 16.2 mm. (European). After Schmidt.

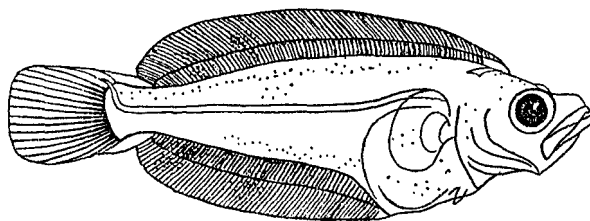


FIGURE 125.—Larva, 22 mm. (European). After Schmidt.

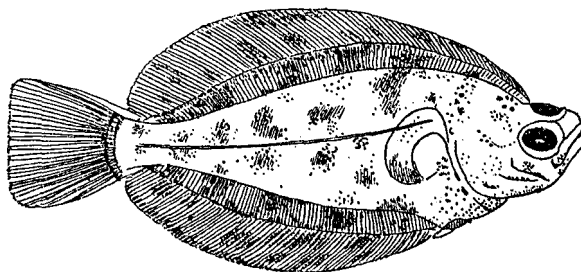


FIGURE 126.—Larva, 34 mm. (European). After Schmidt.

HALIBUT (*Hippoglossus hippoglossus*).

The younger larvae (up to about 25 mm. in length) are made recognizable as halibut by their curiously upturned snout. Older ones that are large enough to show that they belong to some right-handed large-mouthed flounder are separable from the American dab larvae (the only other common Gulf of Maine flatfish with which they agree in both these respects) by the outlines of the head and abdomen.

The early life history of the Pacific halibut has been worked out especially by Thompson and Van Cleve, who have given an excellent series of illustrations of successive stages from newly hatched larvae to young fry a little more than 1 inch long.⁵⁰ How long the young halibut lives adrift at the mercy of the currents, is not known. But the young fry, so small (47–64 mm long) that they had evidently been spawned the preceding spring or

⁴⁵ Contrib. Canadian Biol., N. Ser., vol. 1, No. 21, 1924, pp. 409–412.

⁴⁶ For description of eggs artificially fertilized in the Trondhjem aquarium, see Roloffsen, Kgl. Norske Vidensk. Selsk. Forh., vol. 7, No. 7, 1934, p. 20–23; for descriptions of naturally spawned eggs taken in tow nets in Icelandic waters, see Tåning, Meddel. Komm. Danmarks Fisk. Havunders. Ser. Fiskeri, vol. 10, No. 4, 1936, p. 5; for description of the eggs and larvae of the closely allied Pacific halibut, see Thompson and Van Cleve, Rept. No. 9, Internat. Fisheries Comm., 1936.

⁴⁷ 4 to 4.5 mm. in diameter according to Jensen, Kgl. Dansk Vidensk. Selsk. Skr. Nat., afd. 9, R. 6, 1935, p. 4.

⁴⁸ For illustration of these artificially fertilized eggs in incubation stages, and of the larvae hatched from them, see Roloffsen, Kgl. Norske Vidensk. Selsk. Forhand., vol. 7, No. 7, 1934.

⁴⁹ What little we know of the early stages of the halibut is due to European students, chiefly to Schmidt (Meddel. Komm. Havundersøgelse, Ser. Fiskeri, vol. 1, No. 3, 1904), to Jespersen (Ibid., vol. 5, No. 5, 1917), and to Tåning, (Meddel. Komm. Danmarks Fisk. Havundersøgelse, Ser. Fiskeri, vol. 10, No. 4, 1936.)

⁵⁰ Rept. No. 9, International Fisheries Commission, 1936, figs. 38–49.

summer, have been trawled off Iceland during the last week of July. And the smallest bottom stages have so far been taken only in water shoaler than about 27 fathoms (50 meters), evidence that the larvae of the Atlantic halibut tend both to rise toward the surface, and to drift inshore during their pelagic stage, as is also true of the Pacific halibut.

Fry of $3\frac{1}{8}$ to $5\frac{1}{8}$ inches (80–150 mm.) such as have been taken in considerable numbers in Icelandic waters in June and July probably are in their second year. The average relationship between age and size is as follows according to Jespersen:⁵¹

Age	Average length	Extremes of length	Age	Average length	Extremes of length
	<i>Inches</i>	<i>Inches</i>		<i>Inches</i>	<i>Inches</i>
1 year.....	3.9	3.1 to 5.9	6 years.....	25.6	20.9 to 34.3
2 years.....	9.1	7.1 to 12.6	7 years.....	27.6	21.7 to 40.9
3 years.....	13	8.3 to 18.9	8 years.....	29.1	22.8 to 40.6
4 years.....	18.5	11.8 to 24.4	9 years.....	33.9	26.8 to 42.1
5 years.....	22.4	16.1 to 28	10 years.....	37.4	29.5 to 55.5

Females averaged somewhat longer and heavier than males of the same age, and the fact that the oldest was a fish of 20 years, $68\frac{1}{2}$ inches long, suggests that the immense fish of 400 pounds and more, and upward of 7 feet long, which are occasionally caught, may be half a century old, always assuming about the same rate of growth for the Gulf of Maine halibut as for those that are caught about Iceland.

According to Thompson⁵² Pacific halibut grow at approximately the same rate for the first few years, more slowly after about the eighth year, though with wide differences in the rate of growth on different banks, probably caused by differences in the food supply.

It is probable that most of the female halibut do not mature sexually until they are 9 or 10 years old, some not until they are several years older still; males mature when they are somewhat younger.⁵³

General Range.—Boreal and subarctic Atlantic, in continental waters.

The most southerly record of a halibut, in the western side of the Atlantic is of a 6-foot fish that

⁵¹ Meddelelser fra Komm. Havundersøgelser, Ser. Fiskeri, vol. 5, No. 5, 1917; based on a study of the otoliths of more than 2,000 fish caught around Iceland.

⁵² Report. Comm. Fish. British Columbia, (1914) 1915, pp. 76–99.

⁵³ Females of the Pacific form may mature as young as 8 years, or not until as old as 16 years, with an average of 12; males considerably younger on the average.

was picked up in a pound net near Reedville, Va.⁵⁴ Stragglers have been reported off New Jersey and New York, and off Block Island. And halibut are caught in commercial quantities (or once were) from Nantucket Shoals, inner parts of the Gulf of Maine, Georges Bank, and the Nova Scotian Banks northward to the northern part of the Gulf of St. Lawrence (including the west coast of Newfoundland), the southern part of the Grand Bank, Flemish Cap and to the outer edge of the continental shelf off outer Labrador at depths of 70–90 fathoms or more. But stray specimens, only are reported in along the outer coast of Labrador, i. e., in the icy Labrador current.⁵⁵ And while the range of the halibut was said by Goode⁵⁶ to extend to Cumberland Gulf, we doubt whether there are any halibut in the icy waters along Baffins Land, for the halibut is not known off the Arctic coasts either of Asia or of America. though the Greenland side of Davis Strait supports a regular halibut fishery as far north as Disco Bay.

In the eastern Atlantic, halibut have been reported doubtfully from the Gulf of Cadiz, and definitely from the Bay of Biscay.⁵⁷ Small catches are made regularly as far south as the Irish Sea and English Channel;⁵⁸ and they are more numerous around Northern Ireland and Scotland and in the northern part of the North Sea; in the Faroe-Shetland Region; around Iceland; along the Norwegian Coast; around Spitzbergen and Bear Island; also in Barent's Sea.

The Pacific halibut, an ally so close that it is hardly to be distinguishable to the untrained eye, is one of the most important food fishes of the northeastern Pacific.

Occurrence in the Gulf of Maine.—The history of the halibut in the Gulf of Maine, like that of the salmon, must be written largely in the past tense, for their numbers have been sadly depleted there by over-fishing. In Colonial days the halibut was a familiar fish and seemingly a very abundant one on the coast of northern New England, but was considered hardly fit for food. Wood⁵⁹ for instance, writes "the plenty of better fish makes

⁵⁴ Reported by Walford, Copela, 1946, No. 2, p. 100.

⁵⁵ One, about 20½ inches long, was reported to us by R. H. Backus as found dead in the water, in Cuthroat Harbor, August 5, 1950, by the *Blue Dolphin*.

⁵⁶ Fish. Ind. U. S., Sect. 1, 1884, p. 190.

⁵⁷ Moreau, Hist. Nat. Poissons France, vol. 3, 1881, p. 288.

⁵⁸ 6,614 pounds, for example, were landed from the English Channel in 1932. For further details as to landings from the various statistical areas in the eastern Atlantic, see Thompson and Van Cleve, Rept. 9, International Fisheries Comm., 1936, p. 21.

⁵⁹ New England's Prospect, 1634, p. 37.

these of little esteem, except the head and finnes, which stewed or baked is very good; these hallibuts be little set by while basse is in season." They seem to have maintained their numbers there down to the first quarter of the nineteenth century, when contemporary writers described them as extremely numerous in Massachusetts Bay and along Cape Cod, in fact around the whole coast line of the Gulf of Maine. And they were discovered in abundance on Nantucket Shoals, on Georges Bank, on Browns Bank, and on the Seal Island ground as soon as fishing was regularly undertaken offshore.

The cod fishermen of those days looked upon them as a nuisance, seldom worth bringing to market. And "It was the practice of the fishermen when halibut were troublesome to string them on a line and hang them over the stem of the vessel."⁶⁰ But a demand for halibut developed in the Boston market sometime between 1820 and 1825, and they have been pursued relentlessly ever since then, first inshore and then farther and farther afield.

The Massachusetts Bay—Cape Cod region yielded large numbers of these great fish during the early years of the fishery. Four men, for instance, are reported as having caught 400 in two days off Marblehead in 1837, while a party of equal size is said to have landed 13,000 pounds off Cape Cod in three weeks. And it was discovered some time prior to 1840 that halibut congregated in winter in the 25-30 fathom gully between the tip of Cape Cod and Stellwagen Bank. However, a shrinkage in the supply had been noticed along shore even before 1839, for we find halibut described in that year (in the Gloucester Telegraph) as "formerly" caught along Cape Cod and in Barnstable Bay. And they had been so nearly fished out in the Massachusetts Bay region by about 1850 that it no longer paid small boats to go there especially for them.

Halibut held out better in the northeastern corner of the Gulf where there was not as ready a market for them as there was in Boston; Perley wrote of them as plentiful enough to be a plague to the local fishermen off Brier Island as recently as 1852. But it was not long thereafter before their numbers were greatly reduced there also.

The offshore fishery for halibut began about 1830, when cod fishermen brought word to Gloucester of a great abundance of them on Georges Bank,⁶¹ and they were caught there for a few years thereafter in numbers that seem almost unbelievable today. Thus we read of 250 caught in three hours; of vessels loaded in a couple of days; and of a single smack landing 20,000 pounds in a day. They were taken in great plenty on Nantucket Shoals, also, during this same period. But the supply seems to have dwindled suddenly, in the shoal waters both of Georges Bank and of Nantucket Shoals, and so permanently that few vessels went thither especially for halibut after 1850. Now forced to go further afield, the fishing fleet found that halibut were plentiful on the Seal Island ground; on Browns Bank; and in the Eastern Channel or gully that separates the latter from Georges Bank (localities which supplied the New York and Boston markets for the next decade). And in 1875 halibut fishing was extended to deeper water (100 to 200 fathoms) on the south-east slope of Georges Bank. But it was not long before all these grounds were fished out to the point where it was seldom possible to make paying trips to them for halibut alone. And for many years now, what few halibut have been caught in the Gulf of Maine have been taken incidentally.

The history, in short, of the halibut fishery leaves no doubt that this species shows the effect of hard fishing sooner than most sea fish, it being possible to catch the majority of the stock on any limited area in a few years. Long liners and otter trawlers search all the good ground-fish bottoms of the Gulf of Maine and its banks so thoroughly and constantly that the halibut never have a chance to reestablish themselves in any abundance on the shoaler grounds. They maintain their numbers better on the deeper slopes chiefly because they are subject to less intensive fishing there.

It was fortunate for the fishing industry that the depletion of the Gulf of Maine of halibut was counterbalanced by the discovery of halibut in abundance along the deeper slopes of the banks to the north and east. And halibut fisherman sailing from Gloucester had begun resorting to the Grand Banks region by 1864-1866; to the west Greenland Banks by 1866; to the Magdalens by

⁶¹ Goode and Collins (Fish. Ind. U. S., Sect. 5, vol. 1, 1887, p. 3) have collected data on the Georges Bank halibut fishery and the former abundance of the fish there.

⁶⁰ Goode and Collins, and Fish. Ind. U. S., Sect. 5, vol. 1, 1887, p. 29-30.

1873; to the northern part of the Gulf of St. Lawrence near Anticosti by 1881; to Iceland by 1884.⁶² And the Gloucester vessels continued sailing to the Greenland Banks for halibut until the early 1880's. But by 1889 practically all the salt halibut that was landed in Gloucester, was being brought from Iceland. With salt fish in less and less demand, it became unprofitable, next, to sail so far afield. And it is many years, now, since any halibut fisherman from Gloucester has outfitted for Iceland.

Long liners, out of New England ports, fished especially for halibut in the northern part of the Gulf of St. Lawrence until 1938; on the Grand Banks grounds until 1940 or 1941, when competition with frozen halibut from the northwest coast had become severe, while the majority of fishermen preferred to ship on otter trawlers, for comfort and safety. Vessels continued long lining for halibut down the slopes of the Nova Scotian banks, and in the deep gullies between these, until the middle of the 1940's, but we have not heard of a vessel making a special trip from any New England port for these great fish, during the past few years.

Although there is not one halibut in our Gulf today, where there were hundreds or even thousands of them during the first quarter of the nineteenth century, the geographical range of this noble fish is as extensive there as it ever was. Thus a few halibut are still caught along Cape Cod; in Massachusetts Bay (a few "chickens," 10 pounds and upward, are brought in every summer with some larger fish); along the Maine coast; and on all the offshore grounds. Rich, writing in 1929,⁶³ listed 25 named inshore grounds off the coasts of Massachusetts and of Maine as still yielding a few halibut. We have enjoyed the acquaintance of several fishermen, especially interested in halibut, who treasure to themselves a hard-gained knowledge of particular spots, not too far offshore, where they are likely to catch one, in a day's pleasure fishing. And small groups of halibut accumulate occasionally on suitable patches of bottom; soon to be decimated, however, when their presence is accidentally discovered. Thus, we knew of some 25 or 30 halibut,

ranging from 40 to 110 pounds in weight, being caught within 1 to 3 miles of land, near Mount Desert Island, in 1930, in 10 to 15 fathoms of water. And one of 54 pounds was caught off Boston Harbor, from the steamer *Westport*, on June 24, 1951.⁶⁴

A catch of 9,500 pounds, or perhaps about 135 fish (assuming an average weight of 70 pounds) was reported off the coast of Maine in 1947 on hand lines, while eleven fish (largest 125 pounds) had been caught inshore, off Casco Bay, by local fishermen, up to the last week in May 1951.⁶⁵ And many other instances of this sort might be quoted, no doubt, were our knowledge sufficient.

Halibut are also caught fairly regularly still, about Grand Manan (4,700 pounds reported thence in 1947), but only occasionally about Campobello and near St. Andrews, and not at all along the north (New Brunswick) shore of the Bay of Fundy east of St. John. Small numbers occur, however, right up to the head of the bay on the Nova Scotia side.⁶⁶ And there are enough of them off Brier Island at its mouth and on the fishing grounds along western Nova Scotia to have brought the landings for Digby County and for Yarmouth County to 108,300 pounds in the year in question.

The largest catches of halibut now made within the limits of the Gulf of Maine come from the Cape Sable-Browns Bank ground, from the deeper slopes of Browns Bank, from the deep gully that separates Browns from Georges, and from the eastern part and the deeper slopes of Georges, where otter trawlers are likely to pick up anywhere from 1 to 75 fish per trip. But not many are caught now on Nantucket Shoals where they were once so plentiful.

In 1945 (most recent year for which detailed information is readily available for the coasts of Maine and Massachusetts), landings for the different parts of the Gulf, by United States and Canadian fishermen, were about as follows: off eastern Massachusetts, about 31,000 pounds; off western Maine, about 800 pounds; off central Maine, about 10,000 pounds; small banks in the inner west central part of the Gulf (Cashes, Fippenies, Platts), about 2,500 pounds; off eastern

⁶² See Collins, *Fish. Ind. U. S.*, Sect. 5, vol. 1, 1887, pp. 43-89, and Scudder, *Fish. Ind. U. S.*, Sect. 5, vol. 1, 1887, pp. 90-119, for historical surveys of the fresh and salt halibut fisheries from New England ports.

⁶³ Rept. U. S. Comm. Fish. (1929) 1930, pp. 85-86, 96.

⁶⁴ Reported in the *Boston Globe*, June 25, 1951.

⁶⁵ Reported in *Salt Water Sportsman* for May 29, 1951.

⁶⁶ 11,300 pounds reported for Annapolis and King's Counties, Nova Scotia, in 1947.

Maine about 2,000 pounds; mouth of Bay of Fundy on New Brunswick side, about 700 pounds; Nova Scotian side of Bay of Fundy, about 45,000 pounds; off western Nova Scotia and Browns Bank (Canadian and United States vessels combined), about 73,000 pounds plus an indeterminate part of the landings for Shelburne County, Nova Scotia, that may have come from Browns Bank; Georges Bank, about 65,000 pounds; South Channel, about 4,000 pounds; Nantucket Shoals, about 1,400 pounds; or a total of about 235,000 pounds that can be credited definitely to the Gulf.

For some unknown reason, 1945 was a poor year; the Georges catch alone, for example, was about 110,000 pounds in 1946, about 211,000 pounds in 1947.⁶⁷ And the yearly catch for the Gulf as a whole, by United States and Canadian fishermen combined, averaged about 316,000 pounds for the 6-year period 1941-1946, plus what fish may have been landed in Shelburne, Nova Scotia, from Browns Bank. Even so, the Gulf yields only about one-tenth as much halibut by weight today as it did, say, 30 years ago.⁶⁸

We dare not guess in what degree this continued decrease has been a result of the progressive replacement of long-line fishing by otter trawling, of market conditions, or of a continuing decrease in the numbers of halibut.

Halibut may have maintained their numbers somewhat better on the outer Nova Scotian Banks and slopes, which yielded about 3,400,000 pounds in 1934 (with Browns Bank); about 1,350,000 pounds in 1946.⁶⁹

In the early days of the fishery, halibut were common in the Gulf of Maine in water no deeper than they were farther north; near Anticosti in the Gulf of St. Lawrence for example, or near Miquelon, south of Newfoundland, where many were caught in 5 to 10 fathoms.⁷⁰ A case is on record, for example, of a catch of 5 halibut, made in 1849, on one set of a long line with only 37

hooks, in 7 fathoms, just off the mouth of Gloucester Harbor. A good many, too, were caught in those days on the southeastern part of Stellwagen Bank, where the depth (on the fishing grounds) ranges from 15 fathoms to about 30 fathoms. And many were reported as wintering in the gullies west of Stellwagen and between the latter and the tip of Cape Cod, in depths of 30 to 50 fathoms. Similarly, the early fishery also on Georges was on the shoaler parts of the bank in depths of 15 to 30 fathoms. And the early visitors to this ground describe the halibut, not only as schooling at the surface in pursuit of herring and launce (not an uncommon event in the Gulf of St. Lawrence and off Newfoundland when they are chasing capelin), but as often following their hooked companions up to the top of the water, so that more than one vessel made a good part of her fare by gaffing them alongside. The Nantucket Shoals halibut of old were likewise in less than 30 fathoms depth, and when the fleet first repaired to Browns Bank and to the Seal Island grounds they found halibut very plentiful in water but little deeper than that.

In fact, it was not until 1874 or 1875 that the presence of this fish was suspected in the deeper gullies or on the offshore slopes of the banks below 100 fathoms. But it did not require many years of hard fishing to catch most of the halibut that were living in very shallow water, and so thoroughly that very few are now taken shoaler than 25 to 40 fathoms in our Gulf, while most of the halibut that are caught still on the offshore banks are from water deeper than 75 fathoms.

All that has come down to us as to any general movements of the halibut in the Gulf of Maine during the days of their plenty there, beyond the prevailing tendency of the larger fish to work down deeper than the smaller (p. 250), is that some of them (though not all) worked inshore into shoaler waters for the winter, to work offshore again and deeper for the summer. But this offshore movement in winter may not have extended far, or very deep, if it was to avoid low temperatures, for halibut (or any other fish for that matter), that summer inshore in shoal water where they would be most subject to winter chilling, need never move out for more than 60 miles or so off any part of the coast line of the open Gulf, nor descend deeper than about 70 to 75 fathoms, to find water permanently warmer than 38°, except in the Bay of

⁶⁷ The otter trawlers that carried on investigations for the Bureau of Fisheries in 1913 took halibut on more than half their trips to Georges. Contrast this with a catch of 570 halibut by a long-liner on a patch of rocky bottom there in one day, in the early years of the Georges fishery!

⁶⁸ The Gulf of Maine catch was nearly 3 million pounds in 1919.

⁶⁹ Catch, Cape Sable to Cape Breton in 1946, about 50,000 pounds by United States vessels, about 1,300,000 pounds by Canadian vessels. For a general survey of the catches of halibut in both sides of the Atlantic, for 1934, see Thompson and Van Cleve, Rept. No. 9, International Fisheries Commission, 1936, p. 21.

⁷⁰ Goode and Collins, Fish. Ind. U. S., Sec. 5, vol. 1, 1887, p. 17.

Fundy in the coldest winters, or in the submarine embayment between Jeffreys Ledge and the coast.

We have nothing to contribute as to present-day spawning of halibut within the Gulf of Maine. Of old, ripe females were reported on Georges in May and June, and have been, repeatedly, on the deeper slopes of the Nova Scotian banks generally, to the eastward, as well as off the Grand Banks and in the Gulf of St. Lawrence. But halibut smaller than a couple of pounds are seldom caught in the inner parts of the Gulf though "chickens" of 10 to 20 pounds are not uncommon there, there being a sharp contrast in this respect between the Gulf of Maine and the waters around Iceland, where Jespersen found an abundance of little fish of 8 to 10 inches.

This, added to the fact that the inshore grounds were fished out so soon with little apparent tendency to recover when the fishery slackened, and that depletion by overfishing has not been accompanied by any corresponding decrease in the average size of the fish that are caught, suggests that the halibut population of the inner parts of our Gulf always depended more on immigration from east and north of Cape Sable for its maintenance than it did on local production. Fry may have been produced in greater numbers over the offshore slope of Georges Bank, where the *Albatross III* trawled two little halibut about 6 inches long, at 175 to 195 fathoms, on May 16, 1950.

Importance.—The halibut, because of its present-day scarcity, is of only minor importance commercially in our Gulf; in 1947 the landings in New England, including what halibut were brought in from the Nova Scotian banks eastward from

Cape Sable, amounted to only about 586,000 pounds, valued at \$144,680. But the demand is always so good that all that are brought in are readily salable, and (being so large) each one that is caught is well worth saving. In the year in question (representative of present-day conditions), about one-fifth of the total New England landings, were caught on long lines⁷¹ three-fourths by otter trawlers. The small remainder (10,000 pounds) were taken on hand lines, mostly by small-boat fishermen off the coast of Maine.

We can only regret that there are not enough halibut inshore in our Gulf today to be of any general concern to anglers, for this is a very "sporting" fish as well as welcome on the table.

Greenland halibut *Reinhardtius hippoglossoides*
(Walbaum) 1792

GREENLAND TURBOT; NEWFOUNDLAND TURBOT

Jordan and Evermann, 1896-1900, p. 2611.

Description.—This is a right-handed, large-mouthed flatfish (that is, it lies on its left side, with its eyes on its right side, and its abdomen at its right edge), with slightly concave tail, and symmetrical ventral fins like a halibut. In fact it so closely resembles the halibut that it might easily be taken for one were it not that its lateral line is nearly straight abreast of the pectoral fin, (arched in the halibut) and that its long fins (dorsal and anal) are of rather different shape (compare fig. 127 with fig. 123), though with about the same number of rays (about 100 dorsal and

⁷¹ Goode and Collins (*Fish. Ind. U. S.*, Sec. 5, vol. 1 1887, pp. 10-18) have given a readable account of the long-line fishery.

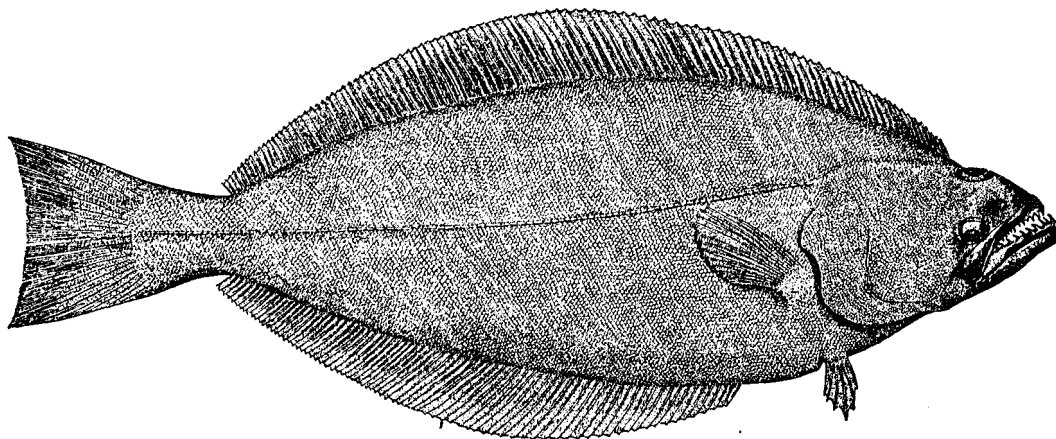


FIGURE 127.—Greenland halibut (*Reinhardtius hippoglossoides*). From Goode. Drawing by H. L. Todd.

75 anal). Its mouth, furthermore, is larger, its eyes smaller relatively and its jaw teeth stronger, though the differences in these respects are not great enough to serve as useful field marks. It is yellowish or grayish brown, paler below than above but not white.

Size.—This is one of the largest of the North Atlantic flatfishes, next to the halibut, growing to a length of about 40 inches and to a weight of 20 to 25 pounds. But fish caught about the Grand Banks weigh only from about 5 to 10 pounds.

General range and occurrence in the Gulf of Maine.—This is a fish of the Arctic and subarctic Atlantic. It is taken from northern Norway and northern Iceland to the Faroe ridge, and to southwest of Iceland ⁷² as a stray. It supports a fishery off west Greenland that is important for the Eskimos.⁷³ In the west considerable numbers are taken off the south coast of Newfoundland,⁷⁴ also on the Grand Banks, hence it is to be expected along outer Labrador, though it has not been reported thence as yet. Odd specimens are to be expected here and there in the Gulf of St. Lawrence too, for it has been taken near the Biological Station at Trois Pistoles.⁷⁵

⁷² Norman (Ann. Mag. Nat. Hist., ser. 9, vol. 13, p. 539) reports a single specimen taken southwest of Iceland.

⁷³ See Jensen (Meddel. Dansk. Komm. Havundersøgelser, Ser. Fiskeri, vol. 7, No. 7, 1927) for a general account of the Greenland halibut off west Greenland.

⁷⁴ According to Goode (Fish. Ind. U. S., Sect. 1, 1884, p. 198) long liners have reported it as "very abundant" in and off Fortune Bay, in 60 to 300 fathoms.

⁷⁵ Vladykov and Tremblay, Natural. Canad., vol. 62 (Ser. 3, vol. 6), 1935 p. 82.

It is described as "not uncommon" off Canso, Nova Scotia,⁷⁶ and as occasionally brought in from the more northerly of the Nova Scotian fishing banks long ago.⁷⁷

Our only reason for mentioning it here is Goode and Bean's⁷⁸ statement that "fishermen take them frequently in the gully between La Have and Georges Bank at depths greater than 200 fathoms." This has been corroborated by the capture of 16 specimens, at 300 to 530 fathoms, along the slope of La Have Bank to the southwestern slope of Georges Bank by the *Cap'n Bill II*, in July 1952. It has no real place in the Gulf of Maine fish fauna.

American dab *Hippoglossoides platessoides* (Fabricius) 1780 ⁷⁹

CANADIAN PLAICE; LONG ROUGH DAB

Jordan and Evermann, 1896-1900, p. 2614.

Description.—The most obvious distinctive characters of the American dab are that it is right-handed and large-mouthed like the halibut, but with a rounded tail instead of concave, and with the lateral line nearly straight instead of arched; it is the only Gulf of Maine flounder in which these characters are combined. Our only other large-mouthed flat-fishes with rounded tails (the

⁷⁶ Cornish, Contrib. Canadian Biol. (1902-1905) 1907, p. 90.

⁷⁷ Jones, Proc. Trans. Nova Scotia Inst., Sci., vol. 5, Pt. 1, 1879, p. 92.

⁷⁸ Amer. Jour. Sci. Arts, Ser. 3, vol. 17, 1879, p. 40.

⁷⁹ Various other common names are applied to this fish in different seas. It is usually termed "Long rough dab" in England and is so listed in British fishery statistics. It is not the "plaice," or the "dab" of Europe.

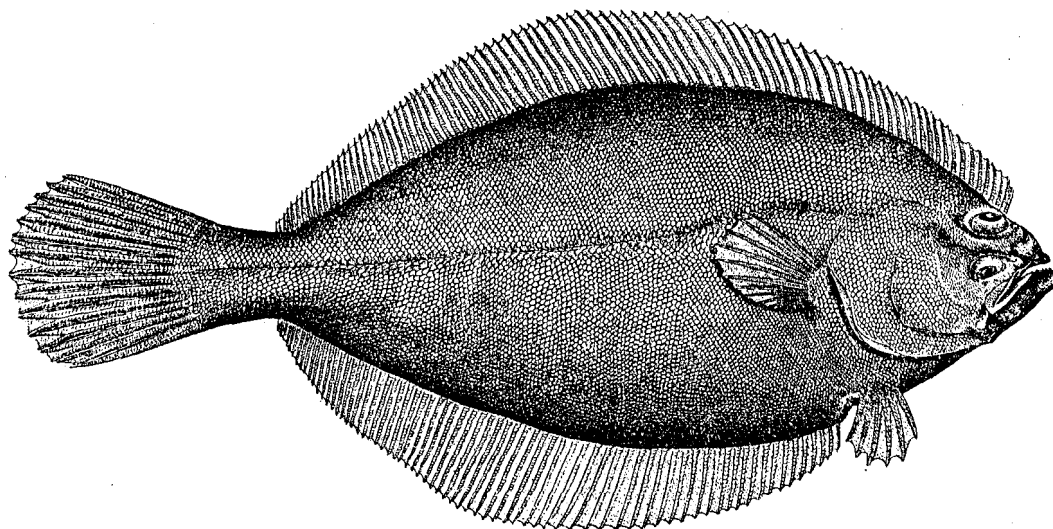


FIGURE 128.—Canadian plaice, or Dab (*Hippoglossoides platessoides*), La Have Bank. From Goode. Drawing by H. L. Todd.

sand-, summer- and four-spotted flounders, pp. 290, 267, and 270) are left-handed, and the wide-gaping jaws readily distinguish the American dab from the various small-mouthed flounders.

It is a comparatively broad (really deep) flounder (about two and one-half times as long to base of caudal fin as it is broad), more rounded in outline than the halibut, with pointed nose, mouth gaping back to abreast of the middle of the eyes, and with one irregular row of sharp conical teeth in each jaw. The free edges of the scales on the entire eyed (upper) side of its body and of its head are serrated with sharp teeth, which give the fish a characteristic rough feeling when handled, but the scales of the blind (lower) side are smooth-edged except on the rear part of the body and along the bases of the fins. The dorsal fin (76 to 96 rays) originates in front of the middle of the left eye and the anal fin (64 to 77 rays) arises slightly in advance of the base of the pectorals. Both of these long fins taper toward the head and toward the tail, and there is a short, sharp, spine (the prolongation of the post abdominal bone) pointing forward close in front of the anal fin. The pectoral fin on the eyed side usually (not always) has one or two more rays than its fellow fin on the blind side, and is longer and more rounded, but the two ventral fins, which are close in front of the anal fin though entirely distinct from it, are alike in size, shape, and location. The margin of the caudal fin is always convex, either rounded or with its middle rays so much the longest as to form a blunt angle. The lateral line on the eyed side is more clearly evident on the dab than on most of our flatfishes, and it is straight from end to end, except for a slight arch over the pectoral fin.

Color.—Dabs run more uniform in color than most of our smaller flatfish, ranging from reddish to greyish brown (darker or paler) above and pure or bluish white below. The tips of the rays of the two long (dorsal and anal) fins are white. On one specimen we saw the right edge of the eyed side was white (like the blind side) from the gill opening to the rearmost ray of the ventral fin but this is unusual. Small fish are usually marked with three to five dark spots along each edge of the body; large ones are occasionally, though they are plain colored as a rule.

Size.—Adults measured by Welsh off Cape Ann ran from about 12 inches to 24 inches, and few of those that are caught in our Gulf are longer than

2 feet. Nova Scotian fish measured by Huntsman⁸⁰ ran from 12 to 24 inches in length, while fish caught in the colder waters off Newfoundland averaged 18 inches.⁸¹ The largest dab recorded from American waters, taken near Sable Island, May 1939, was 32½ inches long and weighed 14 pounds.⁸² The next largest, taken in 90 fathoms on the northern edge of Georges Bank, November 1951, was 29 inches long.⁸³

According to Huntsman, Nova Scotian fish average about half a pound at 12 inches, 1¼ pounds at 16 inches, 1¾ pounds at 18 inches, 2¾ pounds at 20 inches, 4 pounds at 22 inches, and 6 pounds at 24 inches. Massachusetts Bay fish are about equally heavy at corresponding lengths. And a 16-inch fish from Georges Bank that we measured weighed 1 pound 5 ounces; two fish of 18¼ inches weighed 1 pound 13 ounces, and 2 pounds, respectively; one of 19½ inches weighed 2 pounds 8 ounces, and one of 29 inches weighed 9 pounds 6 ounces.

This flatfish tends to differentiate into local races in different seas. Thus the fin rays are more numerous on the average in fish from high latitudes than in those from low latitudes, while the body is relatively wider in fish caught off Greenland and off America than in those from Scandinavia and from the North Sea. But these characters vary so widely even in limited areas that the Arctic-American and European species (*platesoides* and *limandoides*) have been united by common consent long since, and we doubt whether the corresponding "varieties" still recognized by several recent authors will stand the test of time. Huntsman's statement that the dorsal rays average more numerous in dabs from Bay of Islands, Newfoundland, than in those caught on the New Brunswick shore of the Gulf of St. Lawrence, with Welsh's note of a variation of 7 in the number of dorsal rays and of 6 in the anal rays in one lot of fish caught off Gloucester, illustrates this variability. Notwithstanding the low latitude of the locality of capture (about 42° 30' N.), this same lot contained a specimen with the largest number of fin rays yet reported (96 dorsal and 77 anal).

All we dare say until many more specimens are examined is that hereditary local races may perhaps exist off different parts of the American

⁸⁰ Bull. No. 1, Biol. Board Canada, 1918, p. 10.

⁸¹ Frost, Res. Bull. 4, Newfoundland Dept. Nat. Resources, 1938, p. 8.

⁸² McKenzie, Proc. Nova Scotian Inst. Sci., vol. 20, 1940, pp. 43-44.

⁸³ We measured this dab, taken by Capt. Arthur Nelson of the *Eugene H.* who also caught several others, 27 to 28 inches long on this same trip.

shore line, and that the growth marks on the scales, in relation to the length of the fish, may give a clue to the local origin of a given specimen, for it seems that the rate of growth is governed by the temperature of the water (p. 263).

Habits.—Dabs are bottom fish like other flatfishes. But they must rise some distance from the ground on occasion, and move about to a considerable extent to account for the capture of so many in gill nets (p. 264). We once caught one a foot long in a tow net at least 5 to 10 fathoms above the bottom off Ipswich Bay, where the water was about 50 fathoms deep.

Like some other flatfishes, they avoid rocky or hard bottom, preferring a fine, sticky but gritty mixture of sand and mud, such as floors much of the Gulf between the hard patches, from the 20-fathom contour out to the 100 fathom contour. And they are also to be caught in numbers on the soft oozy mud of the deeper basins in the western side of the Gulf, as pointed out below (p. 264).

In one part of their range or another, they are found from tide line down to as deep as about 390 fathoms (700 meters).

This is an arctic-boreal species in its temperature relations, reaching its highest development in water of 35° to 45° F.; able to live, however, in the lowest polar temperatures (29° to 30°); and finding the upper temperature limit to its regular occurrence at about 50° to 55° F.

In different seas it lives through a wide range of salinity, from 30 per mille or lower in the Baltic to upwards of 34 per mille in the open Atlantic. So far as we are aware, it is never found in water which could be described as brackish along the coasts of New England or of the Maritime Provinces. But R. H. Backus informs us that the *Blue Dolphin* found it in brackish water (salinity 23 per mille) at the west end of Lake Melville, Labrador.

Huntsman's⁸⁴ statement that it feeds on minute planktonic plants (diatoms) at first, but on copepods as it grows larger and more active is our only information as to the diet of the young fry in American waters, while they are drifting near the surface. When they first take to the bottom they eat small shrimps and other Crustacea of various sorts. But they turn (as they grow) to

a diet consisting chiefly of sea urchins, sand dollars, and brittle stars, as proved by the contents of their stomachs, though they also take various shrimps, hermit and spider crabs and other crustaceans, mollusks, worms and ascidians (sea squirts), in fact, practically any bottom living animals that are small enough for them to devour. Occasionally they catch small fish.

They do not bite a baited hook as readily as various other ground fishes, partly, no doubt, because they are sluggish fish, but partly, we believe, because the clams, cockles, and herring that are usually used for bait are not their favorite food. Still, considerable numbers are caught on hand and long lines.

All the large predaceous fish that feed near bottom probably prey more or less upon them, and halibut no doubt destroyed great numbers of them in the Gulf of Maine formerly. But the adults can have no serious enemy in our Gulf today except large cod and perhaps the spiny dogfish. In more northern seas Greenland sharks prey regularly on them. Smitt and Huntsman both speak of the numbers of round worms to be found in the intestines and body cavity of the dab, and its gills are sometimes attacked by parasitic copepods.

While the young are drifting near the surface (p. 262), they share in the same involuntary journeyings as other fish fry do, that are spawned at the same place and time. But it is one of the more stationary fishes from the time it seeks bottom. It has been said to work inshore more or less in winter, though not on very definite evidence, and it may congregate on definite grounds for spawning, though this is yet to be proved. But it is certain that they are to be caught at any season of the year wherever they are plentiful. And Huntsman,⁸⁵ who has paid special attention to this fish, believes that it "remains pretty much in the same place from season to season and year to year. Perhaps in the course of years it may shift a few miles."

Individual females produce 30,000 to 60,000 eggs, according to size. The eggs are buoyant and have no oil globule, but they have a transparent (perivitelline) space around the yolk so broad that they are not likely to be confused with those of any other Gulf of Maine fish.

⁸⁴ Bull. Biol. Board Canada, No. 1, 1918, p. 15.

⁸⁵ Bull. Biol. Board Canada, No. 1, 1918, p. 18.

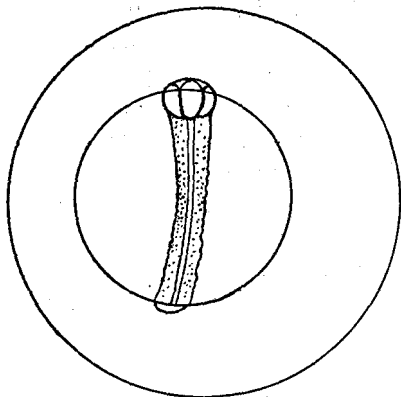


FIGURE 129.—Egg (European). After Cunningham.

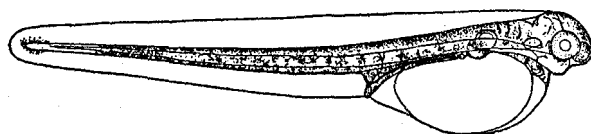


FIGURE 130.—Larva, just hatched, 4 mm. (European). After McIntosh.

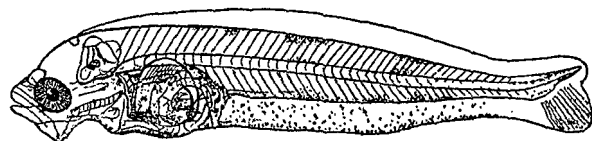


FIGURE 131.—Larva (European), 9 mm. After Ehrenbaum.

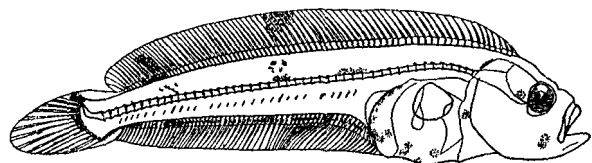


FIGURE 132.—Larva, 14.5 mm., off Massachusetts Bay.

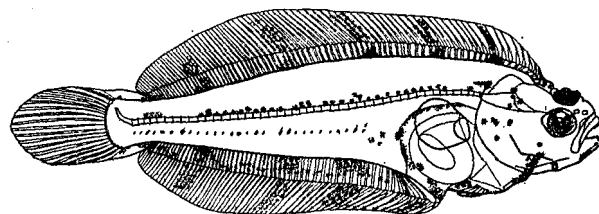


FIGURE 133.—Larva, 22.5 mm., off Cape Cod.

CANADIAN PLAICE, OR DAB (*Hippoglossoides platessoides*).

This space is formed by the entrance of water between the egg proper and its covering membrane, after the eggs are shed, and it about doubles the total diameter of the egg. The eggs we have taken in the Gulf of Maine have averaged about 2.5 mm. in diameter, but they have been reported as small as 1.38 and as large as 3.2 mm. in other seas, depending on the breadth of the perivitelline space.

Incubation occupies 11 to 14 days at a temperature of 39° F., and it seems that the eggs gain weight as development proceeds, for Huntsman found, in the Gulf of St. Lawrence, that the newly spawned eggs floated at the surface, but that eggs nearly ready to hatch drifted suspended at a depth of some 10 fathoms. We have no first-hand information to offer on this point.

During the development of the egg, minute black and yellow pigment cells are scattered over the embryo, not aggregated into any diagnostic clusters. But the pigment gathers in five definite groups very soon after hatching (which takes place when the larvae are 4 to 6 mm. long); one on the gastric region, one about the vent, and three behind the vent; a pattern similar to that of the larval witch flounder (p. 287).

The yolk is absorbed about 5 days after hatching, when the larva has grown to 6.2 to 7.5 mm.

in length. The caudal rays appear shortly after this, the dorsal and anal rays at about 11 to 12 mm., and the three vertical fins are differentiated at about 15 to 18 mm. By this stage the body has begun to assume the deep but very thin form characteristic of all young flounders, while the jaws have developed sufficiently to show that the little fish belongs to one of the large-mouthed species. The left eye may commence its migration when the larva is about 20 mm. long, while Welsh found it visible above the outline of the snout in Gulf of Maine specimens of 24 mm., and almost at the dorsal edge at 34 mm. But larvae as long as 35 mm. may still be symmetrical in other seas.

The only other Gulf of Maine species for which the larval dab might be mistaken (except in its very earliest stages) are the witch flounder and the halibut; but the witch is longer at corresponding stages of development, but with the distance from snout to vent proportionately much shorter, and the outlines of throat and abdomen are sufficiently different to distinguish the dab from the halibut (p. 253).

The young dab drifts freely up to the time of its metamorphosis, as the young of most sea fishes do; close to the surface at first but sinking deeper as it grows, until it seeks the bottom finally.

Welsh's observations suggest that this takes place, in our Gulf, when the little fish are about $1\frac{1}{2}$ to $1\frac{3}{4}$ inches long, with their metamorphosis already complete, their body scaly, and their eyed side densely pigmented. But there is wide variation in this respect. And European authors report that the fry may take to the bottom even before the left eye has completed its migration around the head.

The period occupied in larval growth and in metamorphosis varies with temperature. Probably it covers three to four months in the Gulf of Maine, where we have taken the pelagic larvae as early in the season as May 26 and as late as August 2.

The little fish grow to a length of 2 to 3 inches by their first winter, with their exact size then depending upon how early in the season they are hatched, and probably on the temperature in which they live. And they average about 3 inches long⁸⁶ when they are one year old. Thus it may be assumed that bottom stages $2\frac{3}{4}$ to $3\frac{1}{2}$ inches (69–80 mm.) long that we have trawled off Cape Cod, on May 1, were about one year old; others of $3\frac{3}{8}$ to $4\frac{1}{8}$ inches (85–118 mm.) that we have trawled in July and August off Mount Desert, in the deep gully to the westward of Jeffreys Ledge, on Cashes Ledge, and on the edge of Stellwagen Bank were between $1\frac{1}{4}$ and $1\frac{1}{2}$ years old; and that those of 8 to 10 inches were $2\frac{1}{4}$ to $2\frac{1}{2}$ years old. Subsequent growth is more rapid in higher temperatures than in lower, throughout the temperature range favorable to this particular flatfish. Huntsman,⁸⁷ for example, has found that it takes only 3 to 5 years for dabs to grow to a length of 12 inches in Passamaquoddy Bay, where the bottom water at 15 to 18 fathoms warms to about 49° to 51° F. in August, but that it requires 4 to 6 years in the open Bay of Fundy, where the bottom temperature in summer is somewhat lower (45° – 48°); 6 to 9 years in the cooler water (about 38°) of Chedabucto Bay, eastern Nova Scotia; and upwards of 8 years in the still lower temperatures (colder than 35°) of the Gulf of St. Lawrence.

On this basis, dabs living on the shoaler parts of Georges Bank, and as shoal as 15 fathoms or so in coastwise waters from Cape Cod to Cape Eliza-

beth, probably grow about as fast as the Passamaquoddy Bay fish, i. e., they may reach a length of 15 inches in 5 years or even sooner, gaining something like 4 ounces in weight yearly. Those in the eastern side of the open Gulf of Maine may be expected to grow about as fast as those in the Bay of Fundy, but somewhat more slowly there if they are living as deep as 50 fathoms, though not so slowly as in the Gulf of St. Lawrence. Some individuals may become sexually mature when only 6 inches long, probably all of them do so by their third year; and they are known to live to an age of 24–30 years, perhaps longer, at least in the Gulf of St. Lawrence.

In general, females grow faster than males.

Huntsman has also found, in the Gulf of St. Lawrence, that a majority of the fish of 3 years and younger were males, but that females outnumbered the males among the older fish, while all of those 14 years old and older that he saw were females. We have no explanation to offer for this (apparently) higher mortality rate for the males than for the females among the older fish.

General range.—This is a very common fish on both sides of the North Atlantic, where its range parallels that of the cod, except that it does not extend as far south and west along the American seaboard. It is found in abundance along the outer coast of Labrador, southward from Hamilton Inlet, where (Frost⁸⁸ writes) they are so abundant locally that a 5-minute haul with a torn trawl yielded 50 (at lat. about 54°) in Newfoundland waters in general; on the Grand Banks, including the eastern edge;⁸⁹ in the Gulf of St. Lawrence as a whole, and thence westward and southward to Cape Cod, from close inshore out to the 100-fathom contour. Westward from Cape Cod, a few are caught in the Woods Hole region; off Marthas Vineyard; and off Narragansett Bay which marks their western limit in general. The most southerly and westerly record with which we are acquainted is of one $15\frac{1}{2}$ inches long that was caught off Montauk Point, N. Y., in 112 fathoms, February 6, 1930.⁹⁰

⁸⁶ Res. Bull. 4, Newfoundland Dept. Nat. Resources, 1938, p. 8. R. H. Backus informs us also that the *Blue Dolphin* collected them at various localities as far north as the northern shore of Hamilton Inlet (lat. $54^{\circ}30'$ N.), but did not take any farther north, in spite of extensive collecting.

⁸⁹ Reported in abundance down the eastern edge of the Grand Banks, in the 20th Rept. Dept. Fish. Canada (1949–1950) 1951, p. 36.

⁹⁰ We find no other credible records from New York or from New Jersey, those mentioned by DeKay being market fish which might have come from anywhere to the eastward.

⁸⁷ Huntsman, Bull. Biol. Board Canada, No. 1, 1918.

⁸⁸ Bull. Biol. Board Canada, No. 1, 1918, p. 23.

It is common in west Greenland waters, as far north as Upernavik near the Arctic Circle, in latitude about 72° N.⁹¹ And it ranges in European waters from Iceland and Spitzbergen southward to the North Sea, where it is an important commercial fish, and to the west Baltic; the English Channel is the southern boundary to its regular occurrence.

*Occurrence in the Gulf of Maine.*⁹²—This is not as familiar a fish as are the winter and smooth flounders (pp. 276 and 283), for it is not common in water shallower than 15 to 20 fathoms. But it is probably the most abundant of all Gulf of Maine flatfishes at depths greater than 30 to 50 fathoms, except, perhaps, the witch (p. 285). Thus they are recorded from Provincetown; from Massachusetts Bay; off Cape Ann; on Stellwagen Bank, where we have hand-lined a number of them in 25 fathoms; in Ipswich Bay; near Boon Island; off Cape Porpoise; off Casco Bay; on Cashes Ledge, where we have trawled both young and adults; off Seguin; south of Monhegan (we trawled them at the last four localities on the *Grampus*); close in to Little Duck Island, off Mount Desert; in Passamaquoddy Bay; in St. Mary Bay; and right up to the head of the Bay of Fundy. In fact, they are to be caught all around the inner parts of the Gulf wherever the water is more than 15 fathoms deep or so, and where the bottom is smooth. Trawlings, too, by the *Albatross II* and by the *Atlantis* have shown that they are generally distributed throughout the basin of the Gulf down to 120 fathoms. This, indeed, was the only flatfish, other than the witch (p. 288), that was taken by the *Atlantis* on the soft mud bottoms off Cape Cod, west of Jeffreys Ledge, or off Mount Desert, at 66 to 105 fathoms during her experimental trawlings for the edible shrimp (*Pandalus*) in August 1936.⁹³

Dabs are widespread on Georges Bank also, for they were reported at many localities there by representatives of the Bureau of Fisheries in 1913, while we have seen catches of up to 100 per trawl haul on the northern edge of Georges, in 60 to 100 fathoms of water. They are so plentiful along the 50–100 fathom zone on the northern edge of Georges Bank that draggers fishing there during 1951–1952 were making catches averaging about 5,000 pounds

per day. A good example of their numbers there is furnished by the dragger *Eugene H* of Woods Hole which brought in catches of 10,000 to 25,000 pounds of dabs, fishing in 75 to 95 fathoms, throughout the period August 1951 to January 1952. Many of these fish were large, ranging from 4 to about 9 pounds in weight. And in this same region, in the spring, they appear to be plentiful in water much shoaler, for Capt. Arthur Nelson of Woods Hole reports a catch of 18,000 pounds taken in 25–30 fathoms in four days' fishing early in May 1952. Also, we have the definite evidence of commercial catches, as well as of newly spawned eggs taken in our tow net, that dabs are plentiful on Browns Bank also.

Huntsman has calculated from fishing experiments that they are about one-tenth as numerous as cod in the Gulf of St. Lawrence. No general estimate of this sort is yet possible for the Gulf of Maine. But catches in gill nets (gear not very well adapted for flounder fishing) of 76 dabs to 1,055 haddock, 51 cod, 20 pollock, and 39 rosefish near Boon Island on March 30; of 125 dabs to 40 other flounders, 89 cod, and 113 haddock in part of the net at the same locality on April 20; and of many dabs, but more cod and haddock, on May 3, 1913,⁹⁴ are pertinent here.

This flatfish is often found in very shoal water in colder seas. They are often seen under wharves around Newfoundland, for example, according to Frost.⁹⁵ And some are seined right on the beach⁹⁶ on the West Greenland coast. But we have never seen or heard of an adult specimen caught in less than 10 fathoms of water in the Gulf of Maine, probably because of the high summer temperatures of the shoaler waters, and they are the most plentiful in 15 to 60 fathoms there (in our experience). At the other extreme, 120 fathoms is the deepest definite record for the Gulf of Maine with which we are acquainted; hence this may be set as the lower limit to their occurrence there in any numbers, which, by report, applies to the whole American coastline, including the Scotian banks and the Grand Banks region.

This preference of the dab for moderately deep water in the southern part of its range bars it from most of the Gulf of Maine harbors and river

⁹¹ For an account of it in west Greenland waters, see Jensen (Meddel. Dansk Komm. Havundersøgelser, vol. 7, No. 7, 1925, p. 24).

⁹² Huntsman (Bull. 1, Biol. Board Canada, 1918) gives an interesting account of this fish in Canadian waters.

⁹³ Bigelow and Schroeder, Biol. Bull., vol. 76, 1939, p. 308.

⁹⁴ Recorded by Welsh.

⁹⁵ Research Bull. 4, Newfoundland Dept. Nat. Resources, 1939, p. 8.

⁹⁶ Jensen, Meddel. Dansk. Komm. Havundersøgelser, Ser. Fiskeri, vol. 7, No. 7, 1925, p. 24.

mouths, which are such favored haunts for the winter flounder. But it enters the deeper estuaries and passages between the islands in the north-eastern part of the Gulf, those near Mount Desert, for example, Passamaquoddy Bay, and St. Mary Bay.

We hesitate to draw any definite conclusions from published statistics of the landings of "dab"⁹⁷ as to the regional abundance of this particular flatfish in our Gulf, partly because of the likelihood that other flatfish may appear under this name, or dabs under some other name, and partly because only a few of the otter trawlers fish in the deeper basins of the Gulf where dabs are known to be plentiful.

The returns for 1945, if taken at face value, show about 48,000 pounds landed from off eastern Maine; about 586,000 pounds from off central Maine; about 311,000 pounds from off western Maine; about 43,000 pounds from small grounds in the west central part of the Gulf; about 897,000 pounds from off eastern Massachusetts; about 8,000 pounds from Nantucket Shoals; about 910,000 pounds from the South Channel and Georges Bank combined; about 48,000 pounds from Browns Bank; and about 40,000 pounds from off western Nova Scotia (by United States fishermen); or a total of some 2,890,000 pounds. It was not until 1946 that the dab was listed (as "Canadian plaice") in the Canadian fisheries statistics for Nova Scotia; in that year landings for western Nova Scotia (Yarmouth County) were about 140,000 pounds, and about 41,000 pounds for the Nova Scotian side of the Bay of Fundy (Digby County).

The presence of dabs or Canadian plaice of catchable sizes in the Bay of Fundy in general, and in Passamaquoddy Bay in particular, is interesting as evidence that this is not so stationary a fish there as it seems to be elsewhere, for none are reared there so far as is known (p. 266), so that the maintenance of the local stock appears to depend on immigration from outside. Huntsman's observation is interesting, too, that large ones form a much smaller proportion of the population in Passamaquoddy Bay and in the Bay of Fundy than they do in the Gulf of St. Lawrence. And it seems, similarly, that large ones are less plentiful relatively in

Passamaquoddy Bay than they are in the western side of the open Gulf of Maine. The death rate may be higher in Passamaquoddy waters, as Huntsman has suggested, or it may prove that the fish tend to work out from there into the open Gulf as they advance in age.

The dab is a spring spawner on both sides of the Atlantic, as is well known. The earliest date at which we have taken its eggs in our tow net in the Gulf of Maine has been March 4 (in 1920), off Casco Bay. We have also found the eggs on Browns Bank on the 13th, while Welsh records large female fish, half spent and with eggs exuding, as well as males with running milt, on the 14th of March, near Cape Ann, in 1913. But other fish of both sexes taken with them were unripe still, evidence that spawning is not general until the last of March or first part of April. Dab eggs have appeared regularly in our tows in April (twice in great numbers, namely off Seguin Island on the 10th and off Mount Desert Island on the 12th in 1920). Spawning continues unabated throughout May, when eggs were taken at nearly all our towing stations in 1915. And April and May similarly cover the height of the spawning season in the Bay of Fundy, according to Huntsman.⁹⁸ Our latest seasonal record has been for a single egg, on the 14th of June in 1915.

The dab spawns chiefly during May and June on the banks off Cape Breton and in the southern part of the Gulf of St. Lawrence: until the end of July on the southern part of the Newfoundland Banks (a few eggs were found by the Canadian Fisheries Expedition); until fall around the south-eastern and eastern coasts of Newfoundland, and along the outer coast of Labrador, according to Frost. And the eggs are reported from May into July off West Greenland, by Jensen.

It spawns somewhat earlier in the North Sea than in American waters; i. e., from mid-January till May with the climax in March and April. Huntsman also remarks that there is a difference in the breeding season according to the depth of water, those living shoalest commencing to spawn the earliest, as the vernal warming of the water makes itself felt from above. But we have no clear evidence on this point to offer for the Gulf of Maine.

⁹⁷ It is only during the past few years that the landings of this particular flatfish have been reported separately, as "dab."

⁹⁸ Bull. 1, Biol. Board Canada, 1918, p. 14.

Our egg records, added to Huntsman's observations, show that the dab spawns all around the Gulf of Maine, from Cape Cod on the west to Cape Sable on the east, including the Bay of Fundy, and from close inshore out to the 50-fathom contour. It also spawns on Browns Bank (p. 265), and, while we found no eggs on Georges Bank either in February, March, April, or May, of 1920, the fish is so common there and so stationary in general that it is likely that we simply missed its eggs, either by a failure to tow over the precise spawning localities or by timing our visits between the waves of production. Dabs also spawn abundantly on Sable Island Bank (no doubt on all the other Nova Scotian Banks); off Cape Breton; in the shoaler parts of the Gulf of St. Lawrence;⁹⁹ throughout the general region of the Grand Banks; off the east coast of Newfoundland; along the outer coast of Labrador to Hamilton Inlet at least;¹ and as far north along the west coast of Greenland as the species is known to exist, as is proven by the presence of its eggs in the water there in quantities.²

Although the dab is rather a deep-water fish compared to most of the other flatfishes that are common in the Gulf of Maine, it is doubtful whether it ever spawns at depths much greater than 50 fathoms in the Gulf, for we have few egg records from more than a mile or two outside the 50-fathom curve, while these few have been based on only one or two eggs each. And we have trawled spawning females off Mount Desert, in 20 fathoms. This concentration of our egg catches inside the 50-fathom contour implies that the dabs that live deeper in our Gulf tend to work up into shoaler grounds to spawn. Beyond this, there is no reason to suppose that they gather in any definite localities for the purpose.

The temperatures and salinities in which the eggs are produced can be stated rather definitely for the Gulf of Maine because the dab lies close to the bottom, if not actually on it. The earliest spawning takes place at nearly the minimum temperature for the year, averaging about 37° for all the March and April stations where eggs were

taken. And while the water warms to 41°–43° F. by late May and early June at the depths known to be inhabited by the ripe fish, we have not found its eggs where the bottom temperature was higher than about 40°. Thus the optimum for breeding may be set at 37°–40° for the Gulf of Maine as a whole. Dabs spawn freely in 31°–32° off Cape Breton, and even in water as cold as 29.3°–32° in the Gulf of St. Lawrence, in Newfoundland waters and northward, as well as along the West Greenland coast, proving that the lowest polar temperatures are no bar to the ripening of its sexual products. Neither does the distribution of the bottom stages suggest that warmer water is needed for the survival of the resultant larvae.

In the Gulf of Maine the dab spawns in relatively low salinities, the range there being only from about 31.8 per mille to about 32.8 per mille at the bottom at the stations where eggs were taken in any number. But it does so in considerably more saline waters in the other side of the Atlantic, generally speaking.

Although this flatfish spawns so generally throughout the whole area that it inhabits, there is evidence that different regions differ in their suitability as nurseries, either for its eggs or for the larvae. The southwestern part of the Gulf of Maine must be favorable in this respect, for we have taken larval dabs at 14 stations there, most of these off the Massachusetts Bay region. And they have also been taken at various localities off the southeast coast of Nova Scotia; on the Newfoundland Banks; in the Gulf of St. Lawrence; along the east coast of Newfoundland; in the Strait of Belle Isle; and northward for some distance along the outer coast of Labrador. But it seems that reproduction does not succeed in the Bay of Fundy, for neither the larvae nor the young fry have ever been found there, although dabs spawn there and the eggs develop, at least partially. Failure to find any dab larvae off the coast of Maine east of Penobscot Bay, though eggs are produced there in abundance may be due to the prevailing drift from northeast to southwest along this part of the coast, because of which buoyant eggs produced there are likely to hatch a considerable distance to the west of where they were spawned. The influence that this drift may have on the distribution of larval fish in the Gulf of Maine offers a fertile field for future study.

⁹⁹ Dannevig, Canadian Fisheries Expedition (1914–15) 1919, p. 18, figs. 11, 12, and 13.

¹ See Frost, Res. Bull. No. 4, Newfoundland Dept. Nat. Resources, 1938, chart 2, for the regional and seasonal distribution of dab eggs in Newfoundland and Labrador waters.

² Jensen, Meddel. Dansk. Komm. Havundersøgelser, Ser. Fiskeri, vol. 7, no. 7, 1925, p. 24.

Commercial Importance.—This is an excellent pan fish, but there is no special demand for it in New England markets, as distinguished from other flat fishes of about the same size. If the landings reported as “dab” do not include any significant proportion of other flounders, and if most of the dabs that are taken are reported under that name, the yearly catch in the Gulf by United States fishermen ranged between about 2,700,000 pounds and about 4,400,000 pounds for the period 1942 to 1947, averaging about 3,600,000 pounds. In 1946 Canadian fishermen brought in an additional 181,200 pounds from the eastern side of the Gulf and from the Bay of Fundy, plus an indeterminate amount landed in Shelburne County from Cape Sable to the Yarmouth County line.³ We have no doubt that the catch could be increased greatly in our Gulf if any special demand were to develop for dabs.

The dab lives too far out from the land, on the whole, and too deep, and it does not bite eagerly enough for it to be of any interest to anglers along our shores.

Summer flounder *Paralichthys dentatus*
(Linnaeus) 1766

FLOUNDER; FLUKE; PLAICEFISH

Jordan and Evermann, 1896-1900, p. 2629.

Description.—The summer flounder is left-handed; that is, it lies on the bottom on its right

³ The landings for that year were 60,100 pounds for Shelburne County as a whole.

side, with its eyes on its left-hand side, and its abdomen is on its left edge as it rests on the bottom, which differentiates it at a glance from the American dab (p. 259). It is large-mouthed, like the sand flounder, which is similarly left-handed (p. 290); but its two ventral fins are alike and each of them is separated from the long anal fin by a considerable space, whereas the upper left-hand ventral fin of the sand flounder is continuous with the anal fin. The only Gulf of Maine flatfish with which the summer flounder shares its left-handedness, large mouth, and symmetrical ventral fins, is its close relative, the four-spotted flounder (p. 270), but the color pattern of the latter is distinctive (p. 270) and it has fewer fin rays. The summer flounder is one of our narrower flounders. Its dorsal fin (85 to 94 rays) originates opposite the forward margin of the eye; its anal fin has from 60 to 73 rays; the margin of its caudal is rounded, and its pectoral fins and ventral fins are smaller than those of the dab, relatively.

Color.—It has long been known that flatfishes are generally dark on a dark bottom and pale on a pale one. Perhaps the summer flounder is the most variable in color of all our local species and the one which adapts its pattern the most closely to that of the ground on which it lies. It is white below and of some shade of brown, gray, or drab above, like most flatfishes. But it can assume a wide range of tints, from nearly white on white sand through various hues of gray, blue, green,

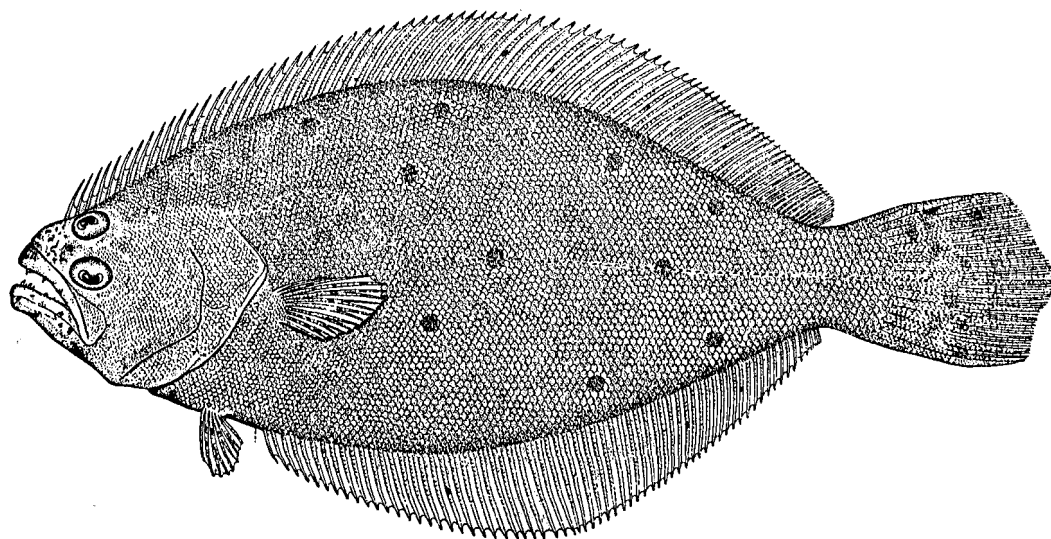


FIGURE 134.—Summer flounder (*Paralichthys dentatus*), Maryland. From Jordan and Evermann. Drawing by A. H. Baldwin.

orange, pink, and brown to almost black.⁴ Its upper surface is variegated with pale and dark, as a rule, with the pattern fine or coarse according to the bottom, and it may or may not be marked with small eyespots of a darker tint of the general ground color. Mast's experiments show that it is slower in adapting its coloration to the actual colors of the bottom than to the general pattern, and also that it responds more rapidly to yellows and browns than to reds, greens, or blues, on which the adaptation may not reach its maximum for two or three months. He also observed that the skin simulates the pattern of the background, and does not reproduce the latter.

Size.—Summer flounders ordinarily grow to a maximum weight of 15 pounds or so, and to a length of 3 feet, or a little more, though one of about 30 pounds has been reported as taken off Fishers Island about 1915.⁵ The largest of which we find definite record weighed 26 pounds. The largest on record, taken in sport fishing, was 37 inches long, weighing 20 pounds, caught at Oak Beach, N. Y., September 7, 1948, by F. H. Kessel, but the average size of the fish caught is only 2 to 5 pounds. The relation of length to weight is about as follows:⁶

Length	Average weight, pounds
15-16 inches.....	1 to 1½
17-18 inches.....	2 to 2¾
20 inches.....	3 to 3½
22 inches.....	4
27 inches.....	8
30 inches.....	10
37 inches.....	20

Habits.—Many fluke come close inshore during the warm half of the year, when they are caught regularly both along open coasts and in bays and harbors, the smaller sizes often from docks and bridges, and some even run up into fresh water rivers. But the great majority of the population, especially of the larger ones, lie farther offshore even at that season, in depths of 8 to 10 fathoms and deeper, at least in the northern part of the fluke's geographic range, as illustrated by the fact that nearly 40 times as many (by weight) are landed in New Jersey and in New York by otter

trawlers as from the many pound nets operating there.⁷ And all of those that do come close inshore from Chesapeake Bay northward move offshore again at some time during the autumn, presumably to escape winter chilling.

The earliest landings from offshore of which we have heard for southern New England have been on October 6th, when some were brought in to Woods Hole from northwest of Nantucket Lightship, from 25 fathoms, and on the 16th of that same month, when the dragger *Eugene H* landed 6,000 pounds, taken west of Nantucket Lightship in about 25 fathoms. Corresponding to this, only a few are seen near Woods Hole after the middle of October, or after the last week of November near New York. And very few reappear near New York before the first week in May, or before about the 10th of May near Woods Hole.

It has been learned since the first edition of this book appeared that the medium sized and larger ones, at any rate, pass the winter and early spring out on the continental shelf from the 25 to 30 fathom contour about to the 80 fathom contour. Otter trawlers now make paying catches there as far north and east as the offing of southern New England, and as far south as the offing of northern North Carolina, during the part of the year when there are only a few "fluke" inshore, or none at all. In 1950 and 1951, for example, the *Eugene H*,⁸ fishing in the general offing of Marthas Vineyard, brought in many fares ranging from a few hundred pounds to more than 20,000 pounds, between the first week of October and the third week of May, with the most productive fishing between early January and mid-April, from 25 to 75 fathoms. But it is doubtful whether many of them work deeper than that, for the *Albatross III* did not take any at depths greater than 80 fathoms off southern New England or New York in mid-May, 1950.

Fluke spend most of their lives on bottom, or close to it, as other flatfishes do. During their stay in shoal water they prefer sandy bottom, or mud, where they are often seen. And it takes one only an instant to bury itself to the eyes in the sand. Fluke often lurk in eel grass, or among the piling of docks; but they are swift swimmers when disturbed.

⁴ Mast, Bull. U. S. Bur. Fish., vol. 34, 1916, p. 177.

⁵ Nichols and Breder, Zoologica, N. Y. Zool. Soc., vol. 9, 1927, p. 177.

⁶ From Goode, Fish. Ind., U. S., Sect. 1, 1884, p. 179; Hildebrand and Schroeder, Bull. U. S. Bur. Fish., vol. 43, Pt. 1, 1928, p. 167; and World Record Marine Game Fishes, Amer. Mus. Nat. Hist., New York, to 1950.

⁷ 1947 landings, New York and New Jersey, about 2,300,000 pounds by otter trawlers; only about 80,000 pounds from pound nets.

⁸ Information contributed by Capt. Henry Klimm.

This is a predaceous fish, like the halibut, feeding largely on smaller fish of various sorts, on squids, crabs, shrimps, and other crustaceans; on small shelled mollusks; on worms, and on sand dollars. It is very fierce and active in pursuit of prey, often following schools of small fish right up to the surface, to jump clear of the water in its dashes, actions very different from those of the sluggish dab and winter flounder.

Little is known of its breeding habits. The fact that nearly ripe females have been taken in October in Chesapeake Bay, in November and February at Beaufort, N. C., and as late as April 15, at 75 fathoms off Nantucket,⁹ whereas Beaufort fish taken in March and April appeared to be spent, show that it is a late autumn, winter, and early spring spawner.¹⁰ This implies that the flukes that spawn in the northern part of their range do so well offshore, and this may also be true of them in the southern part of their range, for fluke that were kept in aquaria at Beaufort through the winter failed to spawn.

The eggs of the summer flounder laid naturally have not been described yet. But it is likely that they are buoyant like those of the four-spotted flounder (p. 271). And their future "lefthandedness" and large mouths are foreshadowed at an early stage in the development of the larvae. Larvae either of the fluke, or of a form (*P. albiguttus* Jordan and Gilbert, 1882), so closely allied that it may prove a race of that species, resemble corresponding stages of the four-spotted flounder in their deep outlines and large heads, but the pigmentation on the rear part of their body is less dense. At a length of 16 mm. the right eye has nearly completed its migration, and the outlines of young fry 26 mm. long approach those of the adult.¹¹

Young fry taken in Chesapeake Bay, had increased in length from about 0.9–2.4 inches long in May and June, to 3–5 inches in the last week of July; were 4.7–7.1 inches by December and January when one year old or a little less; about 8–10 inches long in the following October, when they were a little short of two years old; and they

measured 10½ to 11 inches by their second May; i. e., when a little more than 2 years of age. The subsequent rate of growth has not been traced, so far as we know.

General range.—Continental waters of the eastern United States, from Maine to South Carolina, possibly to Florida,¹² chiefly south of Cape Cod.

Occurrence in the Gulf of Maine.—This is the most important flatfish commercially to the west and south of Rhode Island, and the one most sought after by sportsmen there. It is also plentiful offshore eastward to Nantucket Shoals and to the western part of the so-called South Channel, whence about 531,000 pounds were landed in 1947 (most recent year for which information is at hand). Trawlers also pick up a few on the southwest part of Georges Bank (about 6,000 pounds in 1947), as well as a fish here and there on other parts of the bank.¹³ But there is no reason to suppose that fluke ever stray eastward and northward as far as Brown's Bank, or to outer Nova Scotian waters.

Coastwise, the angle of Cape Cod is the northern boundary to the regular range of the fluke in any great abundance. A number are caught each summer in Pleasant Bay, Chatham, Mass.,¹⁴ where we read of one of 11½ pounds taken as early as the last week of May, in 1951,¹⁵ a few in Town Cove, Orleans, some miles farther north, and a fluke is picked up occasionally by someone casting into the surf on the outer Cape Cod beach.¹⁶ And they were so common near Provincetown and along the inner shore of Cape Cod as far as Wellfleet during the period from 1840 to 1850 that Captain Atwood carried them regularly thence to Boston, recording a catch of 2,000 pounds in a single afternoon inside Provincetown Harbor. But this is the most northerly region where fluke have ever been known to occur in commercial quantities. Even there its numbers were so reduced by a few years of hard fishing that they were described by Goode¹⁷ in 1884 as "only

¹² Florida is usually given as the southern limit for this flounder, but it is possible that the early records from that State (there are no recent ones) actually referred to the southern flounder (*P. lethostigmus*), a common Floridian fish.

¹³ 645 pounds reported from the northwest part of Georges in 1947, 100 pounds from the northeastern edge, and 157 pounds from the central and southeastern part.

¹⁴ This opens on the outer coast of Cape Cod.

¹⁵ Reported in Salt Water Sportsman, June 1, 1951.

¹⁶ There is a record of this, by Kendall, in 1896, and we have known of other cases, of late years.

¹⁷ Fish. Ind. U. S., Sec. 1, 1884, p. 178.

⁹ Trawled by the *Eugene H.*, Capt. Henry Klimm, in 1951.

¹⁰ We dare not draw any conclusions as to spawning season from Hildebrand and Cable's table (Bull. U. S. Bur. of Fisheries, vol. 46, p. 470, table 12) of the seasonal distribution of young fry of different sizes because two species of flounders are included there.

¹¹ Our account of the young stages is based chiefly on Hildebrand and Cable's description (Bull. U. S. Bur. of Fisheries, vol. 46, pp. 469–475), from Beaufort, N. C.

occasionally taken" there. And they have never reappeared in any abundance, so far as we can learn, a fact suggesting that the local body of fish concerned was not very numerous, and that it received but few recruits from the more abundant stock to the southward.

The fluke is so rare a straggler north of Cape Cod Bay that there is only one definite record—for Casco Bay (specimens collected in 1873). We may add that we have never seen or heard of one caught in the inner part of Massachusetts Bay, and that it is unknown in the Bay of Fundy.

Importance.—This is one of the best of our flatfishes on the table, usually bringing a higher price than any other except the halibut; in 1947 it sold for 15 cents on the average in New Bedford, the halibut about 21 cents. And the landings of fluke from within the limits of the Gulf of Maine, totaling about 543,000 pounds (mostly from near Nantucket Shoals) were worth about \$90,000 to fishermen that year. This is also the gamest of our flatfishes, biting freely on almost any bait, even taking artificial lures at times, while large ones put up a strong resistance when hooked. It is too bad that the fluke is not so common north of Cape Cod as it is to the south.

Four-spotted flounder *Paralichthys oblongus*
1815 (Mitchill)

Jordan and Evermann, 1896-1900, p. 2632.

Description.—This flatfish resembles the summer flounder (p. 267) so closely in its general make-up

that we need mention only the points of difference. Most apparent of these are that it has fewer dorsal fin rays (72 to 81 dorsal and 60 to 67 anal rays, contrasted with 85 to 94 and 60 to 73, respectively, in the summer flounder), and that its mottled gray back is invariably marked with four large, oblong, and very conspicuous black eye spots edged with pale pinkish, two of them situated at each margin of the body, as the illustration shows (fig. 135). Incidentally, we have seen two of them on which the lower side, rearward from the gill openings was as dark as the upper side, and marked, similarly, with four eye spots; also others that were more or less dark below.¹⁸

This is also a much smaller fish than the summer flounder, for the adults average only about 12 inches long with 16 inches as about the maximum.

Habits.—Although this is a rather common fish about Woods Hole in May and June, and is still more numerous along the coast of New York, very little is known of its habits. It does not usually come into as shoal water as the summer flounder often does, being caught most often in 7 to 17 fathoms in Vineyard Sound, for example, near Woods Hole. And the many that have been trawled by the *Albatross II* and *Albatross III* between Georges Bank and northern North Carolina, have been generally distributed from about 23 fathoms down to at least 150 fathoms.

¹⁸ Fish trawled by the *Eugene H* off Marthas Vineyard, Jan. 27 to Feb. 3, 1950, at 47 to 67 fathoms.

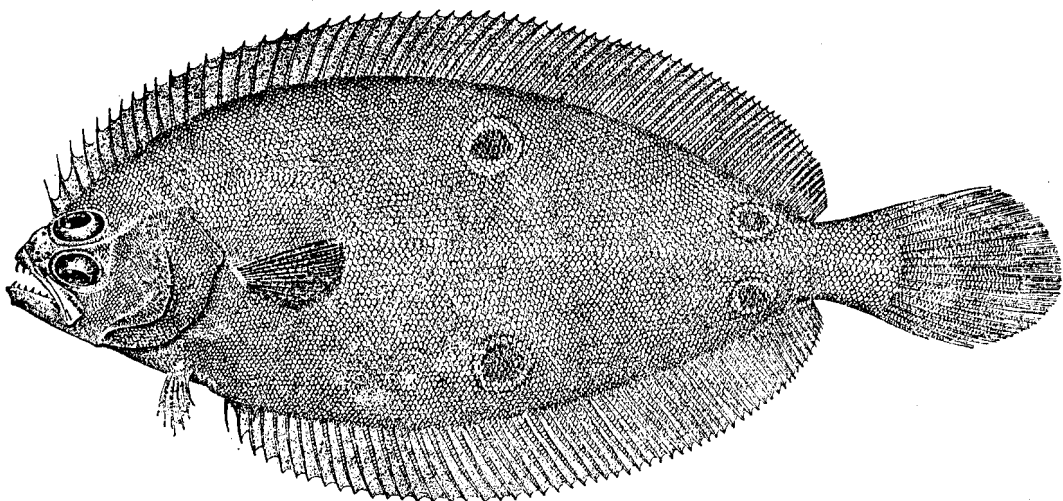


FIGURE 135.—Four-spotted flounder (*Paralichthys oblongus*), Woods Hole. From Goode. Drawing by H. L. Todd.

Its diet is much the same as that of the summer flounder; chiefly small fish and squid, with crabs, shrimps, shellfish, and worms.

It spawns from May until mid-July. The eggs are buoyant, 0.95 to 1.05 mm. in diameter, with a single oil globule of 0.16 to 0.19 mm.¹⁹ The early stages have not been described previously, but certain large mouthed and lefthanded²⁰ flat-fish larvae of 8 to 11 mm. that have been taken in tow nets off New Jersey, by the *Grampus* in 1913, and from Nantucket Shoals southward by the *Albatross II* subsequently, seem likely to have been young four-spots, not summer flounders, because they were taken in June and July (p. 269). If this identification is correct, an aggregation of pigment over the rear part of the trunk, combined with deep outline and a large head are distinctive for this species. Small fry of 2 to 3 inches have been taken at Woods Hole in autumn, evidence that the fry of this flounder complete their metamorphosis and take to bottom about 3 months after they are hatched.

General range.—This flounder has been taken between the eastern part of Georges Bank and the coast of South Carolina.²¹ Its center of abundance appears to lie between southern New England and Delaware Bay.

Occurrence in the Gulf of Maine.—The four-spotted flounder is so plentiful along the continental shelf as far eastward as the general offing of Nantucket, and to the neighboring part of Georges Bank that we counted about 1,800 of them trawled there, by the *Eugene H* in 56 hauls at 47 to 67 fathoms, January 27 to February 3, 1950, also 968 of them on the southwestern part of Georges, in 26 to 75 fathoms, in late June 1951. And a few were trawled in 1931 by the *Albatross II* also along the southern and southeastern parts of Georges Bank. But this last is their most easterly known outpost.

The only records for the four-spot in the coastal waters of our Gulf are from Monomoy at the southern angle of Cape Cod; from the vicinity of Provincetown (where Storer saw a number of

them in June 1847); and from somewhere on the northern shore of Massachusetts Bay where one was taken by the United States Fish Commission in 1878.²²

This is a fair table fish but there is no market for it at present.

Yellowtail *Limanda ferruginea* (STORER) 1839

RUSTY FLOUNDER

Jordan and Evermann, 1896-1900, p. 2644.

Description.—The yellowtail is right-handed (that is, its eyes are on the right side and its viscera are at the right-hand edge as the fish lies on the bottom), and small-mouthed like the winter flounder, the smooth flounder and the witch. But it is easily distinguished from the first of these by its more pointed snout, thin body, arched lateral line, and more numerous fin rays; from the smooth flounder by the last two characters as well as by the concave dorsal (left hand) profile of its head and by being scaly between the eyes; and from the witch by its arched lateral line, its less numerous fin rays, concave dorsal (left) profile of the head, and especially by lacking the mucous pits on the left (white) side of its head that are conspicuous on the witch (p. 285).

The yellowtail is a comparatively wide flounder, nearly one-half as broad as it is long, with an oval body. The dorsal (left hand) outline of its head is more deeply concave than in any other Gulf of Maine flounder; its head is narrower; its snout is more pointed, and its eyes are set so close together that their rounded orbits almost touch each other. The fact that its mouth reaches scarcely as far back as the eyes, with its small teeth and thick fleshy lips, marks it off at a glance from all the large-mouthed flounders. The dorsal fin (76 to 85 rays) originates over the eyes, its middle rays are the longest. Its anal fin is similar in outline to the dorsal, but is much shorter (56 to 63 rays), and it is preceded by a short, sharp spine pointing forward. The two ventral fins are alike, and each of them is separated by a considerable space from the anal fin. But the pectoral fin on the blind side is slightly shorter than its mate on the eyed side. The scales are rough on the eyed side, but smooth on the blind side.

¹⁹ Eggs artificially fertilized by O. E. Sette of the Bureau of Fisheries.

²⁰ Lefthandness foreshadowed in the larger ones by the fact that it is the right eye that had begun to migrate.

²¹ The most southerly record for it is for five specimens trawled in the general offing of Charleston, S. C., lat. 33°00' N., long. 77°44' W., at 92 fathoms, by *Albatross III*, January 30, 1950. Another flounder, *Ancylosetta quadrocellata* Gill, similar in appearance, for it is strikingly marked with four large spots, is found along the South Atlantic and Gulf coasts.

²² In one paper (Am. Jour. Sci., Ser. 3, vol. 17, 1879, p. 40) Goode and Bean state that this specimen was trawled in Gloucester Harbor; in another paper (Bull. Essex Inst., vol. 11, 1879, p. 7) they credit it to the mouth of Salem Harbor.

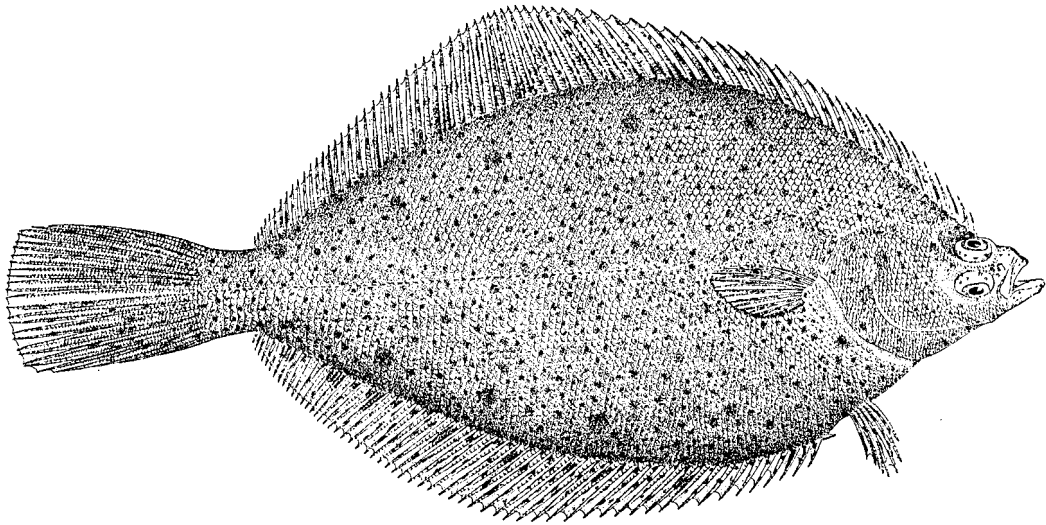


FIGURE 136.—Yellowtail (*Limanda ferruginea*), Gloucester, Mass. From Jordan and Evermann.
Drawing by H. L. Todd.

Color.—The yellowtail is more constant in color than most of the other Gulf of Maine flatfishes. Its eyed side, including the fins, is brownish or slaty olive, tinged with reddish and marked with large irregular rusty red spots. The caudal fin and the margins of the two long fins are yellow, the yellow tail in particular being a very diagnostic character. The blind side is white, except for the caudal peduncle which is yellowish.

Size.—This is a medium-sized flatfish. Several hundred adults caught in gill nets between Cape Ann and Cape Elizabeth (measured by Welsh) ran as follows: Males, average length $15\frac{1}{4}$ inches, extremes $11\frac{1}{4}$ inches to $18\frac{1}{4}$ inches; females, average length 18 inches, extremes $15\frac{1}{2}$ inches to $21\frac{1}{4}$ inches. This series includes the largest specimens that have ever been reported. A yellowtail 12 inches long weighs about one-half pound; one 15 inches long, about 1 pound; and one 18 inches long about 2 pounds.

Habits.—A yellowtail is caught in very shoal water now and then: We heard, for example, of several taken in Pleasant Bay, Cape Cod, in 1950. But 5 to 7 fathoms may be set as its upper limit, generally speaking. Thus it keeps to rather deeper water than either the winter flounder or the smooth flounder. On the other hand, most of those caught are at least from no deeper than 50–60 fathoms,²³ and the bulk of the catch is made

shoaler than 40 fathoms. We saw many yellowtails trawled by the *Albatross III* off Marthas Vineyard and Nantucket in 20 to 40 fathoms, in May, 1950, but only 6 in 41 to 50 fathoms, and none in deeper water. Again, in late June 1951, *Eugene H* averaged about 240 yellowtails per trawl haul, at 26 to 45 fathoms on the western part of Georges Bank, but took only three of them in deeper hauls.

Almost any sandy bottom or mixture of sand and mud suits them, and most of those that Welsh saw taken in gill nets on the Isles of Shoals-Boone Island grounds (p. 274) were over fine black sand between the hard, rocky patches. Rocks, stony ground, and very soft mud are shunned by yellowtails, as they are by most of the other flatfishes.

The yellowtail feeds chiefly on the smaller crustaceans such as amphipods, shrimps, mysids, and on the smaller shellfish, both univalves and bivalves, and on worms. It is also known to eat small fish, but it is not likely that it can catch these often. Its European relative also feeds on sea urchins, starfish, and on algae at times. And it is probable that our yellowtail would be found equally omnivorous were their stomachs examined from various localities. Fish in breeding condition are empty as a rule.

The diet of the yellowtail suggests that it is one of the more sluggish of our flatfishes, and there is no reason to suppose that it ever travels about much after it once takes to the bottom except that it has been described, in Massachusetts Bay, as “in-

²³ One was taken at 50 fathoms by *Albatross II*, September 5, 1926, on the northwestern part of Georges Bank, and two of about 10 inches at 90–95 fathoms on the northern edge of Georges Bank, by *Cap'n Bill II*, August 22, 1952.

habiting the deep water . . . in summer, and approaching the shores in winter,"²⁴ as do various other ground fishes that tend to avoid high temperatures.

If the yellowtails are as stationary as they seem to be, they must be subject to considerable range of temperature from season to season at different depths, in one part of the Gulf or another, from a maximum of about 52°-54° to a minimum of about 33°-36°. And some of them are exposed to still lower temperatures on the Grand Banks, and in the Gulf of St. Lawrence.

The eggs of the yellowtail, artificially fertilized by Welsh in 1912, and hatched at the Gloucester hatchery, were buoyant, without oil globule, spherical, very transparent, and with a narrow perivitelline space. One hundred eggs measured by him ranged from 0.87 mm. to 0.94 in diameter, averaging about 0.9 mm. The surface of the egg is covered with very minute striations, and the germinal disk is of a very pale buff color while alive. The embryonic pigment gathers in three groups shortly before hatching (which takes place in 5 days at a temperature of 50° to 52°); one group on the head, a second group in the region of the vent, and a third group half way between the vent and the tip of the tail. Unfortunately the fish which Welsh hatched were destroyed accidentally, so we cannot describe the early larval stages. Larvae of 11 mm. are still symmetrical. But the left eye is already visible above the profile of the head at 14 mm. (fig. 139, *Grampus* specimen), all the fins are outlined, with their rays present in the final number (76 dorsal and 59 anal in the specimen illustrated). Thus, they show enough of the distinctive characters of the adult for positive identification.

The early larval stages of yellowtails and of winter flounders resemble one another closely; in fact, it is probable that some of the young flatfishes pictured by A. Agassiz²⁵ as winter flounders were yellowtails in reality. But the number of fin rays usually places the larvae in one species or the other after these appear. And the yellowtail does not take to bottom until upward of 14 mm. long, whereas the winter flounder completes its metamorphosis when it is only 8 to 9 mm. long.

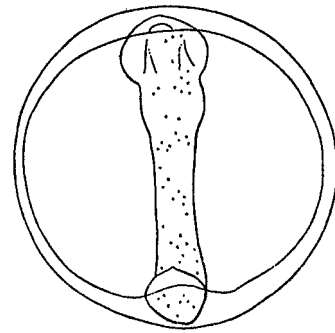


FIGURE 137.—Egg.



FIGURE 138.—Larva, 10.3 mm.

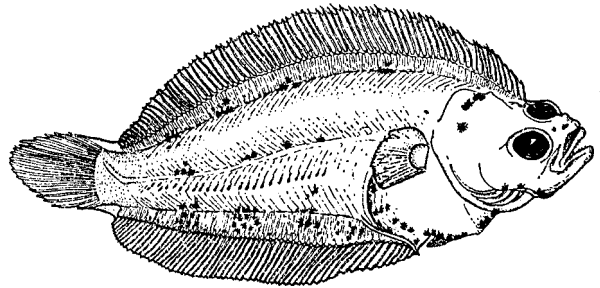


FIGURE 139.—Larva, 14 mm.

YELLOWTAIL (*Limanda ferruginea*)

Captures of young fish 2 to 4 inches long in February; 2¼ to 4½ inches long in April; 2½ to 5½ inches long in May; 3 to 5 inches long in June; and 3 to 6½ inches long in July indicate that the yellowtail grows to an average length of about 5 inches by the time it is one year old. Its subsequent rate of growth has not been traced.

General range.—North American continental waters, from the north shore of the Gulf of St. Lawrence, the Labrador side of the Strait of Belle Isle,²⁶ northern Newfoundland (there are specimens from St. Anthony's in the Museum of Comparative Zoology), and the Newfoundland Banks, southward to the lower part of Chesapeake Bay.²⁷ It is most plentiful on the western

²⁶ Recent records from the Labrador side of the Strait are of one from Barge Bay, July 29, 1910 (Jeffers, *Contrib. Canad. Biol., N. Ser.*, vol. 7, No. 16, 1932, p. 210); and of another taken at Forteau Bay, June 29, 1949, by the Blue Dolphin Expedition, reported to us by Richard H. Backus.

²⁷ We have records of one taken off Hog Island, Va., in lat. 37° 41' S. (Bigelow and Schroeder, *Bull. U. S. Bur. Fisheries*, vol. 48, 1930, p. 340). And it was reported from the southern part of Chesapeake Bay by Uhler and Luggier (*Rept. Comm. Fish., Maryland*, 1876, p. 95; 2d Ed., 1876, p. 79.)

²⁴ Goode and Bean, *Bull. Essex Inst.*, vol. 11, 1879, p. 6.

²⁵ Agassiz, *Proc. American Acad. Arts, Sci., N. Ser.*, vol. 6, 1879, pl. 4.

half of Georges Bank; in the western side of the inner parts of the Gulf of Maine; on the Nantucket grounds; and off southern New England.

This flatfish is represented in north European waters by the European dab, *Limanda limanda*, a close ally, from which it is distinguishable by its smaller scales, more pointed snout, more numerous fin rays, and shorter pectoral fins.

We should also mention the deep-water dab (*Limanda beanii* Goode), for while it has not been taken within the limits of the Gulf of Maine it would not be astonishing to find it on the seaward slope of Georges Bank, for it has been taken westward and southward from Marthas Vineyard in depths of 120 to 896 fathoms.²⁸ It differs from the rusty dab in a shorter head (occupying only two-elevenths of the total length instead of one-fourth); in the fact that the dorsal (left hand) profile of its snout is convex, not concave; in having only about 64 dorsal fin rays instead of 76 or more; in having only 88 rows of scales along its lateral line instead of 90 to 100; and in the fact that its tail fin is marked with a conspicuous black blotch on the outer rays on each side.

Occurrence in the Gulf of Maine.—Little was known of the distribution of the yellowtail in our Gulf previous to the introduction of the otter trawl there, for it is seldom seen close inshore; while its mouth is so small that one is seldom caught on hooks as large as those that are used for cod, pollock, or for haddock. But it has proved so abundant since then, in the general region of Nantucket Shoals and in the neighboring side of the so-called South Channel, that about 4,400,000 pounds were landed thence in the most recent year (1947) for which we have information. The western half of Georges Bank as a whole is good yellowtail ground also. But yellowtails seem to be less numerous on the eastern half of the Bank (though generally distributed there), and less so on Browns Bank, as is illustrated by the landings (in pounds) for 1947,²⁹ as follows: northwest Georges Bank, 930,000; southwest Georges Bank 1,740,000; northeast Georges Bank 210,000; central and southeast Georges Bank 540,000; and Browns Bank 40,310.

Yellowtails are so plentiful on the sandy bottoms in the eastern side of Cape Cod Bay, also, and on Stellwagen Bank, that (with winter flounders) they have long been the mainstay of the draggers that fish there; no doubt the greater part of the 1,150,000 pounds of yellowtails that were reported as taken off eastern Massachusetts in 1947 were trawled on these particular grounds. There are yellowtails in the deeper parts of Massachusetts Bay, too, as Goode and Bean³⁰ remarked long ago. And since Welsh saw many hundred of them taken in gill nets (not very effective gear for flatfishes) between the Isles of Shoals and Great Boars Head, during March and April of 1913, the yellowtail must be one of the most numerous of its tribe in the western side of the Gulf in general, in suitable depths.

Apparently they are less plentiful, however, around the Gulf to the north and northeast, for the reported catches for 1945 were only about 44,500 pounds for Cumberland County, Maine,³¹ which covers Casco Bay and the grounds in its offing; only about 9,000 pounds for Knox and Hancock Counties combined, and none for Washington County in that particular year, though a few hundred pounds have been reported from "eastern Maine" in some other years.

We have taken no yellowtails in the deep basins of our Gulf nor have we heard of any there, probably because of the depth, for the bottom would seem hard enough for them in the eastern trough, at least, even if it is not in the western, or in the bowl west of Jeffreys Ledge. They certainly are uncommon in the Bay of Fundy, too, if not altogether lacking there. And though Huntsman did find a few in St. Mary's Bay, Nova Scotia, United States fishermen bring in only a few hundred pounds from off western Nova Scotia in some years, and none at all in others, though considerable amounts are brought in from the outer Nova Scotian grounds, as mentioned below (p. 275).

Most of the yellowtails that are caught in the inner part of the Gulf of Maine are in 10 to 30 fathoms of water, though they are reported in Shoal water at the mouth of Penobscot Bay; those caught on Georges Bank are in 20 to 45 or 50 fathoms (see p. 272).

²⁸ Localities are listed by Goode and Bean (Smithsonian Contrib. Knowl., vol. 20, 1895, p. 430).

²⁹ To nearest 10,000 pounds.

³⁰ Bull. Essex Inst., vol. 11, 1879, p. 6.

³¹ Apart from those that were brought in to Portland by the large trawlers from more distant grounds.

Trawlers find yellowtails in even greater numbers off the southern New England coast than on Nantucket Shoals, at the proper depths, as illustrated by reported landings thence of about 17¼ million pounds in 1947.³² And they are moderately plentiful offshore, as far as the offing of New York.³³ But southern New Jersey is about the southern limit to their regular occurrence.³⁴

Turning our attention eastward, we find the yellowtail plentiful all along the outer Nova Scotian banks, where about 2,700,000 pounds were taken in 1947 by vessels from Massachusetts,³⁵ besides about 2½ million pounds by Canadian vessels.

They are also reported as numerous on the southern part of the Grand Banks from experimental trawling by the Newfoundland Fishery Research Commission, but are "not in any numbers along the Newfoundland coast,"³⁶ so far as is known, though they are recorded from as far north as the Strait of Belle Isle, as already noted (p. 273). They are also distributed generally in the Gulf of St. Lawrence, but no information is available as to their numbers there, for none are reported from the Gulf in the Canadian Fisheries statistics.

The neighborhood of the Isles of Shoals and of Boars Head, at 20 to 30 fathoms, certainly is an important spawning ground for the yellowtails;³⁷ so, too, the edges of Stellwagen Bank where we have caught spawning specimens. In fact, it is likely that yellowtail eggs are produced in abundance all around the western and northwestern periphery of the Gulf, between the 20 fathom and 50 fathom contours; few, however, in the eastern side, and none in the Bay of Fundy; nor have we found any of its eggs anywhere over depths greater than 50 fathoms. No doubt the yellowtail spawns as actively on the offshore Banks as it does inshore, for though we have not actually found its eggs there we have taken larvae only 7 to 11 mm. long over the western and eastern parts of Georges

Bank in July,³⁸ as well as near Gloucester and near the tip of Cape Cod in July and August.

To the eastward and northward, yellowtail spawn on Sable Island Bank, Banquereau Bank, and the Newfoundland Banks, eggs (no doubt of this species) having been collected on these grounds by the Canadian Fisheries Expedition in 1915.³⁹ In the opposite direction, it certainly breeds as far westward as New Jersey, for our tow net yielded 88 of its larvae (6.5 to 19 mm. long) 11 miles off Sandy Hook on August 1, 1913; adult fish approaching ripeness have been trawled as far southward as Little Egg Inlet, N. J., in April 1930.

Spawning, Welsh found, begins on the Isles of Shoals-Boone Island ground by the middle of March; and many ripe fish were taken there during the last half of April, but the majority were still green as late in the season as May 8, though others were already spawned out. And spawning must last all summer, for we have trawled many ripe males and females in depths of 17 to 25 fathoms on the edge of Stellwagen Bank at the end of July; have taken eggs indistinguishable from those of the yellowtail in our tow nets in June, July, and August, with one even on September 11; and have taken its newly hatched larvae (6 mm. long) off Race Point as late as August 31. And the individual females evidently spawn over a considerable period of time, for Welsh found that only a small part of the eggs ripened simultaneously.

Importance.—The yellowtail is one of the most valuable of the flatfishes caught within the Gulf of Maine. It compares favorably in quality with the summer flounder and the winter flounder, but because its body is thinner it brings a lower price to the fishermen. Thus in 1947 the average price, as landed in New Bedford, was about 8 to 9 cents a pound for yellowtails; winter flounders, about 9 to 10 cents a pound; and summer flounders, about 17 to 18 cents a pound. All the yellowtails that are brought in find a ready sale and they make up a large part of the fillet of sole sold to consumers. In 1947 our Gulf yielded between 15 and 16 million pounds of them. But yellowtails live rather too deep to be of any interest to anglers.

³² Landings in 1947 in Massachusetts ports, from grounds westward from Nantucket Shoals, about 12 million pounds; landings in Rhode Island, about 2¼ million pounds; landings in Connecticut, about 3 million pounds.

³³ About 3¼ million pounds were landed in New York in 1947.

³⁴ *Albatross II* trawled many yellowtails as far southward as the offing of Delaware Bay (lat. 38° 32' N., long. 74° 24' W.) in 12 to 28 fathoms during February, April, and June, of 1929 and 1930.

³⁵ The Newfoundland Fishery Research Commission (Rept., vol. 1, No. 4, 1932, p. 110) reports 680 yellowtails taken per 10 hours trawling on Banquereau.

³⁶ Frost, Research Bull. 14, Newfoundland Dept. Nat. Resources, 1940, p. 15.

³⁷ Welsh obtained many ripe fish there.

³⁸ Station 10050, July 9, 1913; and station 10224, July 23, 1914.

³⁹ Dannevig (Canadian Fisheries Expedition [1914-15], 1919, p. 17) refers these provisionally to the European dab, which does not occur on our side of the Atlantic. Its egg is indistinguishable from that of the American species.

Winter flounder *Pseudopleuronectes americanus*
(Walbaum) 1792

BLACKBACK; GEORGES BANK FLOUNDER; LEMON SOLE; FLOUNDER; SOLE; FLATFISH; ROUGH FLOUNDER; MUD DAB; BLACK FLOUNDER

Jordan and Evermann, 1896-1900, p. 2647.

Description.—This is a small-mouthed, right-handed species (eyes on the right side and viscera on the right). But it is easily separable from the yellowtail, which is similarly characterized, by the fact that its lateral line is nearly straight (at most only slightly bowed abreast the pectoral fin); that the dorsal profile of its head is less concave; that its nose is blunter; that its eyes are farther apart; that it has fewer fin rays; and that its fins are less tapering in outline. The most obvious differences between the winter flounder and the smooth flounder (p. 283) is that the former is rough scaled between the eyes, the latter smooth there, and that the winter flounder has the larger number of anal fin rays. On the other hand, it has only about two-thirds as many dorsal rays as the witch (p. 285); it lacks the mucous pits that are conspicuous on the left (lower) side of the head of the witch, and its tail is much larger proportionately than that of the witch. It is oval in outline, about two and one-fourth times as long to the base of the caudal fin as it is wide, thick-bodied, and with proportionately broader caudal peduncle and tail than any of our other small flatfishes.

Its dorsal fin (60 to 76 rays) originates opposite the forward edge of the eye, and is of nearly equal height throughout its length. Its anal fin (45 to 58 rays)⁴⁰ is highest about midway, and it is preceded by a short, sharp spine. Its ventral fins are alike on the two sides of the body, and both of them are separated from the long anal fin by a considerable gap. The mouth is small, not gaping back to the eye, and the lips are thick and fleshy like those of the yellowtail. The left (under) half of each jaw is armed with one series of close-set incisor-like teeth, but the right (upper) side has only a few teeth, or it may even be toothless. The scales are rough on the eyed side, including the space between the eyes, but they are smooth to the touch on the blind (white) side.

Color.—The winter flounder, like other flatfishes, varies in hue according to the bottom on which it lies, but it is the darkest of Gulf of Maine flatfishes as a rule. Large ones are usually of some shade of muddy or slightly reddish brown, olive green, or dark slate above, sometimes almost black. And they vary from plain or more or less mottled to definitely marked with smaller or larger spots of a darker shade of the general ground tone. There usually is a wide variation in this respect, among any lot of flounders. And fish caught on Georges Bank average more reddish in

⁴⁰ Perlmutter (Bull. Binghain Oceanogr. Coll., vol. 11, Art. 2, 1947, pp. 19, 20) gives a detailed tabulation, and graph of the number of dorsal and anal fin rays from upwards of 1,100 specimens including both the smaller inshore form and the larger Georges Bank form.

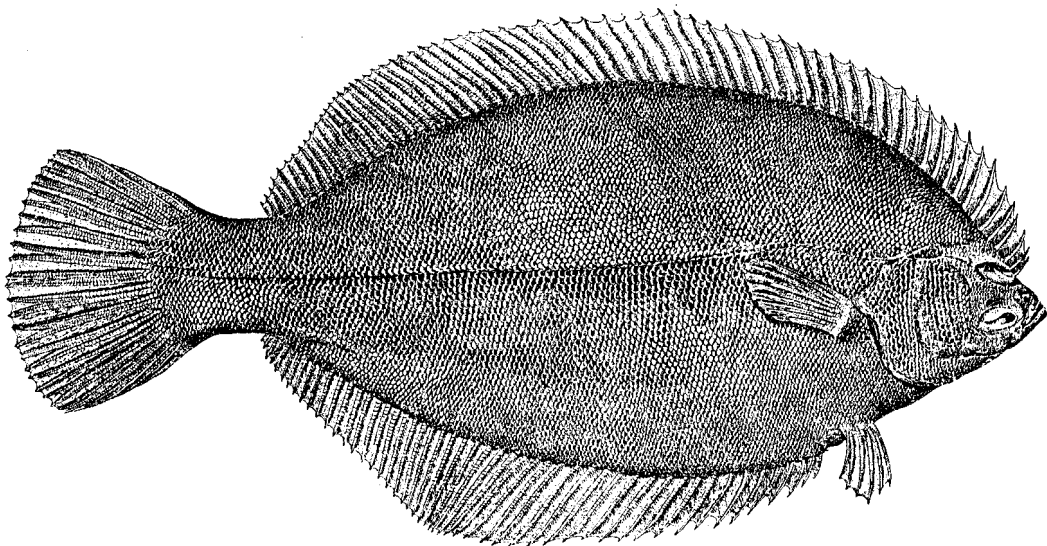


FIGURE 140.—Winter flounder (*Pseudopleuronectes americanus*). From Goode. Drawing by H. L. Todd.

hue than those caught inshore. But this rule does not always hold (see p. 277).

The blind side is white, more or less translucent toward the edge, where it is often faintly tinged with bluish, and the lower side of the caudal peduncle is yellowish on some specimens, but is pure white on others. The long fins usually are tinged with pinkish, reddish, or are yellowish on the eyed side; the ventrals and pectorals of the eyed side are of the general ground tone, but their mates on the blind side are pure white. Small fish average paler and more blotched or mottled than large ones.

Various color abnormalities have been recorded (fish, for example, that are partially white on the eyed as well as on the blind side, or with the blind side yellow-edged) and it is not uncommon to see specimens with dark blotches on the blind side. In fact, one-third of the fish caught near Providence, R. I., during the winter of 1897-98 were these "black bellies," as fishermen call them, but the commissioners of fisheries of that State estimated them as forming only 4 percent of the catch in 1900. And none (or at most only an occasional fish) has been seen since. In 1898, some fry that had been hatched artificially from eggs of black-bellied flounders were released in Waquoit Bay, southern Massachusetts, where this race had been unknown previously, and several "black bellies" 7 to 8 inches long (hence probably two years old) were taken there in 1900, probably the offspring of this planted stock.⁴¹

Winter flounders change color to some extent to suit their surroundings, usually being very dark on mud, and pale on bright sand bottoms. But field experience suggests that they have less control over shade and pattern than the summer flounder has.

Size.—The largest winter flounder on record caught inshore was one 22¼ inches long mentioned by Scattergood;⁴² Nichols and Breder⁴³ report one 20 inches long, weighing 5 pounds; and Welsh saw three of about 19½ inches, weighing 3¼, 3¾, and 4 pounds, respectively, that were caught near Boon Island in April 1913. But fish longer than 18 inches or heavier than 3 pounds are unusual inshore, the general run of adults caught there being from 12 to 15 inches in length and 1½ to 2

pounds in weight. Flounders grow larger on Georges Bank, where many of 4-6 pounds are taken, and where they often are caught up to 7-8 pounds; we have handled one Georges Bank fish of 25 inches, weighing 8 pounds.

Remarks.—The winter flounder shows some tendency to break up into local races in the number of its fin rays,⁴⁴ in the size to which they grow, and perhaps in other characteristics.

The most interesting of these races, from the fisheries standpoint, is the population on Georges Bank, for the flounders tend to grow larger there than they do anywhere inshore. This fact was first brought to scientific attention in 1912, when some of these large flounders from Georges were received by the Bureau of Fisheries, to be made the basis of a new species, *Pseudopleuronectes dignabilis*, by Kendall.⁴⁵ Since that time this Georges Bank flounder has been accepted provisionally as a separate species, supposedly characterized by rather more numerous fin rays, by reddish color, and by a caudal peduncle yellow on the under side, as well as by large size. But our own comparison of specimens of the winter flounder group of various sizes, from Georges Bank, with others from the No Mans Land ground, from Nantucket Shoals, and from many localities, inshore, from Labrador to New York, leads us to conclude that it is simply a large, more rusty-brownish, local race of the winter flounder, for we find no definite regional discontinuity in the number of fin rays or of gill rakers, in the teeth, or in color (p. 277). The names "black-back" and "lemon sole," as used by fishermen, have no bearing on the case, for their choice of the one or of the other is based solely on the size of the fish in question (p. 282).⁴⁶

Habits.—Tide mark, high or low according to the stage of the tide, is the upper limit for this flounder. It runs up into brackish water in river mouths, and we have even caught them in the Susquehanna River, tributary to Chesapeake Bay, where the water was fresh enough to drink.⁴⁷

Its lower limit cannot be stated definitely. It is plentiful certainly at 10 to 20 fathoms in Cape

⁴¹ See Bumpus (American Naturalist, vol. 32, 1898, pp. 407-412) and especially Perlmutter (Bull. Bingham Oceanographic Coll., vol. 11, Art. 2, 1947, pp. 18-23) in this connection.

⁴² Bull. U. S. Bur. Fish., vol. 30, 1912, p. 391, pl. 57.

⁴³ Perlmutter has already emphasized this point in his detailed study of the blackback (Bull. Bingham Oceanogr. Coll., vol. 11, Art. 2, 1947, p. 18).

⁴⁴ Hildebrand and Schroeder, Bull. U. S. Bur. Fish., vol. 43, Pt. 1, 1928, p. 170.

⁴¹ Bull., U. S. Fish Comm., vol. 19, 1901, pp. 305-306.

⁴² Copeia 1952, p. 206.

⁴³ Zoologica, New York Zool. Soc., vol. 9, 1927, p. 180.

Cod Bay and on Stellwagen Bank, while the gill-netters sometimes take very large ones at about this same depth about Boon Island. According to general report, however, few, if any, are caught deeper than this in the inner parts of the Gulf except in the Bay of Fundy, where they are to be taken in winter on soft bottoms down to 30 to 50 fathoms. On Georges Bank they are taken mostly between 25 fathoms and 45 fathoms; 70 fathoms is the deepest definite record for them there of which we know. Usually the smaller fish live the shoalest and the larger ones deeper. But we have seen large flounders caught so often in only a few feet of water that no general rule can be laid down. The young fry are found chiefly in the shallows.

Most of those that are caught inshore are on muddy sand, especially where this is broken by patches of eelgrass. But winter flounders are common enough there on cleaner sand, on clay, and even on pebbly and gravelly ground. And the populations on the offshore banks are on hard bottom of one type or another. When they are on soft bottom they usually lie buried, all but the eyes, working themselves down into the mud almost instantly when they settle from swimming. And flounders that live on the flats usually lie motionless over the low tide to become more active on the flood, when they scatter in search of food. They keep near the bottom, and we have never heard of them coming up to the surface as the summer flounder so often does (p. 269). But though they spend most of their time lying motionless, they can dash for a few yards with astonishing rapidity, to snap up any luckless shrimp or other victim that comes within reach, or to snatch a bait, as any one may see, who will take the trouble to watch them on the flats on a calm day. It is in this manner that they usually feed, not by rooting in the sand. But flounders can sometimes be attracted by stirring the bottom with an oar when they are not biting, or by dragging anchor to bring up small animals from the mud, an old trick.

How close inshore they may come (how shoal) in any particular locality at any particular time depends largely on local conditions of temperature. Generally speaking, the summer temperature is low enough for their comfort close in to shore and up to within a few feet of the surface all around the open coast line of the Gulf, and among the

island passages, but the winter temperatures may be uncomfortably low for them in enclosed situations locally. In Passamaquoddy Bay, for instance, where the temperature of the water falls close to the freezing point in winter, those that are closest inshore in summer work out in winter unless the year is a very mild one. Others, however, that are living at 15 fathoms or so remain there the year around, while it is only in winter that they are known to descend as deep as 30 to 50 fathoms in the Bay of Fundy.⁴⁹

In shallow enclosed bays, however, or harbors, where extensive flats are heated by the sun at low tide in summer but are exposed to very severe chilling in winter, the flounders tend to desert the flats for the deeper channels during the heat of summer, work back again into shoal water in autumn, desert the ice-bound flats once more in winter, and then work up again in spring. Duxbury Bay is a case in point, also Barnstable Harbor, where we have speared many of them in spring, while wading on the flats.

A migration of flounders out into deeper water in the summer and back to shoal for the winter is generally characteristic south of New York, where the coastal waters are warmer, hence the common name "winter flounder." They are very scarce, for instance, in the bays of southern New Jersey in summer, but very plentiful there in winter. And many are caught in Chesapeake Bay from November to the first of June, but none are taken in shoal water there in summer or early autumn.

It has long been believed that the winter flounder is one of the most stationary of our fishes, apart from seasonal movements of the sorts just mentioned, and apart from a general tendency (recently emphasized by Perlmutter)⁵⁰ for the fry that are produced in bays and estuaries to work offshore as they grow older. This essentially stationary nature has been demonstrated recently by extensive marking experiments that have been carried out in Long Island Sound, along southern New England, and on the coast of Maine, for about 94 percent of the recaptures were made in the general areas where the fish had been tagged. Thus the population consists "of many independent localized stocks inhabiting the bays and estuaries along the coast" as Perlmutter words it,

⁴⁹ As proved by captures in shrimp trawls, as reported by Huntsman.

⁵⁰ Bull. Bingham Oceanogr. Coll., vol. 11, Art. 2, 1947, p. 17

with the fish merely tending to scatter "from population centers, a characteristic phenomenon with nonmigratory animals."⁵¹ But some of them may stray for considerable distances. Thus winter flounders tagged at Waquoit Bay, near Woods Hole, in 1931 were recovered off Chatham, on the outer coast of Cape Cod, and on Nantucket Shoals. The case of one that was tagged near Block Island on April 17, 1941, and was recaptured on the central part of Georges Bank (lat. 41°45' N., long. 67°06' W.) on August 27, 1945, is especially interesting,⁵² as showing that some interchange does take place between the inshore and offshore populations of adult fish.

The normal distribution of the winter flounder covers a wide range of temperature at one season or another, from a minimum close to the freezing point of salt water around Newfoundland, in Nova Scotian waters, in the Gulf of St. Lawrence, and in the shoaler parts of the Gulf of Maine in late winter, to a maximum of about 64°-66° F. in shallow water in the southwestern part of the Gulf in summer, and of perhaps about 68°-70° in the southern part of its range.

They sometimes perish by the thousands in very hot spells of summer weather, if they are trapped in shallow enclosed bays, as happened in Moriches Bay, Long Island, N. Y., in 1917, between July 29 and August 4, when the air temperature rose to 82°-89°, and the temperature of the water on the very shallow flats nearly as high, probably.⁵³ But we have never heard of this happening in the Gulf of Maine where cooler water is always close to hand. On the other hand, they may succumb to anchor ice in winter if they are overtaken in very shoal water in a severe freeze, for dead "flounders" of one sort or another are sometimes reported in such locations after unusually severe weather. And observations at Woods Hole have shown that freezing temperatures (say 30° to 29°) drive them down into slightly warmer water.

Experience at the Boothbay and Woods Hole hatcheries, combined with the results of the trawl fishery (p. 283), proves that those living a few fathoms down are as active in winter as they are in summer, both north and south of Cape Cod.

Bean, it is true, has described the winter flounder as going into "partial hibernation in the mud in winter,"⁵⁴ but (as Breder⁵⁵ has pointed out) the reason the hook-and-line fishermen cannot take them in late winter or early spring may simply be that they will not bite then, this being the spawning period when winter flounders fast, as so many other fishes do.

According to Sullivan⁵⁶ diatoms are the first food taken after the yolk of the larval flounder is absorbed. A little later they begin preying on the smaller Crustacea, and Sullivan invariably found isopods in the stomachs of fry that had just passed their metamorphosis. A series of young flounders 1 to 4½ inches long from Casco Bay were found by Welsh to have fed chiefly on isopod crustaceans, with lesser amounts of copepods, amphipods, crabs, and shrimps, which together formed 36 percent of the stomach contents; worms (39 percent); mollusks (2 percent); and various unidentifiable material (22 percent). Linton⁵⁷ who examined about 398 young flounders of various sizes at Woods Hole, likewise found them feeding chiefly on amphipods and on other small Crustacea, together with annelid worms. And his tables of stomach contents show an increase in the ratio of mollusks to Crustacea as the fish grow. The adult winter flounder, like the yellow-tail (p. 271), is limited by its small mouth to a diet of the smaller invertebrates and of fish fry. Sometimes they are full of shrimps, amphipods, small crabs, or other crustaceans; sometimes of ascidians, seaworms (*Nereis*), or other annelids; or of bivalve or univalve mollusks. Three hundred "seed" clams, for example, were found in an 11-inch flounder at St. Andrews, New Brunswick.⁵⁸ And it seems that they often bite off clam siphons that protude from the sand. They also eat squid, holothurians, and hydroids; occasionally they capture small fish; and they sometimes take bits of seaweed. Examination of the stomachs of adults taken at Woods Hole in February 1921 by Breder showed that they cease feeding when they are about to spawn.

In spite of its small mouth the winter flounder bites very readily on clams, pieces of seaworm, or

⁵¹ Bull. 60, New York State Mus., Zool., 9, 1903, p. 778.

⁵² Bull. U. S. Bur. Fish., vol. 38, 1923, p. 311.

⁵³ Trans. Amer. Fisheries Soc., vol. 44, 1914-15, No. 1, p. 135.

⁵⁴ App. 4, Report U. S. Comm. Fish. (1921) 1922, pp. 3-14.

⁵⁵ Fisheries Research Board of Canada, Progress Reports of the Atlantic Coast Stations, No. 52, January 1952, p. 3.

⁵¹ Perlmutter, Bull. Bingham Oceanogr. Coll., vol. 11, Art. 2, 1947, pp. 26, 27.
⁵² This specimen is on display at the Laboratory of the U. S. Fish and Wildlife Service at Woods Hole.

⁵³ This occurrence is described by Nichols (Copeia, No. 55, 1918, pp. 37-39), also by Nichols and Breder, Zoologica, N. Y. Zool. Soc., vol. 9, 1927, p. 70.

almost any other bait for that matter, provided the hook is small enough.

Breeding habits.—The winter flounder is a winter and early spring breeder, spawning from January to May (inclusive) in New England. The season is at its height during February and March south of Cape Cod and in the Massachusetts Bay region,⁵⁹ but it is somewhat later along the coast of Maine; near Boothbay spawning commences about March 1 and continues until about May 10 or 15 with the chief production of eggs usually taking place from March 30 to April 20, according to information supplied by Capt. E. E. Hahn, former superintendent of the Boothbay hatchery. Local differences of this sort in the spawning season are probably due to variations in the temperature of the water. After the severe winter of 1922–23, for example, when the vernal warming of the coastwise waters was slower than usual, Captain Hahn wrote us from Boothbay that “the fish were 10 to 15 days later in spawning than in any previous year, the first eggs being taken on March 24.” On Georges Bank spawning fish have been reported in April and into May.

Thus spawning is well under way inshore while the water is still near its coldest for the year; i. e., about 32° to 35° F. in the Woods Hole region, about 32° to 37° near Gloucester, and about 31° to 35° near Boothbay, according to precise locality and depth. And the major production of eggs takes place there before the water has warmed above about 38°, with about 40° to 42° as perhaps the maximum for any extensive spawning in the inner parts of our Gulf. The picture is not so clear for Georges Bank, for we do not yet know how early in the season flounders commence spawning there. Those that spawn on the Bank in April may do so in temperatures ranging from about 38° to perhaps 42°, depending on the year, on the precise date, and on the locality.

Winter flounders spawn on sandy bottom, often in water as shoal as 1 to 3 fathoms, but as deep as 25 to 40 fathoms on George Bank, and they do so throughout the range of the fish, including the Bay of Fundy, where Huntsman found its larvae common near the mouths of estuaries. Most of the eggs are produced in salinities from about 31 to 32.3 per mille in the inner parts of the Gulf, to somewhere between 32.7 and 33 per mille on Nan-

tucket Shoals and on Georges Bank. But those that spawn in estuaries are known to do so in brackish water, in salinities as low as 11.4 per mille near Woods Hole, for instance.

Individual females produce an average of about 500,000 eggs annually, and nearly 1,500,000 have been taken from a large one of 3½ pounds. They spawn at night, at least those did that were kept in the tanks at Woods Hole, where they seemed indifferent to the electric lights overhead. And Breder⁶⁰ describes the fish of both sexes as swimming in a circle, about one foot in diameter, clockwise so that the vent is outward, with the eggs from the females flowing back along the upper side of the anal fin and along the tail. After about 10 seconds of activity, they sink motionless to the bottom.

This species is peculiar among our local flatfishes in that its eggs are not buoyant but sink to the bottom, where they stick together in clusters, usually so closely massed that the individual eggs are forced into irregular outlines. They are 0.74 to 0.85 mm. in diameter, and newly shed eggs have no oil globule, but some of them (if not all) develop one as incubation proceeds.⁶¹ Incubation occupies 15 to 18 days at a temperature of 37° to 38° F., which is about what they encounter in nature. The young larvae, which are 3 to 3.5 mm. long at hatching, are marked by a broad vertical band of pigment cells that subdivides the post anal part of the body, a characteristic feature; and the end of the gut also is heavily pigmented. In water of about 39° the larva grows to 5 mm. in length, and the yolk is absorbed (fig. 142) in 12 to 14 days. The vertical fin rays begin to appear in 5 to 6 weeks after hatching, at a length of about 7 mm., and the left eye has moved upward by then until about half of it is visible above the dorsal outline of the head, while the whole left eye shows from the right side and the fins are fully formed in larvae of 8 mm. Metamorphosis continues rapidly.⁶² The left eye moves from this position to the right side of the head; the pigment fades from the blind side; the eyed side becomes uniformly pigmented; and the little fish now lies and swims with the blind side down, its metamorphosis complete when it is only 8 to 9 mm. long.

⁵⁹ Copela, No. 102, 1922, pp. 3–4.

⁶¹ Breder, Bull. U. S. Bur. Fish., vol. 38, 1923, fig. 274g.

⁶² Williams, Bull. Mus. Comp. Zool., vol. 40, 1902, No. 1, pp. 1–58, pls. 1–5. See also Sullivan (Trans. Amer. Fish. Soc., vol. 44, 1914–15, pp. 125–136, figs. 1–4) and Breder (Bull. U. S. Bur. Fish. vol. 38, 1923, p. 311).

⁶⁰ This species was propagated artificially at the Woods Hole, Gloucester, and Boothbay hatcheries in large numbers.

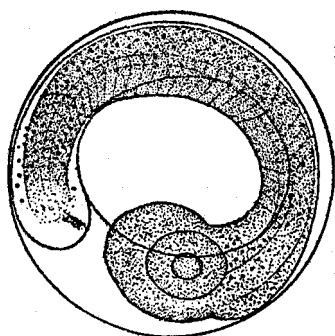


FIGURE 141.—Egg.

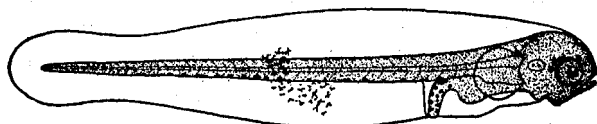


FIGURE 142.—Larva, 4.5 mm.

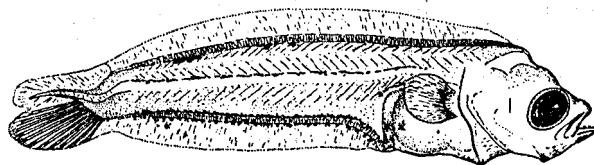


FIGURE 143.—Larva, 5 mm.

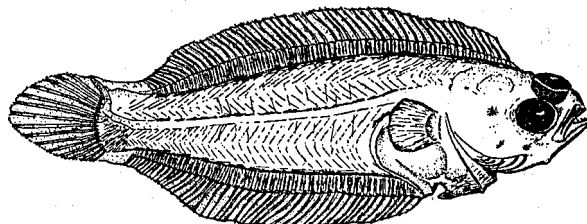


FIGURE 144.—Larva, 8 mm.

WINTER FLOUNDER (*Pseudopleuronectes americanus*.)

The youngest larval stages are made indistinguishable as winter flounders by the pigment bar just mentioned. After the fin rays appear their small mouth separates them from any of the large-mouthed flounders; their short, deep body, combined with the small number of fin rays, separates them from the witch; and the number of fin rays marks them off from the yellow tail (p. 273). The winter flounder also completes its metamorphosis at a smaller size than either of these other small-mouthed flatfishes (pp. 287 and 273).

The rate of development of the larvae is governed by temperature, occupying from about 2½ to about 3½ months, according to the data available, and the larvae that are hatched later may catch up with the earlier hatched ones before their metamorphosis takes place. Larvae in their later stages have been taken in abundance in the tow nets at Woods Hole. But their habits in aquaria suggest that they are less at the mercy of the tide and current than our other flatfishes are, for they have been described as alternately swimming upward and then sinking, to lie for a time on the bottom, instead of remaining constantly adrift near the surface, as the larvae of most of the flatfishes do at a corresponding stage in their development. At any rate, we have not taken any in our tows in the open Gulf⁶³ that were certainly identifiable as winter flounder.

Judging from a large series from Casco Bay, measured by Welsh, and from others seen by us off near Boothbay Harbor and at Mount Desert, the fry of the previous winter grow to an average length of 1½ to 3¼ inches by August, with an occasional specimen as long as 4 inches; they are 2 to 4 inches long by the end of September; and 4 to 6 inches long off southern New England in January and February, when nearing 1 year old, which probably applies north of Cape Cod as well. They may grow somewhat faster in more southern (warmer) waters, as in Chesapeake Bay, where fish of the year are 4¼ to 7 inches long in January and February.⁶⁴

Welsh also concluded, from measurements gathered from various sources, that the winter flounders are 5 to 7½ inches in length at 2 years of age, 7½ to 9½ inches at 3 years, and 9½ to 10 inches long when 4 years old, which accords with 8 to 10 inches at 2 to 3 years in New York waters as reported by Lobell⁶⁵ and by Perlmutter.⁶⁶ Probably they mature sexually at 3 years, for most of the spawners are upwards of 8 inches long. Our only information as to the rate of growth of older fish is that one tagged near Block Island, April 17, 1941, when it was 10¾ inches long, was 17 inches long when it was recaptured on Georges Bank, 4 years and 4 months later.

⁶³ Hildebrand and Schroeder, Bull. U. S. Bur. Fish., vol. 43, Pt. 1, 1928, p. 169.

⁶⁴ 28th Rept., New York Conserv. Dept. 1939, Sup., Pt. 1, p. 86.

⁶⁵ Bull. Bingham Oceanogr. Coll., vol. 11, Art. 2, 1947, p. 17.

⁶³ Three larvae taken in the Gulf in July 1912, were provisionally identified by Welsh as this species.

General range.—Atlantic coast of North America from the coast line out to the offshore fishing banks; common from the Strait of Belle Isle,⁶⁷ the north shore of the Gulf of St. Lawrence where it has been characterized as "all along the coast,"⁶⁸ and southern and southeastern Newfoundland to Chesapeake Bay; recorded from the southern part of the Grand Banks,⁶⁹ and as far north as Ungava Bay, northern Labrador;⁷⁰ and from as far south as North Carolina and Georgia.⁷¹

Occurrence in the Gulf of Maine.—This is the commonest shoal water flounder, and perhaps the most familiar of all the ground fishes of the Gulf of Maine. There is no bay or harbor from Cape Cod to Cape Sable, no inter-island passage, and no stretch of open coast where it is not to be caught, unless the bottom be too smooth and hard, except, perhaps in the very turbid waters at the head of the Bay of Fundy.

As one looks down at low tide from some pier where the water is clear enough, or from a boat, drifting over the flats, one is almost sure to see a flounder here and there, lying partly buried in the sand or mud. And they often come into water so shallow that it is easy to spear them. A flounder spear used to be almost as familiar an instrument along our coasts as an eel spear.

With most of the flounder population of the inner parts of the Gulf living shoaler than 30 fathoms (20 fathoms is the deepest we have caught one there, close in to Little Duck Island, off Mount Desert), the zone occupied by them around the coast north of the elbow of Cape Cod is hardly as much as 8 to 10 miles wide, measured from the outer headlands or islands, except for Stellwagen Bank which lies a few miles farther out, and off Cape Sable, where their outer-depth limit lies something like 15 miles offshore. But their range extends out along the offshore rim of the Gulf, in somewhat deeper water, to include the Nantucket Shoals region as a whole (they must be plentiful

to account for the 2 to 4 million pounds of blackbacks and lemon soles that are brought in from there yearly) and from the shoaler parts of Georges Bank.

The flounders on Georges run so much larger than they ordinarily do in-shore that they have been described as a separate species (p. 277). During the summer of 1913 these soles (as they are called now, if they weigh more than 3 pounds) constituted about 4 percent by number of all the fish of all kinds that were caught on Georges by the several otter trawlers that carried investigators from the Bureau of Fisheries. Nowadays most every otter trawling trip brings in anywhere from a few hundred to several thousand of them according to depth and precise location on the bank. About 4 million pounds of lemon soles (larger than 3 pounds) and blackbacks (smaller than 3 pounds) were brought in from Georges Bank as a whole in 1947.

They seem not to be so plentiful on Browns Bank, to judge from a catch of about 23,000 pounds of large sole and smaller blackbacks there by United States vessels in that same year. But much larger numbers are landed in the fishing ports along the outer coasts of Nova Scotia; about 420,000 pounds of flounders and soles combined, in 1946, the most recent year for which we have seen the Canadian Fisheries statistics.

Fluctuations in abundance.—Declining catches in the fyke nets that were used to take brood fish for the Booth Bay (Maine) hatchery leave no doubt that winter flounders were decidedly less abundant in that vicinity from 1934 to 1940 than they had been from 1925 to 1933. And some decrease in their abundance during the same period is indicated for the southern Cape Cod shore by the catch records of the Woods Hole hatchery; also along Connecticut and near New York, by the evidence of fishermen's logbooks.⁷²

Importance.—The winter flounder, whether blackbacks or lemon soles, is the thickest and meatiest of all the flatfishes smaller than the halibut that are common on our coasts eastward and northward from the elbow of Cape Cod.

In 1946 (most recent year when statistics are available for the Canadian catch as well as for the United States catch), the inner parts of the Gulf, from the tip of Cape Cod around to Cape Sable,

⁶⁷ Jeffers (Contrib. Canadian Biol., N. ser., vol. 7, No. 16, ser. A, General, No. 13, 1932, p. 210) reports it as not uncommon at Raleigh, on the Newfoundland side of the Strait.

⁶⁸ Stearns, Proc. U. S. Nat. Mus., vol. 6, 1883, p. 125.

⁶⁹ At 2 stations, see Rept. Newfoundland Fish. Res. Lab., vol. 2, No. 3, 1938, p. 79.

⁷⁰ Reported from Fort Chimo, Labrador by Kendall (Proc. Portland Soc. Nat. Hist., vol. 2, Pt. 8, 1909, pp. 225, 233); specimen in U. S. Nat. Museum, collected in 1882 or 1883 by L. M. Turner and identified by T. H. Bean.

⁷¹ Reported from Beaufort, N. C. (by Yarrow, Proc. Acad. Nat. Sci., Philadelphia, vol. 29, 1877, p. 205); from the Neuse River, near New Bern, N. C. (by Smith, North Carolina Geol. and Econ. Surv., vol. 2, 1907, p. 390); and from Georgia (by Hildebrand and Schroeder, Bull. U. S. Bur. Fish., vol. 43, Pt. 1, 1923, p. 170).

⁷² For details, see Perlmutter, Bull. Bingham Oceanogr. Coll., vol. 11, Art. 2, 1947, pp. 6-13, who has made a special study of the blackback.

yielded not far from 4 million pounds of flounders smaller than 3 pounds (blackbacks) to New England fishermen,⁷³ and about 49,000 pounds of fish heavier than 3 pounds (lemon sole). Nantucket Shoals, and the neighboring side of the so-called South Channel yielded about 5 million pounds of blackbacks and 1 million of soles; Georges Bank⁷⁴ about 3 million pounds of the larger soles and about 600,000 pounds of the smaller blackbacks.

In addition to all this, Canadian fishermen caught some 4,400 pounds of flounders at the mouth of the Bay of Fundy on the New Brunswick side, 16,200 pounds of "flounders and soles" on the Nova Scotian side of the Bay, and 82,000 pounds off the west coast of Nova Scotia.

Our Gulf as a whole thus yielded something like 14 million pounds of winter flounders, large and small, in the year in question, which seems to have been a representative one.

Most of the commercial catch is made today by the otter trawlers, a small part on hook and line, or in nets of one sort or another. Years ago numbers were speared on the flats; as lately as 1919, about 7,000 pounds were reported as taken

⁷³ The amount cannot be stated any more precisely because of uncertainty as to how much of the 2½ million pounds of black backs reported that year from Cape Cod was caught off the Gulf of Maine coasts of the Cape, and how much off the south shore of Massachusetts.

⁷⁴ Including the statistical area classed as Eastern Side South Channel.

in this way on Cape Cod. But flounder spearing has gone out of fashion so completely of late that no flounders, only eels, are listed under the heading "spears" in the Massachusetts landings by gear for 1945 or for 1946.⁷⁵

Flounder fishing, too, for amusement and for home use goes on in harbors, estuaries, and other sheltered situations all around the shores of the Gulf, from bridges, piers, and small boats. And the number taken in this way must be very large (as well as very toothsome) provided the hook is not too large (Nos. 4 to 8 are best) and the bait is on bottom. Pieces of clam, of large snails, of sea worms (*Nereis*) or of squid, shrimp, and mussels, all are good. And they will take angle worms.

Smooth flounder *Liopsetta putnami* (Gill) 1864

SMOOTHBACK FLOUNDER; EELBACK; FOOLFISH;
CHRISTMAS FLOUNDER; PLAICE

Jordan and Evermann, 1896-1900, p. 2650.

Description.—This flatfish is right-handed (eyes on the right side) and small-mouthed like the winter flounder, yellow tail, and the witch. It resembles the winter flounder (with which it is often caught) closely in its general outline and in

⁷⁵ "Spears" are not included for 1947; only "harpoons," for larger game.

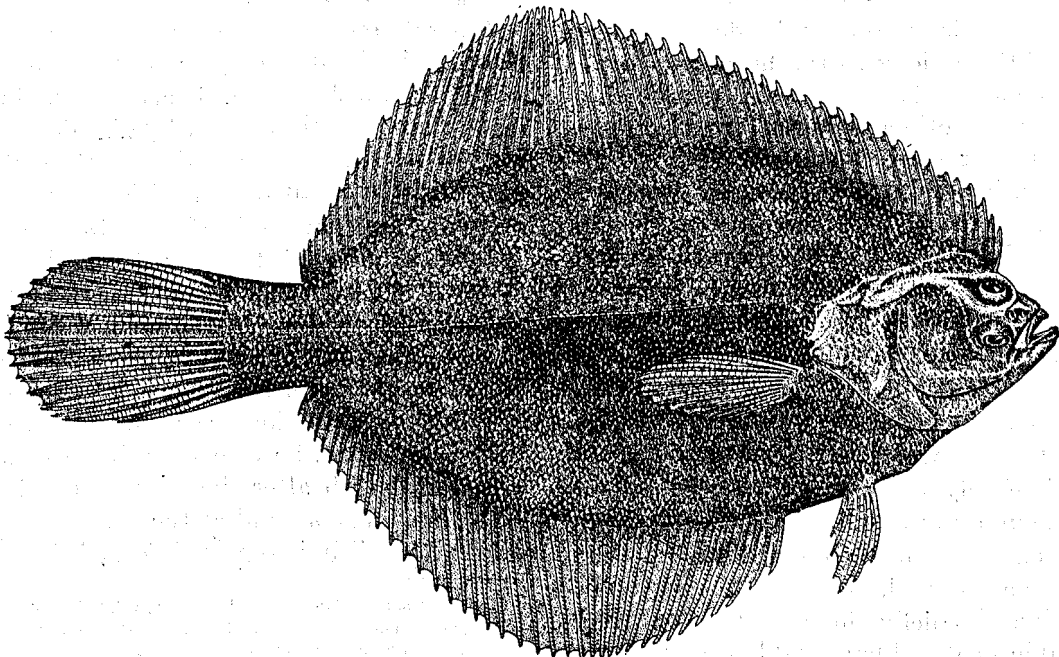


FIGURE 145.—Smooth flounder (*Liopsetta putnami*), Salem, Mass. From Goode. Drawing by H. L. Todd.

the considerable thickness of its body. But it is distinguishable from the winter flounder by the fact that the skin of its head between the eyes is smooth and scaleless. Females are more easily recognized than males, their bodies also being smooth to the touch on both sides; males are nearly as rough skinned on the eyed side (except between the eyes) as the winter flounder, but they have much longer pectoral fins than the latter. Both sexes have fewer anal fin rays (only 35 to 40) and dorsal fin rays (about 56), too, while the caudal fin of the smooth flounder is narrower and more rounded than that of the winter flounder.

The smooth flounder can always be separated from the yellowtail by the facts that its very prominent lateral line is straight, not arched, that the dorsal (left) profile of its head is straight, not concave; and that it has fewer fin rays. It has little more than half as many dorsal and anal rays as the witch, and its long fins are highest midway of the body and tapering toward the head and tail, whereas they are nearly uniform in height from end to end in the witch. It lacks the mucous pits that are so characteristic of the blind side of the head of the latter, a convenient field mark for separating these two species.

The smooth flounder is peculiar among our local flatfishes for its sexual dimorphism. Besides the difference in the scales of the two sexes noted above, the pectorals on the eyed side are longer (about four-fifths as long as the head) and more pointed on the males than they are on the females.

Color.—The smoothback varies from grayish to dark muddy or slaty brown above, or to almost black, either uniform or variously mottled with a darker shade of the same tint; the dorsal, anal, and caudal fins are of the general ground color. These fins were mottled darker or paler, in specimens we have examined, but Storer described them as black spotted. The blind side is white.

Size.—This is the smallest flatfish that is common in the Gulf of Maine, for it grows to a maximum length of only about a foot, and to a weight of about a pound and a half.

Habits.—This flatfish is confined to the close vicinity of the coast throughout its geographic range, occurring chiefly in estuaries or river mouths, and in sheltered bays and harbors; mostly on soft mud bottom. Correspondingly, it is found

from tide line down to a maximum depth of perhaps 15 fathoms, with 2 to 5 fathoms as its zone of greatest abundance in our Gulf.

It prefers soft bottom to hard; so much so that a seine haul on soft mud yielded 23 smooth flounders to 4 winter flounders in St. Mary Bay, whereas another haul, only 100 yards or so distant, but on harder bottom, brought in only 3 smooth flounders to 189 winter flounders, as we learn from Dr. Huntsman's notes.

The shoal water habit of the smooth flounder exposes it to temperatures close to the freezing point of salt water in winter, and as high as 60° in summer, and perhaps higher temperatures still in some places. Little more is known of its life. But its small mouth suggests a diet similar to that of the winter flounder, and Kendall found that young fry 3 to 4 inches long from Casco Bay has been feeding chiefly on small crabs, shrimps, unidentified crustaceans, and polychaete worms.

Winter is its breeding season, females nearly ripe having been taken in Salem Harbor in December and spent fish at Bucksport, Maine, the first week in March, which corroborates fishermen's reports of more than half a century ago that it comes into Salem Harbor to breed at about Christmas time. It is not known whether the eggs sink or are buoyant, nor have its larvae been seen.

General range.—The smooth flounder is Arctic-boreal. It is definitely recorded from as far north as Ungava Bay, hence no doubt occurs along the Atlantic coast of Labrador; it is described as the most plentiful flatfish along the coasts of the Strait of Belle Isle at all seasons;⁷⁶ its young are common in Pistolet Bay on the Newfoundland side of the Strait in shallow sunwarmed pools,⁷⁷ and there are two specimens from the north shore of the Gulf of St. Lawrence in the Museum of Comparative Zoology (collected many years ago, labeled "Labrador").

Evidently it is widespread on the southern side of the Gulf of St. Lawrence, for it is the next most plentiful flatfish after the winter flounder on the Cape Breton shore and at the Magdalens, according to Cox;⁷⁸ it is reported from Prince Edward

⁷⁶ Jeffers (Contrib. Canadian Biol., N. Ser., vol. 7, No. 16 (Ser. A, No. 13) 1922, p. 210). There are specimens from St. Anthony's, northern Newfoundland, in the Museum of Comparative Zoology.

⁷⁷ Rept. Newfoundland Fishery Res. Comm., vol. 1, No. 4, 1932, p. 110.

⁷⁸ Contrib. Canadian Biol. (1918-1920), 1921 p. 113.

Island,⁷⁹ also from Trois Pistoles;⁸⁰ and it has been classed by Huntsman⁸¹ as characteristic of the estuarial transition from fresh to salt waters in the southern side of the Gulf of St. Lawrence generally. We find no record of it on the outer coast of Nova Scotia between Cape Breton and Cape Sable; but we suspect that it has been overlooked there, for it is widespread in the Gulf of Maine to Massachusetts Bay, as detailed below, and has been reported as a stray as far south as Providence, R. I.

Its range probably is continuous in the north with that of its polar relative (*L. glacialis*) of the Arctic coasts of North America and Siberia. Indeed, it is a question whether any valid distinction can be drawn between the two species.

Occurrence in the Gulf of Maine.—The smooth flounder is to be found in estuaries, river mouths and harbors, all along the shores of the Gulf, from the Bay of Fundy to the northern side of Massachusetts Bay. Localities whence it has been recorded in print, or has been definitely reported otherwise, are Annapolis basin, Minas Channel and St. Mary Bay; Grand Manan; Bucksport at the mouth of the Penobscot River; Belfast in Penobscot Bay; Casco Bay; Portland; Salem Harbor; and Boston Harbor. Apparently the latter is the southern limit to its regular occurrence for while there is a specimen in the Museum of Comparative Zoology, from Provincetown at the tip of Cape Cod, it seems to be unknown in Cape Cod Bay, along the outer shore of Cape Cod, or in the Woods Hole region, though a stray individual has been caught at Providence, R. I.⁸²

This flatfish (often confounded with the winter flounder) has been found so often in various markets among the winter flounders as to suggest that it is more plentiful along the coasts of northern New England, than is realized, generally.

In Casco Bay and in estuaries of the Bay of Fundy such as the mouths of the St. Croix and Annapolis Rivers it is abundant in summer, which no doubt applies equally to the intervening coast line. But it is said to run up into harbors in Massachusetts Bay in autumn and winter only;⁸³

nor would such a local difference be astonishing in the case of a cold-water fish, which might well be driven out into slightly deeper water by summer heat in the southern and western parts of the Gulf, but not in the northern and eastern parts.

Commercial importance.—This is an excellent table fish for its size, sweet-meated and thick-bodied like the winter flounder. But it is neither large enough, plentiful, nor widely enough distributed in the open Gulf to be of any commercial importance.

Witch flounder *Glyptocephalus cynoglossus* (Linnaeus) 1758

GRAY SOLE; CRAIG FLUKE; POLE FLOUNDER

Jordan and Evermann, 1896-1900, p. 2657.

Description.—The witch or "gray sole" as it is now named in the United States fishery statistics, is right-handed (viscera on the right hand as the fish lies) and small-mouthed like the winter flounder, the smooth flounder and the yellowtail. But there is little danger of confusing it with any of these for its fin rays are much more numerous, its body narrower relatively, its head much smaller, and the open mucous pits on the blind side of its head large and conspicuous. It is two and one-half to three times as long as it is broad (deep, in reality), elliptical in outline, very thin but with its head occupying only about one-fifth of the total body length, and it has a very small mouth. The dorsal (left-hand) profile of its head is convex. It has 100 to 115 dorsal fin rays and 87 to 100 anal rays, and the anal fin is preceded by a short, sharp spine pointing forward, which is a prolongation of the post-abdominal bone. The two long fins are of about uniform width throughout most of their lengths, except that they narrow gradually toward head and tail. The pectoral fins and the ventral fins are alike on the two sides, or nearly so, while the caudal fin is much smaller, relatively, than that of the yellowtail, of the winter flounder, or of the smooth flounder, though similarly rounded in rear outline.

The lateral line is straight, as a rule, but it is somewhat arched abreast the pectoral fin in some specimens. The teeth are small, incisorlike, and in a single series. There are about 12 open mucous pits or depressions on the blind side of the head, and less obvious ones on the eyed side also. The whole body and head (except for the tip of the

⁷⁹ Cornish, Contrib. Canadian Biol. (1906-1910) 1912, p. 81.

⁸⁰ Vladykov and Tromblay, Nat. Canad., vol. 62 (Ser. 3, vol. 6), 1935, p. 82; (many specimens reported).

⁸¹ Trans. Roy. Soc. Canada, Ser. 3, vol. 12, Sect. 4, 1918, p. 63.

⁸² This specimen, formerly in the Museum of Comparative Zoology, is no longer to be found.

⁸³ Our experience corroborates this to the extent that we have never seen it there in summer.

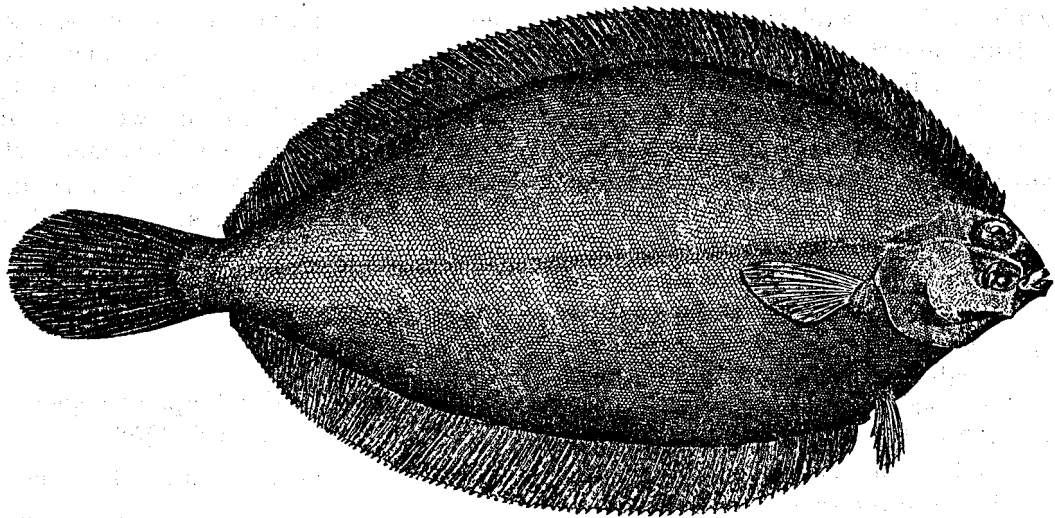


FIGURE 146.—Witch flounder (*Glyptocephalus cynoglossus*). From Goode. Drawing by H. L. Todd.

snout and the lower jaw) are scaly, but the scales are smooth to the touch, which make the witch as slippery to hold as a female smooth flounder (p. 284).

Color.—By all accounts (and the fish we have seen are in line with this) the witch is less variable in color than most of the flatfishes. Most of them are brownish or russet gray on the eyed side, either uniform or with darker transverse bars, with the vertical fins of the general body hue, tinted or tinged with violet, and either plain or spotted. The pectoral fin membrane on the eyed side is dusky or even black, a feature distinctive of this particular flatfish. The lower (blind) side is white, and more or less dotted with minute dark points. An occasional fish is colored on the under side as well as on the upper side; one of this sort, 19 inches long, was landed at the Boston Fish Pier early in March 1931.

Size.—The maximum length is about 25 inches, and fish of 23 or 24 inches, weighing about 4 pounds, are not uncommon. But the general run of those caught are only about 12 to 20 inches long.

Habits.—The witch flounder is rather a deep-water fish, seldom caught shoaler than 10 or 15 fathoms once it has taken to bottom, though taken occasionally close inshore (see footnote, p. 288). Off the American coast the best catches are made between about 60 fathoms and about 150 fathoms. Thus the *Albatross III* caught an average of about 57 witch flounders per trawl haul at 100 to 150 fathoms on the southwestern part of Georges Bank in mid-May 1950. but an average

of only about one fish per haul between 31 fathoms and 80 fathoms. And they have been trawled widespread down the continental slope as deep as 858 fathoms off southern Nova Scotia; to 732 fathoms off Marthas Vineyard; to 788 fathoms off Chesapeake Bay; and to 602 fathoms off North Carolina.⁸⁴

In Swedish waters, according to Melander,⁸⁵ the best catches are made between 80 and 140 fathoms.

They are caught most abundantly on fine muddy sand, on clay, or even on mud. They are said to frequent hard reefs in Scandinavian waters, but this does not seem to be the case in the Gulf of Maine, though they are common there on the smooth ground between rocky patches.

When the witch has once taken to the bottom it seems to be even more stationary in our gulf than some other flounders, for it is caught the year round, with no evidence that it moves in or off shore with the change of the seasons. In Swedish waters, however, it is said to work up into shoaler water in autumn, and deeper again in late winter and spring.⁸⁶

It occurs in the Gulf of Maine in temperatures ranging from about 35°–38° F. (late winter and early spring), to 45°–48° (late summer and early autumn), according to precise locality and depth. In the Gulf of St. Lawrence it occurs in the icy

⁸⁴ Goode and Bean (Smithsonian Contr. Knowl., vol. 30, 1895, p. 433) give a long list of deep-water stations for the witch off southern New England.

⁸⁵ Pub. de Circonstance No. 85, Cons. Internat. Explor. Mer, 1925, p. 3.

⁸⁶ Melander, Pub. de Circonstance, Cons. Internat. Explor. Mer. No. 95, 1925, p. 3.

cold waters (30°–32°) on the banks as well as in the higher temperatures (40°–42°) of the deep channels.⁸⁷ Apparently it is never found in any numbers in water warmer than 50°, but we hesitate to propose high temperature as the factor barring it from shoal water because there is no evidence that it works inshore in our gulf in winter when this bar would not operate.

Food.—It feeds on invertebrates, like other small-mouthed flatfishes; European experience points to small crustaceans, starfish, small mollusks, and worms, as its chief diet.⁸⁸ It is not known to eat fish and does not take a bait often.

Breeding as it does through a long season, over many degrees of latitude, and in both sides of the Atlantic, the witch spawns in temperatures ranging from close to the freezing point of salt water up to 48°–50° F. (p. 288). And experiments, added to captures of eggs naturally spawned, and of newly hatched larvae, have shown that incubation proceeds normally in water at least as cold as 45°–46° F., and as warm as 50°–55° F.

The eggs are buoyant, spherical, transparent, with narrow perivitelline space (the perivitelline space is broad in the eggs of the dab or Canadian plaice, which overlap them in dimensions), without oil globule, and 1.07 to 1.25 mm. in diameter. As noted (pp. 288 and 203), there is danger of confusing

⁸⁷ According to Huntsman, Trans. Roy. Soc. Canada, Ser. 3, vol. 12, Sect. 4, 1918, p. 63.

⁸⁸ No witch-flounder stomachs have been examined in the Gulf of Maine, so far as we know.

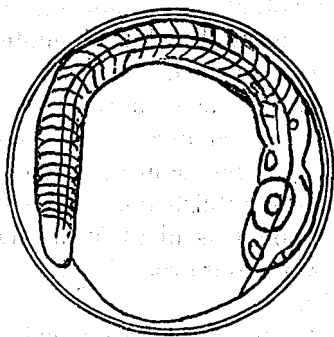


FIGURE 147.—Egg (European). After Cunningham.

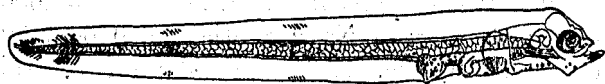


FIGURE 148.—Larva (European), 10 days old, 5.6 mm. After Holt.

newly spawned witch eggs with those of the cod and haddock; for they overlap these in size and in season. But identity is easily recognizable after a few days' incubation, for black pigment is to be seen in the gadoid eggs soon after the embryo is visible as such, but does not appear in the witch-flounder eggs until after hatching.

Incubation occupies 7 to 8 days at temperatures varying from 46° to 49° F., and the newly hatched larvae are about 4.9 mm. long, with a larger yolk sac than those of our other flatfishes. The yellow and black pigment becomes aggregated into five transverse bands on body, yolk (now much reduced in size), and fin folds within a few days after hatching, when the larva is 5 to 6 mm. long. One of these bands is at the region of the pectoral fin, one at the vent, and three of them on the trunk rearward from the vent. The yolk is entirely absorbed in about 10 days after hatching, the caudal rays have begun to appear at a length of 15 mm., the rays of the vertical fins are well advanced at 21 mm. and they are complete in their final number at about 30 mm. The eyes are still symmetrical, or nearly so, up to this stage. But the left eye has moved to the dorsal surface of the head in larvae of about 40 mm. And the migration of the eye is complete at a length of 40 to 50 mm., when the young fish takes to the bottom.

The witch is perhaps the most easily recognizable of Gulf of Maine flatfishes throughout its

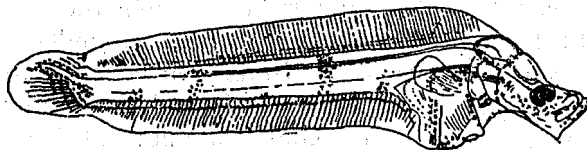


FIGURE 149.—Larva (European), 16 mm. After Kyle.

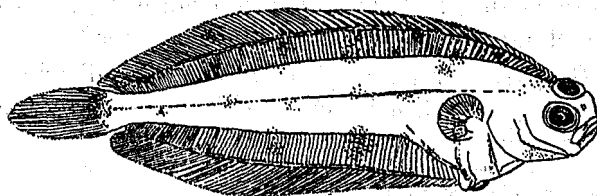


FIGURE 150.—Smallest bottom stage (European), 42 mm. After Petersen.

larval stage. The transverse pigment bars are diagnostic prior to the appearance of the caudal rays, while the curiously concave ventral profile of the throat region with the comparatively long slender trunk are equally so, thereafter. And the great number of dorsal and anal fin rays, coupled with the small mouth, make identification easy after the fins are formed. The witch also grows to a larger size before it completes its metamorphosis than does any other of the right-handed, small-mouthed flatfishes that are found in the Gulf of Maine.

Measurements of the young (American as well as European), suggest that the free-drifting stage may last as long as 4 to 6 months for the witch, which is much longer than for any of our other flatfishes.

Fry of $2\frac{1}{2}$ to $4\frac{1}{4}$ inches, and of $3\frac{1}{2}$ to $4\frac{1}{2}$ inches, such as we have trawled in July and August, respectively, probably are in their second summer, their sizes depending on how early in the season they were hatched the year before. The subsequent rate of growth has not been traced for American fish. If Molander's⁸⁹ estimate for European fish is correct, the size group centering at $6\frac{3}{4}$ to 8 inches that was prominent in our August catches of 1936 were in their third summer.⁹⁰ And subsequent growth is very slow.

General range.—Moderately deep water in both sides of the North Atlantic. Its European range is from northern Norway and Iceland south to the west coast of France. In American waters its free-drifting larvae are reported from as far north as the Strait of Belle Isle, around the coasts of Newfoundland, and over the Grand Banks region in general.⁹¹ The adult is known from the Gulf of St. Lawrence; the south coast of Newfoundland; the southern part of the Grand Banks; in Cabot Strait; along outer Nova Scotia and the Scotian Banks; throughout the Gulf of Maine; and thence westward and southward along the continental shelf and slope as far as the offing of northern Virginia (lat. $37^{\circ} 50' N.$) in moderate depths, to the offing of Cape Hatteras in deep water.⁹²

Occurrence in the Gulf of Maine.—The distribution of this flatfish in our Gulf is governed by the

fact that it is a fish of at least moderately deep water, seldom caught as shoal as 10 fathoms.⁹³ In fact, its very existence remained unsuspected by Massachusetts fishermen until 1877, when the United States Fish Commission caught numbers of them while trawling in the deeper parts of Massachusetts Bay. Since that time it has been reported (or we have trawled it, or both) from St. Mary Bay on the Scotian side of the Gulf; in the Bay of Fundy and its tributaries (where Huntsman describes it as taken very generally below 15 fathoms, if not in any great numbers); at Eastport; off Mount Desert, where we have trawled it as shallow as 10 fathoms; near Monhegan Island; off Seguin Island; off Cape Porpoise; near the Isles of Shoals (where Welsh saw a few taken from the gill nets set in about 25 fathoms in April 1913); in the deep trough to the westward of Jeffreys Ledge; in Ipswich Bay; near Gloucester; off Boston Harbor; at various localities in the deeper parts of Massachusetts Bay; and in both branches of the deep trough of the Gulf west and east down to a depth of 140 fathoms; in the deep channel, between Browns Bank and Georges Bank, and on the slope to the southeast.

Trawlers bring them in regularly from Browns Bank, also from Georges, where Welsh found them widespread, and from Nantucket Shoals.

This is enough to show that the witch is to be expected anywhere in our Gulf where the water is deeper than 15 to 20 fathoms, if the bottom is suitable.

The largest catches are made on the so-called South Channel grounds which include the slopes that lead down from the offing of Cape Cod on the one side and from Georges Bank on the other, into the southwestern part of the basin; farther north off eastern Massachusetts; and off western Maine. And the published statistics suggest that gray soles are about as plentiful as the American dabs are on the various grounds where the trawlers work regularly.

Reported landings of gray soles by New England vessels in 1947 were as follows for the several statistical areas:⁹⁴ Browns Bank, 44,000 pounds; off western Nova Scotia, 2,000 pounds; off eastern Maine, 17,000 pounds; off central

⁸⁹ Based on the structure of the otoliths; Pub. de Circonstance, No. 85, Cons. Perm. Internat. Explor. Mer. 1925, pp. 12-14.

⁹⁰ Bigelow and Schroeder, Biol. Bull., vol. 76, 1939, pp. 318-319.

⁹¹ See Frost, Res. Bull. No. 4, Newfoundland Dept. Nat. Resources, 1938, Chart 6, for Newfoundland localities.

⁹² Goode and Bean (Smithsonian Contrib. Knowl., vol. 30, 1895, p. 433) list it from lat. $34^{\circ} 39' N.$, 603 fathoms.

⁹³ A stray specimen, picked up in a pound net at Eastport, Maine, many years ago, was reported by Gill (Proc. Acad. Nat. Sci., Philadelphia, 1873, p. 360) as a new species, *Glyptocephalus acadianus*.

⁹⁴ To the nearest 1,000 pounds.

Maine, 12,000 pounds; off western Maine, 630,000 pounds; small grounds in west central part of Gulf, 77,000 pounds; off eastern Massachusetts, 582,000 pounds; South Channel grounds, east and west, 629,000 pounds; other parts of Georges Bank, 94,000 pounds; Nantucket Shoals region, 16,000 pounds.⁹⁵

More precise evidence as to their local numbers on suitable bottoms in the appropriate depths is that as much as 500 pounds have been taken in a 15- to 20-minute haul with a small beam trawl in Massachusetts Bay, and that we caught 48 of them in Ipswich Bay in 22 fathoms, in a short haul with an 8-foot beam trawl on July 16, 1912. We also saw 519 of them, 10 to 22 inches long, trawled on the southwestern part of Georges Banks by the *Eugene H.*, in 41 hauls at 26 to 65 fathoms in late June 1951, and learned that this dragger caught 9,000 pounds on the northeastern edge of Georges Bank, in 85 to 95 fathoms, October 12-18, 1951.

Neither the witch flounder nor the American dab is as plentiful as the yellowtail on good flounder bottoms, or the flatfishes of the winter flounder group (blackbacks plus lemon soles). And *Atlantis* took only 156 witch to 279 dabs on soft bottom at 90 to 103 fathoms during experimental trawling in the deeper parts of the Gulf in August 1936.

Gray soles are at least moderately plentiful off southern New England. The *Albatross III*, for example, took 90 there in one trawl haul at 101 to 150 fathoms in mid-May 1950, a few as shoal as 31 to 40 fathoms. And a few thousand pounds are landed yearly in New York and in New Jersey ports.⁹⁶ But records of the witch from farther south than New Jersey are of an occasional fish only.

Reported landings suggest that gray soles are about as plentiful all along the Nova Scotian banks as they are in the Gulf of Maine region. In 1947, for example, New England vessels landed about 555,000 pounds of them from the various grounds from the eastern part of Browns Bank to Banquereau, about half of which came from the Horseshoe ground between Halifax and Sable Island.⁹⁷ And they seem to be moderately plenti-

ful in the southern part of the Gulf of St. Lawrence, for Cox⁹⁸ wrote of many (large and small) as taken off the Cape Breton shore, and in Cabot Strait off Cape North. But no information is available as to their numbers elsewhere in the Gulf of St. Lawrence, or on the Grand Banks.

It seems that the witch does not breed successfully in the Bay of Fundy; at least its eggs have never been found there, nor have its larvae. But probably it does so in other parts of the Gulf in general, including the offshore Banks, though our only positive egg records for it have been off Penobscot Bay, and at the mouth of Massachusetts Bay. And there is no reason to doubt that the more northerly populations are equally self supporting, for the pelagic larvae have been taken at many localities on the more easterly of the Nova Scotian Banks; in the Gulf of St. Lawrence; over the Grand Banks; and along the south and east coasts of Newfoundland, by the Canadian Fisheries Expedition of 1915, and during the cruises of the Newfoundland Fishery Research Commission more recently.⁹⁹ But there is no evidence that the witch spawns to any extent to the west of Cape Cod.

Captures of eggs, certainly of this species, in our tow nets in July and August, with larvae up to 20 to 23 mm. long as early as the first week of July, but others as small as 9 to 10 mm. as late as mid-October, show that the witch is a late spring and summer spawner in the Gulf of Maine as it is in European waters also, with the peak of production probably falling in July and August. Thus its spawning season overlaps that of the haddock. (p. 207).

Its eggs are shed in the Gulf of Maine in temperatures ranging from 39° to 41° F. at the beginning of the season, to 43° to 48° in midsummer. But (being buoyant) the temperature may be considerably higher at the level where their development takes place than deeper down where the spawning fish lie. In fact, it is doubtful if any eggs develop in our Gulf in water as cold as 42° to 43°. Neither is there any reason to suppose that witch eggs develop in water any colder than this in the Gulf of St. Lawrence, or off Newfoundland, for the surface stratum to which they rise after

⁹⁵ An additional 182,000 pounds were landed in Cape Cod fishing ports, source not stated.

⁹⁶ About 19,000 pounds in New York in 1947, about 28,000 pounds in New Jersey.

⁹⁷ Only a few thousand pounds are reported yearly from Nova Scotia, in the Canadian fishery statistics.

⁹⁸ Contrib. Canad. Biol. (1918-1920) 1921, p. 113.

⁹⁹ See Frost, Research Bull. 4, Newfoundland Dept. Nat. Resources, 1938 Chart 6, for Newfoundland localities.

they are shed is comparatively warm (upward of 45°) in these seas also, during the spawning season.

At the other extreme, our captures of eggs and of newly hatched larvae near the surface in July prove that the latter may be hatched in the Gulf in water at least as warm as 50° to 55°. But the upper limit to normal development cannot be stated from the evidence yet in hand, for with a temperature gradient as steep as it is over most of the Gulf of Maine in summer a difference of only a few fathoms in the depth at which the eggs or young larvae are suspended may mean a difference of several degrees of temperature.

One result of the protracted spawning season, combined with the long period occupied by larval development, is that witch larvae of various sizes are to be taken in tow nets throughout the summer and early autumn, as appears from the following table of our catches on the *Grampus*.

Date	Number of larvae	Length in millimeters	Date	Number of larvae	Length in millimeters
July 7, 1915.....	109	8 to 23.5.	Aug. 15, 1912....	3	18.5 to 37.5.
July 8, 1913.....	19	8.5 to 21.5.	Aug. 24, 1912....	6	10 to 18.
July 9, 1913.....	1	14.	Aug. 25, 1914....	19	10 to 19.
July 19, 1916.....	100+	5 to 19.	Aug. 26, 1913....	2	8 and 14.
July 22, 1912.....	1	9.5.	Aug. 29, 1916....	100+	5 to 19.
July 24, 1912.....	2	8.5 and 16.5.	Aug. 31, 1912....	20+	9 to 16.5.
Aug. 5, 1913.....	27	5.5 to 12.5.	Sept. 29, 1915....	22	10 to 14.
Aug. 9, 1913.....	7	10 to 23.	Oct. 18, 1915....	1	9.5.
Aug. 14, 1912....	1	18.5.	Nov. 1, 1916....	20+	29.5 to 50.

All of these catches, like those for other larval flatfishes, and for larval gadoids, have been concentrated in the southwestern part of the Gulf, which must be an important nursery for the witch also. And we may note in passing that the presence of young fry at all stages from immediately after their metamorphosis (that is, 4 to 6 months old) in the Bay of Fundy, where few or none are hatched, points to an immigration of the late larvae, or of the youngest fry, into the Bay, either just before they take to the bottom or soon after they have done so.

Importance.—The witch was of no commercial importance in our Gulf a quarter of a century ago; few fishermen distinguished it from other flounders then, and no record was kept of the catch. It is an excellent table fish; and the bases of its fins are provided with astonishingly large amounts of gelatinous fat for so thin a flounder, of the sort for which the European turbot is famed.

It is now in such demand that it brings about as high a price as either the yellowtail or the American

dab. In 1947, for instance, the average price at Massachusetts ports was about 7 cents for gray sole, about 8 cents for yellowtail, about 7 cents for dab, about 9 to 12 cents, according to size, for flatfish of the winter-flounder type (blackbacks and lemon sole), about 17 cents for summer flounders (fluke), and about 25 cents for halibut. The Gulf yielded between 2 million and 2½ million pounds of gray sole both in 1946 and in 1947, corresponding to something like 1 to 1½ million individual fish.

The otter trawl is the only gear now in use in our waters that is adapted to the capture of witch flounders on a commercial scale. They live too deep, and their mouths are too small for them to be of any concern to small-boat fishermen.

Sand flounder *Lophopsetta maculata* (Mitchill) 1814

WINDOWPANE; SPOTTED FLOUNDER; NEW YORK
PLAICE; SAND DAB; SPOTTED TURBOT

Jordan and Evermann, 1896-1900, p. 2660.

Description.—This is the closest North American relative of the European turbot and brill. It is left-handed (eyes and viscera at the left-hand side) and large-mouthed, like the summer and four-spotted flounders, but it is readily separable from both of these by the outlines of its ventral fins. In all other Gulf of Maine flatfish (except for the hogchoker, p. 296) these are narrow at the base and widen toward the tip, but the ventrals of the sand flounder are as wide at the base as they are at the tip, each simulating a detached segment of the anal fin. Furthermore the two ventral fins are not alike either in location or in size, the left-hand (upper) fin, which is the longer of the pair, being practically a continuation of the anal fin so far as its appearance goes, whereas the right-hand (lower) ventral fin is situated a short distance up the right-hand side of the throat. The general appearance of the dorsal fin is no less diagnostic, for its first 10 or 12 rays are not only free from the fin membrane along the outer half of their lengths, but they are branched toward their tips, so that they form a conspicuous fringe which is without parallel among Gulf of Maine flatfishes. Furthermore, the sand flounder is more nearly round in outline than any of our other local flatfishes (it is only about one and one-half times as long as it is

broad), and so thin through that its body is translucent when it is held up against the light. Its pectoral fins, too, are longer than in our other left-handed flatfishes; its caudal fin is more rounded; and its teeth smaller although the gape of the mouth is wide.

The dorsal (right) fin (63 to 69 rays) tapers toward the tail; the anal (left) fin (46 to 52 rays) tapers toward head and tail, while both of these fins are noticeably thick and fleshy at the base; and there is no free anal spine. The pectoral fin on the eyed side is longer and more pointed than its mate on the blind side; the scales are smooth to the touch; and the lateral line is bowed abreast of the pectoral fin.

Color.—The sand flounder varies less in color than most shoal-water flatfishes do, the general ground tint of its eyed side (both as described by previous authors and in those we have seen) being of a pale and rather translucent greenish olive or slightly reddish or light slaty brown more or less mottled with darker and paler, and usually (if not always) dotted with many small brown spots of irregular shapes. Some fish are also marked on the body and on the bases of the dorsal, anal, and caudal fins with white spots that vary in number

and in size from fish to fish. But others lack these spots. The dorsal, anal, and caudal fins are of the general body tint, more or less mottled with darker, while the pectoral of the eyed side is dark crossbarred or speckled. The blind side is white in most of them, but specimens have been seen on which it was irregularly dark-blotched.¹

Size.—The sand flounder is said to grow to a maximum length of 18 inches and to a weight of 2 pounds. But the largest we have seen (from Waquoit on the southern shore of Massachusetts), were about 15 inches long. And adult fish run only about 10 or 11 to 12 inches in length. Sand flounders from southern New England measured by Moore² averaged about $\frac{1}{4}$ pound at 8 inches; about $\frac{1}{2}$ pound at 10 inches; about $\frac{3}{4}$ pound at 12 inches; and a little more than 1 pound at 14 inches.

Habits.—The sand flounder is a shoal-water fish. Its upper limit is close below the tide mark, and the 20 to 25 fathom line probably marks its lower limit, in general, in the coastal zone north of Cape Cod. But Moore reports it as occurring regularly down to 27 fathoms off Connecticut, and

¹ Moore, Bull. Bingham Oceanogr. Coll., vol. 11, art. 3, 1947, p. 20.

² Bull. Bingham Oceanogr. Coll., vol. 11, art. 3, 1947, p. 53, fig. 12.

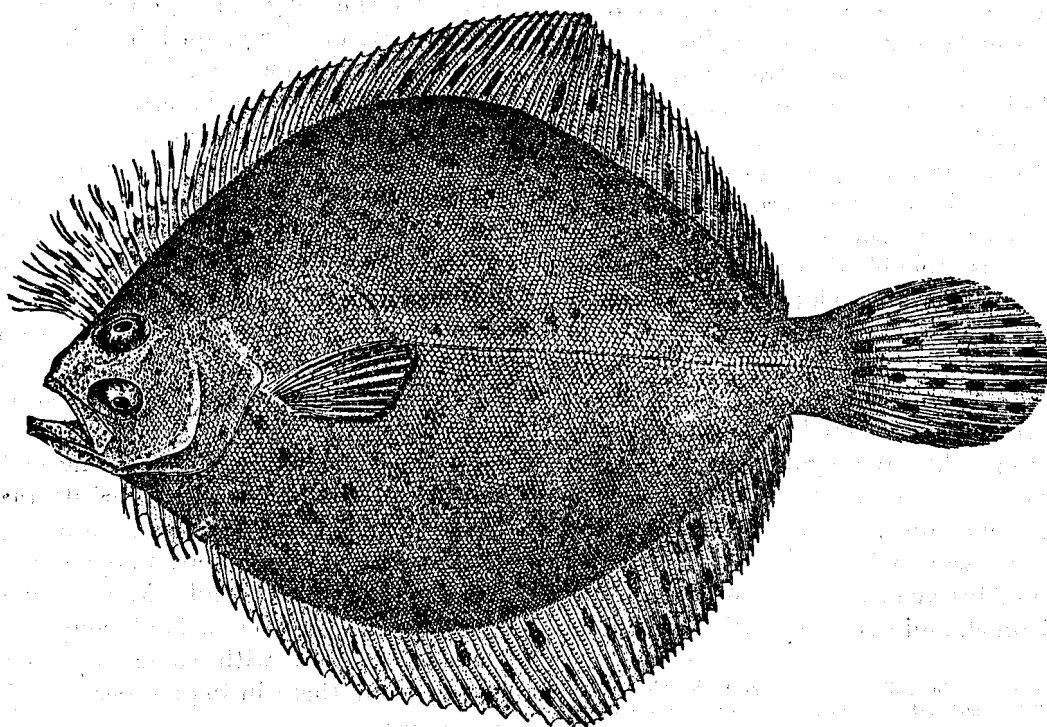


FIGURE 151.—Sand flounder (*Lophopsetta maculata*). From Jordan and Evermann. Drawing by H. L. Todd.

Welsh saw it taken on Georges Bank down to 30 or 40 fathoms, while the *Albatross III* trawled a few on the southwest part of the Bank along this same depth zone in May 1950.

It is caught chiefly on sand bottom off southern New England and southward, as its name implies, but its comparative abundance in Casco Bay and in Minas Channel shows that it also frequents softer and muddier grounds in the Gulf of Maine.

The sand flounder is a year-round resident off the southern New England coast, and probably this applies to it in the Gulf of Maine also, there being no evidence that the adults carry out any migrations inshore or offshore, with the change of the seasons. But such of the young fry as settle to bottom in shallow water inshore tend to work offshore as they grow, and deeper, while tagging experiments off southern New England have shown that individual sand flounders may wander along the coast for considerable distances, or across open water, much as winter flounders do (p. 279). Some of them went as far as 80 miles in 3 months.³ And it is probable that the wanderings of the adults play an important part in the intermingling of local populations.

The adult sand flounder is necessarily attuned to a wide temperature, occurring as it does over many degrees of latitude, and in shallow waters where it is exposed to the extremes of winter chilling and of summer warming. Such of them as winter in shoal bays experience winter temperatures close to the freezing point of salt water in winter, not only in the northern part of their range, but even as far south as the Connecticut shore.⁴ And it is probable that the entire population in the Gulf of Maine winter in water colder than 36° F. But these same fish summer in temperatures of 50° to 70°, according to locality and depth. And some sand flounders summer in still higher temperatures farther south. Nevertheless, it seems that temperature is the factor that governs the northerly range of the species and its local abundance, for it is only where the surface waters warm to 55° or higher in summer, as happens in Massachusetts Bay, in Casco Bay, in Minas Channel, and over the southern shallows

of the Gulf of St. Lawrence, that the sand flounder is able to maintain itself in any numbers. Apparently either its eggs or its young larvae, or both, fail to develop in lower temperatures (p. 293). And these isolated breeding centers are not productive enough to stock the intervening stretches of shoreline in the case of a fish as stationary as the sand flounder. Thus its distribution is somewhat analagous to that of the oyster.

The large mouth of the sand flounder suggests that it feeds on active prey. Welsh, in his field notes, remarked, in fact, that sand flounders caught off Atlantic City, N. J., were full of "schizopod shrimps" (mysids) and of these alone, and mysid shrimps (*Neomysis americana*) had similarly been the predominant item in all months of the year, for 654 Long Island Sound fish examined by Moore,⁵ with shrimps of other kinds ranking second. Moore also concluded that the few fishes included in their diet were not enough to class the sand flounder as a fish eater. But hake, herring, launce, and silversides have been found in their stomachs at Woods Hole, while North Carolina specimens had eaten fish, also crabs and shrimps.⁶ And we suspect that they seize small fish whenever they can, for we once hooked a sand flounder only about 12 inches long on a 2½-ounce metal jig, while we were casting for striped bass in the surf on Orleans Beach, Cape Cod.

A variety of small invertebrates other than shrimp have also been found in their stomachs; Vinal Edwards noted annelid worms, crabs, squid, small mollusks, ascidians and even seaweed, to which Moore adds gammarids and other small Crustacea, worm tubes, sea cucumbers (holothurians), glass worms (*Sagitta*), and sand. A larval sand flounder 11.5 mm. long examined by Moore⁷ contained minute copepods (*Temora* and *Centropages*) and amphipods (*Unciola* and *Leptocheirus*).

The sand flounder is a late spring and summer spawner in the northern part of its range; thus Welsh found them spawning late in June at Gloucester, and ripe fish are taken at Woods Hole in May and June, while Moore reports sand flounders ripe in Long Island Sound from early May to August, with some still incompletely spawned out there in September. And it seems

³ For details, see Moore's (Bull. Bingham Oceanogr. Coll., vol. 11, art. 3 1947, pp. 58-63) detailed study of the sand flounder in southern New England waters.

⁴ Warfel and Merriman (Bull. Bingham Oceanogr. Coll., vol. 9, art. 2, 1944, pp. 61-62) give details of temperature and salinity for Connecticut waters, with references.

⁵ Bull. Bingham Oceanogr. Coll., vol. 11, art. 3, 1947, pp. 54-58.

⁶ Smith, North Carolina Econ. Geol. Survey, vol. 2, 1897, p. 392.

⁷ Bull. Bingham Oceanogr. Coll., vol. 11, art. 3, 1947, pp. 26-27

that they commence spawning still earlier in the season to the westward and southward, for Nichols and Breder⁸ report young fry 20 mm. long in Sandy Hook Bay by May, while the sizes of the young fry taken in winter in Chesapeake Bay suggest that they are hatched there as early as March or April.⁹

It is not yet possible to state the extremes of temperature within which the sand flounder spawns. But 50° to 60° F. has proved favorable for hatching artificially fertilized eggs at Woods Hole, with even 70° not too warm for successful incubation. The eggs are spherical, transparent, buoyant, 1 to 2 mm. in diameter (measurements taken at Gloucester by Welsh), with a single colorless or pale-lemon oil globule of 0.15 to 0.28 mm. And the surface of the egg shows faint irregular markings. Incubation occupies about 8 days at 51°–56°; its duration has not been recorded for higher temperatures. The sand flounder, like the winter flounder, completes its metamorphosis while it is smaller than either the yellowtail (p. 273) or the witch (p. 287). Thus the dorsal and anal fin rays were complete and the ventral fins had formed in one only 8½ mm. long (fig. 153), and its right-hand eye had already moved around to the back-line of the head, while the migration of the eye is completed, and they are ready to take to bottom by the time they have grown to 10 mm. long.¹⁰

Rate of Growth.—It seems that the sand flounder passes through its larval stage more rapidly than most flatfishes do, for many of its fry with the migration of the eye completed have been taken at Woods Hole only 1 to 2 months after spawning commences there. One that was kept in an aquarium there by Williams¹¹ grew from 10 mm. to 22 mm. in length in 11 days; and Nichols and Breder's¹² observation that fry of the year in Sandy Hook Bay grew from an average length of about ¾-inch (to the base of the tail fin) in May, to about 2 to 2½ inches by late September, is in line with Tracy's statement¹³ that the fry are 2 to 3 inches long in July in Rhode Island waters, growing to

4 inches and upwards in December. Fry only 1 to 2 inches long reported by Nichols and Breder at Orient, N. Y., in December, seem to have been from a late-hatched brood.

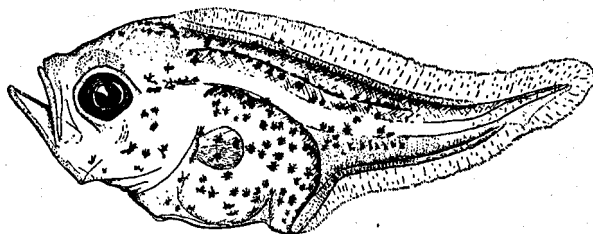


FIGURE 152.—Larva, 5.5 mm.

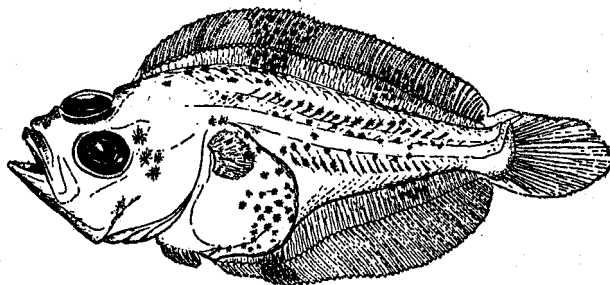


FIGURE 153.—Larva, 8 mm.

SAND FLOUNDER (*Lophopsetta maculata*).

Moore concludes, from her very detailed study of the growth zones on scales and otoliths, that sand flounders in Long Island Sound average about 4½ inches long when they are 2 years old (i. e., at the beginning of their third summer); about 7½ inches at 3 years; about 9 to 10 inches at 4 years; about 11 inches at 5 years; about 11½ inches at 6 years; and about 12 inches at 7 years.¹⁴ And Gulf of Maine fish probably grow at about this same rate. They mature at 9 to 10 inches; i. e., in the third or fourth year, according to the foregoing schedule.

General range.—Coastal waters of eastern North America, from the Gulf of St. Lawrence to South Carolina; most abundant west and south of Cape Cod, north and east of which it is confined to favorable localities.

Occurrence in the Gulf of Maine.—This flounder is not common in the Gulf of Maine, except locally. Dr. W. C. Kendall found it at Monomoy; we have caught one (p. 292) on the outer shore of Cape Cod; Storer found it at Provincetown, where he saw a considerable number in shoal water; it is reported from North Truro; from Gloucester

⁸ Zoologica, New York Zool. Soc., vol. 9, 1927, pp. 181–182.

⁹ Hildebrand and Schroeder, Bull. U. S. Bur. Fish., vol. 43, Pt. 1, 1928, p. 172.

¹⁰ Williams (Bull. Mus. Comp. Zool., vol. 40, 1902, No. 2) has given a brief account of the anatomical changes that take place during the passage of the eye in the sand flounder, and a more detailed account for the winter flounder. For photographs of larvae and small fry, see Moore (Bull. Bingham Oceanogr. Coll., vol. 11, art. 3, 1947, fig. 3).

¹¹ Bull. Mus. Comp. Zool., vol. 40, 1902, p. 3.

¹² Zoologica, New York Zool. Soc., vol. 9, 1927, pp. 181–182.

¹³ Rept. 40, Comm. Inland Fish. Rhode Island, 1910, p. 166.

¹⁴ Bull. Bingham Oceanogr. Coll., vol. 11, art. 3, 1947, pp. 47–51.

Harbor, where a considerable number were collected in 1878 (Welsh found it there in 1916), and at Milk Island nearby. But we have not learned of it anywhere else in the Massachusetts Bay region, and it has never been recorded between Cape Ann and Cape Elizabeth, nor did Welsh see it taken there by the gill-netters during the spring of 1913. It has been reported repeatedly at several localities in Casco Bay, which seems to be a local center of abundance. But it cannot be common along the eastern Maine coast or on the New Brunswick side of the Bay of Fundy, for the only records from this stretch of coastline are from Bucksport, from Eastport, and from Passamaquoddy Bay where one was taken in 1880 and another in 1912. Minas Channel on the Scotian side seems to be a second center of abundance, like Casco Bay, for Leim found it common there.¹⁵ Huntsman reports it in St. Mary Bay also. But we have found no other record of it along the western coast of Nova Scotia.

Welsh saw it taken by the otter trawlers on Georges Bank in June 1913, and we have seen it there on four recent trawling trips, including about a dozen specimens trawled by the *Albatross III* on the southwest part of the bank and off Nantucket in 22 to 39 fathoms, in mid-May 1950, and 132 taken by the *Eugene H* in that same general region, in 36 hauls at 25 to 45 fathoms, in late June 1951. Beyond this, nothing is known of it on the offshore fishing grounds.

The evidence of the Gloucester specimens mentioned above proves that it breeds in the Massachusetts Bay region to some extent, while its local abundance suggests the same for Casco Bay, as does the capture of its larvae for Minas Channel. It may also breed at the heads of the warmer and shoaler bays between Casco Bay and Grand Manan. Seemingly it does not do so in any of the estuaries on the New Brunswick side of the Bay of Fundy for no larvae have ever been found in Passamaquoddy Bay, a fairly representative situation, probably because of low temperature. But we have no doubt that the local stocks in the Gulf of St. Lawrence (p. 294) are self-sustaining.

The sand flounder is much more plentiful west of Cape Cod than it is anywhere in the Gulf of Maine, southward at least to Chesapeake Bay, where it is very generally distributed in depths down to 25 fathoms, especially in the southern

part. And it is reported as common at Beaufort, N. C.¹⁶

The sand flounder is known only here and there to the eastward and northward of our Gulf. Its pelagic larvae have been reported on Middle Ground off Halifax and near Sable Island;¹⁷ a few adults have been taken in Chedabucto Bay, eastern Nova Scotia;¹⁸ Cox¹⁹ states that it is "by no means uncommon" around the Magdalen Islands, in the southern side of the Gulf of St. Lawrence, where Huntsman²⁰ classes it as characteristic of the warm surface stratum inshore; and it has been taken off Port-au-Port on the west coast of Newfoundland.²¹

Importance.—Sand flounders are so small and so thin bodied, and so few of them are caught in the Gulf of Maine that they are of no commercial importance there, nor likely to be. However, a market developed for them during the war years in New York, where a much larger supply was near at hand, culminating in landings of about 340,000 pounds in 1944, and about 360,000 pounds in 1945. But as Moore has pointed out,²² the demand fell off during 1945, as the war drew to its close. And now the sand flounder is a neglected fish again.

Gulf Stream flounder *Citharichthys arcifrons* Goode 1880

Jordan and Evermann, 1896-1900, p. 2683.

Description.—This little flatfish is left-handed (eyes on the left-hand side and viscera at the left-hand edge as the fish lies), with a wide mouth gaping back as far as the forward edge of the eye; with a nearly straight lateral line; and with both of its pectoral fins well developed, though the one on the eyed side is considerably larger than its mate on the blind side. Its left-hand ventral fin stands on the midline of the body, but the right-hand ventral fin is a short distance above it on the blind side, and while the two ventral fins are alike in females, the one on the blind side is much the

¹⁶ Smith, North Carolina Geol. and Econ. Survey, vol. 2, 1897, p. 392.

¹⁷ Report 1, No. 4, Newfoundland Fishery Res. Comm., 1932, p. 110.

¹⁸ Cornish, Contrib. Canadian Biol., (1902-1905) 1607, p. 90.

¹⁹ Contrib. Canadian Biol., (1918-1920) 1921, p. 113.

²⁰ Trans. Roy. Soc. Canada, Ser. 3, vol. 12, Sect. 4, 1918, p. 63.

²¹ Rept., Newfoundland Fish. Res. Comm., vol. 2, No. 1, 1933, p. 127.

²² See Moore (Bull. Bingham Oceanogr. Coll., vol. 11, art. 3, 1947, p. 71) for detailed tabulation of the New York landings, 1943-1945, from the Daily Market News Service, Division of Fishery Industries, U. S. Fish and Wildlife Service. The sand flounder is not included in the general fisheries statistics published yearly by the Fish and Wildlife Service.

¹⁵ Huntsman, Contrib. Canadian Biol. (1921), No. 2, 1922, p. 70.

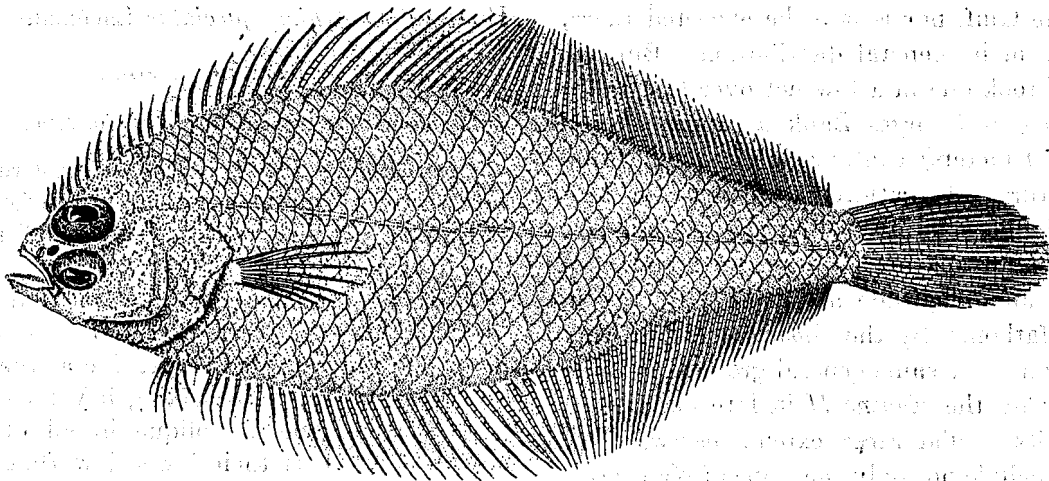


FIGURE 154.—Gulf Stream flounder (*Citharichthys arcifrons*), off Rhode Island. From Goode and Bean. Drawing by H. L. Todd.

longer of the pair in males. The body is ovate in outline and very thin. The long (ventral and dorsal) fins are of moderate breadth, with the dorsal fin (78 to 83 rays) originating over the forward margin of the eye, the anal (left-hand edge) fin (61 to 67 rays) originating a little in advance of the pectorals; and the caudal fin rounded. The scales are so large that there are only about 40 rows of them along the lateral line.

Fish living at different depths vary so widely in the number of fin rays that future studies may reveal the existence of distinct races, if not of species.²³

Color.—Light brown above, with the scales usually more or less outlined with darker brown; brownish white below.

Size.—Maximum length about 7 inches.

Remarks.—This little flatfish parallels the summer, four-spotted, and sand flounders (the latter

its closest Gulf of Maine ally) in its left-handedness. But it is distinguishable from all of these by its nearly straight lateral line; by the great disparity in size between its two pectoral fins; and by its very large scales. Its narrow shape and the fact that none of its dorsal fin rays are branched are further points of distinction between it and the sand flounder; also it is much smaller at maturity than any of the flatfishes that are common in the inner parts of the Gulf of Maine.

Habits.—Little is known of its habits. It is found chiefly in water deeper than 40 fathoms, but it has been trawled as shoal as 12 fathoms. Apparently it spawns from spring through summer, for we have found females with well-developed ovaries in February, while Goode had ripe ones in September. It is not large enough to be of commercial value, but we can witness that it is excellent on the table.

General range.—Eastern coast of America, along the outer part of the continental shelf from the southwestern part of Georges Bank to the offing of Charleston, S. C., where the *Blake* took it many years ago,²⁴ usually at depths of 40 to 200 fathoms, but occasionally as shoal as 12 to 18 fathoms.

A fish occupying this geographic province is misnamed when it is called "Gulf Stream," but this is the only English name by which it has been known.

Occurrence in the Gulf of Maine.—This little flatfish has never been reported from the inner

²³ A second species of this genus (*C. unicornis* Goode 1880) may be expected on the outer slope of Georges Bank in depths of 100 fathoms and more, since it has been taken off Marthas Vineyard in 115 to 150 fathoms. The male is separable from *C. arcifrons* by the fact that there are several short spines on the eyed side of the head above the upper lip (the head of *arcifrons* is spineless although old fish may have a bony protuberance on the snout). Further points of distinction are that *unicornis* has fewer fin rays (only about 74 to 77 dorsal rays and 60 anal rays) and that its body is broader (actually higher) Parr (Bulletin of the Bingham Oceanographic Collection, vol. 4, art. 1, 1931) has published a revision of the genus *Citharichthys* of the western Atlantic.

We have towed the pelagic larvae of still a third small deep-water flounder (*Monolepis sessilicauda* Goode 1880) off the seaward slope of Georges Bank (Bull. Mus. Comp. Zool., vol. 41, No. 8, 1917, p. 277), while the adults have been trawled in depths of 100 fathoms and more off Marthas Vineyard and thence westward and southward along the continental slope. It is left-handed like the summer, four-spotted, and sand flounders, with arched lateral line, but it has no pectoral fin on the blind side. For a detailed description of it see Goode and Bean, Smithsonian Contrib. Knowl., vol. 30, 1895, p. 452).

²⁴ Goode and Bean (Smithsonian Contrib. Knowl., vol. 30, 1895, pp. 443-444) give a long list of localities where it has been trawled, along the continental shelf from the offing of Nantucket to the offing of Charleston, S. C.

parts of the Gulf, nor is it to be expected there, to judge from its general distribution. But the *Albatross I* took one in a tow net over the southwestern part of Georges Bank at about the 82 fathom (150 meters) contour line.²⁵ And subsequent captures of scattered specimens in that general neighborhood in 1931 by the *Albatross II*; at 8 stations (30 specimens) between the offing of Nantucket and longitude about 67° 10' W., in 41 to 150 fathoms, by the *Albatross III* in May 1950; and on those same general grounds in 39 to 65 fathoms by the *Eugene H* in late June 1951, show that its regular range extends eastward far enough to include not only the slope of Nantucket Shoals, but the southwestern sector of Georges Bank arc as well, at the appropriate depth. And it must be considerably more plentiful on the outer part of the shelf off southern New England, for the *Albatross III* has trawled a considerable number of them there, including one catch of 100 off Montauk Point, in February 1950, and another of as many more off Rhode Island on May 13, 1950, at 41 to 50 fathoms.

²⁵ Station 20045, lat. 40° 18' N., long. 68° 09' W., February 22, 1920.

Hogchoker *Achirus fasciatus* Lacépède, 1803

AMERICAN SOLE

Jordan and Evermann, 1896-1900, p. 2700.

Description.—This fish is the closest relative, in northeastern American waters, of the famous sole of Europe. It is right-handed and small-mouthed, and it can be told at a glance from all other Gulf of Maine flatfishes by the fact that it has no pectoral fin on either side. Its mouth gapes along the general fore-and-aft line as the fish lies, with the upper jaw projecting beyond the lower, whereas the gape is oblique in all other local flatfishes, and it is their lower jaw that projects. Furthermore, the rounded outline of the head of the hogchoker, and the lack of a definite snout, gives it an aspect very different from that of any other Gulf of Maine flatfish.

Equally diagnostic among right-handed species is that its right-hand ventral fin is continuous with the anal fin; its long fins are highest toward their rear ends; its dorsal (left-hand) fin originates at the very tip of the nose (thus, further forward than in our commoner flounders); and its small eyes are set flat instead of in prominent orbits. Other characters worth mentioning are that the

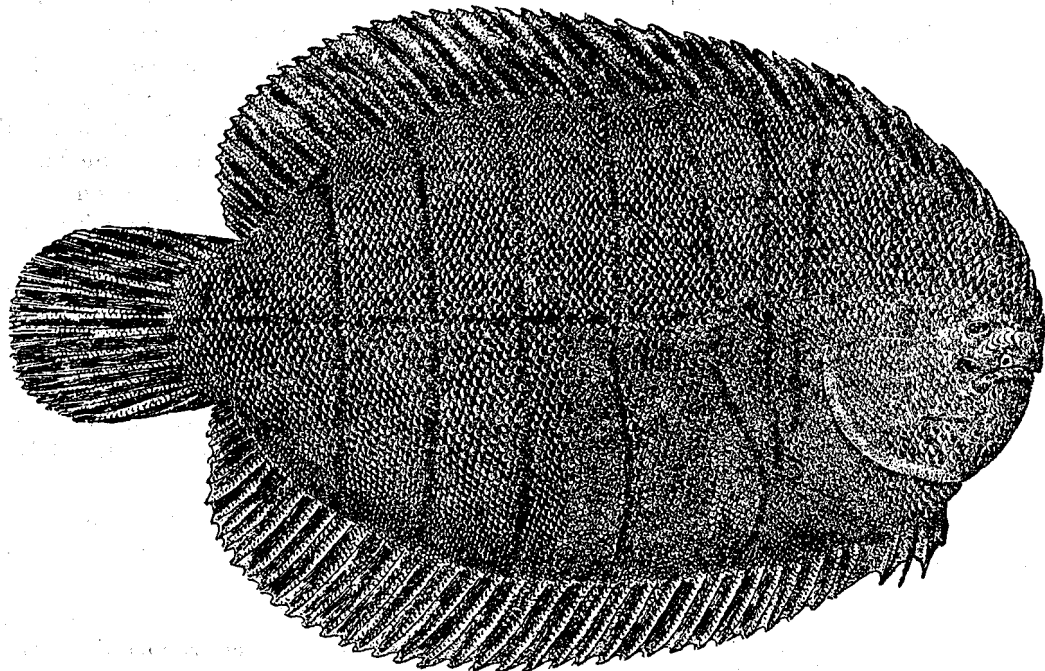


FIGURE 155.—Hogchoker (*Achirus fasciatus*), Woods Hole. After Jordan and Evermann. Original drawing by H. L. Todd.

gape of its mouth is shorter and much more crooked on the blind side than it is on the eyed side (an asymmetry that has been emphasized in most of the descriptions of this species); that it is evenly oval in outline without a definite caudal peduncle; and that there are 50 to 56 dorsal-fin rays and 36 to 42 anal-fin rays, but no pre-anal spine. The scales are very rough on both sides, those of the upper part of the head and chin on the eyed side and on the whole head on the blind side are larger than the body scales, and its skin is slimy with mucus.

Color.—Dusky or slaty olive to dark brown on the eyed side, barred transversely with a varying number (usually 7 or 8) of indistinct darker stripes, with a dark longitudinal stripe along the lateral line, and sometimes with pale mottling. The dorsal, caudal and anal fins are of the general body tint, variously dark clouded. The blind side is dirty white, usually marked with dark round spots which vary in size and number from fish to fish. But some specimens lack these spots.

Size.—Eight inches is about the maximum length.

Habits.—The hogchoker is confined to the immediate vicinity of the coast, is most common in bays and estuaries where the water is more or less brackish, and sometimes runs up into fresh water. It is a late spring and summer spawner. At Woods Hole fish apparently ripe have been taken in May, while in Chesapeake Bay ripe or nearly ripe fish have been collected in June, July, and August. One female, 6½ inches long, contained about 54,000 eggs about 0.3 mm. in diameter, whether buoyant or not is not known.

It reaches a length of 2 to 3 inches at one year of age, and matures when about 4½ inches long. It feeds chiefly on annelid worms and on small crustaceans.²⁶ Fragments of algae also have been found in hogchoker stomachs, but these probably were swallowed with its animal prey.

General Range.—Off the Atlantic and Gulf coasts of North America, from Massachusetts Bay to the Atlantic coast of Panama. The hogchoker is abundant in Chesapeake Bay and to the southward, and moderately common as far north as southern New England, but it is rare north of Cape Cod.

Occurrence in the Gulf of Maine.—This little flatfish has been reported from Provincetown (where Captain Atwood spoke of it as plentiful); from Boston Harbor, whence the Museum of Comparative Zoology has several, all caught long ago; from the mouth of the Charles River (two specimens reported in 1847); and from Nahant (one taken in 1840). But it is more than three-quarters of a century since it has been brought to scientific attention anywhere to the north of Cape Cod; if it is caught there from time to time, as it doubtless is, it has not been recognized. It is not known north or east of Cape Ann, nor on the offshore banks.

Importance.—The hogchoker is said to be delicious eating. But it is so small that it is of no commercial value even in Chesapeake Bay where it is plentiful. Incidentally, the rumored origin of the name "hogchoker" is that hogs that "feed on fish discarded on the beaches, have great difficulty in swallowing this sole, because of the extremely hard, rough scales."²⁷

THE JOHN DORIES. FAMILY ZEIDAE

American John Dory²⁸ *Zenopsis ocellata* (Storer) 1858

Jordan and Evermann, 1896-1900, p. 1660.

Description.—The John Dory is easily distinguishable from all other Gulf of Maine fishes of similar body form by its long dorsal fin spines, bony armor, tiny tail fin, and the curious profile of

its head. Like the butterfish it is very deep (only about one and three-fourths to twice as long as it is deep) and very much flattened sidewise. Its body is rounded in side view, with the dorsal profile of its head noticeably concave, its large mouth is set very obliquely, and its caudal peduncle is very slender. Its dorsal fin is in two parts, spiny and soft rayed; the former, originating over the upper corner of the gill covers, has 9 to 10 spines; the first, second, and third spines very long, the others graduated. And all the spines are filamentous toward the tip. The soft dorsal fin

²⁶ Hildebrand and Schroeder, Bull. U. S. Bur. Fish., vol. 43, pt. 1, 1928, p. 176.

²⁷ Hildebrand and Schroeder, Bull. U. S. Bur. Fish., vol. 43, Pt. 1, 1928, p. 177.

²⁸ Separable from the common John Dory of Europe by having three anal spines instead of four, and by a greater development of the bony plates.

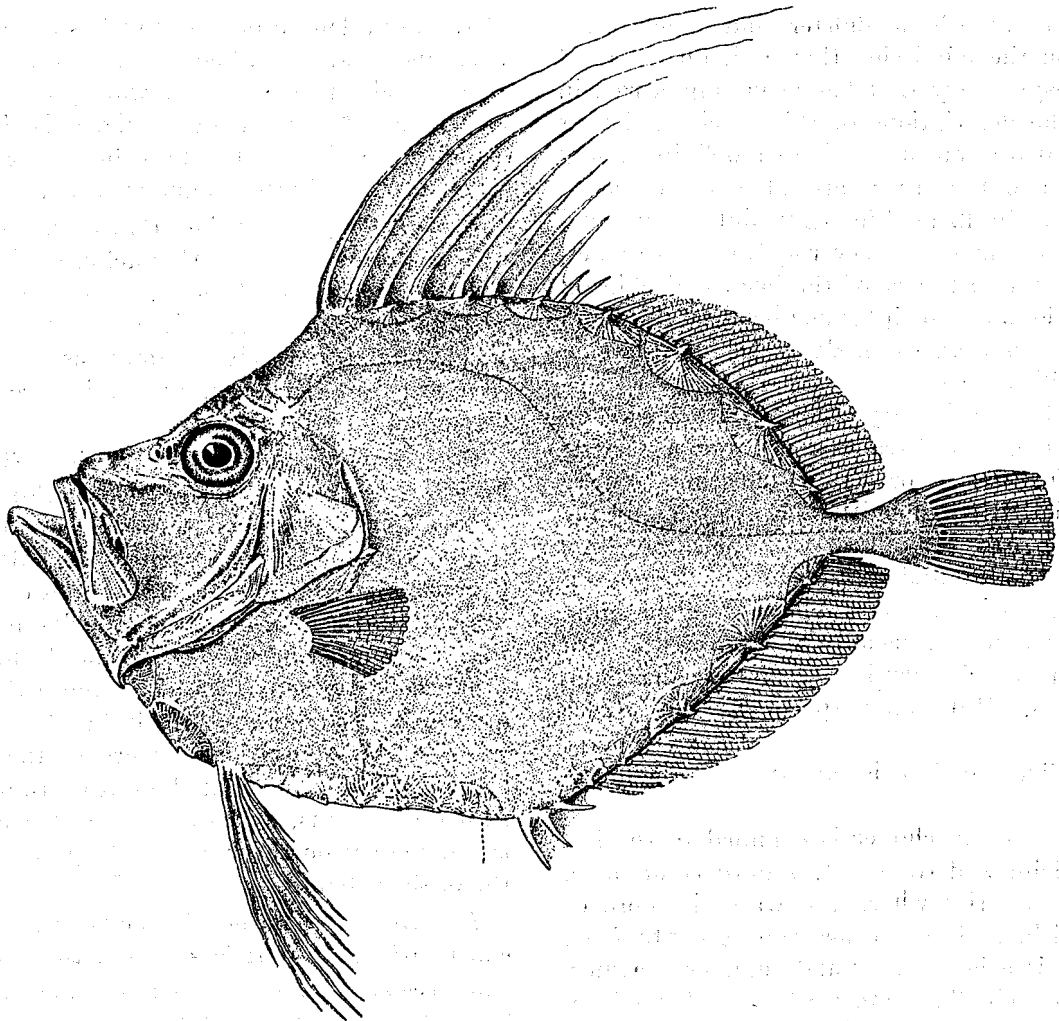


FIGURE 156.—American John Dory (*Zenopsis ocellata*), Provincetown. From Goode. Drawing by H. L. Todd.

(25 to 27 rays) is somewhat longer than the spiny dorsal fin, but less than half as high, and its anterior rays are only about half as high as the posterior ones. The two dorsal fins, together, occupy the entire length of the back of the fish from nape of neck to caudal peduncle.

The anal fin (24 to 26 rays preceded by 3 short stout spines) corresponds to the soft dorsal in location, height, and outline. The very small caudal fin is brush shaped, the ventral fins are very long, with the rays free at their tips, and they are situated in front of the pectorals. The pectorals are short and rounded. The skin is naked except for a series of bony bucklers, each with a hooked thorn or double thorn; two or three of them along the base of the spiny dorsal fin and four along the base of the soft dorsal; two in front of the ventral fins; one in the midline behind the ventrals,

followed by six pairs along the belly to the anal fin; and five along the base of the anal fin.

Color.—Silvery all over. Specimens that we have seen up to about 10 inches long are marked on either side with about 12–24 vaguely outlined dark spots, irregularly arranged, and fish up to about 15 inches long retain some of the spots.²⁹ But it seems that the spots tend to fade out with growth, for larger specimens that we have at hand, 16–20 inches long, have only one vague blotch on each side, a short distance behind the gill opening.

Size.—The largest four specimens yet seen measured 18¼ and 18½ inches;³⁰ 19 inches, weigh-

²⁹ This agrees with the original account of the species (Storer, Proc. Boston Soc. Nat. Hist., vol. 6, 1858, p. 388) and with a photograph of one about 3¼ inches long, from Campobello, New Brunswick, sent us by Dr. A. H. Leim.

³⁰ Taken off Long Island, N. Y., by the *Albatross III*, lat. 39°39' N., long. 72°08' W., May 12, 1950.

ing 3 pounds;³¹ and 20 inches, weighing 4½ pounds and 24 inches, weighing 7 pounds.³²

Remarks.—The presence of plates along the base of its first (spiny) dorsal fin, as well as along the bases of its second (soft) dorsal and anal fins, and of only three anal spines marks our fish off from its close counterpart, the European John Dory (*Zeus faber*), which has four stout anal spines and lacks plates along the first dorsal fin. Other structural differences are that the plates are much larger in our species than in the European, but the thorns smaller and less conspicuous;³³ that the base of each of the dorsal fin spines (except for the first and last one or two) is armed in the European species with a stout thorn (not in the American); and that the upper profile of the head is much the more deeply concave in the American species.

Habits.—All that is known of the habits of our John Dory is that we found two butterfish 6 to 7 inches long and one squid in the stomach of a large one (of about 18½ in.) trawled by the *Albatross III* about 74 miles off Long Island, N. Y., May 12, 1950, at 72 fathoms; and that the ovaries were well developed with orange colored eggs 1.2 to 1.4 mm. in diameter, in a 20-inch female that we saw trawled between January 27 and February 2 on the outer part of the shelf off Marthas Vineyard.³⁴

General range.—Outer part of the continental shelf from the latitude of Chesapeake Bay to the vicinity of Sable Island, Nova Scotia, and perhaps to the Laurentian Channel that separates the Nova

Scotian Banks from the Newfoundland Banks. It reaches the inner parts of the Gulf of Maine now and then as a stray.

Occurrence in the Gulf of Maine.—Only four specimens are known to have been taken in the inner parts of the Gulf of Maine. One (the specimen from which the species was described) was found at Provincetown, at the tip of Cape Cod many years ago; one found in a herring weir at Campobello Island, New Brunswick, at the mouth of the Bay of Fundy in 1942;³⁵ one trawled 25 miles off Cape Ann in 75 fathoms, January 1948.³⁶ One also was trawled on the northeastern edge of Georges Bank in the summer of 1941,³⁷ and one taken in Cape Cod Bay, July 7, 1952, by the dragger *Santina*.

It is to be expected anywhere along the seaward slope of the offshore rim of the Gulf, for the dragger *Eugene H* took them in nearly every trawl haul on the southwest slope of Georges Bank, near Veatch Canyon, at about the 75-fathom contour line, in late March 1951, some hauls bringing in several hundred (estimated) specimens. Other specimens³⁸ have been trawled recently on the outer part of the continental shelf southeast of Cape Henry, Va., from between 28 and 50 fathoms;³⁹ off Long Island, New York, in 72 fathoms and from between 145 and 200 fathoms; off Marthas Vineyard in 55 to 68 fathoms; off Nantucket in 66 to 75 fathoms; on Emerald Bank off Halifax, Nova Scotia, in 70 fathoms; and west of Sable Island, Nova Scotia, at 62 fathoms.

GRAMMICOLEPID FISHES. FAMILY GRAMMICOLEPIDAE⁴⁰

Grammicolepid *Xenolepidichthys americanus* Nichols and Firth 1939

Nichols and Firth, Proc., Biol. Soc., Washington, vol. 52, 1939, pp. 85-88.

Description.—This curious little oceanic fish resembles its near relative the John Dory (p. 297) in the arrangement of its fins, and in general shape, with body so strongly flattened sidewise as to be as thin as a pancake, and with a slender caudal peduncle. But it has a much smaller mouth

than the John Dory, its scales are linear in shape with their long axis dorso-ventral, so that the sides of the trunk are cross marked with a large number of narrow lines, closely crowded together, and the series of bony plates that arm the dorsal and ventral edge of the body of the John Dory are replaced in the Grammicolepids by a double series of short thorns that embrace the bases of the dorsal and ventral fins. Each side of the trunk of the only species known from our waters is

³¹ Reported to us, with a photograph, by Dr. A. H. Leim.

³² This specimen, trawled by the *Agatha and Patricia*, is in the Museum of Comparative Zoology.

³³ Reported in the Boston Traveler for September 9, 1941.

³⁴ Specimens seen by us or reliably reported.

³⁵ Reported by Firth, Copela, 1931, p. 162.

⁴⁰ For a recent account of this family see Myers, Proc., U. S. National Museum, vol. 84, 1937, pp. 145-156.

³¹ Caught on the northeast edge of Georges Bank in the summer of 1941 and reported in the Boston Traveler for September 9 of that year.

³² Taken 85 miles off Marthas Vineyard by the dragger *Eugene H*, May 15, 1950.

³³ Double and sometimes triple in the European *Z. faber*.

³⁴ Trawled by the dragger *Eugene H* from between 55-88 fathoms.

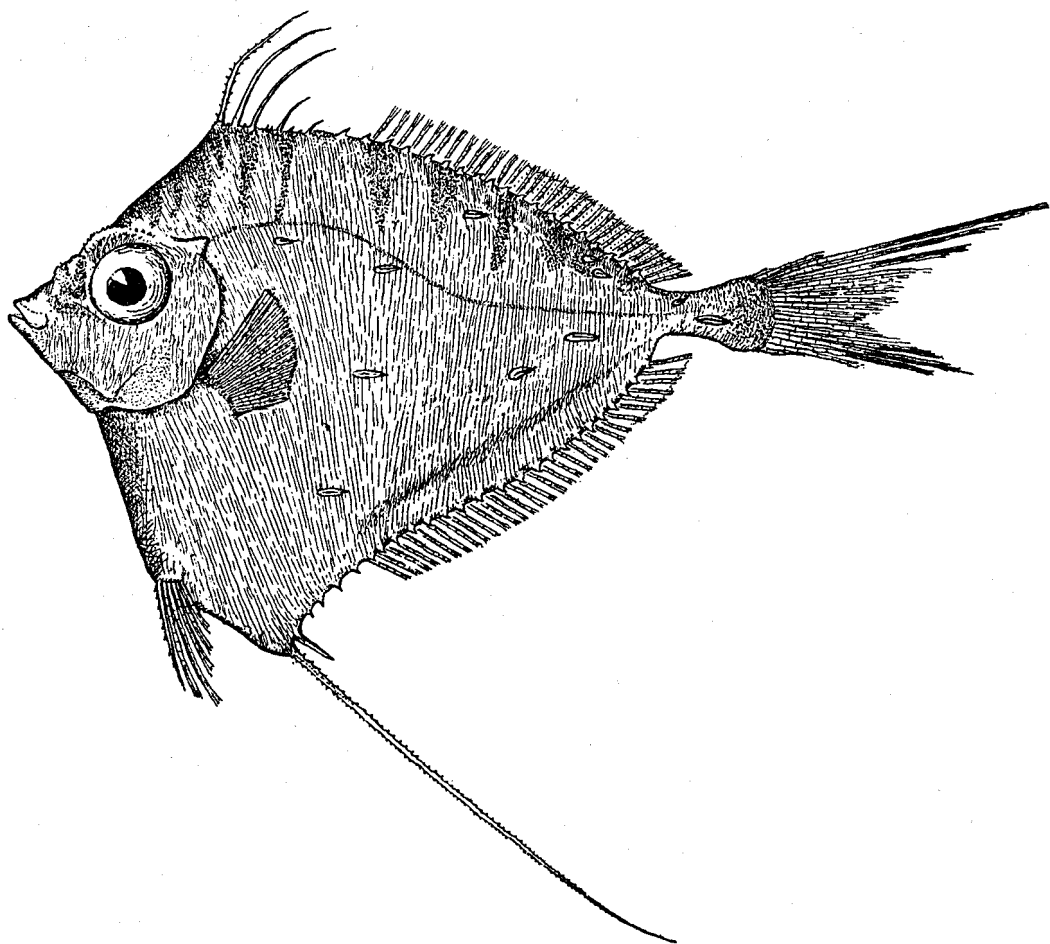


FIGURE 157.—Grammicolepid (*Xenolepidichthys americanus*), Georges Bank. Drawing by H. B. Bigelow. Tail fin after the original illustration by Firth and Nichols.

armed with about 11 or 12 conspicuous, horizontally flattened spines, pointing rearward.

Size.—The only specimen yet seen is about 4 inches (100 mm.) long, to the base of its tail fin.

We need only add, further, of our species, that the forward division of the dorsal fin consists of 5 spines, the forward edge of the first saw-edged, and all of them filamentous toward the tip; that the second dorsal fin, of 33 soft rays (separated from the first by a considerable gap), is about as high as two-thirds the diameter of the eye; is of about equal height from end to end, and reaches back to the caudal peduncle; that the tail fin is deeply forked, its tips pointed, and its upper lobe longer than the lower (unless this is the result of mutilation); that the soft-rayed anal fin, corresponding to the second (soft) dorsal fin, is preceded, after a considerable gap, first by a short, smooth spine, then by another very long spine, saw-toothed along both its front margin and its rear margin for

most of its length, but filamentous toward its tip; and that the ventral fins, of 1 stout, saw-edged spine followed by 6 soft rays, stand a little in advance of the brush-shaped pectorals.

Color.—After preservation in alcohol, the color is "pale, with a series of dark marks on the midline of the back, and about 10 narrow dark bands extending downward from these to the level of the top of the eye . . . the flattened spines, scattered over the body are blackish. Base of anal with a series of dusky blotches, and posterior part of caudal dusky".⁴¹

Range and occurrence in the Gulf of Maine.—So far known only from Georges Bank, where the only specimen yet seen was picked up, in a bucket, from the Sword Fisherman *America*. A closely related species, *X. dalgleishi* Gilchrist 1922, is known from the Caribbean, South Africa, and the Philippines.

⁴¹ Quoted from the original account by Nichols and Firth.