

the marginal pair set edgewise, the lower jaw with a pair of marginal plates set edgewise. The gill openings are vertical, set very low down on the sides of the neck, and each is covered with a flap of skin, paralleling the gill cover of bony fishes.

There are two distinct dorsal fins. The first of these originates about over the gill openings, is triangular, about as high as long, and supported at its anterior margin by a stout spine that is free along the terminal part, with the rear surface of the free part double saw-edged. The second dorsal is separated from the first by a space variable in length, and is less than one-third as high as the first, with straight margin. The small caudal fin, marked off from the second dorsal by a deep notch, is lanceolate in shape, ending as a short, whiplike filament; and it extends a short distance forward along the ventral surface of the trunk, there being no separate anal fin. The pelvics and pectorals both have pointed tips, the latter being much the larger and reaching back nearly to the point of origin of the pelvics. The male has a trifold copulatory organ arising from the base of each pelvic fin on the inner side, and also a supplementary bladlike clasping organ close in front of each pelvic fin, its margin armed with 4 or 5 hooks, and lying in a pocket from which it can be protruded. The skin is smooth; the lateral-line system is well developed and ramifies over the head in several branches.

This species is a close ally of the well known chimaera of north European seas (*Chimaera monstrosa*), but is distinguishable from it by the fact that it has no separate anal fin; that there is a considerable free space between its two dorsal fins; that the outline of the second dorsal fin is

straight; that its caudal filament is much shorter; and that its pectorals hardly reach back to the pelvics.

Color.—Lead color, tan-brown or dark sepia below as well as above, except paler on the throat and grayish on the snout. The margin of the first dorsal, the rear and inner margins of the pelvics, and the rear margins of the pectorals are dark.

Size.—The largest specimen yet reported, taken 85 miles off Cape Sable, Nova Scotia, at a depth of between 400 and 500 fathoms, was 49 inches long and weighed 17½ pounds dressed.

General range.—Not uncommon on the continental slope of North America from the latitude of Cape Cod northeastward, along the Nova Scotia Banks, to the Grand Banks, in 160 fathoms to more than 1,200 fathoms; also in the eastern side of the Atlantic off the coast of Portugal.

Occurrence in the Gulf of Maine.—Our only reason for mentioning this chimaera is that it is (or was) so plentiful along the offshore slopes of the Banks off the eastern part of the Gulf and off Nova Scotia that many were brought in for a few years subsequent to 1875, when fishermen long lining for halibut extended their operations down to 300 fathoms or so. Only one seems to have been reported during the past 25 years, caught off Browns Bank, 85 miles southwest of Cape Sable, between 400 and 500 fathoms on October 15, 1930.⁸⁵ But perhaps it would be found no less plentiful now than of old, if sought at the proper depth. The shoalest capture of which we found record was at 160 fathoms. Nothing is known of its way of life nor have its egg cases been seen.

THE BONY FISHES. CLASS OSTEICHTHYES

THE STURGEONS. FAMILY ACIPENSERIDAE

The sturgeons, like the sharks, have an uneven ("heterocercal") tail with the vertebral column extending out along the upper lobe. But there is no danger of mistaking a sturgeon for a shark for it has only one gill opening on each side, while the gills are enclosed by bony gill covers. And the combination of gills of this kind with sharklike tail and with the fact that the head is covered by

bony plates united by sutures, sets the sturgeons off from all other Gulf of Maine members of their own class. Two species of sturgeons are known from the Gulf, one of which once was rather common there; the other is extremely scarce everywhere.

⁸⁵ Reported by Firth, Bull. Boston Soc. Nat. Hist., 61, 1931, p. 9. It was 49 inches long and weighed 17½ pounds dressed.

KEY TO GULF OF MAINE STURGEONS

1. The successive bucklers in the dorsal row touch each other or even overlap; the space between the dorsal row of bucklers and the uppermost of the two lateral rows is thickly set with coarse prickles..... Sea sturgeon, p. 81.
2. The successive bucklers in the dorsal row are separated one from the next by spaces up to $\frac{1}{2}$ as long as the bucklers; the space between the dorsal row of bucklers and the uppermost of the two lateral rows is only sparsely strewn with fine prickles..... Short-nosed sturgeon, p. 84.

Sea sturgeon *Acipenser sturio* Linnaeus, 1758⁸⁶

Jordan and Evermann, 1896-1900, p. 105

Description.—The skin of the sturgeon is armored with a row of large bony shields or bucklers along the middle of its back (the successive bucklers touching or even overlapping) with a second row of smaller bucklers high up along each side of the body; and with a third row, also smaller, lower down, along the line of transition from side to belly. Each buckler has a longitudinal keel with a spur, which is so sharp on small fish that these are hard to handle, lower and blunter on large. On the average there are 10 or 11 (10-16) bucklers in the mid-dorsal row; 28 or 29 (26-34) in each upper lateral row; and 9 to 14 in each of the lower lateral rows. The dorsal row runs from above the gill covers back to the dorsal fin, and each of the dorsal shields reaches to the next shield or even overlaps it. The upper lateral rows run from the gill openings back to the root of the tail fin; the lower lateral rows from close behind the pectoral fin to the pelvic fin, also from the pelvic fin back as far as the anal fin. And each shield in each of the two lateral rows is separated from the next shield by a space up to one-half as long as the shields.

The body is rather slender and rendered more or less pentagonal in cross section by the five rows of shields, instead of rounded as it is in the majority of bony fishes. The snout is narrow in young sturgeons less than 2 to 2½ feet long, depressed below the level of the forehead, nearly flat below,

and longer (from the eyes forward) than the distance is from the eyes rearward to the upper corners of the gill openings. But it changes shape as the fish grows, becoming blunter, straight in dorsal profile, and considerably shorter relatively. The mouth, situated on the under side of the head, is small, toothless (except in larval stages), with protractile lobed lips, and there are four pointed barbels in a row across the lower side of the snout in front of the mouth. The single rather small triangular dorsal fin stands far back, with its rear edge over that of the still smaller anal fin. The ventral fins are likewise far back. The pectorals are set almost as low as the plane of the belly.⁸⁷

Color.—Olive greenish or bluish gray above, gradually fading on the sides and changing rather abruptly below the upper lateral rows of shields to the white of the belly.

Size.—The sea sturgeon is a very large fish. In the Delaware River where sturgeon persisted until recently in larger numbers than in New England, ripe males are up to about 6 to 7 feet in length, averaging 65 pounds in weight; the spawning females (which are larger), up to about 10 feet and to about 250 pounds,⁸⁸ with a larger one taken from time to time. And the general run was about the same in the Kennebec, to judge from an average weight of 120 pounds for males and females together, during the years when a fishery was carried on there. But some still grow considerably larger in Gulf of Maine waters. Thus 9 weighing between 350 pounds and 600

⁸⁶ It still is an open question, that we cannot answer, whether the sea sturgeon of eastern North America is identical with the European sea sturgeon, is a recognizable race of the latter, or is a separate species; if the last, its scientific name is *Acipenser oxyrinchus* Mitchell, 1815.

⁸⁷ Vladykov and Beaulieu (Natural. Canad., vol. 73, 1946, pp. 143-204), give a detailed account of the characters that separate the sea sturgeon from the lake sturgeon (*Acipenser fulvescens* Rafinesque, 1817).

⁸⁸ According to Cobb, Rept. U. S. Fish Comm. (1899), 1900, p. 277.

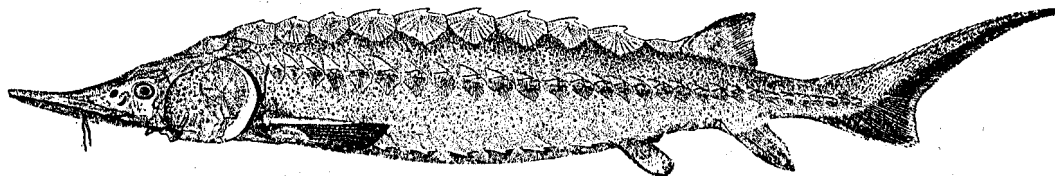


FIGURE 36.—Sturgeon (*Acipenser sturio*), Potomac River specimen. From Goode. Drawing by H. L. Todd.

pounds were landed in Portland, Maine, from the South Channel, Georges Bank, Browns Bank, and Western Bank off Nova Scotia during the period 1927-1935.⁸⁹ About 12 feet is perhaps the greatest length to be expected today. But 18 feet, reported for New England many years ago, may not have been an exaggeration, for sturgeon as long as that have been reported from Europe also. The heaviest Gulf of Maine sturgeon reliably reported (to our knowledge) was one of 600 pounds, landed in Portland by the steam trawler *Fabia* from Georges Bank, December 21, 1932.

The following relationship between length and weight, for sea sturgeons up to 7½ feet long, taken in the lower St. Lawrence River,⁹⁰ would probably apply to Gulf of Maine fish, equally: 7 to 9 pounds at 30 inches (to fork of tail); 15 to 18 pounds at 40 inches; about 35 pounds at 50 inches; 55 to 57 pounds at 5 feet; about 100 pounds at 6 feet; and about 190 pounds at 7½ feet.

Habits.—The sturgeon makes most of its growth in salt water but enters fresh-water rivers to spawn, as do the salmon, the shad, and the alewife. The large adult fish enter (or once entered) the Gulf of Maine rivers late in the spring, working their way slowly upstream beyond tidewater before depositing their eggs. So far as known, spawning takes place in our rivers in May, June, and perhaps as late as July. It has been suggested that some may spawn in brackish water from the fact that females with large eggs have been taken near Woods Hole in June and July (i. e., in the spawning season). Spawning leaves the spent "cows" in very poor condition. In the Delaware, however, and presumably in Gulf of Maine rivers, they "become again quite plump, acquiring considerable additional weight"⁹¹ before they go down stream again, which some of them do not do until September, according to observations in the Delaware. But we do not know how many years in succession a given fish may spawn.

A single female may produce as many as 2,400,000 eggs which hatch in about a week after they are fertilized.⁹² Judging from European observations on artificially reared sea sturgeon,

the larvæ may be expected to grow to 12 mm. in length within 5 days after hatching; to 16-17 mm. in 2 weeks; to 20 mm. in 4 weeks; and to 4-5½ inches in 2 months.

Some young sturgeon may live several years in the lower tidal reaches of the rivers in which they are spawned, until they have grown to a length of 2½ to 3 feet, as appears to be the case in the Hudson.⁹³ And it seems that they pass their entire growth period in the salt estuary of the St. Lawrence River, for sturgeons are taken there of all sizes from a few inches long up to 7-8 feet or longer.⁹⁴ But others may descend during their first year, for sperlets only 5 to 6 inches long have been found at the mouth of the Delaware River and of the Elbe in Europe.⁹⁵

Some Gulf of Maine sturgeon have taken to the sea by the time they have grown to 3 feet or so, as proved by the capture of sturgeons of that size at various points around the coasts of the Gulf, and off southern New England. And recent observations in the Hudson by Greeley make it likely that all the sturgeon that are spawned in rivers emptying into the Gulf of Maine go to sea sooner or later to complete their growth.⁹⁶

Sturgeon grow rather slowly at first while still in their parent streams. Four, for example, that were tagged in the lower St. Lawrence when 29 to 33 inches long, and recaptured nearby 2 to 3½ years later, had gained only about 2 to 5 inches in length per year.⁹⁷ Very slow growth is also indicated by ages of 5 to 6 years at 24 to 28 inches; 7 years at 25 to 31 inches; and 8 years at 32 to 34 inches, for sturgeon from the tidal waters of the lower Hudson, as estimated from the markings on their otoliths.⁹⁸ It also seems that sturgeon, like many other fish, make most of their growth during the warm season in such situations for one marked fish in the Elbe did not grow at all between November and the following February; whereas a second grew from 17 cm. (6½ in.) to 38 cm. (15 in.) in length between January 17 and

⁸⁹ See Greeley (Supp. 26 Ann. Rept. Conserv. Dept. New York, 1937, pp. 68, 78-82, 89) for a study of the sturgeon in the Hudson River.

⁹⁰ A series of 1,592 sea sturgeons from the lower St. Lawrence River, studied by Vladykov (Rapp. Gen. Minstr. Chasse, Pêch. Quebec (1948-1949) 1949, pp. 53-58) included a good representative of sizes from about 4 inches up to 90 inches.

⁹¹ Prince reports a 6-inch sturgeon from Hudson Bay (Rept. Sixty-seventh Meeting, British Assoc. Adv. Sci., Toronto, 1897, p. 687).

⁹² Greeley, Suppl. 28 Ann. Rept. Conserv. Dept. New York, 1937, p. 82.

⁹³ Vladykov (Rapp. Gen. Minstr., Chasse, Pêch. Quebec, 1948-1949, pp. 61-63, 66, table 19).

⁹⁴ Greeley, Supp. 26 Ann. Rept. Conserv. Dept. New York, 1937, p. 68, table 10.

⁸⁹ Records collected by the late Walter H. Rich of the U. S. Bureau of Fisheries.

⁹⁰ According to measurements and weights of 1,592 sturgeons by Vladykov, Rapp. Gen. Minstr. Chasse, Pêch., Quebec (1948-1949), 1949, pp. 43-54.

⁹¹ Ryder, Bull. U. S. Fish Comm., vol. 8, 1890, p. 266.

⁹² Ryder (Bull. U. S. Fish Comm., vol. 8, 1890, p. 231) describes the spawning and early development of the sturgeon in the Delaware River.

the following April, and a third from 43½ cm. (17¼ in.) to 64 cm. (25¼ in.) from April 9 to the following December. But sturgeon grow much more rapidly after they go to sea, if ages (estimated from otoliths) of 11 years for a 75-inch sturgeon, and 12 years for two others of 88 and 100 inches are anywhere near the truth.⁹⁹

The sturgeon is a bottom feeder, rooting in the sand or mud with its snout like a pig (the barbels serving as organs of touch) as it noses up the worms and mollusks on which it feeds and which it sucks into its toothless mouth with considerable amounts of mud. It also consumes small fishes, particularly sand lance. Small ones, while living in estuaries and around river mouths, subsist largely on amphipod and isopod crustacea. Sturgeon, like salmon, eat little or nothing while traveling up river to spawn.

When at ease sturgeon swim slowly to and fro, seeming very sluggish. But they are capable of darting ahead like an arrow on occasion, and they often come to the surface to jump clear of the water. Though they usually offer no resistance when netted, large ones are very strong.

General range.—Coastal waters from the St. Lawrence River to the Gulf of Mexico, running up into rivers to spawn; reported from Hudson Bay, also Scandinavia to the Mediterranean, if the American and European sea sturgeons belong to the same species.

Occurrence in the Gulf of Maine.—The sea sturgeon is (or was) well known in the St. John, Penobscot, Kennebec, and Merrimac Rivers, and has even been taken some distance from the mouths of streams no larger than the Charles River and the Parker River in Essex County, Mass.,¹ where some are still seen jumping in July and one is taken occasionally. In fact, sturgeon once entered practically every stream of any size emptying into the Gulf of Maine. Wood, writing of Massachusetts in 1634,^{1a} described them as "all over the country, but best catching of them be upon the shoales of Cape Code and in the river of Merrimacke, where much is taken, pickled and brought for England, some of these be 12, 14 and 18 foote long." In fact, an odd

sturgeon still enters the mouth of the Merrimac, witness one of 230 pounds netted there on September 14, 1938 and landed in Newburyport.²

Sturgeons may be expected anywhere off the coasts of the Gulf of Maine during their sojourn in salt water. There is definite record of them at sundry localities on both sides of the Bay of Fundy; off Mt. Desert Island; in Penobscot Bay; in Casco Bay; at the mouth of the Piscataqua River; on the Boars Head-Isles of Shoals fishing ground, where several 3 to 4 feet long were taken in gill nets during April and May 1913; at the mouths of the Essex and Ipswich Rivers, where jumping sturgeon have been reported recently in the daily press;³ at the mouth of Gloucester Harbor, where an angler reports catching one of about 12 pounds while fishing for tautog; inside and outside Boston Harbor; at Provincetown; off Truro, Cape Cod; and at Nantucket, as well as along the southern New England coast to the westward. Some also extend their wanderings to the offshore fishing banks as they grow. Thirty, for example, ranging in weight from 120 to 600 pounds were landed in Portland and Boston by otter trawlers from Nantucket Shoals, from South Channel, and from Georges and Browns Banks, during the years 1927-1936.⁴ Probably all of these were on bottom when caught, to judge from their diet (p. 83), and from the fact that sturgeon have been hooked on cod and haddock lines as deep as 25 fathoms in Scandinavian waters. Nothing beyond this is known of their movements in our Gulf.

Importance.—It is only the scarcity of the sea sturgeon in the Gulf of Maine that limits its commercial importance there and in the tributary rivers. The few taken are picked up accidentally in traps or weirs, in drift nets, or by the otter trawlers.

In former years, when our streams were less obstructed and sturgeons more plentiful, the catch was of considerable value in some of the larger rivers. It is interesting, for instance, to read that sturgeon, doubtless from the Kennebec River and cured near what is now Brunswick, Maine, were shipped to Europe as early as 1628; and that large quantities were also shipped to Europe from near Ipswich, Mass., in 1635. In the Kennebec, where an intermittent fishery had long been maintained.

⁹⁹ See footnote 98.

¹ Two sturgeon 44 and 45½ inches long, netted in the Parker River at Newbury, Mass., July 23, 1933, are (or were) in the collection of the Boston Society of Natural History, now the New England Science Museum (Bull. Boston Soc. Nat. Hist., 69, Oct. 1933, p. 8).

^{1a} New England's Prospect, 1634, p. 37.

² Reported in the Boston Globe, Sept. 15, 1938.

³ The Boston Herald, June 1950.

⁴ Reports collected by the late Walter H. Rich, U. S. Bureau of Fisheries, and notices in the daily press.

the catch was about 250 fish in 1880, yielding 12,500 pounds of meat, and not much less in 1898 (10,875 pounds). But the yearly landings were only about one fourth as great there (2,777 pounds) by 1919. And the reported landings of sturgeon from the entire coastline of Maine (including what few were brought in from offshore) had fallen to only 300 pounds in 1940, and 400 pounds in 1947. Reported landings in Massachusetts of 5,300 pounds in 1940 (all by otter trawlers) and of 6,600 pounds (5,000 pounds by otter trawlers, from off shore), corresponding to some 50 to 70 fish, if they weighed as little as 100 pounds each, will further illustrate their present-day scarcity.

We have never heard of a large sturgeon hooked by an angler in the Gulf of Maine. But we hear from time to time of a small one caught in this way, as already remarked (p. 83).⁵ And the skill of a woman angler⁶ who foul-hooked a sturgeon about 6 feet long, and beached it on surf-casting tackle after a long fight, fishing alone at Wasque Point, Marthas Vineyard, on July 15, 1950, was widely heralded in the daily press.

Short-nosed sturgeon *Acipenser brevirostrum*
LeSueur 1818

LITTLE STURGEON

Jordan and Evermann, 1896-1900, p. 106.

Description.—The little sturgeon resembles the sea sturgeon so closely in general appearance that we need note only the most obvious differences. These are that the shields in its dorsal row are relatively smaller, and that each is separated from the next by a space up to $\frac{1}{2}$ as long as the shields themselves (successive dorsal shields in contact or overlapping in the sea sturgeon); that the space between its dorsal row of shields and the upper

⁵ We once saw one small one about 23 inches (575 mm.) long foul hooked in the side off South Beach, New York, December 21, 1923, and heard of a similar experience by the same angler a year later.

⁶ Mrs. George T. Rice. About 30 others were seen by her at the same time in a deep slew formed by a new bar.

lateral row on each side is only sparsely set with fine prickles (closely set with coarse prickles in the sea sturgeon); and that its viscera are blackish (pale in the sea sturgeon); also the number of rays in the anal fin averages smaller in the little sturgeon (19-22) than in the sea sturgeon (23-30). The snout, too, is considerably shorter relatively, as well as broader, than it is in young sea sturgeons of equal size. And while the snout is about as long, relatively, in the one species as in the other when they are full grown, sea sturgeons are then so much the larger that there is no danger of confusing the one kind with the other.

Color.—Described as blackish above, tinged with olive above the upper lateral line of shields, marked with alternate black and pale bands; sides, below the upper lateral row of shields, reddish mixed with violet; abdomen white.⁷

Size.—This is a much smaller fish than the sea sturgeon. Males may mature when only 19-20 inches long and most of them do by the time they pass 21 inches; most of the females at about 24 inches. The largest so far recorded is one of about 36 inches, in the Museum of Comparative Zoology. One about 31 inches long weighed 7 pounds 4 ounces.⁸

Habits.—Nothing is known of the habits of the little sturgeon except that it spawns in rivers and that it does so late in April in the lower Hudson. The fact that fair sized specimens are taken there in summer and also in winter, suggests that it may not be as regularly migratory as the sea sturgeon is.⁹ But the places of capture of the Gulf of Maine specimens mentioned below show that some certainly go out into the open sea and wander for some distance from their parent stream.

General range.—So far as we know, the only

⁷ We have not seen a fresh-caught specimen.

⁸ For further details as to size, see Ryder, Bull. U. S. Fish Comm., vol. 8, 1890, p. 238; and Greeley, Suppl. 26 Ann. Rept. Conserv. Dept. New York, 1937, p. 69, table 11, pp. 82, 90.

⁹ Greeley, Suppl. to 26 Ann. Rept. Conserv. Dept. New York, 1937, p. 90, makes this suggestion.

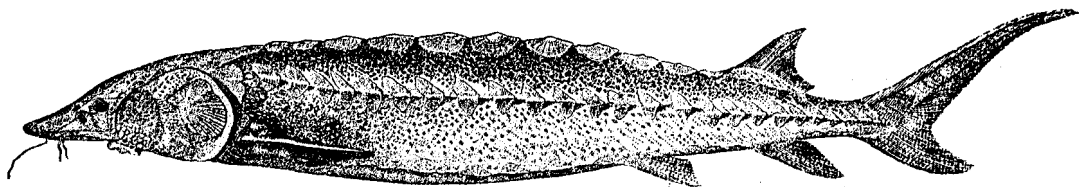


FIGURE 37.—Short-nosed sturgeon (*Acipenser brevirostrum*), Woods Hole specimen. From Goode. Drawing from photograph.

locality records definitely belonging to this species, not to young sea sturgeons, are from Provincetown and Waquoit, Mass.; from the Hudson River, N. Y.; from Delaware Bay and River; and from Charleston, S. C.

Occurrence in the Gulf of Maine.—The only recent record of the little sturgeon in the Gulf is of one about 23 inches long, taken at Provincetown about 1907 and now mounted in the Museum of Comparative Zoology.¹⁰ The Museum of the Essex Institute, Salem, also has—or had—a stuffed sturgeon from Rockport, Mass., identified as this species by Goode and Bean.¹¹ Evidently the sturgeon is now very scarce in our Gulf and there is no reason to think that it ever has been more plentiful there.

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The Herring and Tarpon Tribes

FAMILIES CLUPEIDAE, DUSSUMIERIIDAE, AND ELOPIDAE

The true herrings (Clupeidae) are soft-finned fishes wholly lacking spines, with one short dorsal fin, deeply forked tails, ventral fins situated on the abdomen far behind the pectorals, teeth small or lacking in adults, deep bodies flattened side-wise, and large scales that slip off at a touch. They are, perhaps, the most familiar of northern sea fishes and certainly are the most abundant in number of individuals. Seven species of herring occur in the Gulf of Maine—the hickory shad (not very common), the sea herring, the alewife, the blueback, and the shad (regular and plentiful), thread herring (scarce), and the menhaden (irregular in its occurrence). The shad, menhaden, sea herring, and thread herring are easily named; but the alewife and the blueback resemble one another

so closely that they are often confused, even by the fishermen who handle them constantly. The round herrings (Family Dussumieriidae) differ from the true herrings chiefly in their rounded bellies and less deep bodies. The members of the Tarpon Tribe (Family Elopidae) are very closely allied to the true herrings (Clupeidae), from which they differ in having a bony plate on the throat between the branches of the lower jaw. There are only about five species, all of them tropical. Two are known from the Gulf, as strays.

¹⁰ This Museum also has another of about 36 inches from Waquoit, on the southern shore of Massachusetts.

¹¹ Bull. Essex Inst., vol. 11, 1879, p. 27. A sturgeon was reported as *brevisrostris* from Boston Harbor many years ago, but there is no way now of checking the identification.

KEY TO GULF OF MAINE HERRINGS AND TARPONS

1. Last dorsal fin ray prolonged..... 2
Last dorsal ray not prolonged..... 3
2. Dorsal fin originates in advance of the ventrals; scales only moderately large..... Thread herring, p. 112
Dorsal fin originates behind the ventrals; scales very large..... Tarpon, p. 87
3. Belly rounded..... 4
Belly sharp edged..... 5
4. Scales very small; mouth very large with upper jaw-bone extending considerably beyond the rear edge of the eye; point of origin of dorsal fin about over that of the ventral fins..... Ten pounder; p. 86
Scales large; mouth small, with upper jaw-bone extending rearward only about as far as the front edge of the eye; point of origin of dorsal fin well in advance of that of the ventral fins..... Round Herring, p. 87
5. Head (tip of snout to edge of gill cover) very large, occupying about one-third the total length of the body to base of the central rays of the caudal fin; free edges of scales fluted, not rounded..... Menhaden, p. 113
Head about one-fourth the total length of the body; free edges of the scales rounded..... 6
6. Distance from point of origin of dorsal fin to tip of lower jaw (mouth closed) about as long as from origin of dorsal fin to base of central rays of caudal fin; edge of belly hardly saw-toothed, though sharp; general form comparatively shallow; there is a cluster of teeth on the roof of the mouth..... Sea herring, p. 88
Distance from point of origin of dorsal fin to tip of lower jaw (mouth closed) considerably shorter than from point of origin of dorsal fin to origin of central rays of caudal fin; edge of belly more or less strongly saw-toothed, especially in space between the ventral and anal fins; general form deep; there are no teeth on the roof of the mouth..... 7
7. The tip of the lower jaw extends noticeably beyond the upper when mouth is closed..... Hickory shad, p. 100
The tip of the jaw does not extend appreciably beyond the upper when mouth is closed..... 8

8. The upper outline of the forward part of the lower jaw (visible if mouth is opened) is nearly straight, and does not show a pronounced angle; the upper jaw extends back about level with the rear edge of the eye..... Shad, p. 108
The upper outline of the forward part of the lower jaw is concave with a pronounced angle; the upper jaw reaches back only about to the level of the center of the eye..... 9
9. Breadth of eye is greater than distance from front of eye to tip of snout; back distinctly grey green; lining of belly cavity pale grey..... Alewife, p. 101
Breadth of eye is only about as great as distance from front of eye to tip of snout; back distinctly blue green; lining of belly cavity sooty or black..... Blue back, p. 106

Ten pounder *Elops saurus* Linnaeus 1766

Jordan and Evermann, 1896-1900, p. 410.

Description.—The ten pounder is herring-like in the arrangement of its fins, with the single and soft-rayed dorsal fin originating about midway along its back; in having no adipose fin; in the position of its ventral fins about midway between tip of snout and fork of tail; and in its forked-tail fin. But its scales are very much smaller relatively than those of any of our herrings, and its mouth is much larger, with the upper jawbone extending rearward considerably beyond the rear edge of the eye. Being about one-sixth as deep as it is long, it is a much more slender fish than any of our herrings except the round herring, and its belly is rounded like that of the latter. But its trunk is more flattened sidewise than that of the round herring, its dorsal fin-origin is over the ventrals (well in advance of the ventrals in the round herring), and its tail fin is much wider relatively than that of any herring, and more deeply forked.

A more important structural character is that its throat is stiffened between the branches of its lower jaw by a long bony plate, which it shares with the tarpon, but which no member of the herring tribe has. Its closest affinity among fishes yet known from our Gulf is with the tarpon. But its scales are very much smaller than those of the

latter, nor does its dorsal fin have the prolonged ray characteristic of the tarpon.

Color.—Silvery all over, with the back bluish, the lower parts of the sides and the lower surface yellowish; the dorsal and caudal fins dusky yellowish and silvery; the ventral and pectoral fins yellowish speckled and dusky.

Size.—The ten pounder is said to grow to a length of 3 feet,¹² but few of those caught are longer than about 20 inches.

General range.—Atlantic coast of America, from Brazil northward; commonly to North Carolina, in small numbers and less regularly to southern New England, and perhaps straying around the elbow of Cape Cod on rare occasions. The ten pounder of our Atlantic coast is represented in tropical-warm temperate seas in various other parts of the world by relatives so close that they may all finally prove to represent only the one wide-ranging species.¹³ Our only reason for mentioning this southern fish is that one reported as from Chatham, Mass., may have been taken on the Gulf of Maine shore of Cape Cod.¹⁴ Ten pounders are taken from time to time near Woods Hole.

¹² Jordan and Evermann, Bull. 47, U. S. Nat. Mus., Pt. 1, 1896, p. 410.

¹³ Smith (Sea Fishes Southern Africa, 1949, p. 86) considers this probable.

¹⁴ This specimen, taken on October 19, 1888, and reported by Bigelow and Schroeder (Copeia, 1940, p. 139) is in the Museum of Comparative Zoology.

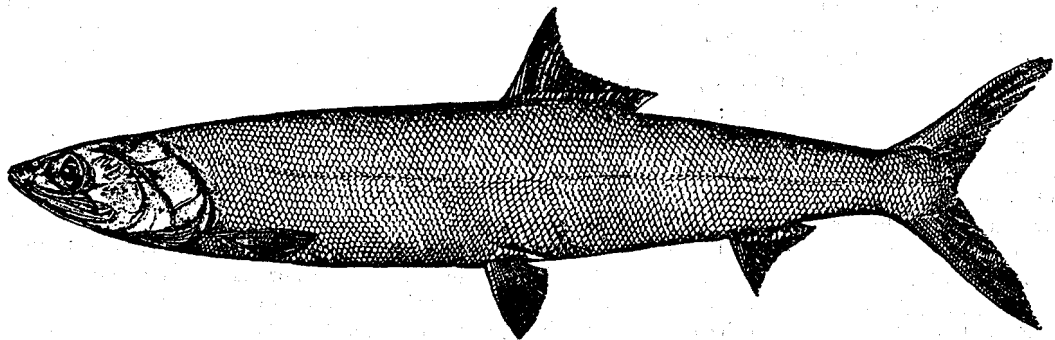


FIGURE 38.—Ten pounder (*Elops saurus*), Massachusetts. From Goode. Drawing by H. L. Todd.

Tarpon *Tarpon atlanticus* (Cuvier and Valenciennes) 1846

Jordan and Evermann, 1896-1900, p. 409, fig. 177.

Description.—The tarpon is herring-like in general form and appearance, but it is made easily recognizable by the fact that the last ray of the dorsal fin is greatly prolonged, its free portion being as long as the fin is high or longer, and by the presence of the bony plate on the throat mentioned above (p. 85) in the characterization of the family to which it belongs. Furthermore, the anal fin of the tarpon is deeply falcate; that of all Gulf of Maine herring-fishes rhomboid in outline. The ventral fins, which are situated under or behind the dorsal fin in herrings, alewives, shad, and menhaden, are considerably in front of the dorsal fin in the tarpon, while the lower jaw of the latter projects relatively further; its scales are relatively larger; and its caudal fin is relatively wider.

Color.—Bright silvery all over, the back darker than the belly.

Size.—Tarpon grow to a length of 6 to 8 feet; the longest recorded was 8 feet 2 inches; the

heaviest taken on rod and reel weighed 247 pounds.¹⁶

General range.—Tropical and subtropical coasts of America, from Brazil to Long Island, casually to Cape Cod, and to Nova Scotia; where it has been recorded off Isaacs Harbor and in Harrigan Cove.¹⁶ Its chief center of abundance is in the West Indies, about Florida, and in the Gulf of Mexico.

Occurrence in the Gulf of Maine.—A specimen 5½ feet long, taken at Provincetown on July 25, 1915,¹⁷ is the only record of the tarpon in the Gulf of Maine, which it reaches only as an accidental straggler from the south.

Round herring *Etrumeus sadina* (Mitchill) 1815

Jordan and Evermann, 1896-1900, p. 420.

Description.—The most distinctive feature of this fish, among herrings, is that its belly is rounded, not sharp edged. It is, furthermore, the most slender of our herrings, its body being only

¹⁶ Taken on rod and reel in the Panuco River, Mexico, Mar. 24, 1938, by H. W. Sedgewick.

¹⁶ Halkett, Check List, Fishes Canada, Newfoundland, 1913, p. 45.

¹⁷ Radcliffe, Copela, No. 26, 1916, p. 3.

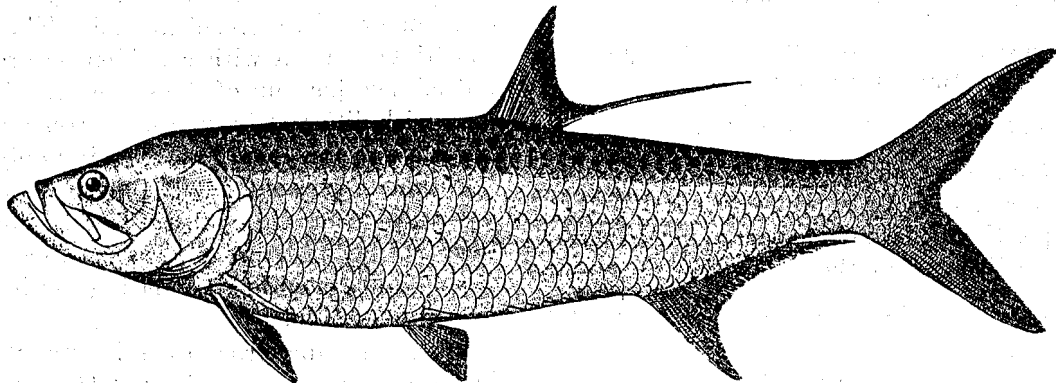


FIGURE 39.—Tarpon (*Tarpon atlanticus*), New Jersey. From Goode. Drawing by H. L. Todd.

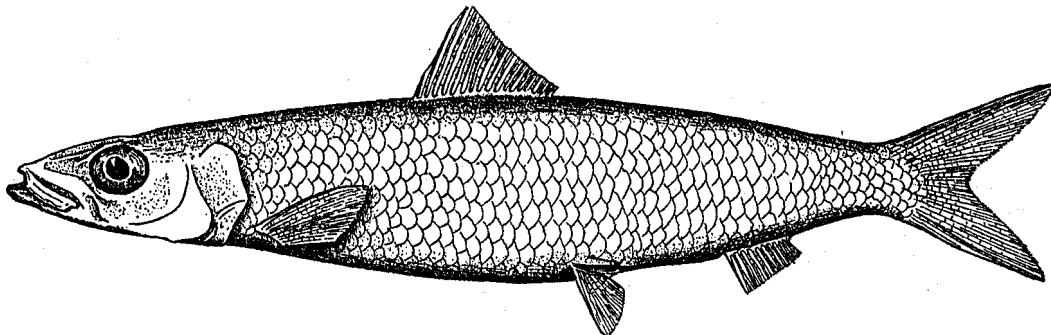


FIGURE 40.—Round herring (*Etrumeus sadina*).

one-sixth as deep as long, thus suggesting a smelt in its general outline. Its dorsal fin, too, stands wholly in front of the ventrals instead of over the latter, as in herring, alewives, and shad; and there are fewer anal fin rays (only about 13, whereas the herring has about 17, the alewife about 19, and the shad about 21) than any of the latter.

Color.—Olive green above with silvery sides and belly.

Size.—Eight to ten inches long when adult.

General range.—Atlantic and Gulf of Mexico coasts of the United States; occasionally common as far north as Woods Hole; sometimes straying past Cape Cod, to the mouth of the Bay of Fundy.

Occurrence in the Gulf of Maine.—This southern fish has been taken at Provincetown, Mass., whence the Museum of Comparative Zoology has two specimens; one was taken in the Yarmouth River which empties into Casco Bay, and one in the bay itself on September 15, 1924;¹⁸ it has been reported from Jonesport, Maine; also from Eastport, Maine, in 1908.¹⁹ And a number of them were taken at Campobello Island, at the mouth of Passamaquoddy Bay in September 1937.²⁰

Herring *Clupea harengus* Linnaeus 1758

SEA HERRING; LABRADOR HERRING; SARDINE;
SPERLING; BRIT

Jordan and Evermann, 1896-1900, p. 421.

Description.—The sea herring is typical of its family in form, with body so flattened that it is much deeper than thick; moderately pointed nose; large mouth situated at the tip of the snout and

¹⁸ Reported to us by the late Walter H. Rich of the U. S. Bureau of Fisheries.

¹⁹ Reported in the newspapers.

²⁰ Reported by Leim, Progr. Rept. 21, Atlantic Biol. Sta. Fish. Res. Bd. Canada, 1937, p. 5; and by McKenzie, Proc. Nova Scotia Inst. Sci., vol. 20, 1939, p. 15.

lower jaw projecting a little beyond the upper when the mouth is closed; sharp-edged belly; and deeply forked tail. The dorsal fin stands over the much smaller ventrals, its origin about midway the length of the body. The scales are large, their rear margins rounded, and so loosely attached that they slip off at a touch. There is no adipose fin, and its absence at once distinguishes all the herrings from any of the salmon tribe. The chief anatomical character separating the sea herring from the shad and from the several alewives (genus *Pomolobus*) is that it has an oval patch of small teeth on the vomer bone in the center of the roof of the mouth. Conspicuous field marks separating herring from shad, hickory shad, and alewife are that the point of origin of its dorsal fin is about midway of the length of its trunk (considerably farther forward in the others); its body is not so deep, a difference shown better in the illustrations; and the sharp midline of its belly is only very weakly saw-toothed but is usually strongly so in the others, especially along the space between ventral and anal fins.

Color.—Deep steel blue or greenish blue on the back with green reflections; the sides and belly silvery; the change from dark belly to pale sides often marked by a greenish band. The gill covers sometimes glisten with a golden or brassy gloss; indeed, fish just out of the water are iridescent all over with different hues of blue, green, and violet; but these colors soon fade, leaving only the dark back and silvery sides. The ventral and anal fins are translucent white; the pectorals, however, are dark at the base and along the upper edge; the caudal and dorsal fins are dark grayish or shading into green or blue.

Size.—Herring grow to a length of about 17 inches and to a weight of about 1½ pounds.

Habits.—The herring is a fish of open waters,

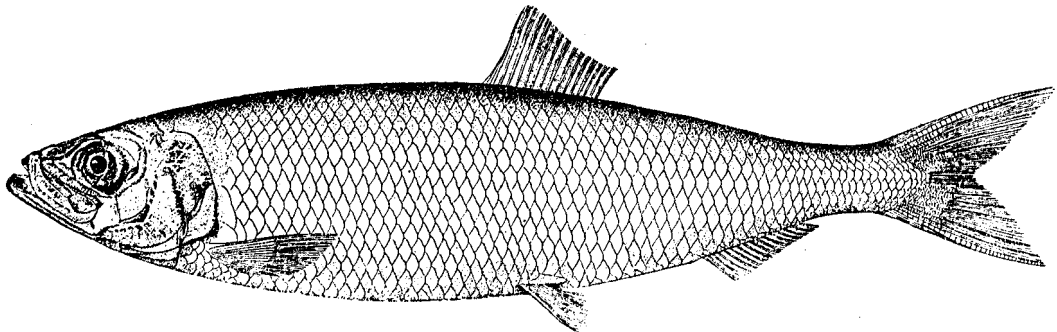


FIGURE 41.—Herring (*Clupea harengus*). From Goode. Drawing by H. L. Todd.

traveling as a rule in schools of hundreds or thousands; single fish are seldom seen, or even small companies of a few dozen. As a rule all the individual members of a school are about the same size, whether large or small. It is not known how long any given school may preserve its identity as such. Fridriksson and Aasen,²¹ it is true, found that herring tagged and released together might be recaptured from widely separated localities, suggesting that schools are more or less temporary formations. But this may not apply to schools that have assembled under natural conditions.

When a school is at the surface, as often happens on a calm day, its presence is betrayed by a fine rippling of the water, but we have never seen herring "finning" or lifting their noses above the surface as menhaden often do (p. 114). They come to the surface most often by night, when their presence is betrayed by their luminous trails, if the water is "firing," as we have often seen. A school is likely to be more or less stationary when feeding, its members swimming slowly to and fro and drifting as a whole with the current.²² But at other times schools are seen traveling with individual fish swimming side by side, rank below rank, as far down in the water as the eye can see from a boat, all heading in one direction apparently with some purposeful intent. We have often watched schools of "sardine" size streaming close past a certain rocky headland in the southern side of Massachusetts Bay, seemingly in unending procession.

As Dr. Huntsman points out, "There is no indication that herring swim against the current unless the water is somewhat turbulent."²³ If they do so under such conditions, it depends on the relationship between their rate of swimming and the strength of the current whether they actually make headway against it or lose ground, tail first.

We might also add that schools of herring, like schools of menhaden, are not so easily frightened by the approach of a boat, as mackerel often are, and striped bass. Herring do not jump unless frightened. But the smaller sizes are often seen jumping when pursued from below by larger pred-

atory fishes, such as silver hake or striped bass, a common spectacle. Fridriksson and Aasen found that herring, held in live-nets, swam constantly at a rate of about 0.2 to 0.25 sea miles per hour (6-8 meters per minute) when not disturbed. And it is certain that they are capable of long journeys, for a number of herring tagged on the northeast coast of Iceland have been recaptured in southern Norway, and some vice-versa.²⁴

The activity of the herring is controlled in great part by the temperature of the water. In Passamaquoddy Bay, for example, they are "observed to move very sluggishly when the water is coldest in February and March,"²⁵ and probably this applies all around the periphery of our Gulf, for the upper 20 fathoms ordinarily cools to about 33 to 36° F. during those months, with the surface often chilling to the freezing point of salt water in bays and harbors. The herring become active again when the water has warmed to about 40 to 43°.

Food.—The herring is a plankton feeder. When first hatched, and before the disappearance of the yolk sac, the larvae (European) feed on larval snails and crustaceans, on diatoms, and on peridinians, but they soon begin taking copepods, and depend exclusively on these for a time after they get to be 12 mm. long, especially on the little *Pseudocalanus elongatus*.²⁶ As they grow older they feed more and more on the larger copepods and amphipods, pelagic shrimps, and decapod crustacean larvae. Examination of 1,500 stomachs²⁷ showed that adult herring near Eastport were living solely on copepods and on pelagic euphausiid shrimps (*Meganctiphanes norvegica*), fish less than 4 inches long depending on the former alone, while the larger herring were eating both.

When feeding on euphausiids, we have often seen them pursuing the individual shrimps, which frequently leap clear of the water in their efforts to escape. Even in winter, when shrimp are rarely seen at the surface, Moore found them an important article in the diet of the Eastport herring. And it is likely that the local appear-

²¹ Fridriksson and Aasen, Rept. Norwegian Fish. Mar. Invest., Skrifter, vol. 9, No. 11, Rept. 1, 1950, pp. 26-27.

²² Huntsman, James Johnstone Memorial vol., 1934, p. 83.

²³ Rept., Norwegian Fish. Mar. Invest. Skrifter, vol. 9, No. 11, Rept. 1, 1950, p. 22.

²⁴ Huntsman (James Johnstone Memorial Vol., 1934, p. 83) gives an interesting account of the movements of herring schools in Passamaquoddy Bay.

²⁵ James Johnstone Memorial Vol., 1934, p. 84.

²⁶ The diet of herring, young and old, in the English Channel and in the North Sea has been described by Lebour in a series of papers (see especially Jour. Mar. Biol. Assoc. United Kingdom, vol. 12, 1921, pp. 458-467), by Hardy (British Fisheries Invest., Ser. 3, vol. 7, No. 3, 1924), and by Jespersen (Medd. Komm. Havund. Ser. Plankton, vol. 2, No. 2, 1928, Copenhagen).

²⁷ Moore, Rept. U. S. Comm. Fish. (1896), 1898, p. 402.

ances and disappearances of schools of large fish in the open Gulf are connected with the presence or absence of euphausiid shrimp of one species or another. A few of the larger fish, however, as well as the smaller ones, will usually be found full of copepods, even when both shrimp and copepods abound, and copepods are the chief dependence of all our herring, large and small, in the absence of shrimp. The amphipod genus *Euthemisto* also is an important food for herring in European seas; hence the absence of *Euthemisto* from the herring stomachs examined by Moore and by us has doubtless been due to the comparative scarcity of this large active crustacean in the coastwise waters of the Gulf of Maine.

The particular species of copepods on which Gulf of Maine and Woods Hole herring depend have not been identified, but we might guess that *Calanus* predominates, with *Pseudocalanus*, *Acartia*, and *Centropages*, and *Temora* also, at its times of abundance, while *Euchaeta* offers a rich food supply when the schools seek the deep waters of the basin frequented by these mammoth copepods.

In default of an abundant supply of Crustacea, and sometimes even when these are plentiful, herring feed on whatever molluscan larvae, fish eggs, Sagittae, pteropods, annelids that the water contains, even on microscopic objects as small as tintinnids and Halosphaera. But the smaller microscopic plants, either diatom or peridinian, are never found in the stomachs of herring more than 15 to 20 mm. long, probably because their gill rakers are not fine enough to retain them.

Although herring normally are not fish eaters, small lance, silversides, and the young of their own species have been found in them at Woods Hole. And Templeman²⁸ reports them as consuming quantities of small capelin, in winter, in Newfoundland waters.

Herring ordinarily pick up their food objects individually by a "definite act of capture" as Battle expresses it,²⁹ while she found that herring in the aquarium at St. Andrews did not feed in complete darkness, though they did in faint light. But it seems that when feeding on very small objects they may strain these out with their branchial sieves as the manhaden does (p. 114), for Moore, a very accurate observer, described them as swimming open mouthed when feeding on

minute crustaceans, crossing and recrossing on their tracks.³⁰

Doubtless it is because of their feeding habits that herring seldom take a baited hook, if they ever do. But we think it likely that large ones when feeding on shrimp would take an artificial fly, as spent and hungry alewives will (p. 104) on their return to salt water, and as shad will on their way upstream (p. 109).

Enemies.—The herring is the best of all bait fishes in our Gulf, where it is preyed upon by all kinds of predaceous fish, especially by cod, pollock, haddock, silver hake, striped bass, mackerel, tuna, salmon, and dogfish, and by the mackerel sharks. Silver hake, in particular, often drive schools of herring up on our beaches, where pursued and pursuers alike strand on the shoaling bottom. We once saw this happen at Cohasset in Massachusetts Bay many years ago, on an October morning, when hake and herring were so intermingled in shallow water at the height of the carnage that we soon filled our dory with the two, with our bare hands. The finback whales also devour herring in great quantities. The short-finned squid (*Illex*) likewise destroys multitudes of the young sardines. On one occasion near Provincetown, in June 1925, we watched packs of perhaps 10 to 50 squids circling around a school of 2- to 4-inch herring, bunching them into a compact mass. Individual squids then darted in, seized one or two herring, ate only a small part, then darted back for more. A silvery streak of fragments of dead herring remaining along the beach bore witness to the carnage.

Breeding habits, development and growth.—Much attention has been devoted to the breeding habits and growth of the herring by European zoologists, by Moore, and by Huntsman in our own Gulf, and by Lea³¹ in more northern Canadian waters.

Herring may spawn in spring, in summer or autumn, according to locality, or both in spring and autumn (for further information on this matter, see p. 98). They do so chiefly on rocky, pebbly, or gravelly bottoms, on clay to some extent, probably never on soft mud. Spawning in the Gulf of Maine (including the Bay of Fundy), takes place chiefly from 2 or 3 fathoms down to about 30 fathoms; perhaps never in the littoral

²⁸ Bull. Newfoundland Government Lab., No. 17, 1948, p. 133.

²⁹ Ann. Rept. Biol. Board Canada (1933), 1934, p. 14-15.

³⁰ Rept. U. S. Comm. Fish. (1896), 1898, p. 402.

³¹ Age and growth of the herrings in Canadian waters. Canad. Fish. Exped., 1914-15 (1919), pp. 75-104.

zone, nor has herring spawn ever been reported as cast up by the surf on the beaches of New England, a fate that often overtakes it in the Gulf of St. Lawrence. Occasionally they spawn as deep as 100 fathoms in Scandinavian waters, perhaps also in the eastern basin of our Gulf where the sea floor is hard, not soft and muddy as it is in the basins in the western side. During the act of reproduction as observed by Moore at Cross Island and at Machias, Maine, "the fish were darting rapidly about, and those who have opportunity to see the fish spawning in more shallow water where observation is more favorable, state that both males and females are in constant motion, rubbing against one another and upon the bottom, apparently by pressure aiding in the discharge of the eggs and milt."³²

A female herring may deposit from 20,000 to upwards of 40,000 eggs, according to her age and size, averaging about 30,000. In sexually mature herrings, the genital organs are so large just before spawning commences that they make up about one-fifth the total weight of the fish.

The eggs sink to the bottom, where they stick in layers or clumps to the sand or clay, to seaweeds, or to stones, by means of their coating of mucus, or to any other objects on which they chance to settle. They are often found massed on net warps, anchors, and anchor ropes. The individual eggs are 1 to 1.4 mm. in diameter, depending on the size of the parent fish and also, perhaps, on the local race of fish involved. The period of incubation is governed by temperature; European students tell us that it requires as long as 40 days at 38–39°, 15 days at 44–46° and 11 days at 50–51° F.; while experiments on the Massachusetts coast by the U. S. Bureau of Fisheries gave 10 to 12 days in the temperature prevailing there in autumn. And MacFarland³³ found that all of the eggs kept at Grand Manan at about 59° (15° C.) hatched, but that none hatched at 32–41° (0–5° C.), and that all died that were warmed to 68° (20° C.). Ten to fifteen days might be stated as an average incubation period for the Gulf of Maine, under existing temperatures.

The larvae of the herring family are very slender and can easily be distinguished from all other young Gulf of Maine fish of similar form (e. g., launce, smelt, or rock eel) by the location of the

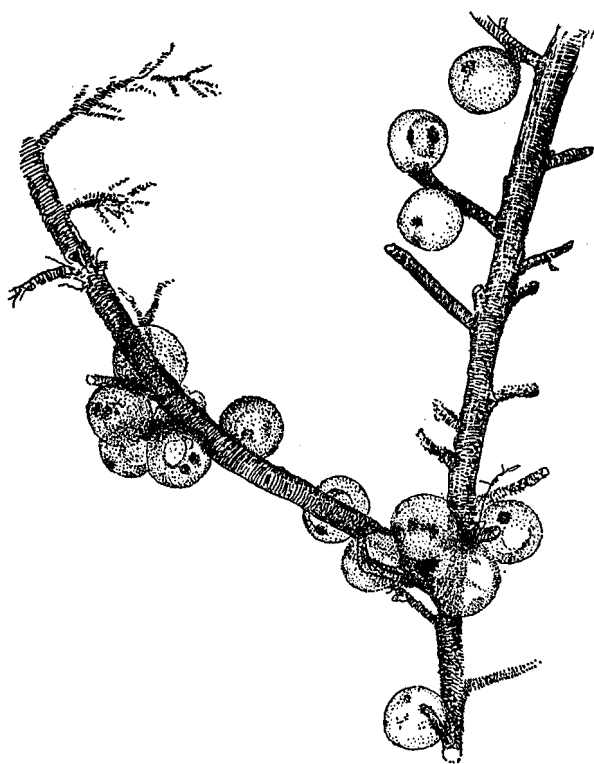


FIGURE 42.—Eggs of the herring (*Clupea harengus*), attached to seaweed (European). After Ehrenbaum.

vent, which is so far back that it lies close to the base of the tail. But it requires critical examination to distinguish our several clupeoids one from another in their early stages.

The sea herring is about 5 to 6 mm. long at hatching, with a small yolk sac that is absorbed by the time a length of about 10 mm. is reached. The dorsal fin is formed at 15 to 17 mm.; the anal at about 30 mm.; the ventrals are visible and the tail well forked at 30 to 35 mm.; and at about 40 mm. (1½ in.), the little fish begins to look like a herring.

According to Huntsman's observations, fry produced on the Grand Manan spawning grounds in late summer and early autumn grow to a length of 17 to 20 mm. by the end of November or first of December; they are 26 to 50 mm. (1–2 in.) long in March and April and 50 to 60 mm. (2–2½ in.) long by June when fry of this size are abundant in the St. Andrews region. This is in line with our own observations that fry of 2 to 2½ inches (50–65 mm.) predominate among the young herring at Provincetown at the end of June, and fry of 2½ to 4 inches (54 to 100 mm.) on Nantucket

³² Moore, Rept. U. S. Comm. Fish. (1896), 1898, p. 412.

³³ Rept. Biol. Board Canada (1930), 1931, p. 23.

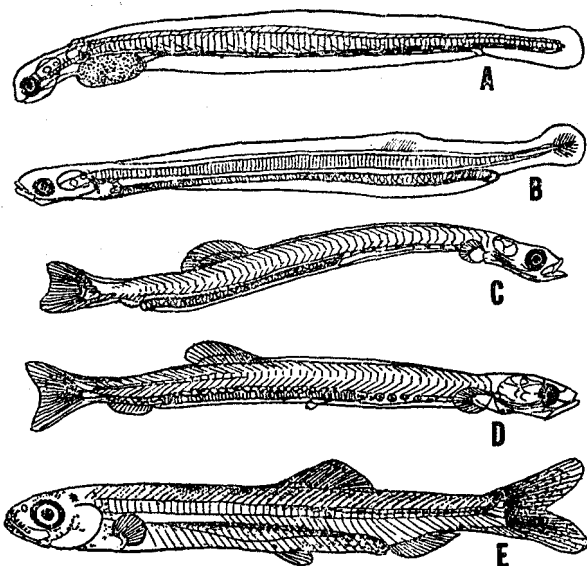


FIGURE 43.—Larval stages of the herring (*Clupea harengus*) European. After Ehrenbaum. A, newly hatched, 7 mm.; B, 10 mm.; C, 19 mm.; D, 29 mm.; E, young fry, 41 mm.

Shoals in mid-July. They grow to about $3\frac{1}{2}$ to near 5 inches (90–125 mm.) by the end of their first year of life; fish of that size, presumably of the previous autumn's hatch, are abundant in the fall in the Bay of Fundy, and at Boothbay, Maine. The growth rate is about the same at Woods Hole, where herring spawned in October and early November are 3 to 5 inches (76–125 mm.) long by the following autumn. The Norwegian herring, also, average about 5 inches (125 mm.) long at the end of their first year, according to Hjort, and North Sea herring are about 4 inches (100 mm.) long then.³⁴

Subsequent growth.—The herring has proved a particularly favorable object for growth studies based on the structure of the scales.³⁵ Without pursuing this subject, which would lead us far afield, we may point out that herring not only grow at different rates at different times of year, with the contrast between the rapid growth of summer and the slow growth of the winter greater or less in different seas, but that they grow rapidly when young and slowly thereafter in some locali-

ties, whereas they may grow slowly at first in other localities, but sustain a more even growth to old age.

The Dogger Bank herring, for example, in the North Sea approximate 4 inches in length at the end of the first year, $8\frac{1}{2}$ to 9 inches at the end of the third year, $10\frac{1}{2}$ at the end of the sixth, and $11\frac{1}{2}$ to 12 inches at the end of the ninth, though with considerable variation. The Norwegian herring, however, spawned in the year 1899, averaged only $7\frac{1}{4}$ inches when 3 years old, but were as large as the Dogger Bank fish of equal ages by their sixth year and subsequently.³⁶ Newfoundland herring grow more slowly at first than those in the southern side of the Gulf of St. Lawrence, but catch up with them as they grow older.

Huntsman credits the Bay of Fundy herring with about 10 inches at the end of their third year; i. e., when 4 years old, which agrees closely with an average growth of $9\frac{1}{2}$ inches at 4 years as calculated by Lea for Gulf of St. Lawrence fish. The average growth rate of the older Bay of Fundy fish probably falls between that of the Gulf of St. Lawrence fish and that of the herring of outer Nova Scotia which grow a little faster; i. e., to between $10\frac{1}{4}$ and $11\frac{3}{8}$ inches at 5 years; between 11 and $12\frac{1}{2}$ inches at 7 years; and between $12\frac{1}{2}$ and $13\frac{3}{8}$ inches at 9 years.³⁷ Bay of Fundy herring make most of their growth from May to September. In the southern parts of our Gulf, where the growth period probably continues a month later into the fall, they may grow as fast as they do along outer Nova Scotia.

When the little herring have reached an age of about 2 years and a length of $7\frac{1}{2}$ to 8 inches (190–200 mm.) they accumulate large amounts of fat among the body tissues and viscera during the warm months of the year when growing rapidly, but lose this fat in winter and also at the approach of sexual maturity. We can bear witness and the fact is well known to fishermen that this "fat" stage is as characteristic of American waters as of European, where "fat" herring are the objects of extensive fisheries.

According to Moore, who examined thousands

³⁴ Huntsman (Canad. Fish. Exped. (1914–1915), 1919, pp. 168–169) believed he could recognize spring as well as autumn-spawned herring fry in the Bay of Fundy, and credits the former with a length of about 90 mm. by the first, and 150 mm. by the second, winter. But this seems to call for confirmation, it being unlikely that any herring now spawn there in spring (p. 98).

³⁵ See Lea (Canad. Fish. Exped. (1914–15), 1919, pp. 75–164) for an account of age determination by analysis of the scales, as applied to the herring.

³⁶ Rapp. and Proc. Verb., Cons. Internat. Explor. Mer, vol. 20, 1944.

³⁷ As scaled from Lea's diagrams (Canad. Fish. Exped. 1914–1915 (1929), figs. 40 and 41). It has been found that the Norwegian herring grow from April to September only, remaining practically stationary in length from October until March; see Lea (Pub. de Circ., Cons. Perm. Internat. Explor. Mer, No. 61, 1911, pp. 35–57) and Hjort (Rapp. Proc. Verb., Cons. Perm. Internat. Explor. Mer, vol. 20, 1914).

of fish about Eastport, herring rarely spawn when less than 9½ inches long; usually not until they are 10 to 10½ inches; and most of the spawners are 12 to 13 inches long. This means that some few spawn when only 3 years old, if the growth schedule outlined above is correct, but most of them not until 4 years or older, to continue spawning annually thereafter as long as they live. In Norwegian waters, too, a few spawn at 3 years, many at 4 years, and the majority at 5 years; some few not until 6 years old. Herring have been seen as old as 20 years, and they may live even longer.

Success of reproduction.—The relative abundance of any species of sea fish from year to year depends less on how many individuals spawn in any locality than it does on how many of the resultant fry survive. And the many age analyses that have been made of herring in European waters have proved that while a very large crop of young may be produced in some years, hardly any are in others, even in favorable nurseries. Apparently this applies more to the northern breeding grounds than to the southern (to some extent, however, to all) the result being that the herring spawned in some one favorable breeding season may dominate the schools over large areas for many years, or until another successful breeding year comes, producing another large crop. In Norwegian waters, for example, the herring produced in 1904 was dominant in the catches for the next six years, at least; this is a classic instance. Lea found, similarly, that herring hatched that same year (1904) dominated the catches on the west coast of Newfoundland as long afterwards as 1914 and 1915. And while precise information is not available for our Gulf, no doubt the same rule governs there.

One case, at least, is well documented of a particular body of Bay of Fundy herring that received no important recruitment for something like 10 years, when the few still remaining seem to have disappeared, from old age (p. 99).

Various explanations have been proposed to account for this, such as abundance or scarcity of microscopic plankton, favorable or unfavorable temperature, salinity, or other factors, all of which may enter in. And while it is during the first few weeks of life that the herring is most vulnerable, it is also possible that the conditions

under which the parent fish lived for the year preceding spawning may influence the fate of the fry. Whatever the explanation, the fact that such fluctuations do occur from year to year, in the numbers of fry reared is of the greatest practical interest to all concerned with the sea fisheries, as evidence that variations existing in the stock of herring, and consequently in the catch, may be due more to the success or failure of reproduction than to any effect the fishery may have on the stock.

General range.—Both sides of the North Atlantic. Off the European coast the herring ranges north to Norway, Iceland, Spitzbergen, and the White Sea; south to the Straits of Gibraltar. It is known on the American coast as far north as northern Labrador and the west coast of Greenland; regularly and commonly as far south as Cape Cod and Block Island; and it is occasionally seen in small numbers as far south as Cape Hatteras in winter. It is replaced by a close ally (*C. pallasii*) in the North Pacific.

Occurrence in the Gulf of Maine.—To list the localities where herring have been recorded would be to mention every hamlet along our coasts whence fishing boats put out, for more or less herring, large or small, appear at one season or another around the entire coast line of the Gulf, and on the offshore fishing banks as well. They also enter bays and estuaries freely, but they have never been reported in our Gulf from water that is appreciably brackish; perhaps 2.8 percent salinity³⁸ may be set at about their lower limit.

The distribution of commercial catches, plotted by Needler (fig. 44)³⁹ shows that herring are far more plentiful from Casco Bay eastward along the coast of Maine, and especially in the Passamaquoddy Bay-Grand Manan region than they are along the western shores of the Gulf on the one hand, or up the Bay of Fundy on the other, or along western Nova Scotia. Thus the landings per unit length of coast averaged 3 times as great for the Passamaquoddy-Grand Manan region and for the coast of Maine to Mount Desert, as for the coast sector from Mount Desert past Penobscot Bay; about 4 times as great as for the Maine coast as a whole, westward and southward

³⁸ Surface, in Bay of Fundy in May.

³⁹ A reliable index, for the herring is a valuable fish.

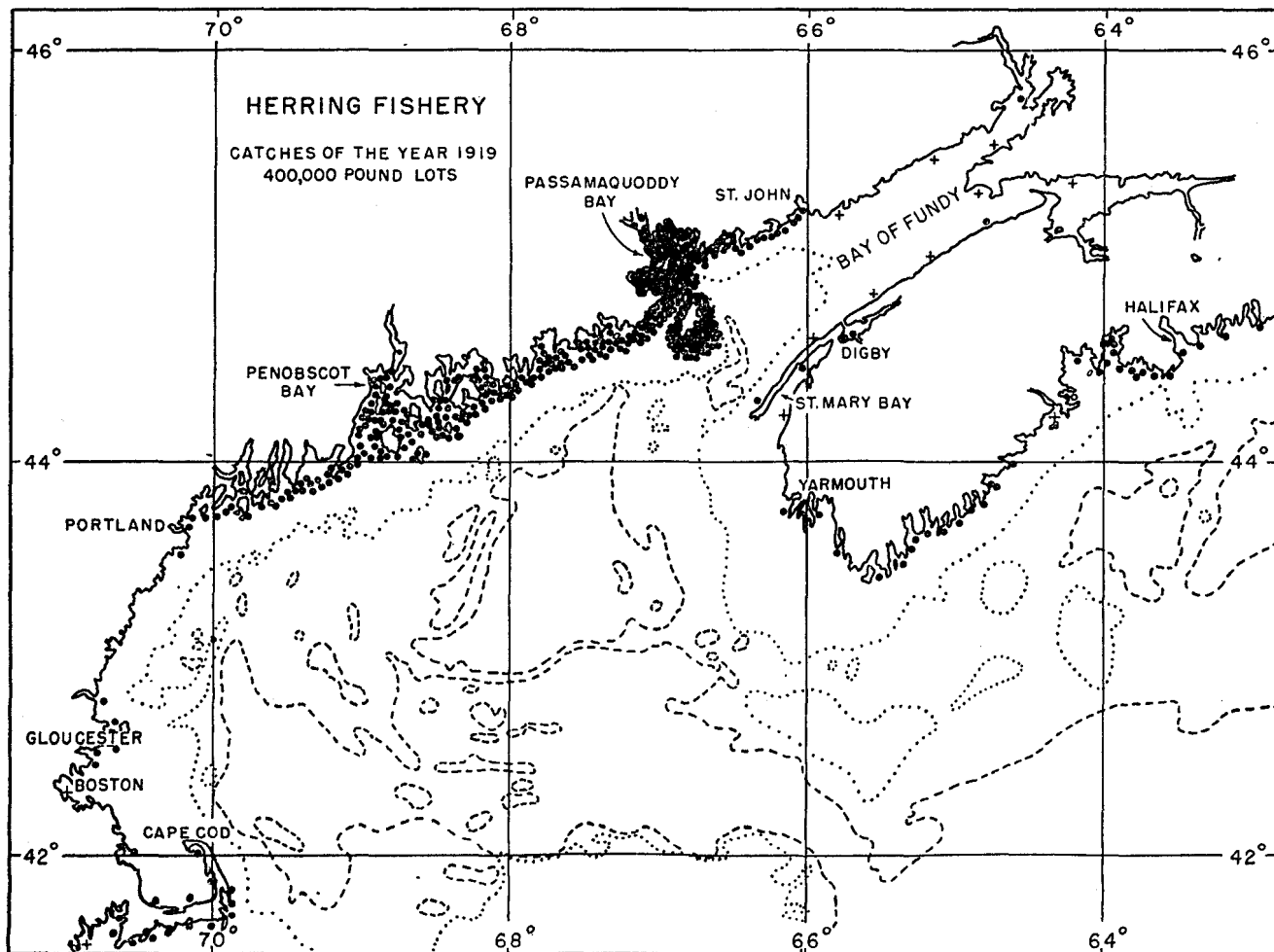


FIGURE 44.—Catches of herring for the year 1919. Each dot represents 400,000 pounds. After Needler.

from Penobscot Bay; and 13 times as great as for the coast of Massachusetts,⁴⁰ for the years 1919, 1928, 1929, and 1930.⁴¹

Present day landings of upwards of 30 million pounds of sardines alone, for Charlotte County, New Brunswick, even in poor years, up to something like 100 million pounds in good years, plus some 9–14 million pounds of larger herring, contrasted with a maximum of only about 17 to 18 million pounds reported for 1947 for any sector of the Maine coast of comparable length,⁴² show that the Passamaquoddy–Grand Manan region has not lost its preeminence as a herring center. The abundance of little herring there is, in fact, the outstanding feature of the distribution of fishes in

the Gulf of Maine. A catch of about 2,400,000 pounds for Massachusetts in 1947, contrasted with some 11,300,000 pounds for the Penobscot Bay region alone in that year, illustrates how much less rich in herring the southwestern side coast line of the Gulf is than the sector that happens to be the least productive part of the northern coast line of the Gulf.

Fishermen tell us, too, that herring are much more regular in their occurrence from year to year in the Passamaquoddy–Grand Manan region than they are either off western Nova Scotia in the one direction, or along the coast of Maine in the other. And this is borne out by such statistics as are conveniently available. Thus only one-fourth to one-fifth as many pounds of herring were caught in the Penobscot Bay region⁴³ in 1947 as either eastward

⁴⁰ Omitting the landings for Suffolk County, Mass., since these represent fish discharged at Boston by the vessel fisheries from offshore.

⁴¹ Graham, *Jour. Biol. Board Canada*, vol. 2, No. 2, 1936, p. 129, table 2.

⁴² Scattergood has given an interesting analysis, regional and seasonal, of the 1947 catch of herring for the coast of Maine.

⁴³ Scattergood's statistical areas 11–14.

to Lubec Narrows on the one hand, or westward past Casco Bay to Cape Elizabeth on the other,⁴⁴ whereas the catches for 1919 were rather evenly distributed along the northern and eastern Maine coast as a whole.

We find herring even more and more sporadic in their appearances and disappearances, both from place to place, from week to week, and from year to year, passing southward around the western periphery of the Gulf. Very few, for example, are seen on the southern side of Massachusetts Bay in some years (as in 1950 and 1951); many schools in others. And herring are such wandering fish in general, here today and gone tomorrow even in their centers of abundance, that the successful location of the weirs depends largely on intimate local knowledge and on close observation of the movements of the schools.

Herring appear, also, to be far less plentiful on the offshore banks and less regular in their occurrences there than they are in their inshore center of abundance in the northeastern part of the Gulf. Trawlers, it is true, occasionally pick up schools on Georges Bank and on Browns Bank, as in 1931, when catches of 3,000 pounds were reported on the northern edge of Georges and of 2,800 pounds on the southwestern part in October. Schools, too, are occasionally reported as seen at the surface, by *Albatross III* for instance, in April-May 1950. Fishermen used sometimes to set drift-nets on Georges for herring for bait in the days of the long line fishery, and small numbers up to 130-160 per haul, were trawled by *Albatross III*, widespread on the western part in depths of 20 to 50 fathoms in May 1950, as well as off southern New England.⁴⁵ But it is more usual for trawlers operating on Georges to pick up only odd fish or none. Thus the maximum catch on any trip during the otter trawl investigation of 1913 was only a dozen or two; 42 hauls by the *Eugene H.*, in late June 1951, yielded only one herring, fishing from Nantucket Lightship out onto the south-central part of Georges; and the stomachs of cod caught on Georges seldom contain herring, if they ever do.⁴⁶

The appearance of schools of large herring or of small is distinctly a seasonal event off most parts

of our coast, and the picture is made still more complex by differences in the behavior of sardine-size, "fat," and spawning herring, the reasons for which are not yet well understood.

The newly spawned fry, less than $\frac{3}{4}$ of an inch (9-11 mm.) long, have been taken in September in the lower part of the Bay of Fundy, a product, doubtless, of the Grand Manan and West Nova Scotia spawning; also in October in Gloucester Harbor where one tow-net haul yielded us a great number on the 24th, in 1916. And they are to be expected wherever herring spawn in numbers in any particular year. It seems likely that most of them remain near their birth place during their first autumn and winter, when the circulation of the Gulf is in its least active stage. But they become widely distributed during the spring (March-May), when $1\frac{1}{2}$ to 2 inches (30-50 mm.) long, both in the lower Bay of Fundy, around the entire periphery of the open Gulf, east as well as west, out over the basin, and on the northern and eastern parts of Georges Bank.⁴⁷

Little seems to be known in detail about the movements of herring during their first year, but those that find their way into enclosed waters where mid-summer temperatures are high, such as Duxbury and Plymouth Bays and Provincetown Harbor, appear to move out during the early part of the summer, being reported as far less plentiful there in June than they are in April and May. Sardine-size herring, 4 to 8 inches long including 1- and 2-year-olds, are to be expected in abundance all summer east of Penobscot Bay, and particularly in the Passamaquoddy Bay region, where they support the sardine fishery for which the latter is famous, and where they are present throughout the year.

It is probable, however, though not proved, that the 1- to 2-year-olds (fish in their second and third years) do not appear along the southwestern coasts of the Gulf until several months later in the season than the little fish of $\frac{1}{2}$ to 2 inches do, that were hatched the preceding autumn. Thus it usually is not until late June, July, or August that "sperling" of 4 to 7 inches are reported in numbers off the Massachusetts coast, or that we

⁴⁷ During March and April 1920 we took them near Cashes Ledge, on the northern and eastern parts of Georges Bank, off Seal Island; off Yarmouth, Nova Scotia; near Machias, Maine, and over the basin in the offing; near Boothbay; and near the Isles of Shoals. Graham (Jour. Biol. Board Canada, vol. 2, No. 2, 1936, p. 112, fig. 8) found them equally widespread in the open Gulf in May 1932, also in the lower Bay of Fundy (none, however, at the head of the Bay).

⁴⁴ Coast sectors of comparable length.

⁴⁵ Average catches per haul about 50 fish at 22 to 40 fathoms, and 28 at 41 to 50 fathoms, but only 8 at 51 to 60 fathoms.

⁴⁶ W. F. Clapp found no herring in many cod and haddock stomachs examined by him on Georges Bank.

have seen them there. They are even more erratic, too, in their appearances and disappearances in Massachusetts Bay and along Cape Cod than they are to the eastward of Mount Desert. At Cohasset, for example, on the southern shore of the Bay where we have had many years' experience, schools of sperling are here today in summer and early autumn, but gone tomorrow. It is also our impression that the sperling, like the larger herring, are not only far less concentrated in favorable localities around the southwestern shore of the Gulf than they are to the north and east, but far less numerous on the whole.⁴⁸

These first two year classes (the fish in their first year having grown to a length of 3 or 4 inches by September; those in their second year to 7 to 9 inches) begin to thin out from the shore waters of the open Gulf after the middle of October as the water cools, and few "sardines" are taken there after early December.

The corresponding ebb and flow, so to speak, for the sardine is suggested in a striking way by the average monthly catches of sardines by the weirs in Charlotte Co., New Brunswick (Passamaquoddy Bay, Campobello, and Grand Manan) for the year 1920, which are equally illustrative of conditions today:

Month	Pounds	Month	Pounds
January.....	11, 000	July.....	3, 315, 000
February.....	None	August.....	6, 475, 000
March.....	56, 000	September.....	6, 730, 000
April.....	1, 049, 000	October.....	6, 012, 000
May.....	3, 036, 000	November.....	1, 325, 000
June.....	2, 542, 000	December.....	147, 000

Here, however, the seasonal variation (as Dr. Huntsman informs us) is simply a matter of local availability, for sardines remain in Passamaquoddy Bay all winter, but do not move about much then. Probably the sardines winter mostly on the bottom. And there is no reason to suppose that the bulk of them travel far in any part of the Gulf.

Very little is known about the Gulf of Maine herring during their third summer, when they have passed the "sardine" or sperling stage and have not yet reached spawning age. In some years these "fat" herring, as they are often called,

⁴⁸ No particular attention is paid to sperling around Massachusetts Bay, for they are too small to be in demand for bait, and they are not plentiful enough (or not concentrated enough) to support a sardine fishery there.

or "summer" herring, weighing up to about one pound (they are called "spawn" herring locally, but this is an error), are taken in the traps at Provincetown for a week or so about mid-April; they are taken at about the same time off Gloucester (in 1915 they were reported 8 to 15 miles off Cape Ann on the 17th), and they are said by the fishermen to "show" first off Seguin Island in May and June, off Mount Desert late in summer. Doubtless they form a large part (just what proportion is not known) of the catches of herring larger than sardines that are made in the Passamaquoddy Bay region, also around Grand Manan. As a rule few of them are taken inside the inner islands elsewhere, though they came into the harbor of Boothbay about May 14 in 1914.

When a mackerel seiner picks up a school of herring out in the open Gulf in summer,⁴⁹ or when an otter trawler makes a catch of herring on Georges Bank (p. 95), most of them are very fat and show no signs of approaching sexual maturity. Thus it seems that they tend to keep farther offshore than do either the younger herring or the still older mature herring.

The peak season for herring larger than "sardines" inshore in the northeastern part of the Gulf is ordinarily from July through October; i. e., some 2 months less than that for the sardines (see p. 96). But a greater proportion of the larger fish continue available there through the cold months than of the younger fish, to judge from the fact that considerably larger catches are made of big herring in winter than of sardines, whereas the total local catch is much larger for the latter than for the former.

A report⁵⁰ on the average monthly landings of large herring for Charlotte County, for the period 1920-1931, to the nearest 1,000 pounds, follows:

Month	Pounds	Month	Pounds
January.....	132, 000	July.....	1, 065, 000
February.....	164, 000	August.....	4, 334, 000
March.....	275, 000	September.....	7, 098, 000
April.....	312, 000	October.....	2, 817, 000
May.....	306, 000	November.....	646, 000
June.....	284, 000	December.....	268, 000
Large herrings, yearly average.....		17, 701, 000	
"Sardines", yearly average.....		30, 698, 000	

⁴⁹ Many events of this sort have been reported. For example, a large catch of fat summer herring was made on Georges Bank and reported to the Massachusetts Commissioners in the mid-summer of 1901.

⁵⁰ From Graham, Jour. Biol. Board Canada, vol. 2, No. 2, 1936, p. 130, table 3.

Large herring (Dr. Hunstman tells us) are also present there throughout late winter and spring, though few find their way then into the weirs.

In the southeastern part of the Gulf, as typified by Cape Cod Bay, large herring appear inshore in greatest numbers to about June and again in the autumn, with very few (and not many sardines) in June or July. This is illustrated by the largest and smallest catches made in 8 traps at North Truro for different months during the years 1946 to 1952. The following data are contributed by the Pond Village Cold Storage Company:

Month	Minimum (in pounds)	Maximum (in pounds)
April.....	0	117, 375
May.....	221	523, 550
June.....	0	88, 657
July.....	0	0
August.....	0	1, 000
September.....	0	57, 287
October.....	0	9, 526
November.....	0	176, 435

The earliest catch of sardines there in those years, or in 1935, 1938, or 1943 was sometime in May, the latest November 16 to 17; the earliest catch of large herring was made between April 20 and 30, the latest on December 10th.

In most years the large herring vanish from the Massachusetts coast at some time in December. In 1950, for example, they vanished about December 4th from Ipswich Bay, where considerable catches had been made for some time previous by about 15 boats.⁵¹

Nothing is known, definitely, as to their seasonal appearances and disappearances over the offshore banks.

About all that is known of the movements of the large mature herring (in their fourth summer and older) is that they are encountered in numbers only for the brief period before, during, and after the spawning season, when they are seen schooling at the surface, and are caught along shore. Fishermen report that they show about the off-lying islands some time before they make their way up the bays; two or three weeks earlier, for instance, at Grand Manan, Jonesport, and about Mount Desert Island than within Machias Bay. They are said to appear some time after the middle of July at Isle au Haut at the eastern entrance of Penobscot Bay, and at Castine within the Bay, though not until the end of that month

or the first of August at Matinicus Island. Such of them as visit the Massachusetts Bay region are not expected there until the last week in September. But they are in full force on all the spawning areas along the shores of the Gulf by October, from Grand Manan to Cape Cod; they are equally widespread, if less abundant, inshore in November, and they are reported in December occasionally, and even later. It is probable that as the fish spawn out most of them move out promptly from the spawning grounds into deeper water, for fish recently spent are not often reported as taken in the weirs.

Probably the spawners merely descend into deeper water to winter, as is the case in European waters. How deep the great body of them go is not known. But it has been proved that herring of all ages remain in the open Bay of Fundy throughout the cold season; also in the passages between the inner and outer divisions of Passamaquoddy Bay, even when water temperatures there are as low as 32° F.⁵² And the abundance of pelagic euphausiid shrimps (a favorite herring food) in the deeper water layers of the northeast corner of the Gulf suggests this as a rich winter pasture for them.

Studies carried out from the Atlantic Biological Station at St. Andrews, chiefly under Dr. A. G. Huntsman's⁵³ leadership, and by the International Passamaquoddy Fisheries Commission⁵⁴ during the early 1930's seem to us to have proved that the factor chiefly responsible for the great concentration of young herring in the Passamaquoddy region, and for their availability to the weir fishery there, is the differential circulation of the shoaler and deeper water layers that is set in motion by the inflow of fresh water from the tributary streams combined with superficial currents set up temporarily by the wind. In other words, the sardine-sized herring acts as does any planktonic animal such as the euphausiid shrimps and the copepod crustaceans, on which it feeds, as it swims to and fro, i. e., it drifts with the current. In technical language, it is "denatant."

The case is not so clear for the larger herring, not because there is any reason to suppose they can direct their journeys more intelligently, and because any directive swimming they may carry

⁵¹ Huntsman, James Johnstone Memorial Vol., 1934, p. 82.

⁵² For summary, see Huntsman, James Johnstone Memorial Vol., 1934, pp. 95-96.

⁵³ See Graham, Jour. Biol. Board Canada, vol. 2, 1936, No. 2, pp. 95-140.

⁵⁴ This happening was reported in the daily papers.

out is far more effective because more rapid; but because so little is known as to journeys any individual school actually makes as season follows season, whether of fat herring or of spawners. Perhaps the most interesting question of all, and one as yet unsolved, is how and why the spawning fish seek their spawning grounds year after year, when their sex organs mature.

Spawning grounds and season.—It appears that the most productive spawning ground for our Gulf formerly was and still is at the mouth of the Bay of Fundy, particularly on the shoals southwest of Grand Manan. The Trinity Ledges off western Nova Scotia are another important ground; and herring are reported as spawning commonly, though irregularly, in Machias Bay; about Jonesport; at Mount Desert; in Frenchmans Bay; among the islands at the mouth of Penobscot Bay (Swans, Isle au Haut, and Matinicus); in Casco Bay; also about Wood Island a few miles south of Cape Elizabeth, which has long been known as the resort of breeding schools. Herring have also been found spawning off the beaches along the western shore of the Gulf, Ipswich Bay, for example; about Cape Ann; in Massachusetts Bay; about Provincetown; along outer Cape Cod; in the Woods Hole region; near No Mans Land; and about Block Island which is the southern breeding limit. But whatever spawning does take place either southward from the vicinity of Cape Elizabeth on the one hand, or in the inner parts of the Bay of Fundy on the other, is trifling as compared with the production along the eastern coast of Maine and in the Grand Manan region.

Spawning takes place both along shore in our Gulf and on the various shoals and ledges that lie for 5 to 25 miles off the coast, a habit betrayed by the eggs that are found sticking to the anchor ropes of fishing vessels. But we find no definite record of herring spawning on Browns or Georges Banks, nor are young fry known there, a fact that was commented upon by Storer long ago.

Spawning season.—Both spring-spawning schools and summer-fall spawning schools of herring were reported formerly, in the Bay of Fundy, the spring spawners visiting the south (Nova Scotia) side of the bay from Bier Island at the mouth in as far as Digby Gut, also the Parrsboro region on the New Brunswick shore near the head of the bay, spawning during April

and May. But they seem never to have been very numerous, and it is not known whether any spawn now in the bay before summer. Spring-spawning as well as autumn-spawning herring have also been reported to us by fishermen along the west coast of Nova Scotia, though we have not been able to verify this. Other than this, spring spawners are neither recorded nor rumored anywhere in the Gulf of Maine.

Around Grand Manan and in Machias Bay nearby, the heaviest runs of summer-autumn spawners usually come in July, August, and September, the spawning season continuing until late in the fall in some years,⁵⁵ but not commencing until early August, and ending by early October in others.⁵⁶ Passing westward we find the breeding period progressively later and shorter; mid-August for example until October around Petit Manan and near Mount Desert, while the few herring that spawn farther south do so chiefly during October in Ipswich⁵⁷ and Massachusetts Bays; in late October and early November in the vicinity of Woods Hole.

So many observations have been taken in the Gulf from the vessels of the Bureau of Fisheries, and in the Bay of Fundy by the Biological Board of Canada, that it is possible to establish the temperatures rather closely at which herring spawn in our waters. Around Grand Manan and in the northern part of the Gulf generally, practically all spawning is carried out in water of about 46–52° F. But such herring as spawn in the southern part of Massachusetts Bay and along the shores of Cape Cod, where autumnal cooling of the surface waters is not so rapid as it is farther north, may do so in slightly warmer water, say up to 53° or 55°. The Gulf of Maine herring spawn in rather low salinities (such characterize the coastal zone as a whole as compared with the North and Norwegian Seas), the most saline water in which it is known to spawn within our limits being not saltier than 33 per mille, the freshest probably about 31.9 per mille. They never spawn in brackish water within the limits of the Gulf, although known to do so at the mouths of certain European rivers in water that is nearly fresh.

Destruction by natural causes.—The herring is a very "tender" fish, prone to wholesale destruction

⁵⁵ So described by Moore, Rept. U. S. Comm. Fish. (1896), 1898, p. 408.

⁵⁶ Dr. Huntsman informs us that this was the case in 1917.

⁵⁷ Allen, Mem. Boston Soc. Nat. Hist., vol. 8, No. 2, 1916, p. 201.

both by stranding on beaches during storms, and by pollution of the water. Many instances of this kind have been reported. Allen,⁵⁸ for example, saw young herring in windrows for miles on the strand at Rye Beach, N. H., in August 1911. A slaughter of herring (still more instructive because the exact course of events was followed) took place at Cohasset, on the south shore of Massachusetts Bay, in October 1920. On the 5th of that month a large school of "sperling," 4 to 5 inches in length, ran up the harbor (which is nearly landlocked), probably driven in by silver hake (at least so local fishermen said); were trapped there by the falling tide, and stranded on the mud. So numerous were they that the flats were entirely covered with them and it was estimated that 20,000 barrels of fish perished. During the next few days the fish (alternately covered and uncovered by the tide) decayed, and despite the tidal circulation, so fouled the water that lobsters impounded in floating cars died. On the 10th there was a second smaller run of herring, and on the 15th a third run came as numerous as the first, the newcomers dying soon after they entered the harbor. Altogether, it was estimated that 50,000 barrels of fish perished, of which more than 90 percent were "sperling," 5 to 10 percent were large adults, and a few were small mackerel and silver hake, besides large numbers of smelt. The flats were silvery with herring scales at low tide by the last half of October, when we saw them, and the residents about the harbor found the stench almost unbearable. But the fish decomposed and the water purified itself during the winter months.

Mass destructions of young herring have also been reported in other Gulf of Maine harbors. Thus, Dr. Austin H. Clark reported that early in August 1925 the mud flats in Manchester Harbor, on the north side of Massachusetts Bay, were white with stranded herring 3 to 5 inches long, packed several deep at low tide along the sides of the little drains and hollows. Another such destruction took place in the same harbor in the summer of 1928. Vast quantities of herring spawn are likewise cast up on the beaches every year to perish in north European waters; this also happens to some extent in the Gulf of St. Lawrence.

Numerical abundance and importance.—Moore

(1898), who sifted many sources of information concluded (we believe rightly) that no general decrease had taken place in the abundance of young herring at the mouth of the Bay of Fundy up to that time. But it is common knowledge among fishermen that both the numbers visiting any given locality on our coast and the duration of their stay varies widely, not only from year to year, but over longer periods. Local spawning grounds, too, may be abandoned for a term of years—a common occurrence.⁵⁹

The best documented case of local disappearances from a previously productive ground took place, as Dr. Huntsman writes us,⁶⁰ from the shoals southwest of Grand Manan, whence large herring (previously very plentiful) withdrew in 1877, to reappear in 1881 on the Nova Scotia coast between Cape Sable and Digby. Dr. Huntsman has suggested that they had circled the Gulf offshore, for their exodus from the Grand Manan shoals was not accompanied by any coincident increase in the catch along the eastern part of the coast of Maine, but rather by the reverse.⁶¹ They persisted on the Nova Scotia shore until 1890, when they gave out, probably from old age, for the large herring that remained in the Quoddy region also dwindled in numbers as shown by the collapse of the winter fishery there, evidence that this particular body of herring did not receive any significant recruitment after about 1880–1881. It remains to be seen whether large herring will ever reappear in their former plenty on the Grand Manan ground, as they did about 1857 in Massachusetts Bay, where the stock had been at a low ebb since 1837; or whether the yearly drain on the population of young herring by the sardine fishery (well started by about 1880) is too great.

The largest reported catch of herring for the Gulf as a whole for any year since 1928 for which statistics are readily available was 219,131,500 pounds taken in 1946, divided as follows: Massachusetts, 2,049,000 pounds; Maine, 80,107,400 pounds; and the Canadian shores of the Gulf, 136,975,100 pounds. The smallest catch was 70,519,886 pounds in 1932, divided 5,687,254 pounds, 31,988,132 pounds, and 32,844,500 pounds,

⁵⁸ Moore, Rept. U. S. Comm. Fish. (1896), 1898, p. 430.

⁵⁹ Based on Canadian fishery statistics.

⁶¹ Earll (Fisheries and Fish. Ind. U. S., sect. 5, vol. 1, 1887, pp. 423, 424) states that the fishery declined near Bois Bubert Island from 1875 to 1880, and that the catch was "considerably below average" at Matineus during the 10 years previous to 1870.

⁶⁰ Mem. Boston Soc. Nat. Hist., vol. 8, No. 2, 1916, p. 202.

respectively. In 1947, incidentally, the herring catch of the Gulf was topped only by the catches of haddock and of rosefish.

It is not clear to what extent this range in the catch from year to year is due to fluctuations in the supply of fish; to differences in their availability; or to the sundry economic factors that enter in. What is certain is that with some 80 percent of the catch consisting of sardine-sized fish weighing only about one-half ounce, the toll taken cannot have been less than 1½ billion fish in the poorest of recent years, 5 to 6 billion in the year when the yield was greatest, i. e., numbers far greater than that for any other Gulf of Maine fish. Come good year then or bad, Capt. John Smith's account of the herring of our Gulf thus applies equally well today: "The savages compare the store in the sea with the hair of their heads, and surely there are an incredible abundance upon this coast."⁶²

The sardine catch of the Bay of Fundy is made almost wholly in weirs, 347 of which were operated on the New Brunswick shore in 1947. On the Maine coast, as a whole, a little less than two-thirds the catch of herring, large and small, is made in weirs and in purse seines, combined, a little more than one-third nowadays in stop seines (about 44,500,000 pounds in 1947). These are used "to prevent the exit of the herring school from a cove or inlet. . . . The seine is stretched around the school with the ends of the net made fast to the shore." And stop seines are used mostly at night, when the presence of fish is betrayed by their luminous trails, if the water is firing, or by the

noise they make as they "flip" at the surface.⁶³ And some are still caught in floating traps (about 2 million pounds in 1947) which we have often seen used in the harbors of Mount Desert.

In 1947, seemingly a representative year, purse seines yielded the Maine fishermen nearly as much herring (about 36,100,000 pounds) as the weirs. Their presence is detected, Scattergood tells us, either by the firing of the water if by night, by echo sounding apparatus, or by the use of a thin wire suspended in the water, the vibrations of which indicate the presence of fish that strike it. In 1947 eleven purse seiners were active in the fall fishery for Maine herring. How many were engaged in the New Brunswick and Maine winter fishery is not known.

Large catches of herring when on bottom also are made by special otter trawls in European waters; and of the closely allied herring of British Columbia of late. But the possibility of developing an otter-trawl fishery for herring in the Gulf of Maine has not yet been explored.

Finally, we may remark that herring fresh from the water are among the most delicious of our fishes, especially the small sizes. Their only drawback is that they do not keep well, being rich-meated and oily, and in the larger sized fish the many hair-like bones are troublesome.

Hickory shad *Pomolobus mediocris* (Mitchill) 1815

FALL HERRING; SHAD HERRING

Jordan and Evermann, 1896-1900, p. 425.

⁶² General History of Virginia, New England, and the Summer Isles, 1616, reprinted in 1819 from London edition of 1629, p. 188.

⁶³ See Scattergood, U. S. Fish and Wildlife Service, Sp. Sci. Rept. No. 67, 1949, p. 8, for further details.

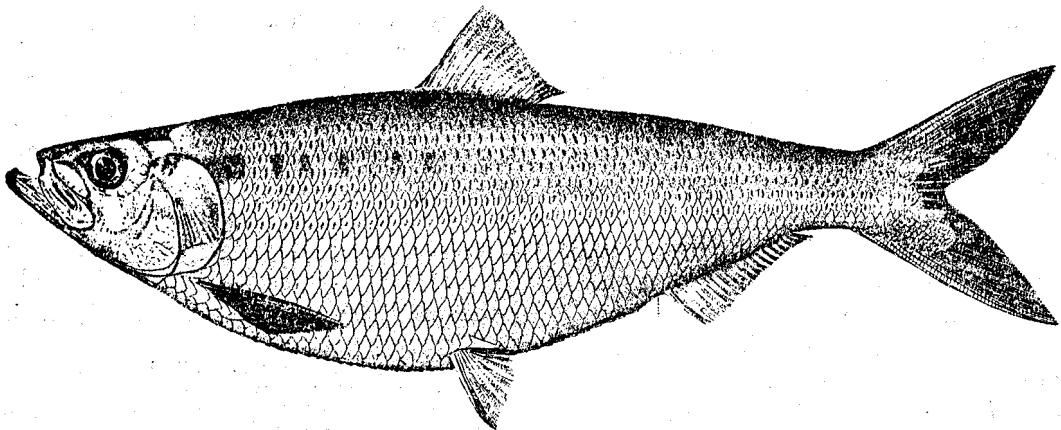


FIGURE 45.—Hickory shad (*Pomolobus mediocris*), Chesapeake Bay region specimen. From Goode. Drawing by H. L. Todd.