CARTILAGINOUS FISHES. CLASS CHONDRICHTHYES

The Shark and Skate Tribes, and the Chimaeroids

These are fishlike vertebrates with well-developed fins and teeth, and with 2 pairs of fins, one of them supported by the pectoral girdle, the other by the pelvic girdle. Their most distinctive character, as contrasted with the bony fishes (p. 80) is that their entire skeleton, including the skull, is cartilaginous, without any true bone, though it is partly calcified, especially in the vertebrae; the skull is far simpler than it is among the bony fishes; the gill filaments are attached throughout their lengths to the partitions between the gill openings instead of being free; and the rear portion of the digestive tract is modified into the so-called "spiral valve" by the development of a special fold from its lining layer, which only a few bony fishes have.

Fertilization is internal in all of them, and is effected by a pair of rodlike copulatory organs, each of which is developed from the inner edge of one of the two pelvic fins, and is supported by one or more cartilages.

The sharks and rays are usually looked upon as more primitive than the bony fishes.

SHARKS, TORPEDOES, SKATES, AND RAYS. SUBCLASS ELASMOBRANCHII

The most obvious external character by which all the sharks, skates, and rays are distinguishable from all of the bony fishes is that they have five or more gill openings on either side of the head, instead of only one. They recall the lampreys in this respect, but it is a commonplace that their jaws and teeth are extremely well-developed. Their skins are tough, and are studded in most of them with denticles (placoid scales), which are not homologous with the scales of bony fishes, for both dermis and epidermis take part in their formation, instead of the dermis alone. The teeth of the sharks and rays represent placoid scales that are modified and are embedded in the gums alone, not in the jaws. The fins are supported at their bases by segmented cartilaginous rods, supplemented in all of the sharks, and in some of the rays by numerous slender horny fibers further out, instead of by rays or spines of the sorts that are seen in the bony fishes. All of their fins are covered with the same leathery skin that clothes the body. Among sharks the tail is uneven ("heterocercal"), with the vertebral column extending out into its upper lobe, but it is whip-like in most of the skates and rays, with no definite caudal fin. The torpedo is an exception to this rule.

The modern representatives of the subclass may be grouped in two orders, the one (Selachii) to include all living sharks, the other (Batoidei) to include the sawfishes, the skates and the rays. They are separated one from the other by the following external differences, and there are skeletal differences between them as well:[26]

1. The gill openings are at least partly on the sides; the edges of the pectoral fins are not attached to the sides of the head in front of the gill openings; the upper edges of the orbits are free from the eyeballs, so that they form free eyelids.....Sharks, (p. 15).
The gill openings are entirely on the lower surface; the edges of the pectoral fins are attached to the side of the head in front of the gill openings; the upper edges of the orbits are attached to the eyeballs so that they do not form free eyelids.....Sawfishes, skates and rays, (p. 57).

[26] For further discussion, see Bigelow and Schroeder, Fishes Western North Atlantic, Pt. 1, ch. 3, 1948, p. 64.

Sharks. Order Selachii

Sharks always are objects of interest, not only to fishermen and mariners but to seaside visitors generally, because of their evil appearance, their ferocity, the large size to which some of them grow, the destruction they wreak on fishermen's nets and lines as well as on the smaller fishes on which they prey, and because of the bad reputation certain kinds have earned as maneaters.

The Gulf of Maine is not particularly rich in sharks (very poor indeed compared with our southern coasts), for while the number of species actually recorded there is considerable (indeed any high-seas shark might stray thither) the little spiny dogfish alone is numerous in the sense in which this term is applied to the various commercial fishes. And only two of the larger species,

the mackerel shark (*Lamna nasus*), and the blue shark (*Prionace glauca*), occur with us in numbers sufficient for one to be fairly sure of seeing them during a summer's boating off the coast north of Cape Cod.

With the larger sharks generally so scarce (the mackerel shark is harmless to anything larger than the fishes on which it feeds, and the blue shark is also harmless, although better armed), the danger of attacks on bathers is negligible in our Gulf. Indeed, not a single well-authenticated instance of the sort is on record [27] for the past 80 years for the coast north of Cape Cod, though the beaches are crowded every summer with vacationists. But as long as the white shark or man-eater (*Carcharodon carcharias*) does stray occasionally into the Gulf (p. 26), it is always remotely possible that we may be horrified some summer by the news of tragedies such as occurred on the New Jersey coast in July 1916, when several persons were killed or injured, presumably by a small shark of this species that was captured nearby a few days later,[28] and near Mattapoisett, on Buzzards Bay, Mass., on July 25, 1936, when a swimmer was fatally injured by a shark, species not determined.[29]

[27] In 1830 (an event often quoted) one Joseph Blaney, fishing from a small boat in Massachusetts Bay off Swampscott, Mass., was attacked by some fish that was seen to overset and sink his boat and, presumably, devoured him, for neighboring fishermen who hastened to his rescue found no trace of him. Whether his attacker was a large shark or a killer whale is an open question.

[28] Murphy and Nichols (Brooklyn Mus. Quart., vol. 3, 1916, No. 4, pp. 145-160) give a detailed account of this occurrence.

[29] See Gudger (Amer. Midland Natural., vol. 44, 1950, p. 714) for clinical details of this case.

All Gulf of Maine sharks give birth to young that are not only practically adult in structure but of relatively large size at birth, and there is a placental connection between mother and embryo in some, but not in others. Still other sharks lay eggs; this is true of the chain dogfish (*Scyliorhinus retifer*, p. 34), which is common out on the continental shelf from the offing of Cape Cod, southward, and of its immediate relatives; also of the heterodontids or Port Jackson sharks which are not represented in the Atlantic.

There is so little market for sharks in Gulf of Maine ports (attempts to introduce the dogfish as a food fish having failed so far) that the amounts landed in Maine and Massachusetts were only about 240,000 pounds in 1947, and about 309,500 pounds in 1949; they interest fishermen chiefly as nuisances because of the damage they do to nets and other gear, except that mackerel sharks are marketable.

It is possible to identify all the sharks so far known from the Gulf (and this includes all that are likely to occur there except strays) by the sizes and relative locations of the fins, and by such tooth characters as may be seen at a glance at the open mouth or easily felt with the finger (after the shark is dead!).

We have attempted in the following descriptions of the several species to include only such features as will tell what shark is at hand; for more minute particulars we refer the reader to our account of the sharks of the western North Atlantic (p. 2).

KEY TO GULF OF MAINE SHARKS

1. There is an anal fin 2
   There is no anal fin 16
2. Head greatly expanded sidewise, at level of eyes, in hammer- or shovel-form 3
   Head of ordinary shape, with rounded or pointed snout 4
3. Outline of front of head only slightly concave opposite nostrils if at all so; grooves (if any) from nostrils shorter than horizontal diameter of eyes; free tip of second dorsal fin is not longer than forward margin of the fin; rear margin of anal fin is only weakly concave; teeth near outer corners of mouth are rounded, without sharp cusps. Shovel head, p. 44

   Outline of front of head is deeply indented opposite each nostril; grooves from nostrils are more than twice as long as horizontal diameter of eye; free tip of second dorsal fin is considerably longer than front margin of the fin; rear margin of anal fin deeply concave; teeth near corners of mouth are like those near center of mouth, with sharp cusps ..... Hammerhead, p. 45
4. Caudal peduncle (root of tail) is not widely expanded sidewise as a lateral keel on either side; upper lobe of caudal fin is much longer than lower lobe 8
   Caudal peduncle is widely expanded sidewise as a lateral keel on either side; lower lobe of caudal fin is nearly as long as upper lobe, suggesting the caudal fin of a mackerel or swordfish 5

5. Gill openings very large, the first pair nearly meeting below the throat; teeth tiny, many hundred in number; gill arches with numerous horny gill rakers directed inward-rearward ..... Basking shark, p. 28
Gill openings, confined to sides of head; teeth large, few in number; gill arches do not have horny gill rakers 6
6. Upper teeth broadly triangular, with serrate edges; anal fin is entirely behind second dorsal fin .....
White shark, maneater, p. 25
Upper teeth with smooth-edged cusp, with or without a denticle on either side, at the base; anal fin is not entirely behind second dorsal fin 7
7. First two teeth from center in each jaw are similar to the succeeding teeth; origin of first dorsal fin is over or in front of inner corner of pectoral fin when latter is laid back; forward part of caudal fin has a small secondary lateral keel on each side, below the primary keel formed by the lateral expansion of the caudal peduncle.
Mackerel shark, p. 20
First two teeth from center in each jaw are noticeably more slender and more flexuous than the succeeding teeth; origin of first dorsal fin is behind inner corner of pectoral fin when latter is laid back; forward part of caudal fin does not have a secondary longitudinal keel ..... Sharp-nosed mackerel shark, mako, p. 23
8. Upper lobe of caudal fin is nearly or quite as long as head and body combined ..... Thresher, p. 32
Upper lobe of caudal is less than one-half as long as head body combined 9
9. Second dorsal fin is nearly as high vertically as first dorsal fin 10
Second dorsal fin is less than one-half as high vertically as first dorsal fin 12
10. First dorsal fin is wholly or mostly forward of the origin of the pelvic fins 11
First dorsal fin is wholly posterior to bases of pelvic fins ..... Chain dogfish, p. 34
11. Teeth high, narrow, sharp pointed, not in mosaic arrangement; snout conical; fifth gill openings well in front of pectoral fins ..... Sand shark, p. 18
Teeth small, low, rounded, in mosaic arrangement; snout flat, broadly rounded in front; fifth gill openings are behind origins of pectoral fins ..... Smooth dogfish, p. 34
12. Origin of first dorsal fin far behind inner corner of pectoral fin; upper surface brilliant blue in life.
Blue shark, p. 38
Origin of first dorsal fin is over or anterior to inner corners of pectorals; ground color of upper surface is gray, brownish or dusky in life, not bright blue 13
13. Length of snout in front of mouth is not more than one-half as great as breadth of mouth; upper jaw has a furrow on either side extending from outer corner forward past level of eye; caudal peduncle with a low longitudinal keel on either side; upper and lower teeth are of shapes shown in figure 11; their margins coarsely serrate.
Tiger shark, p. 37
Length of snout in front of mouth is more than two-thirds as great as breadth of mouth; furrows on upper jaw, if any, do not extend forward-inward as far as level of eye; caudal peduncle without longitudinal ridges; teeth are not of shape shown in figure 11, their margins either only very finely serrate or smooth 14
14. Outer corners of mouth have a short "labial furrow" extending inward-forward along each jaw; teeth are alike in the two jaws, directed sharply outward, margins of upper teeth smooth, as well as those of lower teeth.
Sharp-nosed shark, p. 40
Outer corners of mouth have no labial furrow on lower jaw and upper labial furrow is so short as to be hardly noticeable; teeth directed only moderately outward, their margins only finely serrate; lowers noticeably more slender than uppers 15
15. Origin of first dorsal fin is about over inner corner of pectoral when latter is laid back; vertical height of first dorsal fin is less than distance from eye to first gill opening ..... Dusky shark, p. 41
Origin of first dorsal is about over axil (armpit) of pectoral, its vertical height (after birth) is at least as great as distance from eye to third gill opening ..... Brown shark, p. 43
16. Trunk much flattened dorso-ventrally; eyes on top of head; front margins of pectorals overlap the gill openings.
Angel shark, note, p. 18
Trunk subcylindrical; eyes on side of head; front margins of pectorals do not overlap the gill openings 17
17. Each dorsal fin is preceded by a stout and conspicuous spine 18
Dorsal fin-spines either lacking, or are so nearly concealed in the skin that their presence can be detected by touch only 20
18. Upper teeth with 5 erect cusps; lower teeth with only one cusp, the successive cusps directed outward, forming a nearly continuous horizontal cutting edge all along the jaw ..... *Etmopterus princeps*, p. 47
Upper and lower teeth are alike in shape 19
19. Upper teeth quadrangular as well as lower teeth, with one cusp directed outward, forming a nearly continuous horizontal cutting edge along each jaw ..... Spiny dogfish, p. 47
Upper and also lower teeth each have 3 to 5 erect, triangular cusps ..... Black dogfish, p. 51
20. First dorsal fin well in advance of pelvic fins; upper teeth noticeably different in shape from lower teeth 21
First dorsal fin stands over posterior part of bases of pelvic fins; upper are teeth similar to lower teeth in shape.
Bramble shark, p. 56

21. Lower teeth erect, triangular, their edges serrate ..... *Dalatias licha*, p. 55
Lower teeth quadrate, the cusp directed outward, forming a nearly continuous horizontal cutting edge; their outer margins deeply notched, the edges smooth 22
22. Dermal denticles rounded, overlapping, scale-like, entirely concealing the skin (fig. 20); each dorsal fin is preceded by a short spine, embedded nearly to its tip in the skin, but recognizable by touch ..... Portuguese shark, p. 52
Dermal denticles conical, only moderately close set, the skin visible between them; dorsal fins not preceded by spines ..... Greenland shark, p. 53

NOTE.—Not yet known from the Gulf of Maine though reported from Marthas Vineyard.

THE SAND SHARKS. FAMILY CARCHARIIDAE

Outstanding characteristics of the sand sharks are that they have an anal fin; the two dorsal fins are without spines and are nearly equal in size; the rear end of the base of the first dorsal is over or in front of the origin of the pelvic fins; the anal fin is about as large as the dorsals; the upper lobe of the caudal fin is much longer than the lower, but occupies not more than one-third of the total length of the fish; there are no lateral keels on the caudal peduncle; the fifth gill openings are farther forward than the origins of the pectoral fins; and the teeth are slender and sharp-pointed.

Sand shark *Carcharias taurus* Rafinesque 1810

DOGFISH SHARK; GROUND SHARK

Bigelow and Schroeder, 1948, p. 100.
Garman, 1913, pl. 6, figs. 1–3.

Description.—The large size of the second dorsal fin, and of the anal as well (which is about equal to the first dorsal instead of much smaller) is of itself enough to distinguish this species from all other Gulf of Maine sharks. The fact that the first dorsal fin is located but little in front of the pelvics, and that the trunk seems crowded with fins of equal size, is a useful field mark. We may also point out that the pectoral fins are not much larger than the other fins—triangular rather than sickle-shaped; that the upper lobe of the tail is nearly one-third as long as head and body together and notched near its tip, with the lower lobe about one-third as long as the upper lobe; and that the head is flat above, the snout short, conical with rather sharp tip. The teeth also (alike in the two jaws) are diagnostic, being long, narrow, sharp-pointed, and smooth-edged, with one (rarely two) small spurs ("denticles") on either side near the base.

Size.—Most of the sand sharks that are caught in the northern part of their American range, from Delaware Bay to Cape Cod, are immature, of perhaps 4 to 6 feet. But adults up to 8 or 9 feet long are reported there from time to time, especially from the vicinity of Nantucket, where a commercial shark fishery yielded many of them in

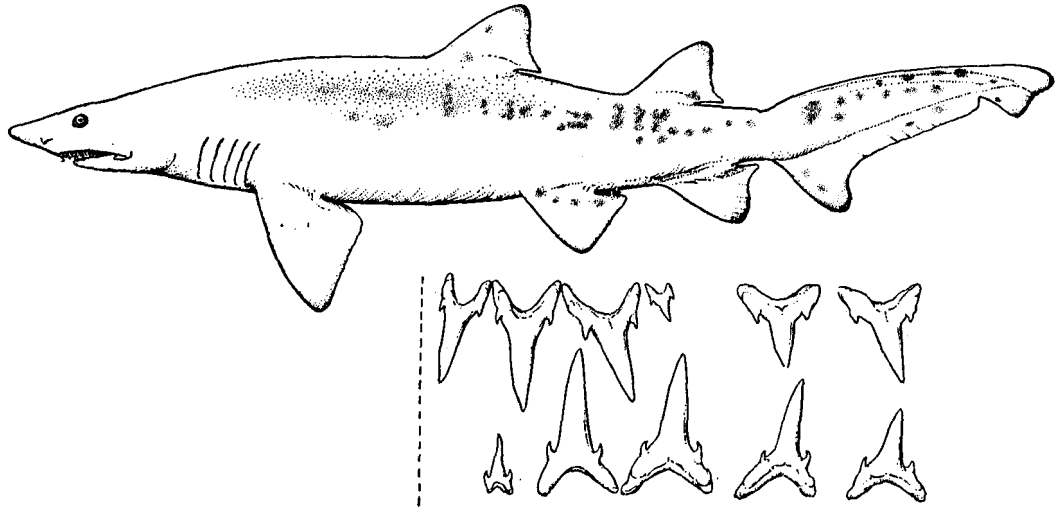

FIGURE 4.—Sand shark (*Carcharias taurus*), about 40 inches long, Cape Cod; and upper and lower teeth from front part of mouth of a larger specimen from New Jersey, about natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

the early 1920's. And large ones, alone, have been reported from North Carolina, southward. The greatest recorded length is 10 feet 5 inches, from southwestern Florida. And the sand shark does not mature sexually until perhaps 7 feet long, or more. A weight of 250 pounds is recorded for one 8 feet 10 inches long, showing how much lighter a fish this is, length for length, than various other sharks.

Color.—Light gray-brown above, darkest along back, snout, and upper sides of pectorals, paling on the sides to grayish white on lower surface; sides of trunk rearward from pectorals variously marked with roundish to oval spots, of which there may be upwards of 100, varying in color from yellowish brown to ocher yellow. The rear margins of the fins are edged with black on some specimens, but not on others.

Habits and food.—Despite its trim appearance and voracious appetite, this is a comparatively sluggish shark, living mostly on bottom or close to it; more active and taking a bait more freely at night than by day. During its summer visits to the New England coast it holds so close to the coast that it has never been reported from Georges Bank, or from the outer part of the Continental Shelf. Most of those caught are from depths not greater than 1 to 5 fathoms, occasionally perhaps as deep as 10 fathoms, and many come right in to tide line along the beaches. They may sometimes be seen moving slowly to and fro at the surface, over bars, with dorsal and caudal fins showing above the water; and they sometimes enter the mouths of rivers. They capture great numbers of small fish, which are their chief diet, particularly menhaden, cunners, mackerel, skates, silver hake, flounders, alewives, butterfish, and south of Cape Cod, scup, weakfish, and bonito. Sand sharks have been seen surrounding and harrying schools of bluefish; they have even been known to attack nets full of bluefish, which gives a measure of their voracity. They also eat lobsters, crabs, and squid

Breeding.—The eggs of the sand shark are hatched within the parent and are retained there until the resultant young are ready for independent existence, but there is no placental connection between mother and developing embryo. It has recently been discovered that while a ripe female contains a large number of eggs, only two embryos develop as a rule, one in each oviduct; they are nourished (at least largely) by swallowing the unfertilized eggs [30] with which the stomach of the embyro becomes greatly distended. Females with large embryos have so far been reported only from Florida and from Louisiana, whereas others taken near Woods Hole have contained eggs only, making it likely that the small specimens that are so common along southern New England have come from a more southerly birthplace.

General range.—Coastal waters on both sides of the Atlantic; Maine to Florida and Brazil in the west; Mediterranean, tropical West Africa, Canaries, and Cape Verdes in the east; also South Africa; represented in Argentine waters and in the Indo-Pacific by close relatives.

Occurrence in the Gulf of Maine.—The sand shark is by far the most common of its tribe, next to the smooth and spiny dogfishes, along southern New England and at the westerly entrance to the Gulf of Maine. It is plentiful at Woods Hole from June to November, to be found anywhere in that region in shoal waters, even coming up to the wharves. At Nantucket, too, it is so abundant that shark fishing, with the sand shark as the chief objective, is a popular sport. The facts that a catch of about 1,900 sharks by three boats on Horseshoe Shoal, in Nantucket Sound, June to September 1918, was mostly of this species, as was another catch of 350 sharks, taken near Nantucket in the early 1920's, illustrate their numbers there. Scattered sand sharks are also caught along the outer beaches of Cape Cod by surf anglers (published records are for Monomoy, Chatham, and Provincetown) and there are enough of them along this stretch of beach in some summers (1951 was a case in point) for them to be a nuisance to anglers casting for striped bass in the surf at night.

In August 1947 we saw a large one at the surface pursuing a striped bass, that was being hauled aboard a fishing boat on a hand line, in the eastern side of Cape Cod Bay, where fishermen tell us that this is not an unusual happening. But this appears to be the northern boundary to their occurrence in any numbers, or with regularity. True, they are recorded at Cohasset, on the southern shore of Massachusetts Bay, where we caught one about 4 feet long, years ago in Boston Bay, and at Lynn, Mass. But so rarely does it stray north of Cape Ann that it has been reported only

[30] For an account of the embryos, see Springer, Copeia, 1948, No. 3, pp. 153-156.

twice from Casco Bay, and once from St. Andrews, New Brunswick, near the mouth of the Bay of Fundy, its most northerly known outpost, where one was taken in a weir in 1913.

In New England waters the sand shark occurs only as a summer visitor. The winter home of those that summer along the northeastern United States is not known, nor has any increase been noted in Florida waters (where they are taken at all times of year) coincident with their winter disappearance from the northern part of their range. Like various bony fishes they may move offshore, and perhaps southward, to escape winter chilling.

Importance.—There were commercial fisheries for the sand shark around Nantucket during the first quarter of the present century, but these were short lived, reputedly because of exhaustion of the local stock. And the sand shark is of no commercial importance on the New England coast at present. Westward from Cape Cod it is of some interest to anglers, who catch considerable numbers, both as objects of special pursuit, for it takes almost any natural bait readily, or incidentally while surf casting for better fish. But it is not plentiful enough in the Gulf of Maine to be worth fishing for.

There is no record of attacks by sand sharks on human beings in North American waters, though bathers often come close to them. Our own experience bears this out; in fact, it is looked upon as a harmless nuisance on the New England coast wherever it is plentiful enough to be familiar. But its relative (or relatives) of East Indian waters have a more sinister reputation.

MACKEREL SHARKS. FAMILY ISURIDAE

Sharks of this family are easily recognizable by the very firm half-moon-shaped (technically lunate) caudal fin, with lower lobe but little shorter than the upper, in combination with large awl-like or blade-shaped teeth, and with gill openings larger than any other Gulf of Maine shark except the basking shark. Their tail fins, in fact, recall the tails of such bony fishes as the mackerel tribe or the swordfish, in outline, likewise in firm texture, hence their common name. The basking shark also has a caudal fin and peduncle of this same sort, but its teeth are minute and very numerous, and its gill openings are so long that those of the two sides nearly meet on the lower surface of the throat.

Other diagnostic features are that they have an anal fin; that their caudal peduncle is expanded as a prominent longitudinal keel on either side; that their dorsal fins are not preceded by spines; and that the inner margins of their gill arches do not have horny gill rakers.

Mackerel shark *Lamna nasus* (Bonnaterre) 1788

PORBEAGLE; BLUE DOG (IN GULF OF MAINE)

Bigelow and Schroeder, 1948, p. 112.
Garman, 1911, pl. 6, figs. 4–6 (as *Isurus punctatus*).

This is a stout, heavy-shouldered shark, tapering in front to a pointed conical snout and behind to a very slim tail root. Its dorsal and pectoral fins are large; the former, originating a little rearward of the armpits of the pectorals, is triangular and about as high as it is long; the pectoral fins are only half as broad as long. The second dorsal and anal fins are very small indeed, and the pelvics but little larger. The second dorsal fin stands over the anal. There is a conspicuous transverse furrow or pit on the upper surface of the root of the tail, also one on the lower surface close in front of the origin of the caudal fin. The lower lobe of the caudal fin is two-thirds to three-fourths as long as the upper lobe, and there is a small secondary keel on the base of the caudal fin on either side, below and behind the rear end of the primary keel formed by the sidewise expansion of the caudal peduncle.

The teeth of the porbeagle are alike in the two jaws, slender, pointed, smooth-edged, and with a sharp denticle near the base on each side (young fish may not have these) which the mako lacks (p. 23).

The only Gulf of Maine sharks with which the porbeagle might be confused are the maneater (p. 25), or the mako (p. 23). And it is easily told from the former by its slender, smooth-edged teeth, as well as by the position of its second dorsal fin directly over the anal; from the mako by the shape of its teeth (*cf.* fig. 5 with fig. 6), each usually with a small basal denticle on either side, which the mako lacks; also by its stouter body and by the presence of the secondary longitudinal keel on the anterior part of its caudal fin.

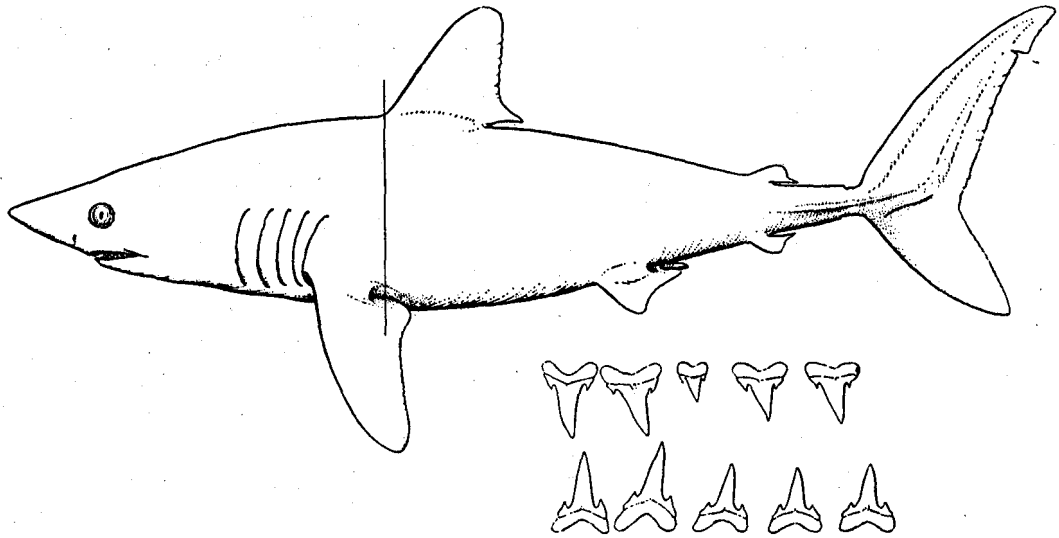

FIGURE 5.—Mackerel shark (*Lamna nasus*), about 37 inches long, Nahant, Massachusetts. Upper and lower first to fifth teeth from center of jaw of a larger specimen from Platts Bank, about 0.7 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

Color.—Dark bluish gray to bluish black above, including the upper surfaces of the pectorals, changing abruptly, low down on the sides, to white below; lower surfaces of pectorals dusky to black on the outer one-half to one-third, more or less mottled white and dark toward their bases, and with the anterior and posterior edges narrowly rimmed with black; the anal is white or slightly dusky.

Size.—The common run of mackerel sharks in the Gulf of Maine are from 4 to 6 feet long, with few heavier than 200 pounds; thus 18 recently landed at Portland and Eastport, Maine,[31] averaged 4 feet 5 inches, the largest being about 8 feet long, the smallest 3 feet 7 inches.

Specimens longer than 7 to 8 feet are not common; only two longer than 8 feet have been recorded previously from the Gulf of Maine, one of which was 10 feet,[32] the largest recorded from either side of the North Atlantic. This shark has been said to reach a length of 12 feet. But the sizes of sharks often are overstated, unless actually measured, point to point, not around the curve of the body. Information as to the relationship between length and weight is restricted to a report of 305 pounds at 8 feet 3 inches, and of about 400 pounds at about 9 feet. One 3 feet long that we measured weighed 20 pounds.

[31] Scattergood, Copeia, 1949, No. 1, pp. 71-72.
[32] Hubbs, Copeia, No. 123, 1923, p. 101

Habits.—The whole mackerel-shark tribe lead a pelagic life, wandering about over the ocean in pursuit of the fishes on which they prey, and often uniting in small companies, though they can hardly be called gregarious. Like swordfish they spend much time at the surface on calm days, when their triangular back fins, followed by the tip of the caudal fin (the bluntness of the former and the wavy track of the latter identify the shark as such) may often be seen cutting through the water. We have sailed close to sharks probably of this species again and again, only to see them sound, just out of harpoon range, plainly visible at first but soon fading from sight as they swim downward.

The porbeagle has often been described as active and strong swimming. But it puts up only a very feeble resistance when hooked. We have never seen or heard of one jumping, as the mako often does (p. 24), nor is there any difficulty in landing one of 4 to 5 feet on an ordinary cod line. It is, in fact, as proverbial among fishermen for its sluggishness when hooked, as is the mako for its activity. While often seen "finning," many are caught close to the bottom, in depths down to 80 fathoms in the gill net fishery for ground fish that is carried on from Portland, Maine; some also on bottom on cod lines; how much deeper they may descend is not known.

Food.—In the Gulf of Maine the porbeagle feeds chiefly on mackerel and on the herring tribe; on butterfish; on ground fish, as cod, hake, cusk, rosefish, flounders, or other kinds available; and on squid. It has also the annoying custom of foraging on the cod and other fish that have been hooked on long lines and biting off the snoods. It is also known to prey on the spiny dogfish in the eastern Atlantic; probably in the Gulf of Maine also. But we find no record of its eating crustaceans of any kind.

Breeding.—The mackerel shark tribe are ovoviviparous; that is, the eggs are hatched within the maternal oviducts, but there is no placental connection between mother and young. The embryos, like those of the sand shark (p. 19), are nourished chiefly by swallowing the unfertilized eggs that lie nearby in the "uterus," and their stomachs become enormously swollen by the masses of yolk that are eaten in this way. Another interesting feature of the porbeagle embryo is that the upper lobe of its caudal fin is much longer at first than the lower lobe, the latter increasing in relative length with growth. The embryos also are very large at birth; young of 18, 19, and 24 inches have, for example, been found in a five-foot mother. Corresponding to their large size, gravid females contain only one to four young (0–2 in each oviduct).

General range.—Continental waters in both sides of the North Atlantic; southern Scandinavia, Orkneys and North Sea southward to the Mediterranean and northwest Africa in the east; northern coast of Newfoundland,[33] Newfoundland Banks and Gulf of St. Lawrence to New Jersey and perhaps to South Carolina in the west; represented in the northwest Pacific and in Australian-New Zealand waters by forms that are closely allied to it, but not identical.

Occurrence in the Gulf of Maine.—It has been known from the days of the earliest settlement that stout-shouldered, surface-swimming sharks of moderate size, with "mackerel" tails and slender, smooth-edged teeth are tolerably common in the Gulf of Maine; they are universally referred to by the fishing population as "mackerel sharks." During the first half of the last century only one such shark species was recognized in our waters. And while more recent researches have proved that two actually occur within the limits of the Gulf (this and the next described) the present species is the more northerly of the pair, and much the more frequently taken in the Gulf. Hence it is probable that most of the mackerel sharks that fishermen often see swimming lazily on the surface, and often catch, off the shores of northern New England, belong here.

Seemingly, the chief centers of population for the porbeagle in the western Atlantic are along outer Nova Scotia, and in the western side of the Gulf of Maine. Thus, while there are but two published records for it from the Newfoundland Banks, and one (besides verbal reports) in the Gulf of St. Lawrence, fishermen report it as the commonest large shark along the Atlantic coast of Nova Scotia. Apparently it tends to shun the cold waters of the Bay of Fundy, for it is recorded only twice from Passamaquoddy Bay, one in August 1900, the other on October 3, 1935.[34] But it is so plentiful farther west in the Gulf that incidental catches are on record of 19 that were taken in one night by six men on hand lines, and of about 150 taken by one crew during three weeks' cod fishing near Monhegan Island, Maine. We have ourselves hooked or sighted about one per three or four days' fishing, on the cod grounds in general in the western side of the Gulf, the majority near Platts Bank off Cape Elizabeth, but some also on Nantucket Shoals.[35] Certainly it is the most often seen of the larger sharks around the Isles of Shoals and near Cape Ann, and it has been characterized repeatedly as "common" in Massachusetts Bay.[36]

To the westward the porbeagle is described as not uncommon near Woods Hole (we have not seen it there). We saw a small one about 3 feet long taken in an otter trawl at 60 fathoms, off Marthas Vineyard, on February 20, 1950, by the *Eugene H*; and it has been reported on several occasions from Rhode Island waters. But it appears only as a stray off New York and to the southward.

Thus, the latitudinal range within which it occurs regularly off the American coast covers only something like 5°. And its on- and offshore range is correspondingly so narrow that no report

[33] One reported at Raleigh, on the Newfoundland side of the Strait of Belle Isle, July 1929, by Dr. W. G. Jeffers.

[34] Reported by McGonigle and Smith, Proc. Nova Scotia Inst. Sci., vol. 19, 1936, p. 160.

[35] Cod tagging cruises of the U. S. Bureau of Fisheries.

[36] Actually no sharks other than the spiny dogfish (p. 47) are "common" in the Gulf of Maine, in the sense that this term is applied to such fish as herring, cod, mackerel, and other species, but only as relative to other sharks of corresponding sizes.

of it has come to hand from Georges or Browns Banks, only one from the Nova Scotia slope off Sable Island, and two from the Grand Banks, as just noted. On the other hand, few come in-shore close enough to be picked up in pound nets or weirs.

All published records of mackerel sharks from the Gulf, and all that we have seen there, have been in the warm half of the year, and something like 70 percent of the landings of porbeagles on the coast of Maine are for August to November. But its presence in the Gulf in winter is proved by our receipt of a photograph of a porbeagle embryo, taken from a female caught in January, off Portland, Maine, in 1927. And it is also caught in winter as well as in summer in north European waters. Apparently it simply descends into deeper water during the winter to escape low surface temperatures, feeding little, else more of them would have been caught in the Gulf during the winter fishery with long lines for hake (*Urophycis*).

In the Gulf of Maine, females containing embryos have been taken in August (near Monhegan Island, Maine); in October (off Barnstable, Mass.); in November (off Portland, Maine); and in January (off Portland, Maine). But the fact that the largest embryos have been found in European seas in summer suggests that most of the young are not born until then.

Importance.—The liver oil of the porbeagle, mixed with other fish oils, was in demand for use in tanning leather during the first quarter of the 19th century. And it is interesting to read that as much as 11 gallons of oil has been obtained from the liver of a single shark 9 feet long.

This demand had almost entirely died before 1850 and has never revived. But a new demand has developed of late years for porbeagle meat, which resembles swordfish in taste as well as in appearance, resulting in landings for this purpose of about 46,000 pounds in 1944 on the coast of Maine, and of 71,600 pounds in 1945. Assuming an average weight of, say, 50 pounds, this corresponds to a commercial catch of about 900 to 1,400 sharks. There is no special fishery for porbeagles at present in the Gulf of Maine, or for any other sharks for that matter. About four-fifths of those brought in are taken in gill nets set on bottom for ground fish, and most of the sharks caught in this way are landed in Portland, Maine. The remainder are taken by seines, traps, weirs, hook and line or harpoons. And most of the porbeagles taken in these ways are discarded at sea.[37] The porbeagle is not "game" enough to be of any interest to sport-anglers.

Sharp-nosed mackerel shark *Isurus oxyrinchus* Rafinesque 1810

ATLANTIC MAKO

Bigelow and Schroeder, 1948, p. 124.

Description.—This shark resembles the common mackerel shark so closely that we need merely point out the points of difference. Most obvious of these is that while the first dorsal originates about above the armpits of the pectorals in the common mackerel shark, it stands over or behind the inner corner of the pectoral in the mako, and that the second dorsal originates a short distance in front of the anal. The teeth, too, differ rather noticeably in appearance, for while of the same awl-like type, those of the mako lack the lateral spurs or denticles that are characteristic of all but the smallest porbeagles, and those in the front part of the mouth are conspicuously flexuous in form. The mako, too, is more slender bodied; its snout is more narrowly conical; its upper and lower caudal lobes are more nearly equal in length; and the forward part of its caudal fin lacks the secondary lateral keels that are to be seen on the caudal fin of the porbeagle (*cf.* fig. 6 with fig. 5).

Color.—Deep blue-gray above when fresh-caught, appearing cobalt or ultramarine in the water, with gradual transition along the sides to snow-white below; but turning dark slate gray above soon after death (especially if preserved), and to bluish white or pale dirty gray below and on the lower surfaces of the pectorals.

Size.—The maximum length reported for a specimen of the Atlantic mako that was actually measured is about 12 feet,[38] though it has been said to grow to 13 feet. The largest western Atlantic specimen of which we find definite record, taken off St. Petersburg, Fla., was 10 feet 6 inches long, and one nearly as large (10 ft. 2 in.) was caught off New York Harbor many years ago. But the common run caught off the middle Atlantic United

[37] See Scattergood, Copeia, 1949, p. 70, for further details as to landings in Maine and methods of capture.

[38] 3.7 meters as calculated from the size of its jaws.

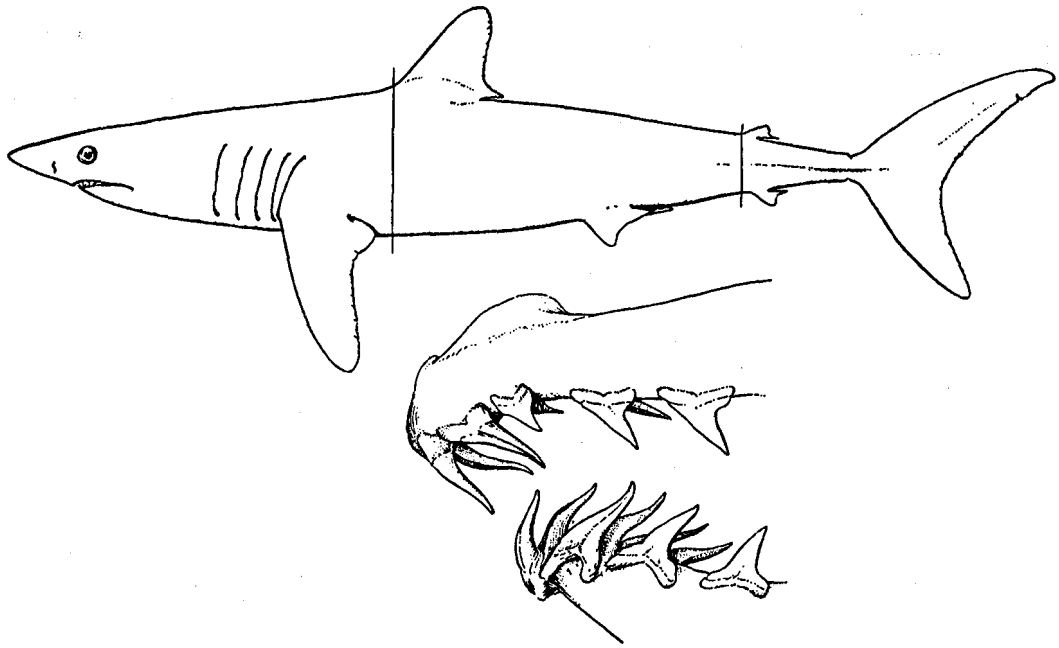

FIGURE 6.—Sharp-nosed mackerel shark, or Mako (*Isurus oxyrinchus*), about 64½ inches long, Maryland. Below, teeth in front of mouth of a large specimen, Cape Cod. From Bigelow and Schroeder. Drawings by E. N. Fischer.

States are perhaps 5 to 8 feet long. Males of about 6 feet are sexually mature (as indicated by the claspers). Recorded weights at different lengths are about 135 pounds at 6 feet, 230 pounds at 7 feet 8 inches; and about 300 pounds at 8 feet. The heaviest Atlantic mako caught on rod and reel of which we have found record was one of 786 pounds taken off Bimini, Bahamas, by Ernest Hemingway in 1936; the largest Pacific mako one of 798 pounds, taken by E. White-Wickham off New Zealand.[39]

Habits.—This is one of the most active and swift swimming of the sharks. In seas where it is more common than it is in our Gulf, it is often seen swimming at the surface, and it is famous for its habit of leaping clear of the water, not only when hooked, but under natural conditions. Seemingly it preys chiefly on schools of smaller fishes of the mackerel and herring tribes. But it also attacks larger fishes. A 730-pound mako, for example, that was harpooned near Bimini in the Bahamas, contained a 120-pound swordfish (*Xiphias gladius*) almost entire, while one weighing about 800 pounds, harpooned off Montauk, Long Island, was seen attacking a swordfish, and was found when landed to contain a large amount of its flesh.[40]

Young embryos of the mako, like those of the porbeagle (p. 22), have greatly dilated stomachs, being nourished on the unfertilized eggs that lie near them in the oviducts, and they are very large at birth, relative to the size of the mother.

General range.—This is an oceanic shark, of the tropical and warm-temperate belts of the Atlantic north and south, including the Mediterranean in the east and the Caribbean and Gulf of Mexico in the west. It is represented in the corresponding thermal belts of the Pacific and Indian Oceans by a close ally, the Pacific mako *Isurus glaucus*.

Occurrence in the Gulf of Maine.—The center of abundance for the mako lies in warmer seas to the southward of our Gulf. Considerable numbers journey northward, however, in summer along the continental shelf, as far as to the offing of southern New England, and a few are caught off Woods Hole. One of the earliest accounts of it in American waters was based partly on one from Cape Cod. During the past few summers we have heard repeatedly of makos seen jumping, or occasionally hooked near the northern end of

[39] A South African shark of 2,176 pounds, landed on rod and reel, and reported as a mako, is proved by the photograph of its teeth (London Illus. News, July 14, 1928, p. 53) to have been a maneater (*Carcharodon*).

[40] See Farrington (Field and Stream, vol. 47, Feb. 1943) for these instances of the mako attacking swordfish, and for other interesting notes on this shark.

Cape Cod, and in the summer of 1941 one about six feet long was landed on rod and reel in the southern side of Massachusetts Bay near Plymouth.[41] Thus stray individuals may be expected to visit the southern part of the Gulf in most summers, though we have never met it there ourselves. It has even been reported as far north as Seguin Island, Maine, but without convincing evidence that the shark in question was not a porbeagle.[42]

Importance.—The chief importance of the Atlantic mako, as of its Indo-Pacific relative, is as a game fish, because of its fast runs when hooked and of its habit of leaping. But it is not plentiful enough anywhere in the Gulf of Maine to be worth fishing for there especially.

Maneater *Carcharodon carcharias* (Linnaeus) 1758
WHITE SHARK

Bigelow and Schroeder, 1948, p. 134.
Garman, 1913, Pl. 5, figs. 5–9.

Description.—The maneater is of the general "mackerel shark" appearance, with firm lunate tail, the upper lobe only a little longer than the lower; and with triangular first dorsal of moderate size originating over the armpits of the pectorals, which are sickle shaped, and roughly twice as long as they are broad. The second dorsal and anal fins are very small, the former a little in advance of the latter; and the root of the tail bears a single well-marked keel on either side. The snout is conical, moderately pointed.

Unfortunately, there is no obvious field mark to distinguish a small maneater from a large porbeagle or from a large mako when seen swimming at any distance. Once captured, however, no confusion could arise, for instead of the slim catlike teeth of the porbeagle and of the mako, we find the maneater one of the best armed of all sharks; its teeth large and triangular, and similar in shape in the two jaws, except broadest in the upper, with nearly straight cutting edges and strongly serrated margins. As a precaution, any large active shark, upwards of 10 or 12 feet long, with the tail not long, out of ordinary proportions, should be looked upon with suspicion, for it might prove to be a maneater. If it were sluggish, resting with the dorsal fin high out of water, it would be no doubt a harmless basking shark (p. 28).

Color.—Maneaters up to 12 to 15 feet long are slaty brown or leaden gray above, sometimes almost black, shading more or less abruptly on the sides to dirty white below. There is a black spot in the armpit of each pectoral fin, and the lower surfaces of the pectorals are black toward their tips, usually with some black spots adjacent. The pelvics are white below, but olive along their anterior edges. Larger specimens (we have seen none) have been described as dun colored above or very pale leaden, and they may lack the black spot at the armpit of the pectoral fin.[43]

[41] Information from Dr. W. J. Mixter.

[42] Various early reports of it in the northern part of the Gulf seem to have referred, actually, to the porbeagle.

[43] Information from Stewart Springer, from large Florida specimens.

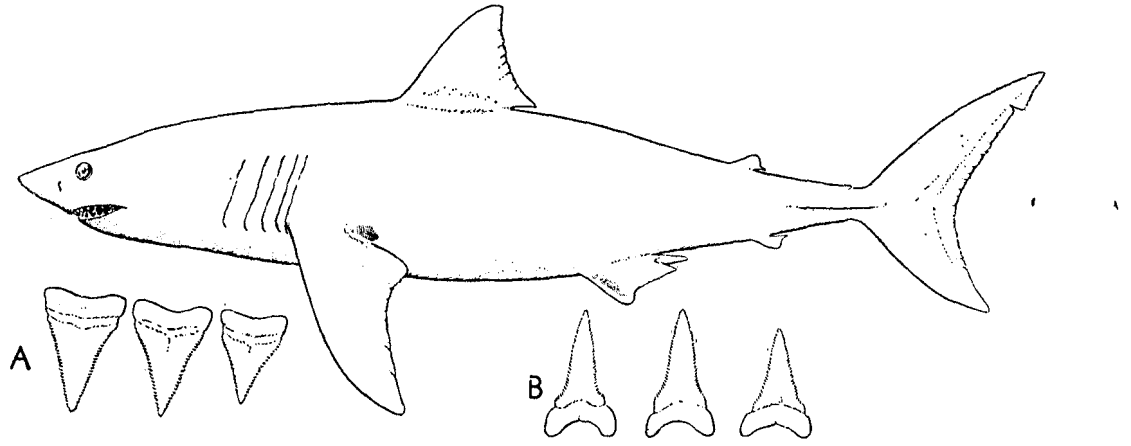

FIGURE 7.—Maneater (*Carcharodon carcharias*), Massachusetts, about 7 feet long. A, first three upper and B, first three lower teeth, from center of jaw, from a specimen about 8½ feet long, Woods Hole, about 0.6 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

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Size.—This is one of the largest of sharks. A gulf of Maine specimen about 3 feet long is the smallest, apart from embryos, that has been seen; one of about 5 feet the next smallest. So far as known it does not mature sexually until it has grown to a length of 12 to 14 feet. Among larger ones, from one place or another, the exact measurements for which have been reported, four have been between 14 and 16 feet long, two between 16 and 18 feet, and three between 19 and 21 feet. The largest on record was 36½ feet long; [44] the next largest about 30 feet, but perhaps not measured exactly.

Maneaters of a given length may vary widely in weight, because of variations in their condition. Thus one specimen 8 feet 2 inches long weighed only 342 pounds, but another of 8 feet 3 inches, weighed 600 pounds. Five, weighing between 910 and 1,000 pounds ranged from 9 feet 8 inches in length to 12 feet 6 inches. Three, of 13 to 13½ feet, weighed 1,291 to 1,344 pounds, but another, from South Africa of 13 feet 3 inches scaled 2,176 pounds, doubtless a very fat fish. A 15-foot 2-inch specimen weighed 1,720 pounds; and one of 21 feet, the largest that has been weighed so far, 7,100 pounds, its liver 1,005 pounds.[45]

Habits.—So few maneaters are seen that little is known of their way of life, apart from their voracity. Most of the records of them have been of specimens taken at or near the surface, and such specimens as visit our Gulf sometimes come very close inshore. Thus two specimens were seined close in, off Swampscott, at the northern entrance to Boston Harbor in 1939; one was harpooned in 1937 about 2 miles off Nantasket Beach, one of the most popular bathing resorts near Boston; another was harpooned about one-half mile off Cohasset, Mass., where the water is not over 20 feet deep; one in 10 feet of water in Provincetown Harbor, many years ago. Some have even been taken in fish traps close to the beach on Cape Cod and near Woods Hole; and in 1916 one was taken in the shallow water of Sandy Hook Bay, N. Y. On the other hand, the largest one that has been weighed yet was caught on a set line off the north coast of Cuba, at a depth of about 700 fathoms.

Nothing is known of its breeding habits, beyond the bare facts that it is ovoviviparous like others of the mackerel shark tribe.

The maneater is one of the most voracious of all the fish tribe, feeding indifferently on large prey and on small. Other sharks, 4 to 7 feet long and practically intact, have been found repeatedly in maneaters' stomachs; and a young sea lion of 100 pounds in one on the coast of California, while seals, sturgeons, and tuna have been found in maneaters no longer than 8 to 9 feet. In southern seas they are described as feeding regularly on sea turtles. But they also devour smaller fishes of whatever kinds are available, including small sharks and chimaeroids, also squids. When they come in on the fishing banks, they are known to take fish that they find hooked on long lines as porbeagles do (p. 22). Thus the mouth of one of 9 feet 8 inches, taken near Cohasset, Mass., and examined by us, carried several hooks with the snoods still attached, while its stomach contained a spiny dogfish (*Squalus acanthias*) that evidently had been torn off a hook. And a large Florida maneater, caught on a set line, contained 2 brown sharks (*Carcharhinus milberti*), 6 to 7 feet long, that had evidently been torn from hooks on the same set line on which the maneater was hooked. The maneater, like the Tiger shark, is not above feeding on slaughterhouse waste or other garbage.

General range.—This is an oceanic shark, widespread in the tropical and warm temperate belts of all oceans, including the Mediterranean. In the western side of the Atlantic it has been recorded as far north as St. Pierre Bank south of Newfoundland, and as far south as Brazil.[46]

Occurrence in the Gulf of Maine.—The maneater is usually looked on as a warm water shark, doubtless correctly so. None the less, it has been reliably reported from the southwestern part of the Gulf of Maine more often than it has from any other coastal sector of comparable length on the Atlantic coast of North America. At least 10, for example, were actually captured or were harpooned and lost in Massachusetts Bay alone during the period 1935 to 1948. We ourselves examined three of these, one that was netted at Swampscott; a female of 9 feet 8 inches weighing 980 pounds that was harpooned within half a mile of the land off Cohassett, in August 1940; one of about 3 feet, that was harpooned in July 1948

[44] This Australian specimen, the jaws of which are in the British Museum, is the basis for repeated statements that the maneater grows to 40 feet.

[45] For further details, see Bigelow and Schroeder, Fishes Western North Atlantic, Pt. 1, 1948, pp. 137-138.

[46] For details and references, see Bigelow and Schroeder, Fishes Western North Atlantic, Pt. 1, 1948, pp. 140-141.

near Boston Lightship, this last being the smallest that is on record to date (p. 26), and one about 14 feet long, weighing 1,050 pounds dressed, which sold for 10 cents a pound, was taken in a trap at North Truro on November 9, 1952.

Carrying the record back to earlier years, a 15-foot shark, taken at Monomoy Point at the elbow of Cape Cod in the autumn of 1928, appears to have been a maneater, and one of about 16 feet, taken in a trap at East Brewster, October 16, 1923, and identified by Dr. Samuel Garman, certainly was, while one of 7 feet 2 inches, taken in Massachusetts Bay, about 1910, was the basis of Garman's (1913, pl. 5, fig. 5) beautiful illustration. Earlier still, a 13-footer, taken at Provincetown, Cape Cod, in June 1848, was described by Storer as a new species, *atwoodi*, while two small ones were mentioned by him as taken by Massachusetts fishermen between 1820 and 1850. And Capt. Atwood reported seeing four, caught in mackerel nets at Provincetown many years ago.[47]

Proceeding northward, we find scattered records from the vicinity of Portland, Maine, most recently, a 13-footer caught in a gill net off Casco Bay in November 1931; one from Eastport, Maine, many years ago; a very large one (estimated as about 26 feet long) taken in a wier at Campobello Island, November 23, 1932 [48] it was suggested locally that it may have been the same specimen that had attacked a fishing boat off Digby, Nova Scotia, the preceding July (p. 27); one from Deer Island, New Brunswick, taken in a herring weir, August 24, 1949;[49] and one from Digby, on the Nova Scotian shore of the Bay of Fundy, July 2, 1932. And there are several reliable records for St. Margaret Bay on the outer coast of Nova Scotia, perhaps also for Halifax.

The most northerly positive record for it on the Atlantic coast of North America is for St. Pierre Bank, south of Newfoundland, where one attacked a fisherman in a dory many years ago, leaving in the sides of the boat pieces of its teeth, from which Dr. Garman was able to identify it.[50]

Westward and southward from the elbow of Cape Cod, we find nine or ten definite records for Nantucket and for the vicinity of Woods Hole (never more than two in any one year), with one of five feet (second smallest on record) netted at Sakonnet, Rhode Island, May 30, 1939. Maneaters are also reported occasionally near New York, notably one of about seven feet, taken in Sandy Hook Bay, July 1916, to which we recur below (p. 27).

Relation to man.—So few man-eaters visit our Gulf that they would deserve only the briefest mention were this not the only shark that is ever likely to attack human beings there. Strong and active, equipped as it is with a most terribly effective set of cutting teeth, it has borne an unsavory reputation as a man-eater from the earliest times, and it is probable that the 7-foot specimen listed earlier from South Amboy, Sandy Hook Bay, was the cause of the shark fatalities along the New Jersey beach in July 1916 (p. 16). A fatal attack on a swimmer at Mattapoisett, on Buzzards Bay, on July 25, 1936, may also have been by a man-eater, though in this case the shark was driven away without being identified.

This is also perhaps the only shark against which unprovoked attacks on small boats are proved by identification of their teeth, embedded in the wood. One such instance, from the Newfoundland Banks, was reported by Putnam [51] many years ago (p. 27). A recent local case is of a very large one that attacked a fishing boat in the Bay of Fundy off Digby Gut, Nova Scotia, July 2, 1932 and left in her keel or lower planking several of its teeth, by which it was identified.[52] Storer [53] wrote of a case where one (apparently the 13-foot specimen that he had described earlier as *atwoodi*) turned furiously on a boat, but was lanced to death and brought into Provincetown. And a 15-foot shark, probably this species to judge from the illustration of it that was published,[54] that was killed off Monomoy Point by two fishermen in November 1928, overturned their dory before it was subdued. And one of about 15 feet (similarly identified by teeth left in the planking) attacked a boat, from which it had been harpooned, in St. Margaret's Bay, Nova Scotia, on June 27, 1920.[55] Hence, so long as maneaters wander within

[47] Putnam, Bull. Essex Inst., vol. 6, 1874, p. 72.

[48] Piers, Proc. Nova Scotian Inst. Sci., vol. 18, 1934, p. 198.

[49] A female 12 feet, 8 inches long, weighing 1,299 pounds, reported by Scattergood, Trefethen, and Coffin, Copeia, 1951, p. 298.

[50] Putnam, Bull. Essex Inst., Salem, vol. 6, 1874, p. 72.

[51] Proc. Essex Inst. Salem, vol. 6, 1874, p. 72; teeth identified by Dr. S. Garman.

[52] Reported by Piers, Proc. Nova Scotia Inst. Sci., vol. 18, 1934, p. 198.

[53] Fishes of Mass., 1867, p. 248.

[54] Reported in Witman and Lee Co.'s Market Letter for Nov. 8, 1928; called to our attention by Dr. Lewis Radcliffe of the U. S. Bureau of Fisheries.

[55] For details of this occurrence, see Piers, Proc. Nova Scotia Inst. Sci., vol. 18, 1934, pp. 196–198.

our limits more often than had been realized previously, the possibility is always open of attacks on bathers along the Massachusetts shores of the Gulf.

Despite its ferocity, muscular strength and size, the man-eater does not put up so spectacular a resistance when hooked as does a mako, neither running so fast nor having the habit of jumping. Neither does it put up as strong a fight, pound for pound, as a tuna ordinarily does, or any of the swordfish tribe. Thus a 1,329-pound maneater was landed on rod and reel by an Australian angler in 53 minutes. One of 2,176 pounds, caught from the shore in South Africa, is the largest fish ever landed on rod and reel that has come to our notice.[56]

[56] London Illus. News, July 14, 1928, p. 53; photograph recorded as a mako but shown by its teeth to have been a maneater.

BASKING SHARKS. FAMILY CETORHINIDAE

Basking shark *Cetorhinus maximus* (Gunnerus) 1765

BONE SHARK

Bigelow and Schroeder, 1948, p. 147.

The basking shark resembles the mackerel sharks in the lunate shape of its caudal fin, with lower lobe nearly as long as upper; also in the presence of a noticeable lunate furrow above and one below on the root of the tail, and in the wide lateral expansion of the latter, forming a pronounced "fore and aft" keel on either side; also in the facts that the second dorsal fin and the anal fin are much smaller than the first dorsal, that its fifth gill opening is situated in front of the origin of the pectoral fin; in the position of the mouth on the under side of the head; and in the wide separation of the nostrils from the mouth. But the teeth of the basking shark are minute and very numerous (large and few in number in the mackerel sharks); its gill openings are so large that they extend right around the neck, with those of the first pair almost meeting below on the throat; and the inner margin of each gill arch bears a great number of horny, bristle-like rakers, directed inward-forward, that correspond to the rakers of various bony fishes in their position and in their function (see p. 30). It was the fancied resemblance of these rakers to the whalebone of the whalebone whales that suggested the vernacular name "bone shark" to the whalemen of olden times.

Corresponding to its feeding habits, the mouth of the basking shark is very large and widely distensible at the corners. The snout is short, conical, with rounded tip on large specimens. But it is much longer, relatively, on small ones,

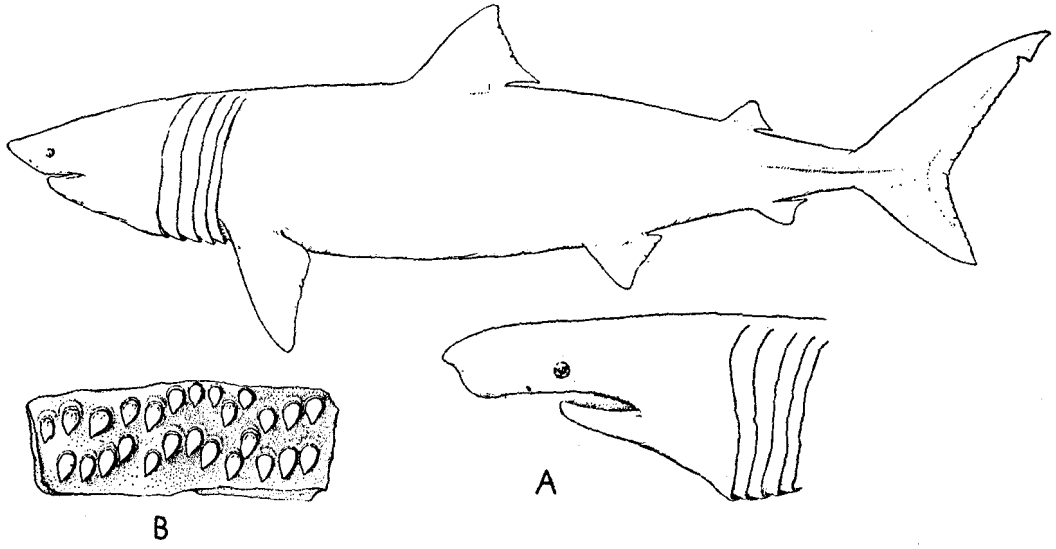

FIGURE 8.—Basking shark (*Cetorhinus maximus*), 26½-foot female, Marthas Vineyard. A, side view of head of 12-foot Long Island specimen; B, a group of the teeth of same, about 1.2 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

projecting far beyond the mouth, obliquely truncate in front, terminating above in a sharp point, and with the head strongly compressed sideways abreast of the front of the mouth. This results in so bizarre an appearance that the young basking shark was thought at first to represent a separate species. A gradual transition takes place from the juvenile shape of head to the adult shape when a length of 12 to 16 feet has been reached. We need only note further that the triangular first dorsal fin stands midway between pectorals and pelvics; though not so high in proportion as that of the mackerel-shark tribe, it rises high in the air when a large basking shark lies awash on the surface, as is their habit, a convenient field mark (p. 29).

Color.—Upper surface grayish brown, slaty gray, or even almost black. The lower surface has been described repeatedly as white. But the Menemsha specimen described by Allen [57] was of a somewhat lighter shade below than above, without white markings, as was a Massachusetts Bay specimen recently examined by us; while one 14 feet long captured at West Hampton, L. I., on June 29, 1915 [58] had the belly as dark as the back, with a white patch underneath the snout in front of the mouth.

Size.—The basking shark rivals, though it does not equal, the whale shark of tropical seas in size. Reports that an occasional basking shark may reach a length of 50 feet probably are not an exaggeration, for the catch on the coast of Norway, for the period 1884 to 1905, included one of about 45 feet and three of about 40 feet, with the six next longest ranging between 36 feet and 30 feet 3 inches. The three longest for which we find definite measurements for the western Atlantic were of 32 feet 2 inches, 32 feet, and 30 feet 3 inches. But others up to 35 feet long have been credibly reported as killed near Eastport, Maine, many years ago; and one captured at Musquash Harbor, New Brunswick, near the mouth of the Bay of Fundy in 1851 was said to have been about 40 feet long. It is probable that they are at least 5 to 6 feet long when born, the three smallest so far reported having been between 5 feet 5 inches and about 8 feet 6 inches long. Matthews [59] concluded from studies of basking sharks taken near the Isle of Skye that fish up to 10 feet are in their first year, those of 15 feet in their second year. Males mature sexually at about 18 to 20 feet as indicated by the lengths of their claspers, females at about 20 to 23 feet; i. e., when 3 years old or perhaps 4, according to Mathews' estimate.

We find no exact weights for large basking sharks from the Atlantic. But 6,580 pounds for one of 28 feet, and 8,600 pounds for another of 30 feet, from Monterey, Calif., is doubtless a fair indication of what a fairly large one may be expected to weigh. Estimated weights for smaller ones, from the Pacific, are about 6,600 pounds at about 23 feet, 1,000 to 1,800 pounds at 13 to 15 feet, and 800 pounds at 8 feet 4 inches.[60] A young one, 12 feet long, killed off Digby, Nova Scotia, August 16, 1939, weighed 359 pounds, after it had bled, [61] and one almost 20 feet long, taken off Portland, Maine, in 1936, weighed 550 pounds, dressed.

Habits.—This is a sluggish, inoffensive fish, helpless of attack so far as its minute teeth are concerned. It spends much time sunning itself at the surface of the water, often lying with its back awash and dorsal fin high out of water, or on its side, or even on its back sunning its belly; sometimes it loafs along with the snout out of water, the mouth open, gathering its provender of plankton. They pay so little attention to boats that it is easy to approach one of them within harpoon range, and excellent motion pictures have been taken of them in Irish waters.[62] But they have also been seen jumping, perhaps to shake off parasites. Those seen in the Gulf of Maine are usually traveling singly. But they are known to congregate sometimes in loose schools which may include as many as 60 to 100 in the peak years of abundance for them in regions where they are more numerous than in the Gulf of Maine.[63] It is chiefly during the warm half of the year that basking sharks are encountered off the northeastern United States and in the northern part of their range in the opposite side of the Atlantic. It is likely that those that summer in the inshore parts of the Gulf simply withdraw in the fall, to pass the

[57] Bull. Boston Soc. Nat. Hist., No. 24, March 1921, p. 5.
[58] Described by Hussakof, Copeia, No. 21, 1915, pp. 25–27.
[59] Philos. Trans. Roy. Soc. London, Ser. B., vol. 234, 1950, pp. 247–316.

[60] For further details as to sizes of basking sharks, see Bigelow and Schroeder, Fishes, Western North Atlantic, Pt. I, 1948, pp. 151–152.
[61] Referred to by McKenzie, Proc. Nova Scotia Hist. Sci., vol. 20, 1940, p. 42.
[62] Shown in the film "Men of Arran."
[63] See Bigelow and Schroeder, Fishes Western North Atlantic, Pt. 1, 1948, pp. 153, 154, for details as to their centers of population and secular fluctuations in abundance in north European waters.

winter in deeper water where the temperature does not fall so low.

Next to its vast bulk and its curiously sluggish habit, the most interesting peculiarity of the basking shark is its diet, for it subsists wholly on tiny pelagic animals, which it sifts out of the water by means of its greatly developed gill rakers, exactly as plankton-feeders among fishes such as menhaden do, and whalebone whales with their baleen sieves. In several cases their stomachs have been found packed with minute Crustacea; this was true of the only western Atlantic specimen of which the stomach contents have been examined. And while digestion is so rapid that the food swallowed is soon reduced to a soupy mass, this usually is reddish, suggesting a crustacean origin.

All that is known of the breeding of the basking shark is that the structure of the internal sex organs of the female accords with the nourishment of the embryo within the maternal oviduct, that the ovary of a female, with empty oviduct contained something like 6 million immature ova instead of the few that are usual in sharks that bear "living" young, and that an embryo about a foot long was said, long ago, to have been taken from its mother.[64]

Basking sharks reported as "sea serpents" or as other "monsters".—The remains of basking sharks have been reported as "sea serpents" on several occasions; nor is this astonishing. "As the carcass of the shark rots on the shore, or is buffeted against the rocks, the whole of the gristly skeleton of the jaws and gill arches . . . as well as the pectoral and pelvic fins, is soon washed away,"[65] leaving only the cranium and the long backbone, with larger or smaller amounts of muscle, so frayed out as to suggest a hairy or bristly mane. As a recent instance from the Gulf of Maine, we may cite the newspaper and radio publicity, that was given, as a supposed sea serpent, to a basking shark skeleton, about 25 feet long, that beached near Provincetown on the outer shore of Cape Cod, in January 1937, that we examined.[66]

A more spectacular instance of the fanciful interpretation that is likely to be placed on any large stranded carcass that has decayed partially, was the famous "Animal of Stronsa," that came ashore on the island of that name in the Orkneys, in September 1808. It was pictured by an eyewitness as having three pairs of limbs, but the published illustration of its cranium, vertebrae, and pelvic skeleton[67] show that it was only the remains of some very large shark, probably a basking shark. It has also been suggested repeatedly that some of the stories of sea monsters of one sort or another may have been based on the dorsal and caudal fins of two or more basking sharks, swimming one behind another as they often do (we dare not touch further on the controversial subject of the "sea serpent").

General range.—This enormous fish, formerly thought to be an Arctic species, straying southward, is now known to be an inhabitant of the temperate-boreal zone of the North Atlantic.[68] It is represented in the corresponding thermal belts of the South Atlantic and of the North and South Pacific by a similar great shark (or sharks), whose exact relationship to the basking shark of the North Atlantic is still an open question.

The northern boundary of the normal range of the basking shark of the North Atlantic appears to follow the line of transition from waters of predominately Atlantic influence to those of Arctic origin. This, roughly, runs from the outer coast of Nova Scotia (1 record), and from southern Newfoundland (4 positive records) to western and southern Iceland, to the Orkney and Faroe Islands, and skirts the Norwegian coast to the North Cape, while basking sharks stray now and then to the Murman coast. To the southward, in the North Atlantic, they range as far as the Mediterranean and Morocco in the east, to North Carolina in the west.

Occurrence in the Gulf of Maine.—Before the coming of the white man this great shark seems to have been a regular inhabitant of the southern part of the Gulf of Maine. And tradition has it that large numbers were taken in Massachusetts waters, especially off the tip of Cape Cod, during the first half of the eighteenth century, for their liver oil which was then in demand for illuminating purposes. However, the local stock seems soon to have gone the same way as the local stock of the North Atlantic right whale; that is, into the try pot. And basking sharks seem never to have

[64] See Matthews, Philos. Trans. Roy. Soc. London, Ser. B, No. 612, vol. 234, 1950, pp. 347—366 for detailed account.

[65] Norman and Fraser, Giant Fishes, Whales and Dolphins, 1937, p. 21.

[66] For account and photograph, see Schroeder, New England Naturalist, No. 2, 1939, p. 1.

[67] Barclay, Mem. Wernerian Soc., Edinburgh, vol. 1, 1811, p. 418.

[68] It has long been realized that old tales of a tremendous whale-eating shark, on which Fabricius based his statement that the basking shark occurs in Greenland waters, were fiction.

visited the northeastern part of the Gulf in any numbers, there being only a few records for the vicinity of Eastport, Maine, and three from within the Bay of Fundy. At the present time the Gulf appears to harbor a sparse and fluctuating population, occasional members of which are encountered from time to time, here or there, but whether as immigrants into the Gulf from the open ocean is not known.

The list of specimens, the capture or stranding of which in the Gulf has come to our attention for the period 1908–1951 is as follows:

1908. One, 18 feet long, near Provincetown, taken in a fish trap; measured by J. Henry Blake.
1909. One, about 22 feet, in Provincetown Harbor.
1913. One, about 29 feet, Provincetown.
1925. One, about 29 feet, near Monhegan Island, Maine.
1931. Female, 12½ feet long, York Harbor, Maine.
1934. One, 29 feet, Whale Cove, Grand Manan Island, and one, 28 feet, Back Bay, Bay of Fundy.[69]
1936. Two off Portland, Maine; the first about 20 feet long, weighing 550 pounds dressed, about May 1; the second, much larger (reported as of about 40 ft.), August 2.
1939. Skeleton of one of about 25 feet, examined by us, found on the beach near Provincetown in January. One of about 25 feet, Yarmouth, Nova Scotia. One of 12 feet, Bay of Fundy off Digby Gut.[70]
1947. Female, about 13 feet long, examined by us, harpooned by W. T. Reid 3rd, near Boston Lightship, August 5th.
1949. A small one (size not recorded), near Rockport, Mass., September; identified from a good photograph by Miss D. E. Snyder of the Peabody Museum, Salem.
1951. One, 12 feet, near Bar Harbor, Maine, harpooned July 28.[71]

Occasional basking sharks also visit the shores of the southern coast of Massachusetts, westward from Cape Cod; one, for example, 12 to 14 feet long was taken at Menemsha on Marthas Vineyard, August 16, 1916; another of 20 feet 6 inches at that same locality on June 24, 1920;[72] one 20 feet 2 inches long was stranded in Hadleys Harbor, Naushon Island, July 1937; and one of 8 feet (among the smallest on record) was taken in a fish trap near Woods Hole on June 15, 1948.

[69] McKenzie, Proc. Nova Scotia Inst. Sci., vol. 20, 1939, p. 14.
[70] McKenzie, Proc. Nova Scotia Inst. Sci., vol. 20, 1939, p. 14.
[71] Personal communication from J. W. Burger.
[72] This specimen, mounted, in the New England Museum of Science and described by Allen (Bull., Boston Soc. Nat. Hist., No. 24, March 1921, pp. 3–10), served as chief basis for the illustration given here of the adult basking shark.

Probably the basking shark is no more plentiful near shore in our Gulf in most years than the paucity of the recent records suggest, for popular interest in sharks is now so keen, as represented by newspaper publicity given to any unusual capture, that any well-grown one is apt to be seen in these frequented and hard-fished waters. We do not find evidence of any considerable incursion by them into coastal waters farther west since 1878, when 20, at least, were found dead in the fish traps near Woods Hole during the summer. And the only report that might be based on the basking shark on the offshore fishing banks that we have received from fishermen has been of a number of unusually large sharks of some sort, seen by Capt. Henry Klimm on the southeast part of Georges Bank during late June and early July 1947.

Importance.—The day of any regular fishery for the basking shark is long since past in New England waters, probably never to return. And no use is made there, nowadays, of the occasional specimens that are captured. But it may be of interest to point out that it was always hunted of old by the sperm whalers from New Bedford, for its liver oil was considered nearly or as good as sperm oil for illuminating purposes. Basking sharks are still the object of intermittent small vessel fisheries off the coast of Iceland, around the Orkneys, off western Ireland, and off southern Norway; also off Ecuador and Peru in the Pacific. And increasing numbers have been landed during the past few years in northern California, where they are considerably more plentiful than they are in the Gulf of Maine,[73] for fish meal and for the liver oil. The yield of oil per fish varies from about 80 gallons to about 200, occasionally to 400 gallons, with as much as 600 gallons reported. The liver of a 30-foot fish weighing 6,580 pounds, taken off Monterey, Calif., had a liver weighing 1,800 pounds, 60 percent of which was oil.[74] But, sad to say, it is very low in vitamin A.

The fishery, wherever carried on, is by harpoon. And basking sharks are so sluggish and so unsuspicious of a boat, large or small, that it usually is a simple matter to harpoon one that is seen at

[73] According to MacGinitie (Science, N. Ser., vol. 73, 1931, p. 496), 21 basking sharks were landed in Monterey, Calif., between November 22, 1930 and February, 1931.
[74] MacGinitie, Science, N. Ser., vol. 73, May 1931, p. 496.

the surface. Once struck, however, a large one is likely to put up an astonishingly active and enduring resistance. We read, for example, of one of 35 to 38 feet harpooned by Capt. N. E. Atwood off Provincetown, Mass., about 1863, that towed the fishing smack all night, and broke loose finally.[75]

[75] Goode, Fish. Ind. U. S., 1884, Sect. 1, p. 669.

THRESHER SHARKS. FAMILY ALOPIIDAE

The threshers (several species are known) are peculiar among sharks for their enormously long tail fin. Their closest affinities in other respects are with the mackerel sharks.

Thresher *Alopias vulpinus* (Bonnaterre) 1758

THRASER; SWIVELTAIL; FOX SHARK

Bigelow and Schroeder, 1948, p. 167.
Garman, 1913, pl. 7, figs. 1–3.

Description.—The thresher is as easily distinguished from all other Gulf of Maine sharks by its long tail as the hammerhead is by its head, the upper caudal lobe being a little longer than the head and body of the fish together, curved much like the blade of an ordinary scythe, and notched near the tip, whereas the lower lobe measured along the front margin is hardly longer than the pelvic fins. We need merely point out in addition that the first dorsal fin (of moderate size and about as high as it is long) stands about midway between pectoral and pelvic fins; that the second dorsal fin and the anal are very small; that the pectoral fin is long and sickle shaped; and that the thresher is a stout-bodied shark with short snout and blunt, rounded nose. Its teeth are small, subtriangular with a single sharp cusp and are smooth edged. Those near the center of mouth are nearly symmetrical, but the successive teeth are increasingly oblique outward, with their outer margins increasingly concave.

Color.—Dark brown, blue-slate, slate gray, blue gray, leaden or even nearly black above, often with metallic luster, grading on the sides to white below, except that the snout and the lower surface of the pectorals are usually about as dark below as above, and that the sides near the pectorals may be more or less mottled with gray, the belly also. The iris is black or green.

Size.—Threshers vary considerably in size at birth, for while free living specimens have been reported as small as 46 inches, with many of 48 to 60 inches (some with umbilical scars still showing), one unborn embryo was 61 inches long. The state of development of the claspers of males, with the lengths (14 ft. 6 in. and about 15½ ft.) of females that have been found with embryos, makes it unlikely that they mature sexually until they are at least 14 feet long (tail included). Lengths up

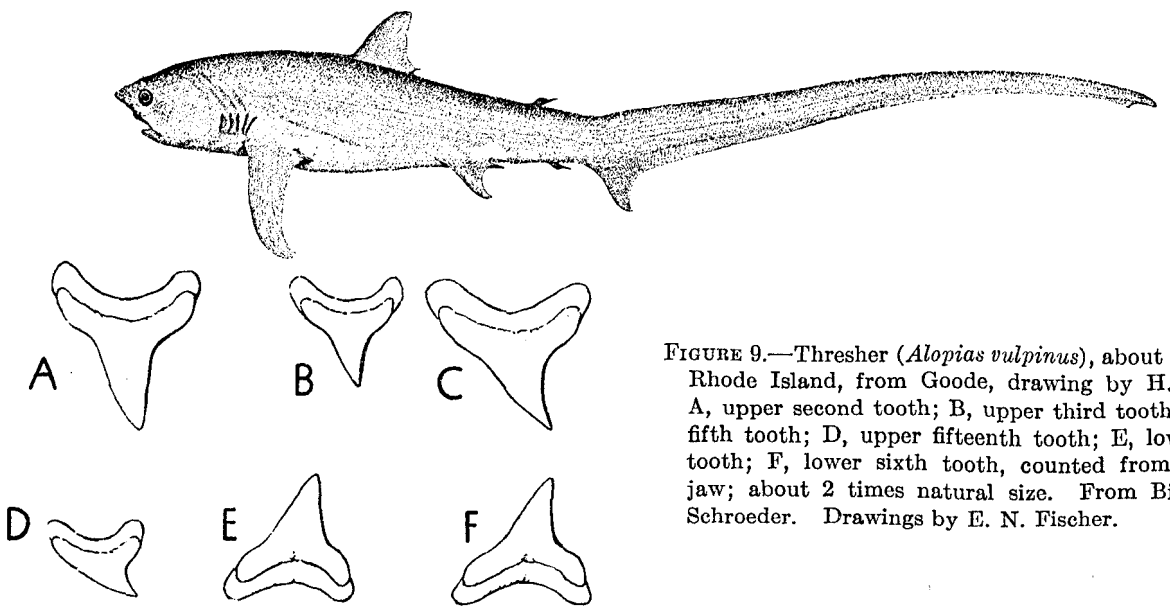

FIGURE 9.—Thresher (*Alopias vulpinus*), about 5 feet long, Rhode Island, from Goode, drawing by H. L. Todd. A, upper second tooth; B, upper third tooth; C, upper fifth tooth; D, upper fifteenth tooth; E, lower second tooth; F, lower sixth tooth, counted from center of jaw; about 2 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

to 16 feet are usual;[76] the maximum length (tail included) is about 20 feet. Threshers are so largely tail that they are much lighter than many other sharks, length for length. The few actually weighed have ranged from about 300 to 320 pounds at about 10 feet, and 375 to 400 pounds at about 13 feet, to about 500 pounds at about 14½ feet. Perhaps 1,000 pounds is about the maximum to be expected for a very large one.

Habits.—The reports of threshers are mostly based on ones seen at the surface or caught either in nets set shoal, or in traps set close inshore. But a thresher has been hooked as deep as 35 fathoms in British waters.[77]

The thresher feeds chiefly if not exclusively on small schooling fishes; in American waters mostly on mackerel, menhaden, herring, and bluefish (*Pomatomus*); also on bonito and on squid. A pair of threshers often work in concert "herding" a school of fish, and it is to frighten its prey together that the enormously long, flail-like tail is employed. Allen [78] gives an interesting eyewitness account of a thresher pursuing and striking a single small fish with its tail.

The tale that the thresher leagues with the swordfish to attack whales is time honored, but has long since been relegated to the category of myth. And so weak toothed is this shark that the second part of the story (it makes a meal of its huge victim) is close to an impossibility. The thresher, we may add, does not harm human beings.

In American waters it is probable that threshers are born throughout its range, very small free living specimens having been caught off New England on the one hand, and off Florida on the other. The embryos do not develop a placental attachment with the mother, and either 2 or 4 have been reported in gravid females.

General range.—This is an oceanic shark of temperate and subtropical seas. In the Atlantic it is known from southern Ireland and the North Sea to Madeira and the Mediterranean in the east, and also from the Cape of Good Hope; from Nova Scotia and the Gulf of St. Lawrence to Cuba and the northern part of the Gulf of Mexico in the west, and again from southern Brazil and northern Argentina. Seemingly it does not occur in the equatorial belt of the Atlantic. But it does in the Pacific, where it is known from Oregon to Panama and Chile. Threshers of this same type are also found in the central and western Pacific and in the Indian Ocean. Whether the thresher of the eastern side of the Pacific is identical with that of the Indian Ocean remains to be determined.

Occurrence in the Gulf of Maine.—The thresher has often been seen off the southern coast of New England and in some numbers. Three about 16 feet long have been taken near Woods Hole, for example, in one trap in a single morning, and it has been classed as the commonest of the large sharks off Block Island. Scattered specimens also visit the Gulf of Maine in some years, though perhaps none in others. Thus two have been reported in print from Nantucket; we saw several large ones in Pollock Rip, off the southern angle of Cape Cod on August 4, 1913; it has been reported repeatedly on the coast of Massachusetts, as at Barnstable on Cape Cod Bay, where one about 10 feet long was taken in a trap on October 21, 1949, and from various localities in Massachusetts Bay (e. g. Boston Harbor and Nahant).

Records for it along the coast of Maine include the vicinity of Monhegan Island, east of Matinicus Island, the offing of Penobscot Bay where one weighing about 500 pounds (estimated) was caught in 1911 and another seen in 1911, in the vicinity of Eastport. It has also been taken in the cold waters of Passamaquoddy Bay; one for instance in a weir at Deer Island, August 28, 1936;[79] also in the Basin of Minas on the Nova Scotian shore of the Bay of Fundy. Occasionally a thresher is netted or seen off the outer coast of Nova Scotia. The most northerly record for it from our side of the Atlantic is for the Bay of Chaleur in the southern side of the Gulf of St. Lawrence. It is to be expected in Gulf of Maine waters only during the warm half of the year, perhaps May to October (April to late autumn for Woods Hole); in the cold season it altogether deserts our northern coasts for warmer seas.

Importance.—The thresher is not common enough in the Gulf of Maine to be of any importance to fishermen one way or another, or to play

[76] Several of that size have been taken in the traps at Woods Hole.

[77] There is another group of species of the genus, with very large eyes, that live at greater depths; for discussion of these, see Bigelow and Schroeder (Fish. Western North Atlantic, Pt. 1, 1948, pp. 162, 163).

[78] Science, N. Ser., vol. 58, 1923, pp. 31–32.

[79] Reported by McKenzie, Proc. Nova Scotia Inst. Sci., vol. 20, 1939, p. 14.

a practical role of any moment among the smaller fish. Further south, however, and wherever it is numerous in the Atlantic, it makes itself a pest, tangling and tearing mackerel nets as well as destroying and chasing away the more valuable fishes on which it feeds.

CAT SHARKS. FAMILY SCYLIORHINIDAE

Distinctive features of these little sharks are that they have five pairs of gill openings and an anal fin; that at least one-half of the base of the first dorsal fin is rearward of the point of origin of the pelvic fins; that the front margin of the nostrils does not bear a fleshy barbel; and that they lay eggs with horny shells and tendrils at the corners. Many species are known. The familiar spotted dogfishes of European seas (two species) fall in this group. And one species calls for mention here.

Chain dogfish *Scyliorhinus retifer* (Garman) 1881

Description.—The chain-like pattern of narrow black stripes with which the reddish-brown back and sides of this little shark are marked are so distinctive that there is no likelihood of confusing it with any other shark. We need only add that its first dorsal fin stands wholly behind the rear ends of the bases of its pelvic fins; that its second dorsal fin is about one-half as large in area as its first dorsal fin; that its tail fin is square-tipped and occupies only about one-fifth of the length of the fish; and that its teeth are similar in the two jaws, narrow-triangular with a small secondary cusp on either side.

Size.—The largest specimen measured so far was 17 inches long.

General range and occurrence in the Gulf of Maine.—The range of the chain dogfish is confined to the 40–125 fathom zone between the offings of Cape Lookout, North Carolina, and of Nantucket. It seems to be the most plentiful off Virginia, in the general offing of Chesapeake Bay, where considerable numbers are taken during the winter trawl fishing. They are caught now and then as far as the offing of Marthas Vineyard, and *Cap'n Bill II* trawled one, in July 1952, south of Nantucket Lightship, Lat. 40°02′ N; Long. 69°37′ W, at 75–90 fathoms which brings it within the arbitrary boundary of the Gulf of Maine.

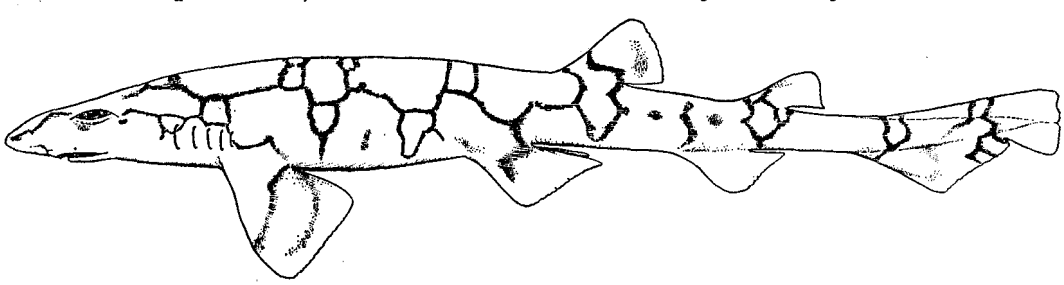

FIGURE 9A.—Chain dogfish (*Scyliorhinus retifer*), male, about 17 inches long, New Jersey. After Bigelow and Schroeder.

SMOOTH DOGFISHES. FAMILY TRIAKIDAE

These are rather small sharks, with two dorsal fins without spines, the second dorsal (in Atlantic species) nearly as large as the first, and they have an anal fin. The tail fin is very strongly asymmetrical, its lower anterior corner forming a low but rather definite lobe in some, but not in others. The teeth are small, with several rows in function imultaneously, flat, and pavement-like in some, but with three or four definite cusps in others. The eye has no nictitating ("winking") membrane, but only a longitudinal fold along the lower eyelid. They resemble the requiem sharks (Family Carcharhinidae, p. 36), except for the teeth, and for the lack of a nictitating membrane. Only one species is known from the Gulf of Maine, or is ever likely to be found there.

Smooth dogfish *Mustelus canis* (Mitchill) 1815

SMOOTH DOG; SMOOTH HOUND; GRAYFISH

Bigelow and Schroeder, 1948, p. 244.
Garman, 1913, pl. 4, figs. 6–9, as *Galeorhinus laevis*.

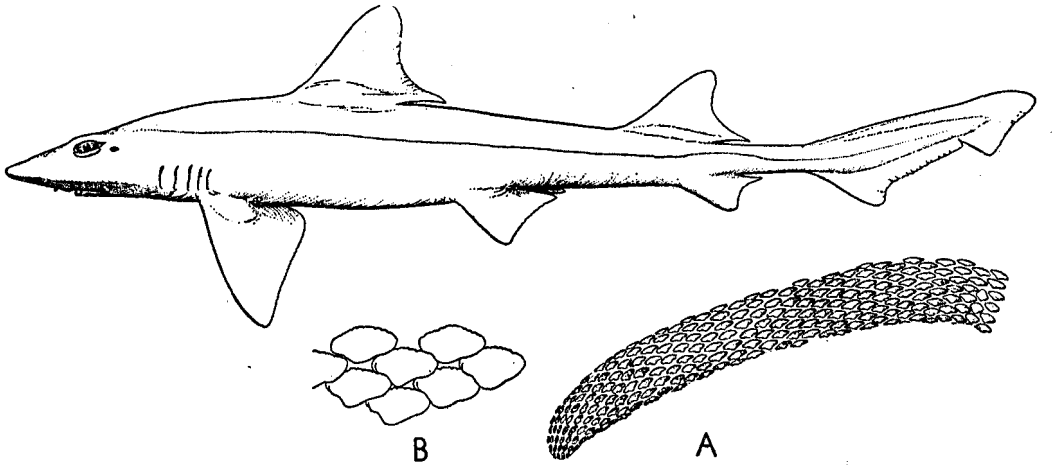

FIGURE 10.—Smooth dogfish (*Mustelus canis*), male, about 31 inches long, Woods Hole. A, tooth band of right-hand side of upper jaw, about 1.8 times natural size; B, teeth of another specimen, about 6 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

Description.—The smooth dog is easily identified among Gulf of Maine sharks by having two large spineless dorsal fins, the second only a little smaller than the first, combined with low, flat, pavement-like teeth. So different, indeed, are its teeth from the awl-like or blade-like teeth of all our other sharks that a glance at the mouth is enough to separate this species from the young of any larger Gulf of Maine shark. In form this little shark is slender, flattened below, with tapering but blunt snout. Its first dorsal fin originates nearly over the hind angle of the pectorals. The second dorsal fin is about twice as large as the anal, over which its stands. The tail is of typical "shark" shape, i. e. with upper lobe much longer than lower. The hind margin of the upper lobe of the caudal is deeply notched near the tip; the lower caudal lobe is very small.

Color.—Upper surface grayish olive, slaty gray or brown, lower surface yellowish or grayish white. Newborn specimens have the upper part of the first dorsal fin edged with dusky gray; the apex of the second dorsal sooty edged or tipped, but with the rear edge white; the tail fin with a sooty blotch above near the tip, but white edged below. But these markings have mostly faded out by the time the little "dog" has grown to a length of two feet or so. Smooth dogs have a greater ability than most sharks to change shade to suit their surroundings, paling to a translucent pearly tint above white sand, but darkening on dark bottom.[80]

Size.—Smooth dogs range from about 11½ inches to about 14½ inches long when born. They mature sexually at about 3 feet, most of the mature females with young are between about 3 feet 3 inches and 4 feet 4 inches long; and a few grow to a length of about 5 feet.

Habits.—The smooth dog is most familiar as a shore fish and a bottom swimmer, commonly entering shoal harbors and bays, and even coming into fresh water. But fishermen also report them as far offshore as the "tile fish" grounds off southern New England and down to a depth of 80 to 90 fathoms. They reach the northern part of their range only as warm-season visitors; at Woods Hole they arrive sometime in May, to withdraw in late October or in November.

Food of the smooth dogfish consists chiefly of the larger Crustacea, and it is perhaps the most relentless enemy of the lobster, which had been eaten by no less than 16 percent of the fish examined by Field. Large crabs are likewise an important article in its diet, as are the smaller fishes. It has been estimated that 10,000 smooth dogfish, in Buzzards Bay, might devour more than 60,000 lobsters yearly, and perhaps one-fifth

[80] Experiments have shown that it requires only 1 to 2 hours for one to darken, but as much as 2 days to pale to the extreme; see Parker (Biol. Bull., vol. 66, 1934, p. 31).

million crabs, besides a great number of small fish (menhaden and tautog are the species most often found in smooth dogfish stomachs). And these figures are based on a sufficient number of observations of the stomach contents to serve as a general indication of the destructiveness of the smooth dogfish. They also feed on squid, especially in spring, and while they do not regularly take hard-shelled mollusks, razor clams have been found in the stomachs of several at Woods Hole. When kept in captivity they are constantly on the move, searching the bottom for food, which they find chiefly by the sense of smell though their sight is also keen.[81] Any crab that may be offered is soon found, seized, shaken to and fro, and eaten. And with packs of these sea hounds hunting over every square foot of our southern bays and sounds it is a wonder any of the larger crustaceans escape where dogfish are abundant. Field[82] also made the interesting observation that the smooth dogfish never molested healthy and active menhaden but soon devoured any sick or injured fish that might be in the same tank with them.

As this is not a characteristic Gulf of Maine fish, we need merely note that it is one of the sharks that develop a placental connection between the embryos and the mother. In other words, it is truly viviparous. The period of gestation appears to be about 10 months; off southern New England the young are born between early May and mid July. The number in a litter usually is between 10 and 20, but as few as 4 have been reported. A description of the unborn young is given by Fowler.[83]

General range.—Coastal waters of the western Atlantic, from Uruguay and southern Brazil, regularly to Cape Cod, and to Passamaquoddy Bay as a stray; also Bermuda.[84]

Occurrence in the Gulf of Maine.—The smooth dog is the second most numerous shark along the southern coast of New England, though falling far short of the spiny dogfish (p. 50). At Woods Hole, for example, pound-net catches varied during the summer of 1903 from 1 to 41, averaging about 7, and catches up to 100 have been reported from the vicinity at one time. Similarly, catches of 5 or 6 on a hand line are common in a few hours' fishing, with as many as 10 to 20 reported. But the elbow of Cape Cod and the region of Nantucket Shoals mark so definite a boundary to their dispersal eastward that while they have been reported from Provincetown, from various localities within Massachusetts Bay, and even from as far north as St. Andrews in the Bay of Fundy, where one was caught in July 1913, neither of us had ever seen one north of Cape Cod until September 21, 1951, when an angler (Ellery Sidney) showed us a female about 3 feet long that he had caught at Cohasset, while casting with an eel skin, for striped bass. So far as known its occasional incursions into the Gulf are sporadic, at least they have not been correlated with unusually warm summers or with the presence of other southern fishes. Neither has it been reported by fishermen from Georges or Browns Banks, nor was it detected there by the representatives of the Bureau of Fisheries during the trawling investigations of the years 1912 and 1913 (p. 60), or subsequently.

REQUIEM SHARKS. FAMILY CARCHARHINIDAE

This family, which includes a large number of species in tropical and temperate seas, is characterized by a head of normal shape, eye with a nictitating (winking) membrane, tail with the upper lobe considerably larger than the lower but not very long, 2 spineless dorsal fins, the first usually much larger than the second in most of the Atlantic species,[85] an anal fin, a caudal peduncle lacking lateral keels, and sharp, bladelike teeth with a single cusp. All bear "living" young;

[81] The senses of this shark have been studied by Parker (Bull., U. S. Bur. of Fish., vol. 29, 1911, pp. 43-57), and by Sheldon (Jour. Compar. Neurol. and Psychol., vol. 19, 1909, No. 3, p. 273).

[82] Rept. U. S. Comm. Fish., (1906), 1907, Spec. Pap. 6, pp. 14-16.

[83] Occas. Pap. Mus. Zool., Univ. Mich., No. 56, 1918, p. 15.

[84] Present indications are that several more or less isolated populations of this shark exist, with their areas of regular occurrence separated by wide gaps, where there is little or no intermingling. One of the best known is along the Atlantic coast, Cape Cod to North Carolina; another centers in the Gulf of Mexico-Caribbean region; a third is along southern Brazil and Uruguay. For further details, see Bigelow and Schroeder, Fishes Western North Atlantic, Part 1, 1948, pp. 250-251.

[85] The lemon shark (*Negaprion brevirostris*) of warmer waters, which has been known to stray to New Jersey, is an exception in this respect; its second dorsal is nearly as large as its first dorsal.

some have a placental connection between mother and embryo, but others do not.

Tiger shark *Galeocerdo cuvier* (LeSueur) 1822

LEOPARD SHARK

Bigelow and Schroeder, 1948, p. 266.

Description.—The tiger shark is characterized among the Atlantic members of its family by the forward position of its first dorsal fin (origin about over the arm pit of the pectorals), combined with a caudal peduncle with a low longitudinal ridge of skin on either side, besides a well-marked semilunar pit below as well as above; a very small second dorsal fin; a furrow, about as long as the snout along either side of the upper jaw; a very slender-tipped caudal fin with moderately large and pointed lower lobe; and large teeth alike in the two jaws, of very characteristic shape, with convex inner margins, deeply and conspicuously notched outer margins and strongly serrate edges (fig. 11).

Young tiger sharks are rather slender, but they become very heavy forward, with growth, though they continue tapering toward the tail. The first dorsal fin is high, triangular, and nearly as large as the pectorals, while the second dorsal is hardly one-third to one-fourth as high as the first and stands over the anal, which is of about equal size. The lower tail lobe is almost half as long as the upper, the rear margin of which is notched near the tip. The large size of the head, with very short, obtusely rounded front outline, and broad mouth occupying nearly four-fifths of the width of the head, with long grooves along the upper jaw, combined with the unique shape of its teeth, make the "tiger" easy to recognize among Gulf of Maine sharks.

Color.—Gray, or grayish brown, darkest on the upper surface. Young "tigers" up to 5 or 6 feet long, are more or less conspicuously spotted or barred with darker brown on the back and along the upper parts of the sides. But these markings fade with advancing age until large specimens are plain colored, or nearly so.

Size.—Tiger sharks are small at birth, corresponding to the large numbers in a litter, free living specimens having been reported only 18 to 19 inches long. By the time they mature they are among the larger sharks; but their size has often been overestimated. The majority of tigers caught in centers of abundance are less than 12 to 13 feet long, and the largest measured lately in the western Atlantic was one of about 18 feet, from Cuba. Repeated statements that the tiger grows to a maximum length of 30 feet have no reliable foundation, so far as we can discover.

A 4-foot specimen from Woods Hole weighed 25¾ pounds when taken from the water. Larger tigers vary widely in weight at given lengths depending on how fat they are and on the stage of development of the young in gravid females. Specimens from various localities have weighed 37 pounds at 5½ feet; 168 pounds at 6 feet; 366 to 718 pounds at 10 to 11 feet; 450 to 825 pounds at 11 to 12 feet; 630 to 1,324 pounds at 12 to 13

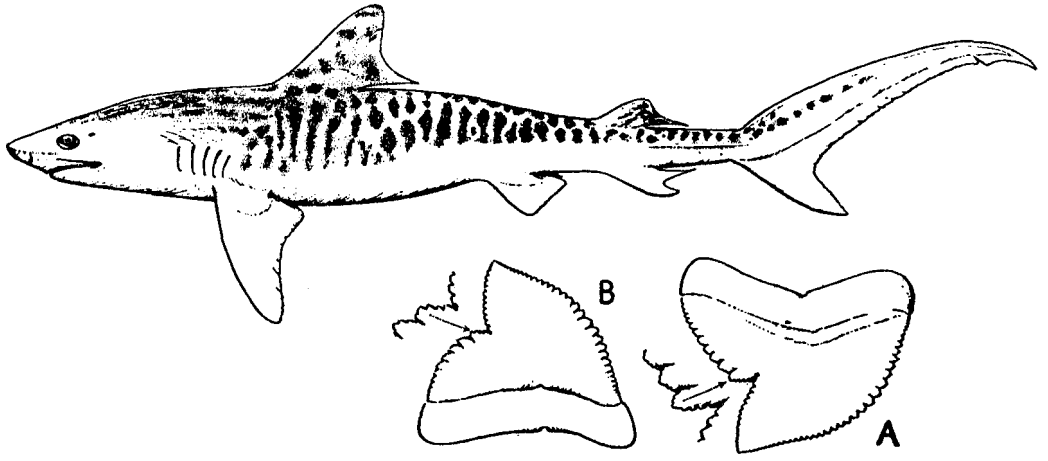

FIGURE 11.—Tiger shark (*Galeocerdo cuvier*), young male, about 49 inches long, Rhode Island. A, upper tooth, and B, lower tooth of larger specimen, enlarged. From Bigelow and Schroeder. Drawings by E. N. Fischer.

feet; and 1,028 to 1,395 pounds at 13 to 14 feet.[86]

Habits.—This voracious shark, with wide jaws and powerful teeth, preys upon the large sea turtles, other sharks, fish, and occasionally on invertebrates such as horseshoe crabs, crabs, conchs, whelks. It is proverbial for its habit of feeding on slaughter-house wastes or any other carrion. Remnants of squeteague, mackerel, hake, scup, menhaden, goosefish, and dogfish all have been found in stomachs of tiger sharks taken at Woods Hole.[87] There is no placental connection between mother and young, and the broods are very large, as many as 82 having been counted in a large female; but other litters as small as 10 to 14. In the West Indies it is much dreaded, whether or not with good cause.

General range.—Cosmopolitan in the warmer waters of all oceans; straying northward as far as Cape Cod on the American coast of the Atlantic.

Occurrence in the Gulf of Maine.—A few tiger sharks are taken in fish traps in the Woods Hole region every year, seldom before August or later than October although one was caught there July 20, 1951.[88] These specimens usually have been about 5 feet long, at most about 8 feet, and very rarely does a full-grown tiger shark stray so far from its tropical home. The tiger has not yet been recorded (on reliable evidence) from within the limits of the Gulf of Maine. It is included here because of the likelihood that a stray specimen may occasionally round the elbow of Cape Cod, or be encountered on the offshore Banks.[89]

[86] For further details and references, see Bigelow and Schroeder, Fishes Western North Atlantic, Pt. 1, 1948, p. 269.

[87] Bell and Nichols (Copeia, No. 92, March 1921, pp. 17–20) list the stomach contents of a number of tiger sharks caught off Morehead City, N. C.

[88] This shark was 8 feet, 3 inches long, taken in a pound net off Quisset Harbor, Buzzards Bay.

Blue shark *Prionace glauca* (Linnaeus) 1758

BLUE DOG

Bigelow and Schroeder, 1948, p. 282.
Garman, 1913, pl. 3, figs. 1–3 (as *Galeus glaucus*).

Description.—The blue shark is slender-bodied, thickest about its mid-length, and tapers toward head and tail (a shape usually named "fusiform"). Its snout is long with rounded tip. Its first dorsal fin is of moderate size, standing far back with the mid point of its base about midway between the inner corners of the pectorals (when these are laid back) and the points of origin of the pelvic fins. The second dorsal fin is less than one-half as high as the first, and is about equal in size to the anal over which it stands. The pectorals are narrow and very long, their tips reaching back nearly as far as the rear corner of the first dorsal. The lower lobe of the caudal fin (measured along its anterior edge) is about one-half as long as the upper lobe; the latter is conspicuously notched near the tip, and both of the lobes of the caudal fin are slender tipped.

The teeth are large, sharp-pointed, with serrate edges, and distinctive in shape. The uppers are so closely spaced that the bases of adjacent teeth

[89] The statement in the first edition that a tiger shark was once taken at Provincetown was an error. The original description of the specimen in question (Atwood, Proc. Boston Soc. Nat. Hist., vol. 10, 1865, p. 81) suggests that it was a mako (*Isurus oxyrinchus*).

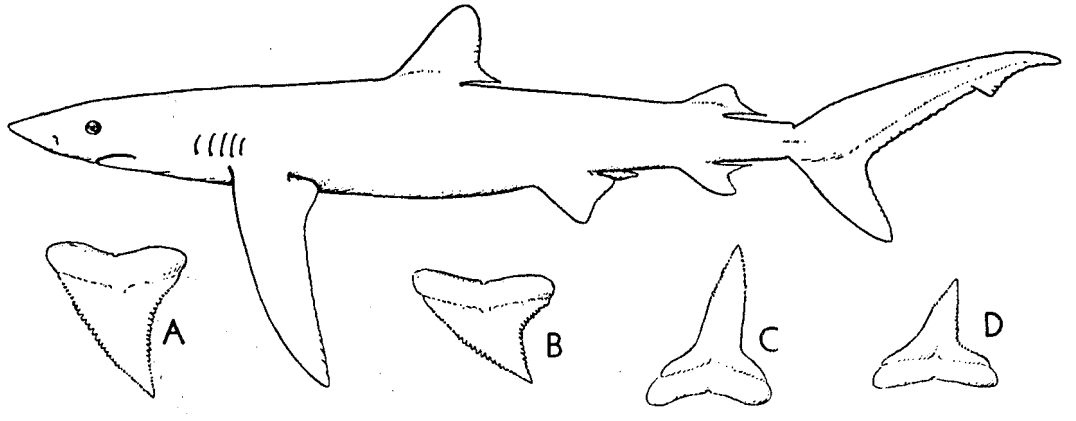

FIGURE 12.—Blue shark (*Prionace glauca*), male, about 7 feet 2 inches long, off Marthas Vineyard. A, third left-hand upper tooth, counted from mid-point of jaw; B, ninth left-hand upper tooth; C, third left-hand lower tooth; and D, eighth left-hand lower tooth; about 1.6 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

overlap. The median upper tooth is nearly symmetrical, but those along the sides of the mouth have strongly convex outer margins, and deeply concave inner margins, while their points curve sharply outward toward the respective corner of the mouth. The lower teeth are narrower, more nearly symmetrical, and nearly erect.

Color.—Living specimens are dark indigo blue along the back, shading to a clear bright blue [90] along the sides; but this beautiful hue changes to a slaty or sooty gray soon after death. The lower surface is snow-white, but with the tips of the pectorals dusky and the anal fin partly sooty.

Size.—The usual length at birth seems to be between 1½ and 2 feet.[91] Blue sharks do not mature until they have grown to be 7 or 8 feet long, to judge from the sizes of the females that have been found with young; the longest we have handled was almost exactly 11 feet long. The fact that the greatest measured length so far reliably reported was only 12 feet 7 inches (3.83 meters) suggests that repeated characterizations of the blue shark as commonly growing to 15 feet are an exaggeration. If any grow to 20 feet, as is rumored, they must be giants of their kind.

Remarks.—The very long slender pectorals of the blue shark, combined with its long narrow snout, the position of its first dorsal fin far back, and its brilliant blue color, give it an aspect very different from that of the tiger shark (p. 37), of the sharp-nosed shark (p. 40), the dusky or brown sharks (pp. 41–43), or that of any other carcharhinid shark that might perhaps straggle to the Gulf of Maine.

Habits.—The blue shark is "encountered indifferently far out at sea and in continental waters, its wanderings no doubt directed chiefly by the search for food, though it may drift with ocean currents. It is frequently seen at the surface, swimming lazily with first dorsal fin and tip of caudal out of water, or basking in the sun. There is no reason to suppose that it ever descends to any great depth." [92] They sometimes follow sailing ships for days on end, to pick up scraps, and their habit of gathering when a sperm whale was killed, to feed on the carcass, was proverbial during the days of the sperm whale fishery.[93] But their normal diet is smaller fishes, of whatever kinds may be available. In northern waters herring, mackerel, spiny dogfish, and various others have been found in their stomachs. And we have several times seen a blue shark pick up a tagged cod, haddock or American pollock that we had put back in the water, on Georges Bank.

The blue shark is viviparous, that is to say, the embryo has a well developed placenta attached to the mother. As many as 28 to 54 young have been reported in a litter in the Mediterranean.

General range.—Cosmopolitan on the high seas in the warmer parts of all the oceans, including the Mediterranean; ranging northward to outer Nova Scotia and as a stray to the Banks of Newfoundland in the western side of the Atlantic; to England and Scotland in the east, with stray specimens reaching the Orkneys and southern Norway. This, we think, is by far the most numerous of the large, oceanic sharks; it is the one with which the sperm whalers were the most familiar; the one around which many of the superstitions about sharks have developed; and the one with which we have had to do most often.

Occurrence in the Gulf of Maine and along Nova Scotia.—Only one blue shark had been reported definitely from the Gulf of Maine in scientific literature, up to the time the first edition of this book was printed, though it was known to be rather common along outer Nova Scotia. But we have learned since then that it is a regular summer visitor to the southern and western parts of the Gulf, appearing occasionally in July, more often in August and September. In 1928, for example, we caught one on Stellwagen Bank on August 26, saw one over the northern end of Jeffreys Ledge on September 2, and caught four on Platts Bank on September 3, with others in sight from the vessel at nearly all times throughout the day. And many more have been seen or caught subsequently, on Platts Bank, in Massachusetts and Cape Cod Bays, where 18 were reported to us during the summer of 1935,[94] on Georges Bank where blue sharks, swimming at the surface, are a familiar sight in summer; and on Browns Bank. Two have also been re-

[90] "Sailor blue," as shown in Ridgeway's Color Standards and Color Nomenclature, 1912, p. 21.

[91] Embryos have been reported as long as about 17½ inches, and free-living specimens as small as 20–21 inches.

[92] Bigelow and Schroeder, Fishes Western North Atlantic, Pt. 1, 1948, p. 286.

[93] Nichols and Murphy (Brooklyn Mus. Sci. Bull., vol. 3, No. 1, 1916, p. 9) have given a graphic account of the blue shark as it was met with by whalers on the high seas.

[94] By J. R. Lowes, an experienced shark fisherman.

ported to us recently from the coast of Maine, a few miles east of Casco Bay.[95]

We have never heard of a blue shark in the northeastern corner of the Gulf, in the Bay of Fundy, nor along western Nova Scotia, whence they may be barred by colder surface waters. But fishermen are familiar with them off the outer coast of Nova Scotia, both offshore, and also near the coast at the times when the warm surface water presses inshore.

Blues were reported near Halifax, for instance, from time to time between August 15 and October 10, 1920, some coming close in to the entrance to the Harbor. And two specimens have been reported at Canso,[96] but whether the "blue dogs" described by local fishermen as common on the neighboring banks actually are this shark, or perhaps the porbeagle, seems doubtful. It has also been recorded from the southwest part of the Grand Bank of Newfoundland.[97]

Following westward from Cape Cod, we find many records of blues from the traps near Woods Hole, and they are often seen (or harpooned) on the continental shelf in the offing. Twenty-eight were counted 4 to 10 miles off Block Island for example, during one hour, and something like 150 to 200 during the day (13 of them were harpooned) on August 22, 1943.

Most of the blues that are seen or taken off our northern coast are medium sized or larger, though very small ones are taken from time to time.[98] And for some obscure reason all but two of the adults seen in our Gulf, for which we have the pertinent information, have been males.

Commercial importance.—This shark is of no commercial value. A few are caught by anglers, mostly on natural bait, and a Blue will sometimes take an artificial lure; we hooked one off Boone Island, Maine, on a feather jig, tipped with pork rind. We have never had blues put up much resistance on a heavy hand line until hauled in to the side of the vessel, when they thrash about violently, but it is said that a large one will make long and powerful runs, if hooked on rod and reel.

The blue shark has always been looked on with contempt by the sperm whalers, who were more familiar with it than anyone else. We find no well-authenticated case of one attacking a swimmer. sailors' yarns to the contrary notwithstanding.

Sharp nosed shark *Scoliodon terrae-novae* (Richardson) 1836

Bigelow and Schroeder, 1948, p. 295.
Garman, 1913, pl. 2, figs. 1–4.

Description.—This little shark is separable from any other carcharhinid that has yet been reported from the Gulf of Maine or that is likely to be, by its upper and lower teeth which are perfectly smooth along the edges from tip to base, combined with a so-called "labial furrow" of considerable length running forward along each side of each jaw from the corner of the mouth toward the nostril. This last character, while not conspicuous, is a precise one.

The trunk is slender, highest about at the first dorsal fin, tapering both fore and aft. The snout varies rather widely in length and in bluntness at the tip. The point of origin of the first dorsal fin

[95] By the late Walter H. Rich, who was long associated with the U. S. Bureau of Fisheries.
[96] Cornish, Contr. Canadian Biol. (1902-1905) 1907, p. 81.
[97] Rept. Newfoundland Fish. Res. Lab., 1935, p. 79.
[98] Robert Goffin reports one only 20 inches long, from Menemsha Bight, near Woods Hole, August 31, 1925; we have seen one of 21 inches, taken a few miles off Block Island, August 22, 1943; and F. D. Firth reports one 34½ inches long taken 65 miles southeast of Highland Light, Cape Cod, on October 23, 1930.

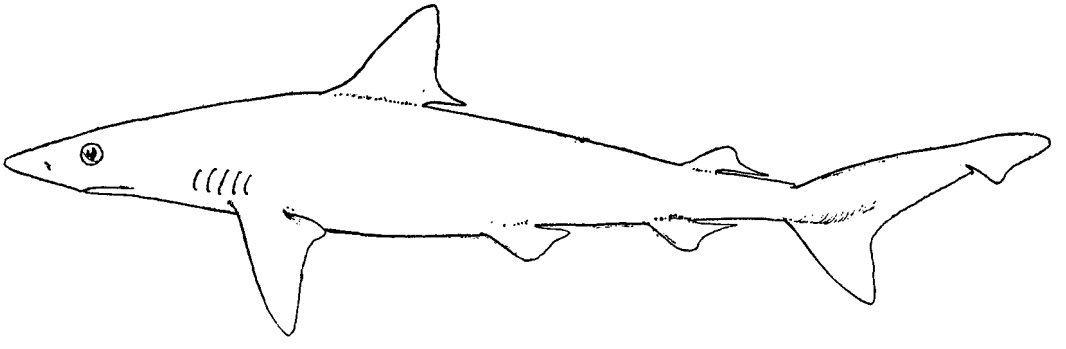

FIGURE 13.—Sharp-nosed shark (*Scoliodon terrae-novae*), female, about 31 inches long, from the Bahamas. From Bigelow and Schroeder. Drawing by E. N. Fischer.

is about over the inner corners of the pectorals when the latter are laid back; its height is about one-half as great as the distance from the tip of the snout to the level of the origin of the pectorals. The second dorsal is only about one-quarter as high as the first; its point of origin is about over the mid-point of the base of the anal fin; the anal is a little larger than the second dorsal. The tail fin occupies about one-quarter of the total length of the shark; its lower lobe (measured along the anterior edge) is a little less than one-half as long as the upper lobe, the rear edge of which is deeply notched near the tip. The pectoral fins are smaller relatively than in any other local species of this family, their length, armpit to tip, being only a little greater than the height of the first dorsal fin. The teeth are alike in shape in the two jaws, sharp-pointed and smooth edged; those in the center of the mouth are symmetrical and erect, but those along the sides have weakly concave inner margins, but deeply notched outer margins, and are increasingly oblique toward the corners of the mouth.

Color.—Brown to olive gray above, with the dorsal and caudal fins more or less dark edged; white below and along the rear margins of the pectorals.

Size.—Mature specimens are commonly between 26 and 30 inches long; a few grow to 36 inches.

General range.—Both sides of the tropical–subtropical Atlantic; Morocco to Cameroon and the Cape Verde Islands in the east; Uruguay to North Carolina in the west; occasional to Woods Hole, and as a stray to the Bay of Fundy.

Occurrence in the Gulf of Maine.—Our only reason for including this warm-water shark is that one was taken at Grand Manan Island,[99] at the mouth of the Bay of Fundy, in 1857.[1-2]

Early reports of it from Newfoundland were based on a misconception.

Sharks of the Genus *Carcharhinus*

The members of the genus *Carcharhinus* are set apart from other Atlantic members of the family Carcharhinidae by the following combination of characters: The mid-point of base of the first dorsal fin is at least as near to the level of the axils of the pectorals as to the level of the origin of the pelvics (separating them from the blue shark, p. 38); no labial furrows on lower jaw, and furrow on upper jaw reduced to a very short slit at the extreme corner of the mouth, directed outward (separating them from the tiger shark, p. 37, and from the sharp-nosed shark, p. 40); second dorsal fin much smaller than first dorsal (separating them from the lemon shark, p. 35, footnote 85); edges of upper teeth more or less finely serrate but without larger denticles near the base, and edges of lower teeth perfectly smooth, without lateral denticles (separating them from the tiger shark, p. 37, from the sharp-nosed shark, p. 40), and from *Paragaleus pectoralis*, a tropical shark that has been taken off southern New England.[3]

This is a warm-water group, fifteen species of which are known to inhabit the western side of the Atlantic, most of them resembling one another closely in general aspect. Only one of these (the dusky shark, described on p. 41) has yet been reported reliably from within the confines of the Gulf of Maine, while only one other (the brown shark, p. 43) is likely to be found there. If a stray *Carcharhinus* from offshore that does not agree with the following descriptions of one or other of these should be taken on Georges Bank, or on Nantucket Shoals east of the longitude of Cape Cod, we hope that its captor can identify it by means of the keys and descriptions of the genus that we have given in Part 1 of the Fishes of the Western North Atlantic.

Dusky shark *Carcharhinus obscurus* (LeSueur) 1818.

Bigelow and Schroeder, 1948, p. 382.

Description.—The combination of characters that place the dusky shark among the western Atlantic members of its genus are: Trunk about one-fifth as high at first dorsal fin as it is long to origin of the caudal fin, tapering both forward and rearward; snout broadly rounded in front, its length in front of the nostrils less than the distance between the nostrils; the front edge of the nostril is not expanded as a definite lobe; the midline of the back between the two dorsal fins has a low but definite ridge, a character which is very precise, though seemingly minor; the first dorsal fin is considerably smaller than in the brown shark

[99] This specimen, collected by A. E. Verrill, is in the Museum of Comparative Zoology.

[1-2] See Jordan and Evermann, Bull. 47, U. S. Nat. Mus., Pt. 1, 1896, p. 43, footnote.

[3] For description, see Bigelow and Schroeder, Fishes of the Western North Atlantic, Pt. 1, 1948, p. 276.

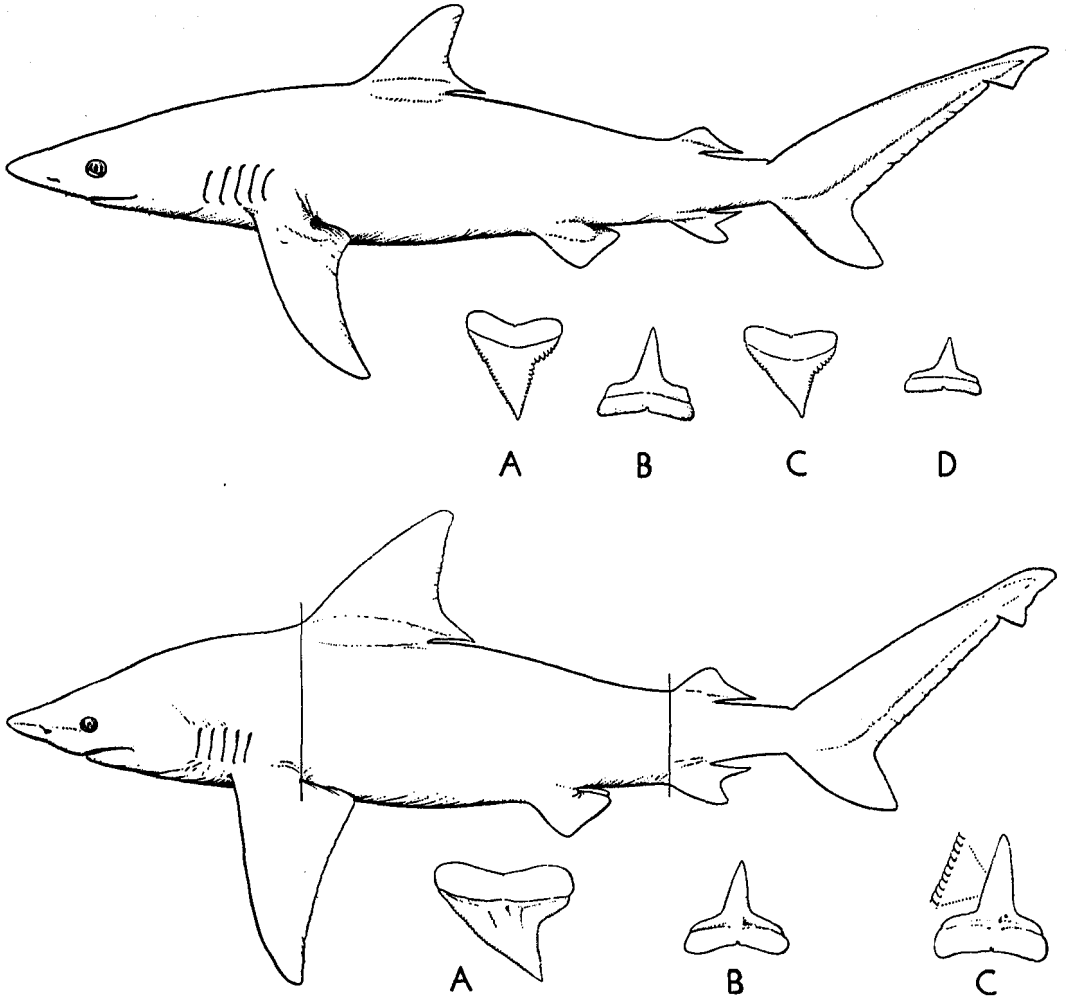

FIGURE 14.—Above: Dusky shark (*Carcharhinus obscurus*), female about 39 inches long, Woods Hole. A, third upper tooth; B, fourth lower tooth; C, ninth upper tooth; D, tenth lower tooth; about 2.4 times natural size. Below: Brown shark (*Carcharhinus milberti*), female, about 4 feet 10 inches long, from Woods Hole. A, ninth upper tooth; B, eighth lower tooth; C, third lower tooth; about 1.4 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

(p. 43), with more deeply concave rear margin, its point of origin about over the inner corner of the pectoral (over the armpit of the pectoral in the brown shark); its apex is narrowly rounded. The free rear corner of the second dorsal fin is less than twice as long as the vertical height of the fin. The anal fin is a little longer, along the base, than the second dorsal and stands about under the latter. The caudal fin occupies between one-quarter and one-third of the total length of the shark, the lower caudal lobe (measured along its anterior edge) is about two-fifths as long as the upper lobe; and the upper lobe is noticeably slender toward its tip. The pectorals are about as long (from origin to tip) as the distance from the tip of the snout to the level of the first pair of gill openings, usually narrower, relatively, than in the brown shark, and sometimes more definitely sickle-shaped.

The upper teeth are broadly triangular; nearly erect toward the center of the mouth but weakly oblique toward its corners; their inner margins are nearly straight, the outer margins increasingly concave outward along the jaw. The lower teeth are erect, symmetrical, with narrow cusp on a broadly expanded base. Both the upper teeth and the lower are serrate along the edges, the lower the more finely so.

Color.—All the fresh caught specimens we have seen have been bluish or leaden gray on the back

and upper part of the sides, including the pectorals, but this shark has also been described as pale gray above or even dirty white, perhaps over a white sand bottom. The trunk is white below, the pectorals grayish, darkening to sooty at their tips; the pelvics and anal fins grayish white.

Size.—The usual length at birth is a little more than three feet.[4] Adult dusky sharks so far measured have ranged from 10 feet 4 inches to 11 feet 8 inches in length, and they are said to grow to 14 feet, though perhaps not on very convincing evidence.

General range.—Western Atlantic, north to southern New England and to Georges Bank, south to southern Brazil, at least by name. A shark very closely allied to *obscurus* has been reported under that name in the eastern Atlantic, from Spain to Table Bay, South Africa, including Madeira, the Canaries, the Cape Verdes, Ascension Island, and St. Helena. But we have yet to learn its precise relationship to the *obscurus* of the western Atlantic.

Occurrence in the Gulf of Maine.—The dusky shark has been taken repeatedly off the coasts of New Jersey and of Long Island, N. Y.; also at Woods Hole, where we have handled 12 specimens during the past few summers, 6 of them in August 1944. But it so seldom strays to cooler waters farther east that only one shark has been recorded from Nantucket, and one from Georges Bank, that probably were of this species and not some other carcharhinid.[5] Thus it has no real place in the fauna of the Gulf.[6]

Brown shark *Carcharhinus milberti* (Müller and Henle) 1841

SAND BAR SHARK

Bigelow and Schroeder, 1948, p. 368.

Garman, 1913, pl. 3, figs. 4–6 (as *Carcharinus platyodon*).

Description.—The brown shark differs from the dusky (only member of its genus that seems actually to have been taken within the Gulf) in the more forward position and larger size of its first dorsal fin, in its broader pectorals, and in its stouter trunk, heaviest forward (compare specimens in figure 14). Also, the anterior edge of its nostril is expanded as a low but definite triangular lobe, which is not the case in the dusky shark. Other characters (in combination) that mark it off from other members of this genus that might stray to the Gulf are: Mid-line of the back with a low ridge between the two dorsal fins; snout forward of a line connecting the front margins of the nostrils, considerably shorter than the distance between the nostrils; point of origin of second dorsal fin about over origin of anal fin, its free rear corner only a little longer than the height of the fin; apex of first dorsal fin angular; length of pectorals along anterior margin about as great as distance from tip of snout to level of second pair of gill openings; distance from rear tips of pelvic fins to origin of anal fin as long as base of anal fin, or longer, fifth gill openings longer than horizontal diameter of eye.

The teeth resemble closely those of the dusky shark (see figure 14).

Color.—Upper surface slate gray to brown; lower surface a paler tint of the same hue, or white; fins without any conspicuous black markings. When alive some of the dermal denticles are bright blue, at least on some specimens.

Size.—Sexual maturity is reached at a length of about 6 feet; maximum length about eight feet.[7]

General range.—Southern Brazil, Louisiana, both coasts of Florida, and northward along the Atlantic coast of the United States to southern New England; also the tropical-subtropical belt of the eastern Atlantic, and the Mediterranean, or represented there by an extremely close relative.[8]

Occurrence in the Gulf of Maine.—Next to the sand shark, this is the most numerous of the larger sharks along the coasts of New Jersey and of New York. Some visit the vicinity of Woods Hole, though so few that the number taken there in most summers probably is not greater than six or seven. It has not been reported as yet from

[4] Embryos have been reported up to 38 in. long (965 mm.), and a free living specimen of only 39 in. (993 mm.); see Bigelow and Schroeder, Fishes Western North Atlantic, Pt. 1, 1948, p. 387.

[5] Probably this species and not the brown shark because 11–12 feet long.

[6] In the first edition of this book, the dusky shark was said to have been taken at three localities within the Gulf. But one of these records, at least, was almost certainly based on a blue shark, and the others probably were (Bigelow and Schroeder, Fishes Western North Atlantic, Pt. 1, 1948, pp. 292, 368).

[7] Seven feet 10 inches is the greatest measured length that we have found recorded, with convincing evidence that the specimen actually was one of this species.

[8] If the eastern Atlantic-Mediterranean form is actually identical with the American, as seems to be the case, the specific name *milberti* of Müller and Henle, 1841, must be replaced by *plumbeus* proposed by Nardo in 1827 for the brown shark of the Adriatic.

within the limits of our Gulf, but is included here on the chance that a stray specimen may be taken, either on the outer coast of Cape Cod, on Nantucket Shoals, or on Georges Bank.

THE HAMMER-HEADED SHARKS. FAMILY SPHYRNIDAE

The peculiar hammer-shaped head, with eyes far apart, sufficiently characterizes the Gulf of Maine sharks of this family, which resembles the requiem sharks (p. 36) otherwise. Five species are known in the western Atlantic, all of them tropical-subtropical in nature. Two of these have been reported from our Gulf, but only as strays.

Shovelhead *Sphyrna tiburo* (Linnaeus) 1758

BONNET HEAD SHARK

Bigelow and Schroeder, 1948, p. 420.

Garman, 1913, pl. 1, figs. 4–6 (as *Cestracion tiburo*).

Description.—The peculiar shovel-shaped head of this shark is enough to distinguish it readily from any other shark known from the Gulf of Maine, except for the hammerhead, from which it is readily distinguished by the fact that its head is considerably narrower, is more rounded in front, and is not deeply indented opposite each nostril; that the posterior margin of its anal fin is only weakly concave, and that the outermost four or five of its lower teeth next each outer corner of its mouth are low and rounded, not blade-like. The eyes of the shovel-head shark, like those of the hammerhead, stand at either edge of the expanded head; the first dorsal fin originates a little behind the "armpit" of the pectoral, is somewhat higher than the pectorals are long, and is higher than long; the very small second dorsal fin originates a little behind the origin of the anal fin; the upper lobe of the tail is notably long (about one-third as long as the body of the fish) and deeply notched near the tip, the lower lobe is about one-third as long as the upper lobe. The anal fin is larger than the second dorsal fin, its posterior margin is only slightly concave; the pectorals are broadly triangular, their anterior margins about as long as the distance from the level of their own points of origin to the front of the mouth.

Color.—Gray or grayish brown above, and a paler shade of the same below; some are marked with a few small dark, roundish spots along the sides.

Size.—This shark is much smaller than the hammerhead, rarely exceeding 5 feet in length; it is said to reach 6 feet.

General range.—Tropical-warm temperate Atlantic; from southern Brazil to North Carolina, in the west, and as a stray to southern New England and Massachusetts Bay; tropical West Africa in the east; also from southern California

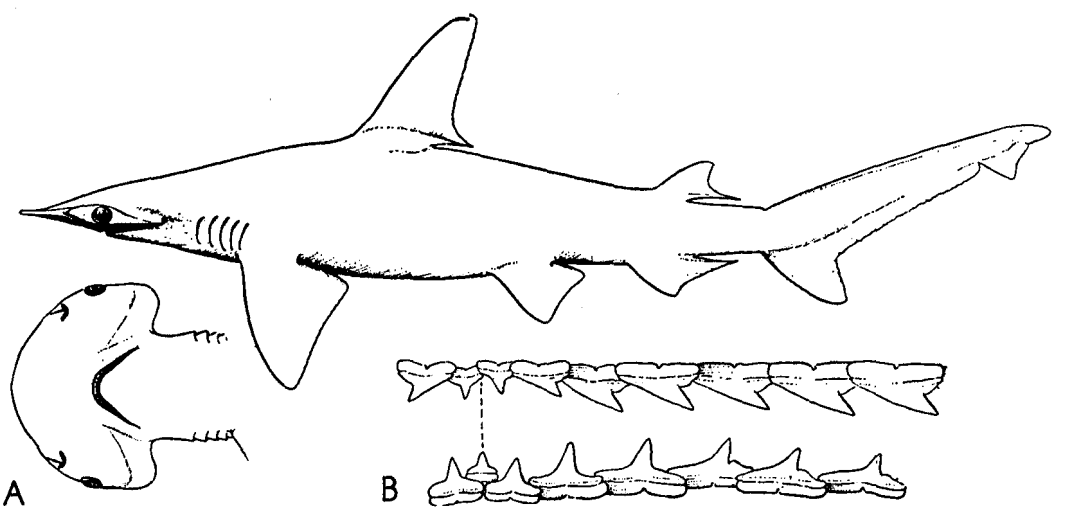

FIGURE 15.—Shovel head (*Sphyrna tiburo*), female, about 14½ inches long, from Rio de Janeiro. A, under side of head; B, first to seventh upper teeth and first to sixth lower teeth counted from center of jaw, about 3.6 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

to Ecuador on the Pacific Coast of America, or represented there by a very close relative.[9]

Occurrence in the Gulf of Maine.—Our only reason for including the shovel-head here is that a stray specimen has been reported from Massachusetts Bay.[10] It has also been taken once at Newport, R. I., and a commercial shark fishery that was carried on in Nantucket Sound in the summer of 1918 is said to have yielded six of them.[11]

Common hammerhead *Sphyrna zygaena* (Linnaeus) 1758

Bigelow and Schroeder, 1948, p. 436.

Description.—The very differently shaped head of the hammerhead, the shape of its anal fin with much more deeply concave posterior margin, and the fact that the outermost four or five of its lower teeth on each side are blade-like, like those nearer the center of its mouth, are ready field marks to separate the hammerhead from the shovelhead (cf. fig. 16 with fig. 15). The anal fin, too, is only about as large as the second dorsal in the hammerhead (considerably larger than the second dorsal in the shovelhead). Otherwise the positions and shapes of the fins and the size and shape of the tail are much alike in the two species.

Color.—Leaden or brownish gray above, shading along the sides to pure or grayish white below; the tips and edges of the dorsal and caudal fins are more or less dusky; and the tips of the pectorals are black on some specimens.

[9] On this point, see Bigelow and Schroeder, Fishes of the Western North Atlantic, Pt. 1, 1948, p. 425, footnote 20. A shark has also been reported as *tiburo* from China and from the Philippines, but without convincing evidence as to its identity.

[10] By Garman, Mem. Mus. Comp. Zool., vol. 36, 1913, p. 161. Apparently the specimen is no longer in existence.

[11] Personal communication by R. H. Bodman, who operated this fishery.

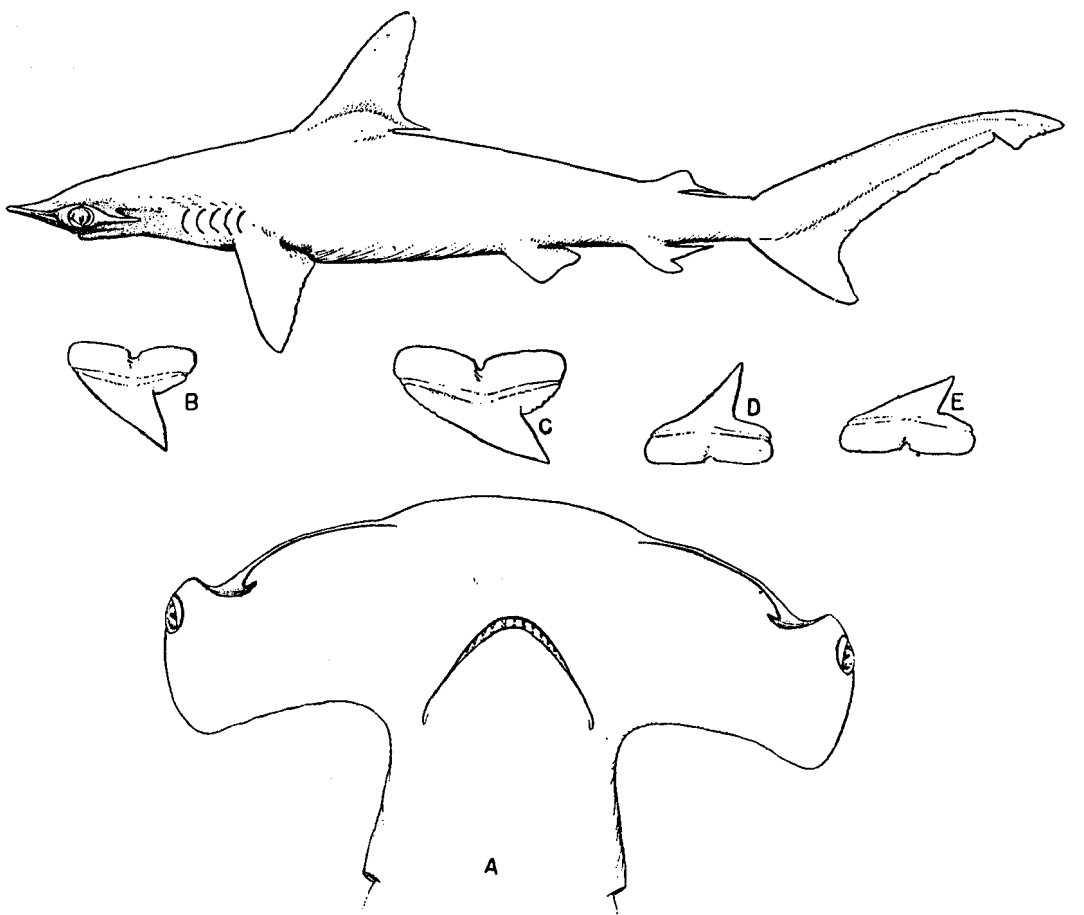

FIGURE 16.—Hammerhead (*Sphyrna zygaena*), female, about 27 inches long, from Nahant, Massachusetts. A, head from below, about one-third natural size; B, second upper tooth; C, ninth upper tooth; D, third lower tooth; E, ninth lower tooth; about 4 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

Size.—It appears that hammerheads are commonly about 19 to 20 inches long when they are born; seemingly, they mature sexually at about 7 to 8 feet; they are often taken 9 to 11 feet long, and occasionally as long as 12 to 13 feet.[12] Most of those that visit southern New England are less than 6 to 7 feet long, some very small indeed.[13] In 1805, however, one of 11 feet was netted at Riverhead, L. I. And the fact that it contained parts of a man in its stomach has been chiefly responsible for the bad reputation of this species of hammerhead.

Two other large sharks closely related to the common hammerhead, the tropical hammerhead (*Sphyrna lewini* Griffith, 1834)[14] and the great hammerhead (*Sphyrna mokarran* Rüppell, 1835) [15] occur along the South Atlantic coast of the United States. The first of these, in particular, might stray as far as Cape Cod, as many tropical fishes do, for it has been recorded from the offing of Cape May, New Jersey. They resemble the common hammerhead closely in general appearance, but both of them may be distinguished from the latter by the fact that the front outline of their head is scalloped in the midline, not evenly rounded there as it is in the common hammerhead. For further accounts of them, see Bigelow and Schroeder.[16]

Habits.—Since hammerheads are an accidental visitor to the Gulf, we need only remark that they are pelagic in habit, often swimming with dorsal and caudal fins out of water, and are to be met with indifferently out at sea or near land. They feed chiefly on fish, including smaller sharks (including their own kind), and sting rays, the tail spines of which are sometimes found imbedded in their jaws. Like tiger sharks, they make themselves a pest in warmer latitudes where fisheries for sharks are carried on, by devouring those that they find entangled in the nets. As many as 30 to 37 embryos have been found in a gravid female, and the embryos do not develop any placental connection with the mother, so far as is known.

General range.—Widespread in the tropical to warm temperate belts of the Atlantic, of the Pacific, and probably of the Indian Ocean as well; north commonly to southern New England, straying to Massachusetts Bay and as far as Halifax, Nova Scotia.[17]

Occurrence in the Gulf of Maine.—Hammerheads (often in small schools) wander northward every summer, along the Atlantic seaboard; they are often to be seen basking at the surface (some harpooned) a few miles out, off Marthas Vineyard and Nantucket; and one is occasionally taken in one or another of the fish traps near Woods Hole. But the longitude of Cape Cod so sharply bounds their yearly dispersal that the only records from the Gulf of Maine, or from Nova Scotia waters, are of stray specimens from Chatham and Provincetown on the outer shores of the Cape; of one about 27 inches long from Nahant, in the inner part of Massachusetts Bay;[18] of two small ones recently from Casco Bay;[19] of one taken many years ago, off Brier I., on the Nova Scotian side of the Bay of Fundy;[20] of a 12-footer harpooned between Georges and Browns Banks in August 1928 by the sword fishing schooner *Doris M. Hawes;* of a small one caught in Halifax Harbor, Nova Scotia, in September 1932;[21] and of another about 21 inches long taken in a trap off Sambro Head, near Halifax, August 25, 1938.[22]

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[12] The larger hammerheads that are sometimes reported probably are not this species, but the great hammerhead (*Sphyrna mokarran*, p. 46, note 16).

[13] Dozens of little ones, of about 2½ feet, have been seined on the outer shore of Long Island, N. Y., in August.

[14] The account of this species, in Bigelow and Schroeder, (Fishes of the Western North Atlantic, Pt. 1, 1948, p. 415) was as *diplana* Springer, 1941. But Fraser-Brunner (Rec. Austral. Mus., vol. 22, No. 3, 1950, pp. 213-214), has shown that it cannot be separated from the Indo-Pacific *S. lewini* of Griffith, 1834, a much older name.

[15] Tortonese has recently pointed out (Ann. Mag. Nat. Hist. Ser. 12, vol. 3, No. 36, 1950, p. 214) that the name *tudes* Valenciennes 1822 that has been applied commonly to the great hammerhead of the Atlantic actually belongs to a different species; consequently that the correct name of the great hammerhead is *mokarran* Rüppell, 1835, it being identical with that Indo-Pacific species.

[16] Fishes Western North Atlantic, Pt. 1, 1948, pp. 415, 428.

[17] For further details of distribution, see Bigelow and Schroeder, Fishes of the Western North Atlantic, Pt. 1, 1948, p. 442.

[18] This specimen, obtained many years ago by Louis Agassiz, is in the Museum of Comparative Zoology.

[19] Seen in the fish market at Portland, Maine, by the late Walter H. Rich.

[20] McKenzie, Proc. Nova Scotia Inst. Sci., vol. 20, 1939, p. 13.

[21] Vladykov, Proc. Nova Scotia Inst. Sci., vol. 19, Pt. 1, 1935, p. 8.

[22] McKenzie, Prov. Nova Scotia Inst. Sci., vol. 20, 1939, p. 13.

THE SPINY DOGFISHES. FAMILY SQUALIDAE

This group is characterized by the lack of an anal fin, combined with the presence of two dorsal fins, each of which is preceded by a fixed spine which is long and conspicuous in some, but so short in others that its presence can be detected only by touch. The teeth are alike in the two jaws in some, unlike in others.

Spiny dogfish *Squalus acanthias* Linnaeus 1758

DOGFISH; PIKED DOGFISH; GRAYFISH

Bigelow and Schroeder, 1948, p. 455.
Garman, 1913, pl. 14, figs. 1–4.

Description.—Any little gray or brownish shark, with a large sharp spine lying along the front margin of each dorsal fin, caught within the Gulf, or on the shoaler parts of the offshore fishing banks, is practically sure to be this "dog," of which there are thousands in the Gulf to every one shark of any other kind. One of its relatives, the black dogfish (p. 51), is a regular inhabitant of the deeper slopes of the offshore Banks that front the Gulf, where we also trawled more than 50 specimens of another relative *Etmopterus princeps* Collett 1904 during the summer of 1952. But there is no danger of confusing the common spiny-dog with either of these, for they are velvety black in color, the rear margins of their tail fins are indented near the tip, which is not the case in the spiny-dog, and each of their teeth, at least in the upper jaw (lower jaw as well in the black dogfish) has 3 to 5 sharp points, but only one point in the spiny dog.

This is a slender little shark, with flattened head and snout tapering to a blunt tip. Its first dorsal fin stands between pectorals and pelvics; its second dorsal fin is about two-thirds as large as the first; its pectorals form nearly an equilateral triangle; and its pelvics are well forward of its second dorsal fin. The dorsal fin spines lie close along the front margins of the two dorsals, the first not more than one-half as long, and the second nearly as long as the front margin of their respective fin, and they are very sharp. The spiny-dog has no anal fin, a lack separating it from all smooth-finned sharks known from the Gulf of Maine, except for the Greenland shark (p. 53), *Dalatias* (p. 55), and the bramble shark (p. 56). There is a low fold of skin on either side of the root of the tail back of the second dorsal fin, so small, however, that there is no danger of confusing it with the caudal keels of the mackerel-shark tribe. The teeth are small, their sharp points bent toward the outer corners of the mouth so that they form a nearly continuous cutting edge along each jaw.

Color.—The upper surface is slate colored usually, sometimes tinged brown, with a row of small

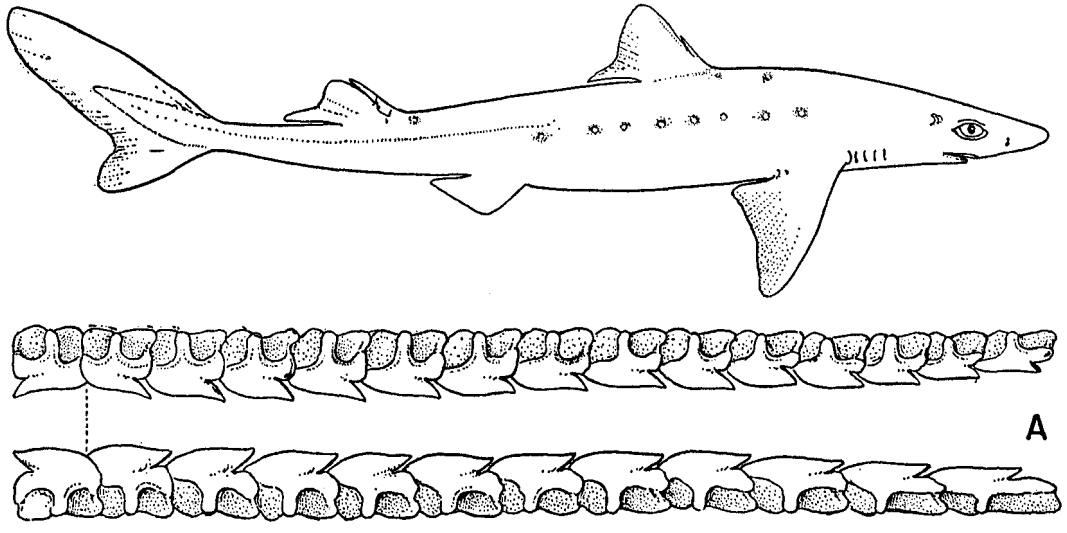

FIGURE 17.—Spiny dogfish (*Squalus acanthias*), female, 27 inches long; after Garman. A, upper and lower teeth, midpoint of mouth marked by the dotted line, about 3 times natural size. From Bigelow and Schroeder. Drawing by E. N. Fischer.

white spots on each side from the pectoral fin to abreast of the anal fin, and with a few other white spots in front of the first dorsal and behind it, also in front of the second dorsal fin. These spots are most conspicuous on small fish up to 12 or 14 inches long and they fade with growth until they disappear altogether in some specimens. The margins of the first and second dorsals, and of the caudal are more or less dusky at birth, but soon fade. The lower surface ranges from pale gray to pure white.

Size.—The majority are between 8¾ and 13 inches long when born. Most of the adult males are from about 2 feet to a little less than 3 feet long; adult females are from a little less than 2½ feet to almost 3½ feet; maximum length about four feet. Mature females average 7 to 10 pounds, a few reach 15 pounds if very fat, and 20 pounds has been reported.

Habits.—Much has been written of the habits of the spiny dogfish, but nothing to recommend it from the standpoint either of the fishermen or of its fellow creatures in the sea. It is one of the more gregarious of our fishes, swimming in schools or packs. Swedish fishermen assert that young dogs school separately from their parents, and it is certain that fish of a size continue to associate together as they grow, the result being that any given school runs very even, consisting as a rule either of the very large mature females, or of medium-sized fish (either mature males or immature females), or of small immature fish of both sexes in about equal numbers.

Apart from their general seasonal migratory movements, dogfish are governed by the movements of the fishes on which they prey. And recent marking experiments have shown that some of them cover long distances in their wanderings, for two tagged near St. Johns, Newfoundland, in mid-July 1942 were recaught off Cape Ann,[23] one on November 23, 1943, the other on December 4 of that year,[24] while others from the same tagging experiment were caught within the Gulf of St. Lawrence.[25] Fortunately they seldom stay long in one place, but there is seldom, if ever, a time during the summer when they are not common on some part of the Gulf of Maine coast. So erratic are their appearances and disappearances that where one has good fishing today he may catch only dogfish tomorrow and nothing at all the day after, the better fish having fled these sea wolves and the latter departing in pursuit.

The dogfish use their back spines for defense, curling around in a bow and striking, which makes them hard to handle on the hook. It is probable, too, that the spines are slightly poisonous, general report to this effect being corroborated by the fact that the concave surfaces are lined with a glandular tissue resembling the poison glands of the venomous "weever" (*Trachinus draco*)[26] of Europe.

Voracious almost beyond belief, the dogfish entirely deserves its bad reputation. Not only does it harry and drive off mackerel, herring, and even fish as large as cod and haddock, but it destroys vast numbers of them. Again and again fishermen have described packs of dogs dashing among schools of mackerel, and even attacking them within the seines, biting through the net, and releasing such of the catch as escapes them. At one time or another they prey on practically all species of Gulf of Maine fish smaller than themselves, and squid are also a regular article of diet whenever they are found. Dogfish are also known to take worms, shrimps, and crabs. And when they first arrive at Woods Hole in May they are often found full of Ctenophores, being one of the few fish that eat these watery organisms. Often, too, they bite groundfish from the hooks of long lines, or take the baits and make it futile to fish with hook and line where they abound.

Fishermen are familiar with the fact that the female spiny dog bears "living" young (this has been known since the days of Aristotle). The eggs are large, well stored with yolk, and during early stages those in each oviduct (so-called "uterus") are contained in a horny capsule that breaks down later, leaving the embryos free in the "uterus," to which they have no placental attachment. The number in a litter is commonly 4 to 6; sometimes as many as 8 to 11, or as few as 2.

According to recent studies, the females carry their young for 18 to 22 months. Accordingly, the adult females caught in our Gulf contain either very early embryos, averaging only about three-fourths of an inch in length by September, or

[23] About 14 miles offshore.

[24] On Middle Ground about 25 miles off Cape Ann.

[25] Templeman, Fish. Res. Bull., Newfoundland Dept. Nat. Res., No. 15, 1944, pp. 67-69.

[26] Evans (Philos. Trans. Royal Soc., London, Ser. B, vol. 212, 1923, pp. 8, 27) describes the spines and gives clinical records of the effects of wounds inflicted by them.

much larger ones, 7 to 11 inches long by that month; i. e., nearly ready for birth. Similarly, we have taken females with embryos 9 to 10¼ inches long in November, on the Cholera Bank near New York Harbor. And it now seems established that most of the young are born on the offshore wintering grounds.[27] But dogfish so small as evidently to have been newborn are occasionally taken along southern New England and in the Gulf in early summer; also on Nantucket Shoals where the *Albatross II* trawled some of 10½ to 13 inches in August, showing that the season of production extends through the spring, or even into the summer as in 1905 when females taken off Gloucester in July gave birth to young on capture.[28]

General range.—Both sides of the North Atlantic, chiefly in the temperate and subarctic belt; also both sides of the northern Pacific;[29] and represented in the corresponding thermal belt of the southern hemisphere by a relative (or relatives) so close that it is doubtful whether they differ in any recognizable way from the spiny-dog of the north.

Occurrence in the Gulf of Maine. The spiny dogfish ("dogfish" or "dog" in common parlance) makes up for the comparative rarity of other sharks in the Gulf of Maine by its obnoxious abundance. To mention all the localities from which it has been reported there would be simply to list every seaside village and fishing ground from Cape Cod to Cape Sable. It is as familiar, too, on the offshore banks as it is along the coast; also along outer Nova Scotia, in the Gulf of St. Lawrence, on the Grand Banks, and along the east coast of Newfoundland to southeastern Labrador. There is no record of it from the North American coast north of Hamilton Inlet, but stray specimens have been taken along the southwest coast of Greenland.[30] To the southward, fishermen are familiar with it in season as far as Cape Lookout, N. C., and a few stray even to southern Florida and to Cuba.[31]

Dogfish are seasonal visitors on the coast, striking in about as early along New Jersey (March), and even on Georges Bank (March–April), as along North Carolina. In the inner parts of the Gulf of Maine the date of the first heavy run of dogfish varies widely from year to year and from place to place. We have not heard of them there before May. But the period of freedom may close as early as the last half of the month, in some years.

In 1903, for example, they had appeared as far north as Penobscot Bay by the middle of May. And while it is not until June that they usually arrive in numbers in the Massachusetts Bay region, it is sometimes impossible to set gill or drift nets anywhere between Cape Cod and Cape Elizabeth after the first days of that month, so numerous are they. In 1913 the first heavy run of dogfish struck Ipswich Bay on June 14, and they appeared there at about the same date in 1905, but there is much local variation in this respect. In 1903, for example, they did not appear until early July at Provincetown, though swarming a month earlier in Massachusetts Bay, in Ipswich Bay, and off Penobscot Bay. But in 1920 they appeared at Provincetown by May 25 to 26 when one set of mackerel traps caught 23 barrels of them, and another 21 barrels. They usually strike in all along the northern Maine and west Nova Scotia coasts by the end of June; but few are seen until late in July in Passamoquoddy Bay. They have been recorded as early as July 1 near Raleigh, on the Newfoundland side of the Strait of Belle Isle, but they are not caught in any numbers in the inner parts of the Gulf of St. Lawrence until well into July, and they have not been reported from southeastern Labrador until early in September.[32]

In the southern part of its range, from North Carolina to New York, the spiny dogfish is a spring and autumn transient only. West of Cape Cod (at Woods Hole, that is, and along Long Island)

[27] Females that we saw trawled off Block Island in 60-65 fathoms in late January 1950, gave birth to young on the deck of the vessel.

[28] McIntire, Rept. Comm. Fish. Game Massachusetts, (1905) 1906, p. 108.

[29] We have found no consistent differences between North Atlantic and North Pacific specimens. For further discussion of this point, and further details as to the occurrence of the spiny-dog in the two sides of the North Atlantic, see Bigelow and Schroeder (Fishes of the Western North Atlantic, Pt. 1, 1948, pp. 453, 463).

[30] Jensen (Selachians of Greenland, Mindeskr. Japetus Steenstrup, Pt. 2, No. 30, 1914, p. 7) lists several definite records of this species at Sukkertoppen and near Holsteinborg, West Greenland.

[31] Repeated reports of it as plentiful along eastern Florida seem to have referred to some other shark; the basis for similar reports from Cuba and Trinidad doubtless was the Cuban dogfish, *Squalus cubensis* Rivero.

[32] See Templeman (Res. Bull. 15, Newfoundland Dept. Nat. Res., 1941, pp. 56, 64) for dates of arrival around the coast of Newfoundland in different years.

they are transients mostly, passing north in spring and south in autumn, though some summer there; even considerable numbers in some years.[33] And it seems that most of them withdraw from Massachusetts Bay also during the warmest period, for few are taken there between June and September. But they continue present all summer along outer Cape Cod, and here and there throughout the northern and eastern parts of the Gulf, in varying abundance.

Most of the dogfish take their autumnal departure from the inner parts of the Gulf during October, few being caught on the coast north of Massachusetts Bay after November 1. But they sometimes stay later, as in 1903 (a big dogfish year), and again in 1942, when they were abundant along the outer shore of Cape Cod as late as the first week of November. Ordinarily none are caught within the Gulf of Maine north of Georges Bank in winter, but this has its exceptions. In 1913, for example, a few were caught 20 miles off Cape Ann on November 19 to 24, many near Boon Island from December 5 to 13, and on Jeffreys Ledge on December 11 and 12.

In 1882, schools were reported off Portsmouth, N. H., even as late as February, an exceptional event.

Dogfish appear earlier in spring and linger later into the winter on Georges Bank (fig. 18) than in the inner parts of the Gulf. It is safe to say that there are few there in March, the earliest definite record (obtained during the investigations of 1913, only year of record, being of 25 fish caught on the "winter cod ground" east of the shoals (long. about 67°, lat. about 41°40′) between the 20th and the 22nd, and of 46 from the same general region from the 27th to the 30th, while some are trawled there all summer. In 1913, a few were taken in November and in December; a few also on the southern part of the Bank (lat. about 41°, long. about 67°30′) on January 20 to 22 in 1914.

Apparently dogfish reach Browns Bank later than they do Georges, for none was taken there on April 14 in 1913, though they are only too plentiful there in summer. It is also likely that they depart earlier, although a few lingered as late as December 3 to 12 on Western Bank off Halifax in that year.

[33] For details, see Bigelow and Schroeder, Fishes of the Western North Atlantic, Pt. 1, 1948, p. 464.

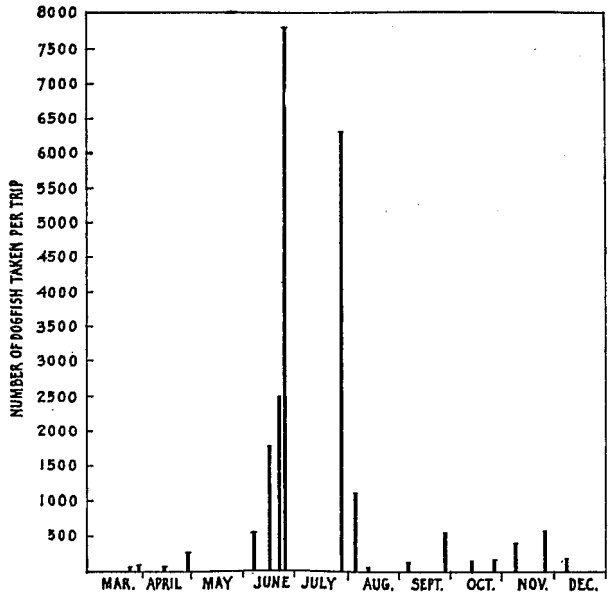

FIGURE 18.—Numbers of spiny dogfish caught on certain otter trawling trips to Georges Bank, during the different months of 1913.

It now seems certain that the spiny dogfish winter chiefly in deeper water offshore, for considerable numbers have been trawled at that season on the outer part of the continental shelf off Block Island, in 50 to 65 fathoms, where we saw several hundred (200 in one haul) trawled during the last week of January 1950; off New York in November and January; [34] also in February off the Middle Atlantic coast in 16 to 70 fathoms, south as far as the offing of Cape Hatteras. On the other hand, the fact that numbers of them have been found washed on shore in January on the southwest coast of Newfoundland suggests that some of those that summer in that general region may survive the winter in the deep trough of the Gulf of St. Lawrence. They are usually so thin when they reappear on the coast in spring as to suggest that they feed but little during the winter.

This is the only Gulf of Maine shark that even remotely rivals the important food fishes in numbers. Unfortunately, the statistics of the commercial landings for American waters do not afford any information in this regard. But spiny dogs must be plentiful indeed in our waters when they can sometimes be caught as fast as they can

[34] Mr. Thomas Quast informs us that many were taken from the schooner *Victor*, long-lining for tile fish, on the outer edge of the continental shelf, off New York, during the second week of January 1928.

be hauled in; when a long line, with 1,500 hooks, has been known to bring in a dogfish on nearly every hook; and when an average trawl catch of 6,000 to 8,000 per trip was made on Georges Bank in 1913 during their season of abundance. At the time of the 1904 to 1905 peak it was estimated from recorded catches that at least 27,000,000 were being taken yearly off the coast of Massachusetts.[35]

More precise information from waters farther north is that 10,391,000 pounds, or 2 to 3 million individual dogfish, were caught in 1938, in Placentia Bay, Newfoundland, with no apparent effect on their numbers.[36] In short, they may be as plentiful in our Gulf as they are on the Cornish coast, where the record catch of 20,000 in a single haul was made many years ago.

Spiny dogfish appear to have been more numerous in the Massachusetts Bay region during the last quarter of the past century and during the early nineteen hundreds than they had been previously. At Woods Hole, on the contrary, they are said to have been much more plentiful before 1887 than they have been at any time since. To a certain extent, of course, reports of fluctuations in abundance from year to year must be discounted as reflecting the movements of the great schools that may visit one part of the coast one summer and another part the next, not a general alteration of the stock. But the many fishermen who reported to the Massachusetts Commissioners in 1905 were unanimously of the opinion that dogfish had multiplied steadily for 20 to 30 years past, and reports from British coasts were to the same effect. Perhaps the years 1904–1905 marked the apex of this wave of multiplication; at any rate dogfish were reported as distinctly less troublesome to the mackerel netters in 1913 than they had been previously. And little complaint has been made of them in late years.

But it is not safe to conclude from this that the stock is at a low ebb at present, for it was the hand- and long-line fishermen that suffered most from them; and it is only as they increase the amounts of trash fish dumped overboard that the dogfish bother the otter-trawlers.

Importance.—During the years when the ground fishery was chiefly by hook and line, fishing often was actually prevented by dogfish in Massachusetts and Ipswich Bays, unless cockles (*Polynices*) were used for bait, for dogfish do not take these. The general replacement of hook and line fishing by the otter trawl has put an end to widespread complaints on this score. But when schools of dogfish get into a net or seine, they so snarl the twine that disentanglement and repair may be the work of days. And it has been estimated that they may do some $400,000 worth of damage annually to fishing gear, and to fish caught by such gear, off the coast of Massachusetts alone, during their peaks of abundance there.

With the dogfish so plentiful and destructive, it is no wonder that serious efforts have been made to make them a source of revenue instead of a dead loss. And the dog is a far better food fish when fresh than is generally appreciated, as is evident by the large amounts landed in the fishing ports of northwestern Europe. But it has never been in any demand for the table, on our coasts, though it would offer a large supply of cheap food were a satisfactory method found for canning it. During their more recent periods of plenty various efforts have been made to utilize them on a large scale for fertilizer, and for liver oil (it compares favorably with cod for vitamin A, though it is much poorer in vitamin D), on the Atlantic coasts of the United States and Canada; however such developments have been short-lived. And dogfish have not been of sufficient value up to the present to compensate for a hundredth part of the damage they do.[37]

Black dogfish *Centroscyllium fabricii* (Reinhardt) 1825

Bigelow and Schroeder, 1948, p. 482.
Garman, 1913, pl. 10, figs. 5–8.

Description.—The notched margin of the upper tail lobe distinguishes this shark at a glance from the spiny dogfish, with which it agrees in having a long pointed spine at the front edge of each dorsal fin. It differs further from the common dogfish in that its dorsal spines are deeply grooved along each side, whereas in the "dog" they are rounded; in the location of the pelvic fins, the rear axils of

[35] Report, Comm. Fish and Game, Mass., (1906), 1907, p. 20.
[36] Templeman, Newfoundland Fish. Res. Bull., 15, 1944, p. 72.

[37] For further discussion of the damage done by dogfish and of their commercial possibilities, see Ann. Rept., Comm. Fish. Game Mass. (1905), 1906, pp. 97–169; Rept. U. S. Comm. Fish. (1902) 1904, pp. 228–229; Field, Doc. 622, Rept. U. S. Comm. Fish. (1906) 1907, pp. 21–23; Field, Bull. U. S. Bur. Fish., vol. 28, 1910, pp. 243–257; Mayor, Contr. Canad. Biol. (1918–1920) 1921, pp. 125–135; and Templeman, Newfoundland Fish Res. Bull. 15, 1944

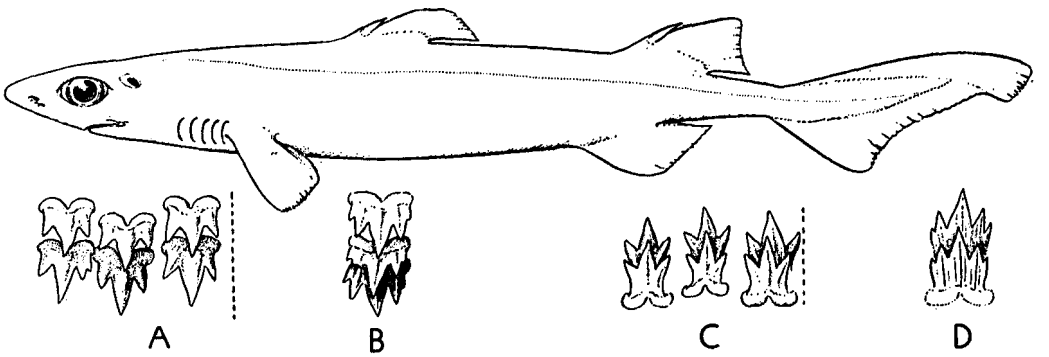

FIGURE 19.—Black dogfish (*Centroscyllium fabricii*), female, about 25 inches long, from the southeast slope of Georges Bank. A, first three upper teeth counted from center of jaw; B, twentieth upper tooth; C, first three lower teeth; D, lower sixteenth tooth; about 5 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

which stand almost directly under the front origin of the second dorsal fin instead of some distance in front of the latter; in its small pectorals of rounded outline; in the shapes of its teeth, each of which has 3 or 5 sharp points; in its broad rounded snout; and in its very dark color. Like the spiny dogfish, it lacks an anal fin.

Size.—Adult specimens range from 2 to 3½ feet in length, that is, about the same size as the spiny dogfish.

Color.—Uniform dark brown to black, below as well as above.

Habits.—In West Greenland waters cephalopods, pelagic crustaceans, and medusae have been found in their stomachs, and females have been taken with embryos in February. Perhaps they are luminescent, for their skins bear minute deeply pigmented dots, suggesting the light organs of the brilliantly luminescent shark *Isistius brasiliensis.*

General range.—Northern North Atlantic; Faroe Bank, Faroe-Shetland Channel and Iceland in the east; West Greenland; Davis Strait; and outer slopes of the fishing banks in the west, southward to Georges Bank; chiefly deeper than 150 fathoms.

Occurrence in the Gulf of Maine. In the years when a long line fishery for halibut was carried on regularly, black dogfish were often caught along the slopes of the offshore Banks, from Grand to Browns and to the eastern part of Georges, if sets were made down to 200 fathoms or deeper. And while they dropped out of sight with the general abandonment of that fishery, no doubt they are as plentiful now as formerly, for we trawled about 100 of them, 6 to 24½ inches long, off southwestern Nova Scotia, at 290 to 580 fathoms, on the *Caryn* of the Woods Hole Oceanographic Institution, in June 1949. How far they range to the west and south, at the appropriate depths, is not known.[38]

Portuguese shark *Centroscymnus coelolepis* Bocage and Brito Capello, 1864

Bigelow and Schroeder, 1948, p. 494.

Garman, 1913, pl. 14, figs. 5–8.

Description.—This shark can be identified easily by the fact that while its general appearance (especially the absence of anal fin, the situation of its pelvics far back under the second dorsal, and its rather stout form and blunt snout) might lead a hasty observer to think he had caught a small Greenland shark; more careful examination, by touch if not by eye, would reveal a short spine close in front of each dorsal fin. The first dorsal fin is smaller than in any of our sharks except in the "Greenland," (p. 53), and in *Dalatias licha* (p. 55), the second dorsal is a little larger than the first, and the pelvics are larger than either of the dorsals. The tail is noticeably short and broad and the rear edge of its upper lobe is notched. The teeth are different in the two jaws; narrow, pointed, and of the seizing type in the upper; broader, oblong, with a notch on the outer side near the tip, and forming a continuous cutting edge in the lower. The dermal denticles are flat, scale-like, closely overlapping, and clothe the entire trunk.

Color.—Dark chocolate brown, belly as well as back and fins.

[38] Its range has been said to extend to New York, but without supporting evidence; and report of a young one from the Gulf of Mexico (Goode and Bean, Smithsonian Contrib. Knowledge, vol. 30, 1895, p. 11), probably was based on some other shark.

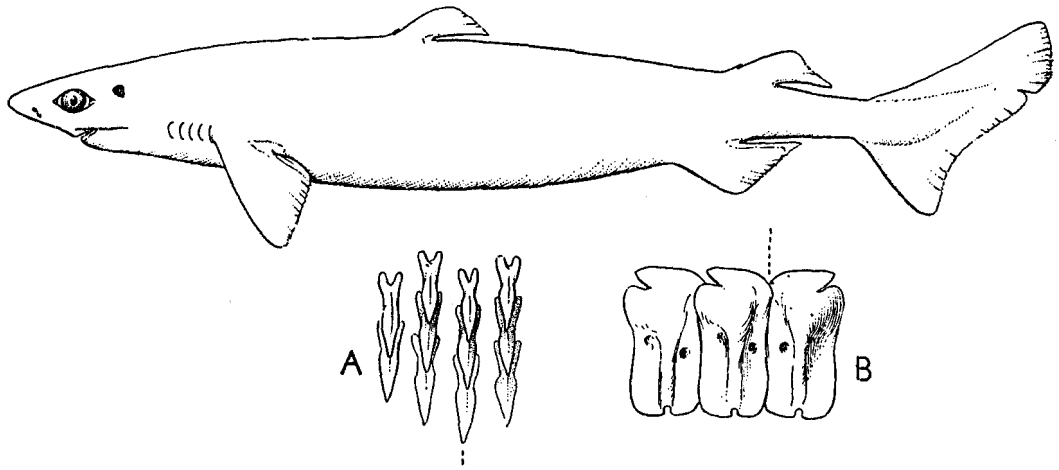

FIGURE 20.—Portuguese shark (*Centroscymnus coelolepis*), female about 42½ inches long, off Banquereau Bank. A, upper teeth, and B, lower teeth from center of mouth, about 3.4 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

Size.—Adults measure from 3 to 3½ feet long, as they are caught. Garman records one 44 inches long taken off the coast of New England. About 9 inches is the smallest recorded.[39]

Habits.—Little is known of its habits beyond the fact that it is a deep-water species, and that it was caught regularly by Portuguese fishermen with hand lines, a fishery that Wright [40] described as follows:

> Some 600 fathoms of rope were let out, the first 30 or 40 fathoms of which had fastened to it at intervals of a fathom a series of small ropes, on each of which was a large hook baited with a codling. This fishing tackle remained below for about two hours, when they commenced to haul it in. When it arrived at the last few fathoms, they pulled in, one after another, five or six specimens from 3 to 4 feet long. The species was the *Centroscymnus coelolepis* Bocage and Capello. These sharks, as they were hauled into the boat, fell down into it like so many dead pigs.

Thirteen to 16 young have been found in females caught off Portugal.

General range.—This deep-water shark, originally discovered off Portugal, has since been taken at various other eastern Atlantic localities.[41] Definite records of it for the western Atlantic are from the slopes of the Nova Scotian Banks and of Georges, at depths of 180 to 250 fathoms, perhaps 15 to 20 specimens in all. But Goode and Bean's [42] old characterization of them as abundant on the Banks at 200 fathoms and deeper presents its local status more correctly, for fishermen long lining for halibut often caught one or two a trip in the deeper gullies between the offshore Banks.

THE GURRY SHARKS. FAMILY DALATIIDAE

The gurry sharks, like the spiny dogfishes, lack anal fins, but they have no spines in their dorsal fins. The teeth in the upper jaw are noticeably unlike those in the lower.

Greenland shark *Somniosus microcephalus* (Bloch and Schneider) 1801

SLEEPER SHARK; GURRY SHARK; GROUND SHARK

Bigelow and Schroeder, 1948, p. 516.
Garman, 1913, pl. 15, figs. 4–6.

Description.—The Greenland shark is notable for its small dorsal fins, without spines, the second dorsal being of about the same size as the first, and for small pectorals hardly larger than the pelvics, coupled with the absence of an anal fin and with a tail of more fish-like form than that of most other sharks except for the mackerel-shark tribe. Bearing these points in mind, particularly the absence of an anal fin and of dorsal spines, it cannot be confused with any shark common in our Gulf. And while it resembles the rare Portuguese shark in the sizes and relative situa-

[39] A male 228 mm. long, examined by us, in the U. S. National Museum from the continental edge south of Nantucket.

[40] Ann. Mag. Nat. Hist., Ser. 4, vol. 2, 1868, p. 426.

[41] Iceland; Faroe Bank; Madeira; Azores; Morocco; Cape Verde I.: For key to other species of the genus, see Bigelow and Schroeder, Fishes Western North Atlantic, P. 1, 1948, p. 494.

[42] Smithsonian Contrib. Knowledge, vol. 30, 1895, p. 14.

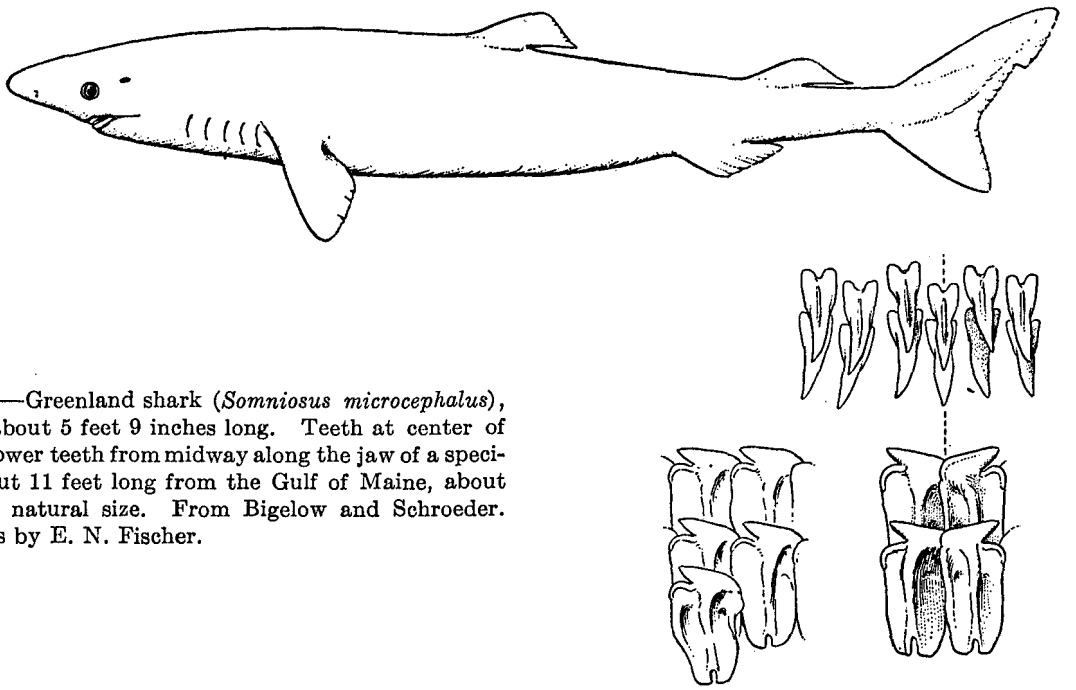

FIGURE 21.—Greenland shark (*Somniosus microcephalus*), female, about 5 feet 9 inches long. Teeth at center of mouth; lower teeth from midway along the jaw of a specimen about 11 feet long from the Gulf of Maine, about 1.8 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

tions of its dorsal and anal fins, in its general form, and in its teeth, it is easily separable from the "Portuguese," both by lacking any trace of spines in its dorsal fins, by its thorn-like and loosely spaced dermal denticles, and by its more lunate tail. It also grows much larger than the Portuguese shark. We need only note, further, that while its upper teeth are narrow and awl-like, its lowers are broad, squarish, forming a nearly continuous cutting edge, with the single cusp directed sharply outward; that its gill openings are short and located low down on the sides of the neck; that its eyes are very small; and that it is stout shouldered, with blunt rounded snout, as Scoresby pictured it more than a century ago.[43]

Color.—Blackish, coffee brown, or ashy-, purplish-, or slate gray, below as well as above; changing to bluish gray if the epidermis is rubbed off, as is apt to happen when one is caught; the back and sides are marked with many indistinct dark crossbars on some specimens.

Size.—This is one of the larger sharks. It is said to grow to a length of 24 feet, but 21 feet is the largest of which we find definite record,[44] and 16- to 18-footers are unusual. One of 16½ feet was reported from the Grand Banks in 1934; one of 16 feet off Portland, Maine, in 1846; one of about 15 feet off Cape Ann in 1849; and another of about that same size was caught on a long line north of Cape Ann in February 1931. Perhaps 8 to 14 feet is a fair average for adults, that is not often exceeded among the hundreds caught annually off West Greenland and around Iceland. The 21-foot British specimen mentioned above was said to weigh about 2,250 pounds; two Gulf of Maine specimens, each about 11 feet long, weighed about 600 and 650 pounds, respectively.

Habits.—Off Greenland, and along the Labrador coast, the Greenland sharks tend to approach the surface in winter, often coming right up to the ice. But most of them withdraw in summer to 100 fathoms or deeper. And the few that visit our Gulf appear to hold rather closely to the bottoms of the deeper troughs, though a stray may come so close to the shore now and then, and into water so shoal as to blunder into a fish weir; one such event is on record for Passamaquoddy Bay.

This is one of the most sluggish of sharks, offering no resistance whatever when hooked, and it is entirely inoffensive to man.[45] But it is ex-

[43] Arctic Regions, 1820, vol. 2, pl. 15, figs. 3 and 4.

[44] Jenkins, Fishes British Isles, 1925, p. 325.

[45] Tales to the effect that it attacks Greenlanders in their kyaks are apparently mythical, and Doctor Porsild, Director of the biological station at Disko, said that the Eskimos do not fear it as they do the killer whale; nor is there any authentic instance on record of a shark attacking a human being near Iceland.

tremely rapacious. It devours any carrion eagerly, such as whale meat, blubber from whaling operations, or the carcasses of young seals that are left on the ice off the Newfoundland-Labrador coasts. And its habit of gathering when there has been a big killing of narwhals in Greenland waters is proverbial. Apart from carrion (which cannot be available except on rare occasions), its diet includes a wide variety of fishes, large and small. Seals are a favorite food, and in view of its sluggishness, it is somewhat astonishing that it should be able to capture prey as active as seals, halibut, and salmon. The specimen from Cape Cod Bay, mentioned above, contained half a dozen flounders and a large piece (with hide and hair) that had been bitten out of the side of a seal. It is also known to eat crabs, large snails, even medusae. Objects as large as an entire reindeer (without horns), a whole seal, a 3-foot cod, and a 39-inch salmon, found in Greenland shark stomachs, give some measure of their appetite. In line with this, they will bite on any fish or meat bait, the more putrid and ill smelling the better.

Large numbers of soft eggs, without horny capsules, ranging in size up to that of a goose egg, have been found repeatedly in female Greenland sharks, but never any embryos, suggesting that this may be an egg-laying species.[46]

General range.—Northern Atlantic, from Polar latitudes south to the North Sea and accidentally to the mouth of the Seine and perhaps to Portugal in the east; south regularly to Newfoundland and the northern part of the Gulf of St. Lawrence in the west, and less commonly to the Gulf of Maine. It is represented in the Mediterranean region, in the North Pacific, and in the sub-Antarctic by forms that appear to be distinct, though closely allied to it.[47]

Occurrence in the Gulf of Maine.—Although there is no reason to suppose that the Greenland shark ever appears in our Gulf save as a straggler from the north, its presence there has been signalized on a number of occasions. Two specimens, for example, were taken in the neighborhood of St. Andrews in 1915 (one caught in a weir and the other on a long line). It has been reported off Eastport; off Cape Elizabeth whence 6 were landed at Portland between 1925 and 1948;[48] on Jeffreys Ledge, where one of about 15 feet was caught on a long line, on February 16, 1931;[49] near Cape Ann; off Marblehead and Nahant; in Massachusetts Bay; off Barnstable in Cape Cod Bay; at Provincetown; and in Cape Cod Bay off the entrance to the Cape Cod Canal, where one between 10 and 11 feet long was taken by a trawler in April 1924, landed in Boston and identified by us.

Recorded captures in the Gulf include small specimens as well as large, and have been for all four seasons of the year, suggesting that when a Greenland shark does stray southward to the Gulf, it may survive there for years. The local records are distributed so widely as to show that an odd specimen is to be expected anywhere in the deeper parts of the Gulf. And rumor has it that they were more numerous in our waters in early colonial times when Atlantic right whales were still being killed in numbers off the Massachusetts coast.[50]

Commercial importance.—This shark is not plentiful enough in our Gulf to be even of potential value. But it has long supported a fishery off northern Norway, around Iceland, and in West Greenland waters, chiefly for its liver oil.[51] In Greenland the flesh is dried also for dog food, and to a small extent in Iceland for human consumption. But it produces an intoxicant poisoning if eaten fresh, though it is wholesome if dried.[52]

Dalatias licha (Bonnaterre) 1788

Bigelow and Schroeder, 1948, p. 502.

Description.—This shark resembles the Portuguese shark in the relative sizes and positions of its fins; also in its scales. But its dorsal fins do not have any trace of spines, while the serrate margins of its lower teeth, in combination with their triangular shape, mark it off from any other shark without an anal fin that is known yet from the North Atlantic. Its trunk is rather slender, its snout short and bluntly rounded, and the lower-anterior corner of its tail fin is not expanded as a definite lobe. Its upper teeth are slender, awl-

[46] The Mediterranean *Somniosus rostratus*, on the contrary, bears living young.

[47] For recent discussion of the species of *Somniosus*, see Bigelow and Schroeder, Fishes Western North Atlantic, Pt. 1, 1948, p. 515.

[48] Reported to us by the late W. W. Rich.

[49] This one was landed in Boston, where we saw it.

[50] When they gather to feed on whale, narwhal, and seal carcasses in their northern home, they may linger for a long time in the vicinity.

[51] The annual catch off West Greenland was around 32,000 during the first decade of the present century.

[52] For accounts, see Jensen, 1914 (Selachians of Greenland, Mindesk. Jap. Steenstrup, vol. 2, No. 30, 1914, p. 12); also Clark (Science, N. Ser., vol. 41, 1915, p. 795).

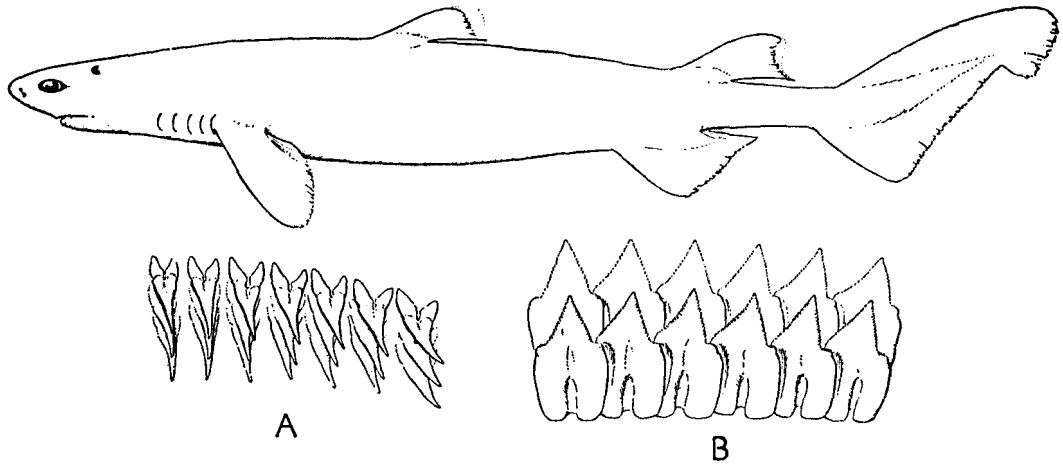

FIGURE 22.—Dalatias (*Dalatias licha*), female, 58 inches long, from Georges Bank. A, upper teeth and B, lower teeth from central part of mouth, about 1.5 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

shaped, curving somewhat outward toward the corners of its mouth; but the lowers are erect, broadly triangular, with serrate edges.

Color.—Dark chocolate, cinnamon, or violet brown below as well as above; the upper surface sometimes with poorly defined blackish spots; the dorsal and pectoral fins with pale or whitish edges, the tail tipped with black.

Size.—Most of those caught are between 40 and 60 inches long; 72 inches is the longest recorded so far. The Gulf of Maine specimen illustrated in figure 22 was about 5 feet long and weighed 23½ pounds, gutted.

General range.—Eastern Atlantic, from tropical West Africa to the Irish Atlantic slope; recorded once from the American coast.

Occurrence in the Gulf of Maine.—Our only reason for mentioning this shark is that a female, about 5 feet long, was taken on the northern edge of Georges Bank on August 19, 1937 (fig. 22).[53]

THE BRAMBLE SHARKS. FAMILY ECHINORHINIDAE

The only living representative of this family (it is represented among the tertiary sharks) resembles the Greenland shark and its allies in lacking both anal fin and dorsal spines, but its teeth are alike in the two jaws.

Bramble shark *Echinorhinus brucus* (Bonnaterre) 1788

SPINY SHARK

Bigelow and Schroeder, 1948, p. 527.

Description.—The location of the first dorsal fin above the pelvics instead of about midway between the latter and the pectorals, and the very different shape of its tail fin (*cf.* fig. 23 with fig. 21), are the most conspicuous field marks separating this shark from the Greenland shark. *Brucus* also differs from the latter in that the teeth are alike in the two jaws, instead of unlike, and that the skin of its back and sides is sparsely strewn with large scales with either one or two sharp points.

[53] Recorded by Nichols and Firth, Proc. Biol. Soc. Wash., vol. 52, 1939, p. 85.

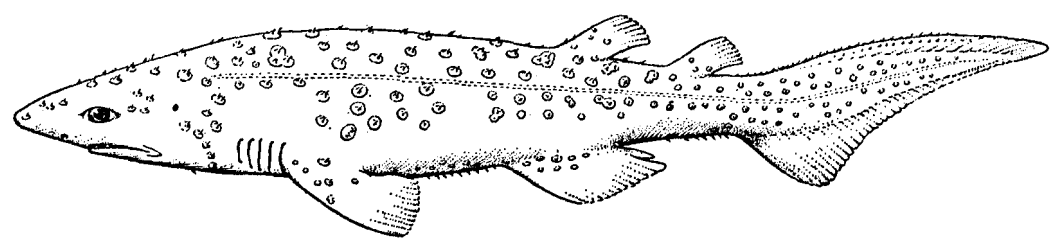

FIGURE 23.—Spiny shark (*Echinorhinus brucus*), eastern Atlantic specimen about 3 feet long. From Bigelow and Schroeder. Drawing by W. P. C. Tenison.

Color.—Described as dark gray, olive or brown above, with metallic reflections, and with or without darker blotches; as paler brown or gray to white below. The scales have been described as luminescent,[54] but there are no special luminous organs.

Size.—The largest of which we have found a record (a specimen from British waters) was 9 feet long. One 8 feet 4 inches long weighed about 300 pounds.

General range.—Eastern Atlantic (including the Mediterranean) from tropical West Africa to Ireland and the North Sea, and accidental in the western Atlantic; represented in South Africa; off California; in the Hawaiian, Japanese, and Australo-New Zealand regions, and in Arabian waters by forms that probably cannot be distinguished from *brucus* of the Atlantic.

Occurrence in the Gulf of Maine.—A single specimen of this little known shark came ashore at Provincetown in December 1878. This and one taken near Buenos Aires more recently [55] are the only records of it from the western Atlantic.

Torpedoes, Skates, and Rays. Order Batoidei

This tribe falls into four groups, so far as the Gulf of Maine fauna is concerned: first, the torpedoes (family Torpedinidae), with large caudal fin, interesting because provided with electric organs capable of giving a strong shock; second, the skates (family Rajidae), with very thin bodies, comparatively short tails without tail spines, and only a trace of caudal fin; third, the sting rays (families Dasyatidae and Rhinopteridae), with long whiplike tails armed with a stiff saw-edged spine (or spines); and fourth, the devil rays (Mobulidae) with two ear-like fins extending forward from the front of the head. Most of our common species belong to the second group.

Among torpedoes, skates, and rays, fertilization is internal as it is among sharks, and the modification of the posterior edges of the pelvic fins into rodlike semitubular claspers (the copulatory organs) distinguishes males and females at a glance. Some bear "living" young, ready for independent existence; others lay eggs.

[54] Cornish, Zoologist, Ser. 2, vol. 10, 1875, p. 4501.

[55] Berg, Com. Ictiol. Comm. Mus. Nac. Buenos Aires, vol. 1, No. 1, 1898, p. 10.

KEY TO GULF OF MAINE SKATES AND RAYS

1. The front of the head bears a pair of separate, ear-like fins, extending forward ..... Devil ray, p. 77
   The front of head does not bear a pair of separate ear-like fins extending forward 2
2. There is a large triangular caudal fin, as well as two well developed dorsal fins on the tail ..... Torpedo, p. 58
   There is no distinct caudal fin; the dorsal fins, if any, are very small 3
3. No long dorsal spine on tail ..... Common skates 4
   There is a long saw-edged dorsal spine (or spines) on the tail 11
4. The upper surface of the disc is marked with conspicuous black rosettes ..... Leopard skate, p. 66
   The markings on the upper surface of the disc are not in the form of black rosettes 5
5. There are no conspicuous thorns along the mid-dorsal zone of disc between the spiracles and the base of tail; the lower surface of disc is marked with black dots or dashes, marking the openings of the mucous pores.
   Barndoor skate, medium sized and large specimens, p. 61
   There are one or more rows of conspicuous thorns along the mid-dorsal zone of disc rearward from the spiracles; the lower surface of disc is not marked with black dots or dashes 6
6. There are no large thorns on the rear ¼–⅓ of tail ..... Smooth-tailed or Prickly skate, p. 70
   There are one or more rows of large thorns along the rear part of tail as well as farther forward along it 7
7. There are no large thorns on upper side of disc between the spiracles and the level of axils of pectoral fins.
   Barndoor skate, very small specimens, p. 61
   The upper side of disc, rearward from spiracles, has more or fewer large thorns 8
8. The thorns of the midrow on the tail are much larger and more conspicuous than any other thorns on the tail, and not more than 9 or 10 in number ..... Thorny skate, p. 72
   No one row of thorns along the tail is much larger or more conspicuous than the other thorns on the tail; there are at least 15 thorns in each of the rows along tail 9