How far offshore lampreys wander is not known. Probably, however, most of them remain in the coastal zone, if not in estuaries, and there is no evidence that they ever descend to any considerable depth. A few were brought in from Georges and Browns Banks, however, during the early years of the Bureau of Fisheries.[13]

Since lampreys never take the hook or are captured in nets except on rare occasions they are seldom seen in salt water; only when running up our rivers are they familiar objects.

In Europe, during the middle ages, lampreys were esteemed a great delicacy—historians tell us Henry I of England died of a surfeit of them—and formerly, when they were much more plentiful than nowadays, considerable numbers were captured in the rivers of New England, particularly in the Connecticut and Merrimac Rivers. They were, indeed, regularly sought in the former until well into the last half of the past century, but for 40 years now the lamprey fishery has been hardly more than a memory except locally and in a small way for home consumption. In the salt water of the Gulf of Maine the lamprey has never been of any commercial importance; the average fisherman might not see one in a lifetime, nor is there any sale for the few picked up by chance.

TRUE FISHES. CLASS PISCES

Sharks and rays. Subclass Elasmobranchii

The most obvious external character by which all sharks and rays are distinguishable from the bony fishes is that there are five or more pairs of gill openings on either side of the neck, instead of only one. In this they agree with the lampreys, but it is a commonplace that their jaws and teeth are extremely well developed. Their skins are tough and leathery and studded with denticles (placoid scales), which but remotely suggest ordinary scales and which are not homologous with the scales of bony fishes, for both dermis and epidermis take part in their formation, instead of the former alone. The teeth of the sharks and rays are essentially such placoid scales modified and simply embedded in the gums, not in the jaws. The fins are supported at their bases with segmented cartilaginous rods, and further out by numerous slender horny fibers, instead of by such rays or spines as are to be seen in the bony fishes. All the fins are covered with the same leathery skin that clothes the body. Among sharks the tail is uneven, with the vertebral column extending out into its upper lobe, but in most skates and rays it is whiplike, with no definite caudal fin. The torpedo (p. 68) is an exception to this rule.

The skeleton is for the most part cartilaginous, the skull far simpler than it is among the bony fishes, and the gills are attached throughout their lengths to the partitions between the gill openings instead of being free, while 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. Sharks are usually looked upon as the most primitive of the true fishes.

[13] Report of the Commissioner of Fish and Fisheries for 1879 (1882), pp. 811, 812, and 814. Washington.

SHARKS

Sharks are always 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 the bad reputation certain kinds have earned, rightly or wrongly, as man-eaters.

The Gulf of Maine is not particularly rich in sharks (compared with our southern coasts, very poor indeed), for while the number of species actually recorded there is considerable (indeed any high-seas shark might straggle thither) the little spiny dogfish alone is numerous in the sense in which this term is applied to the various commercial fishes. Only one of the larger species, the mackerel shark (*Isurus punctatus*), visits us in numbers sufficient for one to be fairly sure to see it during a summer's boating off the coast north of Cape Cod. With the larger sharks generally so scarce (the mackerel shark is weak-toothed and perfectly harmless to anything larger than the fishes on which it feeds), the danger of attacks on bathers is negligible. Indeed, not a single well-authenticated instance of the sort is on record[14] for the past 80 years for the coast north of Cape Cod, though the beaches yearly are crowded with vacationists. As long as the white shark occasionally strays into the Gulf, however (p. 40), it is always remotely possible that some summer we may be horrified by the news of such a tragedy as occurred on the New Jersey coast in July, 1916, when several persons were killed or injured, presumably by a shark of this species that was captured nearby a few days later.[15]

Most Gulf of Maine sharks—certainly all the commoner ones—are viviparous, giving birth to young not only practically adult in structure but of relatively large size at birth.

As sharks are of little commercial value in the Gulf of Maine (attempts to introduce the dogfish as a food fish having failed so far) they are an unmitigated nuisance to the fishermen because of their damage to nets and other gear.

It is possible to identify all sharks so far known from the Gulf—and this includes all that are apt to occur there except as strays—by the size, structure, 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!).

In the following descriptions of the several species we have attempted to present only such features as will tell what shark is at hand; for more minute particulars we refer the reader to Garman's monograph (1913), which is not only the most authoritative work on this group of fishes, but in which almost all our species are beautifully pictured.

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[14] 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, as we think more likely, a killer whale, is an open question.

[15] Murphy and Nichols (The shark situation in the waters about New York. The Brooklyn Museum Quarterly, Vol. III, October, 1916, No. 4, pp. 145-160. Brooklyn) give a detailed account of this occurrence.

KEY TO GULF OF MAINE SHARKS

1. Head hammer-shaped ..... Hammerhead, p. 31
   Head of ordinary shape; rounded or pointed nose 2
2. Only one dorsal fin; six gill slits on each side; body eel-shaped ..... Eel shark, p. 24
   Two dorsal fins (the second may be small but is always perfectly distinct); only 5 gill slits; body of ordinary shark form 3
3. Both dorsal fins have spines at their forward margins; no anal fin 4
   Dorsal fins lack spines 6
4. Rear margin of upper lobe of tail not notched; a very common species ..... Spiny dogfish, p. 44
   Rear margin of upper lobe of tail notched near the tip 5
5. Dorsal spines so small they are hardly visible, though easily felt ..... Portuguese shark (*Centroscymnus cœlolepis*), p. 51
   Both dorsal spines large ..... Black dogfish, p. 53
6. There is no anal fin, the paired ventrals being the only fins on the ventral surface 7
   Anal fin present 8
7. First dorsal fin situated about midway between pectorals and ventrals ..... Greenland shark, p. 53
   First dorsal far back as ventrals ..... Bramble shark (*Echinorhinus brucus*), p. 55
8. No lateral keels on caudal peduncle (root of tail); upper lobe of caudal fin much longer than lower 9
   A longitudinal keel on either side of caudal peduncle; lower lobe of tail more nearly as large as upper, suggesting tail of a swordfish 14
9. Upper lobe of caudal fin nearly, if not quite, as long as head and body together ..... Thresher, p. 32
   Caudal fin less than half as long as head and body combined 10
10. Second dorsal at least half as high as first 11
    Second dorsal less than half as high as first 12
11. Second dorsal considerably smaller than first; teeth small, blunt, and arranged like a pavement ..... Smooth dogfish, p. 24
    Second dorsal about as large as first; teeth narrow and pointed ..... Sand shark, p. 34
12. Origin of first dorsal hardly behind pectorals; upper and lower teeth alike; skin spotted ..... Tiger shark, p. 27
    First dorsal originates well behind the pectorals; upper teeth broader than lower; skin not spotted 13
13. The first dorsal originates about over the inner corner of the pectorals when these are laid back; snout broadly rounded ..... Dusky shark,[16] p. 29
    First dorsal originates far behind inner corner of pectoral; snout long and pointed ..... Blue shark, p. 28
14. Gill slits very long; first pair nearly meeting on throat; gills with rakers; teeth tiny ..... Basking shark, p. 41
    Gill slits short, confined to sides of neck; no gill rakers; teeth large 15
15. Teeth broad, triangular, with serrate edges; second dorsal fin well forward of anal ..... White shark, p. 39
    Teeth slender, smooth-edged; second dorsal fin over or hardly in front of anal 16
16. First dorsal fin originates above axil (armpit) of pectoral ..... Mackerel shark (*Isurus punctatus*), p. 36
    First dorsal fin originates well behind the axil f pectoral ..... Sharp-nosed mackerel shark (*I. tigris*), p. 38

[16] The brown shark (*Carcharinus milberti*), very abundant west and south of Cape Cod but not yet known from the Gulf, is easily distinguished from its close relative, the dusky shark, by its very tall dorsal fin.

THE EEL SHARKS. FAMILY CHLAMYDOSELACHIDÆ

3. Eel shark (*Chlamydoselachus anguineus* Garman)

FRILLED SHARK; SNAKE SHARK; SEA SERPENT

Jordan and Evermann, 1896–1900, p. 16.
Garman, 1913, p. 14.

Description.—The readiest field marks for this curious shark are the eel-like form of its body and tail, the fish being about fifteen times as long as deep; the fact that there is only one dorsal fin, situated far back over the anal but smaller than the latter; that there are six gill openings on a side instead of five; and that the mouth is more nearly terminal than in most sharks, with the snout hardly projecting

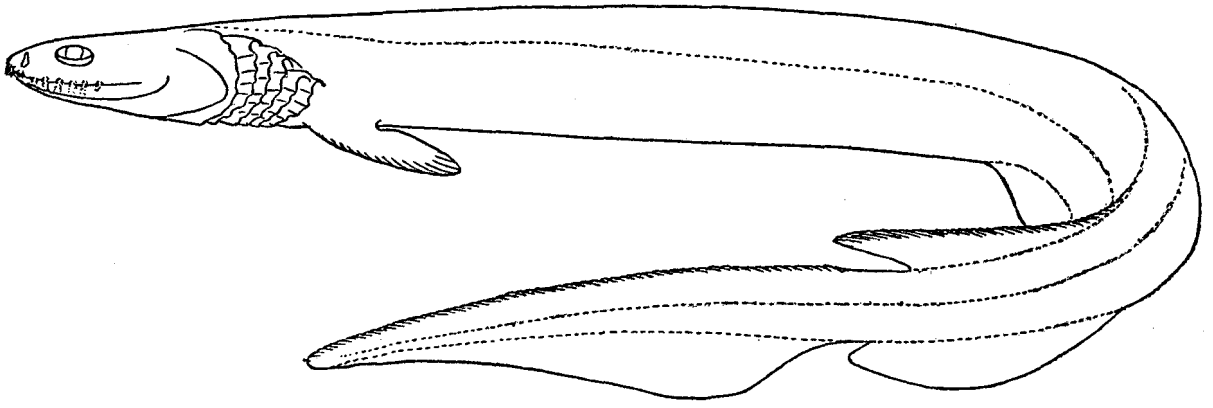

FIG. 4.—Eel shark (*Chlamydoselachus anguineus*). After Goode and Bean

beyond it. The pectorals, it may be added, are relatively small; the ventrals are larger and close in front of the anal.

Size.—The few eel sharks so far recorded have been from 2 to 5 feet long.

Color.—Uniform brown.

General range.—Probably cosmopolitan in the deep waters of temperate and tropical oceans. This shark has been taken, on several occasions, in Sagami Bay, Japan; also off New South Wales, Madeira, and Norway.

Occurrence in the Gulf of Maine.—A curious eel-like fish found dead in a net near Pemaquid Point, Me., in 1880 [17] may have been an eel shark, and this is its only claim to mention here. It would not be surprising should it stray into our Gulf along the trough of the basin from the open Atlantic, for it is as likely to live off our coast as off any other, so widely separated are the localities of capture, listed above.

[17] Described by Hanna (1883).

THE SMOOTH DOGFISHES. FAMILY GALEORHINIDÆ

These are rather small sharks (17 known species) with two dorsal fins, the first large and the second usually much smaller, without spines. The upper lobe of the tail is much longer than the lower, anal fins are present, and the teeth are flat and pavementlike. Except for the teeth they closely resemble the requiem sharks (family Carcharinidæ, p. 27).

4. Smooth dogfish (*Galeorhinus lævis* Valmont)

GRAYFISH; SMOOTH DOG; SMOOTH HOUND; SWITCH-TAIL; WHIPPER-TAIL

Jordan and Evermann (*Mustelus canis* Mitchill), 1896–1900, p. 29.
Garman, 1913, p. 176.

Description.—The smooth dog is easily identified by the presence of two large spineless dorsal fins, the first larger than the second, combined with an anal as well as the paired ventral fins on the lower surface; a tail of typical shark outline—that is, the upper lobe longer than the lower but not excessively elongated—and with flat granular teeth. So different, indeed, are the teeth from the cutting teeth

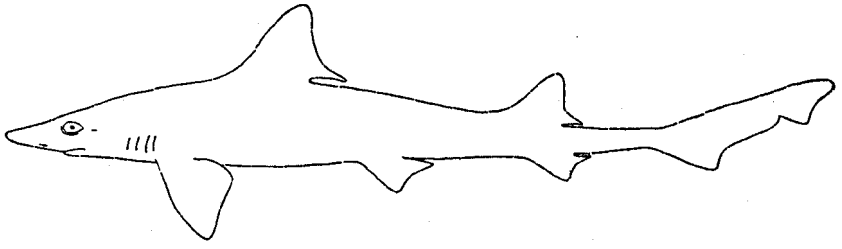

FIG. 5.—Smooth dogfish (*Galeorhinus lævis*)

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 originates nearly over the hind angle of the pectorals and is decidedly larger than the second. The latter, in turn, is about twice as large as the anal, over which it stands. The hind margin of the upper lobe of the caudal is deeply notched near the tip; the lower caudal lobe is very small.

Size.—Adult smooth dogs average about 2 to 3 feet in length, but they have been taken up to 5 feet in length.

Color.—Light gray above; paler gray below.

General range.—Cape Cod to Cuba in American waters; also off the coasts of southern Europe.

Occurrence in the Gulf of Maine.—The smooth dog is extremely abundant west and south of Cape Cod. In Long Island waters, for example, it is one of the commonest and most generally distributed of fishes from June until November, and it abounds equally throughout the summer and early autumn in the Woods Hole region on all kinds of bottom. This, however, is the most easterly outpost for its presence in any numbers, for though it has 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, it occurs only as a southern straggler in the Gulf of Maine, and that so rarely that neither of the authors has ever seen it north of Cape Cod. 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.

On the outer part of the continental shelf Nantucket Shoals must be regarded as the easterly limit of its regular occurrence, for it is not recorded nor reported by fishermen from either 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. 9).

The smooth dog is most familiar as a shore fish and a bottom swimmer, commonly entering shoal harbors and bays, nor is it known to descend to any considerable depth.

Food.—The food of the smooth dog 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 per cent of the fish examined by Field (1907). Large crabs are likewise an important article in its diet, as are the smaller fishes. Field estimated that in Buzzards Bay 100,000 smooth dogfish would annually devour over 600,000 lobsters, 90,000 to 100,000 fish of one kind or another (menhaden and tautog are the species most often found in dogfish stomachs), and a couple of million crabs. While these figures are to be taken only as broadly suggestive, they are based on a sufficient number of observations of the stomach contents to serve as a general indication of the destructiveness of dogfish. They also feed on squid, especially in spring, and while they do not regularly take 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.[18] 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 Crustacea escape when dogfish are abundant. Field also made the interesting observation that the smooth dogs never molested healthy and active menhaden but soon devoured any sick or injured fish that might be in the same tank with them.

Breeding habits.—Not being a characteristic Gulf of Maine fish we need merely note of its breeding habits that it is viviparous,[19] giving birth to from 4 to 12 young at a litter, the pups being about a foot long and practically of adult form when born; and that in the Woods Hole region females containing eggs and embryos at various stages in development are to be found throughout the summer. How many litters of young are produced by any one female during a year is still to be learned.

[18] The senses of this shark have been studied by Parker (Bulletin, U. S. Bureau of Fisheries, Vol. XXIX, 1909 (1911), pp. 43-57) and by Sheldon (Journal of Comparative Neurology and Psychology, vol. 19, 1909, No. 3, p. 273).

[19] In the report of the Massachusetts Commissioners of Fish and Game for 1905 it is erroneously said to be oviparous, apparently being confused with the European dogfish, *Scyllium canicula*.

REQUIEM SHARKS. FAMILY CARCHARINIDÆ

This family, containing a large number of species in tropical and temperate seas, is characterized by a head of normal shape, tail with the upper lobe much larger than the lower but not greatly elongate, two spineless dorsal fins, the first usually much larger than the second and situated over the space between the pectorals and the ventrals, a caudal peduncle lacking lateral keels, and sharp teeth.

5. Tiger shark (*Galeocerdo arcticus* Faber)

Jordan and Evermann (*G. tigrinus* Müller and Henle), 1896–1900, p. 32.
Garman, 1913, p. 148.

Description.—The tiger shark is characterized among the "smooth" (spineless) sharks by the fact that it has an anal as well as ventral fins, that the upper lobe of the tail is much larger than the lower, that the second dorsal fin is very much smaller than the first, and that the latter originates little, if any, behind the "armpit" of the pectoral. The only Gulf of Maine shark with which it might be confused is the dusky shark (p. 29), but it is easily separable from the latter by the more forward position of the first dorsal fin and by the fact that it is spotted instead of plain colored. I may also note that its teeth are large and alike in both jaws.

The body is slender, rather heavy forward of the pectorals, and tapering toward the tail. The head is large, very short, and broad. The snout is rounded

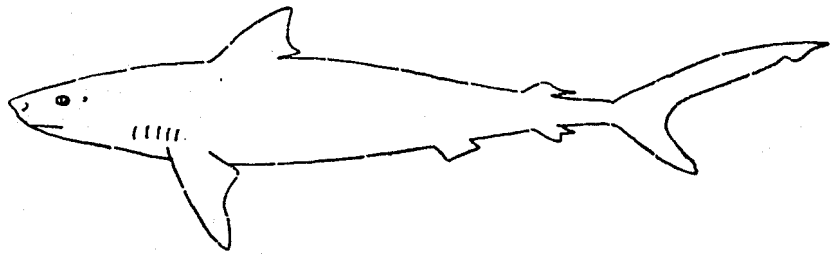

FIG. 6.—Tiger shark (*Galeocerdo arcticus*)

(not pointed) and the mouth is very broad, occupying nearly two-thirds of the width of the snout. The first dorsal is high, triangular, and nearly as large as the pectoral, 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.

Color.—Young tiger sharks are light brown, more or less spotted and barred with darker brown. These markings fade with advancing age until adults are nearly plain colored.

Size.—This is one of the largest sharks, frequently being 12 to 15 and occasionally as much as 30 feet in length, though such a size is altogether exceptional. Most specimens caught north of the Carolinas are small.

General range.—Cosmopolitan in the warmer waters of all oceans, whence it strays northward as far as Cape Cod on the American coast of the Atlantic.

Occurrence in the Gulf of Maine.—Every year a few young tiger sharks are taken in the fish traps in the Woods Hole region, where, according to the records of the Bureau of Fisheries, it is the latest shark to arrive, rarely being seen before August

or after October. The specimens captured there usually have been about 5 feet long, and very rarely does a full-grown tiger shark stray so far from its tropical home. But, curiously enough, one at least of the several specimens recorded from Provincetown, its furthest known outpost and the only locality where it has been captured in the Gulf of Maine, must have been of good size, for its stomach contained a whole full-grown swordfish.

Habits.—This slender, active, and voracious shark, with wide jaws and powerful teeth, is an inhabitant of the high seas, preying upon the large sea turtles, other sharks, fish, and occasionally on invertebrates such as horseshoe crabs, crabs, conchs, whelks, etc. Remnants of squeteague, mackerel, hake, scup, menhaden, goosefish, and dogfish all have been found in stomachs of tiger sharks taken at Woods Hole.[20] In the West Indies it is much dreaded, whether or not with good cause. So seldom does this species round Cape Cod (in fact none has been reported east or north of the cape for many years) that the chance of running across one in the Gulf of Maine is extremely remote. It has never been recorded from the offshore banks.

6. **Great blue shark** (*Galeus glaucus* Linnæus)

BLUE SHARK

Jordan and Evermann (*Prionace glauca* Linnæus), 1896–1900, p. 33.
Garman, 1913, p. 145.

Description.—The blue shark is slender bodied, thickest at about its mid-length, and tapering thence toward the head and tail (that is, the shape usually named "fusiform"), its long pointed snout separating it at a glance from the blunt-nosed tiger. The first dorsal is of moderate size, standing well behind the middle of the space between pectorals and ventrals. The pectorals are very long, their tips reaching as far back as the first dorsal, and their very narrow and pointed outlines, combined with the location of the first dorsal and the pointed snout, give it an aspect very different from that of the dusky shark, which resembles it in the relative sizes of the fins. The second dorsal is less than half as high as the first—about equal to the anal over which it stands. The lower lobe of the tail is only one-third as long as the upper. The latter is notched near the tip, and both tail lobes are sharp pointed.

The teeth of the blue shark are very characteristic, being large and serrate, each series forming a continuous cutting edge. Those of the upper jaw are broadly triangular with curved tips, while the lower teeth are narrower, pointed, and stand more erect.

Size.—The blue shark grows to a length of about 12 feet.

Color.—The color varies from grayish to light or bright steel blue, or even to bluish black above. Below it is dirty white.

General range.—Cosmopolitan in the warmer parts of all oceans. On the northeastern coast of North America it is taken from time to time at Woods Hole,

[20] Bell and Nichols (Copeia, No. 92, Mar. 15, 1921, pp. 17–20) list the stomach contents of a large number of tiger sharks caught off Morehead City, N. C.

where it is one of the rarer sharks, and at Nantucket. While only a stray in the Gulf of Maine, it must visit the outer coasts of Nova Scotia in some numbers every summer, for Harry Piers, of the Provincial Museum, Halifax, informs us that there are three specimens in the museum—one of them 10 feet 5 inches long—taken near Halifax. He also reports a fourth taken there in 1895, and writes that this shark was "plentiful at entrance to Halifax Harbor about 25 August, 1920; first seen about 15 August; last seen 23 September." Cornish [21] also saw two specimens at Canso, Nova Scotia, but whether the "blue dogs" described to him by local fishermen as common on the neighboring fishing banks actually are this shark seems doubtful. On the European side of the Atlantic the blue shark is not uncommon in summer around the south coasts of Great Britain, and has been taken casually as far north as southern Norway.

Occurrence in the Gulf of Maine.—The claim of this species to mention here rests on a single specimen from Massachusetts Bay recorded by Garman (1913), but being comparatively so common off Nova Scotia it is to be expected in the Gulf

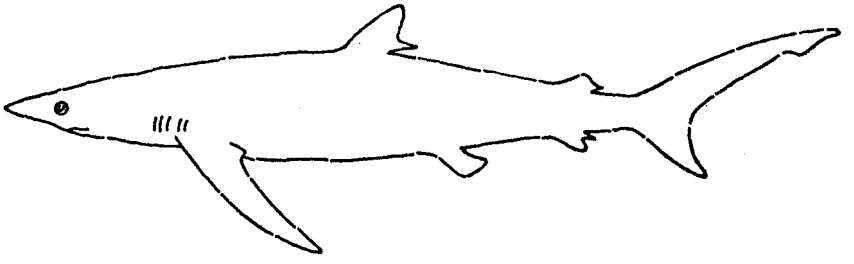

FIG. 7.—Great blue shark (*Galeus glaucus*)

any summer. It may be noted in passing that it is viviparous, and that Nichols and Murphy [22] have given a graphic account of it as it is met with by whalers on the high seas.

7. **Dusky shark** (*Carcharhinus obscurus* LeSueur)

SHOVELNOSE

Jordan and Evermann, 1896–1900, p. 35.
Garman, 1913, p. 130.

Description.—In the dusky shark (a moderately stout-bodied species) the second dorsal is not over one-half as high as the first. The latter stands well back of the pectorals, but, being nearer these than to the ventrals, is relatively further forward than in the blue shark and further back than in the tiger shark. The rear margin of the first dorsal is deeply concave; the pectorals are relatively long and narrow (twice as long as broad) and reach back as far as the rear edge of the first dorsal. The second dorsal is even smaller than the anal, over which it stands. The tail is long, occupying more than one-fourth of the total length of the shark,

[21] Further Contributions to Canadian Biology, 1902–1905 (1907), p. 81. *In* 30th Annual Report of the Department of Marine and Fisheries, 1906, Fisheries Branch. Ottawa.

[22] Brooklyn Museum Science Bulletin, vol. 3, No. 1, 1916, p. 9. Brooklyn.

but its lower lobe is relatively shorter than in either tiger or blue shark. The dusky shark is further distinguished from the latter by its blunt rounded nose and broad flat head. The upper teeth are broad, triangular, serrate, and with concave outer edges; the lower teeth are narrower, more pointed, with broad bases, and stand more erect.

Size.—This shark occasionally reaches a length of 14 feet, but the larger specimens caught in the traps are usually only 6 to 9 feet long. The relation of length to weight may be judged from the fact that one 11 feet 6 inches in length weighed 650 pounds.

Color.—Gray brown above; whitish below. It is said that this shark is sometimes blue above.

General range.—Middle Atlantic; from North Carolina to Portland, Me., on the coast of North America.

Occurrence in the Gulf of Maine.—Like several other sharks the shovelnose is sufficiently plentiful all along the shores of southern New England, as far east as

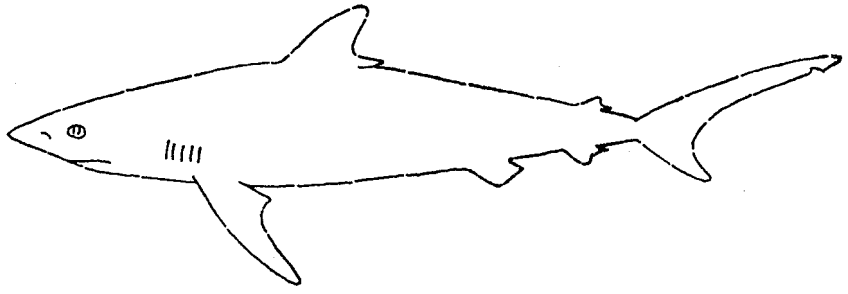

FIG. 8.—Dusky shark (*Carcharhinus obscurus*)

Cape Cod, throughout summer and early autumn, to be well known to the local fishermen. At Woods Hole, for example, it is very common, but it rarely strays into the colder waters beyond the cape. The localities within the Gulf of Maine where it has been definitely recorded are Crab Ledge off Chatham, Nahant, Massachusetts Bay, and Cod Ledge near Cape Elizabeth (the most northerly occurrence yet known), where one was caught in 1864 by Capt. B. J. Willard. So rare are these stragglers that neither of the writers has ever seen one in the Gulf. In short, it has no place in the fauna of the latter except as a stray. Neither recorded capture nor fishermen's report credits it to Georges or to Browns Bank.

Food.—The shovelnose is a bottom swimmer, feeding chiefly on fish and squid but also eating the larger Crustacea. Cunners, menhaden, scup, skates, and silver hake have been found in specimens caught at Woods Hole. It is harmless to human beings.

THE HAMMER-HEADED SHARKS. FAMILY CESTRACIONTIDÆ

The peculiar shape of the head, described below, sufficiently characterizes the only Gulf of Maine representative of this family, which otherwise resembles the requiem sharks (p. 27).

8. **Hammerhead shark** (*Cestracion zygæna* Linnæus)

Jordan and Evermann (*Sphyrna zygæna* Linnæus), 1896–1900, p. 45.
Garman, 1913, p. 157.

Description.—The bizarre outline of the head of the hammerhead, easier drawn than described, has been so widely heralded that probably everyone at all concerned with fishes is perfectly familiar with it. It can not possibly be confused with that of any other fish. The eyes stand at either edge of the "hammer"; the first dorsal fin originates slightly behind the "armpit" of the pectoral, is considerably larger than the latter, and is much higher than long; the very small second dorsal is hardly one-fifth as high as the first; 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 hardly one-half as long as the upper.

Size.—The hammerhead is one of the larger sharks, growing to a length of 15 feet or more.

Color.—Gray to ashy brown above; paler brown to dirty white below.

General range.—A warm-water species, cosmopolitan in tropical seas northward to the Gulf of Maine in the western North Atlantic, and to British waters in the eastern North Atlantic.

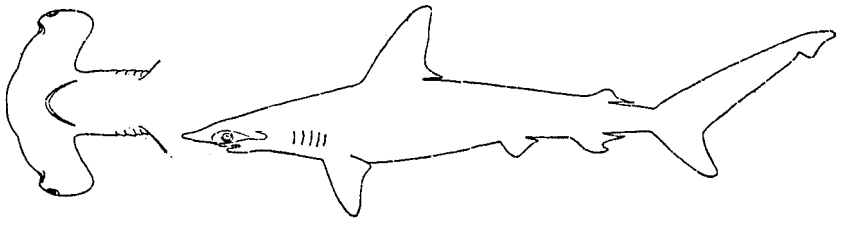

FIG. 9.—Hammerhead shark (*Cestracion zygæna*)

Occurrence in the Gulf of Maine.—The hammerhead, like most of its tropical relatives, finds Cape Cod and the cool water that it meets when it strays beyond that natural boundary the eastern and northern limit to its regular annual occurrence. In the Woods Hole region, only a few miles west of the cape, it is caught from time to time in the fish traps from July to October almost every year. So far, however, the only definite reports of it in the Gulf of Maine with which we are acquainted are from Chatham and Provincetown, the latter its most northerly record on the American coast; nor is it likely that the hammerhead is more common in the Gulf than these few records suggest, for so easily recognized is it among sharks that it is far more apt to be reported than are the various tropical species of more conventional appearance. It would not be surprising to see it on Georges or Browns Bank, though no rumor of its presence there has reached us.

With the hammerhead, as with many other tropical fishes, the examples that visit the shores of New England are usually small. At Woods Hole about 4 feet is the commonest length and 6 to 8 feet the maximum. In 1805, however, a specimen 11 feet long was netted at Riverhead, Long Island, N. Y., and the fact that

this specimen contained parts of a man in its stomach is chiefly responsible for the bad reputation of the hammerhead.

Habits.—The hammerhead is pelagic in habit, often swimming with dorsal and caudal fins above the surface. It feeds chiefly on fish and squids but is also known to eat crabs and even barnacles. It is viviparous. Thirty-seven embryos have been taken from the oviducts of a female 11 feet long, and probably such specimens as wander north of the Chesapeake Capes give birth to their young in summer, for specimens as small as 1½ feet long have been taken at Woods Hole in July and August.

THE THRESHER SHARKS. FAMILY VULPECULIDÆ

The only representative of this family (the well-known thresher) is peculiar among sharks for its enormously elongate tail. Its closest affinities otherwise are with the mackerel sharks (p. 35).

9. **Thresher** (*Vulpecula marina* Valmont)

THRASER; SWIVELTAIL; SWINGLETAIL; FOX SHARK

Jordan and Evermann (*Alopias vulpes* Gmelin), 1896–1900, p. 45.
Garman, 1913, p. 30.

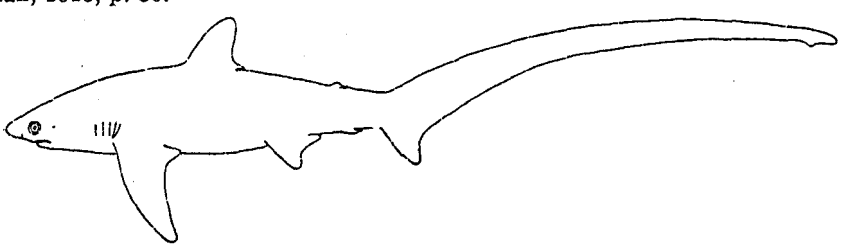

FIG. 10.—Thresher shark (*Vulpecula marina*)

Description.—The thresher is as easily distinguished by its long tail as the hammerhead is by its head, the upper caudal lobe being about as long as 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 is hardly longer than the anal fin. It need merely be pointed out in addition that the first dorsal (of moderate size and about as high as long) stands about midway between pectoral and ventral, that the second dorsal and the anal are very small, the pectoral is very long and sickle shaped, and that the thresher is a stout-bodied shark with short snout, blunt, rounded nose, and small triangular teeth.

Size.—The thresher grows to a length of about 20 feet or more, fish as large as 16 feet in length having several times been taken at Woods Hole. One of 13 feet has been found to weigh about 400 pounds.

Color.—Dark lead brown to nearly black above; white below, except that the lower sides of the pectorals are leaden in hue.

General range.—An inhabitant of all warm seas, especially numerous in the Mediterranean and temperate Atlantic.

Occurrence in the Gulf of Maine.—The most northerly locality on the east coast of the United States where the thresher can be called fairly abundant is off Block Island, where, say Nichols and Murphy,[23] it is the commonest large shark, appearing in May, most plentiful in June, and remaining until late in the fall. At Woods Hole, too, it has occasionally been taken in the fish traps from April until late in the autumn. Specimens as large as 20 feet in length have been caught there—three fish of 16 feet each in one trap in a single morning. Although only two specimens have been reported at Nantucket, the thresher evidently enters the Gulf of Maine more often than do most of its tropical relatives (e. g., the blue shark) for it has been recorded repeatedly on the coasts of Maine and Massachusetts—at Provincetown, Massachusetts Bay, Boston Harbor, Nahant, off Monhegan, east of Matinicus, off Penobscot Bay where a specimen estimated to weigh 500 pounds was caught in 1911, and off Eastport. It is said to have been taken—even to have been common—in the past in the Bay of Fundy, though there is no recent record of it there, and it has been reported entangled in nets off the Nova Scotian coast and even from the Gulf of St. Lawrence. To these records we can add that of several large threshers seen leaping near the *Grampus* as she sailed through Pollock Rip on August 4, 1913. In fact, next to the mackerel sharks (p. 35) the thresher is no doubt the commonest large pelagic shark in the Gulf. No doubt it also occurs in the mackerel season on Georges and Browns Banks, though we find no definite record of it there. The thresher is to be expected in our waters only in the spring, summer, and autumn; in the cold season it altogether deserts the northern coasts for warmer seas.

Food and habits.—The tale that the thresher leagues with the swordfish to attack whales is time honored, but it seems that it must be relegated to the category of myth, for few, if any, experienced whalemen can be found to credit it (except in yarns spun to entertain and awe landlubbers!), and so weak toothed is this shark that the second part of the story—that it makes a meal on its huge victim—is an impossibility. In actual fact the thresher feeds chiefly, if not exclusively, on such schooling fishes as mackerel, menhaden, herring (of which it destroys great numbers), and, in European waters, pilchard. A pair of threshers often work in concert "herding" a school of fish, and it is to frighten its prey together that its enormously long, flail-like tail is employed. Allen [24] gives an interesting eyewitness account of a thresher pursuing and striking a single small fish with its tail. It is, we may add, perfectly harmless to human beings.

Commercial importance.—In the Gulf of Maine the thresher is not common enough to be of any importance to fishermen one way or another, or to play a practical rôle of any moment among the smaller fish. Further south, however, and wherever it is numerous in the Atlantic, it makes itself a great pest, tangling and tearing mackerel nets as well as destroying and chasing away the more valuable fishes on which it feeds.

[23] Brooklyn Museum Science Bulletin, vol. 3, No. 1, 1916, pp. 1–34, pls. 1–3. Brooklyn.
[24] Science, New Series, Vol. LVIII, No. 1489, July, 1923, pp. 31–32.

THE SAND SHARKS. FAMILY CARCHARIIDÆ

In the sand sharks the two dorsal fins are spineless and nearly equal in size, the upper lobe of the tail is much larger than the lower, there are no keels on the caudal peduncle, and the teeth are very slender and pointed.

10. Sand shark (*Carcharias taurus* Rafinesque)

SHOVELNOSE; DOGFISH SHARK; BLUE DOG; LITTLE MACKEREL SHARK; GROUND SHARK

Jordan and Evermann (*Carcharias littoralis* Mitchill), 1896–1900, p. 46.
Garman, 1913, p. 25.

Description.—The large size of the second dorsal and anal fins (which are 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 first dorsal fin being located but little in front of the ventrals, the trunk seems crowded with fins of equal size—a useful field mark for this species. 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 the tip, with the lower lobe about one-fifth as long as the upper; and

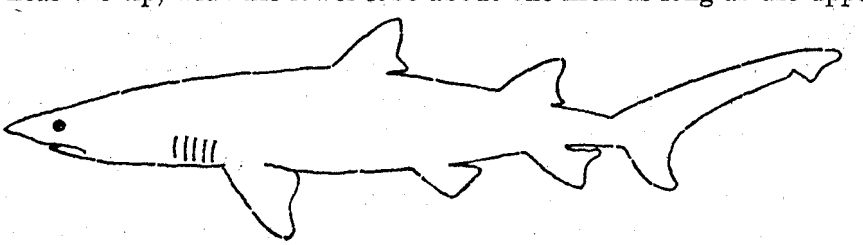

FIG. 11.—Sand shark (*Carcharias taurus*)

that the head is flat, the nose short and blunt at the tip. The teeth of the sand shark (they are alike in both jaws) are likewise diagnostic, being long, narrow, and pointed, with a spur at either side near the base, and smooth-edged.

Size.—Adult sand sharks are usually about 4 to 5 feet long, often a foot or more longer, and rarely taken up to 8 or 9 feet.[25] They have been reported up to 12 feet long, but this is so much longer than the general run as to raise the question whether these monsters were actually sand sharks and not some other species.

Color.—The ground color is gray, darker above, lighter below, indistinctly spotted with darker brown, and the edges of the fins are sometimes edged with black.

General range.—Coastal waters of the United States from Maine to North Carolina.

Occurrence in the Gulf of Maine.—The sand shark is the commonest of all its tribe (except the smooth and spiny dogfishes) at the westerly entrance to the Gulf of Maine. It is very plentiful at Woods Hole from June to November and is to be found everywhere 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, and although we find it far less abundant once we

[25] Sherwood (Copeia, Nov. 15, 1921, No. 100, p. 77) records one of 8 feet 10 inches, caught at Clinton, Conn.

pass the southern elbow of Cape Cod, it is more often seen and taken in the Gulf of Maine than is any other large shark except the mackerel shark (p. 36) or perhaps the thresher. There is well-established record of its presence at Monomoy, North Truro, Provincetown (where it has been caught often enough to have received the local name of dogfish shark, appropriate because of its small size), Cohasset in Massachusetts Bay (where the senior author caught one about 4 feet long years ago), in Boston Bay, at Lynn, at the mouth of Casco Bay, and even near St. Andrews in the Bay of Fundy—its most northerly outpost—where a stray specimen was taken in a weir in 1913. Probably, were all the sand sharks that entangle themselves in nets reported, we would find that it ranges northward as far as Casco Bay every summer and in much greater numbers than the actual published record would suggest. Any "shovelnose" reported from northern New England would probably belong to this species; and no doubt it is represented among the "ground sharks" taken by fishermen on Georges Bank, though definite information is lacking on this point.

Habits and food.—This shark, in the warm months at least, swims chiefly near the bottom in shoal water, often coming right up on the beaches almost to tide mark and even entering the mouths of rivers. Over certain bars, however, it often comes to the surface, where it may be seen moving slowly to and fro with its dorsal and tail fins projecting above the surface. It captures great numbers of small fish, which are its chief diet, particularly menhaden, cunners, mackerel, skates, silver hake, flounders, alewives, butterfish, and—south of Cape Cod—scup, weakfish, and bonito. It also eats lobsters, crabs, and squid. Although comparatively sluggish in habit, as sharks go, sand sharks have been seen surrounding and devouring schools of bluefish, and have even been known to attack nets full of bluefish, which gives a measure of their voracity. There is no record or even well-grounded rumor that this shark ever attacks human beings. Indeed, it is looked upon merely as a harmless nuisance wherever it is common enough to be familiar. So far as the Gulf of Maine and, indeed, the southern coast of New England as a whole are concerned, the sand shark occurs only as a summer visitor, moving away either southward or into deep waters during the cold season.

Breeding habits.—Nothing is definitely known of its breeding habits. Females with unripe eggs have been taken at Woods Hole in July.

Commercial value.—This shark has no commercial value except the negative one of damaging nets, but so readily does it bite a hook that it is of some importance as an object of sport, though hardly so in the Gulf of Maine, where it is never plentiful enough to be worth fishing for.

THE MACKEREL SHARKS. FAMILY ISURIDÆ

This group of sharks is easily recognizable by the fact that the tail is very firm and lunate in outline with the lower lobe but little smaller than the upper, suggesting a swordfish's tail, and that there is a prominent keel on either side of the caudal peduncle. The dorsal fins are spineless.

11. **Mackerel shark** (*Isurus punctatus* Storer)

BLUE SHARK; PORBEAGLE

Jordan and Evermann (*Lamna cornubica* Gmelin), 1896–1900, p. 49.
Garman, 1913, p. 36.

Description.—The mackerel sharks (this and the two species following) are easily told from all the sharks so far mentioned by the shape of the tail, for while its lower lobe is sharklike, somewhat smaller than the upper, the difference is slight, the tail being almost evenly forked, with the upper lobe directed so sharply upward, the lower downward, that the tail as a whole is crescentic and much broader than long. In fact it recalls the tails of such pelagic bony fishes as the mackerel tribe or the swordfish in outline, likewise in its firm texture. More precise if less obvious a character is that the root of the tail bears a well marked longitudinal ridge or keel on either side, a feature shared by the white and basking sharks (pp. 39 and 41).

This is a stout, heavy-shouldered shark, tapering in front to a sharply pointed snout and behind to a very slim tail root. Its dorsal and pectoral fins are very large; the former, originating over the armpit of the pectoral, is triangular and about as high as long; the latter, broad-based but tapering sicklelike to a narrow tip,

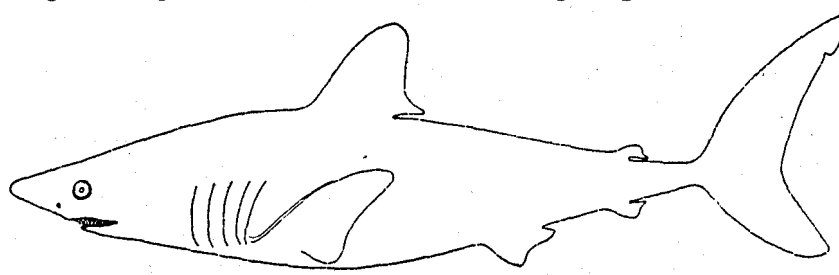

FIG. 12.—Mackerel shark (*Isurus punctatus*). After Garman

is only about half as broad as long. The second dorsal and anal fins are very small indeed, and the ventrals but little larger. The second dorsal stands over the anal. The positions of the dorsal fins are the readiest field mark to distinguish this species from the sharp-nosed mackerel shark (p. 38). The teeth are alike in the two jaws—small, slender, pointed, smooth-edged, and without spurs on the sides—and their structure differentiates this shark from the European porbeagle (*Isurus nasus*), which it otherwise resembles closely but in which the teeth bear a sharp denticle on either side at the base of the cusp.

Size.—The larger mackerel sharks are usually about 8 to 10 feet long, growing to an extreme length of about 12 feet.

Color.—The upper parts are dark bluish gray to bluish brown, changing abruptly to white below. According to Garman the dorsal, pectoral, and tail fins are tipped with black, there is a black area in the armpit of the pectoral followed by a white space on the fin and body, and there is a large and very noticeable black spot on the outer half of the pectoral, which is one of the distinguishing features of this species.

General range.—North Atlantic and Pacific Oceans. Closely allied to the ommon porbeagle (*Isurus nasus* Bonaterre) of British seas.

Occurrence in the Gulf of Maine.—From the days of the earliest settlement it has been known that stout-shouldered, surface-swimming sharks of moderate size and with "mackerel" tails are tolerably common in the Gulf of Maine, 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, but more recent researches have proved that there are actually two—the present one and the next—readily separable by the position of the first dorsal fin relative to the pectorals and of the second dorsal relative to the anal, but so much alike in general appearance that it is usually impossible to determine without actually examining the specimens to which species many of the records actually belong. However, since *I. punctatus* is the more northerly of the pair, and since far more specimens of it than of *I. tigris* have actually come to hand, probably most of the mackerel sharks that fisherman so often see swimming lazily on the surface off the shores of Northern New England belong here.

Although these sharks are far more often seen than captured, we have definite record of the common mackerel shark at Provincetown, in Massachusetts Bay, off Cape Ann, and at various localities along the Maine coast—e. g., off Cape Elizabeth, in Casco Bay, off Monhegan, and even Passamaquoddy Bay in the Bay of Fundy, where, however, Huntsman (1922a) records but a single specimen. During our *Grampus* cruises we have seen many mackerel sharks, particularly between Cape Ann and the Isles of Shoals, and off Monhegan Island. This shark likewise ranges northward along the Nova Scotian coast and into the Gulf of St. Lawrence. It may, in fact, be described as common, if not abundant, and to be expected anywhere in the Gulf of Maine during the summer. In winter it apparently departs (no doubt for warmer seas), and it is during its southward journey throughout autumn and up to the end of November that mackerel sharks are commonest in the Woods Hole region, while at Nantucket they (or the next species) are commonest in spring when they are taken in the mackerel drift nets. As yet our knowledge of the migrations of this shark into and out of the Gulf of Maine is of the haziest. Certainly, however, it visits us in greater or less number annually, and is most numerous when mackerel are plentiful.

Habits.—The whole mackerel-shark tribe, as contrasted with the ground sharks, are strong, active swimmers, leading a pelagic life near the surface of the high seas, 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. Again and again we have sailed up on sharks probably of this species, only to see them sound, just out of harpoon range, plainly visible at first but soon fading from sight as they swim downward with undulating motion. This is a viviparous species. In the Gulf of Maine gravid females, each carrying a pair of young, have been taken in winter.[26]

[26] Kendall, 1914, p. 186.

Food.—The mackerel shark feeds on small fish, especially on mackerel and no doubt also on herring (which are an important article in the diet of its European congener) as well as on such other schooling fishes as shad and menhaden. It is also known to eat hake and squid. We find no record of its eating Crustacea, nor do fishermen report it as doing so.

Commercial importance.—At the present time the mackerel shark is not of any practical value in the Gulf of Maine. On the contrary it is often a serious nuisance from its habit of rolling itself up in an inextricable snarl of twine when it entangles itself in drift or gill nets. Many years ago shark oil was prized by curriers, and the livers of this species were tried out in considerable quantity, but this was never more than a minor industry, abandoned before the middle of the past century. It is interesting to read, however, that as much as 11 gallons of oil have been obtained from the liver of a single shark 9 feet long, and report has it that the richness of the livers in oil fluctuates over periods of years.

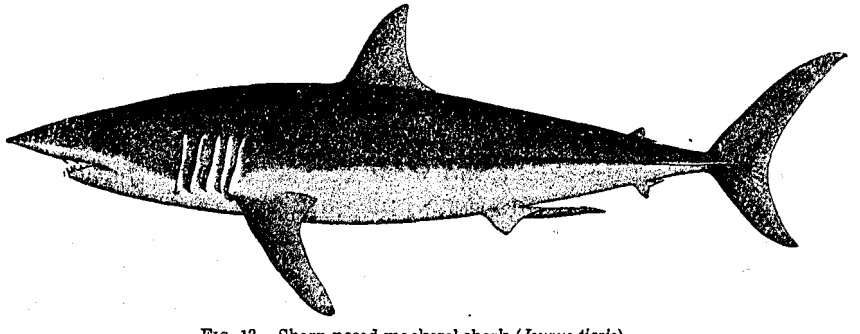

FIG. 13.—Sharp-nosed mackerel shark (*Isurus tigris*)

12. Sharp-nosed mackerel shark (*Isurus tigris* Atwood)

Jordan and Evermann (*Isurus dekayi* Gill), 1896–1900, p. 48.
Garman, 1913, p. 36.

Description.—This shark so closely resembles the common mackerel shark that I need merely point out the points of difference. Most obvious of these is that while in the latter the first dorsal originates above the armpit of the pectoral, in *I. tigris* it stands altogether behind the inner corner of the latter, and the second dorsal originates a short distance in front of the anal. Its snout, likewise, is sharper, its pectorals narrower, and there is a color difference.

Size.—About the same size as the porbeagle; that is, growing to a maximum length of about 10 feet.

Color.—Dark bluish-gray or bluish to ashy brown above, white below, and without the black spot on the pectoral fin so characteristic of the common mackerel shark.

General range.—Gulf of Maine to the West Indies.

Occurrence in the Gulf of Maine.—As I have pointed out above, there is no knowing how many of the "mackerel sharks" reported by fishermen in the Gulf of Maine may actually belong to this and not to the preceding species. However, not only is it nowhere common so far as known, but its center of abundance seems to be

south of Cape Cod. The only definite Gulf of Maine records for it, so far as we can learn, are as follows: Off Seguin Island, Casco Bay, Provincetown, Cape Cod, and Massachusetts Bay. We have not seen it. It has been netted in Vineyard Sound as late in the season as December, and occurs as far south as the Gulf of Mexico. On the other hand it is known to wander as far north as Maine.

Habits and food.—This shark is a more slender fish than the common mackerel shark—large, powerful, and swift-swimming, feeding upon small fish and squid. Little is known of its habits, though what has been written of its relative, *I. punctatus*, probably applies equally to *I. tigris*. Its breeding habits are not known.

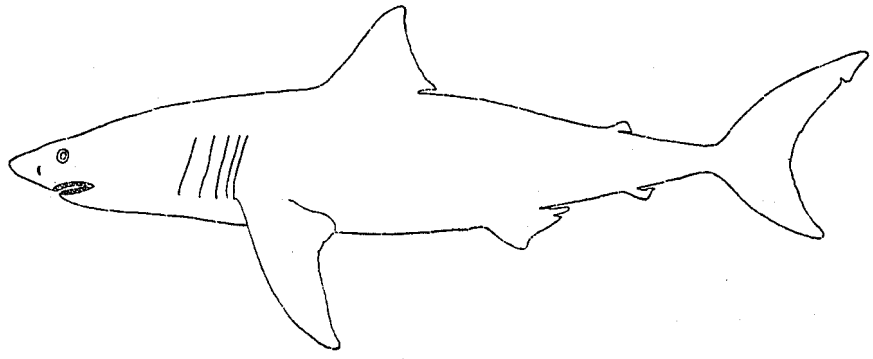

FIG. 14.—White shark (*Carcharodon carcharias*)

13. White shark (*Carcharodon carcharias* Linnæus)

MAN-EATER SHARK

Jordan and Evermann, 1896–1900, p. 50.
Garman, 1913, p. 32.

Description.—The white shark is of the general "mackerel shark" appearance, with firm lunate tail, the upper lobe only slightly longer than the lower, triangular first dorsal of moderate size originating over the armpits of the pectorals, which are sickle shaped, and roughly twice as long as broad. The second dorsal and anal fins are very small, and the root of the tail bears a well-marked keel on either side. The snout is pointed. Unfortunately there is no obvious "field mark" to distinguish a small white shark from the common mackerel shark when seen swimming, for while the former is the slimmer fish the difference in form is not great. Once captured, however, no confusion could arise, for instead of the slim catlike teeth of the porbeagle we find the man-eater best armed of all modern sharks, its teeth large and triangular and similar in shape in the two jaws though broadest in the upper, with nearly straight cutting edges and serrated margins. As a precaution, however, any *very* large, active shark, upwards of 18 feet (3 fathoms) long, with the tail *not* long (out of ordinary proportions) should be looked upon with suspicion—it *might* prove to be a man-eater. If it were sluggish, resting with the dorsal fin high out of water, it would no doubt be a harmless basking shark (p. 41).

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Size.—This is one of the largest sharks, growing, it is said, to a length of 40 feet or even more. In the British Museum there are the jaws of a specimen 36 feet long. In a shark as large as this the teeth are about 3 inches long. A white shark 12 feet 8 inches long, taken near Woods Hole, was estimated to weigh 1,000 pounds.

Color.—Back slaty or leaden gray, shading gradually to the white of the under parts. In the porbeagle the transition on the sides from dark back to pale belly is more sudden. There is a black spot in the armpit of the pectoral fin, but neighboring parts of fin and body are white. Dorsal, pectoral, and caudal fins are darkest at their rear margins, but the ventrals are darkest (olive) along the forward edge, fading rearward to white.

General range.—Cosmopolitan in tropical and warm-temperate seas, straying northward at rare intervals as far as New England and casually to Banquereau Bank off eastern Nova Scotia.[27] It is apparently rare everywhere.

Occurrence in the Gulf of Maine.—The only reliable Gulf of Maine records of this ill-omened shark are of two small ones mentioned by Storer as taken by Massachusetts fishermen between 1820 and 1850; one about 13 feet in length and weighing about 1,500 pounds, killed at Provincetown in June, 1848, which he described under the name *C. atwoodi*; another captured at Eastport, Me., in 1872; one 7 feet 2½ inches long taken many years ago in Massachusetts Bay (figured by Garman, Memoirs, Museum of Comparative Zoology of Harvard University, Vol. XXXVI, 1913, pl. 5, figs. 5–9); and one 16 feet long, taken in a trap at East Brewster, Mass., October 16, 1923, and identified by Doctor Garman. Captain Atwood[28] also writes that he saw four caught in mackerel nets at Provincetown. Several more (all rather small) have been taken at Woods Hole in the fish traps, and one off South Amboy, N. J., on July 14, 1916.

So seldom does this tropical shark stray to the Gulf of Maine that it would deserve no more than the briefest mention were it not the only shark likely to attack human beings. Being equipped as it is with a most terribly effective set of cutting teeth, and strong and active, the white shark has borne an unsavory reputation as a man-eater from the earliest times, and it was probably a small "man-eater"—in fact, the specimen listed above from South Amboy—that was responsible for the shark fatalities along the New Jersey beach in July, 1916 (p. 22). Hence, so long as white sharks do occasionally wander within our limits the possibility of similar attacks on bathers along beaches of Massachusetts is always open, if exceedingly remote. So far as we can learn, however, there is no actual record of a white shark wantonly attacking human beings in the Gulf (p. 22), but Captain Atwood tells us of a case where a rather small one (apparently the 13-foot specimen described by Storer) turned furiously on a boat but was eventually lanced to death and brought into Provincetown. It is on record, also, that one about 13 feet long attacked a fisherman in a dory on Banquereau Bank many years ago, leaving in the sides of the boat fragments of its teeth, by means of which Doctor Garman was able to identify the species to which the shark belonged.[29]

[27] Putnam. Bulletin, Essex Institute, vol. 6, 1874, p. 72. Salem.
[28] Quoted, by Goode et al, 1884, p. 671.
[29] Putnam. Bulletin, Essex Institute, vol. 6, 1874, p. 72.

Habits and food.—So rare (and fortunately so) is this shark even in the tropics that practically nothing is known of its habits. It feeds on large fish, on sea turtles, and perhaps on porpoises. Off the California coast sea lions also fall prey to it—vide Jordan and Evermann's account of a young sea lion of 100 pounds weight in the stomach of a 30-foot white shark. As to its breeding habits nothing is known, though presumably it is viviparous like its close relatives.

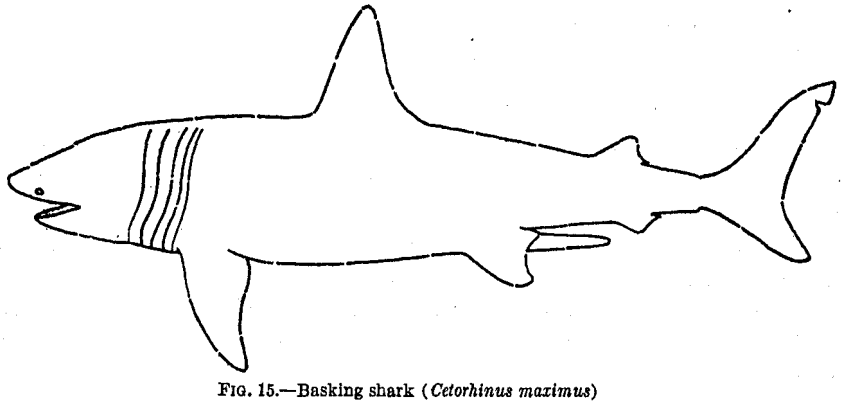

FIG. 15.—Basking shark (*Cetorhinus maximus*)

14. **Basking shark** (*Cetorhinus maximus* Gunner)

BONE SHARK

Jordan and Evermann, 1896–1900, p. 51.
Garman, 1913, p. 39.

Description.—The basking shark resembles the other mackerel sharks in its lunate tail, which is much broader than long and with the lower lobe but little shorter than the upper; in the presence of a strong "fore and aft" keel on either side of the root of the tail; in the fact that the second dorsal fin is very much smaller than the first; and in its form, tapering in both directions to snout and tail. However, it is set apart from all other sharks by the enormously long gill slits, which extend nearly right around the neck, and—even more significant—that alone of all its tribe, except its relative the whale shark (Rhinodon), it has rakers on its gill arches, suggesting (though not corresponding to) those of herring, menhaden, etc., among bony fishes. 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, but its teeth are very small though numerous. I need only note further that the triangular first dorsal fin stands midway between pectorals and ventrals, and though the back fin is little longer in proportion than that of the other mackerel sharks it rises high in the air when the fish lies awash on the surface, as is its habit—a valuable field mark (p. 39). The nose of large specimens is of ordinary "shark" outline—short, conical, bluntly pointed. In young fish, however, up to 12 or 13 feet in length, it is curiously contracted in front of the mouth into a semicylindrical snout pointed at the tip.

Size.—The basking shark grows to a length of at least 45 feet, perhaps larger. Several specimens 28 to 35 feet in length have been recorded from the New England coast, and still larger ones have been reported, but on doubtful evidence.

Color.—This shark is grayish-brown, slaty, or nearly black above. The under parts are usually described as white, but the Menemsha specimen recorded by Allen [30] was of a lighter shade of slate below than above, and one 14 feet long captured at West Hampton, Long Island, on June 29, 1915,[31] had the belly as dark as the back, the only white being a patch underneath the snout in front of the mouth.

General range.—This enormous fish is usually said to be native to Arctic seas, straying southward to Portugal on the one side of the Atlantic, to Virginia on the other side, and to California in the North Pacific. It would, we think, be more accurate to say that it roams the whole North Atlantic from latitude about 35° north to Iceland and northern Norway, Smitt [32] having shown that it is not, strictly speaking, an Arctic fish, and that the old tales of a tremendous whale-eating shark, on which Fabricius based his statement that the basking shark occurs in Greenland seas, were false. It is also plentiful enough off the coasts of Ecuador and Peru in the South Pacific to support a considerable local fishery.[33]

Occurrence in the Gulf of Maine.—Of recent years the bone shark has been seen but seldom in the Gulf of Maine, the list being as follows: One 28 feet long was killed in Maine waters in 1828; one off Musquash Harbor in the Bay of Fundy in August, 1851; one of 34 feet at Eastport in 1839; several ranging in length from 25 to 35 feet, killed there in 1868 and 1870; a considerable number seen and several secured off Cape Elizabeth in 1848 by a whaler cruising for humpback whales; one of 35 to 38 feet harpooned but lost between Boston and Provincetown in 1864; and one killed near Provincetown in 1835, another in 1836 or 1837, a third in 1839, and a fourth in 1847. We do not find another definite record of the bone shark in the Gulf of Maine until October 8, 1908, when one 18 feet long (measured by J. Henry Blake) was taken in a weir near Provincetown. Two more have been killed there since—one a 22-foot fish on October 9, 1909, and the other of 29 feet on June 8, 1913, both in the harbor. Mr. Blake also reported one of 31 feet (16 feet in girth) as taken at Long Point, near by, but the year is not recorded. A small one of 12 to 14 feet was caught at Menemsha Bight on Marthas Vineyard on August 16, 1916, and one of about 26 feet 6 inches [34] at the same locality on June 24, 1920. The bone shark is so large a fish and so conspicuous, thanks to its basking on the surface, that every specimen visiting the coastwise waters of the Gulf is almost certain to be seen sooner or later and to be harpooned. Hence it is probably no commoner there than the meager record suggests.

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[30] Bulletin, Boston Society of Natural History, No. 24, March, 1921, p. 5.

[31] This specimen is described by Hussakof (Copeia, Aug. 24, 1915, No. 21, pp. 25-27).

[32] Scandinavian Fishes, 1892, p. 1146.

[33] This fishery is described by Stevensen (Report, U. S. Commissioner of Fisheries for 1902 (1904), p. 228).

[34] This specimen is now preserved, mounted, in the Boston Society of Natural History, and described by Allen (Bulletin, Boston Society of Natural History, No. 24, March, 1921, pp. 3-10), who collected the foregoing records.

Before the coming of the white man this great shark seems to have been a regular inhabitant of the Gulf of Maine, which afforded it an excellent pasture, for old tradition has it that large numbers were taken in Massachusetts waters for their oil during the first half of the eighteenth century. However, the local stock soon went the same way as the local stock of the North Atlantic right whale—into the try pot—and this seems also to have been its fate in Norwegian waters, where it was sufficiently abundant to support a regular fishery up until about 1820, since which time it has been killed down to but a fraction of its former numbers. Indeed, the basking shark to-day is something of a rarity off the coast of Norway, but in other parts of the world, particularly in Icelandic waters, off Ireland, and off Peru, as noted elsewhere (p. 42), it is still moderately plentiful.

Habits.—This is a sluggish, perfectly inoffensive fish, helpless of attack so far as its minute teeth are concerned, and spending much time sunning itself on the surface of the water, often lying with its back awash, on its side, or even on its back, and sometimes loafing along with the snout out of water. Hardly a writer mentioning this shark but tells us that two or three swimming tandem, with the dorsal fins high in the air, are the basis for "sea-serpent" myths. At times bone sharks are gregarious, traveling together in schools. Nothing whatever is known of the breeding habits of the basking shark.

Food.—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 minute Crustacea, particularly on copepods, and on other tiny pelagic animals, which it sifts out of the water by means of its greatly developed gill rakers, exactly as do such plankton feeders as menhaden on the one hand and whalebone whales with their baleen sieves on the other.

Commercial importance.—Although the day of the bone shark in New England waters is long past, probably never to return, it may be of interest to point out that it has always been hunted whenever encountered by the sperm whalers from New Bedford, and that it is still an object of pursuit off the coasts of Iceland and Ireland. It was and is valued solely for its liver oil, individual fish as a rule yielding from 80 to 200 gallons (average about 125 gallons), with as much as 400 gallons from a single liver not unheard of and a yield of 600 gallons reported. The basking-shark fishery has always been carried on with harpoons, the shark being quite indifferent to the approach of a boat though it swims actively and strongly when struck. Fat ones are subdued more easily than lean ones.

THE SPINY DOGFISHES. FAMILY SQUALIDÆ

This group is characterized and made easily recognizable by the presence of two dorsal fins, each with a fixed spine, but no anal fin, while the teeth are alike in the two jaws in some, unlike in others.

15. Spiny dogfish (*Squalus acanthias* Linnæus)

DOGFISH; PIKED DOGFISH; GRAYFISH

Jordan and Evermann, 1896–1900, p. 54.
Garman, 1913, p. 192.

Description.—So rare are all other spiny sharks in the Gulf of Maine that any little shark with a large sharp spine close in front of each dorsal fin caught there is practically sure to be a "dog," of which there are thousands in the Gulf to one of any other shark. Should the fish be uniform dark brown or black it might possibly (but not probably) prove to be the black dogfish (p. 52). A glance at the tail fin will settle the question, for the rear margin of the latter is deeply notched near its tip (fig. 19), whereas in the common spiny dog its margin is entire.

This is a slender little shark with tapering but rounded head and flattened snout. Its first dorsal fin stands between pectoral and ventral; its second dorsal is about

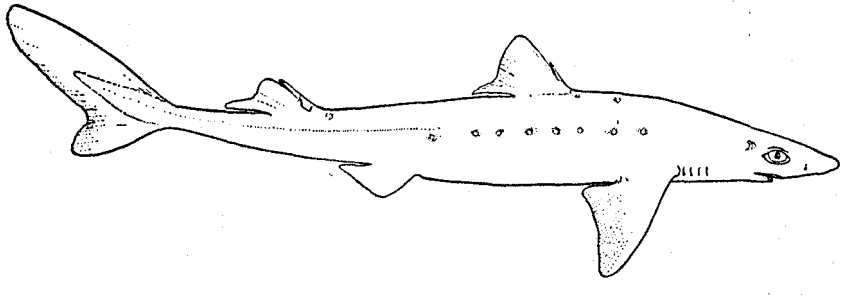

FIG. 16.—Spiny dogfish (*Squalus acanthias*). After Garman

two-thirds as large as the first; its pectoral is triangular, broader at the base than it is long; the lower lobe of the tail fin is well marked; and the ventrals are well forward of the second dorsal. The spines are close up against the front margins of the two dorsals, the first shorter and the second nearly as long as their respective fins are high, and they are very sharp, as every fisherman knows to his cost. The spiny dog has no anal fin, a lack separating it from all smooth-finned sharks known from the Gulf of Maine, except the Greenland shark (p. 53). 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 keels of the mackerel sharks. The teeth are small, their sharp points bent toward the outer corners of the mouth and each row forming a continuous cutting edge.

Size.—Mature dogs are ordinarily 2 to 3½ feet long. Mature males grow to a length of about 3 feet and a weight of 5 to 6 pounds; females to 3 or 3½ feet and a weight of 8 pounds. Occasionally very large fat specimens may reach a weight of 15 pounds.

Color.—Usually slate colored above but sometimes brown, with a row of small white spots on each side from the pectoral to abreast of the anal, and a few other white spots in front of and behind the first dorsal and in front of the second dorsal fins. These spots are most conspicuous in small fish up to 12 or 14 inches in length and fade with growth until in some specimens they disappear altogether. It is gray to white below.

General range.—Both sides of the North Atlantic, also Mediterranean; on the American coast from the Gulf of St. Lawrence and the banks of Newfoundland south to Cuba. Replaced by closely allied species in the North and South Pacific and Indian Oceans.

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 every fishing ground from Cape Cod to Cape Sable. On the offshore banks, too, it is as familiar as it is along the coast. Dogfish are seasonal visitors. In spring they strike in almost simultaneously along the whole coast from New England to North Carolina, appearing at Cape Lookout in April, off Long Island abundantly in May, and as early in the season on Georges Bank (April–May) as at Cape Lookout. 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 in Massachusetts Bay before May. Indeed, summer warming is hardly appreciable more than a few fathoms below the surface until well into that month, so they could hardly be expected earlier. However, according to reports of local fishermen the period of freedom may close there as early as the last half of the month in some years. In 1903, for example, they appeared as far north as Penobscot Bay by the middle of May, and though as a rule it is not until June that they 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 dogs 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 other parts of Massachusetts Bay, in Ipswich Bay, and off Penobscot Bay. However, they usually strike in all along the northern Maine and west Nova Scotian coasts by the end of June, though earlier in the open Bay of Fundy than in Passamaquoddy Bay, where few are seen until late in July.

West of Cape Cod (that is, at Woods Hole and off Long Island) it was formerly believed that these little sharks were only transients, passing north in spring, south in autumn, which were the only seasons when they were seen inshore regularly. However, dogs, both large and small, are caught in the traps of the Woods Hole region in July, and Latham's [35] recent discovery that adult spiny dogfish are common in deep water in Long Island Sound in summer, together with the fact (on which he comments) that young ones are taken in great numbers in the traps on Long Island

[35] Copeia, Oct. 15, 1921, No. 99, p. 72.

in July and August, is sufficient proof that while some of the fish that visit the middle Atlantic coast in spring may go north to the Gulf of Maine, others merely drop down into deeper water to summer, coming inshore again for a time in autumn.

Most of the dogfish take their departure from the inner parts of the Gulf during October, few being caught on the coast north of Massachusetts Bay after November 1. Rarely, however, they stay later, as in 1903 (a big dogfish year), when they were abundant along the outer shore of Cape Cod as late as the third of the month. Ordinarily none are caught within the Gulf of Maine north of Georges Bank in winter, but this, like most rules, has its exceptions. In 1882, for example, schools

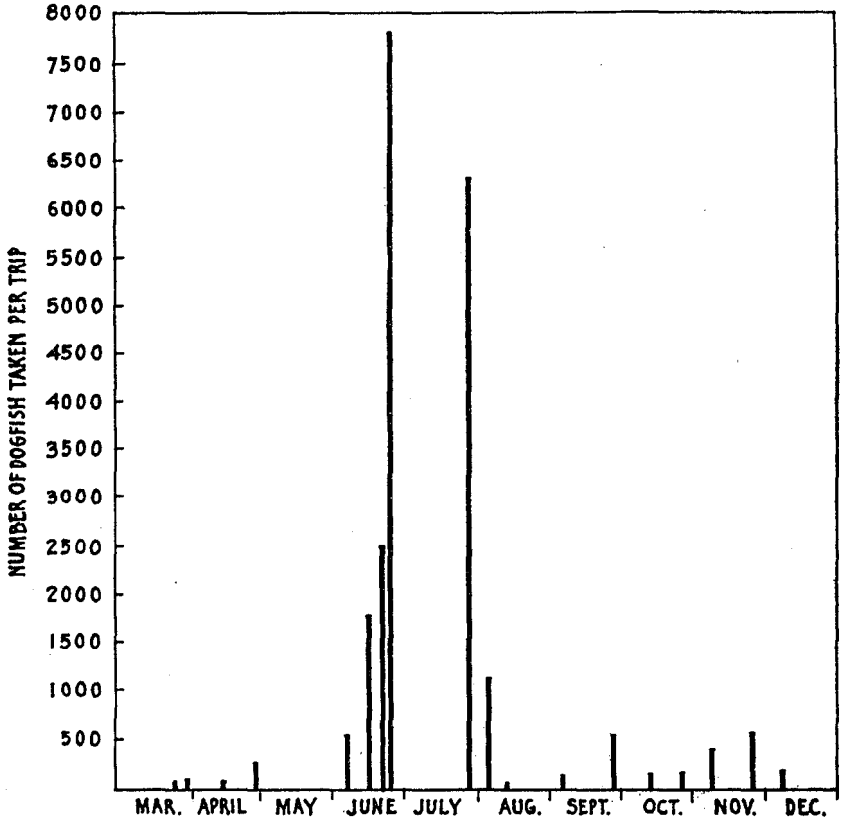

FIG. 17.—Numbers of spiny dogfish caught on certain otter-trawling trips to Georges Bank during the different months of 1913

were reported off Portsmouth in February, while in 1913 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 Jeffrey's Ledge on December 11 and 12.

Dogfish appear earlier in spring and linger later into the winter on Georges Bank (fig. 17) 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) being of 25 fish caught on the "winter cod ground" east of the shoals (longitude about 67°, latitude about 41° 40′) between the 20th and the 22d, and of 46 from the same general region from the 27th to the 30th. Their numbers

increase rapidly in April on Georges Bank, however, and they are a pest there after the 1st of May, while the last half of June, July, and August sees them at the height of abundance at least on the portions of the bank resorted to by the otter trawlers at that season. Whether by chance or as reflecting an actual diminution in the stock of dogfish present, the catches fell off markedly during September in 1913, but considerable numbers were taken throughout that month. Very few were actually captured by the trawlers in October, but there was a considerable increase in November, probably reflecting the southward passage of the schools that had spent the summer further east. A few were caught in November and December, and one on the southern part of the bank (latitude about 41°, longitude about 67° 30′) as late as January 20 to 22. Thus February is the only month when the bank is entirely free of them. The time table just outlined for the year 1913 may be taken as typical, for it corroborates the various reports of fishermen tabulated by the Massachusetts Commissioners of Fisheries and Game in 1905. Apparently dogfish reach Browns Bank rather later than they do Georges, for none were taken there on April 14 in 1913, though they are only too plentiful there in summer. It is also very likely that they depart thence rather earlier, though a few lingered as late as December 3 to 12 on Western Bank off Halifax in that year. Gravid females have been described as arriving before the males in spring, but this remains to be confirmed.

The accompanying graph (fig. 17) of the numbers of dogs taken by certain otter trawlers on Georges Bank at various dates during the year 1913 will more graphically illustrate the seasonal fluctuations of this fish there, with the reservation that the precise catches are governed not only by the abundance of the stock but also by the precise grounds fished on and by the general success of the sets.

The winter home of the Gulf of Maine dogfish is still to be learned. They have often been said to migrate south to the Tropics, and it is certain that some dogfish do reach Cuba during the cold season, but the fact that they appear so nearly simultaneously all along the coast north of North Carolina in spring, and that they leave Georges Bank so late in the season, with the discovery of dogfish in deep water in Long Island Sound in summer (p. 45) argues for an on-and-off rather than a longshore migration, with the deep water off the continental slope as their winter home. This is corroborated by the fact that on February 20 to 21, 1920, the *Albatross* trawled several specimens in depths of 90 and 199 fathoms along the continental edge off Chincoteague, Va., and off Delaware Bay. Also, they are usually so thin when they appear in spring that they can feed but little during the winter. In short, evidence is gradually accumulating to the effect that the seasonal movements of the spiny dogfish parallel those of the mackerel (p. 191).

It is generally believed that dogfish not only summer more regularly in the region of Massachusetts Bay now than of old, but that they are far more numerous there than during the first half of the past century. At Woods Hole, on the contrary, they and the smooth dogfish were much more plentiful before 1887 than at any time since then. 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, there being no general alteration of the stock, but the many fishermen who reported to the Massachusetts Commissioners in 1905 were so unanimously of the opinion that dogfish had multiplied steadily for 20 to 30 years past as to point unmistakably to the conclusion that the species as a whole was then in one of the periodic upswings characteristic of various other fishes. Reports from British coasts are to the same effect. Perhaps the years 1904–5 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 in previous years, and since that time less complaint has been made of them, though it is too soon to say whether a general diminution of the stock is actually in progress.

Much has been written of the habits of the spiny dogfish, all to the effect that it has 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, of medium-sized fish (either mature males or immature females), or of small immature fish of both sexes in about equal numbers.[36]

Apart from its general seasonal migratory movements, the dogfish are governed by the movements of the fishes on which they prey and in pursuit of which they roam about, striking in here and there in multitudes. 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 to-day he may catch only dogfish to-morrow 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*).[37]

Strong, swift-swimming, 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 the sight of packs of dogs dashing among schools of mackerel, and even attacking them within the seines, biting through the net, ruining the gear, and releasing such of the catch as escapes them. Often, too, they bite groundfish from the hooks of long lines, take the baits and make it vain to fish where they abound. In Massachusetts and Ipswich Bays,

[36] Ford (Journal of the Marine Biological Association of the United Kingdom, new series, Vol. XII, No. 3, Sept., 1921, pp. 468–505, Plymouth, England) has recently published very interesting notes on this and other phases of the life-history of the spiny dogfish, with a summary of the earlier statements as to the breeding season.

[37] Dale (Philosophical Transactions, Royal Society of London, series B, Vol, 212, 1923, p. 27) describes the spines and gives clinical records of the effects of wounds inflicted by them.

indeed, as well as about the Isles of Shoals, hook-and-line fishing is often actually prevented during the period of summer plenty unless cockles be used for bait, for dogfish do not take these. When schools of dogfish rush headlong into net or seine, as often happens, they so snarl the twines that disentanglement and repair may be the work of days, and it has been estimated that they do no less than $400,000 worth of damage annually to fishing gear and to fish caught by such gear off the Massachusetts coast alone—probably no less along the shores of Maine, so that in the aggregate they are a heavy debit in the economic scale. Rumor has it, even, that packs of dogfish have been known to attack swimmers and literally bite them to pieces, but we can not vouch for this. 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, prawns, and crabs, and when they first arrive at Woods Hole from the south in May they are often found full of Ctenophores, being one of the few fish that eat these watery organisms. It would be pure guesswork to attempt to estimate the actual numerical strength of the dogfish, but they must be plentiful, indeed, when they can often be caught as fast as they can be hauled in, when line trawls with 1,500 hooks have brought in a dogfish on nearly every hook, and when as many as 20,000 have been recorded in a single draught of a seine in British waters.

Breeding habits.—From time immemorial fishermen have known that the spiny dogfish is viviparous. Aristotle, indeed, describes its manner of bearing young. The eggs are large, well stored with yolk, and during early stages of development those in each oviduct (the so-called "uterus") are contained in a horny capsule that later breaks down, leaving the embryos lying free in the "uterus" with which they have no placental attachment. Ford's studies, mentioned above, suggest about 10 to 11 months as the period from fertilization to birth, which takes place when the young are 9 to 12 inches (23 to 31 cm.) long, and as they are then practically of adult form with the yolk almost wholly absorbed, strong and active, their chance of survival is excellent. Ordinarily a female has 3 or 4 young to a litter—sometimes as few as 1 or as many as 8 to 11—and while the embryos are developing in the uteri a fresh set of ovarian eggs is growing, ready to take their place. It has often been suggested that the dogfish may give birth to 2 or 3 litters—that is, upwards of 20 pups—annually, but if Ford's estimate of the duration of gestation is correct one litter per year would be the rule. Statements as to the season at which the young are born are conflicting. At Plymouth, England, this takes place from January until March, according to Garstang; from August until December, according to Ford. This, of course, suggests two distinct breeding seasons, and we believe that, similarly, among the dogfish that visit the Gulf of Maine some females give birth to their young in late autumn, others in late winter or early spring. For the evidence on which we base this view we are indebted to Dr. H. V. Neal, whose acquaintance with dogfish on the Maine coast is very intimate. It has long been known that when the dogs first appear on the Massachusetts coast in May or June many of the females contain embryos

of some size, which, as Doctor Neal tells us, grow to 4 to 7 inches in length by July. However, during this same month other females caught along the coast of Maine are found to contain embryos in very early stages of development, from the formation of the germ ring to a length of about 4 mm. By September the embryos of the older generation range from 7 to 11 inches in length, some of them being almost ready to be born, while those of the younger generation (any given female contains only embryos of one or of the other generation, never of both) have grown to an average of about 17 mm. Probably the older generation is born in October and November, while the younger one winters in the uterus of the mother, to be born in spring. Fall-bearing females are then fertilized again, the development of the next set of eggs commencing in the early winter, while spring-bearers are fertilized in early summer, which corroborates 11 months as the known period of gestation (p. 49). This would also explain the fact that dogfish smaller than a foot in length are never reported in the Gulf of Maine, for the young are produced during the season when there are very few dogs on this coast, these few probably being immature. In short, the inner parts of the Gulf of Maine probably do not serve as a nursery for the dogfish, plentiful though this fish is there in summer, but the young are born somewhere offshore and probably while the parents are in deep water. It seems, however, that this seasonal schedule does not apply west of Cape Cod, for Latham[38] records a great abundance of very young ones taken in the traps in Long Island Sound in August, showing that one generation is produced there in midsummer. Dogfish only 1 foot long, hence new born, have been found in the stomach of a goosefish at Woods Hole in July (p. 527).

Commercial value.—With the dogfish so destructive to fish and to gear, and with so many of them caught both by lines and by otter trawls during more than half the year, it is no wonder that serious efforts have been made to utilize them on a large scale—to make them marketable and a source of revenue instead of a dead loss. Since this matter has been the subject of discussion elsewhere we need point out only that the dog is a far better food fish when fresh than is generally appreciated, and that it would offer a tremendous supply of cheap food were a satisfactory method of canning it to be worked out. Dogfish have also been used in the manufacture of fertilizer, and enough dogfish livers are brought into New England fishing ports to yield almost 10,000 gallons of oil annually, which is combined and sold with cod-liver oil. Up to the present, however, dogfish have not been of sufficient value to compensate for a hundredth part of the damage they do and most of those caught are thrown back into the sea.[39]

[38] Copeia, Oct. 15, 1921, No. 99, p. 72.

[39] For further discussion of the damage done by dogfish and of their commercial possibilities, see the following: "Report upon the damage done by dogfish in the fisheries of Massachusetts," Annual Report, Commissioners of Fisheries and Game [of Massachusetts] for 1905 (1906), pp. 97-169; "Aquatic products in arts and industries," by Charles H. Stevenson. Report of the Commissioner, U. S. Commission of Fish and Fisheries, Part XXVIII, 1902 (1904), pp. 228-229; Field, 1907, pp. 12-18, 40-49; "Sea mussels and dogfish as food," by Irving A. Field. Proceedings of the Fourth International Fishery Congress. *In* Bulletin, U. S. Bureau of Fisheries, Vol. XXVIII. 1908 (1910), pp. 243-257; and Mavor, 1921, pp. 125-135.

16. **Portuguese shark** (*Centroscymnus cœlolepis* Bocage and Capello)

Jordan and Evermann, 1896–1900, p. 55.
Garman, 1913, p. 204.

Description.—This shark can easily be identified by the fact that while its general appearance—particularly the absence of anal fin, the situation of the ventrals 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 is smaller than in any of our sharks except the "Greenland," the second is about as high as the first, and the ventrals are larger than either. The tail is notably short and broad and its upper lobe is notched. The teeth are very different in the two jaws—narrow, pointed, and of the seizing type in the upper; broader, oblong, with a notch on one side near the tip, and forming a cutting edge in the lower.

Size.—Adults run from 3 to 4 feet long, as they are caught. Garman records one 44 inches long off the coast of New England, but 10 inches is the smallest we find mentioned.

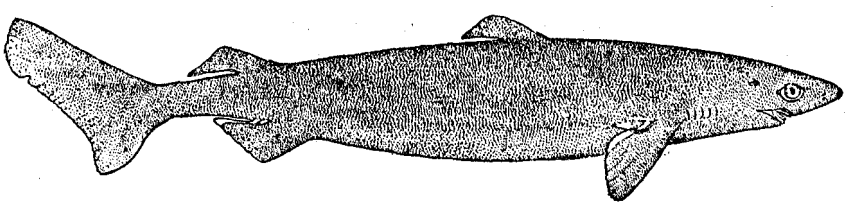

FIG. 18.—Portuguese shark (*Centroscymnus cœlolepis*). After Garman

Color.—Described as deep chestnut brown on the belly, as well as the back.

General range.—This rare deep-water shark, originally known from off Portugal, has since been taken at various other localities.[40] Its claim to mention here rests on the fact that it was once reported off Gloucester; on the specimen "taken off the coast of New England," just mentioned; and on Goode and Bean's (1896) statement that it is abundant on the slopes of our offshore banks at 200 fathoms and more.

Habits.—Little is known of its habits beyond the fact that it is a deep-water species regularly caught by Portuguese fishermen with hand lines, a fishery that Wright (Annals and Magazine of Natural History, series 4, Vol. II, 1868, p. 426) describes 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 cœlolepis* Bocage and Capello. These sharks, as they were hauled into the boat, fell down into it like so many dead pigs.

This species is viviparous, 13 to 16 young having been found in females caught off Portugal.

[40] Known from Portugal, the Mediterranean, Madeira, Japan, the Faroes, and recently reported from Iceland by Sæmundsson (Videnskabelige Meddelelser fra Dansk naturhistorisk Forening i Kjøbenhaven [Copenhagen], Bind 74, 1922, p. 167).

17. **Black dogfish** (*Centroscyllium fabricii* Reinhardt)

Jordan and Evermann, 1896–1900, p. 56.
Garman, 1913, p. 231.

Description.—As pointed out elsewhere (p. 44), the notched margin of the upper tail lobe distinguishes this rare shark at a glance from the spiny dogfish, with which it agrees in the possession of a long pointed spine at the front edge of each dorsal fin, the second being longer than the first. It differs further in that its dorsal spines are deeply grooved on each side, whereas in the "dog" they are rounded; in the location of the ventral fins, the rear axils of which stand almost directly under the front origin of the second dorsal instead of some distance in front of it; in its small pectorals of rounded outline; in the structure of its teeth, each of which is tridentate, with sharp points; in its broad rounded snout; and in its very dark color. Like the spiny dogfish, it lacks an anal fin.

Size.—The specimens so far described have ranged from 2½ 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.

General range.—Positive records for this shark are from Greenland, Iceland,[41] rather deep water off the outer banks, Grand to Georges,[42] off the Hebrides and Faroes where two specimens were taken by the Norwegian fisheries steamer *Michael Sars* in 400 to 600 fathoms, and from the North Atlantic (two specimens in the British Museum). But since Tate-Regan [43] thinks a specimen that he examined

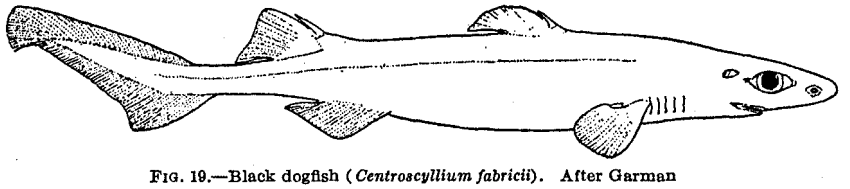

FIG. 19.—Black dogfish (*Centroscyllium fabricii*). After Garman

from the Falkland Islands is identical, while Goode and Bean (1896) tentatively refer to it a young shark from the Gulf of Mexico, and the Japanese *C. ritteri* seems hardly distinguishable, the black dogfish may prove to have a cosmopolitan range in deep waters.

Occurrence in the Gulf of Maine.—Evidently the black dogfish is very rare in the Gulf of Maine, for it has so far been reported there only from Georges Bank, from the slope off Browns in 200 fathoms, and vaguely from off Gloucester, which might mean any of the fishing grounds between Cape Cod and Newfoundland. However, it has been taken repeatedly on the offshore slopes of the Nova Scotian Banks in 200 to 250 fathoms, whence a number were brought into the Bureau of Fisheries by halibut fishermen many years ago.[44] Nothing is known of its habits.

[41] Sæmundsson. Videnskabelige Meddelelser fra Dansk naturhistorisk Forening i Kjøbenhaven, Bind 74, 1922, pp. 159-205.
[42] According to Garman (1913), Greenland to New York.
[43] Annals and Magazine of Natural History, Vol. II, Eighth Series, 1908, p. 49. London.
[44] For list of these specimens see Bean (1881, p. 116).

THE NURSE SHARKS. FAMILY SCYMNORHINIDÆ

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

18. **Greenland shark** (*Somniosus microcephalus* Bloch and Schneider)

NURSE SHARK; SLEEPER SHARK; GURRY SHARK; GROUND SHARK

Jordan and Evermann, 1896–1900, p. 57.
Garman, 1913, p. 241.

Description.—The Greenland shark is notable for its very small dorsal fins, without spines, the second being of about the same size as the first, and for small pectorals hardly larger than the ventrals, coupled with the absence of an anal fin and with a tail of more "fishlike" form than that of most other sharks except the mackerel-shark tribe. Bearing these points in mind, particularly the absence of anal fin and dorsal spines, it can not be confused with any shark common in our Gulf. The location of the first dorsal—about midway between pectorals and ventrals—is the most obvious "field mark" to distinguish it from the rare *Echinorhinus brucus* (p. 55). We may note further that the Greenland shark is compara-

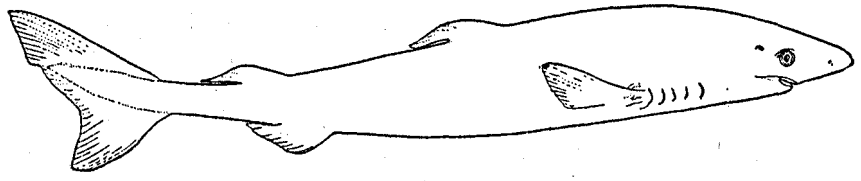

FIG. 20.—Greenland shark (*Somniosus microcephalus*). After Garman

tively stout shouldered, tapering thence toward the tail; that its snout is blunt and rounded as Scoresby [45] represented it a century ago (many more recent figures of it are caricatures in this respect); that the gill openings are short and located low down on the sides of the neck; and that the teeth are unlike in the two jaws, being narrow in the upper, and broad, square tipped, and notched at the outer corners in the lower jaw.

Size.—This is one of the larger sharks. It is said to grow to a maximum length of 24 feet, but few, if any, actually reach such a size, 18 feet being unusual. One 15 feet long has been taken in Cape Cod Bay; another of 13½ feet (now in the Museum of Comparative Zoology) in Massachusetts Bay. Perhaps 8 to 12 feet would be a fair average for adults; nor is this size exceeded often among the hundreds annually caught about Iceland and Greenland.

General range.—Arctic seas; south to Cape Cod in the western North Atlantic, and to France in the eastern North Atlantic; to Oregon in the Pacific. It is the object of a regular fishery in Greenland, Iceland, Norway, and Spitzbergen.

Occurrence in the Gulf of Maine.—Although there is no reason to suppose that the Greenland shark is ever common in our Gulf or appears there other than as a

[45] An account of the Arctic Regions, and of the whale fishery, 1820, Vol. II, Pl. XV, figs. 3 and 4.

straggler from the north, its presence has been signalized on several 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 also been reported off Eastport, 80 miles off Cape Elizabeth, near Cape Ann, off Marblehead and Nahant, in Massachusetts Bay, off Barnstable in Cape Cod Bay (where R. E. Smith killed the fish noted above many years ago), at Provincetown, and in Cape Cod Bay off the entrance to the Cape Cod Canal, where a large one between 10 and 11 feet long was taken by a trawler in April, 1924. Although the localities of capture are so widely scattered, the total number of specimens definitely recorded from the Gulf of Maine is not over a dozen. Of recent years this has certainly been so rare a shark within the limits of the Gulf of Maine that one might fish a lifetime without seeing it, but in old days, when right whales were still plentiful and many of them were killed off the Massachusetts coast, it may well have been more abundant—such, indeed, is the rumor—for in its northern home it is attracted from afar to feed on whale, seal, and narwhal carcasses, from which it gets one of its popular names. When there has been a big killing of narwhals, such as falls to the lot of the Eskimo of Disko Bay at rare intervals, schools of these great carrion eaters may linger in the vicinity for several years.

Food.—This is one of the most sluggish of sharks, offering no resistance whatever when hooked, entirely inoffensive[46] but extremely rapacious, biting on anything in the way of meat, the more putrid and ill-smelling the better. Apart from carrion, which can be available only at rare intervals, it feeds on fish and seals. Cod, ling, and halibut have been found in its stomach, and an entire reindeer has been found in one. The specimen from Cape Cod Bay, mentioned above, contained half a dozen flounders and a large piece bitten out of the side of a seal. It is also known to eat crabs. An old story has it that the Greenland shark attacks live whales, but this is not confirmed by recent observation and is most improbable. Although so sluggish, apparently it is able to catch live seals, for not only have whole ones been found in its stomach, but when sharks gather seals soon become very scarce.

Habits.—The nurse is a bottom swimmer, seldom coming to the surface except in pursuit of the scent of carrion, such as of a whale being cut up. In Icelandic waters it comes up into water as shoal as 40 to 50 fathoms in winter, but in summer descends to 200 or 300 fathoms, lying chiefly on the muddy or clay bottom of troughs or folds in the sea bottom. In the Gulf of Maine, then, it would be more apt to be found in the deep basin than near land.

Breeding habits.—Nothing definite is known of its breeding habits. Its close relative, *Somniosus brevipinna*, of the Mediterranean, the coasts of Portugal, and of Japan, has long been known to be viviparous, and the early belief was that this also applies to the Greenland shark, Faber stating that its young are born in July and August. However, no one has recently reported a fetus in a Greenland shark, and the fact that females often contain great numbers of eggs (up to the size of

[46] 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 about Iceland.

goose eggs) all at about one stage of development,[47] has led to the common belief in Iceland that it is oviparous. For ourselves, it seems so unlikely that, of two sharks closely allied in every way, one should retain the fetuses in the oviducts until they are of considerable size and fully developed, and the other lay eggs, that we incline to the belief that the Greenland shark will also prove to be viviparous.

Commercial importance.—Were the nurse more plentiful in our waters it might be a useful scavenger. Off Iceland it is caught for its liver oil, and in the Arctic the flesh is dried for dog food. It is very interesting to note in passing that while the meat is perfectly wholesome when dried, it produces a sort of intoxicant poisoning when eaten fresh.[48]

THE BRAMBLE SHARKS. FAMILY ECHINORHINIDÆ

The only living representative of this family (it is represented among the tertiary sharks) resembles the nurse-shark family (p. 53) in lacking both anal fin and dorsal spines, but its teeth are alike in the two jaws.

19. **Bramble shark** (*Echinorhinus brucus* Bonnaterre)

Jordan and Evermann (*E. spinosus*), 1896–1900, p. 58.
Garman, 1913, p. 243.

Description.—As pointed out above, the location of the first dorsal fin, above the ventrals instead of about midway between the latter and the pectorals, is

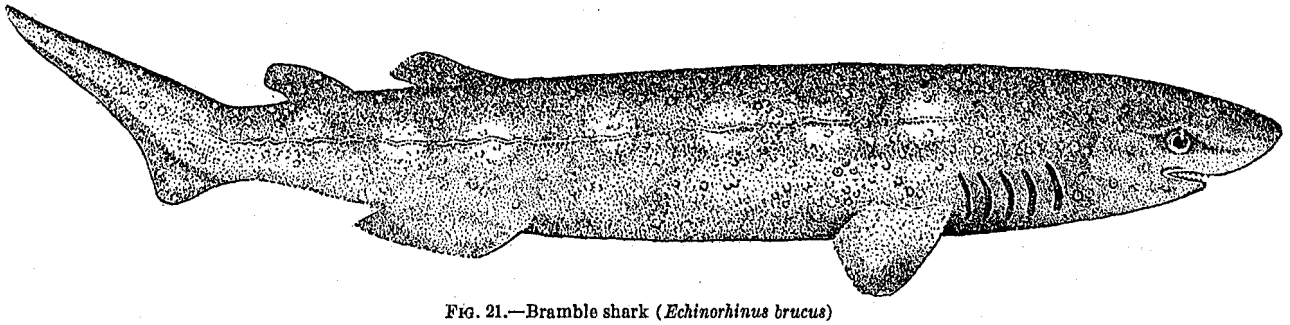

FIG. 21.—Bramble shark (*Echinorhinus brucus*)

the readiest field mark to enable separation of this form from the Greenland shark. *Brucus* also differs from the latter in its more slender form, longer gill slits, and especially in the fact that the teeth are alike instead of unlike in the two jaws.

Size.—The largest (a specimen from British waters) of which we have found a record was 9 feet long, and it has been credited with a weight of 400 pounds.

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[47] Smitt (Scandinavian Fishes, 1892) describes one with "innumerable" small eggs and discusses this question, and Helbing (Nova Acta, Kaiserlichen Leop.-Carol. Deutschen Akademie der Naturforscher, vol 82, 1904) has recently given a good description and figures of fetuses of *Somniosus brevipinna* (as *Læmargus rostratus*), with a discussion of the relationship of this species to the Greenland shark (as *Læmargus borealis*).

[48] This is described by Jensen in "The Selachians of Greenland." Saertryk af Mindeskrift for Jepetus Steenstrup, pp. 12–14, 1914. Translation by A. H. Clark, Science, New Series, Vol. XLI, Jan.-June, 1915, p. 796.

Color.—Described as dark brown above, with or without darker blotches; lower surface lighter to white.

General range.—Formerly thought to be confined to the eastern Atlantic, off the coasts of Europe and north Africa, and to the Mediterranean in rather deep water, this shark has since been recorded from the Cape of Good Hope, the Pacific, and from Australia. Apparently, however, it is rare everywhere, unless it be that the rarity of capture is due to its habit of living at considerable depths.

Occurrence in the Gulf of Maine.—A single specimen of this little known shark came ashore at Provincetown in December, 1878, and this still remains the only record of it from the western Atlantic.

Habits.—Nothing is definitely known of its habits or whether it is a regular inhabitant of the continental slope at and below 200 fathoms, as its wide distribution and proclivity for deep water suggests.

SKATES AND RAYS

Skates, with their disklike outlines, thin as a shingle, and their long tails, are familiar objects along our shores. The Gulf of Maine supports four species in great abundance, while several others have been recorded on rare occasions. So far as the local fauna is concerned, this tribe falls into three groups—first, the skates (family Rajidæ) with comparatively short tails and without spines; second, the sting rays (families Dasybatidæ and Myliobatidæ) with long whiplike tails armed with stiff spines; and third, the torpedo (family Narcaciontidæ), interesting because provided with electric organs capable of giving a strong shock. All our common species belong to the first group.

Among skates and rays, as among sharks, fertilization is internal and the modification of the posterior edges of the ventral fins into rodlike semitubular claspers—the copulatory organs—distinguishes males from females at a glance. Some families are viviparous; others lay eggs.

The common skates look so much alike that fishermen seldom discriminate between them but speak of them all, large and small, simply as "skates." For this reason we know very little about the individual differences in habits between the several species. All, however, live chiefly on or close to the bottom, moving through the water by undulations of the flexible pectoral fins, steering themselves with the tail. All are decidedly omnivorous, feeding largely on the larger Crustacea—shrimps, crabs, lobsters—as well as on mollusks, worms, etc., and to a greater or less extent on fish. In the Gulf of Maine they are a nuisance, for they bite the hook readily and often are caught in great numbers in otter trawls. To give some idea of their abundance on the offshore banks I may note that the average number of skates (all species together) taken on Georges Bank, per trip of 4 to 7 days, on 25 trips by several trawlers, January to December, 1913, was approximately 800, the largest catch being 4,521 skates, the poorest 82. Whether they are equally abundant on Browns Bank is not clear, for though they are familiar enough there, no statistics as to the actual numbers caught are available. Skates are as plentiful inshore as on the banks, as appears from the following representative catches on long lines:

1. 13 miles from Gloucester, 2,540 baited hooks. Total fish caught, 540; skates, 65; dogfish, 321.

2. 15 miles off Monhegan, June 24–25, 1913. Total fish caught, 5,463; skates, 170.

3. 20 miles east of Cape Cod, November 11, 1913. Total fish caught, 6,532; skates, 202.

4. Jeffreys Ledge, December 11–12, 1913. Total fish caught, 3,996; skates, 62.

Now and then a long line comes in with a skate on almost every hook, but this is unusual. Fishermen report them as present on the inshore as well as the offshore fishing grounds throughout the year.

On our seaboard skates are salable only in special markets and are of so little commercial importance that in 1919, which may serve as a representative year, the total amount brought into the several ports of Maine, New Hampshire, and Massachusetts was only 102,739 pounds, valued at $550. From time to time a few have been utilized as fertilizer. All others caught are thrown overboard.

All our common Gulf of Maine skates are oviparous, laying large eggs with blackish or sea-green leathery shells, roughly oblong in outline with a hollow tendril at each corner by which they cling to seaweeds. The empty egg shells—"mermaids' purses"—are common on our beaches among the flotsam along high-water mark.

While still in the egg the embryos develop temporary external gill filaments from the walls of the gill clefts, but these disappear completely after hatching.

Many years ago Wyman (1867) published some notes on the development of one of our local skates (species not named) and figured the newly hatched young, since which time no attention has been paid to the development or life history of any of the species that occur in the Gulf of Maine. Probably, however, all spawn over a considerable part of the year with an incubation period of from 4 to 8 months, as is true of most of the European skates.[49] The sting rays are viviparous, but it is not likely that any of these strays from the south breed in the Gulf of Maine.

It is easy to tell a skate from a ray (at least among species with which we are concerned) by the presence or absence of a dorsal spine on the tail, while its large caudal fin places the torpedo at a glance, but identification of the several skates is proverbially difficult. In the following key we have endeavored to facilitate it by characters obvious in handling them at sea or on the dock.

KEY TO GULF OF MAINE SKATES AND RAYS

1. No long dorsal spine on the tail 2
   Tail with long dorsal spines (sting rays) 8
2. Two small dorsal fins, but no distinct caudal on the tail (includes all our common skates) .. 3
   There is a large triangular caudal fin as well as the two dorsals on the tail .. Torpedo, p. 68
3. The midline of the back, immediately over the backbone behind the shoulders, does not bear a row of large thorns, though it may be flanked by such 4
   The midline of the back bears a row of large thorns on the rear part of the disk, on the tail, or on both 5

[49] Clark (Journal of the Marine Biological Association of the United Kingdom, New Series, Vol. XII, No. 4, Oct., 1922, p. 629) described the eggs and young fry of several British species.

4. Teeth in about 50 rows; upper surface brown with dark spots..... Little skate, p. 58
   Teeth in about 90 rows; upper surface usually with two large whitish eye spots near the rear angles of the disk [50]..... Spotted skate, p. 60
5. The front angle of the disk is much blunter than a right angle; the whole upper surface of the disk is more or less thorny, with a row of very large thorns along the midline behind the shoulders..... Prickly skate, p. 62
   Front angle of the disk is not blunter than a right angle; smoother species with noticeable thorns only in restricted patches..... 6
6. Front angle roughly a right angle with the snout hardly projecting; with stout thorns on the midline of the disk as well as of the tail..... 7
   Front angle more acute than a right angle, with the blunt tipped snout projecting; no thorns in the midline except on the tail..... Barn-door skate, p. 66
7. Tip of snout blunt; outer corners of disk bluntly angular; thorns large... Brier skate, p. 64
   Tip of snout sharp-pointed; outer corners of disk rounded; thorns small..... Smooth skate, *Raja senta*, p. 65
8. No dorsal fins on tail..... 9
   Tail with a dorsal fin in front of spine..... Cow-nosed ray, p. 72
9. Tail rounded above, without a keel..... Sting ray (*Dasybatus marinus*), p. 70
   Upper side of tail, behind the spine, with a distinct keel.... Sting ray (*D. hastatus*), p. 70

THE SKATES. FAMILY RAJIDÆ

20. Little skate (*Raja erinacea* Mitchill)

COMMON SKATE; BONNET SKATE; SUMMER SKATE; HEDGEHOG SKATE; OLD MAID; TOBACCO BOX

Jordan and Evermann, 1896–1900, p. 68.
Garman, 1913, p. 337.

Description.—The most diagnostic characters are small size, absence of thorns along the midline of the back, and blunt nose. The anterior angle of the disk is blunter than a right angle and the tip of the snout is rounded, with margins bulging opposite the eyes. The teeth are in about 50 rows. Females have thorns scattered all over the upper surface except on the midline back of the shoulder girdle, especially prominent on head, snout, shoulders, and sides of tail. Males are less spiny, but in both sexes the spines on tail, shoulders, and along either side of the back ridge are especially strong. Males have bands of erectile hooks near the outer corners of the pectoral fins, presumably for holding the female. The outer angles of the pectorals are bluntly angular. The two dorsal fins are close together; the tail is about half the total length.

Size.—16 to 20 inches; at the most 2 feet in length. Northern specimens average larger than southern. A specimen 20 inches long is about 12 inches wide.

Color.—Grayish to dark brown, or clouded light and dark brown above, paler at the edges of pectoral fins; usually with many small round darker spots; white or grayish below.

General range.—Coastal waters off the Atlantic coast of America; Nova Scotia and Gulf of St. Lawrence to Virginia.

Occurrence in the Gulf of Maine.—This, the smallest of our skates, is the commonest and the most familiar from its habit of coming up into very shoal water in

[50] When this eye spot is lacking, as sometimes happens, it may be necessary to count the teeth to separate the "spotted" from the "little" skate.

summer and of stranding on the beaches, where dried skate carcasses are often to be seen. It occurs all along the coasts from the Gulf of St. Lawrence and Nova Scotia to Cape Cod, and much farther south. It is very abundant both on the New Brunswick and the Scotian sides of the Bay of Fundy, and is taken everywhere and anywhere along the coasts of Maine and Massachusetts, far more commonly, indeed, than one might suspect from the few definite records that have found their way into scientific literature. To what extent it enters into the skate population of the offshore banks is as yet unknown.

The little skate carries out a more or less definite migration up into shoal water in April and May, where it remains throughout the summer, autumn, and early winter, to return again to somewhat deeper water, say 30 to 50 fathoms, in Decem-

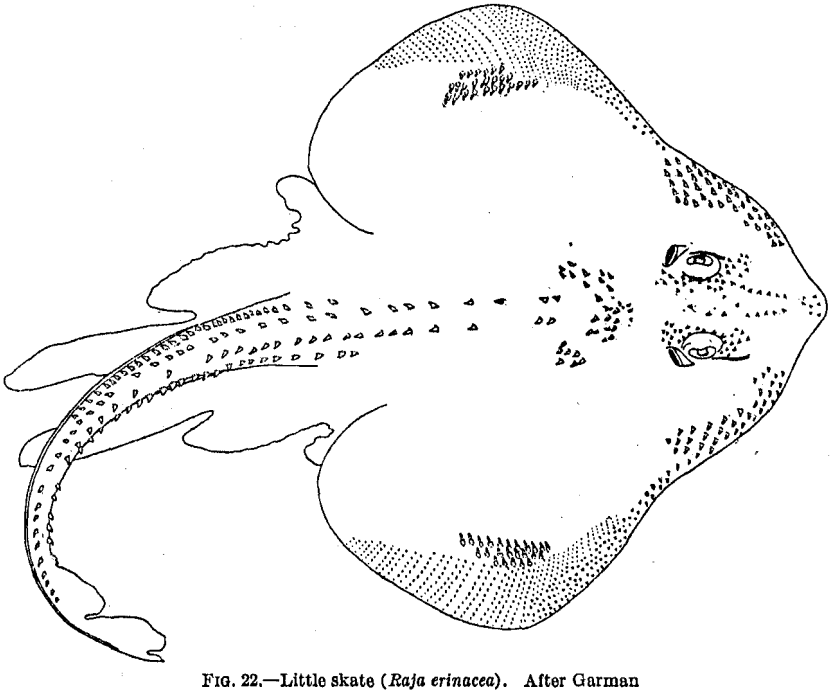

FIG. 22.—Little skate (*Raja erinacea*). After Garman

ber or January. In summer it is perhaps most numerous at depths of from 5 to 15 fathoms, many even following the shelving bottom up to within a few feet of low-water mark. Others, however, lie deeper. It has been trawled at 25 fathoms even in midsummer, for example. On Georges Bank it is probably to be found at 30 to 40 fathoms throughout the year, and there is no reason to suppose that it ever descends to any greater depth than this. It is common knowledge that skates are most abundant on sandy or pebbly bottom; however, they are likewise found on mud and over ledges. They bite the hook readily, affording amusement to vacationists.

Food.—Little skates are omnivorous. Hermit and other crabs, shrimps, worms, amphipods, ascidians ("sea squirts"), bivalve mollusks, squid, small fishes, and even such tiny objects as copepods have been found in their stomachs. Prob-

ably crabs loom largest in their diet, for more than 29 per cent of the skates opened by Field (1907, p. 26) contained them; 15 per cent had bottom-dwelling shrimps (Crago); 6 per cent had eaten squid. Launce, alewives, herring, cunners, silversides, tomcod, silver hake, all have been found in the stomachs of these skates.

Habits.—The spawning habits of the summer skate have not been followed in the Gulf of Maine, but off southern New England its eggs have been taken as early as March and in abundance during July, August, and September, both in fish traps and in dredges in a few fathoms of water. In all probability its breeding covers the same period north of Cape Cod—that is, eggs are laid in spring and early summer, hatching in late summer and autumn. The eggs measure about 2 by 2½

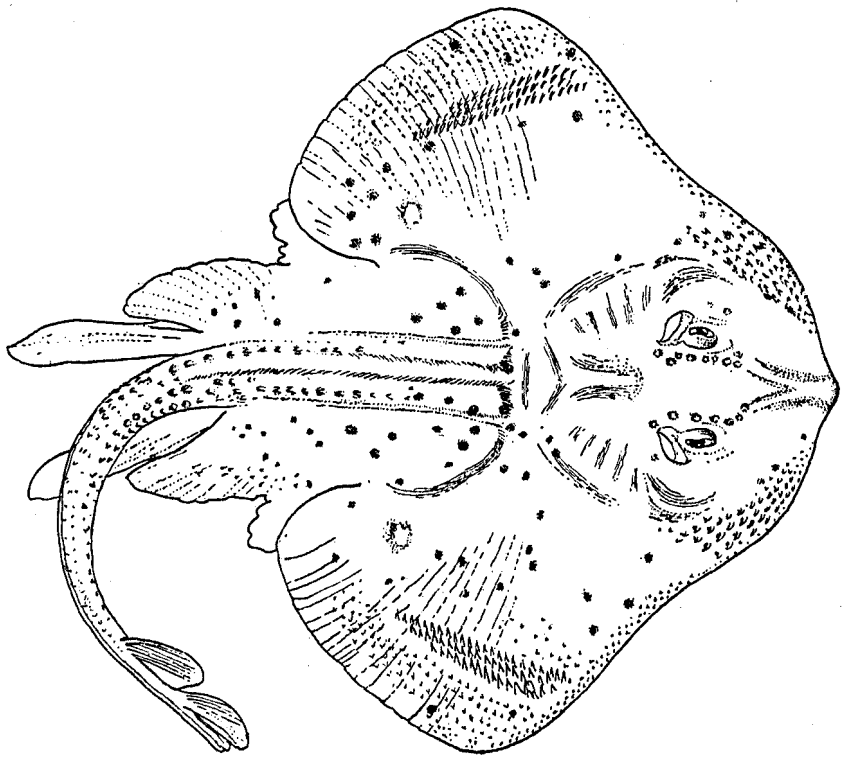

FIG. 23.—Big skate (*Raja diaphanes*). After Garman

inches, and the great majority of the empty skate eggs washed up on the beach belong to this species. Huntsman's observations suggest that young hatched near the head of the Bay of Fundy descend to deeper water the first winter, and this probably applies to the Gulf of Maine as a whole.

21. **Big skate** (*Raja diaphanes* Mitchill)

SPOTTED SKATE; WINTER SKATE; EYED SKATE

Jordan and Evermann (*Raja ocellata* Mitchill), 1896–1900, p. 68.
Garman, 1913, p. 339.

Description.—This skate is much like the little skate, but is larger, has more numerous teeth, and is of a different color. The front angle of the disk is much

blunter than a right angle, bulging opposite the eyes, and the tip of the snout is rounded. The teeth are in from 80 to 110 rows on a jaw instead of in only about 50 rows, as in *erinacea*, and they are sharper in males than in females. The backs of both sexes are rough, with sharp spines on the head, around the eyes, along the anterior margins of the pectorals, over the shoulders, and on the sides of the tail, but the midline of the back behind the shoulders is free of spines, at least in adults. Males have rows of retractile hooks on the outer parts of the pectorals. The two dorsal fins are close together; the outer corners of the pectorals are bluntly angular; the claspers in males reach about halfway back along the tail, which occupies about half the total length of the fish.

Size.—This skate grows to about 3 feet in length, commonly from 30 to 34 inches; specimens 32 inches in length are about 21 inches wide.

Color.—Light brown above with round darker brown spots. As a rule there is a large white eye spot with black center near the posterior angle of the pectoral fin, and often two smaller ones close to the latter. When these eye spots are present they serve to identify this skate at a glance; sometimes, however, they are lacking, in which case half-grown specimens so closely resemble the little skate that recourse must be had to the number of teeth to tell one from the other. There is a translucent or white area on each side of the snout in front of the eyes and the lower surface is white.

General range.—Atlantic coast of North America from New York northward to the Gulf of St. Lawrence, where it is common.

Occurrence in the Gulf of Maine.—This, the second in size of our skates, occurs commonly all around the Gulf of Maine from Nova Scotia to Cape Cod. There are many locality records from the Bay of Fundy as well as from the coasts of Maine and Massachusetts, and it probably makes up a large proportion of the skate population on Georges Bank. It is very plentiful in Massachusetts Bay, but so closely does a two-thirds grown big skate resemble the adult little skate (p. 58) that it is often impossible to tell to which species reports refer. It is said to come up into shoal water on sandy beaches, but we have no first-hand information to offer on this point, and at Woods Hole it is never found in water shoaler than 5 to 6 fathoms. South of Cape Cod the name "winter skate" is appropriate enough, for it is only during the cold season that it is common about Woods Hole. Similarly, it is said to be taken in larger numbers in winter than in summer in the Massachusetts Bay region, though we can not verify this. However, this is distinctly a misnomer in the northern part of the Gulf of Maine, for not only is it abundant in shoal water in the Bay of Fundy (e. g., Passamaquoddy Bay) from May to November, but to judge from temperature this probably applies to the whole coast line east of Cape Elizabeth.

Spotted skates feed on the same diet as do little skates. Rock crabs and squid are their chief diet, but they also take annelids, amphipods, shrimps, and razor clams, and they prey upon whatever small fish are available, the list at Woods Hole including smaller skates, eels, herring, alewives, bluebacks, menhaden, smelt, launce, chub mackerel, butterfish, cunners, sculpins, silver hake, tomcod, and hake.[51]

[51] From Vinal Edwards' and Linton's notes.

This skate is taken on hook and line, in weirs, and in otter trawls. The breeding habits of this species, as they apply to the Gulf of Maine, have not been traced. Its egg cases are little larger than those of the little skates—2½ by 1¾ inches.

22. **Prickly skate** (*Raja scabrata* Garman)

Jordan and Evermann (*Raja radiata* Donovan), 1896–1900, p. 69.
Garman, 1913, p. 340.

Description.—The prickly skate can be identified at a glance, or rather touch, by the fact that the midline of the back behind the shoulders, and of the tail, is armed with a row of very stout thorns. As in the little and spotted skates, the

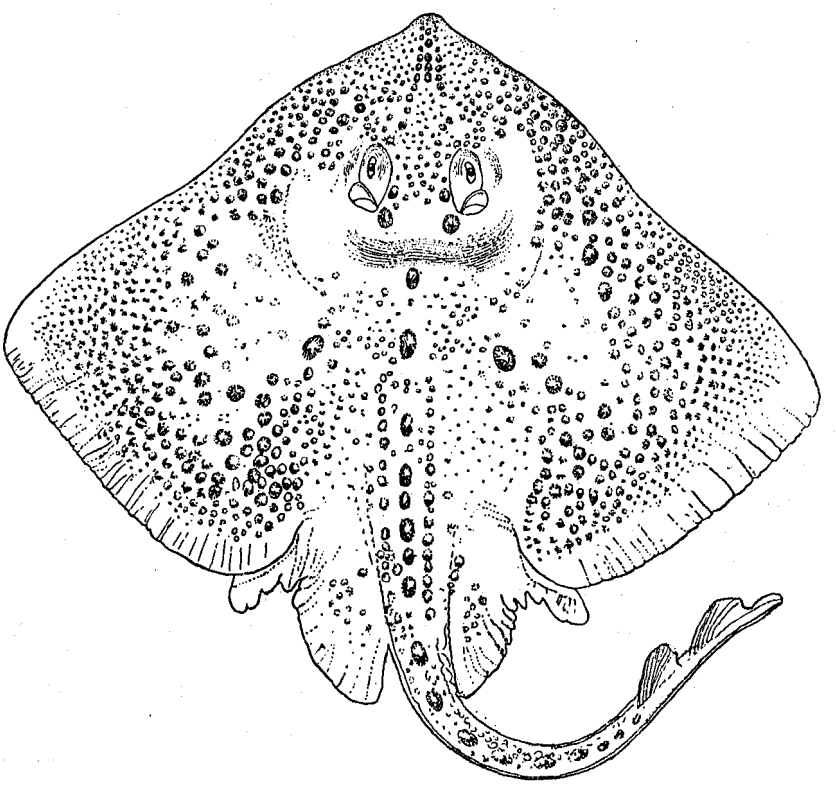

FIG. 24.—Prickly skate (*Raja scabrata*). After Garman

anterior angle of the disk is blunter than a right angle, its margin bulging somewhat abreast of the eyes, and the tip of the snout is blunt. There is a pair of large, hooked tubercles or bucklers on each shoulder, one in front of and one behind each eye, as well as one behind each spiracle, besides the mid-dorsal row of 14 or more just mentioned. Smaller thorns occur on the snout and are scattered generally over the upper surface of the pectoral fins. The bases of the spines on the pectorals are star-shaped, a very diagnostic character; those of the bucklers shieldlike. Males have two rows of hooked, erectile thorns near the outer corners of the pectorals, the latter being more angular than in either the little or spotted skates, while the two

dorsal fins are separated by a definite space in the adult but are confluent in the young.

Size.—This skate grows to 2½ feet in length, or slightly larger; males as small as 26 inches, nearly mature, have been found. Specimens 21 to 22 inches long are 15 to 16 inches wide.

Color.—Brown above, either uniform or slightly clouded with lighter and darker. Young ones are spotted with darker brown, but adults ordinarily lack these spots. Garman (1913, p. 34) mentions a partial albino, white above with a few reddish-brown and brown spots.

General range.—The prickly skate is a northern cold-water fish, its range hardly extending west or south of Cape Cod, for it appears but rarely and at long intervals at Woods Hole, nor is it known south of this. How far north it ranges is yet to be determined. It is plentiful along the east coast of Nova Scotia and in the Gulf of St. Lawrence where it lives indifferently on the ice-cold banks and in the warmer water in the bottom of the deep channels, but it has not been recorded from Labrador north of the Straits of Belle Isle nor so far as we can learn from the eastern shores of Newfoundland. In north European waters it is represented by an extremely closely allied if not identical form (*Raja radiata*), which occurs from the Bay of Biscay in the south to Greenland, Spitzbergen, and the White Sea in the north.

Occurrence in the Gulf of Maine.—The prickly skate is usually thought to be less common on our coast than either of the two species just mentioned, and it is certainly rare in very shallow water within our limits; but it is frequently taken on the New Brunswick side of the Bay of Fundy in depths of 10 fathoms or deeper, in 20 to 30 fathoms in St. Mary Bay (Nova Scotia),[52] while we ourselves trawled it (13 specimens) in 22 and 27 fathoms on sandy bottom in Ipswich Bay in July, 1913. Since it has also been recorded from Casco Bay, Ipswich Bay, Gloucester, Salem, Nahant, and Provincetown, it evidently occurs generally all along the shores of the Gulf in moderate depths. Judging from the considerable depths to which its European relative descends—it has been trawled down to 450 fathoms—skates caught in the deeper parts of the Gulf are more likely to belong to this than to either of the preceding species, and it may be the prevalent skate on the offshore banks. It has not been recorded below about 200 fathoms off our coasts.

Habits.—Nothing is recorded of its habits in the Gulf, nor, so far as we can learn, have its eggs or young ever been definitely recognized there, but probably what is known of the spawning habits of its European representative applies equally here, briefly, that it comes up from deeper water into shoal water in spring to spawn there during the summer, retreating once more to greater depths in winter; that the egg case measures about $2^1/_2$ by $1^3/_5$ inches (exclusive of its tendrils); and that the fry remain near land during their first winter.

Food.—The prickly skate, like most of its relatives, feeds indiscriminately on small fish, amphipods, worms, etc. Such, at least, is true of the European form. So far as we can learn no stomachs have been examined on this side of the Atlantic.

[52] According to Huntsman (1922a).

23. **Brier skate** (*Raja eglanteria* Bosc)

Jordan and Evermann, 1896–1900, p. 71.
Garman, 1913, p. 341.

Description.—The brier, like the prickly skate, is armed with a row of stout thorns along the midline of the back from shoulder to dorsal fin near the tip of tail. Otherwise, however, it is a much smoother species and its snout is more acute. There are groups of large spines opposite and behind the eyes and on the sides of the tail, with a pair on each shoulder. Elsewhere the upper surface of the disk

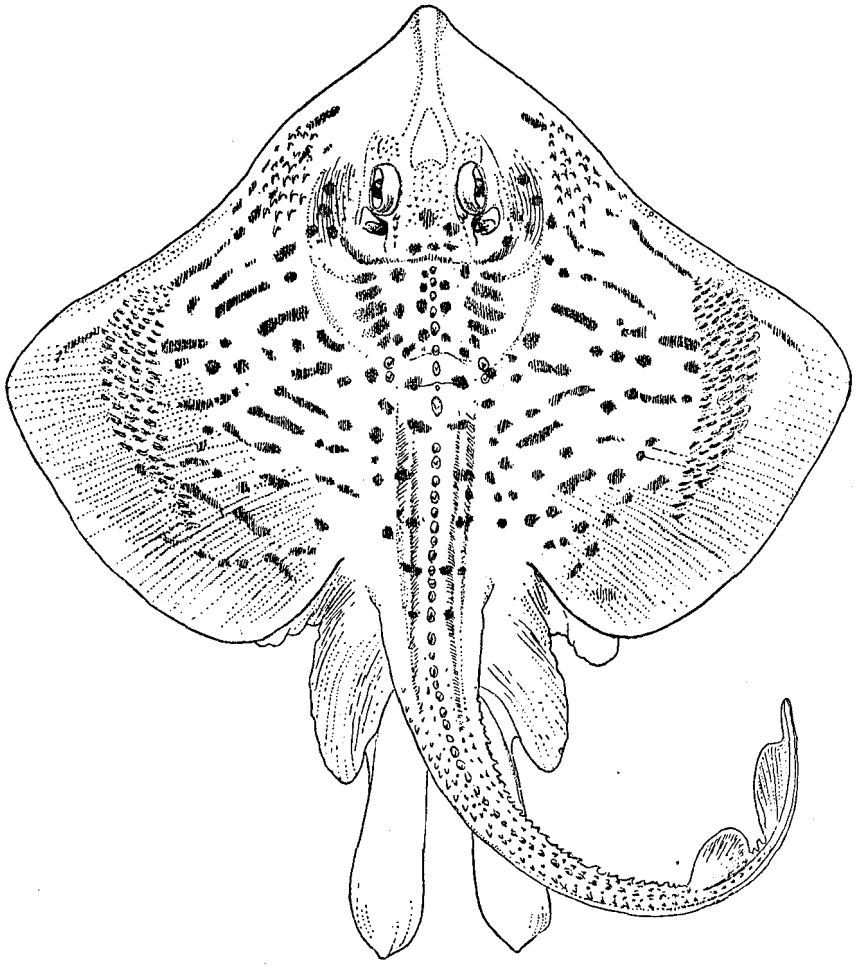

FIG. 25.—Brier skate (*Raja eglanteria*). After Garman

bears only very small but very sharp prickles, these being most numerous on the anterior parts of the pectorals, over the head and snout, and on the middle of the back and tail among the larger thorns, whence its common name. The males, we might add, are provided with several rows of large erectile hooks on the outer parts of the pectorals, which the females lack. The snout angle is roughly a right angle, its margin bulging less opposite the eyes than in any of the blunter-nosed

skates. The outer corners of the pectorals are distinctly angular. The dorsal fins are separated by a considerable interval in which there are usually one or two spines, instead of close together as in the little, spotted, and prickly skates.

Size.—The brier skate grows to a length of about 2 feet. Specimens of from 21 to 22 inches are 13 to 14 inches wide.

Color.—Described as brown above; the pectorals variously mottled, blotched, and barred with darker; a translucent or white space on each side of the snout; white below.

General range.—Off the eastern coast of the United States from Cape Cod to Florida.

Occurrence in the Gulf of Maine.—This is a southern species, uncommon even as far north as Woods Hole and decidedly rare in the Gulf of Maine, where it has been taken only at Provincetown and at Gloucester, the latter its most northerly outpost.

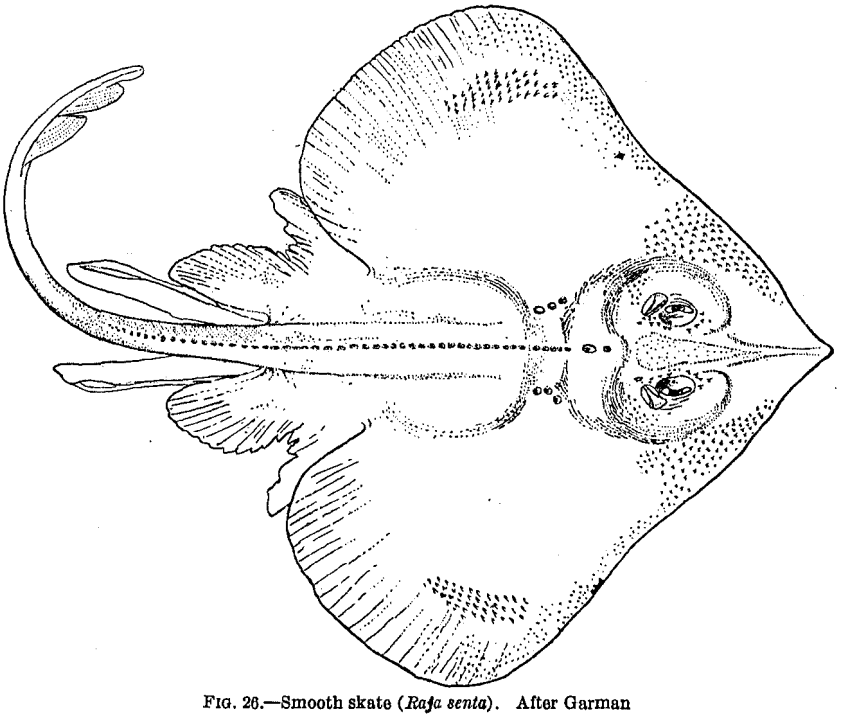

FIG. 26.—Smooth skate (*Raja senta*). After Garman

24. Smooth skate (*Raja senta* Garman)

Jordan and Evermann, 1896–1900, p. 71.
Garman, 1913, p. 338.

Description.—This skate is recognizable by its sharp snout, the rounded outline of the outer margins of the pectoral fins, and by the fact that the mid-dorsal line of thorns runs back only to about the middle of the tail, where it dwindles and disappears. There are also large spines on the front parts of the pectoral fins, on the ridges about the eyes, and a group on each shoulder; otherwise the back and top

of tail are rough with small spines only, except that males have the usual rows of hooks on the outer parts of the pectorals. The anterior snout angle is roughly a right angle; the tip of the snout itself is sharp instead of rounded. The two dorsals are close together, not separated by spines as in the brier skate.

Size.—The largest recorded specimen was 22½ inches long, the tail being almost exactly half the total length. Its width was 14 inches.

Color.—Rusty brown above clouded with darker, not spotted; no doubt white below like other skates. Young examples have been seen with white spots.

General range and occurrence in the Gulf of Maine.—Of the distribution of this skate, evidently very rare in our Gulf, nothing is known further than that specimens have been taken on LaHave Bank and off Provincetown, on the strength of which it has usually been described as "a deep-water form, Banks of Newfoundland Cape Cod." Nothing whatever is known of its habits.

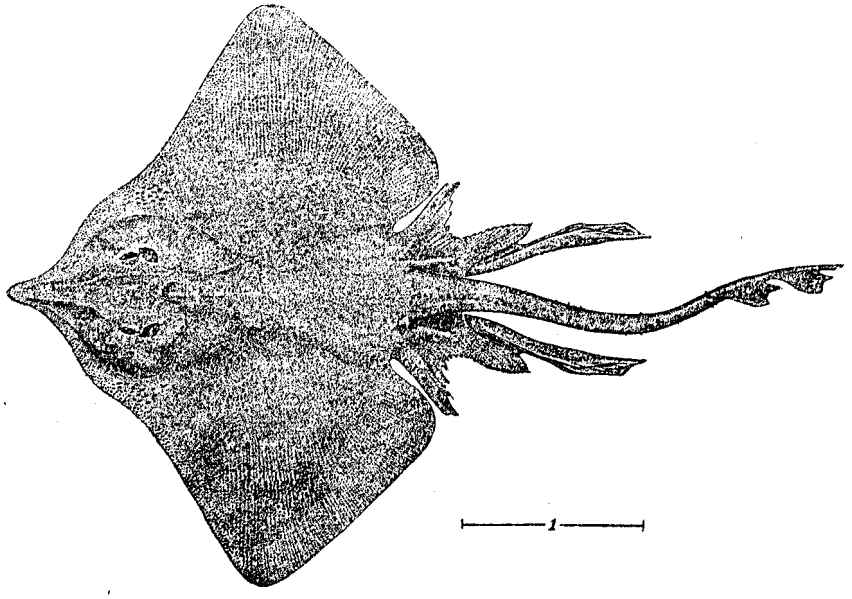

FIG. 27.—Barn-door skate (*Raja stabuliforis*)

25. Barn-door skate (*Raja stabuliforis* Garman)

Jordan and Evermann, 1896–1900 (*Raja lævis* Mitchill), p. 71.
Garman, 1913, p. 341.

Description.—The barn-door skate is easily identified by its large size, very pointed snout, and smooth skin. The mid-dorsal thorns are comparatively small and run only from the hinder part of the back over the tail; otherwise the spines, which are very small, are restricted to the sides of the tail, top of the tip of the snout, and to narrow bands along the front edges of the pectoral fins, in front of and between the eyes, with a few scattered here and there over shoulders and back. Thus the whole upper surface is smoother than in any of the other skates. The male is provided with the erectile hooks on the outer parts of the pectorals common

to all skates of this genus. The anterior angle of the disk is sharper than in other skates, being more acute than a right angle. The snout itself is long but blunt tipped, the outer corners of the pectorals are angular, and the disk as a whole is diamond or lozenge shaped. The two dorsal fins are separated by a short space, with one or more spines, and the tip of the tail extends farther beyond the second dorsal than in most skates.

Size.—The barn-door is our largest skate, growing to a length of 6 feet or even more. One of 58 inches length was 42 inches wide with a tail 27 inches long.[53]

Color.—The barn-door, like so many sea fish, varies in color. As a rule the upper surface is brown, usually of a distinctly reddish hue, variously marked with small scattered darker spots or blotches of varying size, often with pale marblings or waterings. The lower surface is not as uniformly pale as in most skates, its gray or white ground being shaded with darker toward the snout and speckled with black over the abdomen.

General range.—Atlantic coast of North America from the Gulf of St. Lawrence and the outer coast of Nova Scotia, where it is common, to Florida. In European seas it is replaced by a very close ally, the "common skate," *Raja batis.*

Occurrence in the Gulf of Maine.—This is a common fish off the New England coast and in all parts of the Gulf. Any very large skate taken or reported there is almost certain to be a "barn-door." Following the coast around from east to west we find it reported as plentiful off the Nova Scotian shore; it is known from St. Mary Bay; is found very generally though not abundantly in the Bay of Fundy and up in Passamaquoddy Bay; is reported from Eastport, Casco Bay, and generally along the coast of Maine; is known from various localities in Massachusetts Bay, where we have seen many caught; and is taken in abundance by the trawlers on Georges Bank.[54] In short, it is to be expected anywhere in the Gulf. Like most other skates, it is often taken in shoal water in summer; seldom or never in winter. Huntsman tells us that it comes up into Passamaquoddy Bay from May to November. We took one nearly 5 feet long at Cohasset in Massachusetts Bay in only a couple of fathoms of water in midsummer. Indeed, it is often stranded on the beaches. This inshore migration, however, does not involve the entire stock—witness its presence in 20 to 60 fathoms on Georges Bank and off Cape Cod throughout the year and the fact that it is reported by fishermen and has been trawled by vessels of the bureau below 100 fathoms in summer. In the warmer waters off the south coast of New England it comes inshore in spring and autumn, descending to deeper water in summer.

Habits and food.—Barn-door skates, like other skates, are bottom swimmers, preferring smooth to rocky ground, but the fact that the lower surface is more or less pigmented instead of white suggests that it hugs the bottom less closely than do other skates. Garman, the foremost authority on this group, has pointed out that the spines on the snout of this skate are usually worn smooth, as though used to dig in the mud or sand—very likely it thus obtains the bivalves that form part of its diet. It also feeds on worms, various crustaceans, particularly large rock crabs

[53] Described by Garman (1913, p. 342).

and lobsters, on squid, and on fish. Probably, thanks to its large size, it is more destructive to the latter than are any other skates. At Woods Hole the list includes spiny dogfish, alewives, herring, butterfish, launce, cunners, tautog, menhaden, sculpins, silver hake, hake, and flatfish. No doubt cod, haddock, etc., suffer to some extent from this skate on the offshore fishing grounds, for its European relative is a well-known enemy of the cod, and there is no reason to suppose that our "barn-door" is less voracious. It is a strong, active swimmer, as anyone who has landed a large one on a hand line will agree. It bites readily on almost any bait, and is often caught on hand and long lines as well as in the otter trawl and in weirs along shore.

Breeding habits.—Very little is known of its breeding habits. Probably it spawns when in shoal water, that is, during the warm season of the year. Eggs, probably belonging to the barn-door, are 5¼ by 2¾ inches.[55]

Commercial value.—The barn-door skate is of no commercial value except as entering into the small landings of skates mentioned on page 57.

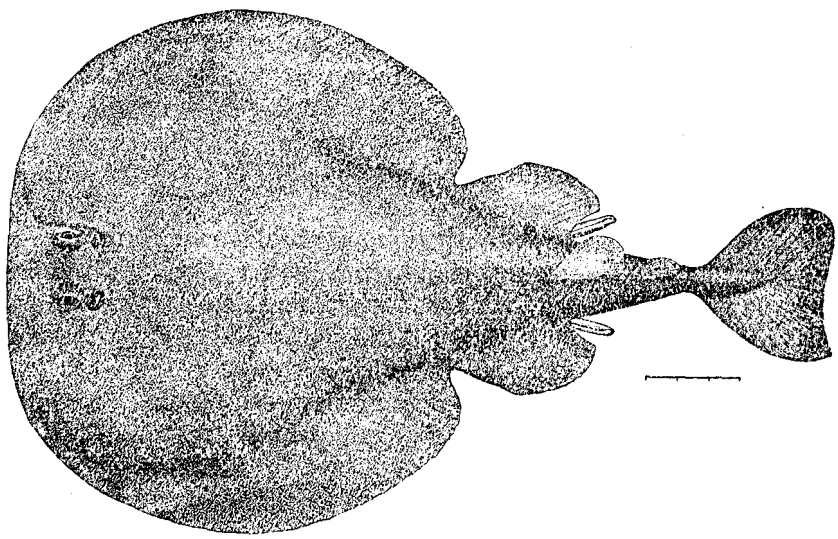

FIG. 28.—Torpedo (*Narcacion nobilianus*)

THE TORPEDOES. FAMILY NARCACIONTIDÆ

26. Torpedo (*Narcacion nobilianus* Bonaparte)

ELECTRIC SKATE; CRAMPFISH; NUMBFISH

Jordan and Evermann (*Tetranarce occidentalis* Storer), 1896–1900, p. 77.
Garman, 1913, p. 310.

Description.—No one would be apt to mistake the torpedo for any other skate or ray, the rounded outline of the disk and the large caudal fin identifying it at a glance. Furthermore, the skin is soft and naked, without the spines so characteristic of all our common skates. The disk is roughly subcircular, truncate in front, and considerably broader than long. The eyes are very small and are set far for-

[55] Doctor Garman supplied this note.

ward. The two dorsal fins, of which the anterior is the taller, stand at the forward end of the tail, the anterior, indeed, partly above the bases of the ventral fins, and they are separated by an interspace nearly as long as the second dorsal fin. The tail fin is of ordinary fish form—triangular and about three-quarters as long as deep. The tail is shorter than in the skates—that is, it occupies only about one-third the total length of the fish. The most interesting feature of the torpedo is its electric organ and its ability to give electric shocks of considerable strength to anyone touching it.

Color.—Dark chocolate brown above; lower surface white except that the edges of disk, fins, and tail are of the same dark chocolate tint.

Size.—Adult torpedoes are usually 2 to 5 feet long and heavy for their size. Specimens taken at Woods Hole average about 30 pounds, ranging from 4 or 5 up to 75 pounds. Torpedoes as heavy as 200 pounds have been recorded, and they have been taken up to 170 pounds or more in Massachusetts Bay.

General range.—Tropical and temperate parts of both sides of the Atlantic; Maine to Cuba on the American coast.

Occurrence in the Gulf of Maine.—The torpedo is a southern fish, which, like so many others, finds the northerly limit to its common occurrence at Cape Cod. It strays past the cape into the Gulf of Maine often enough, however, to be looked upon as a regular, if rare, summer visitor. It has been recorded even as far east as Eastport (not, however, in the Bay of Fundy), as well as at various other localities along the coast of Maine (e. g., Williamsport, off Seguin Island, and Casco Bay); likewise at Cape Ann, in Cape Cod Bay, near Provincetown, and along the outer shores of Cape Cod, so it would be no surprise to find it anywhere along our shores. It has also been reported from Georges Bank. Most of the records date back many years. It is said to have been unusually common in the year 1819 and for four or five years thereafter. Again in 1845 about a dozen came ashore or were otherwise taken near Provincetown. It is as apt to be found in our Gulf now as then, for one was seined off Seguin in about 1880, another was caught on a long line set from the *Grampus* on LaHave Bank in the summer of 1890, one was taken in a trap at Wood Island near Cape Elizabeth in 1894, and torpedoes were collected by Dr. W. C. Kendall of the Bureau of Fisheries at several localities along the coast of Maine in 1896. West of Cape Cod it is much more numerous, appearing not uncommonly from May to November about Woods Hole.

Breeding and habits.—The torpedo, like others of its tribe, is a bottom fish. It feeds chiefly on small fish and to some extent on Crustacea. Probably it does not succeed in breeding in the cold waters of the Gulf, but at Woods Hole it has been found to contain nearly ripe eggs by the end of June. It is viviparous, the embryos having been figured by Garman (1913, pl. 61).

Commercial value.—Nowadays the torpedo is of no commercial value, but years ago before the use of kerosene oil was general its liver oil was considered equal to the best sperm for illuminating purposes.

THE STING RAYS. FAMILIES DASYBATIDÆ AND MYLIOBATIDÆ

27. Sting ray (*Dasybatus marinus* Klein)

STINGAREE; CLAM CRACKER

Jordan and Evermann (*Dasyatis centrura* Mitchill), 1896–1900, p. 83.
Garman, 1913, p. 382.

Description.—The most characteristic features of the sting ray are the very long whiplike tail without dorsal fins and the strong saw-toothed spines that the tail bears on its dorsal surface. The disk is roughly quadrangular, one-fourth wider than long, with the anterior corner much blunter than a right angle, the anterior and posterior margins nearly straight, and the lateral corners bluntly angular. The ventral fins are relatively much shorter than in the common skates. The tail is more than twice as long as the disk, rounded above and tapering regularly to a very narrow tip. The spines, of which there are from one to several,[56] are situated about one-fifth of the way back along the tail. Young sting rays are smooth-skinned, but adults bear scattered tubercles on the middle and hind parts of the back and on the back and sides of the tail, which become more and more numerous as the ray grows.

Size.—Maximum length, including the tail, about 12 feet.

Color.—The general ground tint varies according to the background.

General range.—Both sides of the tropical and temperate Atlantic, north on the American coast to Cape Cod, and (according to Smith [57]) not known south of Cape Hatteras.

Occurrence in the Gulf of Maine.—The only claim of the sting ray to mention here is that it has been recorded from Chatham, on the outer shore of Cape Cod, and that it is said to have been seen on the shoaler parts of Georges Bank. It has no real status as a Gulf of Maine fish, where it appears only as a waif from the south, though common enough as far east as Woods Hole, where it appears in June or early July. Beware of handling any skate with a long whiplike tail lest it prove a sting ray, for its spine is a dangerous weapon.

Breeding habits.—The sting rays are viviparous.

28. Sting ray (*Dasybatus hastatus* DeKay)

Jordan and Evermann (*Dasyatis hastata* DeKay), 1896–1900, p. 83.
Garman, 1913, p. 391.

Description.—This ray so closely resembles *D. marinus* that we need only point out that the tail bears a low keel on its dorsal surface behind the spines instead of being rounded above as in its relative.

General range.—Atlantic coast of America, Cape Cod to Brazil.

Occurrence in the Gulf of Maine.—This southern sting ray is mentioned here because recorded many years ago from Chatham on Cape Cod.

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[56] There are three in a specimen figured by Garman and two in one we have examined.

[57] The fishes of North Carolina, by Hugh M. Smith. North Carolina Geological and Economic Survey, Vol. II, 1907, p. 44.

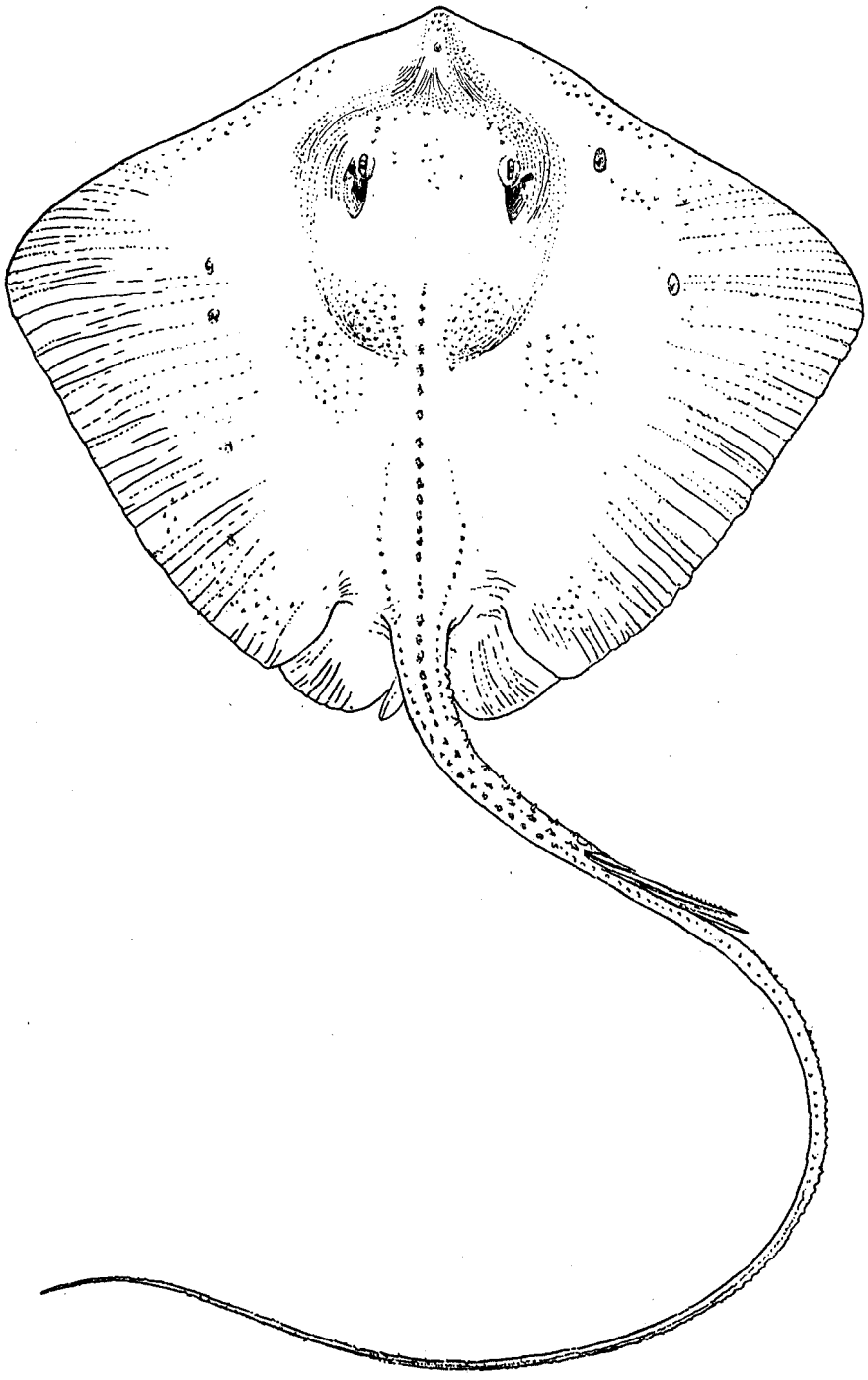

FIG. 20.—Sting ray (*Dasybatus marinus*). After Garman

29. Cow-nosed ray (*Rhinoptera quadriloba* LeSueur)

Jordan and Evermann (*Rhinoptera bonasus* Mitchill), 1896–1900, p. 90.
Garman, 1913, p. 444.

Description.—The cow-nosed ray and all its close relatives are of such characteristic batlike outline, with head so peculiar and teeth so different from those of our other Gulf of Maine skates and rays, that once seen they are never apt to be mistaken for anything else. The anterior angle of the disk is much blunter than a right angle; the outer corners of the pectorals are acute, pointed, and their posterior margins distinctly concave. The ventral fins are comparatively very small, longer than wide, reaching but a short distance back of the posterior corner of the pectorals. There is a single small dorsal fin originating a short distance back of the bases of the ventrals, and immediately back of it stands a stout spine. The tail is hardly twice as long as the disk, whiplike and tapering to a very slender tip. The cranium

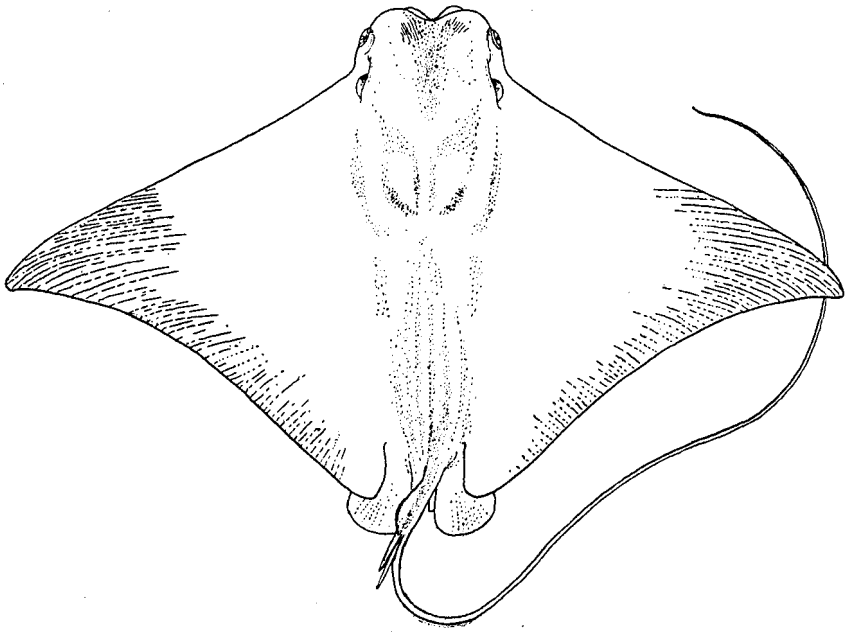

FIG. 30.—Cow-nosed ray (*Rhinoptera quadriloba*). After Garman

of the cow-nosed ray is raised above the general level of the disk with the large eyes set lateral instead of dorsal, and in front of the fins instead of far back as in other skates and rays. Its teeth are flat and arranged like the bricks or tiles in a pavement in a manner more easily figured than described.

Size.—The cow-nosed ray grows to a length of about 7 feet. In one about 33½ inches in total length the disk was 25 inches long by 32½ inches broad.[58]

Color.—Brown above; white below, except toward the outer corners of the pectoral fins where it is brownish.

General range.—Atlantic coast of the United States, Nantucket to Florida.

[58] Described by Radcliffe (Bulletin, U. S. Bureau of Fisheries, Vol. XXXIV, 1914 (1916), p. 279).

Occurrence in the Gulf of Maine.—The cow-nosed ray has even less claim to be called a Gulf of Maine fish than have the sting rays just mentioned, for while it is often taken in the traps at Woods Hole—145 in one day on one occasion—and is recorded from Nantucket, it has never actually been seen east or north of Cape Cod.

Chimæroids. Subclass Holocephali

THE CHIMÆRAS. FAMILY CHIMÆRIDÆ

The chimæras find their nearest affinities in the sharks but are separated from the latter by many important anatomic characters, the most obvious of which are the facts that there is no spiracle, there is but one gill opening on either side, the tail is symmetrical, and the gills are fringelike and free at the tips like those of bony fishes. In general aspect the chimæras remotely suggest the grenadiers (p. 467), but are easily separable from them by the location of the ventral fins, which are set far back under or behind the tips of the pectorals; by the fact that the fin on the back is separated by a deep notch into dorsal and caudal portions; by the very small eye; and by the large size of the pectoral fins, to list only the most obvious differences. There is no danger of confusing them with any other Gulf of Maine fishes, so curious is their appearance.

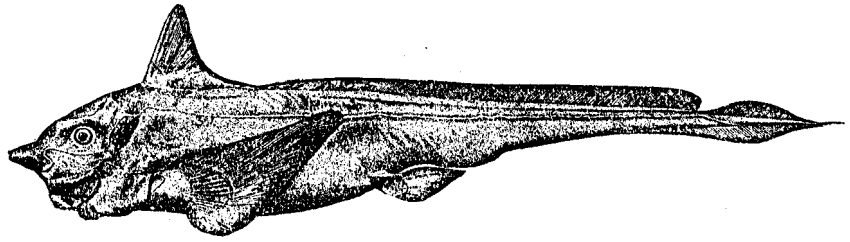

FIG. 31.—Chimæra (*Chimæra affinis*)

30. Chimæra. (*Chimæra affinis* Capello)

Jordan and Evermann, 1896–1900, p. 95.

Description.—The chimæra is deepest (one-seventh to one-eighth as deep as long) just behind the gills, tapering gradually backward to a weak slender tail, and is very soft bodied. The head is short, its dorsal profile oblique and prolonged into a short, soft, conical knob above the mouth. The forehead of the male bears a curious cartilaginous hook, armed with recurved prickles on its lower surface, which probably serve to clasp the female. The mouth is inferior in position, relatively small, the upper jaw with four, the lower with two, flat plates, set edgewise, in place of teeth, and with thick fleshy lips. The gill openings are vertical, set low down on the sides of the neck, and each is covered with a flap of skin paralleling the gill covers of bony fishes.

There are two distinct dorsal fins. The first of these originates over the gill opening, is triangular, about as high as long, and supported at its anterior margin by a stout spine that is free at the tip. The second dorsal is separated from the first by a space that probably varies in length, and is less than half as high as the