

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

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

*General range.*—Eastern Atlantic (including the Mediterranean) from tropical West Africa to

Ireland and the North Sea, and accidental in the western Atlantic; represented in South Africa; off California; in the Hawaiian, Japanese, and Australo-New Zealand regions, and in Arabian waters by forms that probably cannot be distinguished from *brucus* of the Atlantic.

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

### Torpedoes, Skates, and Rays. Order Batoidei

This tribe falls into four groups, so far as the Gulf of Maine fauna is concerned: first, the torpedoes (family Torpedinidae), with large caudal fin, interesting because provided with electric organs capable of giving a strong shock; second, the skates (family Rajidae), with very thin bodies, comparatively short tails without tail spines, and only a trace of caudal fin; third, the sting rays (families Dasyatidae and Rhinopteridae), with long whiplike tails armed with a stiff saw-edged spine (or spines); and fourth, the devil rays

(Mobulidae) with two ear-like fins extending forward from the front of the head. Most of our common species belong to the second group.

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

<sup>55</sup> Berg, Com. Ictiol. Comm. Mus. Nac. Buenos Aires, vol. 1, No. 1, 1898, p. 10.

<sup>54</sup> Cornish, Zoologist, Ser. 2, vol. 10, 1875, p. 4501.

### KEY TO GULF OF MAINE SKATES AND RAYS

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

9. There is only one row of large thorns along the midzone of the disc from the nape to the level of the axils of the pectoral fins; the first and second dorsal fins are separated by a definite space or at least by 1 or 2 thorns; the forward angle of the disc is less than  $110^\circ$ ; the upper surface of the disc is marked with short dark bars as well as with roundish spots..... Brier skate, p. 65
- There are at least three rows of thorns along the midzone of the disc from the nape to the level of the axils of the pectoral fins; the first and second dorsal fins are not separated by a definite interspace or by a thorn or thorns; the forward angle of the disc is more than  $125^\circ$ ; the upper surface is not marked with dark bars though it is variously spotted..... 10
10. Upper teeth in at least 72 series, most often 90-100; does not mature sexually until at least 26 inches long. Big skate, p. 63
- Upper teeth in not more than 66 series and usually less than 54; matures when only 18-20 inches long. Little skate, p. 67
11. There is a small dorsal fin on the upper side of the tail, in front of the spine (or spines); the crown of the head is high-domed, with the eyes and spiracles on the sides; there are only 7-9 series of teeth in the form of large flat grinding plates..... Cow nosed ray, p. 76
- There is no dorsal fin on the tail; the crown is low, flat, and with the eyes and spiracles on the upper surface; the teeth are in many series, in mosaic arrangement..... Sting ray, p. 74

### THE TORPEDOES OR ELECTRIC RAYS. FAMILY TORPEDINIDAE

The trunk of the electric rays has the form of a flattened, roundish or oval disc, fleshier toward the margins than it is in other Gulf of Maine skates or rays, and the body is softer. The tail, too, is broader and shorter; there are one or two relatively larger dorsal fins on the tail, and the latter ends in a well-developed caudal fin also.

The most interesting feature of the electric rays is that they have two large electric organs, each of which occupies one side of the front part of the

disc. In the only Gulf of Maine species the two organs together make up about one-sixth of the total weight of the fish.

#### *Torpedo Torpedo nobiliana* Bonaparte 1835

#### ELECTRIC RAY; NUMBFISH, CRAMPFISH

Bigelow and Schroeder, 1953, p. 96.

Garman, 1913, pl. 25, fig. 2, as *Narcacion nobilianus*.

*Description*.—No one would be apt to mistake a

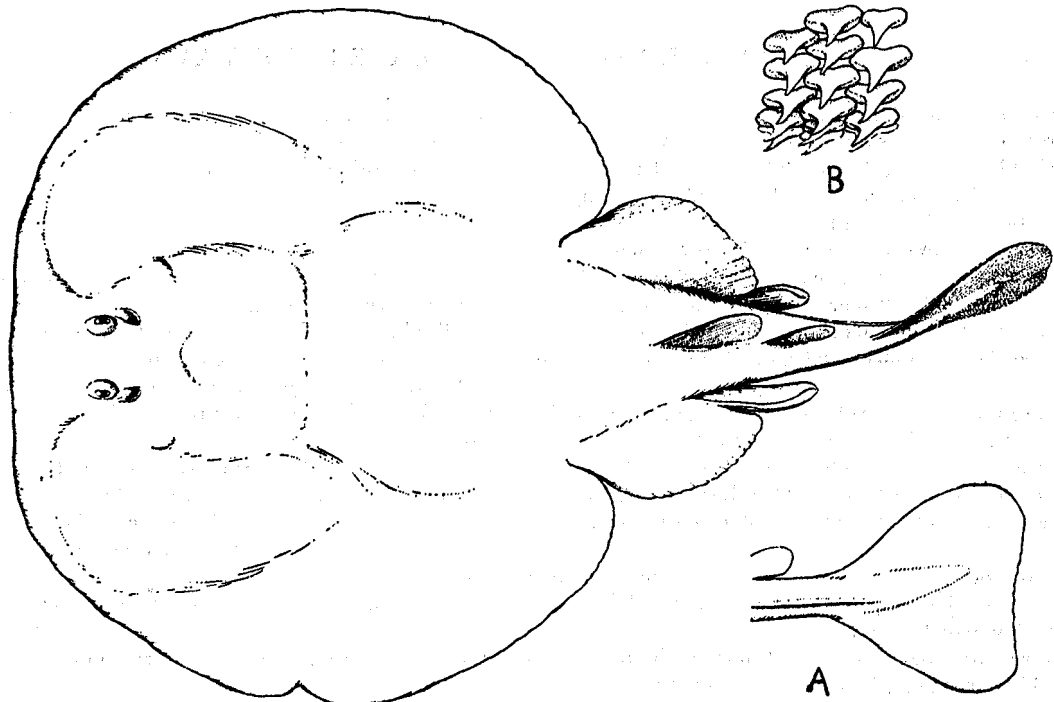


FIGURE 24.—*Torpedo (Torpedo nobiliana)*, male, about 33 inches long, off Plymouth, Massachusetts. A, side view of caudal fin; B, teeth 3 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

torpedo for any other Gulf of Maine skate or ray, the rounded outline of the disk and the large caudal fin identifies it at a glance. Furthermore, its skin is soft and naked, without the spines or thorns so characteristic of all our common skates. The disk is roughly subcircular, truncate in front, and somewhat broader than long. The eyes are very small and set far forward. The two dorsal fins, of which the first is the larger, stand on the forward end of the tail, the first, indeed, partly above the bases of the pelvic 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 nearly as long as it is deep. The tail is shorter than in the skates for it occupies only about two-fifths the total length of the fish, measured from the cloaca. The teeth are small, with sharp curved points, and are in about 60 series, with up to 7 rows exposed and functioning at one time.

*Color.*—Dark chocolate to purplish brown above, some with a few obscure darker spots; lower surface white except that the edges of disk, fins, and tail are of the same dark tint as the upper side.

*Size.*—Adult torpedoes are usually 2 to 5 feet long or a little longer, and heavy for their size. Specimens taken at Woods Hole average about 30 pounds, while most of those taken anywhere on our Atlantic coast weigh less than 75 pounds. But we have seen one only about 4 feet long from Chesapeake Bay that weighed about 100 pounds; one of 144 pounds was brought from Nantucket to the U. S. Fisheries Station at Woods Hole many years ago; and the heaviest taken near Provincetown were estimated long ago by a fisherman of keen observation as 170 to 200 pounds.

*Habits.*—The most interesting thing about the torpedo is its ability to give electric shocks of considerable strength to anyone touching it. The statement, even, has long been current that the shock from a large one in rested condition may be strong enough to throw a full grown man to the ground. And the story is told of a dog which was in the habit of wading on a Cape Cod beach in shoal water to catch flounders, but was so shocked by a torpedo that it ran away howling and could never be persuaded to go fishing again. In fact, this anecdote antedates the scientific naming of the New England torpedo. But shocks of a

strength even approaching what is suggested by such reports are to be expected only from torpedos of the largest size in rested condition. The voltage recorded recently was 170 to 220 for one that had been kept in a live well. And the most we have felt ourselves from medium-sized torpedos lying on the dock at Woods Hole has been a slight numbing sensation.

The torpedo, like others of its tribe, is a bottom fish. It is a fish eater. The stomach of one taken at Woods Hole contained a summer flounder (*Paralichthys dentatus*) about 14½ inches long. A 2-pound eel, a 1-pound flounder, plaice (*Pleuronectes platessa*), red mullet (*Mullus surmuletus*), a salmon weighing 4 or 5 pounds, and the remains of spotted dogfish (genus *Scyliorhinus*) have been found in the stomachs of British specimens. The wide distensibility of its jaws allows it to swallow fishes much larger than might be considered possible from the breadth of the mouth when closed. And it is generally believed that it stuns its prey by its electric shocks. Otherwise it is difficult to conceive how so sluggish a fish could capture such active prey.

It bears "living" young, but there is no placental connection between embryo and mother. And it seems that the young are born offshore, for the smallest torpedo yet recorded from American inshore waters (from New Jersey) was about 2 feet (610 mm.) long. And we doubt if it succeeds in producing young in the colder waters of our Gulf.

*General Range.*—Both sides of the North Atlantic <sup>56</sup> from southern Nova Scotia (La Have Bank), Bay of Fundy, and Georges Bank to North Carolina in the west;<sup>57</sup> and from northern Scotland to the Mediterranean, Azores, Madeira, and tropical West Africa in the east.

*Occurrence in the Gulf of Maine.*—The torpedo is more common south and west from Cape Cod than to the northward and eastward. But it strays past the elbow of the Cape often enough for it to be classed as a regular member of the Gulf of Maine fish fauna. The most northeasterly records for it are of one presumably of this species taken in St. Margarets Bay, Nova Scotia, some 30 years ago; one caught on a long line set for cod

<sup>56</sup> Comparison of American specimens with one from the North Sea revealed no differences.

<sup>57</sup> This torpedo is also reported from the Florida Keys and from Cuba, but on doubtful evidence.

on La Have Bank in 1890,<sup>58</sup> and from Eastport, Maine, at the mouth of the Bay of Fundy. It has also been taken at Williamsport, Maine; off Seguin Island where one was examined in 1880; at the mouth of Casco Bay; at Wood Island near Cape Elizabeth (1, in a trap, in 1894); near Cape Ann; off Plymouth in the southern side of Massachusetts Bay; near Provincetown; and on the outer coast of Cape Cod, so it would be no surprise to find it anywhere along the shores of the Gulf. It has been caught occasionally on Georges Bank;<sup>59</sup> there are records of long standing of torpedos off Nantucket and Marthas Vineyard, and they are caught yearly in Vineyard Sound and in Buzzards Bay.

Most of the reports of torpedoes within the Gulf have been based on single specimens. But it has been known for a long time that torpedoes are caught in much larger numbers in some years than in others. Thus they are said to have been unusually common near Provincetown in 1819 and for the next 4 or 5 years, when 60 to 80 were taken there yearly. Again in 1845 about a dozen

came ashore or were caught otherwise near Provincetown. Any fluctuation, however, that may have taken place from year to year thereafter seems to have attracted no attention until the summer of 1896, when Dr. W. C. Kendall, of the U. S. Fish Commission collected several along the coast of Maine. The Massachusetts Bay specimen mentioned above, taken off Plymouth and now in the Harvard Museum of Comparative Zoology, is the only torpedo from the inner part of the Gulf of which we have heard since that time. But it is as likely to be found in the Gulf now as it ever was.

*Importance.*—The torpedo is of no commercial value nowadays, but its liver oil was considered equal to the best sperm for illuminating purposes before the use of kerosene oil was general. There is an old tale that its oil was a good cure for cramps if rubbed on externally, for stomach trouble if taken internally. And when one is landed on the dock at Woods Hole it is an object of interest to the workers at the Biological Laboratory because of its electric discharges.

### SKATES. FAMILY RAJIDAE

Skates, with their disc-like outlines, thin as a shingle toward their outer edges, and with their rather long tails, are familiar objects along our shores. The outer edges of their pelvic fins are concave (convex in the sting rays), they have two very small dorsal fins on the rear part of the tail, but no distinct tail fin, and they lack the large tail spine that is so characteristic of the sting rays. The Gulf of Maine supports four species in abundance, while two others have been recorded on rare occasions.

The common skates look so much alike that fishermen seldom distinguish between them. For this reason we know very little about the individual differences in habits among the several species. All live chiefly on the bottom or close to it, spending much of the time partially buried in the mud or sand. They move 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,

such as shrimps, crabs, lobsters; on mollusks, worms, and to a greater or less extent on fish.

All the true skates lay large eggs with blackish or sea-green leathery shells, roughly oblong in outline, with a hollow tendril at each corner by which they become fastened to seaweeds or other objects. The empty eggshells, "mermaids purses," are familiar objects on our beaches among the flotsam along high water mark. While still in the egg the embryo skate develops temporary external gill filaments from the walls of the gill clefts, but these disappear completely before it hatches. Probably all our local skates spawn over a considerable part of the year, with incubation periods of several months up to a year or more.<sup>60</sup>

To give some idea of their abundance on the offshore banks we 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 about 800, the largest catch 4,520, the

<sup>58</sup> Reported by G. F. O. Hansen, then second mate and later master of the U. S. Fish Commission schooner *Grampus*, who doubtless was acquainted with the torpedo at Woods Hole.

<sup>59</sup> The most recent record is of one 58 inches long, trawled on the southwest part in December 1930.

<sup>60</sup> Under aquarium conditions the incubation period for the little skate (*R. erinacea*) was 5 to 6 months (p. 69); and it ranged from 4½ to about 14½ months for 6 common European skates; see Clarke, Jour. Marine Biol. Assoc. United Kingdom, vol. 12, No. 4, 1927, p. 687.

poorest 82. Again, on a trip to the northeastern part of the bank, September 1929, on the otter trawler *Kingfisher*, 37 hauls yielded from 0 to 105 skates per haul (total 495) and 42 trawl hauls by the *Eugene H.*, fishing from Nantucket Lightship to the south-central part of Georges Bank in late June 1951 caught an average of 146 skates per haul (total, 6,130 skates), which works out at about 9 to 10 skates per acre.<sup>61</sup> Probably they are equally abundant on Browns Bank; certainly they are familiar enough there, but statistics are not available of the actual numbers caught. Skates are also plentiful inshore as appears from catches of about 1 skate to 33 fishes of all kinds on long lines, at various localities in the Gulf of Maine.<sup>62</sup>

In the Gulf of Maine, skates are only a nuisance for they bite the hook readily and often are caught in great numbers in otter trawls, most of them to be thrown back into the sea, the market demand for them being so small that the total landings reported for New England (Massachusetts and Maine) in 1947 was only 28,200 pounds; and 59,100 pounds for 1948. But some are now being landed in Maine for fish meal.<sup>63</sup> They are much more highly valued in northwestern Europe for food with landings for the years just preceding World War II, running around 90 to 100 million pounds.

#### Barn-door skate *Raja laevis* Mitchill 1817

Bigelow and Schroeder, 1953, p. 217.

Garman, 1913, pl. 22, fig. 2, as *R. stabuliforis*.

*Description.*—The barn-door skate is easily identified by its large size, its very pointed snout, and its smooth skin. The thorns along the midline of its back are comparatively small and run only from the hinder part of the disc back along the tail; the tail also has one or two rows of large, sharp spines (smaller on males than on females) along each side, besides the median row. There are small thorns on the snout also, sometimes below as well as above, and along the front edges of the pectoral fins. The male has a patch of erectile hooks on the outer part of each pectoral covering an area measuring 5 by 1¼ inches on one side, and 4½ by 1½ inches on the other in a speci-

men 52 inches long; otherwise the pectorals are smooth for the most part. The front angle of the disc is sharper than in our other skates, being more acute than a right angle, but the tip of the snout is blunt. The outer corners of the pectorals are angular and the disc as a whole is diamond or lozenge-shaped. The two dorsal fins are separated by a short interspace, with one or more spines, and the tip of the tail extends farther beyond the second dorsal fin than it does in most skates. The teeth of the female are flat and pavement-like, but those of adult males are provided with sharp slender cusps. Thirty to forty series of teeth have been counted in the upper jaw, 28 to 38 series in the lower jaw.

*Color.*—The barn-door skate like so many sea fish, varies in color. The upper surface is brown (as a rule usually of a distinctly reddish hue), variously marked with small scattered darker spots or blotches of varying size, and often with pale marblings or waterings; usually there is a large oval spot on the base of each pectoral fin, in line with the outer angle. The lower surface is not as uniformly pale as it is in most skates, its gray or white ground being shaded with darker toward the snout, and speckled on one-third grown specimens and larger, with black or dusky dots or short streaks that mark the mucous pores, a conspicuous feature.

*Size.*—The barn-door skate is our largest, growing to a length of 5 feet; it has been said to reach 6 feet though there is no definite record of one that large. One of 58 inches was 42 inches wide with a tail 27 inches long, and a female of 50 inches, taken by us, was 33¼ inches wide, with a 22-inch tail. Barn-door skates weigh about 4 to 6 pounds when 28 to 30 inches long, about 10 to 11 pounds at 36 inches, and about 19 to 21 pounds at 45 to 46 inches. Very small specimens are seldom taken.

*Habits.*—Barn-door skates are bottom fish. They prefer smooth to rocky ground, and we have caught them on very soft mud bottoms as well as on sand and gravel. The fact that the lower surface is more or less pigmented instead of white suggests that it hugs the bottom less closely than other skates, and it is a strong, active swimmer, as anyone will agree, who has landed a large one on a hand-line. Its usual depth range is from close to the tide line, down to about 100 fathoms. It is perhaps more plentiful at 25

<sup>61</sup> Three mile hauls with the trawl sweeping a strip about 35 feet wide.

<sup>62</sup> Examples are: 15 miles off Monhegan I., Maine, June 24-25, 1913, total fish caught, 5,463; skates 170. Twenty miles east of Cape Cod, Nov. 11, 1913; total fish caught 6,532, skates 202. Jeffreys Ledge, Dec. 11-12, 1913; total fish caught 3,906, skates 62.

<sup>63</sup> Scattergood, Coppola, 1950, p. 169.

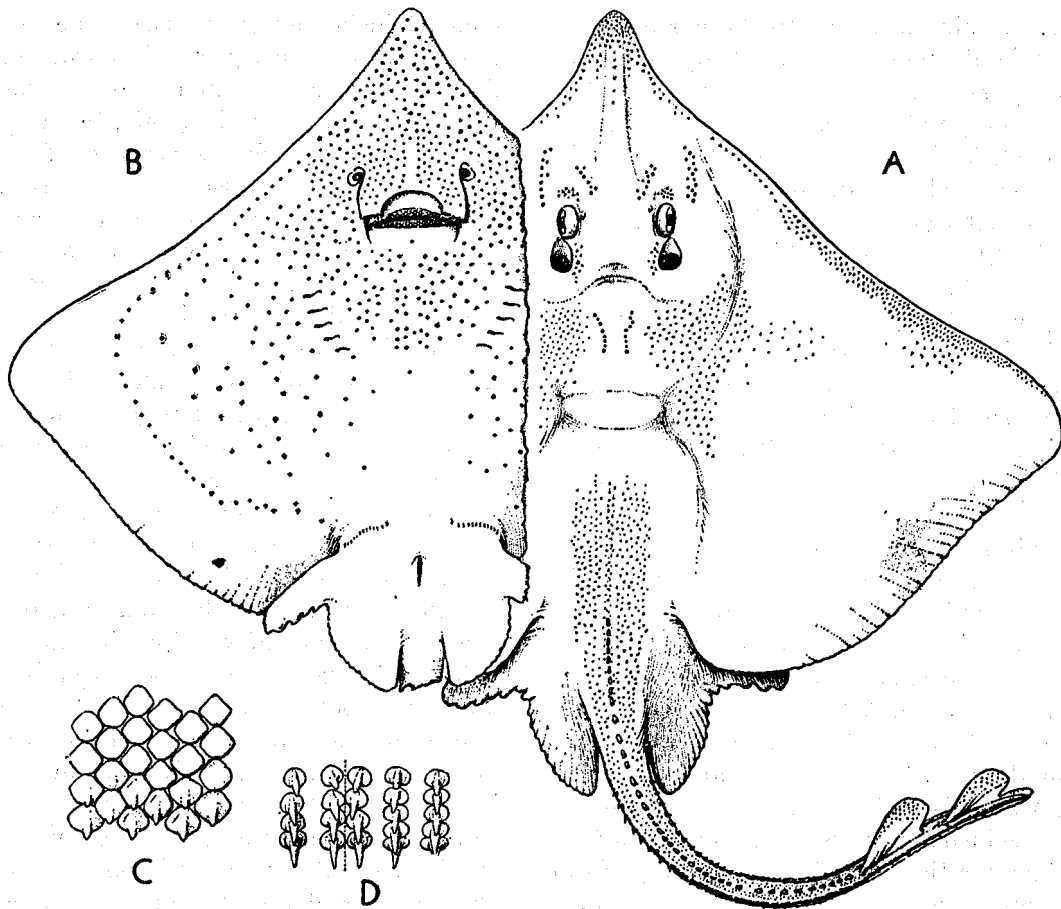


FIGURE 25.—Barn-door skate (*Raja laevis*). A, dorsal view of female, about 47 inches long, Massachusetts; B, ventral view of one of about 26½ inches to show the black markings; C, upper teeth from center of jaw of female 50 inches long; and D, upper teeth from center of jaw of male 52 inches long. B, C, and D from Nantucket Shoals. From Bigelow and Schroeder. Drawings by E. N. Fischer.

to 35 fathoms on Georges Bank and on Nantucket Shoals than deeper, judging from average catches of 32 per haul at 26 to 35 fathoms, 13 per haul at 36 to 49 fathoms, and 6 per haul at 50 to 75 fathoms in 42 trawl hauls by the *Eugene H.*, late June 1951, fishing from Nantucket Lightship to the south-central part of Georges Bank. But the *Atlantis* found it widespread (though not numerous), as deep as 100 fathoms both in the open trough of our gulf and in the bowl west of Jeffreys Ledge during experimental trawling, in August 1936; and it has been reported as deep as 235 fathoms off Nantucket.

The temperature range of the barn-door skate is wider than that of the little skate (p. 67). They are found in the southern side of the Gulf of St. Lawrence in the icy-cold-bottom water on the banks, also, at lesser depths that warm in summer to 60° F. (16° C.) or more. In the Gulf of Maine,

at one locality or depth or another, they are exposed to temperatures ranging from perhaps as low as 32° to as high as 64 to 68° and the upper limit must be considerably higher in the southern part of their range.

Garman 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 on large rock crabs and lobsters, shrimps, squid, and on fish. Probably it is more destructive to the latter than are any other of our skates thanks to its large size. Woods Hole records list spiny dogfish, alewives, herring, menhaden, butterfish, launce, cunners, tautog, sculpins, silver hake, hake, and flatfish among its foods. No doubt cod, haddock, and other fish, suffer to some extent from this skate on the off-

shore fishing grounds, for its European relative is a well-known enemy of the cod, and there is no reason to suppose that the barn-door skate is less voracious. It bites readily on almost any bait, and is often caught on hand and long lines as well as in otter trawls, and in weirs along shore.

Little is known of the breeding habits. The yellowish or greenish brown egg cases are about  $4\frac{1}{2}$  to  $5\frac{1}{2}$  inches (124–132 mm.) long by  $2\frac{1}{2}$  to  $2\frac{3}{4}$  (68–72 mm.) inches broad, not counting the horns, and thus much larger than those of any other Gulf of Maine skate. Females containing fully formed egg capsules have been taken in December and January in Nova Scotia waters, evidence that the eggs are laid in winter. However, it seems that the young are not hatched until late spring or early summer, for we have seen one, taken on Nantucket Shoals in July, so small (about  $7\frac{1}{8}$  in. long) that it could not have been set free long before its capture.

*General range.*—Atlantic Coast of North America from the Banks of Newfoundland, Gulf of St. Lawrence and outer coast of Nova Scotia and the Nova Scotia Banks to North Carolina.<sup>64</sup> It is replaced in European seas by a very close ally, the common skate, *Raja batis*.

*Occurrence in the Gulf of Maine.*—This is a common fish in all parts of our Gulf, and 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 outer Nova Scotia shore; it is known from St. Mary Bay; is found very generally though not abundantly in the Bay of Fundy and 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 its abundance on Georges Bank and on Nantucket shoals is illustrated by an average catch of about 21 per haul (about 14 percent of all the skates caught), in 42 trawl hauls by the *Eugene H.*, fishing from Nantucket Lightship out into the south central part of Georges Bank in late June 1951. In short, it is to be expected anywhere within the limits of the Gulf. Like most other skates, it is often taken in shoal water in our Gulf in summer; seldom or never in winter. Huntsman tells us that it comes to Passamaquoddy Bay from May to November. We once caught one nearly 5 feet

long at Cohasset in Massachusetts Bay in less than a fathom of water in midsummer; indeed, it is often stranded on the beach. 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 former Bureau of Fisheries, also by the *Atlantis*, as deep as 100 fathoms in summer. In the warmer waters off the southern coast of New England it comes inshore in spring and autumn, descending to somewhat deeper water for the summer.

*Commercial value.*—The barn-door skate is of no commercial value except as entering into the small landings of skates mentioned on page 61.

### Big skate *Raja ocellata* Mitchill 1815

SPOTTED SKATE; WINTER SKATE; EYED SKATE

Bigelow and Schroeder, 1953, p. 240.

Garman, 1913, p. 339, pl. 29, fig. 2, as *Raja diaphanes*.

*Description.*—This skate looks very much like the little skate, but it is larger and has more numerous teeth. The front angle of the disc is much blunter than a right angle, bulging opposite the eyes, and the tip of the snout is rounded. The teeth are in from 72 to 110 series in each jaw instead of 66 series, or fewer 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. The midline of the back behind the shoulders is almost always free of spines in adults. But we have one specimen, a female 18 inches long taken near Jeffreys Ledge, November 1, 1927, which bears a row of large spines along the midline of back and tail from the shoulder girdle to the first dorsal fin. Males, like those of other skates, 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 of adult males reach about halfway back along the tail, which occupies about half the total length of the fish.

*Color.*—Light brown above with round dark brown spots. As a rule there is a large white eye spot with black center near the rear corner of the pectoral fin, and often two smaller ones

<sup>64</sup> Doubtfully reported from Florida.

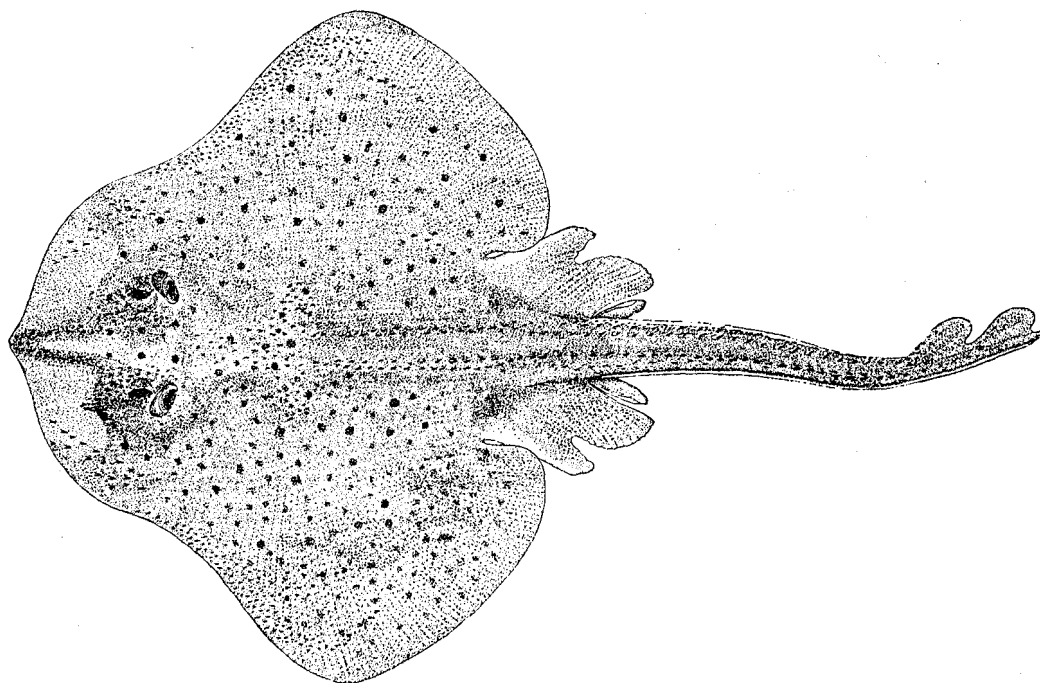


FIGURE 26.—Big skate (*Raja ocellata*), male, about 36 inches long. From Jordan and Evermann. Drawing by H. L. Todd.

close to it. And we have seen two large specimens from Georges Bank with several of these eye spots on each side of the disk. There is a translucent or white area on each side of the snout in front of the eyes and the lower surface is white.

The eye spots, if present, 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 the one from the other.

*Size*.—This skate does not mature until at least 25 to 26 inches long, and grows to about 3½ feet in length, commonly from 30 to 34 inches. Specimens 32 inches in length are about 20 inches wide.

*Habits*.—Big skates feed on the same diet as little skates do (p. 69). Rock crabs and squid are favorite prey, but they also take annelid worms, amphipods, shrimps, and razor clams, and they eat whatever small fish are readily 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.<sup>65</sup>

It is caught right up to the wharves in the Gulf of St. Lawrence; often comes into very shoal water on sandy beaches, and we once caught an adult male in September in only 2 or 3 feet of water in Nauset Marsh on the outer coast of Cape Cod, but few are found shoaler in our Gulf than 2 to 4 fathoms. They are much more plentiful at 25 to 35 fathoms than deeper, on the offshore grounds, as appears from average catches, of 48 per haul at 26 to 35 fathoms, but only 11 per haul at 36 to 49 fathoms, and none at 50 to 75 fathoms, in 42 trawl hauls by the *Eugene H.*, fishing from Nantucket Lightship to the south-central part of Georges Bank in late June 1951, and very few are caught deeper than about 50 fathoms anywhere.

In our Gulf they inhabit about the same range of temperature as the little skate does, i. e., from 68° or so, for those along the Massachusetts coast in summer, down to 34–36° in the coastal belt as a whole in winter, and to near 32° in the Bay of Fundy region, at least in some years. In the southern side of the Gulf of St. Lawrence they are found in the icy bottom water on the banks as well as shoaler, where temperatures rise to 61° (16° C.) or more in summer. Those living the shoalest in the southern part of their range

<sup>65</sup> From Vinal Edwards' and Linton's notes.



must be exposed to temperatures as high, perhaps, as 68° to 70° at the warmest time of the year.

Off the Atlantic Coast of Nova Scotia this skate deposits its eggs from summer into autumn, and probably through the same season in the Gulf of Maine for Scattergood<sup>66</sup> reports females with egg capsules in Maine waters in September. And it continues to do so into December and January off southern New England. Its egg cases are larger than those of the little skate, 2½ to 2¾ inches by about 1¾ inches, not counting the horns. The length of the period of incubation is not known.

*General range.*—Atlantic Coast of North America from northern North Carolina to the southern side of the Gulf of St. Lawrence, and to the southern part of the Newfoundland Banks.

*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 for it for the Bay of Fundy as well as from the coasts of Maine and Massachusetts, but so closely does a half or two-thirds grown big skate resemble an adult little skate (p. 68) that it is often impossible to tell to which species published reports refer. It also makes up so considerable a proportion of the skate population on Georges Bank that about 14 percent of the catch of skates made on Georges Bank by one otter trawler in September 1929, and about 18 percent (1,116) of the skates taken in 42 trawl hauls by the *Eugene H.*, late June 1951, fishing from Nantucket Lightship to the southwestern part of Georges Bank, were this species. But it has never been reported from the deeper troughs of the Gulf, nor have we taken it there.

The name "winter skate" seems appropriate enough for it along the southern coast of New England, for it is only during the cold season that big skates come close inshore near Woods Hole. And they are said to be taken in larger numbers in winter than in summer in the Massachusetts Bay region (we cannot verify this). However, this is a misnomer in the cooler waters of the northern part of the Gulf of Maine, for it is common inshore in Passamaquoddy Bay from May to November, and this probably applies to the whole coastline east of Cape Elizabeth to judge from temperature.

Big skates are taken on hook and line, in weirs, and in otter trawls, but they are of no commercial value, except as they form a part of the general

landings of skates. And they are only a nuisance to anglers.

### Brier skate *Raja eglanteria* Bosc 1802

Bigelow and Schroeder, 1953, p. 165.

Garman, 1913, pl. 23.

*Description.*—In the brier skate, as in the thorny skate, the midline of the back and tail is armed with a continuous row of stout thorns from the shoulders to the first dorsal fin near the tip of the tail, usually with 1 or 2 in the gap between the 2 dorsal fins. But the thorns of this row are not much larger than those along the sides of the tail (they are in the thorny skate), and there are at least 16 thorns in the midrow along the tail (not more than 9 to 10 in the thorny skate). There also are groups of large thorns opposite and behind the eyes, with 1 to 5 on each shoulder and 1 to 4 rows along either side of the tail. Elsewhere the upper surface of the disc bears only small sharp prickles (hence its name), most numerous on the forward parts of the pectorals, over head and snout, and along the middle of the back and tail among the larger thorns. Thus it is a much smoother species than the thorny skate, and its snout is more acute, its outline being about a right angle with the margins bulging less opposite the eyes than in any of the blunter-nosed skates. The outer corners of the pectorals are distinctly angular, and the dorsal fins are separated by a short gap.

*Color.*—Brownish to grayish above; the pectorals variously marked with darker spots and blotches and with more elongate bars; this last is a characteristic feature; there is a translucent space on each side of the snout; it is white below. It is most readily recognized by its color pattern, with short dark bars as well as spots, which is not shared by any other Gulf of Maine skate.

*Size.*—The brier skate ordinarily grows to a length of about 2½ feet. The largest on record was about 37 inches long.

*General range.*—Off the eastern coast of the United States from Massachusetts Bay to both coasts of 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. It has been recorded once from Gloucester, its most northerly outpost, and also from

<sup>66</sup> Copela 1951, No. 2, p. 169.

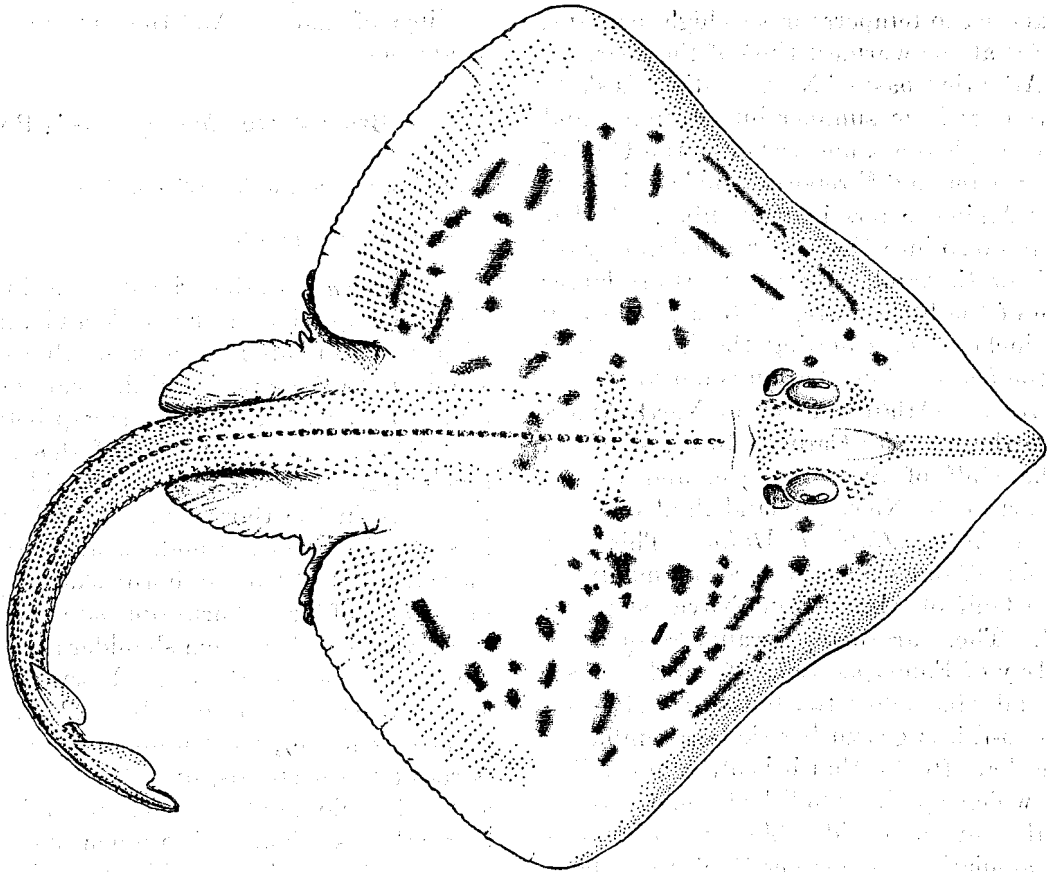


FIGURE 27.—Brier skate (*Raja eglanteria*), female, about 29 inches long, Woods Hole, Massachusetts. From Bigelow and Schroeder. Drawing by E. N. Fischer.

Provincetown. Two specimens were taken on Nantucket Shoals near Round Shoal buoy by the *Halcyon*, one in July, the other in September, in 1924.

**Leopard skate *Raja garmani* Whitley 1939**

ROSETTED SKATE

Bigelow and Schroeder, 1953, p. 200.

Garman, 1913, pl. 18, fig. 2.

*Description.*—The conspicuous dark rosettes on the upper surface make this skate recognizable at a glance, since no other skate of the western Atlantic is marked in this way. And its tail is longer relatively than that of any other Gulf of Maine skate.

The disc is considerably blunter in front than a right angle, with anterior margins bulging rather conspicuously a little anterior to the level of the eyes; the outer corners of the pectorals are very broadly rounded; the tail measured from the

center of the cloaca to the tip is about 1.5 times as long as the body from tip of snout to center of cloaca; and there is a definite gap with one or two thorns between the two dorsal fins.<sup>67</sup>

There are thorns along the ridge of the snout; a row around the inner and posterior margins of the eyes with a few in the space between the latter; a group on each shoulder; and one row along the midbelt of the back and tail in young specimens, increasing to 2 to 6 irregular rows in large ones. In young specimens the skin of the disc, as a whole, and of the tail, is also rough with small prickles, but, most of these are lost with growth, leaving large specimens mostly naked except for the thorns. The lower surface is smooth.

There are 46 to 52 series of teeth in the upper jaw, a few less in the lower, and those of adult males are only a little sharper than those of females.

*Color.*—The upper side is pale buff or brown,

<sup>67</sup> Garman's illustration is of an abnormal specimen with three dorsal fins.

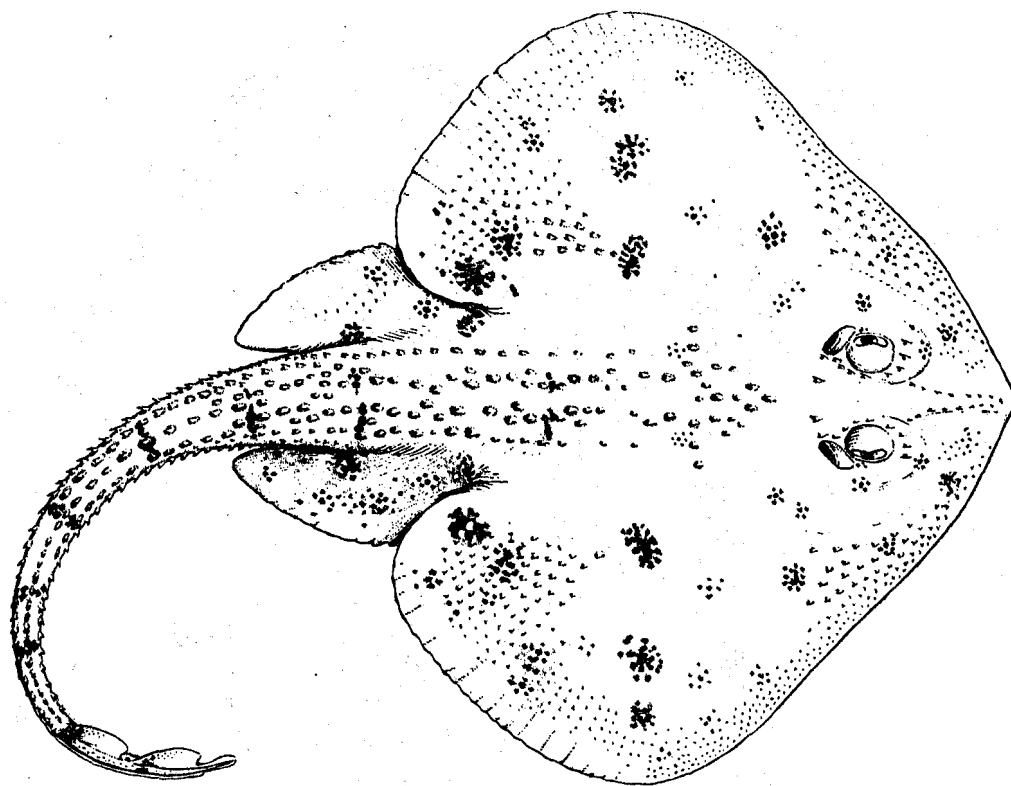


FIGURE 28.—Leopard skate (*Raja garmani*), female, 16 inches long, offing of Montauk Point, New York. From Bigelow and Schroeder. Drawing by E. N. Fischer.

freckled with small spots, darker or lighter, and conspicuously marked with dark rosettes, each consisting of a group of 6 or more dark brown or black spots surrounding a dark central spot. The lower surface is white or pale yellow.

*Size*.—This is one of the smaller skates, males maturing when only about 16 inches long.

*General range*.—Outer part of the continental shelf and upper part of the continental slope from southern Florida to the offing of Nantucket, in depths of 30 to 300 fathoms.

*Occurrence in the Gulf of Maine*.—Our only reason for mentioning this species is that one specimen was trawled by the *Albatross III*, May 14, 1950, at 52 fathoms southeast of Nantucket Lightship (lat. 40°05' N., long. 69°22' W.). And this is probably close to the eastern boundary of its range, for it has never been reported among the other skates that are trawled in abundance along the seaward slopes of Georges and of the Nova Scotia Banks. But it is one of the most plentiful of skates offshore to the westward, along southern New England.

#### Little skate *Raja erinacea* Mitchill 1825

COMMON SKATE; SUMMER SKATE; HEDGEHOG SKATE; TOBACCO BOX

Bigelow and Schroeder, 1953, p. 176.

Garman, 1913, pl. 20.

*Description*.—The most distinctive characters of grown specimens are their small size, absence of thorns along the midline of the back (except in the young) and blunt nose.

The anterior angle of the disc is blunter than a right angle and the tip of the snout is rounded, with the margins bulging opposite the eyes. The teeth are in only about 38 to 66 series. Females have thorns scattered generally over the upper surface; these are especially prominent on head, snout, shoulders, and sides of tail. Ordinarily there are no spines on the midline, back of the shoulder girdle; but we found one fish, 13½ inches long, among the many we have observed, with a median row of spines extending from the shoulder girdle to the first dorsal fin near the

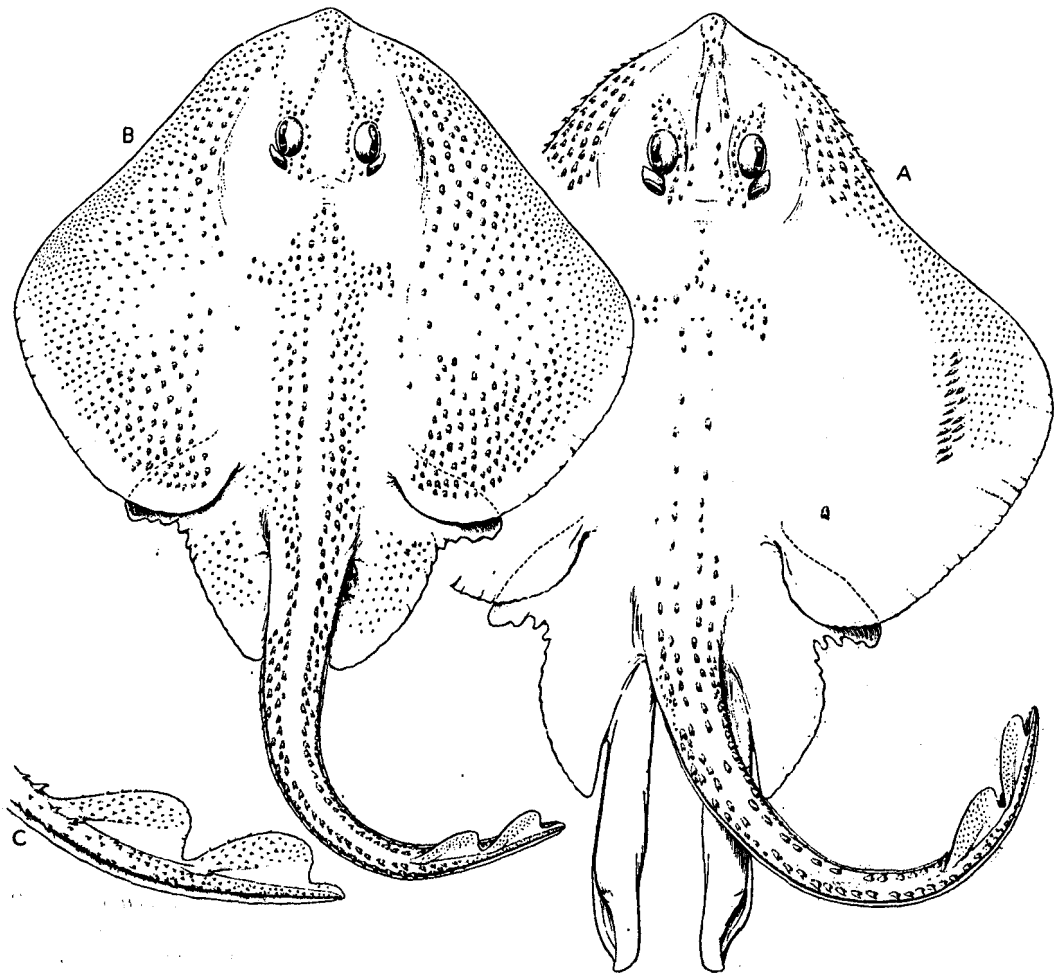


FIGURE 29.—Little skate (*Raja erinacea*). A, male, 20 inches long, Boston Harbor; B, female, 17½ inches long, Mystic Connecticut; C, side view, end of tail of same, about 0.6 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

end of the tail, and this is true of newly hatched specimens in general. Males are less spiny, but the spines on tail, shoulders, and along either side of the back ridge are noticeably strong in both sexes. The two dorsal fins are close together; the tail is about half the total length. Large ones closely resemble small specimens of the big skate (*R. ocellata*, p. 63) that may chance to lack the ocellar spots with which that species usually is marked. A count of the teeth is then the only sure clue to the identity of the specimen in hand.

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

**Size.**—Ordinarily up to 16 to 20 inches long;

the maximum recorded length is 21 inches (53 cm.); they weigh about ¾ to 1 pound at 16 to 17 inches and anywhere from 1½ to 2 pounds at 18 inches. Females mature sexually when 12½–17 inches (32–43 cm.) long, males at about 14 to 17½ inches.<sup>68</sup>

**Habits.**—It is common knowledge that this skate, like others, is most abundant on sandy or pebbly bottom; but they are likewise found on mud and we have seen them lying on ledges at times.

The usual depth range is from close to tide line down to 75 fathoms or so. Many even follow up the shelving bottoms of our beaches until they

<sup>68</sup> Information supplied by Dr. Daniel Merriman, Dr. Y. H. Olsen, the Misses S. B. Wheatland and L. H. Calhoun, who have made a detailed study of the little skate in southern New England waters.

strand. And the bulk of the population hold to depths of less than 40 to 50 fathoms, as appears from average catches, per haul, of 100 at 26 to 35 fathoms, and 95 at 36 to 49 fathoms, but only 12 at 50 to 75 fathoms, in 42 hauls by the *Eugene H.*, fishing from Nantucket Lightship to the southcentral part of Georges Bank, in late June 1951. Fifty fathoms (off the Bay of Fundy) is, in fact, the deepest that positively identified specimens are known, in the inner parts of our Gulf; 80 fathoms off southern New England.<sup>69</sup>

The little skate tolerates a wide range of temperature, being found in water as warm as 68–70° in summer, while they are exposed to temperatures close to 32° in the Bay of Fundy in some winters, unless they move out, and deeper there than seems likely. In the southern side of the Gulf of St. Lawrence, writes Huntsman,<sup>70</sup> they are found in the intermediate zone between the icy cold waters of the banks and the surface stratum, which last warms to 61° (16° C.) or higher in summer.

They have never been reported, to our knowledge, where the water is appreciably brackish.

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. Probably crabs loom largest in their diet, for more than 29 percent of the skates opened by Field at Woods Hole, contained them; 15 percent had bottom-dwelling shrimps (*Crigo*); and 6 percent had eaten squid. In Long Island Sound, however, amphipods (*Leptocheirus*) are the dominant item in their diet, forming from one-third to one-half of the stomach contents at all seasons of the year.<sup>71</sup> Launce, alewives, herring, cunners, silversides, tomcod, silver hake, have all been found in their stomachs, and they bite a baited hook readily, affording amusement to vacationists.

The spawning habits of the little skate have not been followed in the Gulf of Maine. Studies, at the Bingham Oceanographic Laboratory, however, suggest that they ordinarily deposit their eggs in water not deeper than 15 fathoms and on a sandy bottom. It appears from anatomical examination of the sexual organs of the mature females that

population may take place at any time throughout the year, and frequently. Observations, too, on skates kept in aquaria have shown that the eggs are laid in pairs at intervals of from five days to several weeks; also that they are usually buried in sand, at least partially.<sup>72</sup> The eggs have been taken off Southern New England, in fish traps and dredges in a few fathoms of water in abundance from July through September.

Examination of large numbers of females has shown that eggs are laid there throughout the year. And there is no reason to doubt that this is the case to the north and east of Cape Cod as well. Aquarium experiments have also shown that eggs laid in the period, May–July, hatched between the end of November and the beginning of January, i. e., after 5 to 6 months. But the incubation period is likely to be somewhat longer for spring–summer laid eggs in nature because of somewhat lower temperatures; and considerably longer for eggs laid in autumn and early winter.

The eggs measure about 1½ to 1¾ inches by about 2½ to 2¾ inches, not counting the horns, and the great majority of the empty skate eggs that are washed up on the beaches of our Gulf belong to this species. The young skate, which emerges through a transverse opening at the edge of the egg case at the end that has the longer pair of horns, is about 3¾ to 4 inches long at hatching; its abdomen is still swollen with yolk, and its tail terminates in a whiplash-like extension that disappears within a few days. 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.

It appears from information of various sorts that a little skate 8 inches (20 cm.) long may be 1 to 1½ years old; one of 11¾ to 12 inches (30 cm.) 2 to 3 years; one of 15¾ to 16 inches (40 cm.) 3 to 4 years; one of 19¾ to 20 inches 6 to 8 years old. And the mortality rate appears to be very high after five years, for very few of those taken are longer than about 18 to 19 inches.<sup>73</sup>

*General range.*—Atlantic coast of America; southern side of the Gulf of St. Lawrence and

<sup>69</sup> Seventeen that we saw trawled on the *Albatross III*, May 1950.  
<sup>70</sup> Trans. Roy. Soc. Canada, Ser. 3, vol. 12, sec., 4, 1918, p. 63.  
<sup>71</sup> Information from Dr. Daniel Merriman, Dr. Y. H. Olsen, and the Misses S. B. Wheatland and L. H. Calhoun.

<sup>72</sup> This summary of the breeding habits is based on extensive information supplied by Dr. Daniel Merriman, Dr. Y. H. Olsen, and the Misses S. B. Wheatland and L. H. Calhoun.  
<sup>73</sup> Information from Dr. Daniel Merriam, Dr. Y. H. Olsen, and the Misses S. B. Wheatland and L. H. Calhoun.

northern Nova Scotia to Virginia, in coastal waters and on the shoaler of the offshore banks.

*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 summer and of stranding on the beaches, where dried skate carcasses are often to be seen. It occurs all along the coast in the southern side of the Gulf of St. Lawrence and along outer Nova Scotia; is very abundant both on the New Brunswick and on the Nova Scotia sides of the Bay of Fundy, and is to be caught everywhere and anywhere along the coasts of Maine and of Massachusetts; far more commonly, indeed, than one might suspect from the few definite records that have found their way into scientific literature.

An average catch of about 88 per haul (about 60 percent of all the skates taken) in 42 trawl hauls by the *Eugene H.*, in late June 1951, fishing eastward from Nantucket Lightship suggests that this is the most plentiful skate on the southwestern part of Georges Bank and on the Nantucket grounds. But it seems to be far less numerous on the northeastern part of the Bank, if it is present there at all; at least we failed to find a single one, among 495 skates of other kinds caught there in 37 hauls by the otter trawler *Kingfisher* in September 1929. And we have never found it (nor has it been reported) in the deeper basins and troughs of our Gulf, probably because it is restricted in general to depths less than 40 to 50 fathoms (p. 69).

In our Gulf many of the little skates appear to carry out an irregular migration into shoal water in April and May, where they remain throughout the summer, autumn, and early winter, to retire again to somewhat deeper, hence, warmer water in December or January. Its migration schedule appears to be more complex in Long Island Sound waters where summer temperatures are higher; i. e., inshore in spring, offshore in mid- or late summer, inshore again in late autumn and offshore again in midwinter.<sup>74</sup> Doubtless little skates breed throughout the shoaler parts of the Gulf, and on the offshore banks.

They are of no commercial importance in our Gulf except as they form a part of the landings of trash fish.

**Smooth-tailed or prickly skate *Raja senta***  
Garman 1885

Bigelow and Schroeder, 1953, p. 264.

Garman, 1913, pl. 25, fig. 1.

*Description.*—By the time this skate has grown to one-fourth its adult size it is made recognizable by the fact that the middorsal line of thorns runs back only to about the middle of the tail, where the thorns so dwindle in size that they are not distinguishable from the tiny prickles with which the tail is clothed, generally. Newly hatched specimens in which this character is not yet established are separable from all other Gulf of Maine skates by the color pattern of the tail, which has two pale crossbars, each outlined in front and behind by a dark band or blotch.

There is a single row of 16 or more medium-sized to large thorns along the midline of the back, spaced irregularly, and usually about 20 to 30 along the anterior one-half or so of the tail; about 10 to 13 around the inner ridge of each eye; and 3 to 5 on each shoulder. Immature specimens of both sexes are also closely and uniformly roughened with small prickles over the disc as a whole, on the pelvics and on the upper side of the tail. But irregular bare areas develop on the shoulders and around the outer parts of the pelvics of females as they approach maturity while mature males lose the prickles from the central part of the disc as a whole, but develop a few thorns on the mid-ridge of the snout besides larger thorns over a roughly triangular area on either side of the head abreast of the eyes and farther forward. They also develop two rows of the usual curved sexual spines on either side on the pectorals, about 13 to 14 per row. The lower surface of the disc is smooth, except that a few prickles develop, with growth, along the margins near the snout.

The lower surface of the tail as a whole is prickly on females and on immature males, but tends to become smooth on males by the time they mature sexually.

The anterior angle of the snout is a little more obtuse than a right angle (about 110°); the tip of the snout is sharper than in either the big skate, the little skate, or the thorny skate. There are 38 to 40 series of teeth in the upper jaw, 36 to 38 series in the lower jaw; those of females are low, with only faintly indicated points, but those of mature males are longer, sharper, recurved, and

<sup>74</sup> Information from Dr. Daniel Merriman, Dr. Y. H. Olsen, the Misses S. B. Wheatland and L. H. Oalhoun of the Bingham Oceanographic Laboratory.

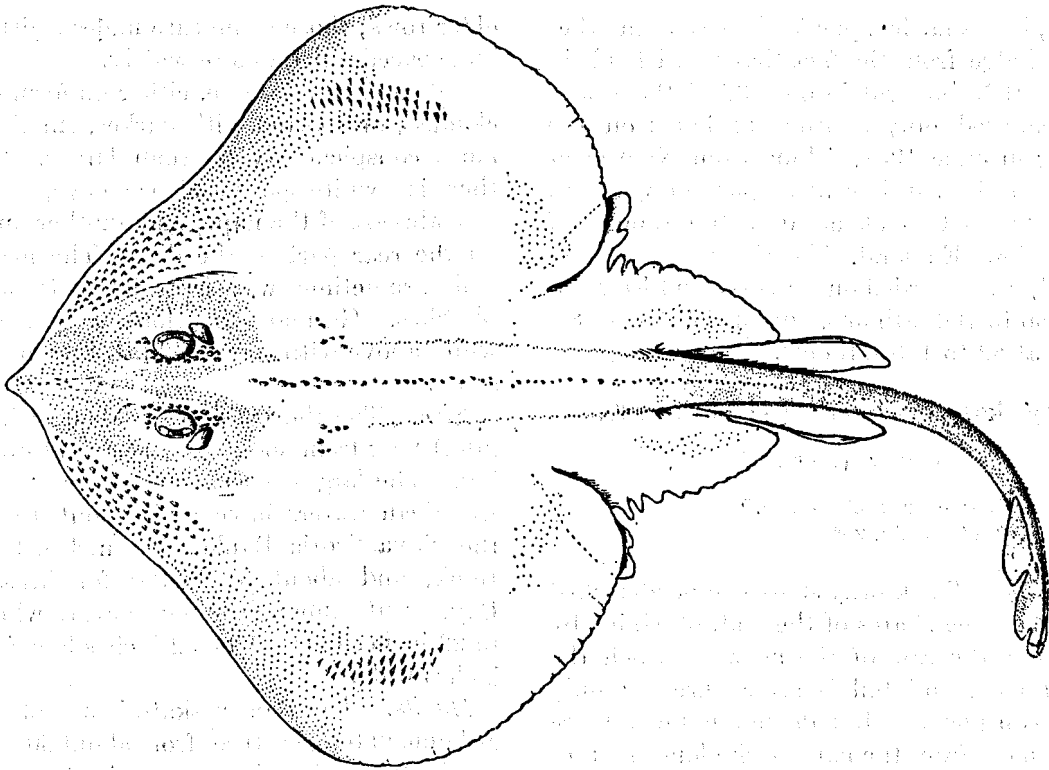


FIGURE 30.—Smooth-tailed or prickly skate (*Raja senta*), male, about 20½ inches long, Emerald Bank, Nova Scotia. From Bigelow and Schroeder. Drawing by E. N. Fischer.

spaced more loosely. There is no free space between the two dorsal fins. The disc is a little broader than long (1.2 to 1.3 times); the tail occupies about one-half of the total length.

*Color.*—The upper side, including the tail, is pale brown, with many obscure darker spots. Newly hatched specimens are also marked on the tail with two pale cross bars, each outlined by a darker cross bar or blotch in front of it and one behind, but these bars disappear with growth. The lower surface is white, either plain or with a few dusky blotches. Sometimes the rear part of the tail is uniformly dark below.

*Size.*—A male about 20 inches (515 mm.) long that we have seen seems to be sexually mature. The largest specimen of which we have record was 24 inches long.

*Habits.*—This skate appears equally at home on the soft mud and clay bottoms of the deeper basins of the Gulf and on the sand, broken shells, gravel and pebbles of the offshore fishing banks. Nothing is known of its diet. Egg cases, apparently of this species, have been trawled in deep water (82–164 fathoms), in the estuary of the St.

Lawrence River in July and August; probably they are laid in summer in the Gulf of Maine, as well.

*General range.*—Atlantic shelf of North America from the offing of Charleston, S. C., to the Nova Scotia Banks and Gulf of St. Lawrence, a few reaching the southern part of the Newfoundland Banks; mostly in depths greater than about 40 to 50 fathoms. The deepest record for it is 478 fathoms off South Carolina.

*Occurrence in the Gulf of Maine.*—This skate, once considered a rare species, is now known to occur generally throughout the western side of the Gulf wherever the water is more than 45 to 50 fathoms deep, 25 fathoms being our shoalest record for it and on the offshore Banks as well. We have trawled it on several occasions in the deep trough west of Jeffreys Ledge; in deep water (80–100 fathoms) near Cashes Ledge; also in the basin east and southeast of Cape Cod. And, being known from the southeastern slope of Browns Bank, it is to be expected generally in the eastern side of the Gulf, as well as in the western, at the proper depth. It is widespread on Georges

Bank also, but is far less plentiful there than other skates, to judge from the fact that trawl hauls in September 1929 brought in only 37 of them, and that we counted only 8, from 42 hauls on the *Eugene H*; in June 1951, fishing from Nantucket Lightship to the south central part of Georges. We have trawled it at 50 to 250 fathoms off southern New England. To the eastward and northward, it is recorded on La Have and Emerald Banks at 50 to 100 fathoms, and in the Gulf of St. Lawrence at 82 to 178 fathoms.

### Thorny skate *Raja radiata* Donovan 1807

#### STARRY SKATE<sup>75</sup>

Bigelow and Schroeder, 1953, p. 255.<sup>75</sup>

Garman, 1913, pl. 21, fig. 2.<sup>76</sup>

*Description.*—The thorny skate can be identified at a glance among skates of the Gulf of Maine by the fact that the row of thorns with which the midline of back and tail is armed are not only large and conspicuous, but do not number more than 19 at most from the nape back along the tail. There are also 2 or 3 large thorns on each shoulder; and one in front of each eye and one behind it; one close to the inner end of each spiracle; and other smaller thorns scattered on snout, pectoral fins, and tail. The bases of the thorns on the pectorals are star-shaped, a very distinctive character; those of the still larger thorns along the midline of the back are oval. Adult males have 2 rows of hooked, erectile thorns near the outer corners of the pectorals.

The anterior angle of the disc is considerably more obtuse than a right angle (110–140°), and the tip of the snout is blunt with the margins bulging somewhat a little in front of the level of the eyes; the outer corners of the pectorals are less broadly rounded than in either the little skate or the big skate; and the two dorsal fins may either be joined at the base or be separated by a short space. There are 36 to 46 series of teeth in each jaw, those of females and of young males with low cusps that are worn nearly smooth along the

<sup>75</sup> When the first edition of this book appeared, it was an open question whether the thorny skate of American waters (named *R. scabrata* by Garman 1913) was identical with the thorny skate of northern Europe (*R. radiata* Donovan, 1807). Our subsequent comparison of American specimens with others from Greenland and Norway has convinced us that they all belong to the one species, which must be called by the older of the two scientific names.

<sup>76</sup> Figure 1 of Garman's plate 21 is not of a thorny skate, as it is named in the accompanying caption, but is of a small specimen of the big skate that we have examined.

older rows; those of mature males a little sharper and spaced a little more widely.

*Color.*—Brown above, either uniform or slightly clouded, or spotted with darker, small specimens more conspicuously so than larger. Sometimes there is a white spot beside each eye, one on either side abreast of the nape, and another on each side on the rear part of the disc. The lower side is white, sometimes with irregular sooty or brownish blotches. Garman mentions a partial albino, white above with a few reddish brown and brown spots.

*Size.*—The thorny skate is about 4 inches (100 mm.) long from snout to first dorsal fin at hatching. The largest specimens so far recorded from American waters have been about 40 inches for the Nova Scotia Banks, 35¼ inches for Georges Bank, and about 31 inches for Massachusetts Bay. But some males may mature when only 21 to 22 inches long. One 32 inches long is about 23 inches wide.

*Habits.*—The thorny skate is a cool water fish, at home in temperatures from about 50° or so down nearly to the freezing point of salt water. It is also restricted in general to depths greater than about 10 fathoms, even in the northernmost part of its range. In the Gulf of St. Lawrence it lives indifferently on the ice cold banks and in the warmer water on the bottom of the deep Laurentian Channel. Average catches of 1 per haul at 26 to 35 fathoms, 22 per haul at 36 to 49 fathoms, and 5 per haul at 50 to 75 fathoms, in 42 trawl hauls, by the *Eugene H* fishing from Nantucket Lightship, the central part of Georges Bank, June 1951, suggest a rather definite preference for the intermediate depth zone, perhaps because of the food supply. But thorny skates have been taken at many stations, also, down to 336 fathoms off the American coast, and as deep as 459 fathoms near Spitzbergen.

The stomachs of thorny skates caught on Georges Bank contained shrimps, spider crabs, anemones, hydroids, and fish digested past identification.

The egg cases vary considerably in size, probably depending on the size of the parent fish. One from a fish 32 inches long, taken on Georges Bank, measured 3 by 2¼ inches exclusive of the horns. Others that have been measured from the Nova Scotia Banks ranged from 3 to 3½ inches in length. They are flat on one side, strongly convex



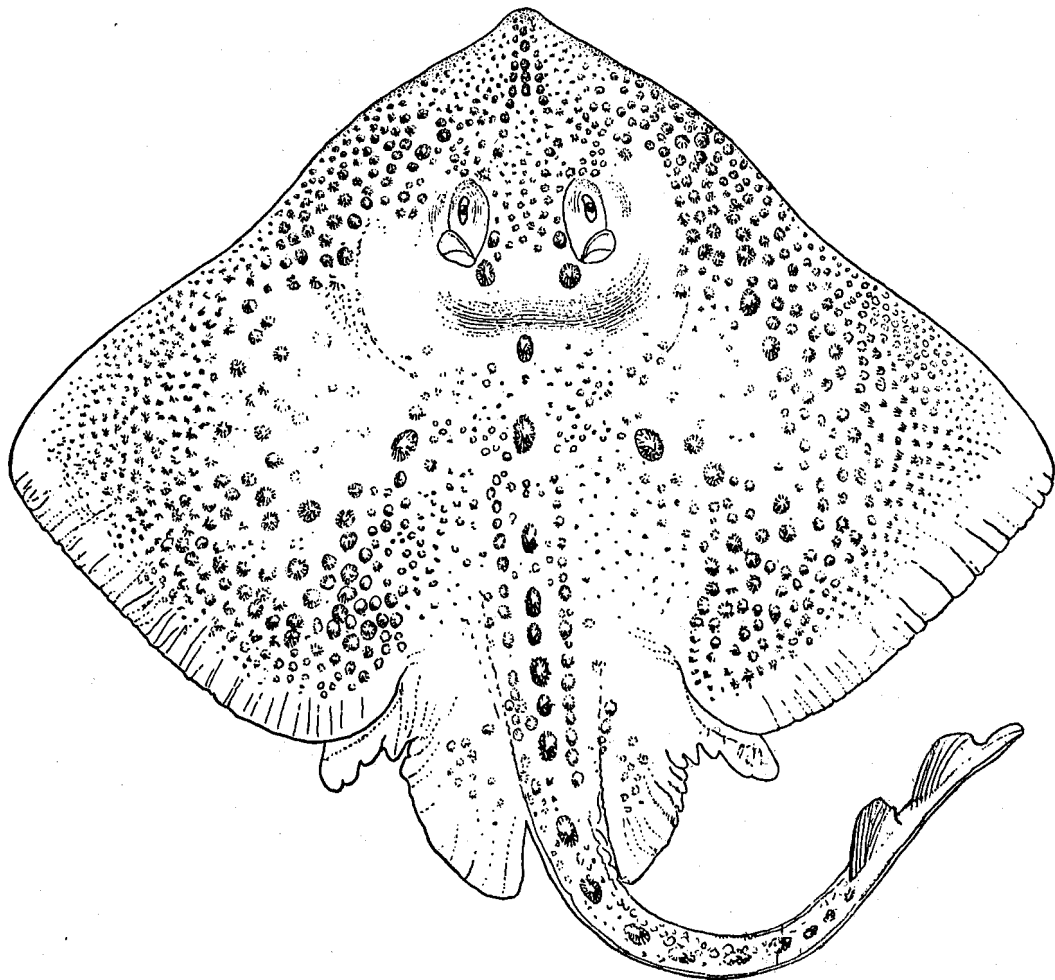


FIGURE 31.—Thorny skate (*Raja radiata*), female, about 31¼ inches long. After Garman.

on the other, and are rough with narrow cross-ridges. A mass of delicate fibrils, matted together, extends along each of the longer sides and partly over the surfaces also. And each horn ends in a slender fibril.

*General range.*—The thorny skate is known on both sides of the northern Atlantic. In the east its range extends from the White Sea and Barents Sea to the North Sea, Dutch coast, and western part of the Baltic;<sup>77</sup> in the west from West Greenland, Hudson Bay, Atlantic coast of Labrador, east and south coasts of Newfoundland, Grand Banks, Gulf of St. Lawrence and outer coast of Nova Scotia with the off-lying fishing grounds, to the Gulf of Maine, and thence westward and southward along the edge of the continental shelf to the

offing of New York; and as a stray to the offing of Charleston, S. C.<sup>78</sup>

*Occurrence in the Gulf of Maine.*—The thorny skate is not often seen close inshore along our coast, being restricted in general to moderately deep water (p. 72). But it is now known to be generally distributed in the deeper waters of the Gulf. Thus 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 on the Nova Scotia side. It has been recorded from Casco Bay; from Ipswich Bay, off Gloucester, Salem and Nahant, and off Provincetown; and we have taken it ourselves in numerous places in the Gulf at 14 fathoms and deeper, including the

<sup>77</sup> Doubtfully reported from Belgium and the Bay of Biscay.

<sup>78</sup> One taken in lat. 33°10' N., long. 77°25' W., in 74 fathoms, by the *Albatross III* in the Museum of Comparative Zoology.

vicinity of Mount Desert; Platts Bank; and in the bottoms of the deep troughs. It has also been trawled at many stations on Georges Bank, likewise along the upper part of the continental slope off southern New England, down to 336 fathoms.

There is nothing in the available record to suggest that it carries out any regular migrations, whether in or offshore, or along the coast. And it is more catholic in respect to its choice of bottom than some other skates, for while it is most plentiful on the good fishing grounds of sand, gravel, and broken shells, we have taken it at many stations in the Gulf on soft mud. And it is one of the most plentiful of Gulf of Maine skates at appropriate depths. Thus 325 were caught in 37 trawl hauls on the northeastern part of Georges Bank on one trip in 1929; again, in June 1951, we counted

432, from 42 trawl hauls (7 percent of the total catch of skates), on the *Eugene H* fishing from Nantucket Lightship to the south central part of Georges. We once caught 12 in the western side of the Gulf in a beam trawl only 8 feet across the mouth in 30 minutes; and we have taken 1 to 100 of them in 26 hauls with larger trawls, between Mount Desert Island and Massachusetts Bay.

Females containing eggs about ready to be laid, and deposited eggs in various stages of incubation, have been taken in Nova Scotian waters or in the Gulf of Maine, in April, June, July, and September, and they are to be expected there in winter as well, having been reported in January and February off Norway, and from February to June in Scottish waters.

### THE WHIP-TAILED STING RAYS. FAMILY DASYATIDAE

The whip-tailed sting rays, like the skates, are disc-like in form, very thin toward the outer edges, with the anterior parts of the pectoral fins fused with the sides of the head, and with the eyes and spiracles on the upper surface. Their pelvic fins, however, have convex outer edges, not concave as are those of the skates. They have no dorsal fin. Their tails are long and whiplash-like toward the tip and armed, in most of them with one to several sawedged, venomous spines on the upper side. Their teeth are small and in many series, closely crowded in bands along the jaws. The upper surface of disc and tail is smooth in some of them, variously roughened with tubercles, thorns or prickles in others. They do not lay eggs as the skates do, but bear "living" young (p. 57). And the young resemble their parents closely when born. Four species are known along the Middle and South Atlantic States, but only one of them reaches the Gulf of Maine, and then only as a stray. Should any long-tailed sting ray be picked up within the limits of the Gulf that does not fit the following description, its captor is referred to Bigelow and Schroeder, 1953,<sup>79</sup> for its identification.

#### Sting ray *Dasyatis centroura* (Mitchill) 1815<sup>80</sup>

##### STINGAREE; CLAM CRACKER

Bigelow and Schroeder, 1953, p. 352.

Garman, 1913, pl. 33, figs. 1, 2, as *Dasybatus marinus*.

*Description.*—The most distinctive features of this sting ray, among other Gulf of Maine fishes, are its very long, whiplash-like tail without dorsal fins, and the long, sawedged spine or spines with which the upper side of its tail is armed. The disc is rhomboid, about  $1\frac{1}{2}$  to  $1\frac{1}{4}$  times as broad as it is long; the anterior angle is much blunter than a right angle ( $130-140^\circ$ ); and the tip of the snout projects very little if at all. The anterior margins of the disc are nearly straight, the posterior margins are only slightly convex, and the posterior corners are abruptly rounded or even angular. The tail, measured from the center of the cloaca, is about  $2\frac{1}{2}$  times as long as the body from cloaca to snout. The lower side of the tail has a narrow fold of skin extending rearward from below the origin of the tail spine for a distance about as

<sup>80</sup> This ray was mentioned as *Dasybatus marinus* and as *D. hastatus* in the first edition of this book. But the specimens in question all belong to one species, the correct scientific name for which is *Dasyatis centroura*, proposed by Mitchill in 1815, as *Raja centroura*.

<sup>79</sup> Fishes Western North Atlantic, Pt. 2, Mem. 1, Sears Foundation, 1953.

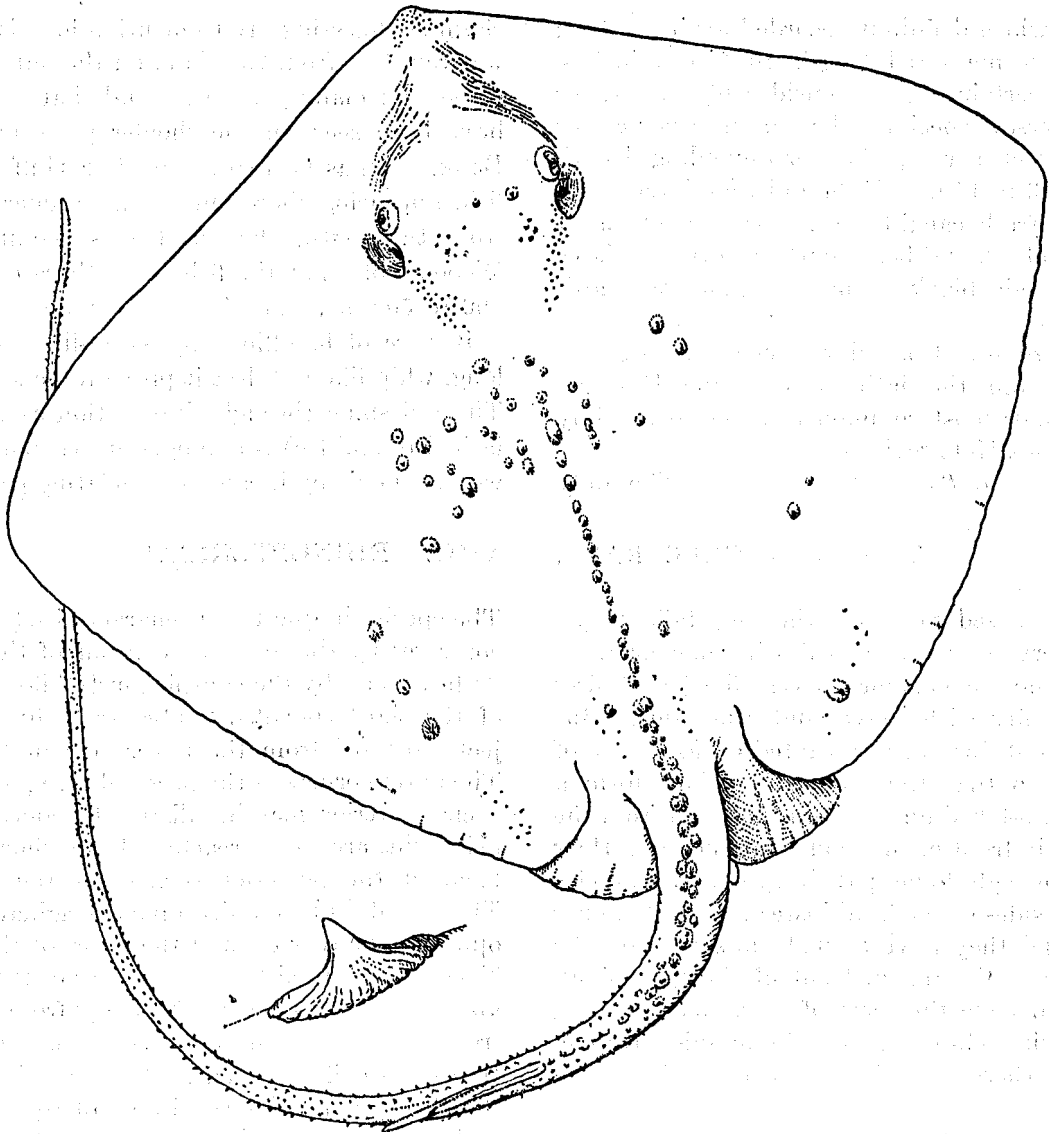


FIGURE 32.—Sting ray (*Dasyatis centroura*), male, about 55½ inches wide, Woods Hole, Massachusetts, and tubercle from tail, about 0.7 times natural size. From Bigelow and Schroeder. Drawings by E. N. Fischer.

long as from its own origin to the cloaca; the upper side of the tail is rounded, except for a low ridge close behind the spine (or spines). The spear-pointed tail spines, of which there are 1, 2, or sometimes 3, are situated well back on the tail. One spine that we examined had about 40 saw teeth on each edge.

Young ones are smooth skinned (except for the tail spines). Larger ones develop 1 to 3 irregular rows of conical tubercles along the midline of the disc, with others on the shoulders as well as on the outer posterior part of the disc, and the tail becomes very rough finally, with conspicuous thorns

along its whole length on its upper side, and rearward from abreast of the tail spines on its lower side. The lower side of the disc is smooth.

Large specimens are easily distinguishable from other sting rays of our Atlantic coast by their very thorny tails and by the large tubercles on the outer parts of their discs. Small ones on which the thorns and tubercles have not yet developed, are recognizable by the shape of the disc, combined with the presence of a skin fold on the lower side of the tail but none on the upper side.

*Size.*—This appears to be the largest sting ray of the western North Atlantic. The greatest

measured width definitely recorded for it is 5 feet, the greatest measured length 10 feet 3 inches. But some certainly grow considerably larger, for a New Jersey specimen has been reported as nearly 7 feet across; the corresponding length would be 13 to 14 feet, if the tail were intact.

*Color.*—Fresh caught specimens seen by us at Woods Hole have been dark brownish above with the tail black from the spine rearward; white below.

*General range.*—Coastal waters of the western Atlantic, from the latitude of Cape Hatteras to Cape Cod; most common from Delaware Bay to the Woods Hole region.

*Occurrence in the Gulf of Maine.*—The only

claim of this sting ray to mention here is that one was reported from Chatham on the outer shore of Cape Cod many years ago, 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, appearing there only as a summer straggler from the south, though it is so common near Woods Hole that the fish traps there catch some 400 to 500 of them in ordinary summers.<sup>81</sup>

Beware of handling any skate-like fish with a long, whip-like tail, lest it prove to be a sting ray. The tail spine (brought into action as the tail is lashed to and fro) is a dangerous weapon; and the wounds made by it cause excruciating pain.

## THE COW-NOSED RAYS. FAMILY RHINOPTERIDAE

The cow-nosed rays, like the whip-tailed rays, have a very long tail armed with one or more poisonous sawedged spines; a very flat broad disc; and pelvic fins with convex outer margins. But their pectoral fins are interrupted on each side of the head, so that the forward portions form a separate two-lobed fin extending forward from the lower side in front of the mouth and nostrils; their crowns are high-domed; their eyes and spiracles are on the sides of the head instead of on its upper surface; and they have a small dorsal fin on the upper side of the tail in front of the tail spines. Their teeth have the form of large, flat grinding plates, fitting close together in mosaic arrangement; and there are only 7 to 9 series of them in each jaw.

### Cow-nosed ray

*Rhinoptera bonasus* (Mitchill) 1815

Bigelow and Schroeder, 1953, p. 469.

Garman, 1913, pl. 37, as *Rhinoptera quadriloba*.

*Description.*—The cow-nosed rays with all their close relatives<sup>82</sup> have such characteristic outlines, the shape of their heads is so peculiar with the eyes and spiracles on the sides, and their large, flat, plate-like teeth are so different from those of any other Gulf of Maine skates or rays that they are not apt to be mistaken for anything else.

The species in question is characterized among its conferees by the indented contour of the front of its head, and by the conspicuously bilobed outline of the short so-called "subrostral" fin that projects forward from the lower side of the latter. The outer corners of the pectorals are pointed, and their posterior margins distinctly concave. The pelvic fins are small, reaching but a short distance back of the posterior corners of the pectorals. The dorsal fin is rounded above, originating about opposite the rear ends of the bases of the pelvics. The tail measured from the center of the cloaca is about twice as long as the body from cloaca to front of head on adults if not damaged, nearly 3 times on small specimens. The tail spines (1 or 2) are close behind the rear limits of the pelvic fins, and thus much further forward on the tail than those of the sting rays (p. 74). There usually are 7 series of teeth in each jaw, with up to 11 to 13 rows exposed, and in function simultaneously.

*Size.*—The cow-nosed ray has been said to grow to a breadth of 7 feet. But the largest specimen the width of which has either been actually measured or can be calculated from some other dimension, was only about 38 inches wide.<sup>83</sup>

*Color.*—Brownish above, white or yellowish white below. Some of them are marked both above and below with many narrow faint dark lines radiating out from the center of the disc.

*General range.*—Western Atlantic coast from middle Brazil to southern New England.

<sup>81</sup> This estimate is based on our own observations near Woods Hole.

<sup>82</sup> The eagle rays, family Myliobatidae, and butterfly rays, family Gymnuridae, are close allies of the cow-nosed rays; none of them has yet been encountered in our Gulf.

<sup>83</sup> Calculated from the dimensions of the head of one from Rio de Janeiro.

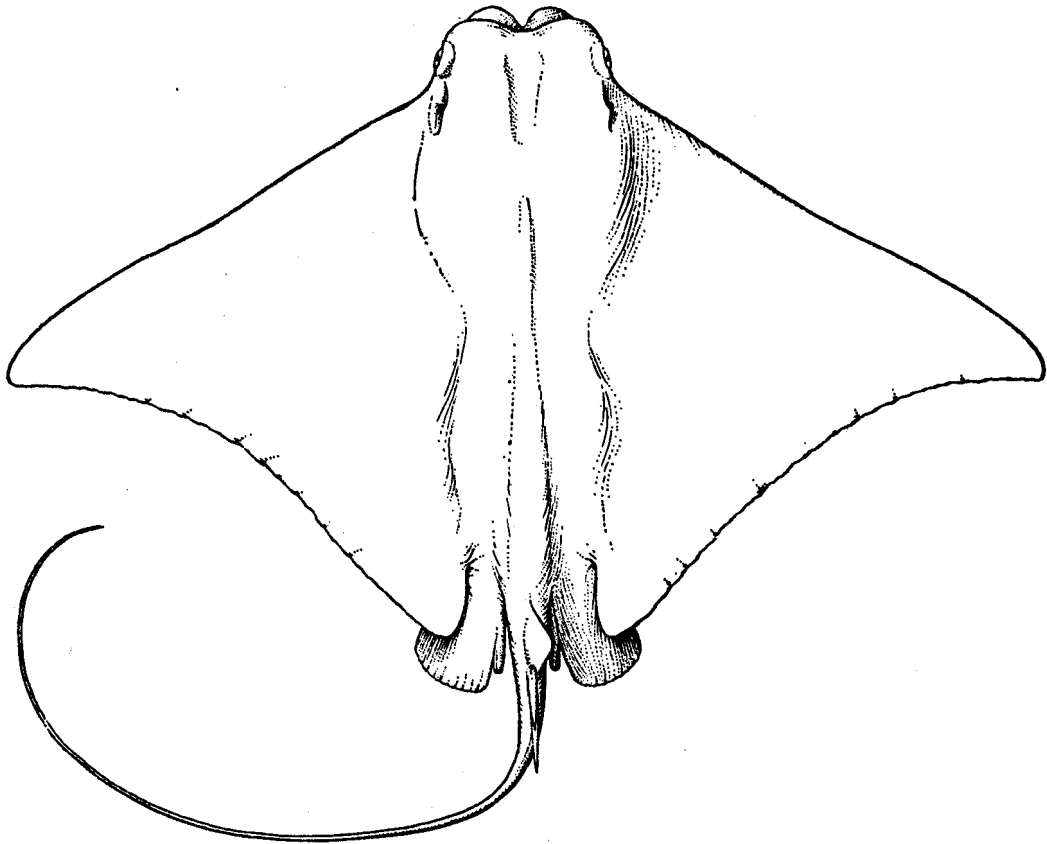


FIGURE 33.—Cow-nosed ray (*Rhinoptera bonasus*), about 22 inches wide, Newport, Rhode Island. From Bigelow and Schroeder. Drawing by E. N. Fischer.

*Occurrence in the Gulf of Maine.*—The cow-nosed ray has even less claim than the sting ray to be called a Gulf of Maine fish, for while schools of them appear occasionally near Woods Hole where

145 of them were taken in the fish traps in one day on one occasion, and while it is recorded from Nantucket, it has never been seen, actually, east or north of the elbow of Cape Cod.

### DEVIL RAYS. FAMILY MOBULIDAE

The devil rays, like the sting rays (p. 74) and cow-nosed rays (p. 76) have the pectoral fins interrupted along the sides of the head close behind the eyes. But they differ very noticeably from the others mentioned above in the shape of the anterior parts of the pectorals, for these are in the form of two separate narrow ear-like fins, set vertically and curving forward from the front of the head. They are further unique among skates and rays in the fact that they feed on small pelagic animals, which they sift, by a complex sieve-like modification of their gill arches, out of the water that is gulped in by the mouth and passed out via the gill clefts. Some of them are the largest of the rays and among the largest of

fishes. Being tropical-subtropical in nature they have no real place in the fish fauna of our Gulf, but *Manta*, the largest of them all, has been known to reach Georges Bank as a stray from warmer latitudes.

#### Devil ray *Manta birostris* (Donndorff) 1798

Bigelow and Schroeder, 1953, p. 502.

*Description.*—The so-called cephalic fins of the devil ray, pointing forward, give it so distinctive an appearance that it could not be confused with any other fish, except for some other member of its own family. And it is marked off from all others of these that are known in the Atlantic by the

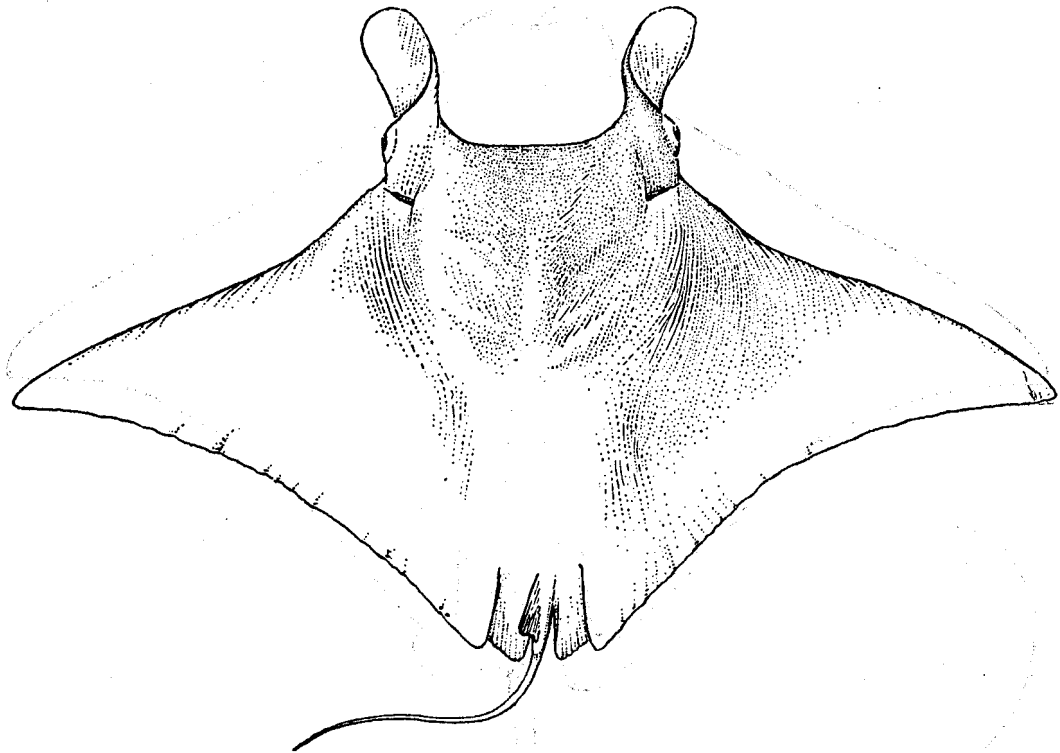


FIGURE 34.—Devil ray (*Manta birostris*), juvenile male, 11 feet 5½ inches wide, Bimini, Bahamas. From Bigelow and Schroeder. Drawing by E. N. Fischer.

position of its mouth, which extends across the front of its head instead of being on the under side. Its cephalic fins are about one-half as broad at the base as they are long, with thin lower edges and thick fleshy upper edges and rounded tips, and each arises nearly vertical from the side of the head. When the owner is swimming they point directly forward, but when the ray is feeding, they can be curved inward, one toward the other until their tips nearly meet in front of the mouth. The disc (not counting the cephalic fins) is a little more than twice as broad as long, with tapering outer corners. The tail measured from the cloaca is at least as long as the body from cloaca to front of head and perhaps longer still if not damaged. And it bears a small rounded dorsal fin on its base. Some specimens have been described as having one or two small tail spines close behind the dorsal fins. However, those that we have seen have had none, but a rounded knob in its place, supported by a mass of bony tissue with a minute pointed spur on the upper side that can be felt but does not break the skin. The skin of disc, pelvic fin, and tail is roughened with small tubercles, below as well as above. The mouth is

very wide, extending across a little more than one-half the whole breadth of the front of the head. And the teeth, the lower jaw only, are minute and very numerous; we counted about 270 series in about 12 to 18 rows or a total of about 4,500 in one specimen about 11½ feet wide. The gill openings are noticeably long.

*Color.*—The upper side varies from reddish or olive brown to bluish slate colored or black, either plain or with various white markings. The lower side is white toward the center of the disc but gray around the margins, and there may be various dark blotches in the region of the gills and on the abdomen. The rear part of the tail is gray.

*Size.*—This giant ray matures when about 14 to 15 feet wide. They commonly grow to 18 feet or so, and there are recent records of measured specimens 19 feet 8 inches, 21 feet 2 inches, and 22 feet wide. One 14 feet wide weighed 1,686 pounds, one from the Galapagos Islands, 18 feet wide, 2,310 pounds; and one of 20 feet taken long ago off Venezuela weighed 3,502 pounds.

*General range.*—*Manta* is known in the Atlantic from middle Brazil to the Carolinas and as a rare

stray to southern New England and Georges Bank; from Bermuda; from Madeira; and from tropical West Africa. Mantas are also widespread in the tropical-subtropical belt of the Pacific and Indian Oceans, but it is not yet known whether they are identical with the Atlantic species or not.

*Occurrence in the Gulf of Maine.*—The only reason for mentioning this giant ray here is that a pair, judged to be 18 to 19 feet wide, were

encountered on the southeast part of Georges Bank late in August 1949, by Capt. Henry W. Klimm, while out after swordfish, and so close at hand that their cephalic fins and purplish color were noted. The nearest record to the westward and southward is of one 19 feet wide, weighing 1,686 pounds, harpooned by a sword fisherman a few miles off Block Island and landed there in August 1921.<sup>84</sup>

## CHIMAERIDS. SUBCLASS HOLOCEPHALI

The chimaeroids, being cartilaginous fishes, are allied to the sharks, skates and rays, but are separated from them by many important anatomic characters. Most obvious of these externally are that they have no spiracle; that they have only one external gill opening on either side; that their tails are symmetrical; and that their gill filaments are free at the tips like those of bony fishes. The chimaeroids remotely suggest the grenadiers in general body form (p. 243), but are easily separable from them at a glance; first of all by the softness of their bodies and by their naked

skins, also by the location of the pelvic fins which are set far back under or behind the tips of the pectorals, 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.

They lay eggs that are astonishingly large for the size of the parent fish, and enclosed in brown horny capsules which are elliptical, spindle-shaped or tadpole-shaped in different species. But fertilization is internal.

### The Chimaeras. Order Chimaerae

#### FAMILY CHIMAERIDAE

*Chimaera Hydrolagus affinis* (Brito Capello)  
1868

Bigelow and Schroeder, 1953, p. 539

*Description.*—This species of chimaeroid, the only one known from within the geographic limits of the Gulf, is deepest (one-sixth to one-seventh as deep as long) just behind the gills, tapers gradually backward to a weak slender tail, and is very soft-bodied. The head is short, its dorsal

profile oblique, the snout conical with a blunt tip. The forehead of the male bears a curious cartilaginous hook, armed with recurved prickles on its lower surface, which probably serves to clasp the female. The mouth, on the lower side of the head, is small, with thick fleshy lips; the upper jaw is armed with 4 flat plates in place of teeth,

<sup>84</sup> Reported by Gudger (Science, N. Ser., vol. 55, 1922, p. 339). There are photographs of this specimen in the American Museum of Natural History in New York.

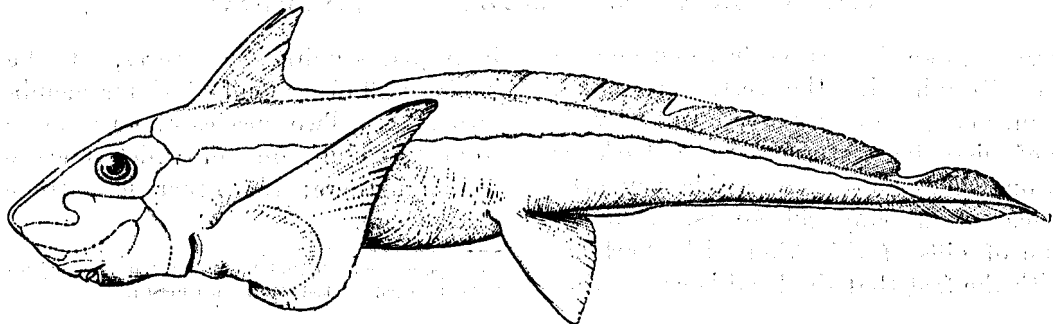


FIGURE 35.—*Chimaera (Hydrolagus affinis)*, female, about 31¼ inches long, Banquereau Bank. From Bigelow and Schroeder. Drawing by E. N. Fischer.