CANADIAN ATLANTIC FAUNA

12. CHORDATA

12d. MARSIPOBRANCHII (LAMPREYS)
12e. ELASMOBRANCHII (SHARKS AND RAYS)
12f. HOLOCEPHALI (CHIMAEROIDS)

BY

HENRY B. BIGELOW AND W. C. SCHROEDER

WITH FIGURES

(Contribution No. 61 of the Woods Hole Oceanographic Institution)

Printed by
THE UNIVERSITY OF TORONTO PRESS
for the
BIOLOGICAL BOARD OF CANADA

TORONTO
1934

CANADIAN ATLANTIC FAUNA

12. CHORDATA

12d. MARSIPOBRANCHII (LAMPREYS)
12e. ELASMOBRANCHII (SHARKS AND RAYS)
12f. HOLOCEPHALI (CHIMAEROIDS)

BY

HENRY B. BIGELOW AND W. C. SCHROEDER

WITH FIGURES

(Contribution No. 61 of the Woods Hole Oceanographic Institution)

Printed by
THE UNIVERSITY OF TORONTO PRESS
for the
BIOLOGICAL BOARD OF CANADA

TORONTO
1934

CANADIAN ATLANTIC FAUNA

MARSIPOBRANCHII, ELASMOBRANCHII ET HOLOCEPHALI

The numbers placed after the specific names refer to the numbered articles in the list of selected literature. Those in heavy type refer to articles containing descriptions or figures of the species.

Specimens of all, except the starred (*) species have been available.

SELECTED LITERATURE*

(1) Bigelow, H. B., and Schroeder, W. C. Notes on northwest Atlantic sharks and skates. Bull. Mus. Comp. Zool., Vol. 68, pp. 239-251, 1927.

(2) Bigelow, H. B., and Welsh, W. W. Fishes of the gulf of Maine. Bull. U.S. Bur. Fish., Vol. 40, Part 1, 567 pp. 1925.

(3) Ehrenbaum, E. Die Fische. Fauna Arctica, Vol. 2, pp. 65-168. 1902.

(4) Garman, S. The Plagiostomata (Sharks, skates and rays). Mem. Mus. Comp. Zool., Vol. 36, 515 pp., Atlas 77 pls. 1913.

(5) Halkett, Andrew. Check list of the fishes of the Dominion of Canada and Newfoundland. 138 pp., pls. 1-14. Ottawa, 1913.

(6) Jensen, Ad. S. The selachians of Greenland. Mindskrift for Japetus Streenstrup. 40 pp., pl. 30. 1914.

(7) Jordan, D. S., and Evermann, B. W. The fishes of north and middle America. Bull. U.S. Nat. Mus., No. 47, Parts 1-4, 3313 pp., 392 pls. 1896-1900.

(8) Smitt, F. A. A history of Scandinavian fishes. Ed. 2, Vol. 2; pp. 567-1240, pls. 28-53. Stockholm, 1895.

(9) Clark, R. A. Rays and skates. Fishery Board for Scotland. Scientific Investigations, No. I, 66 pp., 44 figs. and 36 pls. 1926. Edinburgh.

KEY TO MAJOR DIVISIONS OF CANADIAN ATLANTIC FISHES

1. (2) Mouth soft, without articulated jaws; no paired fins. Class MARSIPOBRANCHII (p. 2)

2. (1) Mouth with well-developed jaws; pectoral fins present in all Canadian Atlantic species. Class PISCES (p. 4)

3. (6) Skull and skeleton cartilaginous; teeth not imbedded in the jaws.

*The nomenclature employed here follows Jordan and Everman (7) for the lampreys; Garman (4) for the sharks, skates and rays.

4. (5) Five or more pairs of large gill openings on each side of the neck.
Sub-class ELASMOBRANCHII (p. 4)
5. (4) Only one gill opening on each side of the neck. Sub-class HOLOCEPHALI (p. 38)
6. (3) Skull largely bony; teeth (if present) imbedded in the jaws.
Sub-class TELEOSTOMI (in later part)

MARSIPOBRANCHII. LAMPREYS AND HAGS

Mouth jawless situated at tip of snout, form eel-like, no paired fins. Skeleton cartilaginous, scarcely separated into skull and vertebral column. No ribs, shoulder, or pelvic girdles. Nostril single, median; skin naked.

KEY TO GENERA

1. (2) Only one fin on the back; snout with barbels, only one gill opening on each side. **MYXINE** (p. 2)
2. (1) Two separate dorsal fins; snout without barbels; seven gill openings on each side. **PETROMYZON** (p. 3)

MYXINIDAE. HAGFISHES

One gill opening on each side; snout with several barbels; dorsal fin-fold continuous.

Genus **MYXINE** Linnaeus
Characters as above.

M. glutinosa Linnaeus. Hagfish. **2, 3, 5** (*Myxine limosa*), **7, 8.** (Fig. 1)

Body slender, eel-like, about 24 times as long as thick. Mouth with 2 barbels on each side; stellate in outline when closed; no lips; nostril surrounded by 4 barbels; tongue evertible, with two rows of 7-9 and 8-10 rasplike horny "teeth". Continuous fin-fold extends from posterior third of back, around tip of tail, and forward two-thirds the way along lower surface. A series of mucous sacs, with prominent pores, on either side of abdomen, extending from about one-thirteenth the way back from snout, to beyond cloaca. Pores 26-33 in front of branchial apertures; 57-66 between branchial aperture and cloaca (up to 70 recorded), and 11-13 behind cloaca, on 9 specimens from Grand Manan. In European specimens 24-34+54-64+10-14 are recorded. Both European and American specimens examined. Colour, grayish, to brownish, or reddish above, mottled or plain; whitish or pale gray below. Length up to 18 inches.

Depth 20 to 525 fathoms. Mud bottom. Greenland and Grand banks to North Carolina; most plentiful north and east of cape Cod; in Europe from White sea to English channel.

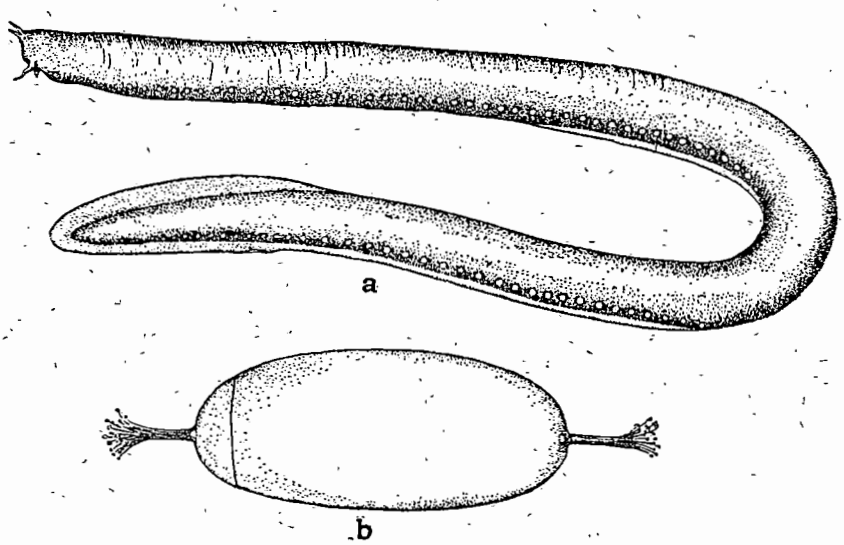


Fig. 1. Hagfish (*Myxine glutinosa*). a, Adult. b, Egg. After Bigelow and Welsh.

PETROMYZONTIDAE. LAMPREYS

Gill openings 7 on each side; snout without barbels; dorsal portion of fin-fold deeply notched or divided into two dorsal fins; rear part continuous around the tail.

Genus **PETROMYZON** Linnaeus

Buccal disk large, with numerous teeth arranged in concentric series. Dorsal fin-fold divided into two separate fins.

P. marinus Linnaeus. Sea lamprey. **2**, 3, 5, **7**, **8**. (Fig. 2)

Body eel-like. Skin naked. Mouth a longitudinal slit when closed, an elliptical disk when open; anterior lingual lamella sharply curved, but without differentiated median cusp. Gill clefts 7 on each side. Horny teeth numerous, in 11 or 12 concentric rows in radiating series; innermost teeth the largest. Dorsal fin-fold well separated, the first originating near middle of body, the second continuous around tail with ventral fold. No paired fins. Colour, mottled

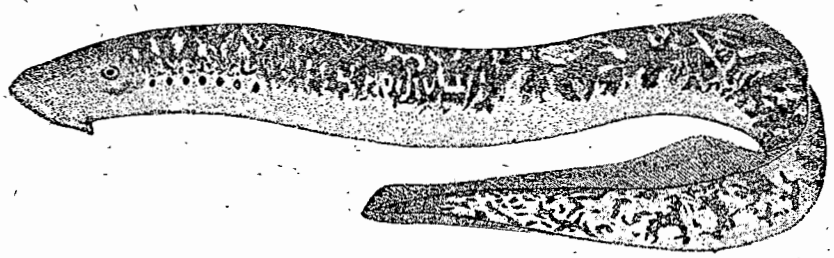


Fig. 2. Sea lamprey (*Petromyzon marinus*). After Jordan and Evermann.

brown above, sometimes greenish, reddish, or plain blue; below whitish, gray, or a paler shade of ground colour of back. Length usually less than 2½, rarely up to 3 feet.

Anadromous, ascending freshwater streams in spring to spawn. West Greenland and southern Labrador to Florida; Iceland; Norway and Faroes south to Mediterranean and west Africa.

PISCES. TRUE FISHES.

ELASMOBRANCHII. SHARKS AND RAYS

Five or more pairs of gill openings; skin leathery, with denticles (placoid scales). Fins supported by cartilaginous rods, and horny fibres, and covered by the leathery skin. Skeleton chiefly cartilaginous; skull far simpler than in bony fishes; jaws and teeth highly developed, the latter imbedded in the gums, with successive rows becoming functional. Gills attached throughout their lengths to the partitions between the gill clefts.

Inner margins of ventral fins modified into rod-like, semi-tubular copulatory organs, in males.

KEY TO GENERA (ADULTS)

1.	(32)	General form cylindrical.		(*Sharks*)
2.	(3)	Head hammer- or shovel-shaped.	**CESTRACION**	(p. 9)
3.	(2)	Head of ordinary shape; rounded or pointed snout.		
4.	(5)	One dorsal fin; 6 gill clefts.	**CHLAMYDOSELACHUS**	(p. 5)
5.	(4)	Two dorsal fins; 5 gill clefts.		
6.	(15)	No anal fin.		
7.	(8)	First dorsal far back, over ventrals.	**ECHINORHINUS**	(p. 20)
8.	(7)	First dorsal well in front of ventrals.		
9.	(14)	First and second dorsals each preceded by a spine, long or very short.		
10.	(13)	Dorsal spines long.		
11.	(12)	Rear margin of upper lobe of tail notched near tip.	**CENTROSCYLLIUM**	(p. 18)
12.	(11)	Rear margin of upper lobe of tail not notched.	**SQUALUS**	(p. 17)
13.	(10)	Dorsal spines very short.	**CENTROSCYMNUS**	(p. 17)
14.	(9)	No dorsal spines.	**SOMNIOSUS**	(p. 19)
15.	(6)	Anal fin present.		
16.	(17)	Gill clefts very long, nearly meeting below; gills with horny rakers; teeth tiny.	**CETORHINUS**	(p. 16)
17.	(16)	Gill clefts confined to sides of neck; gills without rakers; teeth large.		
18.	(21)	Caudal peduncle with a strong longitudinal keel on either side; tail lunate with lower lobe at least two-thirds as long as upper.		
19.	(20)	Teeth broad, triangular, with serrate edges; pectoral 1½ to 2 times as long as first dorsal is high.	**CARCHARODON**	(p. 15)
20.	(19)	Teeth slender, lanceolate, pectoral only slightly longer than first dorsal is high.	**ISURUS**	(p. 13)
21.	(18)	No longitudinal keels on caudal peduncle; upper lobe of tail much longer than lower lobe.		

22. (23) Upper caudal lobe nearly as long as head and body combined. **ALOPIAS** (p. 11)
23. (22) Upper caudal lobe less than half as long as head and body combined.
24. (25) Teeth small, blunt, and arranged in a pavement. **MUSTELUS** (p. 6)
25. (24) Teeth erect, pointed, and only one or two rows functional at a time.
26. (27) Second dorsal nearly as high as first. **CARCHARIAS** (p. 12)
27. (26) Second dorsal less than half as high as first.
28. (29) Origin of first dorsal close behind axilla of pectorals; outer margins of teeth deeply notched. **GALEOCERDO** (p. 8)
29. (28) Origin of first dorsal considerably behind axilla of pectorals; outer margins of teeth not deeply notched.
30. (31) First dorsal originates nearer to ventrals than to pectorals; snout long, pointed. **PRIONACE** (p. 7)
31. (30) First dorsal originates nearer to pectorals than to ventrals; snout short, rounded. **CARCHARINUS** (p. 7)
32. (1) General form flat and disk-like. (*Skates and Rays*)
33. (36) No long dorsal spines on tail; extremity of tail comparatively stout.
34. (35) Caudal fin very small; skin more or less prickly. **RAJA** (p. 21)
35. (34) Caudal fin large, triangular, skin perfectly smooth. **NARCACION** (p. 35)
36. (33) Tail with one or more long dorsal spines. **DASYBATUS** (p. 36)

CHLAMYDOSELACHIDAE. EEL SHARKS

Six gill clefts; 1 dorsal fin without spine; no nictitating membrane; nostrils on top of snout.

Genus **CHLAMYDOSELACHUS** Garman

Characters as above.

C. anguineus Garman. Eel shark. **2, 3, 4, 7.** (Fig. 3)

Body eel-like; mouth terminal. Six pairs of gill clefts. Teeth similar in the two jaws, with a broad base and 3 curved, slender cusps; $\frac{28}{26}$ to $\frac{32}{32}$ rows; one median tooth. Dorsal fin far back, low, somewhat smaller than and above anal. Caudal pointed. Colour, uniform brown. Length 2 to 5 feet.

Japan; New South Wales; Madeira; Norway; and doubtful record from Pemaquid point, Maine.

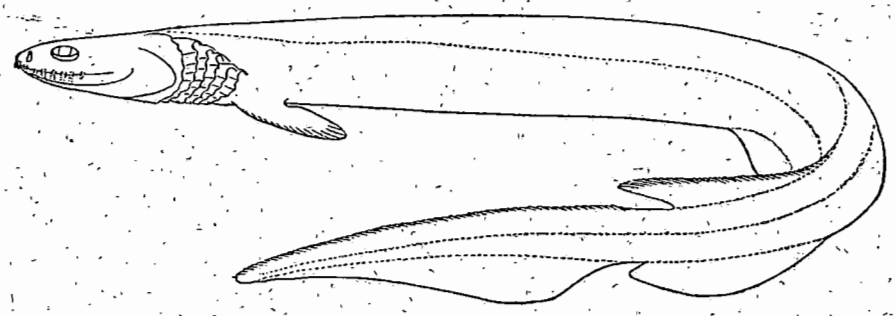


Fig. 3. Eel shark (*Chlamydoselachus anguineus*). After Goode and Bean.

MUSTELIDAE.[1] SMOOTH DOGFISHES

Five gill clefts; 2 dorsal fins without spines; anal fin present; axis of tail little raised; nictitating membrane present; teeth in bands, or in pavement, several series functioning at once.

Genus **MUSTELUS**[1] Linck

Teeth blunt, in pavement. No nasoral grooves.

M. canis (Mitchill). Smooth dogfish. **2** and **4** (*Galeorhinus laevis*), **7**. (Fig. 4)

Trunk slender; snout flattened, blunt at tip; mouth crescentic; teeth small, low, blunt, rhomboid to oval, their upper surface convex, some with outer edges more or less deeply notched, arranged like a pavement, $\frac{74}{80}$ rows in specimen examined. First dorsal triangular, its rear margin concave, originating close behind axilla of pectorals. Second dorsal similar to first, about two-thirds as high, situated far back, but originating in front of anal. Lower caudal lobe only about one-fourth as long as upper, rear margin of upper deeply notched. Pectorals about as large as first dorsal. Colour, plain gray or olive to brown sometimes with pale spots above; white yellowish, or pale gray below. Length of adults usually 2 or 3 feet; maximum about 5 feet.

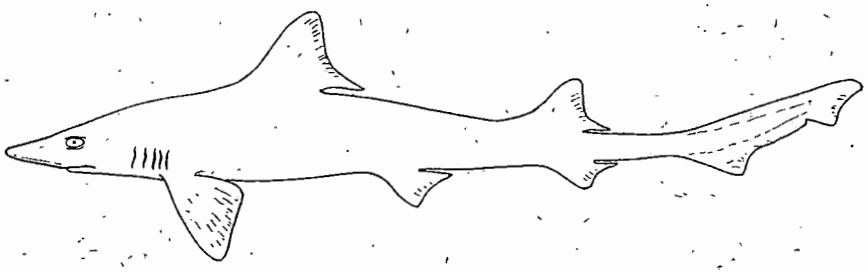
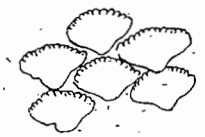
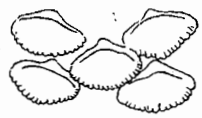


Fig. 4. Smooth dogfish (*Mustelus canis*). After Garman.





Teeth.

Shoal water. Bay of Fundy to Cuba, not common north of cape Cod; Atlantic coasts of southern Europe; Mediterranean; South Africa from the cape to Natal.

---

[1]Opinion 93, International Commission on Zoological Nomenclature (Science, N. S., vol. 65, p. 300) places *Mustelus* in the official list. Consequently *Mustelidae* replaces *Galeorhinidae* as the family name.

CARCHARINIDAE. REQUIEM SHARKS

Teeth compressed, sub-triangular, sharp-edged, pointed, with a single large cusp, one series functional at a time; otherwise as in Mustelidae (p. 6).

Genus **CARCHARINUS**

First dorsal (western Atlantic species) originates nearer to axilla of the pectorals than to ventrals. No spiracle. Some or all of the teeth serrate; their cusps erect, or only slightly oblique.

C. obscurus* Lesueur. Dusky shark. **2, 4, 7.** (Fig. 5)

Trunk heaviest at or behind the pectorals; snout blunt, broader than long, rounded at tip; short grooves at corners of mouth. Teeth erect, separate, with serrate margins, in about $\frac{29}{30}$ rows; upper triangular; inner margin convex, outer notched; lower teeth with narrow lanceolate cusps and broad bases. Height

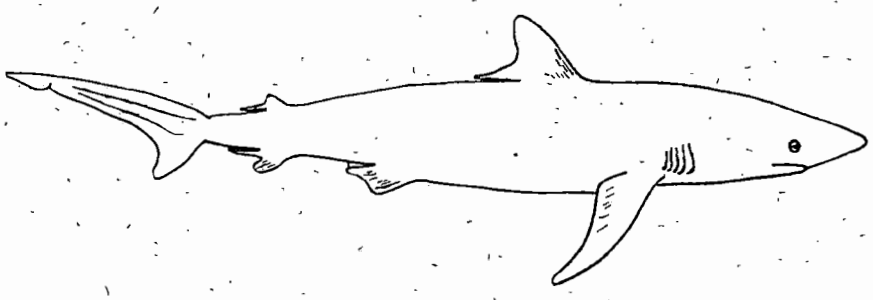


Fig. 5. Dusky shark (*Carcharinus obscurus*). After LeSueur, slightly emended.

of first dorsal nearly equal to distance from eye to first gill cleft, origin behind inner angle of pectoral. Second dorsal above anal, noticeably smaller than latter. Upper caudal lobe much the larger; pectorals relatively long and narrow. Colour, gray brown above; whitish below. Length to about 14 feet, usually 6 to 9 feet.

Teeth, after LeSueur.

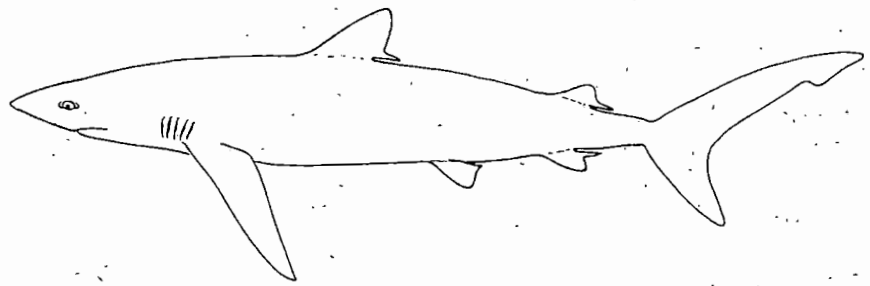
Coastal waters, north casually to cape Elizabeth, Maine, and northeastern part of Georges bank; southern range doubtful because of confusion with other species. Madeira; Canary islands; South Africa.

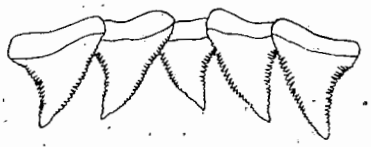
Genus **PRIONACE** Linnaeus

First dorsal nearer to ventrals than to pectorals; teeth serrate, unlike in the two jaws; no spiracles.

P. glauca (Linnaeus). Great blue shark. **1, 2, 4** (*Galeus glaucus*); **5, 7** (*P. glauca*); **8** (*Carcharias glaucus*). (Fig. 6)

Body fusiform, rather slender. Snout conical, pointed. Mouth crescentic, teeth usually $\frac{28}{28}$ to $\frac{31}{31}$, exceptionally as few as 23 rows in lower jaw; upper teeth triangular, serrate, curved outward, inner margins convex, outer margins concave; lower teeth narrower, with nearly straight cusps and weaker marginal serrations.





Teeth.

Fig. 6. Great blue shark (*Prionace glauca*). Based on photographs of specimens taken on Georges bank.

Teeth more strongly serrated in small than large fish. First dorsal notably small, height equal to about snout to eye, origin nearer ventrals than axilla of pectorals. Second dorsal less than half as high as first, over anal. Lower caudal lobe about half as long as upper, each measured from the corresponding caudal pit. Pectorals, long, scimitar-shaped, length equal to about snout to third gill cleft. Colour, strong blue[2] above, shading to paler on sides; white below, tips of pectorals usually dusky; anal sometimes partly dusky. Maximum length in northern seas usually 10 to 12 feet.

Pelagic in all warm oceans. North to Nantucket shoals and Nova Scotia, and occasionally to Grand banks.

Genus **GALEOCERDO**

First dorsal much closer to pectorals than to ventrals. Teeth serrate, alike in the two jaws. Small spiracles present.

---

[2]"Sailor Blue," plate XXI, Color Standards and Color Nomenclature, Robert Ridgway, 1912, Washington.

G. arcticus (Faber). Tiger shark. **2, 4, 7** (*G. tigrinus*). (Fig. 7)

Body heaviest forward of first dorsal, tapering toward tail; snout short, broad, rounded; mouth nearly two-thirds breadth of snout; labial folds much longer on

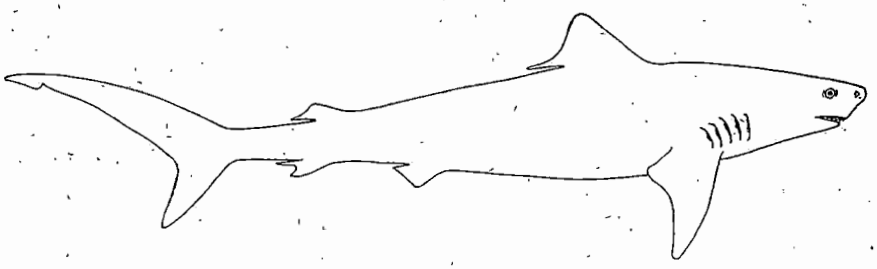


Fig. 7. Tiger shark (*Galeocerdo arcticus*). From a specimen 4½ feet long in the Museum of Comparative Zoölogy.

Teeth.

upper jaw than on lower. Teeth large, sharp-edged, alike in the two jaws, in $\frac{21}{21}$ to $\frac{25}{25}$ rows; points directed toward the corners of the mouth, inner edges convex, outer edges concave and deeply notched; both edges with coarse serrations near the base, but nearly smooth near tip. First dorsal triangular, slightly smaller than pectorals; originating very slightly behind axilla of pectoral in specimen examined (its position variously described). Second dorsal and anal very small, about equal, the former standing before the latter. Pectorals as long as distance from eye to third gill cleft; upper caudal lobe notched, about twice length of lower, or one-fourth length of fish. Caudal peduncle with low keels. Colour, light brown, more or less spotted and barred with darker brown, these markings fading with growth. Length frequently 12 to 15 feet; exceptionally to 30 feet.

Cosmopolitan in warm parts of all oceans; chiefly coastal; not uncommon north to Woods Hole; occasional at Provincetown, cape Cod.

CESTRACIONTIDAE. HAMMERHEAD SHARKS

Characters as in Carcharinidae, except frontal region of skull expanded laterally, in characteristic "heart" or "hammer" outline, with the eyes at the tips.

Genus **CESTRACION**

Characters as above.

Key to species

Head very broad, its greatest width about 3 in total length.	**zygæna**
Head less broadly expanded, its width about 5 in total length.	**tiburo**

C. zygæna (Linnaeus). Hammerhead. **2, 4, 7** (*Sphyrna zygæna*). (Fig. 8)

Trunk slender. Head hammer-shaped with the eyes at ends of lateral processes. Teeth in $\frac{29}{28}$ to $\frac{36}{34}$ rows; similar in the two jaws; usually oblique, sometimes nearly erect, margins nearly straight, outer notched, more or less serrate (fig. 8); lower narrower than upper. First dorsal higher than length of its base, origin well behind axilla of pectoral; second dorsal hardly one-fifth height of first, above anal, which is similar. Upper caudal lobe (measured from its pit) notably long, equal to about 30 per cent of total length of fish; deeply notched near its tip; lower lobe less than half length of upper; pectorals broadly triangular, smaller than first dorsal. Colour, gray to ashy brown above; paler brown to dirty white below. Maximum length 17 feet.

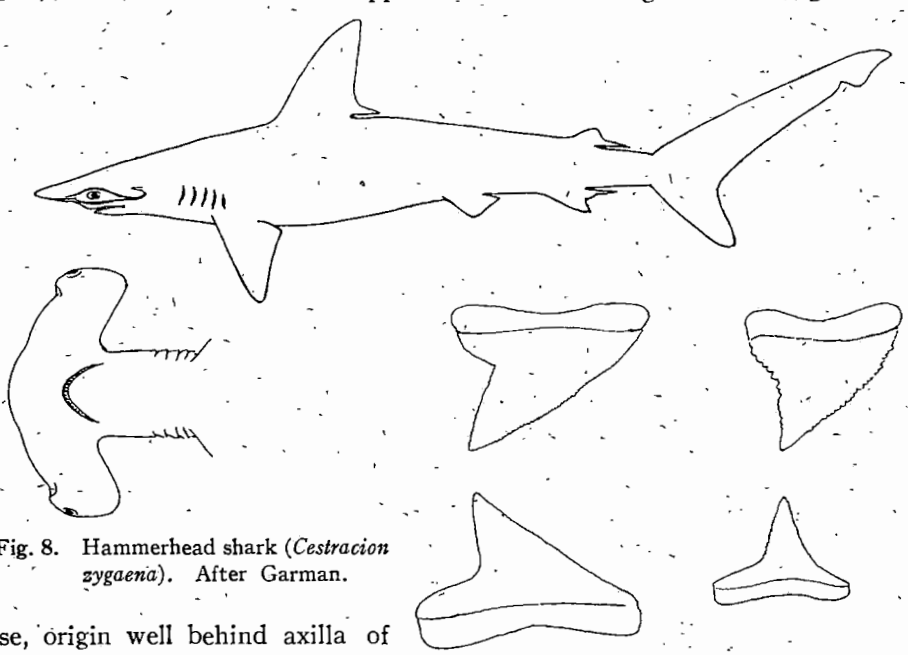


Fig. 8. Hammerhead shark (*Cestracion zygaena*). After Garman.

Upper and lower teeth of two specimens, showing individual variation.

Cosmopolitan in warm coastal seas; north to offing of southern Nova Scotia and England.

C. tiburo (Linnaeus). Bonnet shark. **4, 7** (*Sphyrna tiburo*). (Fig. 9)

Body moderately slender, compressed; lateral expansions of head shorter and relatively much broader than in *C. zygæna*. Mouth crescentic. Teeth in $\frac{26}{25}$ to $\frac{32}{31}$ rows, with broad bases, and low cusps, upper more oblique than lower.

First dorsal origin behind axilla of pectoral, height greater than length of base; second dorsal and anal relatively larger than in *C. zygæna*, nearly one-third as high as first dorsal. Caudal long, upper caudal lobe deeply notched near tip, lower lobe less than half length of upper. Ventrals larger than in *C. zygæna*;

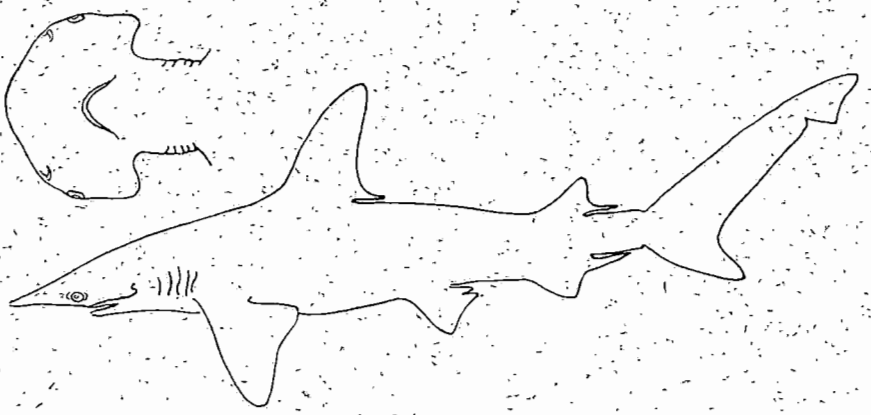


Fig. 9. Bonnet shark (*Cestracion tiburo*). After Garman.

length of pectorals about equal to height of first dorsal, broader than in *C. zygæna*. Colour, grayish above, sometimes with a few small dark spots on sides. Pale below. Length seldom more than 5 feet.

Widespread in warm, coastal seas. Casual to Massachusetts bay.

ALOPIIDAE. THRESHER SHARKS

Characters as in Carcharinidae (p. 7), except tail enormously elongate, and no nictitating membrane.

Genus **ALOPIAS**

Characters those of the family.

A. vulpinus (Bonnaterre). Thresher. **2** and **4** (*Vulpecula marina*), **5**, **7** and **8** (*A. vulpes*). (Fig. 10)

Body stoutest opposite pectorals; snout broadly rounded, notably short;

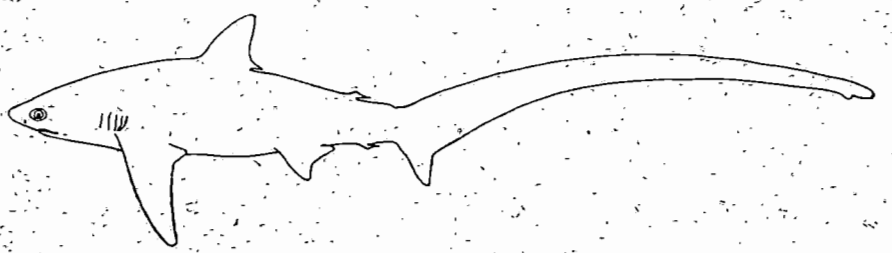
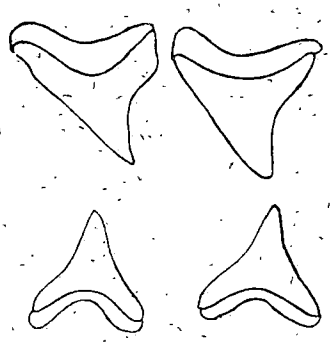


Fig. 10. Thresher (*Alopias vulpinus*). After Garman.



Teeth of *A. vulpinus*.

teeth in $\frac{42}{37}$ to $\frac{50}{50}$ rows; alike in the two jaws, small, triangular, with smooth edges. First dorsal relatively low, origin well behind axilla of pectoral. Second dorsal very small, similar to and in front of anal. Caudal enormously long, scythe-shaped, the peduncle without keels or pits. Ventrals much larger than anal, about as long as lower caudal lobe; pectorals sickle-shaped, length about twice height of first dorsal. Colour, dark leaden brown to nearly black above; white below; lower sides of pectorals leaden. Maximum length 20 feet or more.

All warm seas, north to Nova Scotia, and perhaps gulf of St. Lawrence.

CARCHARIIDÆ. SAND SHARKS

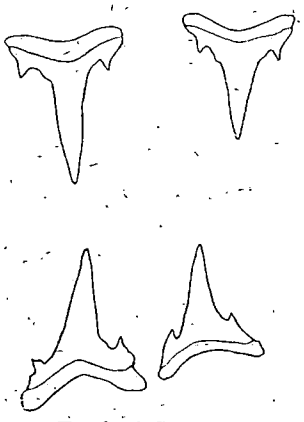
Characters as in Carcharinidae (p. 7), except no nictitating membrane.

Genus **CARCHARIAS**

Snout short; upper caudal pit well developed; lower caudal lobe well developed.

C. taurus Rafinesque. Sand shark. **2, 4, 7** (*C. littoralis*). (Fig. 11)

Body stout; snout short, flattened above, blunt at tip. Teeth in $\frac{40}{36}$ to $\frac{46}{40}$ rows; alike in the two jaws, long, narrow, pointed, smooth-edged, most of them with a denticle at either side near base. First dorsal, originating well behind inner angle of pectoral, relatively small, height about equal to snout to eye, its base equal to height. Second dorsal and anal, similar to first dorsal, and nearly as large. Upper caudal lobe deeply notched, about 30 per cent total length of fish; lower lobe about one-third length of upper. Pectorals triangular, slightly larger than first dorsal. Colour, gray, darker above than below, indistinctly spotted or mottled with darker; fins sometimes edged with black. Length of adults usually 4 to 6 feet, rarely 8 or 9 feet.



Teeth of *C. taurus*.

Shoal coastal waters, North Carolina to gulf of Maine, casual to bay of Fundy; Mediterranean and South Africa.

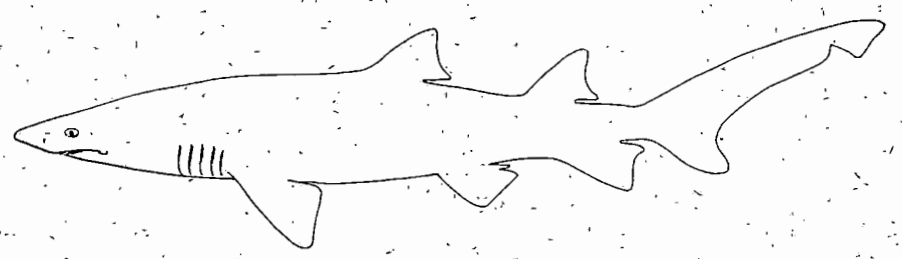


Fig. 11. Sand shark (*Carcharias taurus*). After Garman.

ISURIDAE. MACKEREL SHARKS

Anal fin present; no dorsal spines. Vertebral axis of tail turns abruptly upward from horizontal; lower caudal lobe only slightly shorter than upper. A strong mid-lateral keel on either side of caudal peduncle; deep upper and lower caudal pits.

Genus **ISURUS**

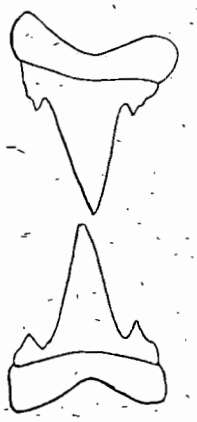
Gills without horny strainers. Teeth large, narrow, pointed, their margin not serrate.

Key to species

First dorsal origin well behind axilla of pectoral. Teeth without denticles.	**tigris**
First dorsal origin over axilla of pectoral. Teeth with lateral denticles in adults.	**nasus**

I. nasus (Bonnaterre). Common mackerel shark. **1, 2** (*I. punctatus*+*I. nasus*), 3 (*I. cornubicus*), **4** (*I. punctatus*+*I. nasus*), 5 and 7 (*Lamna cornubica*), **8** (*I. cornubicus*). (Fig. 12)

Trunk very stout, thickest opposite pectorals; snout conical, pointed; teeth in $\frac{24}{20}$ to $\frac{32}{28}$ rows, alike in the two jaws, with narrow pointed cusps, and broad bases, having small, sharp denticle on each side near base in adults; these denticles lacking in some or all teeth in young. Third tooth from centre in upper jaw very small. First dorsal arises directly over axilla of pectoral, triangular, about as high as long, height about equal to eye to second gill cleft. Second dorsal very small; origin over origin of anal. Anal similar to second dorsal. Tail lunate; upper caudal lobe (measured from its pit) nearly one-third distance from snout to caudal base, its rear margin notched near tip; lower caudal lobe about 70 per cent as long as upper. Pectorals longer than first dorsal is high; falcate-triangular. Colour, dark bluish gray above; white below; pectorals dusky, on outer half or one-third. Anal white or slightly dusky. Usual maximum length about 12 feet.



Teeth of *I. nasus*.

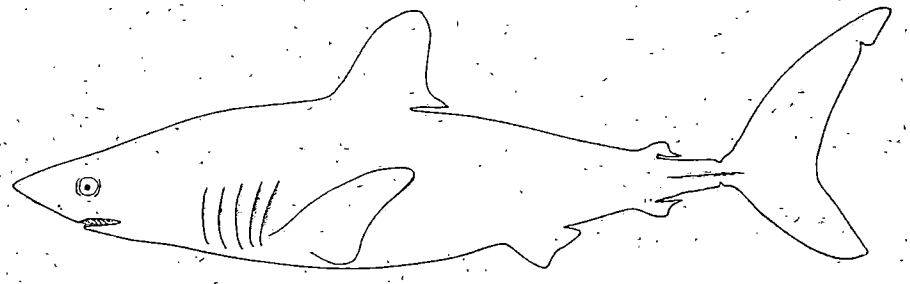


Fig. 12. Common mackerel shark (*Isurus nasus*). After Garman.

Pelagic in north Atlantic, Mediterranean and north Pacific; regularly north to Maine, occasional to the gulf of St. Lawrence and to southeastern Newfoundland.

I. tigris (Atwood). Sharp-nosed mackerel shark. **1, 2, 4, 7** (*I. dekayi*). (Fig. 13)

Trunk fusiform, snout conical, more pointed than in *I. nasus*. Teeth in about $\frac{26}{26}$ rows; alike in the two jaws, with narrow, pointed cusps, broad-based, without lateral denticles. First two teeth from the median line of the mouth longest, and more flexuous than the others. Third upper tooth smaller than the fourth. First dorsal, arising over rear angle of pectoral, relatively shorter than in *I. nasus*; origin of second dorsal anterior to anal origin. Lower lobe of caudal relatively longer than in *I. nasus*, about 75 per cent as long as upper lobe, each measured

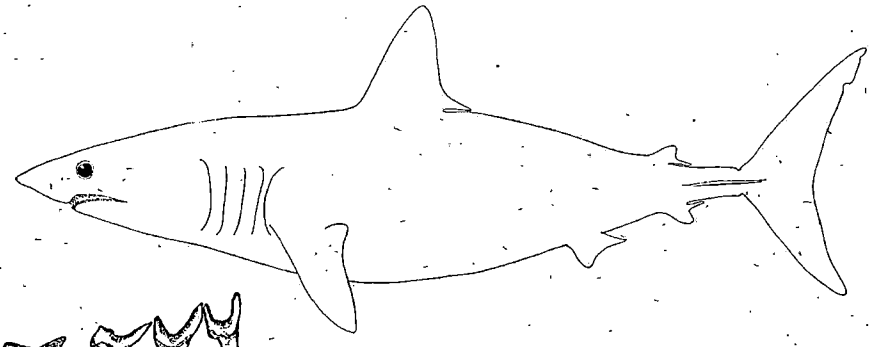


Fig. 13. Sharp-nosed mackerel shark (*Isurus tigris*) from a painting by J. Henry Blake, of a Massachusetts bay specimen, 8 ft. 4 in. long.

First four teeth from centre of upper and lower jaw. After Murphy.

from caudal pit. Colour, dark clear blue to ashy brown above; white below, with demarcation sharply defined. Pectoral without dusky blotch at the tip. Maximum length about 10 feet.

Pelagic in western Atlantic; West Indies to Massachusetts bay; perhaps identical with *I. oxyrhynchus* of Mediterranean and eastern Atlantic.

Genus **CARCHARODON**

Gills without horny strainers; teeth large, triangular, with serrate margins.

C. carcharias (Linnaeus). White shark. **2, 4, 5, 7.** (Fig. 14)

Trunk fusiform; snout conical, relatively shorter than in *Isurus*; distance

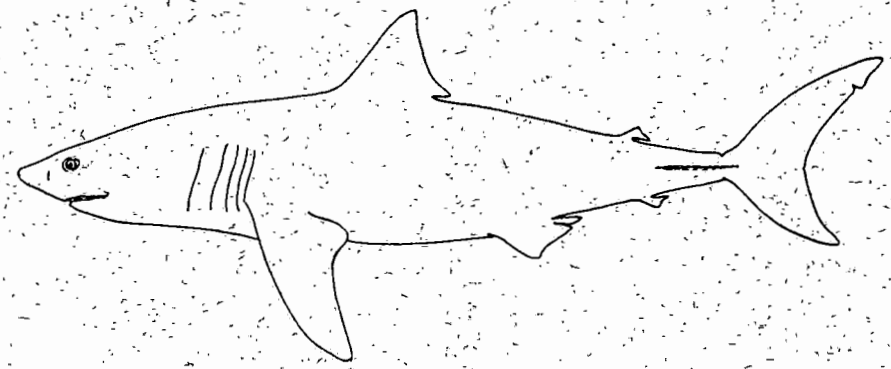
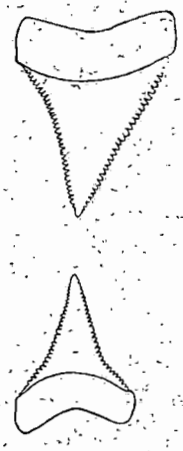


Fig. 14. White shark (*Carcharodon carcharias*). After Garman.



Teeth.

from its tip to eyes same as to mouth; teeth in about $\frac{26}{24}$ rows, triangular, serrate, lower narrower than upper, with edges more concave. First dorsal origin slightly behind axilla of pectoral; base slightly longer than height; height about equal to distance from corner of mouth to first gill cleft. Second dorsal very small, entirely in front of anal. Pectorals large, falciform, length equal to distance from snout to first gill cleft. Caudal lunate; lower lobe 73 to 92 per cent as long as upper, measured from pit; upper lobe notched. Caudal peduncle with deep pit above, a shallow below; with well developed longitudinal keels. Colour, slaty, leaden or blue-gray above; white below; a black spot in axilla of pectoral, sometimes extending out on fin, and on trunk. Maximum length to 40 feet; northern specimens usually small.

Cosmopolitan in warm seas; nowhere abundant; occasional in Massachusetts bay, bay of Fundy, and probably southeastern Nova Scotia.

Genus **CETORHINUS**

Gills with horny strainers; gill clefts very long; teeth small, conical.

C. maximus (Gunner). Basking shark. **2**, 3, **4**, 5, **7**, **8**. (Fig. 15)

Trunk stout; snout, in adult, blunt conical, flattened above (14 inches in front of mouth in 26 ft. specimen): in young produced in front of mouth into a sub-cylindrical proboscis (**8**, fig. 331) pointed at tip;

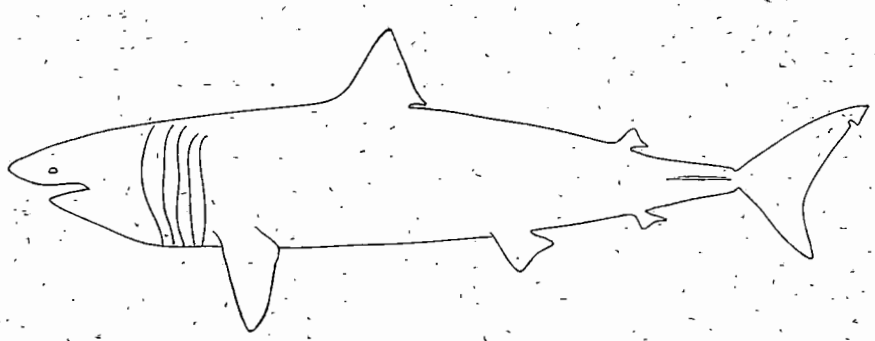


Fig. 15. Basking shark (*Cetorhinus maximus*), from a specimen about 26 feet long, in Boston Society of Natural History.

(about 9 inches long in 8-ft. Japanese specimen examined). Teeth minute, numerous, $\frac{200}{200}$ rows recorded, conical, points directed inwards; several rows functional at once. Skin of throat loose, widely distensible. First dorsal originates well behind posterior angle of pectoral, height equal to about one-twelfth total length; triangular. Second dorsal and anal very small, former originating in front of latter, similar, their height equaling about one-fourth length of first dorsal. Caudal in adult of Isurid form, margin notched; lower lobe about two-thirds length of upper; lower lobe relatively shorter in young (**8**, fig. 331a), about half upper in 8 ft. specimen. Caudal peduncle with shallow upper and lower caudal pits; its sides described as with strong longitudinal keels. Pectorals much longer than first dorsal is high. Colour, grayish brown to slaty above; under parts nearly the same or paler, uniform or shading into white, sometimes with white patch under snout. Maximum size at least 40 feet, often 25 to 35 feet.

North Atlantic northward to gulf of Maine, Newfoundland, Iceland, and northern Norway; Mediterranean; north and south Pacific; Australian region; South Africa.

SQUALIDAE. SPINY DOGFISHES

No anal fin. Two dorsal fins, with sharp spines.

Genus **SQUALUS**

Rear margin of the upper caudal lobe not notched; teeth alike in the two jaws; dorsal spines long.

S. acanthias. Linnaeus. Spiny dogfish. **2, 3, 4, 5, 6, 7, 8.** (Fig. 16)

Trunk slender; snout flattened above, rounded at tip; long diameter of eye equals about half eye to snout; teeth in about $\frac{26}{26}$ rows; similar in the two jaws;

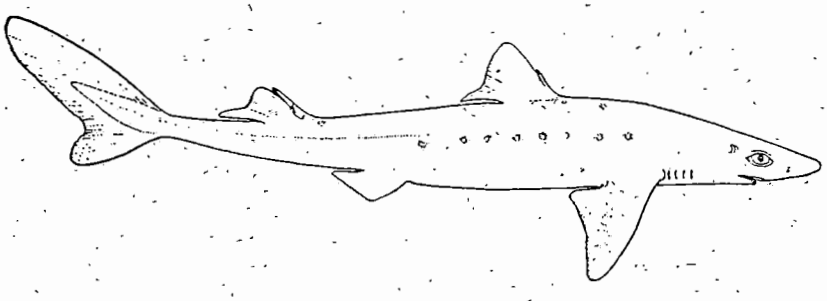
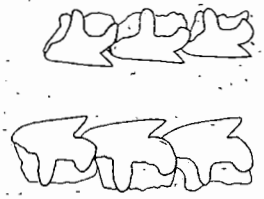


Fig. 16. Spiny dogfish (*Squalus acanthias*). After Garman.



Teeth.

outer margins notched, points turned towards corners of mouth. First dorsal originates behind rear angle of pectoral; triangular, its rear margin only slightly concave; with a smooth spine less than half length of fin. Second dorsal about two-thirds as high as first, with a smooth spine nearly as high as the fin. Lower caudal lobe about 40 to 45 per cent as long as upper. A low, longitudinal fold of skin on each side of caudal peduncle; no caudal pits. No anal. Ventrals well in front of second dorsal. Pectorals large, triangular, broader than long. Colour, slate coloured, rarely brown above; young with a row of small white spots from pectoral to anal; other spots in front of and behind first dorsal and in front of second; the spots fading with age. Gray to white below. Length of mature males up to about 3 feet; females to about 3½ feet.

Both sides of north Atlantic; Mediterranean; South Africa; west Greenland and strait of Belle Isle to Cuba in western Atlantic; most plentiful North Carolina to gulf of St. Lawrence.

Genus **CENTROSCYMNUS**

Caudal notched; teeth unlike in the two jaws; each tooth with only one cusp; dorsals each with a very small spine; eyes large.

C. coelolepis Bocage and Capello. Portuguese shark. **2, 4, 5, 7.** (Fig. 17)

Snout short, rounded; eye large, diameter equal to about 60 per cent distance from snout to eye; teeth in about $\frac{70}{42}$ rows, upper narrow, lanceolate; lower broad, flat, rectangular, outer margins notched, forming a cutting edge. First dorsal far back, about midway between pectorals and ventrals, notably small, height about equals snout to eye. Second dorsal slightly larger than first (smaller in most other sharks). Upper caudal lobe roughly rectangular, notched, lower lobe about half length of upper. No anal fin. Pectorals small, rear margin nearly straight; angles scarcely rounded. Colour, deep chestnut or blackish brown, above and below. Length, 3 to 4 feet.

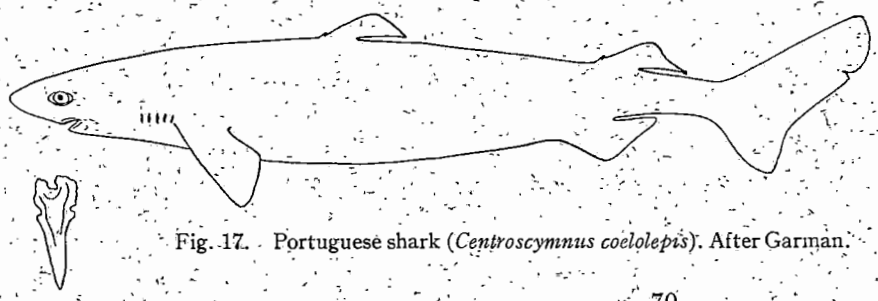


Fig. 17. Portuguese shark (*Centroscymnus coelolepis*). After Garman.

Teeth.

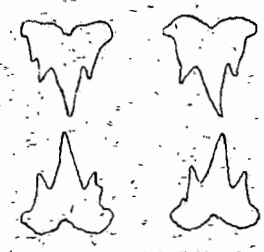
Usually deeper than 150 fathoms. Grand bank, La Have, Georges; Iceland, the Faroes, Portugal, Madeira, Mediterranean, Japan.

Genus **CENTROSCYLLIUM**

Dorsal spines long, grooved longitudinally on each side; teeth alike in the two jaws; each with several cusps; caudal notched in Atlantic species.

C. fabricii (Reinhardt). Black dogfish. **2, 3, 4, 5, 6, 7.** (Fig. 18)

Trunk slender; snout short, bluntly rounded. Eye notably large, long diameter nearly equal to snout to eye; teeth in about $\frac{70}{70}$ rows, alike in the two jaws; each with 3 sharp triangular cusps, the central one longest. First dorsal small, its upper edge rounded; originating well behind rear angle of pectoral. Second dorsal larger than first, roughly triangular. Dorsal spines deeply grooved. No anal fin. Lower caudal lobe but weakly marked off from upper; about half as long. Rear axil of ventral under origin of second dorsal. Pectorals small, rounded. Colour, uniform black or dark brown, above and below. Length $2\frac{1}{2}$ to $3\frac{1}{2}$ feet.



Teeth of *C. fabricii*, after Garman.

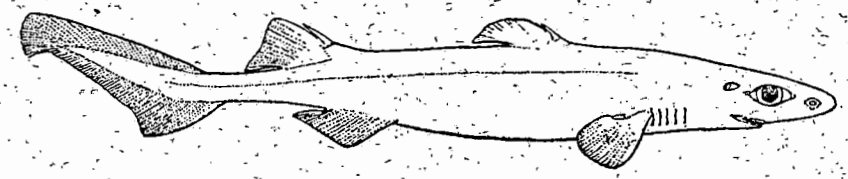


Fig. 18. Black dogfish (*Centroscyllium fabricii*). After Garman.

Usually deeper than 150 fathoms. West Greenland; slopes of Grand bank to Georges bank; gulf of Mexico; Faroes, Hebrides, Iceland; perhaps Falkland islands, Japan.

SCYMNORHINIDAE. NURSE SHARKS

No anal fin; two dorsal fins lacking spines in Atlantic genera; neither caudal pits nor lateral keels; teeth unlike in the two jaws; snout short.

Genus **SOMNIOSUS**

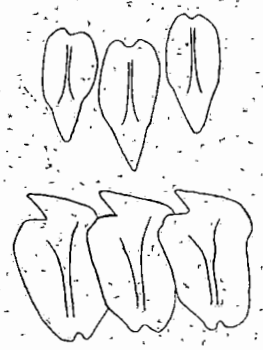
Second dorsal about as large as first: lower teeth forming a continuous cutting edge, facing the upper jaw; eyes notably small.

S. microcephalus (Bloch and Schneider). Greenland shark. **2**, 3 (*Acanthorhinus carcharias*), **4**, 5, 6, **7**, **8** (*Acanthorhinus carcharias*). (Fig. 19)

Trunk moderately stout, head strongly arched above; snout short, flattened above, rounded at tip; diameter of eye less than one-third snout to eye; teeth in about $\frac{41}{48}$ rows, upper narrow, triangular to lancet-shaped, erect; lower quadrate,

Fig. 19. Greenland shark (*Somniosus microcephalus*). After Garman.

their tips sharply bent toward the corners of mouth, outer margins deeply notched, inner nearly straight. Height of first dorsal equal to about half distance from mouth to snout; origin midway between snout and base of caudal; posterior angle projecting rearward for a distance greater than height of the fin. Second dorsal similar to first, slightly smaller. Distance from axilla to origin of first dorsal equals 31 to 40 per cent of distance from axilla to ventrals.



Teeth.

Caudal axis only slightly raised; upper caudal lobe notched; the lower about 70 per cent as long. No caudal pits, nor keels. No anal fin. Pectorals very small, with rounded angles. Colour, gray, brownish or black, nearly as dark below as above, sometimes purplish; back and sides with many indistinct dark transverse bands; some specimens with white spots. Length of adults averages 8 to 12 feet; rarely to 18 feet.

Chiefly deeper than 20 to 30 fathoms, on muddy bottom. Arctic and sub-Arctic; south to cape Cod; to North sea and English channel; and to Oregon.

ECHINORHINIDAE. BRAMBLE SHARKS

No anal fin. Two dorsals without spines; neither caudal pits nor lateral keels; teeth similar in the two jaws, forming cutting edges.

Genus **ECHINORHINUS**

Characters of the family.

E. brucus* (Bonnaterre). Bramble shark. **2, 4, 7** (*E. spinosus*). (Fig. 20)

Trunk moderately slender; snout short with rounded tip. Teeth alike in the two jaws; diagnostic in outline, the pointed cusps directed towards corners

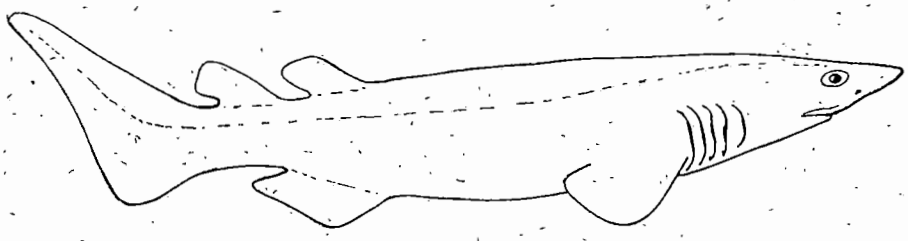
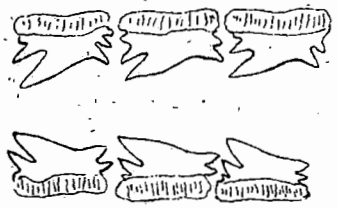


Fig. 20. Bramble shark (*Echinorhinus brucus*). From Goode and Bean, after Day.



Teeth, after Moreau.

of mouth, each margin with one or two deep notches near its base. All fins small, as in *Somniosus*. First dorsal far back over ventrals. Second dorsal close behind first. Caudal axis sharply bent. No anal. Skin notably spinous. Colour, dark brown above, with or without darker blotches; paler brown to white below. Maximum recorded length, 9 feet.

Chiefly deeper than 100 fathoms. Great Britain to north Africa; Mediterranean; cape of Good Hope; New Zealand; Australia; Japan; accidental at Provincetown, cape Cod.

RAJIDAE. SKATES

General form flat, disk-like; tail moderately stout, without serrated dorsal spines; caudal fin present but very small; skin of the disk or tail with at least a few small spines, and often thorny.

Genus **RAJA**

Snout supported by a distinct cartilage; dorsal fins near end of tail; margins of pectorals not produced into sharp points; disk rhombic. Males with several bands of erectile hooks near the outer corners of the pectorals.

Key to species

1.	(2)	Lower surface with minute rounded tubercles.	**granulata**
2.	(1)	Lower surface smooth.	
3.	(6)	No large thorns along mid-dorsal zone of disk between eyes and ventral fins.	
4.	(5)	Mid line of disk densely provided with small spines.	**spinicauda**
5.	(4)	Mid line of disk smooth.	**stabuliforis**
6.	(3)	One or more rows of large thorns along mid-dorsal zone of disk behind eyes.	
7.	(8)	Posterior third of tail without thorns.	**senta**
8.	(7)	Thorns on tail extending at least to dorsal fin.	
9.	(18)	One row of large thorns on tail.	
10.	(11)	Mid row of thorns between eyes and first dorsal numbering about 47 to 50.	**lintea**
11.	(10)	Mid row of thorns less than about 45.	
12.	(13)	Lower surface of disk with irregular dark blotches.	**hypoboreas**
13.	(12)	Lower surface of disk white or grayish without dark blotches.	
14.	(17)	Mid row of thorns not exceeding 20.	
15.	(16)	Upper surface smooth between the thorns.	juvenile **scabrata**
16.	(15)	Upper surface prickly between the thorns.	**radiata**
17.	(14)	Mid row of thorns numbering about 34 to 37.	juvenile **fyllae**
18.	(9)	Two or more rows of thorns on tail.	
19.	(20)	Mid row of thorns on tail much larger than any others.	**scabrata**
20.	(19)	Mid row of thorns on tail not much larger than the others.	
21.	(22)	Upper surface of disk with many narrow irregular dark bars, as well as spots.	**eglanteria**
22.	(21)	Upper surface of disk either plain or spotted, but not barred.	
23.	(24)	Teeth in more than 65 rows in each jaw.	**diaphanes**
24.	(23)	Teeth in less than 65 rows.	
25.	(26)	Teeth in 38 to 60 rows; upper surface of disk with many small round dark spots; with or without a large spot on each pectoral.	**erinacea**
26.	(25)	Teeth in 30 to 36 rows; upper surface of disk plain; with or without a large spot on each pectoral.	**fyllae**

R. erinacea. Mitchill. Little skate. **2, 4,** 5, **7.** (Fig. 21)

Anterior outline obtuse. In specimens, 17 to 21 inches long, distance from snout to centre of eye equals 37 to 40 per cent the breadth of disk abreast the eyes; length of disk, from snout to rear angle of pectoral, equals 82 to 86 per cent of breadth of disk; and 48 to 51 per cent of total length. Tail about half total length. Teeth in $\frac{46}{48}$ to $\frac{50}{52}$ rows in 3 adult specimens examined: 38 to 60 rows reported.

Large thorns on back and sides of tail, shoulders, head and snout, in several irregular rows along the dorsal ridge, and scattered generally over upper surface of disk, but (except rarely) no definite mid-dorsal row much larger than the others. Colour, grayish to dark brown above, often clouded with lighter and darker, usually with many small round darker spots; sometimes with whitish eye-spots near rear angles of pectorals; white or pale grayish below. Maximum length about 24 inches.

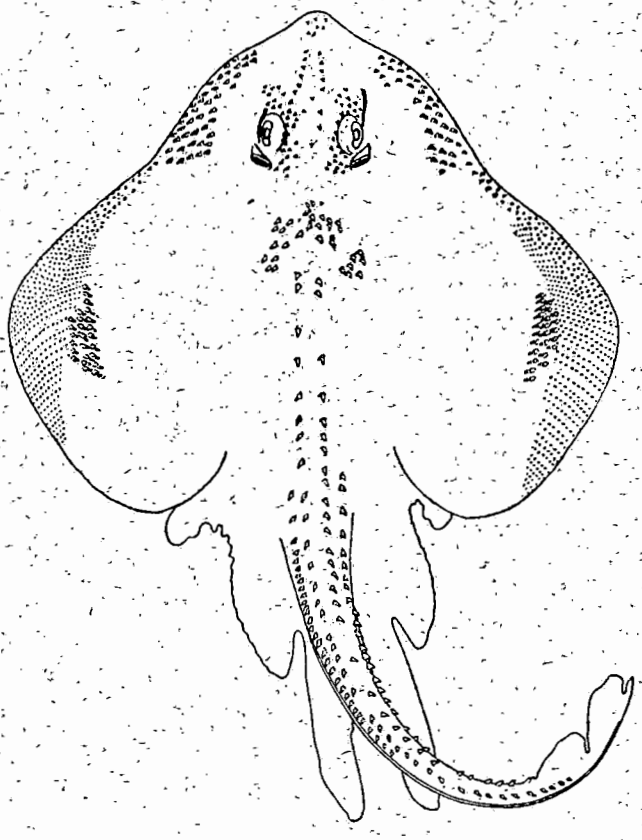


Fig. 21. Little skate (*Raja erinacea*). After Garman.

Tide line down to about 50 fathoms; commonest in shoal water. Continental shelf of eastern North America, Scotian banks and southern side of gulf of St. Lawrence to Chesapeake bay; mostly shoal.

R. diaphanes Mitchill. Spotted skate. **2, 4,** 5 and **7** (*R. ocellata*). (Fig. 22)

Anterior outline obtuse; snout short. In specimens 18½ to 36 inches long distance from snout to centre of eye equals 36 to 38 per cent of breadth of disk abreast the eyes; length of disk from snout to rear angle of pectoral equals 78 to

87 per cent breadth of disk; and 49 to 53 per cent of total length. Tail about half the total length. Teeth as in *erinacea*, except more numerous; 66 to 104 rows in each jaw, in 13 specimens, 15½ inches (immature) to 36 inches long. Thorns as in *erinacea*, the large spines along the midline being rarely present except in very young. Colour, light brown above, spotted with round darker patches: with or without one or two large pale eye spots, often black centred,

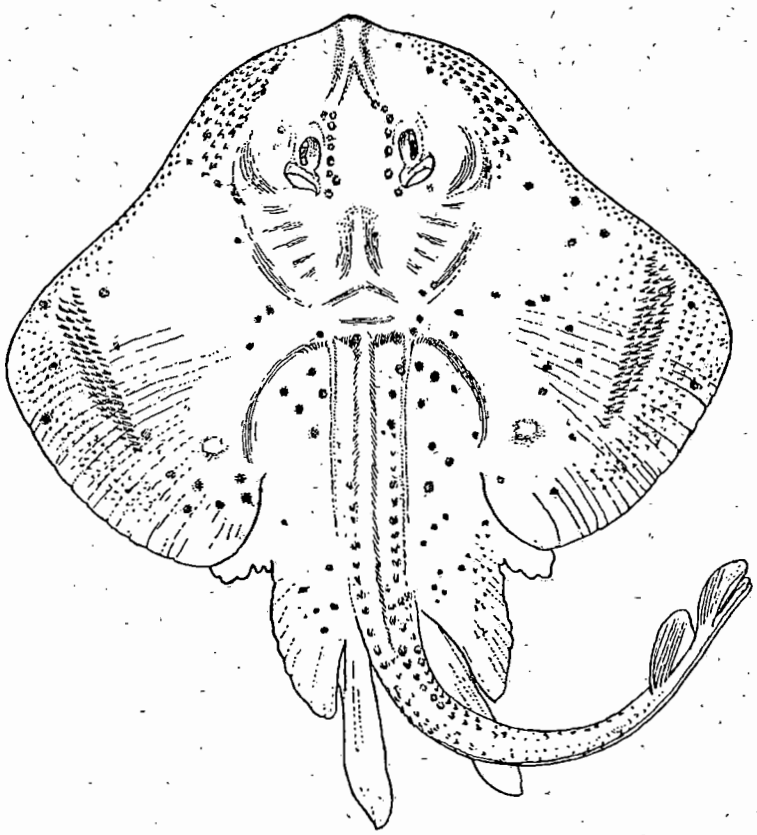


Fig. 22. Spotted skate (*Raja diaphanes*). After Garman.

near rear angle of pectoral. Sides of snout translucent; lower surface white. Maximum length about 3 feet; adults usually 30 to 34 inches.

From near tide mark down to 50 fathoms. Atlantic shelf of North America; southern side of gulf of St. Lawrence and western part of Grand bank, to Chesapeake bay.

R. scabrata Garman. Thorny skate. **2, 4,** 5 and **7** (*R. radiata*). (Fig. 23)

Anterior outline obtuse. Distance to eye in 5 Massachusetts bay specimens one from Halifax, and one from Sable island, 9½ to 31 inches long, equals 29 to 40

per cent of breadth of disk opposite eyes; length of disk from snout to rear angle of pectoral equals 79 to 90 per cent of breadth of disk; and 51 to 59 per cent of total length. Teeth in pavement, in $\frac{42}{40}$ to $\frac{42}{44}$ rows (3 specimens). Twelve to sixteen very large curved thorns with notably stellate bases along midline of tail and disk; a pair on each shoulder; one in front and one behind each eye; one behind each spiracle. Smaller thorns on the snout, in a row flanking the mid-dorsals, on each side of the latter, scattered over the pectorals and disk, and on

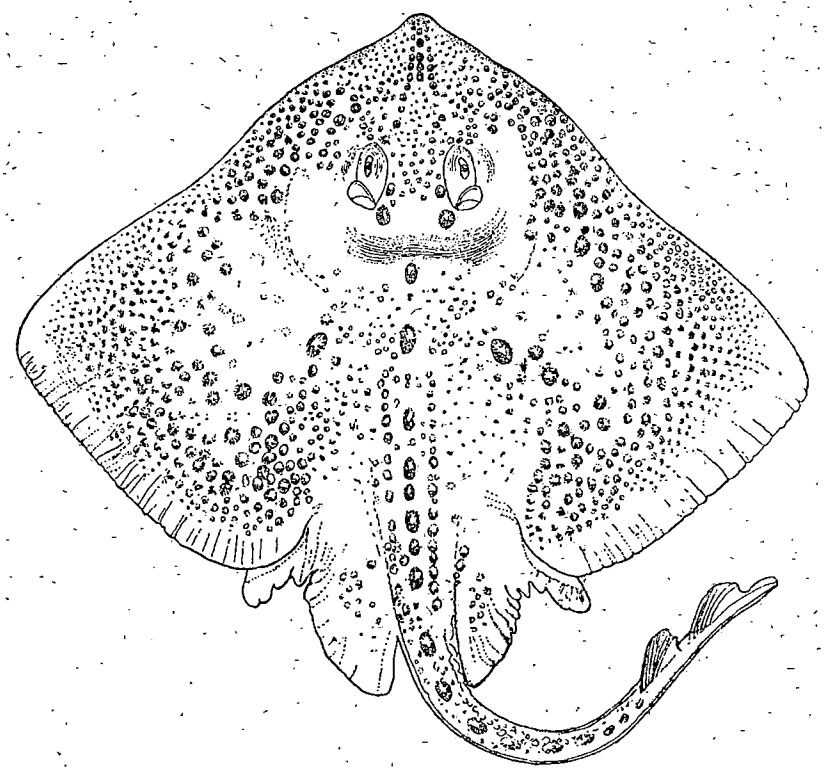


Fig. 23. Thorny skate (*Raja scabrata*). After Garman.

the tail. Large smooth bare patches on back behind spiracles, flanking dorsal ridge, and opposite bases of pectorals and of ventrals. Two dorsal fins usually separated by a free space with a thorn. Outer angles of pectorals bluntly angular. Colour, brown above, uniform or clouded: more definitely spotted when young: some with pale spots; white below. Maximum length about 3 feet.

Deeper than 10 to 15 fathoms. Atlantic shelf of North America; Hudson bay, north and east coasts of Newfoundland, the Grand bank and gulf of St. Lawrence to Woods Hole, Mass.; perhaps intergrading with the north European *R. radiata*.

R. radiata Donovan. Starry skate. 3, 4, 6, 8, 9. (Fig. 24)

Anterior outline obtuse. Distance from snout to eye (in two Norwegian specimens) equals 33 per cent of breadth of disk opposite eyes; length of disk equals 79 to 80 per cent of width of disk, and 54 to 55 per cent of total length. Teeth in 38 to 45 rows. Mid-dorsal thorns as large as in *R. scabrata*, but averaging more numerous; 11 to 19 recorded. Large thorns scattered over body and

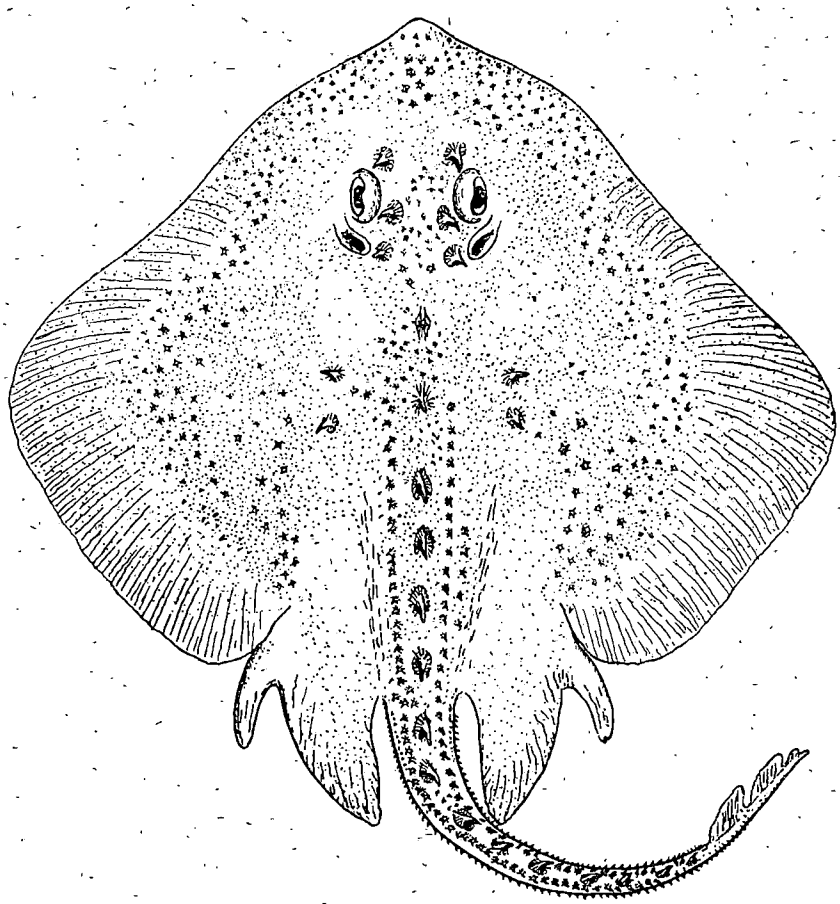


Fig. 24. Starry skate (*Raja radiata*). From Norwegian specimen.

disk, the skin between thorns with tiny spines; outer margin of disk and ventrals almost smooth. Smooth below. Colour, chocolate brown above, with or without paler markings, sometimes irregularly blotched with darker; white below, tinged with pink at margins of fins, and sometimes with brown spots on tail. Maximum reported length 25 inches.

Down to 460 fathoms, usually less than 100. Davis strait, west coast of Greenland, coastal slopes of northeastern Atlantic, from bay of Biscay and North sea north to White sea, Spitzbergen.

R. fyllae* Lütken. 3, 4, 5, 6, 7, 9. (Fig. 25)

This species varies considerably in colour, shape and spination, according to age. Anterior outline of disk obtuse, slightly undulated in young, deeply notched

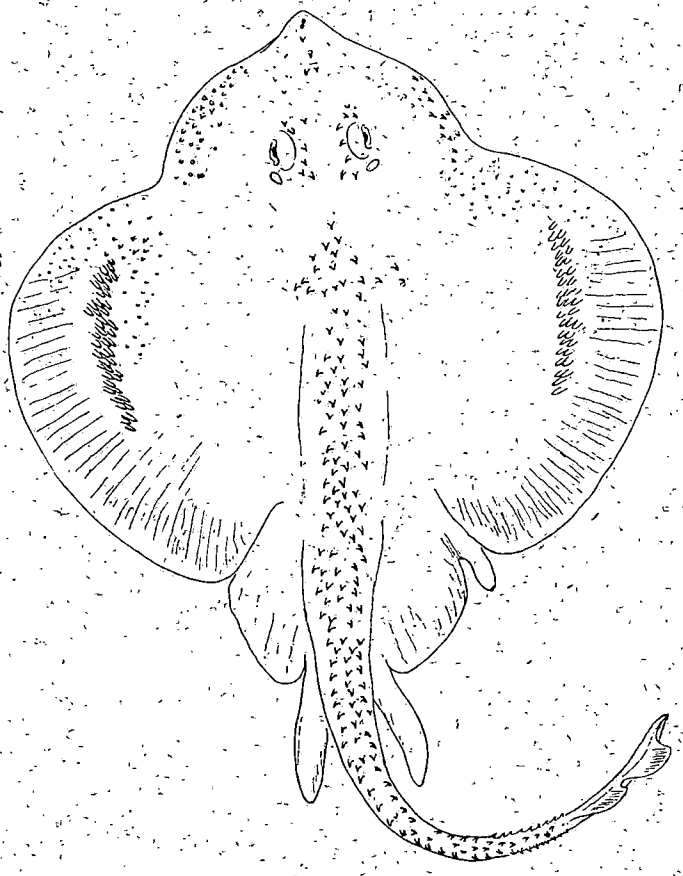


Fig. 25. *Raja fyllae*. After Lutken.

opposite spiracles in adult male. Width of disk 51 to 56 per cent of total length of fish; length of disk 42 to 47 per cent. Teeth vary with age, 30 to 36 rows in upper jaw, sharp pointed in adults. Upper surface entirely spinulose in young, with bare patches on median and posterior disk and ventrals in adult males. A median row of spines (34 to 37) extends from the shoulder to the first dorsal in young; no spines between dorsals, which are close set. Median series in adult

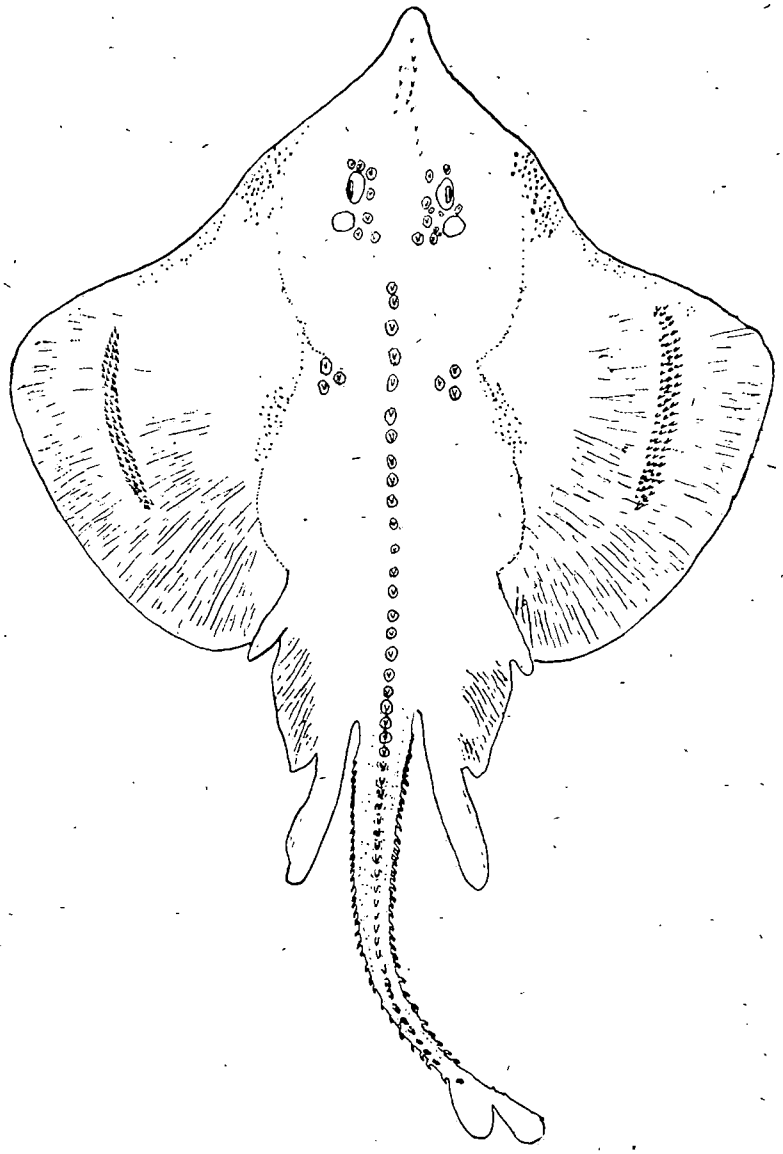


Fig. 26. *Raja lintea*. After Clark.

reduced in number while side rows, inconspicuous in young, are much more pronounced. One or 2 preorbital and 1 or 2 postorbital spines in young with 3 in adult. Adult male with spines along margin of snout and anterior pectoral region with elongate patch usual on pectorals of the male of various species. Smooth below. Colour of adult male uniform ashy gray above, white or grayish brown below. Young brown, with large spots or blotches of darker brown more or less pronounced. Reaches a length of about 22 inches.

From 216 to 983 fathoms. Davis strait, Spitzbergen, Barents sea, northwest Scotland.

R. lintea* Fries. **4, 6, 8, 9.** (Fig. 26)

Anterior outline acute. Distance from snout to centre of eye about 55 to 59 per cent of breadth of disk abreast the eyes; length of disk from snout to rear angle of pectoral equals about 87 to 93 per cent of breadth of disk; breadth of disk 59 to 64 per cent of total length of fish; tail from hind margin of anus slightly less than one-half the total length. Teeth in 47 to 50 rows in each jaw, pointed, with shorter points and broader bases in the female than in the male. Upper surface more or less smooth. A row of 47 to 48 thorns along mid line of back from a little behind spiracles to base of dorsals which are confluent. Several spines immediately in front of and along inner margin of eye with a triangular patch opposite each spiracle; a triangular patch also over each shoulder. Various small spines on rostral process, on outer margin of disk opposite eyes, with a few scattered on other parts of body. A band of coarse spines near outer margins of pectorals in male. Tail has on each side of the median row a marginal series of strongly recurved spines. Lower surface smooth.

Colour slate gray above; under surface white, usually with a broad band of gray around the outer angle and along posterior margin of disk; a patch of gray on each side of vent, on posterior lobe of ventrals; tail spotted or banded with gray. Reaches at least 42 inches in length.

From 80 to 350 fathoms. Davis strait, Iceland, Norwegian coast.

R. spinicauda* Jensen. **6, 9.** (Fig. 27)

Anterior outline nearly a right angle. In two specimens 29 and 41¼ inches long, respectively, distance from snout to centre of eye equals about 53 per cent of breadth of disk abreast the eyes; length of disk from snout to rear angle of pectoral equals about 87 per cent of the breadth of disk; breadth of disk 65 to 70 per cent of total length of fish; tail from hind margin of anus 66 to 69 per cent of total length. Teeth in about 31 or 32 rows in each jaw (one specimen, 55 inches long). Upper surface with numerous small spines, particularly dense along mid line of body and tail; a single row (21-26) of larger spines along mid line of tail. Smooth below. Colour, blue-gray above; white below, with dark

gray spots along posterior margin of disk, on ventrals and tail. Recorded up to 55 inches in length.

From 120 to 440 fathoms. Davis strait, southwest Greenland.

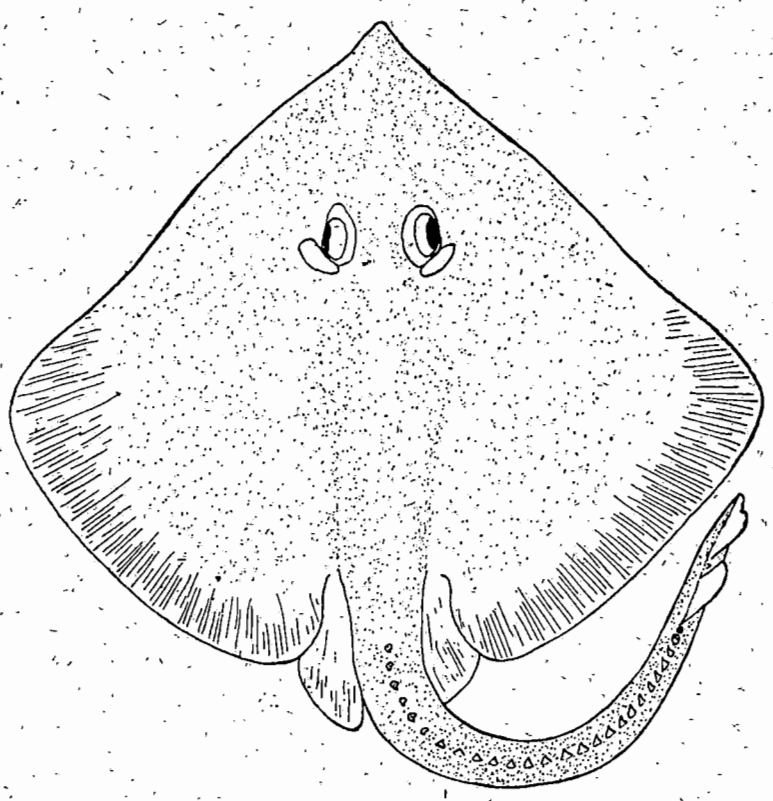


Fig. 27. *Raja spinicauda*. After Jensen.

R. granulata Goode and Bean. Deep water skate. **1**, 4, 5, 7. (Fig. 28)

Anterior outline acute. Disk rhomboidal, anterior part about a right angle; lateral angles acute. Snout to centre of eye equal to 49 per cent breadth of disk opposite eyes, in specimen 33½ inches long. Length of disk 73 per cent of breadth, and 56 per cent of total length. Spiracles close to eyes. Mouth forms an obtuse angle, its width equal to about 46 per cent of breadth of disk opposite outer corners of mouth. Teeth scattered, in about $\frac{56}{56}$ rows, long, pointed, with broad bases. Ventrals deeply notched. Dorsals higher than long: space between them equal to height of the second dorsal. Eight large thorns along mid-dorsal line of disk from shoulders to base of tail; and 5 on the anterior third of tail. Other large thorns before eye (1); behind eye and opposite inner angle of

spiracle (3); and shoulder (2). Numerous small prickles with stellate bases on snout, between eyes, along anterior and posterior parts of disk, and along sides of tail. Naked areas between and behind spiracles, flanking dorsal ridge, and on ventrals. Ventral surface of disk sprinkled sparsely with minute rounded tubercles. Colour, in alcohol, light brown above, darker along margin of fins, pale (probably white) below, but with margins of pectorals dark brown; large dark areas on central part of disk and on ventrals. Maximum size unknown.

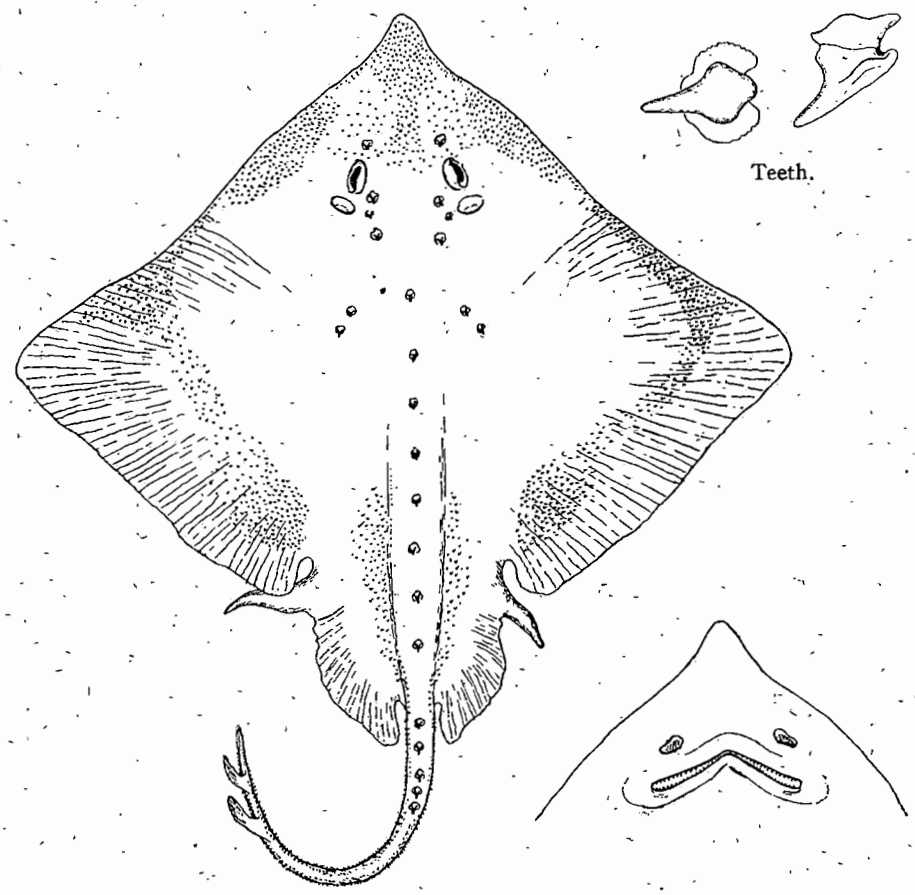


Fig. 28. Deep water skate (*Raja granulata*). · From specimen described (p. 29).

From 200 fathoms. La Have bank (type) and continental edge off Halifax, Nova Scotia (lat. 42°37′; long. 62°55′).

R. hyperborea* Collett. Arctic skate. 3, **4**, 6, **8**, **9**. (Fig. 29)

Anterior outline acute. Distance from snout to centre of eye equal to about 50 per cent of breadth of disk opposite eyes; length of tail from cloaca 39 to 46

per cent of total length; large thorns arranged as in the *radiata-scabrata* group, except smaller, their bases less definitely stellate; with a larger number (22-31) in the mid-dorsal line, and usually 3, instead of 2, on each shoulder, and 3 at the inner margin of each orbit. Many smaller prickles between the large thorns, and sides of the tail prickly; lower surface smooth. Teeth scattered, needle-pointed; alike in the two sexes; 40 to 44 rows in upper jaw. Dorsal fins usually

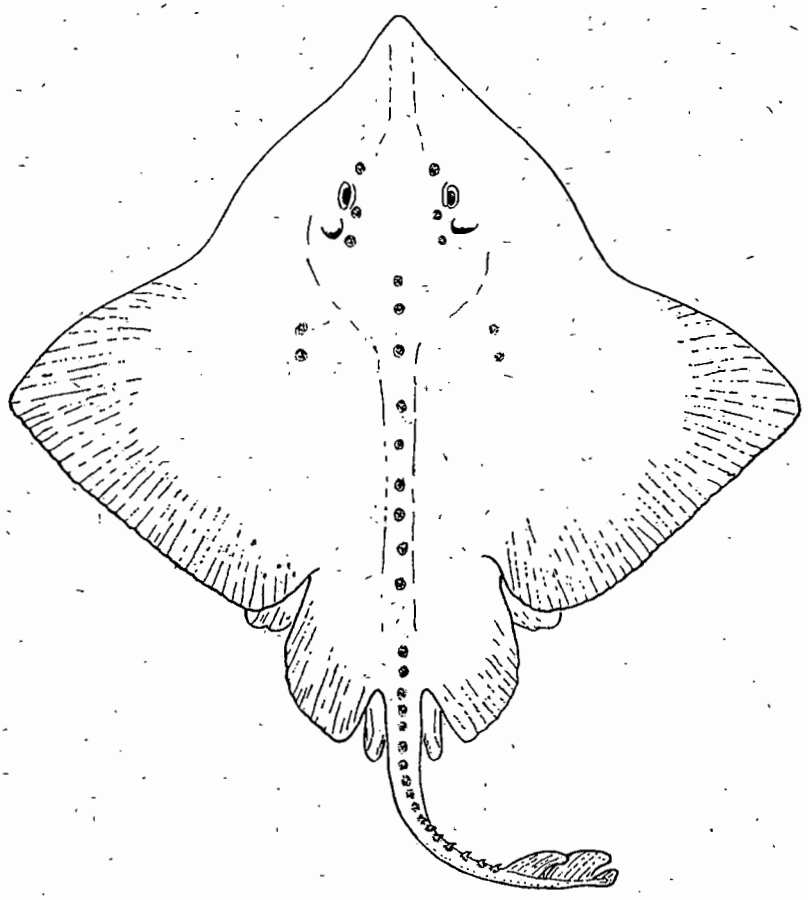


Fig. 29. Arctic skate (*Raja hyperborea*). After Collett.

separated by 1 or 2 thorns. Colour, bluish to brownish gray, or red-brown above, sometimes with light and dark spots; lower surface variegated white and dark. Maximum recorded length about 34 inches.

Down to 1300 fathoms. Arctic: western coast of Greenland, Spitzbergen and north of Russia and south to Faroe channel.

R. eglanteria Bosc. Clear nosed skate. **2, 4, 7.** (Fig. 30)

Anterior outline approximately a right angle; distance from snout to centre of eye equal to 48 to 51 per cent of breadth of disk opposite eyes; length of disk equals 80 to 84 per cent of breadth, and 53 to 56 per cent of total length. Teeth in about $\frac{48}{48}$ rows. Dorsal fins separated by a considerable interval, interspace usually

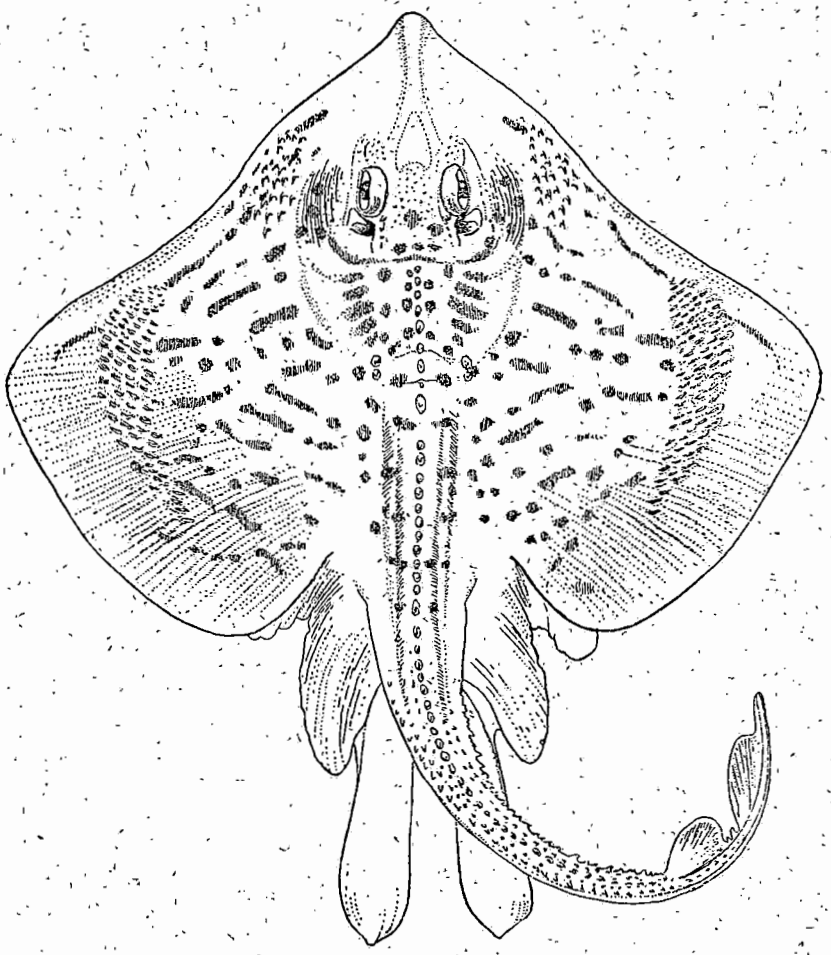


Fig. 30. Clear nosed skate (*Raja eglanteria*). After Garman.

with one or two thorns. Large thorns confined to mid-dorsal line, to groups opposite and behind eyes, a pair on each shoulder, and to sides of tail. Elsewhere upper surface of disk bears small, very sharp prickles, most thick-set on anterior parts of pectorals, over head and snout, and amid the large thorns on middle of back and along tail. Colour, brown above, variously spotted with round to elongate

darker brown blotches with a large and very conspicuous translucent or white space on either side of snout; lower surface white. Maximum length about 3 feet.

Chiefly shoaler than 15 fathoms. Cape Ann, Massachusetts, to Florida; rare north of Nantucket shoals.

R. senta Garman. Smooth skate. 2, 4, 5, 7. (Fig. 31)

Anterior outline roughly a right angle. Distance from snout to centre of

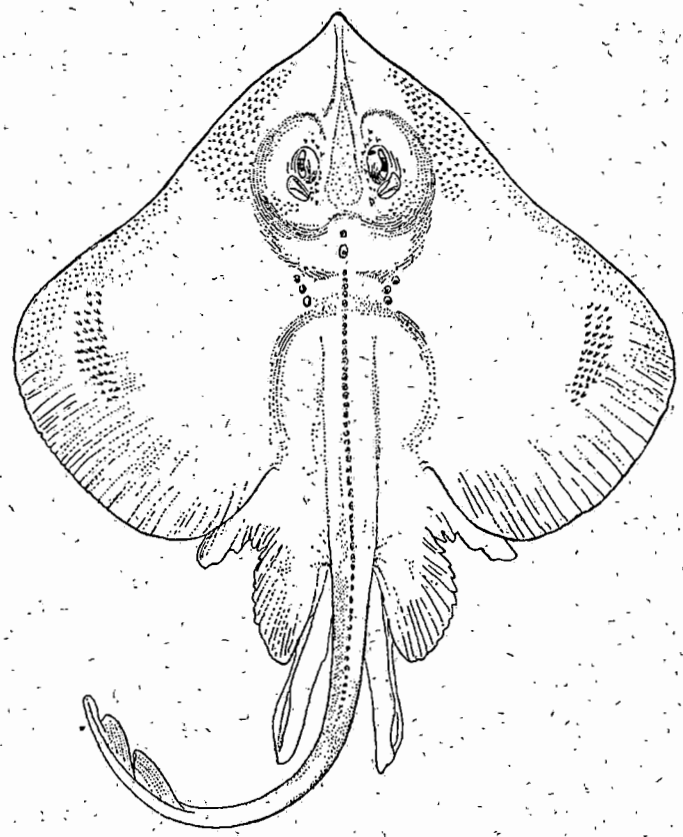


Fig. 31. Smooth skate (*Raja senta*). After Garman.

eye equals about 47 per cent of breadth of disk opposite eyes; length of disk equals 80 to 87 per cent of breadth, and about one-half total length; outer angles rounded. Teeth in about $\frac{38}{38}$ rows. About 30 thorns (some lost) in mid-dorsal row, beginning about midway between eye and shoulder, and extending one-third way back along tail, decreasing in size posteriorly; other large thorns about eye

and on shoulder. Upper surface of disk and ventrals covered almost everywhere with small spines which are somewhat larger anteriorly. Males with a patch of larger spines on outer pectorals. Tail with small spines which extend underneath. No free space between dorsals. Separable from *R. eglanteria* by smoother skin, absence of spots and of mid-dorsal thorns on rear half of tail; from *stabuliforis* by less produced snout, and extension of mid-dorsal thorns forward to shoulders; from *R. granulata* by smooth, white, lower surface, and more numerous mid-dorsal thorns. Colour of upper surface pale brown with numerous rather obscure spots darker than the ground colour, sometimes with white markings. Maximum length 2 feet.

La Have bank; generally distributed in gulf of Maine on hard or soft bottom; on offshore fishing banks and in deeper parts (80 to 100 fathoms). Shoalest capture 25 fathoms.

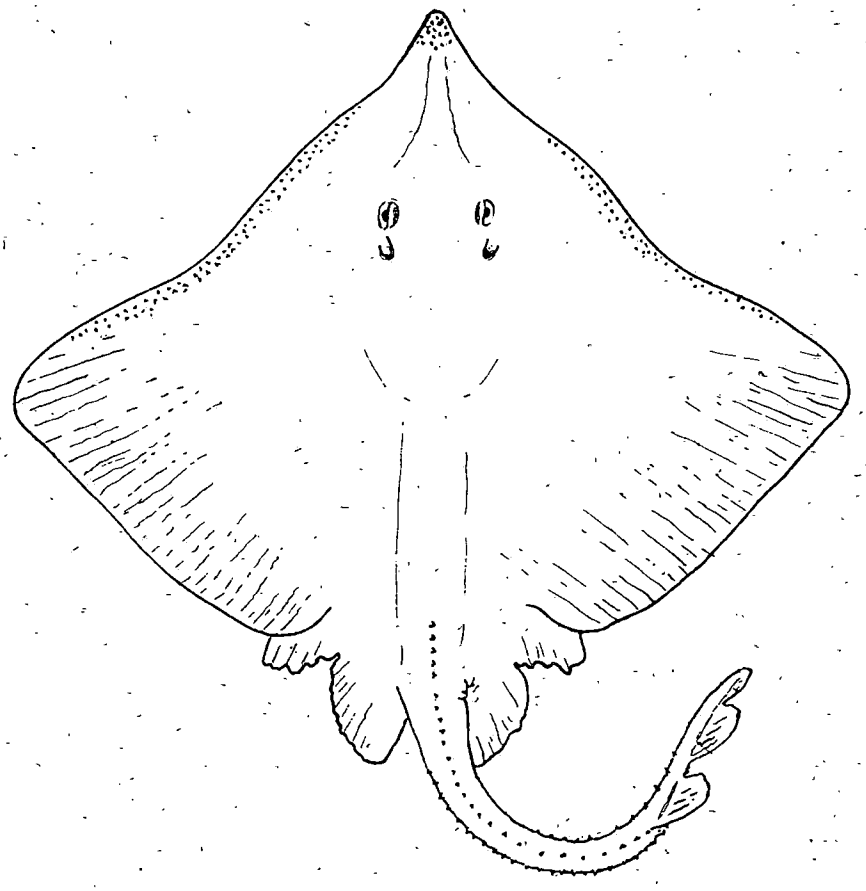


Fig. 32. Barndoor skate (*Raja stabuliforis*). After Garman.

R. stabuliforis Garman. Barndoor skate. **2, 4,** 5 and **7** (*R. laevis*). (Fig. 32)

Anterior outline very acute. Distance from snout to eye (2 specimens, ♂41¾ and ♀47¼ inches long) equals 55 to 59 per cent of breadth of disk opposite eyes; length of disk equals 77 to 78 per cent of breadth of disk and 56 to 73 per cent of total length. Teeth in pavement, in $\frac{32}{32}$ to $\frac{36}{36}$ rows, sharper in males than in females. Snout narrow, projecting; but blunt tipped; outer corners of pectorals angular; disk diamond- or lozenge-shaped; dorsal fins separated by a definite interspace, with one or more spines; tip of caudal extending farther than in other local species. Mid-dorsal thorns along tail and on hinder part of back. Other spines relatively smaller than in other local skates; restricted to sides of tail, tip of snout, bands along front edges of pectorals and anterior margins of disk; in front of and behind eyes; with a few others sparsely scattered. Skin of back between spines smooth. Colour: upper surface brown, usually reddish, variously marked with darker brown blotches or spots, sometimes pale-edged; and often with pale marblings. Lower surface white or pale gray; darker toward snout; spotted with black on abdomen. The largest of local skates; maximum length 6 feet or more.

Tide mark down to more than 100 fathoms; chiefly 5 to 60 fathoms. Continental shelf of eastern North America, southern side of gulf of St. Lawrence and southwestern part of Grand bank to Florida.

NARCACIONTIDAE. TORPEDOES

General form flattened; tail stout, without spines; caudal fin large, triangular; skin perfectly smooth, without spines or prickles; electric organs present.

Genus **NARCACION**

With two dorsal fins; tail shorter than disk, with lateral folds; ventral fins not united.

N. nobilianus (Bonaparte). Torpedo. **2, 4, 7** (*Tetronarce occidentalis*). (Fig. 33)

Disk subcircular, considerably broader than long, its margin evenly rounded, truncate anteriorly. In specimen examined, 31½ inches long; distance from tip of snout to eyes (relatively much smaller than in the skates) only about 20 per cent of breadth opposite eyes; length of disk about equal to 55 per cent of total length; tail about 40 per cent of total length. First dorsal at anterior end of tail, origin in front of rear end of base of ventrals; second dorsal only about half as high as first, its height nearly equal to interspace. Caudal fin large, triangular, with rounded angles. Skin smooth. Colour, dark chocolate brown above, and along lower edges of disk, fins and tail; otherwise white below. Length of adults usually 2 to 5 feet. Maximum recorded weight, about 200 pounds.

Tropical and temperate coastal waters, on both sides of north Atlantic; La Have bank and eastern Maine southward to Cuba along American coast. Occasional north of cape Cod.

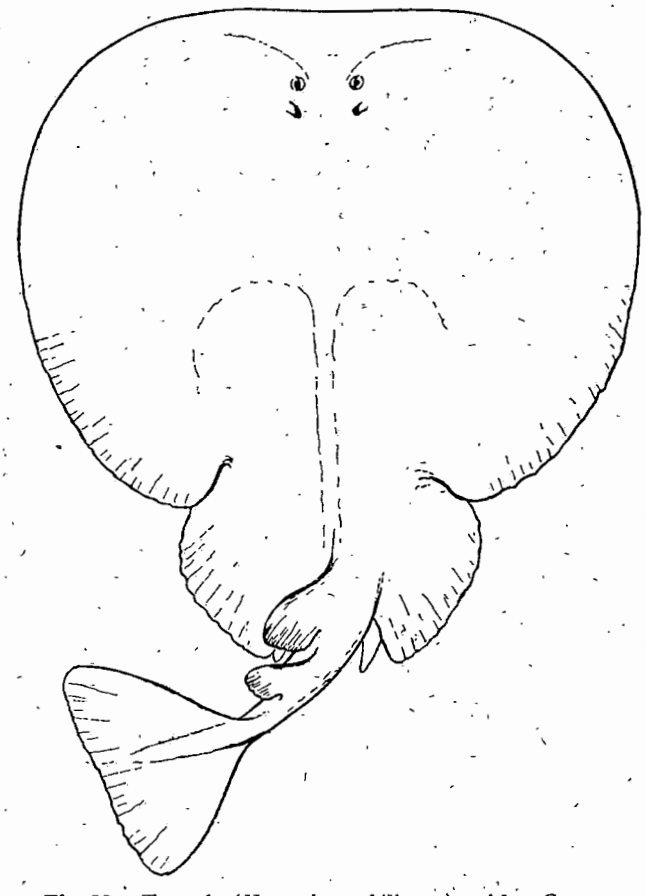


Fig. 33. Torpedo (*Narcacion nobilianus*). After Garman.

DASYBATIDAE. STING RAYS

General form flattened, disk-like; tail very slender, with one or more long, serrated, dorsal spines in Atlantic species; no caudal fin; snout not supported by a rostral cartilage; pectorals meeting in front without definite rostral fins. Skull flattened, with eyes on dorsal surface; teeth small, in pavement of many rows. Nasoral grooves present.

Genus **DASYBATUS**

No dorsal or caudal fins. Tail at least as long as disk, with one or more dorsal spines, its end lash-like; disk rhombic, broader than long.

D. centroura (Mitchill). Sting ray. **2** and **4** (*D. marinus*); **7** (*Dasyatis centrura*) (Fig. 34)

Disk quadrate, anterior outline very obtuse, distance from snout to eye in specimen 44 inches long equals 31 per cent of breadth of disk opposite eyes; length of disk 85 per cent of breadth, 30 per cent of total length. Lateral corners of pectorals bluntly angular. Tail more than twice as long as disk, tapering to

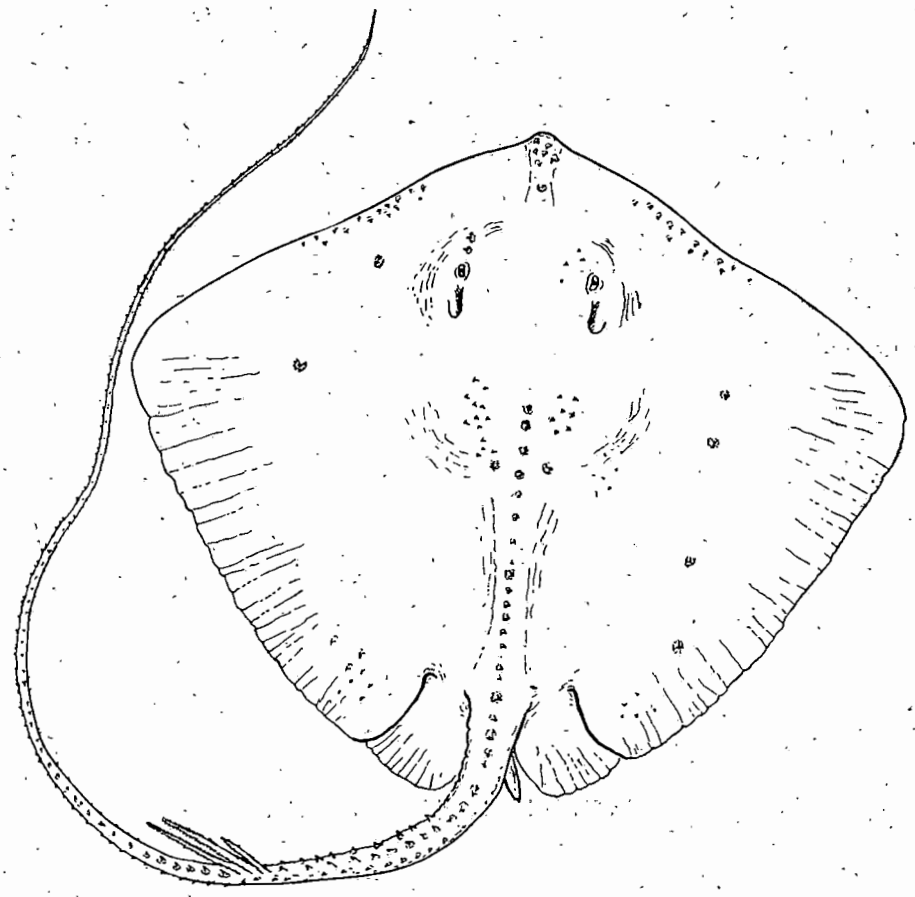


Fig. 34. Sting ray (*Dasybatus centroura*). After Garman (*D. marinus*).

a lash-like tip, with a cutaneous keel below, but none above, rounded above behind spines. Caudal spines one to three or more, about one-fifth the way back on tail, erectile, their lateral edges strongly serrate. Skin smooth in young specimens; adults with tubercles scattered over central and posterior dorsal surface of disk, and along tail, increasing in number with growth. Colour, brown above, varying dark to light; white below; tail brown. Maximum recorded length, including tail, about 12 feet.

Western Atlantic from cape Cod and Georges bank to cape Hatteras, mostly southward; also Mediterranean.

HOLOCEPHALI. CHIMAEROIDS

No spiracle; gills fringe-like and free at the tips as in bony fishes; gill clefts enclosed by flaps of skin, with only one external gill opening on each side; only 3 pairs of dental plates, 2 in the upper, 1 in the lower jaw, set edgewise. Tail nearly symmetrical.

CHIMAERIDAE. THE CHIMAERAS

Nose pointed, without definitely elongate, or flap-like proboscis; caudal fin without inferior lobe; claspers of male bifid or trifid.

Genus **CHIMAERA**

Characters of the family.

C. affinis Capello. Chimaera. **2, 5, 7.** (Fig. 35)

Body compressed, tapering. Head moderately pointed; without definite proboscis, but its dorsal profile prolonged into a knob above mouth; forehead of male with an erectile cartilaginous hook, its lower surface armed with prickles. Mouth inferior. Gill openings vertical, low on sides of neck. Dorsal fins separated by short interspace, but connected by ridge of skin (about 1½ inches in

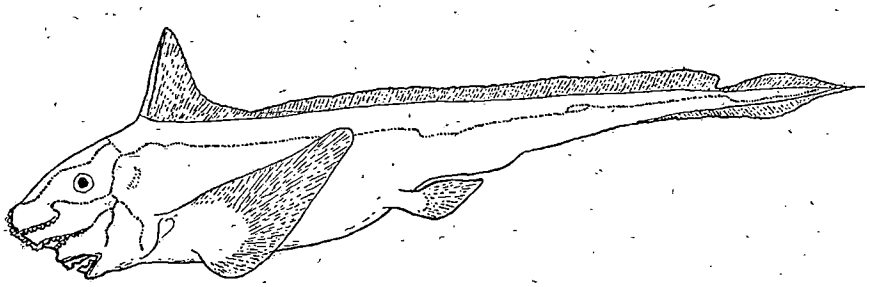


Fig. 35. Chimaera (*Chimaera affinis*).

specimen 3½ feet long). First dorsal triangular, length about equal to distance from snout to rear margin of eye, about as high as long, preceded by a spine, free at tip. Second dorsal less than half as high as first, its margin straight, extending back along whole length of trunk; separated from caudal by a deep notch, but no definite interspace. Caudal lanceolate, terminating in a short filament (filament about 1½ inches in 3½ ft. specimen). No separate anal. Ventrals and pectorals triangular; the latter much the larger, their tips reaching nearly to ventrals. Skin smooth, or slightly prickly. Colour, brown or leaden, above and below. Maximum length about 4 feet.

Chiefly 200 to 1200 fathoms. Grand banks to gulf of Mexico; Portugal.