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THE SHARKS AND RAYS OF BEAUFORT, NORTH CAROLINA



By Lewis Radcliffe

*Scientific Assistant, U. S. Bureau of Fisheries*



Contribution from the United States Fisheries Biological Station, Beaufort, N. C.



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## INTRODUCTION.

The present report deals with the species of sharks and rays of the Beaufort region and includes two species from the Gulf Stream near by. It is intended primarily to serve as a laboratory guide to investigators in this field. The demand for a work of this character has been augmented by the addition to the fauna of a number of little-known species not previously reported from the eastern coast of the United States, by lack of adequate descriptions in some instances and inaccessibility of literature in others. The latest descriptive report on the species of the North Carolina coast contains but 18 of the 37 listed herein.

This report was begun at Beaufort in the summer of 1912 and continued intermittently through the summers of 1913 and 1914. It is not the intention to supply complete descriptions for each species, but to furnish data of a character generally lacking in papers on the subject and to make the report of special value as a field manual. For the most part, descriptions and illustrations<sup>a</sup> are based on material from this region; for completeness material has been obtained wherever possible. The report contains working keys and aims to include in the synonymy of each species all published references on the subject for this region and no others. The species are arranged in accordance with the classification of Dr. Samuel Garman in "The Plagiostomia" (Memoirs Museum Comparative Zoology, vol. xxxvi, 1913, in two parts), and the nomenclature used in that report has been adopted.

Many of the sharks and rays are too large to preserve or even transport to one's laboratory. The question of what notes should be taken or what is the minimum of material that must be preserved to insure identification of the form often arises. The writer finds that, in addition to the usual field notes, if the jaws and a piece of the shagreen below the first dorsal are preserved, these are all that will be required to identify the sharks. In most species the form and sculpturing of the dermal denticles from a definite body region appear to vary little, if any, with age; in others age differences appear. The amount or extent of variation for all species could not be determined with the limited amount of material obtainable. The denticles from the side of the body below the first dorsal have been used in every case in which they

<sup>a</sup> The drawings were made by Mrs. E. Bennett Decker, of Washington, D. C.; the photographs of jaws, embryos, and adults by the author.

were available at the time. With the exception of the two species of hammer-headed sharks, the character of the teeth or denticles, or both, have been of value in identifying the species.

The writer is indebted to the assistants at the Beaufort laboratory who aided in this work; and also to Mr. Barton A. Bean, of the United States National Museum; Mr. Russell J. Coles, of Danville, Va.; Mr. Vinal N. Edwards, of the Woods Hole laboratory; Dr. E. W. Gudger, of Greensboro, N. C.; and Mr. John T. Nichols, of the American Museum of Natural History, for the use of material.

### UTILIZATION OF SHARKS AND RAYS.

In the United States there is a prejudice against the use of this class of animals for food that results in waste of what rightfully should be a resource. In England and Wales, for example, 64,996 hundredweight of dogfish, valued at £20,242, were landed in 1913. As the flesh of these small sharks, when properly prepared, is palatable, there appears to be no valid reason against its use. The United States Bureau of Fisheries has been conducting preliminary experiments in the preparation of this meat, and there is good ground for the belief that a demand for the article will be created. Even now sharks are more universally eaten than is generally known. As an instance of this, a letter from Mr. Vinal N. Edwards, of Woods Hole, Mass., states that the trap fishermen of that region ship all of the large species of sharks, with one exception, caught in their traps. Among those shipped are the thresher (*Vulpecula marina*), dusky sharks (*Carcharhinus obscurus* and *milberti*), and the black-finned shark (*Carcharhinus limbatus*), the exception being the sand shark (*Carcharias taurus*). The fishermen remove the head, fins, and tail; the body then looks not unlike a swordfish and is shipped to Boston or New York, where it is sold as deep-water swordfish. The fishermen receive from 3 to 8 cents per pound for this class of food.

There are still other uses to which the sharks and rays might be put. For example, oil may be extracted from the liver, which reaches a very large size in these forms; the skins, which have been used to a limited extent, possess certain characteristics which, it would seem, might be capable of more general use. Stevenson (Report of the United States Commission of Fish and Fisheries for 1902, p. 347-348) says:

The skins of sharks, rays, and dogfish are commonly very rough and studded with numerous horny tuberculous markings or protuberances. Some have small imbricated and triangular scalelike tubercles; others unimbricated and nearly rhomboid, which in one species are ranged near each other in quincunxes, or they may be quite square, compact, and comparatively smooth on top. These protuberances are usually firmly fixed to the skin so that they are not easily separated therefrom. They are rough and hard and take a polish almost equal to stone.

These skins, like those of all cartilaginous fishes, are very durable. A peculiarity, in addition to the markings above noted, is the nonporous character. The pores that are everywhere present in the skins of most mammals, which give the natural grain in the tanned leather, are entirely indiscernible in the skins of these fish. The result is to render them almost proof against water absorption. Although by skillful tanning the fibers of seal and other skins may be plumped and the body of the membrane solidified, yet much water exposure loosens the fiber and gradually permits absorption. Not being of a porous nature, shark skin is naturally free from this defect; but the advantage is also a disadvantage in some respects. The nonporous leather is practically airtight as well as waterproof, and that is a serious defect when its use for footwear is considered. Beyond this, the skins of sharks and similar fishes may be prepared into a very durable, noncracking leather, for which many uses may be found.

Formerly large quantities of these skins were used for polishing wood, ivory, etc., for which they are excellent, owing to their roughness, hardness, and durability; but the great improvements made in preparing emery compositions and sandpapers have resulted in substituting them almost entirely for polishing purposes. However, a small demand yet exists for shark skins for cabinetworkers' use.

The principal uses made of the skins of sharks and allied fishes at the present time are for covering jewel boxes, desk ornaments, cardcases, sword sheaths, sword grips, and a great variety of small articles for which the tuberculous markings peculiarly adapt them. The demand for these purposes, however, is small and restricted, and each producer has to develop his own market. Comparatively few of these skins are prepared in the United States, and diligent search among the tanneries and leather stores will result in the finding of only a few skins. Many, however, are prepared in France, Turkey, and other countries of southern Europe, and also in China and Japan.

A Parisian manufacturer has made quite a reputation tanning the skins of a species of Malabar shark into morocco, and establishments in Turkey make green leather from the skin of the angel shark found in the Mediterranean Sea. The skin of the diamond shark obtained in the North Sea, and so called because of the shape of the markings or protuberances, is used to cover the sword grips of German officers, and for this purpose is not surpassed by any material obtainable. Some parts of the skin of certain varieties of sharks when dried and hardened take a polish equal to that of stone and bear a strong resemblance to the fossil coral porites, and are much used in the manufacture of ornaments and jewelry.

In preparing them for the use of cabinetmakers, shark skins are merely cleaned and not tanned. The hard, dry skins are soaked in lukewarm water for three or four days, shaved on the flesh side to remove surplus flesh and muscular tissue, and then dried. The skins of some species of sharks are so hard that they can not be shaved. The appearance of these skins is improved by bleaching, using chloride of lime and sulphuric acid. The durability of some of them is remarkable, outwearing many sheets of sandpaper of equal area.

In tanning shark skin for leather or ornamental purposes an alum process is generally employed. Each establishment usually has its own particular method, but the general process is much the same, consisting of a preliminary soaking, liming, bating, and fleshing, and then tanning or preserving in an alum compound. The hard skins are first soaked in water four or five days and then in limewater for two to six days, depending on the condition of the texture, temperature of water, etc. The skins are washed free of lime and bated in bran water, then shaved on the flesh side to remove all excess of flesh and the like. The alum solution in which they are immersed is composed of a pound of alum and one-fifth pound of salt to a gallon of water. The skins remain in the solution two or three days, with occasional stirring. On removal they are dried and are then ready for manufacturing.

## Class CHONDROPTERYGIA. The sharklike fishes.

### Subclass PLAGIOSTOMIA. The sharks, skates, and rays.

KEY TO THE ORDERS AND FAMILIES OF PLAGIOSTOMIA REPRESENTED IN THE BEAUFORT, N. C., REGION.

I. ANTACEA: Body subfusiform; pectorals not attached to the head; gill openings lateral.

a. Body subcylindrical.

b. Anal fin present; two spineless dorsals.

c. Nictitating membrane absent; spiracles present.

d. First dorsal fin inserted more or less in advance of ventrals.

e. Caudal fin not lunate; upper lobe two or more times length of lower, with a notch below toward tip; sides of caudal peduncle not keeled.

f. Last gill slit entirely in front of pectoral fin; teeth long, subulate, with a slender cusp on each side.....Carchariidæ.

ff. Last gill slit above pectoral base; teeth triangular, compressed; caudal longer than body.....Vulpeculidæ.

ee. Caudal fin lunate; caudal peduncle with a keel on each side; last gill opening entirely in front of the pectoral.....Isuridæ.

dd. First dorsal fin over or behind the ventrals; last gill slit above base of pectoral.

- g. Nostrils confluent with mouth (in species included herein), with a nasoral groove and a cirrus on the anterior nasal valve; first dorsal above ventrals..... Orectolobidæ.
- gg. Nostrils not confluent with the mouth (in species included herein); cirri absent or rudimentary; first dorsal behind ventrals..... Catulidæ.
- cc. Nictitating membrane present; spiracles absent or present.
- h. Teeth more or less compressed, triangular, one or two series functioning.
- i. Head normal, not expanded across the orbital region..... Carcharhinidæ.
- ii. Head much expanded across orbital region, hammer-headed or kidney-shaped..... Cestraciontidæ.
- hh. Teeth depressed, paved, several series functioning..... Galeorhinidæ.
- bb. Anal fin absent; two dorsals each with a spine; spiracles present; mouth protrusible, with a deep groove at each angle..... Squalidæ.
- aa. Body and head depressed; no anal fin; pectorals produced but free from the head; two spineless dorsals on the tail..... Rhinidæ.
- II. PLATOSOMIA: Body discoid; pectorals attached to the head; gill openings on ventral surface of disk.
- a. Tail comparatively thick, with two dorsals and a caudal fin; no serrated caudal spines.
- b. Nasoral grooves absent; disk narrow and elongate; tail strong.
- c. Snout sawlike, much produced, flat, armed with strong teeth on each side, set at right angles to its axis; disk small; pectorals not continued forward at side of head..... Pristidæ.
- cc. Snout more or less produced, not sawlike, toothless; disk moderate; pectorals continued at side of head, not reaching end of snout..... Rhinobatidæ.
- bb. Nasoral grooves present; disk broad, rounded, or angular; tail moderate to short.
- d. Disk subcircular; skin smooth; an electric battery at each side of head..... Narcaciontidæ.
- dd. Disk rhomboidal; skin usually rough, with spines or tubercles; no electric battery. . Rajidæ.
- aa. Tail slender, with one or no dorsal fin and usually with one or more serrated spines.
- e. Pectoral fins uninterrupted, confluent around the snout; teeth small; disk subcircular to rhomboidal..... Dasybatidæ.
- ee. Head bearing a pair of rostral or cephalic fins, representing a partly or entirely separated section of the pectoral fins; disk very broad and angular.
- f. Head bearing a pair of rostral fins; teeth broad, molarial.
- g. A pair of rostral fins joined in front of snout, forming a single lobe..... Myliobatidæ.
- gg. Snout in two separate lobes, the rostral fins not joined in front of the skull and not continuous at the sides of the head with the pectorals..... Rhinopteridæ.
- ff. Head bearing a cephalic fin, a separate section of the pectorals, extended forward as a hornlike process from each side; teeth small, numerous, in pavement..... Mobulidæ.

### Family CARCHARIIDÆ. The sand sharks.

#### Genus CARCHARIAS Rafinesque.

#### 1. *Carcharias taurus* Rafinesque. Sand shark; sand-bar shark.

*Eugomphodus littoralis*, Yarrow, 1877, p. 217.

*Carcharias americanus*, Jordan and Gilbert, 1879, p. 387.

*Carcharias littoralis*, Jordan, 1886, p. 26; Jenkins, 1887, p. 84; Jordan and Evermann, 1898, p. 2748; Smith, 1907, p. 37; Guder, 1913b, p. 98; Coles, 1914, p. 91.

*Teeth*.—Teeth slender, in  $\frac{45}{39} \left( \frac{40-46}{36-40} \right)$  rows; bases two-rooted, with one or two slender, sharp-pointed denticles at each side of cusp; teeth in front of mouth long, subulate, sinuate, slightly protruding; on the sides of the jaws they are graduated, the length and crookedness of median cusp diminishing, the 10 or 12 rows nearest angles of mouth being tricuspidate, several rows at angles minute; teeth of first row in upper jaw slightly smaller than the second; those of the fourth row in the upper jaw and the first row in the lower jaw much smaller; some of the upper teeth have two small denticles on one or both sides; two rows of functioning teeth.

<sup>a</sup> Garman, *Plagiostomia*, p. 25.

*Denticles*.—The dermal denticles are relatively large, being about 0.42 mm. long by 0.47 mm. broad in a shark 105 cm. long, very unequal in size, not close set, and not, or only slightly, overlapping; outer surface 3-keeled, keels high, median keel very prominent, with a deep groove on either side, lateral keels resting on a narrow, raised, flattened marginal area, the margin of the latter sometimes curved

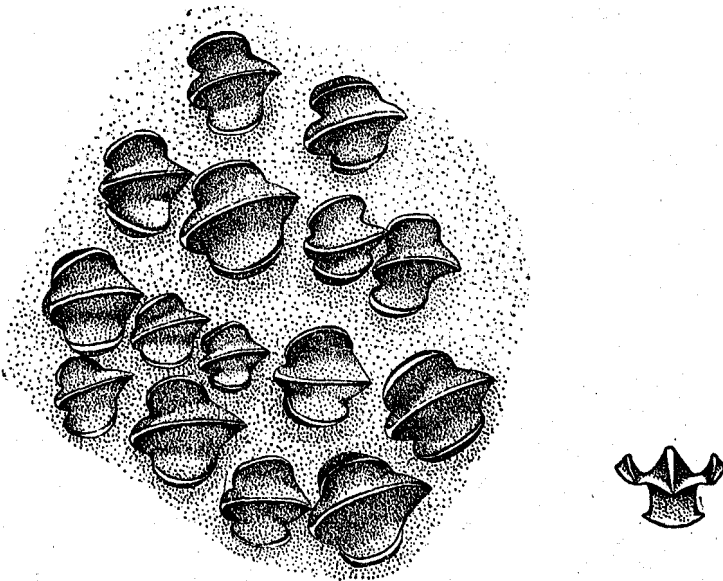


FIG. 1.—Denticles, *Carcharias taurus*, about 152 cm. long, from Cape Lookout, N. C.

upward; apical margin with a prominent, obtuse-angled median lobe, and without a deep indentation between tips of median and lateral keels; basal margin trilobed or rounded; pedicel of medium size and height; basal plate small.

MEASUREMENTS OF A MALE 105 CM. (41 $\frac{3}{8}$  INCHES) LONG FROM WOODS HOLE, MASS.

	cm.		cm.
Tip of snout to—		Base of second dorsal.....	7.2
Origin of first dorsal.....	42.0	Length of outer margin of pectorals.....	13.6
Anterior margin of eye.....	8.1	Length of inner margin of pectorals.....	6.3
First gill slit.....	22.0	Breadth of pectorals.....	10.2
Last gill slit.....	26.0	Axil of pectorals to base of ventrals.....	21.2
Base of pectoral.....	26.0	Length of outer margin of ventrals.....	8.2
Spiracle.....	13.3	Length of inner margin of ventrals.....	4.1
Front of mouth.....	5.5	Breadth of distal margin of ventrals.....	8.3
Outer angles of nostrils.....	4.7	Length of claspers.....	3.5
Horizontal diameter of orbit.....	1.4	Length of anterior margin of anal.....	8.6
Vertical diameter of orbit.....	1.2	Length of posterior margin of anal.....	2.7
Distance between nostrils.....	3.2	Length of base of anal.....	6.9
Height of gill apertures (subequal).....	5.2	Distance from posterior base of anal to origin of lower	
Length of anterior margin of first dorsal.....	10.5	caudal lobe.....	3.1
Length of posterior margin of first dorsal.....	3.6	Length of upper caudal lobe.....	30.0
Base of first dorsal.....	8.0	Length of lower caudal lobe.....	10.7
Distance between dorsals.....	10.8	Distance of notch from tip of caudal.....	7.5
Length of anterior margin of second dorsal.....	9.5	Breadth of lower margin of caudal tip.....	5.5
Length of posterior margin of second dorsal.....	2.8		

This species is very voracious and is said to be very destructive to fishes; working together in schools, they surround and attack schools of other fish, even those imprisoned in the nets of fishermen. At times it is abundant along the banks, and in the spring wherever the haul seine fishermen operate dead specimens usually are to be found on the beaches. On April 24, 1913, at least a dozen examples, 3 to 5 feet in length, were seen on the beach in the bight of Cape Lookout. Coles states that the species is not a regular habitant of this region, but that they occasionally arrive in schools, especially

on Lookout Shoals, where they prove very troublesome to the bluefish fishermen, attacking the fish in the nets, tearing the nets, and liberating the fish. The fishermen sometimes confuse this species with another (*Hypoprion brevirostris*), and some of the large examples reported to be the sand shark were presumably the latter species.

Family VULPECULIDÆ. The thresher sharks.

Genus VULPECULA Valmont.

2. *Vulpecula marina* Valmont.

*Vulpecula marina*, Radcliffe, 1914, p. 474.

*Alopias vulpes*, Coles, 1914, p. 91.

*Teeth*.—Teeth two-rooted, in  $\frac{42}{44} \left( \frac{42}{37} \right)^a$  rows, small, compressed, subtriangular; cusps narrow, smooth-edged, sharp-pointed, slightly recurved at tip, anterior margin sinuate, posterior margin concave; bases broad; a minute denticle present on one or both sides of many of the teeth, frequently absent on functioning teeth; teeth in the third row in upper jaw and in the eighth row in the lower jaw smaller;

a row of minute teeth on each side of symphysis of lower jaw; teeth at angles of mouth small; outer row and part of the second functioning.

*Denticles*.—The dermal denticles are normally five-keeled, very small, being about 0.21 by 0.21 mm. in an example about 458.2 cm. long, thin, subequal, close-set, closely overlapping; outer surface flattened; keels low, distinct, interspaces not deeply grooved; apical margin slightly dentate; basal margin rounded; pedicel small, slender, high; basal plate small, rhomboidal.

The first record of this species for the coast of North Carolina is that of an example found on the beach in the bight of Cape Lookout April 24, 1913. This specimen had evidently become entangled in the nets of the fishermen; the elongate caudal lobe had been severed from the body and

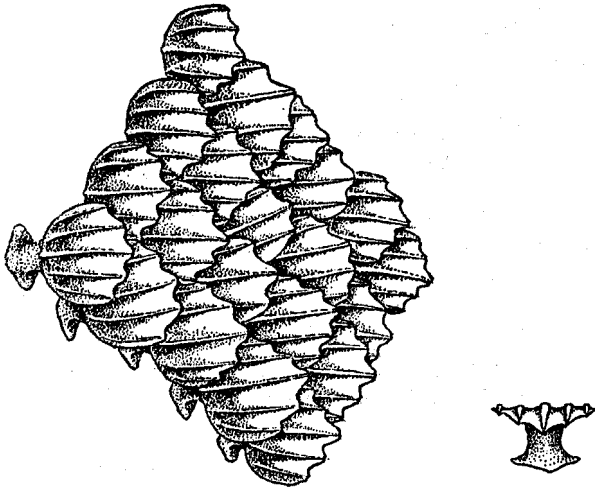


FIG. 2.—Denticles, *Vulpecula marina*, about 458.2 cm. long, from Cape Lookout, N. C.

lost. The length of the body to the base of the caudal was about 228.6 cm. (7 feet); estimated total length, 457.2 cm. (15 feet).

Head short, thick, very robust; snout short, subconical, its length less than the distance from its tip to front of mouth; eye large, without nictitating membrane, horizontal diameter 1.25 in vertical diameter, 2.66 in snout; nostrils large, interspace between nostrils about double length of aperture; nasal flap acute-angled, aperture divided; mouth small, its length nearly equal to its width; spiracle small, behind middle of eye, its distance from eye 1.75 in horizontal diameter of eye, aperture one-tenth horizontal diameter of eye.

First dorsal large, as high as long, distal margin concave, lower lobe acute; origin of dorsal over inner angle of pectoral; second dorsal very small, its distal margin straight, produced posteriorly in a long, acuminate lobe; anal small, similar to second dorsal, situated nearer base of caudal than base of ventrals; ventrals short, broad, breadth about equal to length, distal margin sinuous, rather deeply concave mesially; claspers slender, pointed, very elongate, nearly four times length of inner lobe of ventrals, their tips extending beyond origin of anal; pectorals narrow, falcate.

Color of back and sides bluish slate, sides of head below spiracle lighter; region around mouth, thence backward on ventral surface, white; from axil of pectoral to behind base of first dorsal the white coloration of belly extends well up on the sides of the body; behind the ventrals the white coloration again encroaches on the sides of the body.

Coles reports observing one of these sharks feeding in the bight of Cape Lookout late in July, 1914.

<sup>a</sup> Garman, *The Plagiostomia*, p. 31.



## Family ISURIDÆ. The mackerel sharks.

## KEY TO THE GENERA.

- a. Gills without strainers; teeth compressed; one or two series functioning.  
 b. Teeth large, triangular, edges serrated, basal denticles absent. . . . . *Carcharodon*.  
 bb. Teeth awl-shaped, smooth-edged, with or without basal denticles. . . . . *Isurus*.  
 aa. Gills with strainers; teeth small, conical, several series functioning. . . . . *Cetorhinus*.

## Genus CARCHARODON Smith in Müller and Henle.

3. *Carcharodon carcharias* (Linnæus).

*Carcharodon carcharias*, Coles, 1914, p. 91.

*Teeth*.—Teeth in  $\frac{26}{24}$  rows, large, erect, triangular, coarsely serrated, cutting edges nearly straight; teeth relatively longer and narrower, without distinct basal shoulders and more uniform in size than in species of *Carcharhinus*; third row on each side of symphysis of upper jaw of slightly smaller teeth than those in the second or fourth rows; teeth in lower jaw similar in form to those in the upper except that they are narrower, edges slightly more concave; a wide toothless space at symphysis of lower jaw;

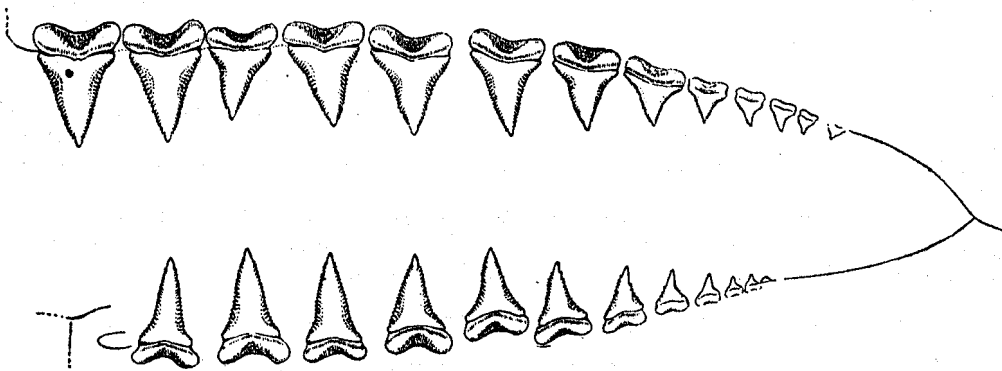


FIG. 3.—Teeth, *Carcharodon carcharias*, from Woods Hole, Mass. (U. S. National Museum no. 11845.)

two rows of small teeth at angles of mouth. (Description of teeth based on a set of jaws in the United States National Museum, from Woods Hole, Mass.)

*Dermal denticles*.—As figured by Garman (*The Plagiostomia*, pl. 5, fig. 9), the denticles are regular in arrangement, slightly overlapping, three-keeled, keels parallel; lateral keels submarginal; apical margin with three sharp-pointed lobes, median one most prominent; basal margin rounded; pedicel and base small.

In 1905 and again in 1913 Coles observed several very large sharks in the vicinity of Cape Lookout which he believed to be this species. As yet none has been captured on the coast of North Carolina.

## Genus ISURUS Rafinesque. Mackerel sharks.

4. *Isurus tigris* (Atwood).

*Isuropsis dekayi*, Yarrow, 1877, p. 217.

*Isurus dekayi*, 1907, p. 31.

*Teeth*.—"Teeth smaller than those of *I. oxyrinchus*, similarly without basal denticles, with a sharp slender curved cusp, and with the third tooth at each side of the middle of the mouth on the upper jaws much smaller than the second or the fourth."<sup>a</sup>

*Denticles*.—No material or description available. Dr. Yarrow states that he saw a skeleton of this species. Although later observers have failed to find examples of it and have not included it in their faunal lists, the species doubtless visits these waters.

<sup>a</sup> Garman, *The Plagiostomia*, p. 37.

## Genus CETORHINUS Blainville. The basking sharks.

5. *Cetorhinus maximus* (Gunner).*Cetorhinus maximus*, Coles, 1914, p. 92.

*Teeth*.—Teeth small, subconical, recurved, numerous, many-rowed, slightly compressed along lateral margins, back of teeth slightly more flattened than the front, apex pointed; teeth arranged in regular rows, five or six teeth in each row functioning; numerous pockets along outer margin of jaw from which teeth have been shed.

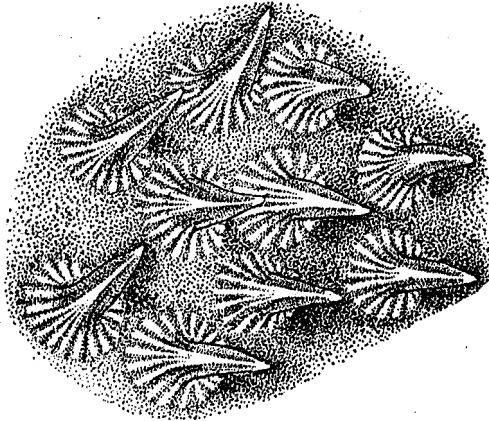


FIG. 4.—Denticles, *Cetorhinus maximus*, from Monterey, Cal. (U. S. National Museum no. 27024.)

*Denticles*.—The denticles are small, unequal, suberect, close-set, thornlike, with recurved tips; outer (anterior) surface with a low, corrugated median ridge which broadens out at base with a slight groove along each side on apical portion; base large, circular, corrugated. (Description of teeth and denticles based on parts of a specimen in the United States National Museum, from Monterey, Cal.)

In July, 1905, Coles observed a huge shark lying motionless on the surface of the water out from Cape Lookout. The size accredited to this specimen by Coles would indicate that it was the basking shark, although no examples have ever been captured on this coast.

## Family ORECTOLOBIDÆ. The nurse sharks.

## Genus GINGLYMOSTOMA Müller and Henle.

6. *Ginglymostoma cirratum* (Bonnaterre).*Ginglymostoma cirratum*, Coles, 1914, p. 89.

*Teeth*.—Teeth in  $\frac{36}{31}$  rows, arranged in regular rows both transversely and laterally, about 9 teeth in a transverse row in front of upper jaw and 12 in the lower jaw; each tooth with a prominent, pointed, median cusp and three smaller cusps on each side of it, base broad. At the sides of the jaw the cusps are smaller, slightly curved toward angles of mouth; along anterior edge of the jaw the margin of each tooth is practically smooth, cusps and denticles being worn away. (Description based on a set of jaws of an adult from Pensacola, Fla., now in United States National Museum.)

In an example 26.7 cm. (10.5 inches) long from the American Museum of Natural History, collected in Brazil, the teeth in the front of the mouth have a single cusp; behind these are tricuspid teeth indicating that the form of the teeth changes considerably with age.

*Denticles*.—The dermal denticles are large, being about 0.41 mm. long by 0.31 mm. broad in a specimen 26.7 cm. long, ovate, leaflike, quite regular in outline and arrangement and of nearly uniform size; sculpturing consists of a short distinct median keel extending along median line of basal half of denticle and normally with a shorter lateral keel on each side, the latter sometimes absent; pedicel high, slender; base short, broad, stellate.

Coles observed a school of these sharks in Lookout Breakers in the summer of 1913 and succeeded in capturing one 273.3 cm. (9 feet) in length.

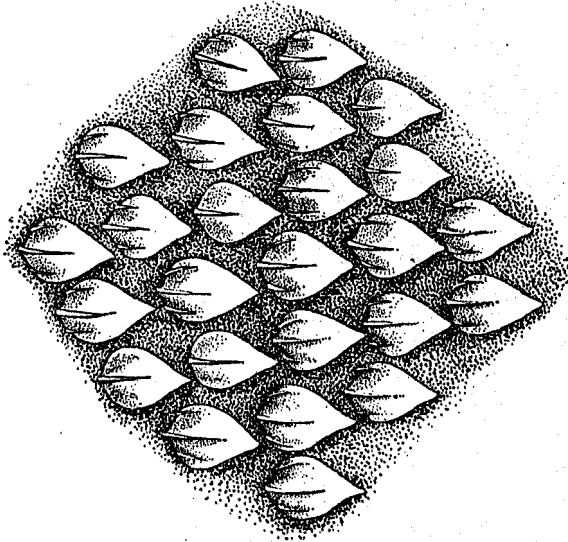


FIG. 5.—Denticles, *Ginglymostoma cirratum*, 26.7 cm. long, from Brazil.



#### Family CATULIDÆ. The cat sharks.

##### Genus CATULUS Valmont.

#### 7. *Catulus retifer* (Garman).

*Catulus retifer*, Smith, 1907, p. 31.

**Teeth.**—Teeth similar in both jaws, small, suberect, subequal, with a median, lanceolate cusp and normally with two smaller lateral cusps; cusps of lower teeth relatively stouter, more nearly subequal, number of lateral cusps more variable; teeth arranged in quincunx, several teeth in each row functioning.

**Denticles.**—The denticles are large, unequal, suberect or recurved, not crowded or overlapping; irregular in arrangement, quite similar in form on the different parts of the body. Exposed outer surface of denticle long, narrow, recurved, lanceolate at tip, frequently with one to three lateral serrations, mesial portion hollowed out with a low keel on each side and with or without a low median keel; pedicel short; base very large, rhomboidal. Denticles around mouth and on under side of snout short, depressed, leaflike, without sculpturing; those along dorsal surface of caudal slightly enlarged and more closely set than those on sides of body.

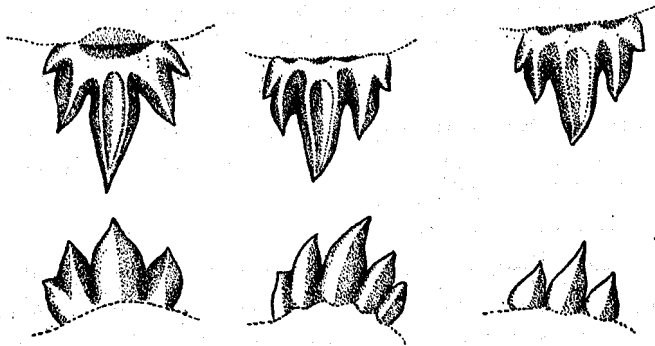


FIG. 6.—Teeth near front of mouth, *Catulus retifer*, 16.7 cm. long, from *Fish Hawk* station 7315, Gulf Stream, off Cape Lookout, N. C.

Two examples in the laboratory collections 15.2 and 16.7 cm. in length, dredged by the *Fish Hawk*

at station 7315 in 172 fathoms, have the characteristic color pattern of this species. The fins are more rounded at tip than shown in Goode and Bean's illustration (*Oceanic Ichthy.*, 1895, pl. IV, fig. 14), the origin of the first dorsal is about an eye's diameter nearer tip of snout than tip of tail and the caudal is more elongate. In these respects they more closely resemble *C. boa* (Garman, *The Plagiostomia*, p. 77).

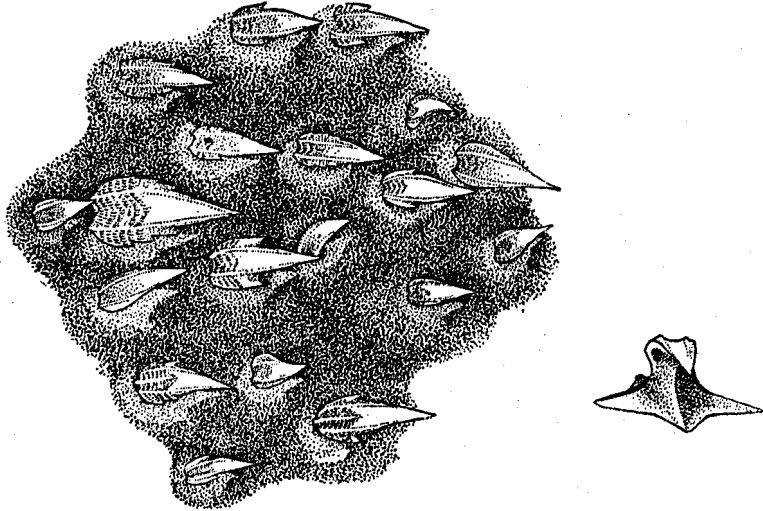


FIG. 7.—Denticles, *Catulus retifer*, 16.7 cm. long, from *Fish Hawk* station 7315, Gulf Stream, off Cape Lookout, N. C.

### Family CARCHARHINIDÆ. The requiem sharks.

#### KEY TO THE GENERA.

- a. Spiracle absent; lower teeth narrower than upper.
  - b. Labial folds at angles of mouth well developed, extending along both jaws; teeth entire, oblique, notched ..... *Scoliodon*.
  - bb. Labial folds rudimentary; teeth erect and entire or serrated, some or all, on bases and cusps.
    - c. Teeth without serrations, slender, erect, sharp-pointed; upper teeth slightly larger. . . . . *Aprionodon*.
    - cc. Teeth of upper jaw serrate on basal shoulders only; lower teeth entire, slenderer, erect.
      - ..... *Hypoprion*.
      - ccc. Teeth serrated, some or all, on bases and cusps; teeth in upper jaw in most species more broadly triangular than those in *Aprionodon* or *Hypoprion*..... *Carcharhinus*.
- aa. Spiracle present, minute; teeth large, coarsely serrate, alike in both jaws, notched on outer margin; labial folds at angles of mouth well developed..... *Galeocerdo*.

#### Genus SCOLIODON Müller and Henle

8. *Scoliodon terræ-novæ* (Richardson). Sharp-nose; sharp-nosed shark; dog shark.

*Scoliodon terræ-novæ*, Jordan and Gilbert, 1879, p. 388; Linton, 1905, p. 342; Smith, 1907, p. 34; Coles, 1914, p. 90.

*Carcharhinus terræ-novæ*, Jordan, 1886, p. 26; Jenkins, 1887, p. 84.

*Carcharhinus terræ-novæ*, Wilson, 1900, p. 355.

*Scoliodon terranovæ*, Gudger, 1910, p. 399.

*Teeth*.—Teeth in  $\frac{26}{24}$  rows, oblique, compressed, broad-based, without serrations, each with a single cusp inclined toward the angle of the mouth, and a deep notch on posterior margin below the cusp; teeth at symphysis of each jaw slightly smaller; median row in upper jaw and two rows at symphysis of lower jaw erect; bases of teeth in upper jaw higher and cusps broader than in lower jaw; toward the angles of the mouth the inclination of cusps falls, the anterior margin being almost horizontal in the teeth at the angles; near front of mouth, the tips of the cusps are slightly bent toward symphysis, the anterior margin being slightly concave; this character is more pronounced in teeth of lower jaw; near angles of mouth, anterior margin straight.

*Denticles*.—The denticles are three-keeled, very small in size, being about 0.17 by 0.17 mm. in a shark 61 cm. long, subequal, slightly overlapping; keels low but distinct, interspaces relatively flat, not deeply concave; lateral keels intramarginal: apical margin of denticle with three acute-angled pro-

jections, corresponding to the keels, median one longest; basal margin rounded, with a slight concavity between the keels; pedicel slender; base small, rhomboidal.

The denticles of this species differ from those of *Carcharias taurus* in being smaller, more uniform in size, closer set, overlapping, more regular in arrangement; interspaces between keels not so deeply concave, lobes on apical margin sharper, incisions between apical lobes deeper, pedicel more slender.

This is one of the most common sharks in the Beaufort region. From the laboratory records it appears that the species is scarce or absent from the harbor during the winter months. The young, 28 to 45 cm. long, are abundant in the harbor during June and July. In the surf along the banks and on the offshore fishing grounds, the species is common and the readiness with which it takes the hook renders it a source of annoyance at times to the line fishermen in these places.

From the ovary of a female 101.6 cm. (40 inches) in length, taken in the surf on Shackelford Bank, August 9, 1912, four embryos, three females and a male, 5.5 to 6 cm. in length, were taken. These were attached to the yolk sac, and still possessed the mass of long, threadlike, external gill filaments. The

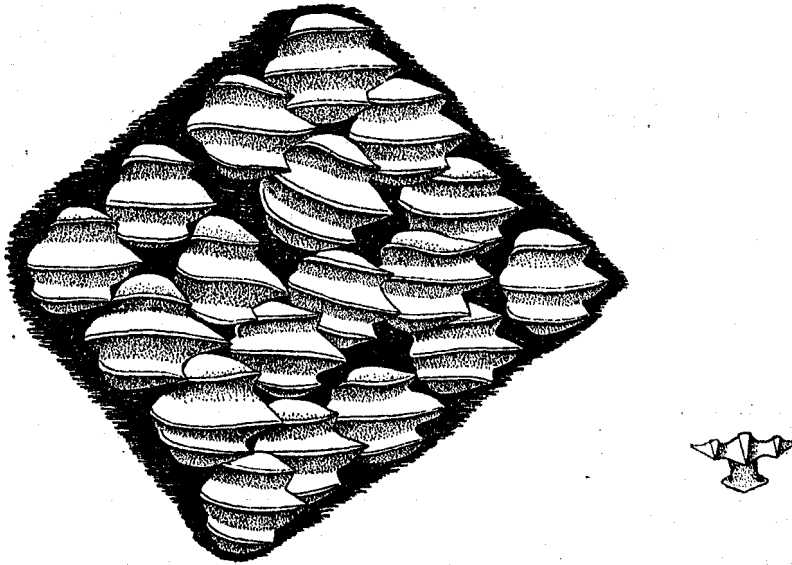


FIG. 8.—Denticles, *Scoliodon terra-nova*, 62.5 cm. long, from Cape Lookout, N. C.

claspers in the male were distinct, reaching posterior margin of ventrals. In addition to the embryos, the ovary contained a number of small eggs.

The stomachs of specimens examined in June and July, 1912-13, contained hogfish, silversides, Irish pompano, shrimp, the feet of mollusks, and other partly digested matter.

TABLE OF LENGTHS AND WEIGHTS OF THESE EXAMPLES.

Month taken.	Length.	Weight.
	Centimeters.	Grams.
June.....	34.9	152
Do.....	36.6	175
Do.....	38.5	154
Do.....	<sup>a</sup> 38.4	184
July.....	39.7	184
Do.....	33.0	110
Do.....	37.5	211
Do.....	37.5	241

<sup>a</sup> This was a female. All the others were males.

## Genus APRIONODON Gill

9. *Aprionodon isodon* (Müller and Henle).*Aprionodon isodon*, Radcliffe, 1914, p. 414.

**Teeth.**—Teeth in  $\frac{1}{1}$  rows, small, erect, compressed, without serrations; cusps narrow, sharp-pointed; bases broad, forming a distinct shoulder; three rows of minute teeth at symphysis of upper jaw; a median row of minute teeth at symphysis of lower jaw, a row on either side of it of smaller teeth than those which follow; lower teeth smaller than the upper.

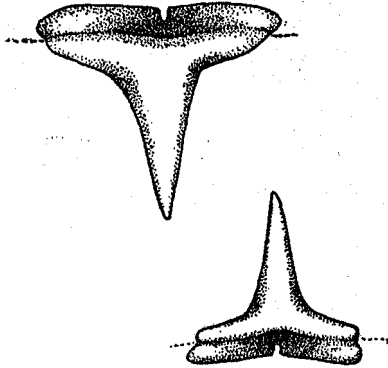


FIG. 9.—Teeth, *Aprionodon isodon*, 50.8 cm. long, in Beaufort collection. (Same specimen as fig. 10.)

**Denticles.**—The dermal denticles are very thin and small, being about 0.27 mm. long by 0.28 mm. broad in a shark 50.8 cm. in length, three-keeled, imbricated, outer surface relatively flat, keels low, parallel; apical margin normally with three sharp-pointed lobes, the number varying from three to five, median lobe longest, incision between lobes sharp-cut, relatively deep; in many of the denticles these lobes are broken or worn away; basal margin rounded; pedicel short, stout; base large, stellate. The denticles of this species differ from those of *Scoliodon terra-novae* in being more closely imbricated, slightly larger, with weaker keels, lobes of apical margin sharper and longer, three to five in number, pedicel shorter and stouter.

The laboratory collections at Beaufort contain a single example of this species 50.8 cm. (20 inches) in length, for which there is no record as to date or method of capture.

## MEASUREMENTS OF THIS EXAMPLE, A FEMALE.

	cm.		cm.
Total length.....	50.8	Length of posterior margin of first dorsal.....	2.2
Tip of snout to—		Base of first dorsal.....	5.0
Origin of dorsal.....	17.0	Distance between dorsals.....	10.0
Anterior margin of eye.....	4.3	Length of anterior margin of second dorsal.....	2.5
First gill slit.....	10.6	Length of posterior margin of second dorsal.....	2.2
Last gill slit.....	12.4	Base of second dorsal.....	2.2
Base of pectoral.....	12.1	Length of outer margin of pectorals.....	7.5
Front of mouth.....	3.8	Length of inner margin of pectorals.....	2.7
Outer angle of nostrils.....	2.5	Breadth of pectoral.....	4.5
Horizontal diameter of orbit.....	1.0	Axil of pectorals to base of ventrals.....	9.5
Vertical diameter of orbit.....	0.8	Length of outer margin of ventrals.....	2.9
Distance between nostrils.....	2.8	Length of inner margin of ventrals.....	2.9
Length of nasal aperture.....	0.75	Breadth of distal margin of ventrals.....	2.7
Distance between angles of mouth.....	4.2	Length of anterior margin of anal.....	3.1
Height of—		Length of posterior margin of anal.....	2.2
First gill slit.....	2.6	Base of anal.....	2.3
Second gill slit.....	2.7	Axil of anal to origin of lower caudal lobe.....	3.7
Third gill slit.....	2.8	Length of upper caudal lobe.....	14.1
Fourth gill slit.....	2.7	Length of lower caudal lobe.....	5.9
Fifth gill slit.....	2.2	Tip of caudal to notch.....	3.8
Length of anterior margin of first dorsal.....	6.2	Breadth of tip of caudal lobe.....	3.3

Snout short, depressed, blunt, its length about equal to breadth of mouth; nostrils small, with a short, rounded, flaplike projection near inner angle, length of aperture equal to vertical diameter of orbit; distance from tip of snout to outer angle of nostrils, one-half distance from angle of nostril to angle of mouth; mouth large, distance from tip of mandible to angle slightly less than distance between angles. An eye diameter behind eye, there is a porelike aperture which resembles a rudimentary spiracle. Gill slits elongate, the third longest, 2.8 times horizontal diameter of eye; fifth shortest, above pectoral base.

First dorsal high, nearer base of pectorals than ventrals, distal margin concave, anterior lobe

rounded, posterior lobe acute-angled; second dorsal small, over anal, posterior lobe elongate, distal margin straight; pectorals larger than first dorsal, inner angle reaching beyond vertical from origin of first dorsal, distal margin slightly concave; ventrals truncate; anal slightly larger than second dorsal, distal margin incised, posterior lobe acute; caudal long, 3.63 in total length; subcaudal lobe deep, rounded, terminal lobe distinct, deep. This rare species, according to Jordan and Evermann, has been recorded from New York, Virginia, and Cuba.

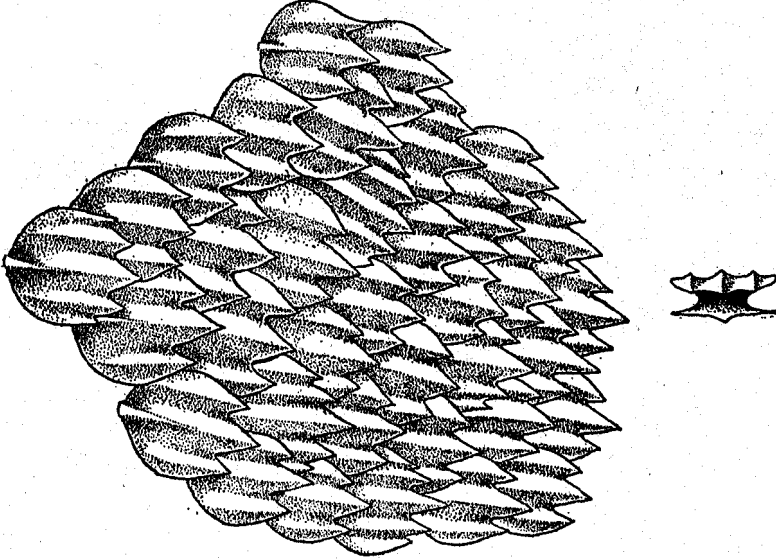


FIG. 10.—Denticles, *Aprionodon isodon*, 50.8 cm. long, in Beaufort collections.

#### Genus HYPOPRION Müller and Henle.

##### 10. *Hypoprion brevirostris* Poey. Sand shark.

*Carcharhinus obscurus*, Linton, 1905, p. 339 (in part); Smith, 1907, p. 33 (after Linton).

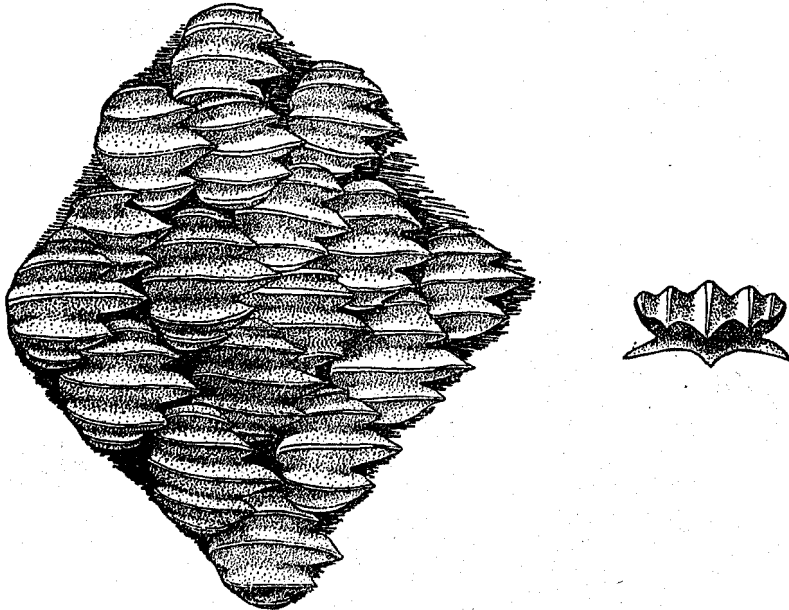
*Hypoprion brevirostris*, Radcliffe, 1913, p. 396; Coles, 1914, p. 90.

*Teeth*.—Teeth in  $\frac{33-33}{29-31}$  rows, suberect, subulate, narrow-cusped, broad-based, two-rooted; cusps

of lateral teeth in upper jaw slightly inclined toward angles; teeth near angles with a distinct notch; cusps smooth, shoulders distinctly serrate; lower teeth slenderer, without serrations on cusps or shoulders, cusps more nearly erect; three rows of small teeth at symphysis of each jaw. Three rows of teeth at angles of mouth resembling the teeth of *Scoliodon terra-nova*.

*Denticles*.—The denticles are large, being about 0.4 to 0.62 mm. long by 0.4 to 0.6 mm. wide in a shark 248.9 cm. in length, heavy, normally five-keeled (three to five), unequal, imbricated; median keel very heavy, interspaces rather deeply concave; keels parallel; apical margin usually five-lobed (three to five), median lobe strongest, with a deep incision on each side; basal margin rounded; pedicel reduced to a very short, heavy neck, resting on a large stellate basal plate.

Three large males were caught with a shark hook baited with butterfly rays and toadfish floated out from first jetty on Pivers Island so that the bait hung about 2 feet below surface, as follows: A specimen (no. 1) 228.6 cm. ( $7\frac{1}{4}$  feet) long, August 31, 1912; one (no. 2) 205.7 cm. ( $6\frac{3}{4}$  feet) long, September 1, 1912; and one (no. 3) 248.9 cm. ( $8\frac{1}{8}$  feet) long, August 12, 1913. In each case these were hooked during the night.

FIG. 11.—Denticles, *Hypobryon brevisrostris*, 248.9 cm. long, from Beaufort, N. C.

## MEASUREMENTS OF SPECIMENS.

	No. 1.	No. 2.	No. 3.
	cm.	cm.	cm.
Total length.....	228.6	205.7	248.9
Depth at origin of first dorsal.....	32.0	31.0	.....
Tip of snout to—			
Origin of first dorsal.....	78.0	76.0	90.0
Anterior margin of eye.....	15.0	14.9	15.0
First gill slit (upper angle).....	41.0	38.7	43.0
Last gill slit (upper angle).....	.....	50.6	.....
Base of pectoral.....	.....	50.0	49.0
Front of mouth.....	.....	11.0	11.0
Outer angle of nostrils.....	.....	8.4	8.5
Horizontal diameter of orbit.....	2.3	2.2	2.5
Distance between nostrils.....	.....	10.2	.....
Distance between angles of mouth.....	.....	21.0	22.0
Height of—			
First gill slit.....	.....	9.2	.....
Second gill slit.....	.....	9.8	.....
Third gill slit.....	.....	10.2	.....
Fourth gill slit.....	.....	9.5	.....
Fifth gill slit.....	.....	8.8	.....
Length of anterior margin of first dorsal.....	28.0	25.3	31.0
Length of posterior margin of first dorsal.....	10.0	9.1	12.0
Base of first dorsal.....	22.0	19.7	22.0
Distance between dorsals.....	41.0	37.0	48.0
Length of anterior margin of second dorsal.....	22.0	19.4	22.0
Length of posterior margin of second dorsal.....	7.5	7.3	8.0
Base of second dorsal.....	16.0	14.5	.....
Length of anterior margin of pectoral.....	39.5	37.0	42.0
Length of posterior margin of pectoral.....	15.0	12.9	.....
Length of distal margin of pectoral.....	38.0	36.3	.....
Distance from origin of pectorals to base of ventrals.....	65.0	62.0	77.0
Length of anterior margin of ventrals.....	19.0	17.3	.....
Length of base of ventrals.....	13.0	13.7	.....
Length of claspers.....	.....	.....	14.0
Distance from posterior base of ventrals to origin of anal.....	20.0	17.8	.....
Length of anterior margin of anal.....	20.0	19.1	.....
Length of posterior margin of anal.....	6.5	5.2	.....
Length of anal base.....	12.5	12.3	.....
Axil of anal to lower caudal lobe.....	13.0	12.3	.....
Length of upper caudal lobe.....	54.0	50.0	60.0
Length of lower caudal lobe.....	28.0	29.3	27.0
Breadth of tip of caudal lobe.....	14.0	11.8	.....



In the largest example the distal margin of the first dorsal was deeply concave; second dorsal large, similar in shape to the first; pectoral short, broad, distal margin slightly concave; anal similar in form to second dorsal but much smaller. Labial fold short.

In smallest example the liver was very large, more than half the length of the body; 400 cc. of bile in gall bladder; stomach empty except for bait, spiral valve as in *Scoliodon terraenovae*; heart small, ventricle 6.1 cm. from apex to base, width at base 5.7 cm., length from apex to insertion of conus 6.6 cm. The red corpuscles of the blood were 16  $\mu$  by 12.4  $\mu$ , somewhat irregular in outline, but generally oval; the white corpuscles had an average diameter of 8.8  $\mu$ .

*Color at death.*—Ground color of back dark bluish-gray, lemon-yellow tinge below, shading into white on belly; fins grayish except the anal, which was yellowish edged with gray; claspers white; margins of gill openings white, shading to dark gray, with an intramarginal area above and below white; eye yellow-gray, pupil black; interior of mouth white.

The toadfish (*Opsanus tau*) proves a very effective bait for sharks. If hooked carefully through the jaws it will live for several days, and is immune to attacks from crabs and other fishes.

Among the fishes recorded by Linton (1905, p. 339) is *Carcharhinus obscurus* of which he says:

"These sharks are referred to this species although they do not agree in all diagnostic features with the descriptions published in Jordan and Gilbert's Fishes of North America or Jordan and Evermann's later work. The pectorals do not reach quite to the first dorsal. The second dorsal is larger than the anal. There is not much difference between the upper and lower teeth. They agree rather with *Prionace* in the character of the fins, but the nose is much shorter and broader than in that genus." With the exception of the one caught by Coles on July 26, 1902, these appear to have been examples of *H. brevirostris*. The short pectorals, second dorsal larger than anal, similarity of teeth in each jaw, and the short and broad snout are characters which are more diagnostic of this species than any other found in this region.

From recent data the species appears to be fairly common in the Beaufort region and has undoubtedly been confused with other species by earlier writers. The writer has been unable to obtain an authentic record of the presence of *C. obscurus* in this region.

### Genus CARCHARHINUS Blainville.

#### KEY TO THE SPECIES.

- a. Fins black-tipped; teeth similar in form in both jaws, narrow-cusped, broad-based in  $\frac{33-34}{30-31}$  rows; dermal denticles small, imbricated, three-keeled in small examples, five to seven keeled in large ones; snout elongate ..... *limbatus*.
- aa. Fins not black-tipped; teeth in upper jaw triangular, notched or not; cusps of lower teeth narrow, erect.
- b. Dermal denticles three-keeled, not closely imbricated without or with distinct apical lobes; upper teeth narrowly triangular, longer than broad, without distinct basal shoulders, in 29 to 31 rows; lower teeth narrow-cusped in 27 to 30 rows; snout short, broad, blunt, its length slightly greater than distance between angles of mouth; pectorals broad, breadth 1.7 times length, without prominent lower lobe. .... *milberti*.
- bb. Dermal denticles five-keeled, closely imbricated, upper teeth deeply notched or broadly triangular.
- c. Snout elongate, moderately pointed; teeth in  $\frac{26}{23-25}$  rows; upper teeth deeply notched; lower teeth short, very narrow-cusped. .... *acronotus*.
- cc. Snout short, broad, blunt, its length less than distance between angles of mouth; teeth in  $\frac{27-31}{26-32}$  rows; upper teeth broadly triangular, broader than high; cusps of lower teeth rather broad; pectorals long, narrow, twice as long as broad, with a prominent basal lobe. .... *commersonii*.

#### 11. *Carcharhinus limbatus* (Müller and Henle).

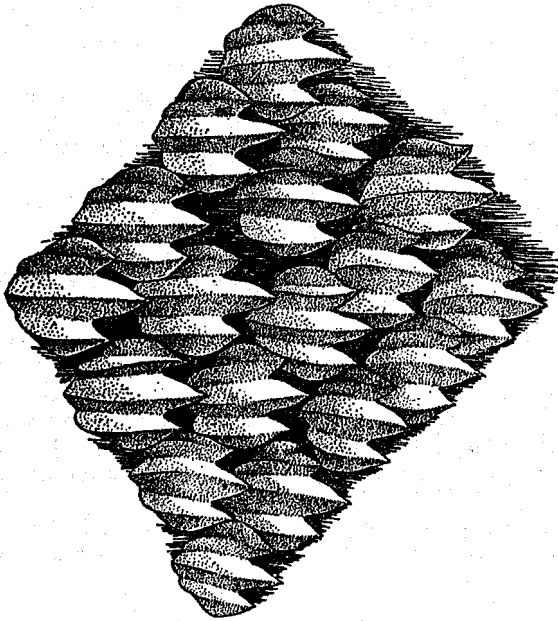
*Carcharhinus obscurus*, Linton, 1905, p. 339 (in part).

*Carcharhinus limbatus*, Gudger, 1913a, p. 2; Coles, 1914, p. 90.

*Teeth.*—Teeth in  $\frac{33-34}{30-31}$  rows, erect, subulate, narrow-cusped, broad-based; cusps of upper teeth finely serrate, basal shoulders finely denticulate; cusps of lower teeth normally with small serrations, bases smooth; two to three rows of small teeth at symphysis of each jaw.

The teeth of this species resemble those of *H. brevisrostris* more closely than the other species of *Carcharhinus*, the difference being so slight as to suggest the advisability of including the species of that genus under the genus *Carcharhinus*.

*Denticles*.—The sculpturing of the dermal denticles varies with age. In specimens 60 to 70 cm. in length the denticles are small (0.25 mm. long by 0.28 mm. broad in a 70 cm. specimen), three-keeled,



subequal, close-set, imbricated; keels low, distinct; apical margin three-lobed, with deep incisions between the lobes; basal margin rounded; pedicel short and stout; basal plate large, rhomboidal.

In two examples 135 and 175 cm. in length, the denticles are five to seven keeled; apical margins relatively smooth, the apical lobes in most cases being worn down. In places where the skin has been abraded and new denticles are being formed, the changes in form may be noted. In the early stages of development, the denticles are usu-

FIG. 12.—Denticles, *Carcharhinus limbatus*, 70 cm. long, from Beaufort, N. C.

ally smooth, ovate in outline; later a sharp median keel appears, followed by a lateral one on each side; at this stage the apical margin may be entire or deeply three-lobed as in individuals 60 to 70 cm. long. Later one or two additional lateral keels on each side appear.

MEASUREMENTS OF A FEMALE, 70 CM. (27½ INCHES) LONG, TAKEN IN THE POUND NET AUG. 27, 1913.

	cm.		cm.
Total length.....	70.0	Length of posterior margin of first dorsal.....	3.1
Depth at origin of first dorsal.....	10.8	Base of first dorsal.....	7.5
Tip of snout to—		Distance between dorsals.....	13.7
Origin of first dorsal.....	22.4	Length of anterior margin of second dorsal.....	3.4
Anterior margin of eye.....	4.8	Length of posterior margin of second dorsal.....	2.9
Upper angle of first gill slit.....	14.0	Base of second dorsal.....	3.2
Upper angle of fifth gill slit.....	17.9	Length of anterior margin of pectoral.....	12.2
Base of pectoral.....	17.1	Length of posterior margin of pectoral.....	3.4
Front of mouth.....	5.7	Length of distal margin of pectoral.....	8.5
Center of nostrils.....	3.7	Distance from origin of pectorals to base of ventrals.....	18.6
Horizontal diameter of eye.....	1.35	Length of anterior margin of ventrals.....	4.2
Distance between nostrils.....	3.7	Length of posterior margin of ventrals.....	3.8
Distance between angles of mouth.....	6.3	Base of ventrals.....	2.6
Height of—		Distance between ventrals and anal.....	6.6
First gill slit.....	2.5	Length of anterior margin of anal.....	4.0
Second gill slit.....	2.7	Length of posterior margin of anal.....	2.6
Third gill slit.....	2.9	Base of anal.....	3.3
Fourth gill slit.....	2.8	Distance from base of anal to origin of caudal.....	4.0
Fifth gill slit.....	2.3	Length of upper caudal lobe.....	19.6
Length of anterior margin of first dorsal.....	9.6	Length of lower caudal lobe.....	8.4
Height of first dorsal.....	6.5		

This species is easily recognized by the black-tipped fins. It is ferocious, very gamy, and not easily captured when hooked. In the Beaufort region it is not common, although a number, ranging in length from 59 to 175 cm., were taken in the summer of 1914. A male taken in the pound July 10, 1912, 60 cm. in length, weighed 1,280 g. From its stomach a menhaden (*B. tyrannus*) and a butterfish (*P. alepidotus*) were taken. The sting of a sting-ray was found embedded in the skin under the jaw of a female 175 cm. long.

Under *C. obscurus*, Linton (1905, p. 339) lists a specimen captured by Coles, July 26, 1902, 6 feet in length. He says: "It was a much cleaner-cut and more graceful shark than any other seen by me at Beaufort. The tips of the pectorals were black, a character not noted in the others. \* \* \* Mr. Coles stated that the tips of all the fins of his specimen were black when it was first captured. He also said that it was much more voracious and gamy than the others he had taken." These characters agree more closely with *C. limbatus*, the black tips of the fins and game qualities being characteristics of that species.

## 12. *Carcharhinus milberti* (Müller and Henle).

*Carcharhinus milberti*, Smith, 1907, p. 34 (in part).

*Teeth*.—Teeth  $\frac{29-31}{27-30}$  rows; upper teeth long, narrowly triangular, with serrate cutting edges; several rows at symphysis erect, cutting edges straight; toward the angles of the mouth the outline of the teeth changes, the anterior margins from straight to convex, posterior margins from straight to concave to slightly notched; teeth without distinct basal shoulder, except those at angles; a row of minute, finely serrated teeth at symphysis; lower teeth erect, narrow cusped, with short but distinct basal shoulders; cusps slender, subulate, finely serrate in small individuals, smooth, or with traces of serrations in larger ones; basal shoulders smooth; a row of minute, unserrated teeth at symphysis.

In an example 182.9 cm. long the teeth in the front of the upper jaw are longer than broad, resembling those of *Carcharodon carcharias*, but more finely serrated.

*Denticles*.—The dermal denticles vary somewhat in outline with age. In a shark 54.6 cm. in length they are small, 0.2 mm. long by 0.3 mm. broad, three-keeled, unequal in size, not close set and not overlapping; keels low, parallel, interspaces not deeply channeled; apical margin truncate, without or with

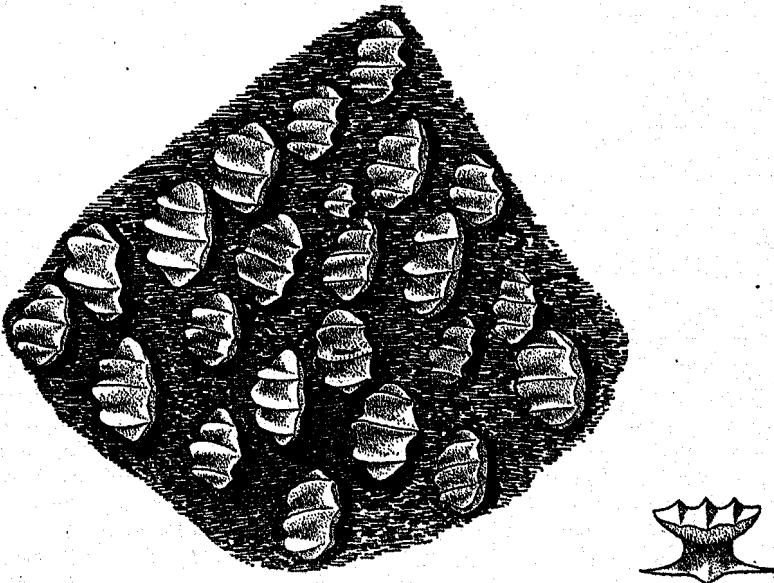


FIG. 13.—Denticles, *Carcharhinus milberti*, 81 cm. long, from Cape Lookout, N. C.

only slightly projecting lobes; pedicel of medium size; base large, stellate.

The extent of the area on sides of body below dorsal having this type of denticle varies in different specimens and with age, being larger in small examples than in large ones. Outside this area the

denticles grade into a form which has three sharp-pointed lobes on the apical margin, with a deep indentation between the lobes, keels high and distinct. These differences may be noted without the aid of a microscope by passing the fingers forward over the surface of the skin, that portion devoid of apical lobes feeling comparatively smooth. In the example 182.9 cm. long, the denticles are closer together, and in nearly all cases the median keel projects slightly, apical margin more rounded. The characteristic form and sculpturing of the denticles in this species have proved to be of marked value in identifying the species.

MEASUREMENTS OF A SPECIMEN (No. 1) 81 CM. ( $31\frac{1}{8}$  INCHES) LONG FROM CAPE LOOKOUT, N. C., AND ONE (No. 2) 182.9 CM. (6 FEET) LONG FROM WOODS HOLE, MASS.

	No. 1. No. 2.	
	cm.	cm.
Total length.....	81.0	182.9
Tip of snout to—		
Origin of first dorsal.....	24.0	58.5
Anterior margin of eye.....	7.8	16.9
First gill slit.....	16.4	38.5
Last gill slit.....	19.5	49.5
Base of pectoral.....	18.7	44.0
Front of mouth.....	6.9	15.2
Outer angles of nostrils.....	4.8	9.8
Depth of body at origin of dorsal.....	11.4	.....
Horizontal diameter of orbit.....	1.7	2.8
Distance between nostrils.....	4.9	10.6
Length of nasal aperture.....	1.4	3.2
Distance between angles of mouth.....	7.5	16.1
Height of—		
First gill aperture.....	3.2	5.8
Second gill aperture.....	2.9	5.9
Third gill aperture.....	2.9	5.7
Fourth gill aperture.....	2.7	5.5
Fifth gill aperture.....	1.8	4.6
Length of anterior margin of first dorsal.....	2.0	26.1
Length of posterior margin of first dorsal.....	3.7	9.3
Base of first dorsal.....	9.6	20.0
Distance between dorsals.....	18.7	.....
Length of anterior margin of second dorsal.....	4.0	9.6
Length of posterior margin of second dorsal.....	3.4	7.4
Base of second dorsal.....	3.6	8.1
Distance from second dorsal to caudal.....	.....	14.0
Length of outer margin of pectorals.....	14.4	36.0
Length of inner margin of pectorals.....	5.0	11.0
Breadth of pectorals.....	8.3	20.4
Axil of pectorals to origin of ventrals.....	15.4	.....
Length of outer margin of ventrals.....	5.3	.....
Length of inner margin of ventrals.....	5.0	.....
Breadth of distal margin of ventrals.....	4.9	.....
Length of claspers.....	4.1	.....
Length of anterior margin of anal.....	5.9	12.1
Length of posterior margin of anal.....	3.4	7.2
Base of anal.....	4.0	8.1
Axil of anal to lower caudal lobe.....	6.0	10.0
Length of upper caudal lobe.....	20.4	48.8
Length of subcaudal lobe.....	9.0	22.7
Tip of caudal to notch in upper lobe.....	5.2	.....
Breadth of distal margin of caudal tip.....	4.3	.....

Snout (in smaller example, a male) short, broad, blunt, its length slightly greater than distance between angles of mouth; nostrils widely separated, distance from outer angle to tip of snout nearly 1.5 in preoral length, aperture less than diameter of eye, valves with a short, pointed lobe.

First dorsal high; upper lobe rounded; posterior lobe produced, acute; distal margin concave, origin over axil of pectoral; second dorsal small, acuminate behind; distal margin very slightly concave; origin of fin in advance of anal; pectorals large, breadth 1.7 in length, distal margin slightly concave; ventrals truncate, claspers small; anal slightly larger than the second dorsal, distal margin deeply concave; caudal large, about one-fourth total length, subcaudal lobe large.

The larger individual agrees in general with the one just described. The nasal aperture is greater than diameter of eye, the first dorsal is more erect and the upper lobe is more pointed, distal margin slightly sinuous, concave posteriorly; second dorsal considerably smaller than the anal; caudal about 3.7 in total length.

Color of upper surface of body and fins smoke gray, ventral surface massicot yellow, dusted with black and gray.

This species appears to be rare in the Beaufort region. Specimens are occasionally taken in the bight of Cape Lookout. On May 6, 1914, two examples 62.2 and 65.4 cm. in length were taken in Newport River. In the Beaufort region it has been confused with *C. commersonii* (see description of that species). It is quite generally confused with *C. obscurus* in regions where both occur; in fact, examples from northern waters, New Jersey and New England, identified as *C. obscurus*, which the writer has examined, have, almost without exception, proved to be *C. milberti*.

### 13. *Carcharhinus acronotus* (Poey).

*Carcharhinus acronotus*, Gudger, 1913a, p. 2; Radcliffe, 1913, p. 396; Coles, 1914, p. 90.

*Teeth*.—Teeth in  $\frac{26}{23-25}$  rows; upper teeth broad, oblique, triangular; with a distinct notch on the posterior margin; cusps broad, serrate, inclined toward angles of mouth, anterior margin without distinct basal shoulder, posterior margin with a distinct, coarsely serrated basal shoulder below notch;

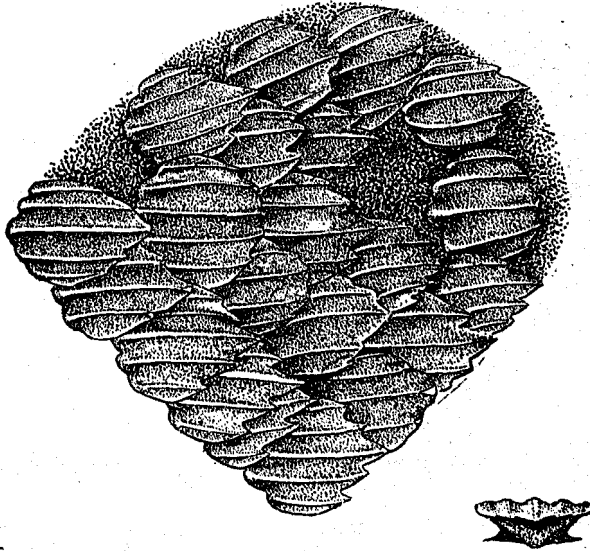


FIG. 14.—Denticles, *Carcharhinus acronotus*, about 60 cm. long, from Cape Lookout, N. C.

one or two rows of small teeth at symphysis, second and third rows on either side slightly larger, graduated; lower teeth smaller than the upper, erect; cusps short, narrow, pointed, very finely serrate, resting on a low, broad base; a median row of minute teeth at symphysis.

*Denticles*.—The dermal denticles are large, leaflike, closely imbricated, five-keeled; keels low, narrow, parallel, distinct, interspaces not deeply channeled; apical margin in denticles not badly worn, with five small, graduated lobes, corresponding to the keels, median lobe longest; pedicel short, heavy, resting on a large rhomboidal basal plate.

MEASUREMENTS TAKEN FROM A FEMALE 134 CM. (52¾ INCHES) LONG, CAUGHT ON A HOOK BAITED WITH MULLET, IN THE SURF ON SHACKLEFORD BANKS, AUG. 9, 1912.

Tip of snout to—	cm.		cm.
Anterior margin of eye.....	11.0	Origin of first dorsal to origin of second dorsal.....	42.0
First gill slit.....	25.0	Length of anterior margin of pectoral.....	20.5
Front of mouth.....	10.0	Distance from base of ventrals to anal.....	17.0
Base of pectoral.....	32.5	Length of caudal.....	32.5
Origin of ventrals.....	69.0	Length of subcaudal lobe.....	14.5
Origin of dorsal.....	43.0		

This West Indian species is rare in the Beaufort region, the first example being taken by Coles in the bight of Cape Lookout in July, 1911. In July, 1914, Coles took six additional specimens in the same locality. It may be expected at other points in the South Atlantic States.

14. *Carcharhinus commersonii* Blainville.

*Carcharhinus milberti*, Linton, 1905, p. 341; Smith, 1907, p. 34 (in part).

*Carcharhinus lamia*, Gudger, 1913b, p. 97; Coles, 1914, p. 90.

*Teeth*.—Teeth in  $\frac{27-31}{26-32}$  rows; upper teeth erect, very broadly triangular, coarsely serrate; anterior margins straight to slightly convex, posterior margin straight to slightly concave; tips of teeth near angles slightly recurved, those at angles more or less distinctly notched; one or two rows of minute teeth at

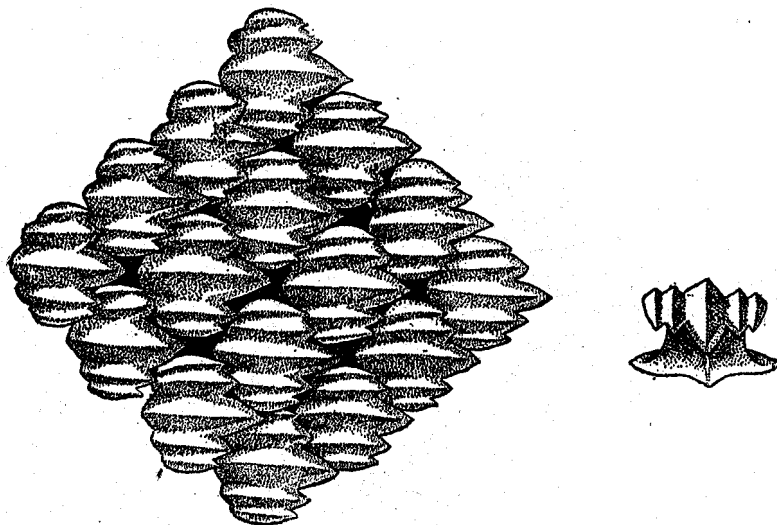


FIG. 15.—Denticles, *Carcharhinus commersonii*, taken from back behind first dorsal, specimen from Cape Lookout, N. C.

symphysis; lower teeth smaller, erect, with relatively short cusps and broad bases, cusps very finely serrate, broader than in related species; two or three rows of minute teeth at symphysis.

The teeth of this species more closely resemble those of *C. milberti* than any other in this region. The upper teeth are shorter and broader, the length of the side of a tooth is more nearly equal to its breadth at base than in *milberti*, serrations coarser, posterior margins of lateral teeth straighter; lower jaw with two or three rows of minute teeth at symphysis instead of one.

*Denticles*.—The dermal denticles are large (about 0.32 mm. long by 0.42 mm. broad in a shark 2 m. long), closely imbricated, heavy, five-keeled; keels prominent, parallel; apical margin smooth, scalloped or with five distinct pointed lobes, depending upon position and wear they have been subjected to; pedicel low, stout, resting on a large rhomboidal basal plate.

The denticles represented in the drawing were taken from the back behind the first dorsal fin and were the only ones available at the time. Denticles under the dorsal have much less prominent apical lobes, more closely resembling apical margin of *C. acronotus*.

MEASUREMENTS OF A MALE 2 M. (6 FEET 6 $\frac{3}{4}$  INCHES) LONG, FROM STATION 10,208 (UNITED STATES COAST SURVEY STEAMER "BACHE"), MAR. 21, 1914.

(Furnished by Mr. W. W. Welsh.)

	cm.		cm.
Total length.....	200.0	Length of anterior pectoral margin.....	47.0
Tip of snout to—		Axil of pectorals to base of ventrals.....	54.0
Origin of first dorsal.....	62.0	Length of ventrals.....	13.0
Anterior margin of eye.....	16.0	Length of claspers.....	18.0
First gill slit.....	33.0	Base of ventrals to origin of anal.....	19.0
Front of mouth.....	14.0	Length of anterior margin of anal.....	13.0
Horizontal diameter of eye.....	2.5	Length of posterior margin of anal.....	9.0
Distance between nostrils.....	12.0	Base of anal.....	7.0
Distance between angles of mouth.....	20.5	Anal to lower caudal lobe.....	12.0
Depth of body at base of first dorsal.....	32.0	Length of upper caudal lobe.....	57.0
Base of first dorsal.....	23.0	Length of lower caudal lobe.....	26.0
Interdorsal space.....	44.0	Caudal notch to tip of fin.....	14.0
Base of second dorsal.....	6.5	Caudal fork to tip of fin.....	50.0
Distance from second dorsal to base of caudal.....	14.0		

First dorsal broad, upper lobe rounded, height of fin greater than length of base, distal margin sinuous, concave near acuminate lower lobe; second dorsal small, similar in form to the first, but more deeply concave, lower lobe relatively longer; pectorals long, narrow, twice as long as broad, with a distinct basal lobe; claspers elongate; anal larger than second dorsal, distal margin deeply incised, anterior lobe rounded, posterior lobe acuminate; caudal large, its length 3.5 in total length of fish; subcaudal lobe nearly one-half length of caudal fin.

Through the courtesy of Mr. Coles, I have been enabled to examine the jaws of the specimen incorrectly identified as *C. milberti* (Linton, 1905, p. 341) and the jaws and denticles of a smaller example. These are *C. commersonii*. Mr. Coles has taken three specimens, the only ones taken on the North Carolina coast.

Genus GALEOCERDO Müller and Henle. The tiger sharks.

15. *Galeocerdo arcticus* Faber.

*Galeocerdo tigrinus*, Coles, 1914, p. 89.

*Teeth*.—Teeth in  $\frac{21-23}{23}$  (21-25)<sup>a</sup> rows; upper and lower teeth similar in form; cusps oblique; anterior margins convex, posterior margins incised, with a deep notch and a prominent basal shoulder; tips of

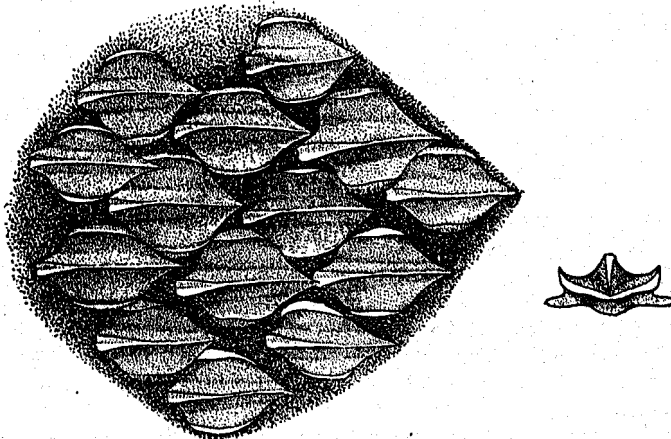


FIG. 16.—Denticles, *Galeocerdo arcticus*, 365.8 cm. long, from Beaufort, N. C.

cusps finely serrate (frequently smooth in functioning teeth), coarsely serrate on basal portion; basal shoulder denticulate, the denticles finely serrate; a median row of smaller, more nearly erect teeth at symphysis of each jaw; the first row and part of the second functioning.

<sup>a</sup> Garman, *The Plagiostomia*, p. 148.

*Denticles*.—The dermal denticles are large, subequal, slightly imbricated, ovate in outline, with a high, arched median keel, and a deep channel on each side of keel; lateral margins curved outward, upturned edges sometimes thickened, keellike, outer edge truncate, or with a narrow basal winglike expansion; apical margin pointed, acute-angled; pedicel broad, little more than a constriction of outer denticle, resting on a large rhomboidal basal plate. Description of specimens 264.2 to 365.8 cm. long. In an example 198.1 cm. long the denticles were smaller, unequal, rather widely separated, without or with only slightly upturned lateral margins.

MEASUREMENTS OF AN EXAMPLE (No. 1) 198.1 CM. (6½ FEET) LONG FROM MENEMSHA BIGHT MASS., TAKEN AUG. 13, 1913, AND ONE (No. 2) 279.4 CM. (9 FEET 2 INCHES) LONG FROM BEAUFORT, N. C., TAKEN AUG. 8, 1914.

	No. 1.	No. 2.
Tip of snout to—	cm.	cm.
Base of dorsal.....	56.0	80.0
Anterior margin of eye.....	12.5	21.0
First gill slit (upper angle).....	29.6	48.0
Last gill slit (upper angle).....	37.4	.....
Base of pectoral.....	35.0	.....
Front of mouth.....	8.3	12.0
Outer angle of nostrils.....	7.5	.....
Spiracle.....	17.9	.....
Horizontal diameter of orbit.....	2.7	3.5
Length of aperture of nostrils.....	2.8	4.0
Distance between nostrils.....	8.1	.....
Distance between angles of mouth.....	15.7	23.0
Height of—		
First gill slit.....	4.5	.....
Second.....	4.8	.....
Third.....	5.0	.....
Fourth.....	5.3	.....
Fifth.....	3.9	.....
Length of anterior margin of first dorsal.....	19.0	28.0
Length of posterior margin of first dorsal.....	9.2	16.0
Base of first dorsal.....	14.4	22.0
Distance between dorsals.....	.....	70.0
Anterior margin of second dorsal.....	.....	11.0
Posterior margin of second dorsal.....	.....	13.0
Base of second dorsal.....	.....	12.0
Distance from second dorsal to base of caudal.....	.....	22.0
Length of anterior margin of pectoral.....	24.0	41.0
Length of posterior margin of pectoral.....	8.8	14.0
Breadth of pectorals.....	15.1	25.0
Axil of pectorals to origin of ventrals.....	.....	79.0
Anterior margin of ventrals.....	.....	14.0
Distal margin of ventrals.....	.....	16.5
Posterior margin of ventrals.....	.....	9.0
Distance between axil of ventrals and anal.....	.....	19.0
Anterior margin of anal.....	.....	17.0
Posterior margin of anal.....	.....	10.0
Base of anal.....	.....	17.0
Length of upper caudal lobe.....	55.0	76.0
Length of subcaudal lobe.....	19.5	28.5
Breadth of distal margin of caudal tip.....	2.5	.....
Tip of caudal to notch.....	9.5	.....

Head short, broad, very blunt and robust; snout short, depressed, semicircular; eye large, lateral, above middle of sides of mouth, nictitating membrane present, highest anteriorly; mouth large, nearly semicircular, near tip of snout; angles with a distinct labial fold above and below; distance between angles nearly equal to their distance from tip of snout; nostrils widely separated, length of aperture nearly one-third of their distance apart, anterior margin with a prominent lobe; spiracle small, about an eye diameter behind eye, in line with its upper margin; body slender, tapering posteriorly to a very slender caudal peduncle; a distinct ridge along median line of back between dorsals; caudal peduncle depressed, angled laterally.

Origin of first dorsal above tip of lower pectoral lobe, fin small, high, anterior lobe slightly rounded, posterior lobe long, acuminate; distal margin concave, slightly sinuous; base of fin nearly equal to its height; second dorsal resembling the first, anterior lobe more rounded; pectorals small, falcate, tips barely reaching to posterior base of first dorsal; ventrals truncate; anal origin slightly behind origin of second dorsal, anterior lobe acute, sickle-shaped, posterior lobe acuminate, distal margin very deeply incised; caudal elongate, about 3.7 in total length, upper lobe very narrow, subcaudal lobe narrow, elongate.



*Color*.—Upper parts silvery gray, lower sides lighter, shading into white of ventral surface; three rows of large spots of darker coloration than the ground color along upper sides and on caudal nearly to tip.

On August 8, 1914, a small school of large tiger sharks appeared in the Fort Macon Channel near the fisheries laboratory and swam around the *Fish Hawk*. A baited shark hook thrown over the side was seized by the largest of the school. The line offered little resistance to this big fellow and he disappeared, taking bait and hook with him. During the time that elapsed while another hook was being secured and baited, the rest of the school came up under the stern of the ship, showing no fear of the men in the cockpit a few feet above them. Apparently the sharks were very hungry and were prepared to grasp anything that might fall to them in the nature of food. When the second hook was thrown over, it was seized by one of the school. This shark, which was killed and brought on deck, was 264.2 cm. (8 $\frac{2}{3}$  feet) in length. For the second time this hook was thrown overboard and soon another specimen, 307.3 cm. (10 $\frac{1}{4}$  feet) in length was captured and hung from the end of the boom with its head out of the water. On the third cast, another, 279.4 cm. (9 $\frac{1}{8}$  feet) in length, was captured. About this time a shark, larger than any of those taken, swam up to the one hanging from the boom, and raising its head partly out of the water, seized the dead shark by the throat. As it did so, the captain of the *Fish Hawk* began shooting at it, with a 32-caliber revolver, as rapidly as he could take aim. The shots seemed only to infuriate the shark, and it shook the dead one so viciously as to make it seem doubtful whether the boom would withstand its onslaught. Finally it tore a very large section of the unfortunate's belly, tearing out and devouring the whole liver, leaving a gaping hole across the entire width of the body large enough to permit a small child to easily enter the body cavity. At this instant one of the bullets struck a vital spot, and after a lively struggle on the part of the launch's crew, a rope was secured around its tail. The four specimens, all females, were brought to the laboratory for examination. The last shark was 365.8 cm. (12 feet) in length, and the liver of the smaller one was still in its stomach, the estimated weight of which was 40 pounds. At the time of capture one of the sharks regurgitated a rat, another a small shark about 61 cm. in length. As this was not saved, its identity was not determined. A shark sucker (*Leptecheneis naucrates*) 26.2 cm. long was also taken with one of the sharks.

Mr. Coles reports the capture of an example of this species by fishermen in the bight of Cape Lookout in 1912.

#### Family CESTRACIONIDÆ. The hammer-head sharks.

##### Genus CESTRACION Klein.

##### KEY TO THE SPECIES.

- a. Head hammer-shaped; nostril with a well-developed groove extending along front of head. . . . . *zygæna*.  
 aa. Head kidney-shaped; nostril with frontal groove short or obsolete. . . . . *tiburæ*.
16. *Cestracion zygæna* (Linnæus). Hammer-head; hammer-headed shark.

*Sphyrna zygæna*, Yarrow, 1877, p. 217; Jordan and Gilbert, 1879, p. 387; Jordan, 1886, p. 26; Jenkins, 1887, p. 84; Wilson, 1900, p. 355; Smith, 1907, p. 36, fig. 6 (a and b); Gudger, 1907, p. 2005; id., 1913a, p. 20; Coles, 1914, p. 90.

*Teeth*.—Teeth in  $\frac{32-36}{31-34}$  rows, differing in form in different individuals.

In an example 52.3 cm. in length they are oblique, compressed, with a sharp-pointed cusp and a deep notch on the posterior margin, similar in form in both jaws, with no specific differences in form from those of *Scoliodon terræ-novæ*. In a male 124.5 cm. long, the upper teeth are oblique, notched, like those of *S. terræ-novæ*, lower teeth erect, or nearly so, narrow-cusped, several rows of oblique teeth at angle of jaws. In a male 132 cm. long the teeth are low, broad-based, without or with a very short cusp, bases somewhat swollen, not compressed as in the specimens mentioned above. Three rows of small teeth, with a short, erect, pointed cusp, at symphysis of upper jaw; in the teeth adjacent to these, the cusps are slightly bent toward the angles, with a distinct notch on posterior border; this type grades into a cusplike form, five rows at each angle being pavementlike. Lower teeth similar, except that the number of rows with an erect cusp is greater and the transition to the pavement type more abrupt, eight or nine rows of the latter adjacent to angles. The teeth in this species show a transition from the compressed triangular forms of the foregoing species to the pavement teeth of the smooth dogfish.

Through the courtesy of Dr. E. W. Gudger, the writer has examined the jaws of the female hammer-head, 381 cm. (12 feet 6 inches) long, taken in Beaufort Harbor, July 20, 1906. The teeth are oblique

in  $\frac{36}{34}$  rows, cusps long, pointed, basal shoulder on posterior margin prominent, cutting edges distinctly serrate; teeth at symphysis erect, or nearly so, with a distinct shoulder on each side of cusp.

*Denticles.*—The dermal denticles vary in form of sculpturing with age, three-keeled in the young, five-keeled in older examples. In a specimen 52.3 cm. long the denticles are very small, being about 0.17 mm. long by 0.16 mm. broad, closely imbricated, normally three-keeled (3 to 5); apical margin normally five-lobed (3 to 5), lobes long, narrow, sharp-pointed; pedicel short and heavy, resting on a

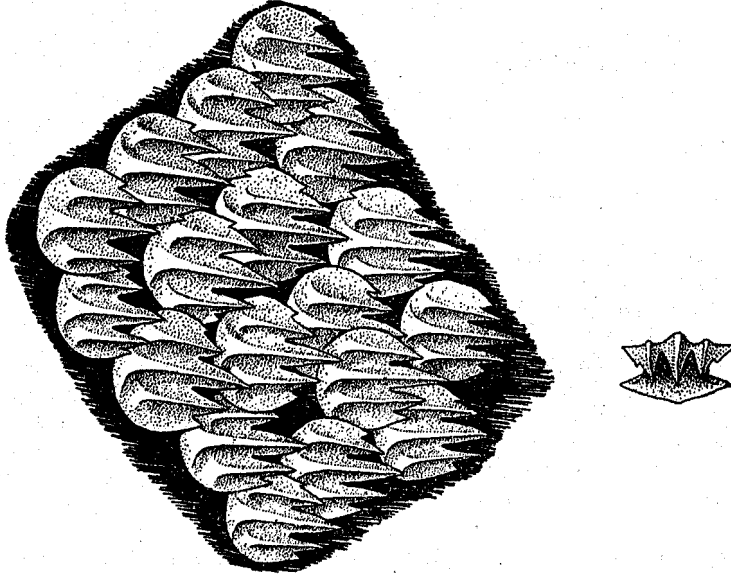


FIG. 17.—Denticles, *Cestracion zygaena*, 52.3 cm. long, from Beaufort, N. C.

large rhomboidal base. In an example 124.5 cm. long they are five-keeled; with or without lobed apical margin.

MEASUREMENTS OF A MALE 124.5 CM. (49 INCHES) LONG, TAKEN IN THE POUND NET, JULY 11, 1914.

	cm.		cm.
Breadth of head.....	35.0	Distance between dorsals.....	29.5
Width of hammer.....	10.0	Length of anterior margin of second dorsal.....	5.0
Tip of snout to—		Length of posterior margin of second dorsal.....	7.5
Origin of first dorsal.....	35.0	Base of second dorsal.....	5.0
First gill slit.....	21.0	Distance from second dorsal to caudal base.....	9.0
Last gill slit.....	28.8	Length of outer margin of pectorals.....	16.5
Base of pectoral.....	26.0	Length of inner margin of pectorals.....	6.5
Front of mouth.....	7.0	Breadth of distal margin of pectorals.....	15.0
Depth of body at origin of first dorsal.....	17.0	Axil of pectorals to origin of ventrals.....	23.5
Horizontal diameter of orbit.....	2.5	Length of outer margin of ventrals.....	9.0
Length of nasal aperture.....	2.5	Length of inner margin of ventrals.....	3.5
Distance between angles of mouth.....	8.5	Breadth of distal margin of ventrals.....	9.0
Height of—		Length of claspers.....	4.5
First gill slit.....	4.0	Distance between base of ventrals and anal.....	10.5
Second gill slit.....	4.0	Length of anterior margin of anal.....	7.0
Third gill slit.....	4.5	Length of posterior margin of anal.....	5.0
Fourth gill slit.....	4.0	Length of base of anal.....	6.5
Fifth gill slit.....	3.0	Posterior base of anal to caudal.....	9.0
Length of anterior margin of first dorsal.....	20.0	Length of upper caudal lobe.....	39.5
Length of posterior margin of first dorsal.....	5.5	Length of subcaudal lobe.....	15.0
Base of first dorsal.....	19.5	Tip of caudal to notch.....	8.2

Dorsal very high, anterior margin nearly straight; distal margin sinuous, markedly concave basally, lower lobe short, acuminate, origin of fin over axil of pectoral; second dorsal small, its origin over anterior

third of anal, distal margin slightly concave, lower lobe acuminate, reaching nearly to base of caudal; pectorals small, distal margin nearly straight; ventrals broad, distal margin very slightly concave; anal larger than second dorsal, anterior lobe recurved, acute-angled, distal margin deeply concave, posterior lobe acuminate, not as long as that of second dorsal.

*Color*.—Dorsal surface deep olive-gray, sides light olive-gray, shading into white of belly; fins body color, with dusky margins.

*Stomach contents*.—Three menhaden 21, 22.2, and 22.8 cm. long respectively. One taken in 1913 had been feeding on small shrimp. A male 132 cm. long taken in Newport River, August 3, 1914, had in its stomach four menhaden, each 26 cm. long.

This species is not common in the harbor. None was taken by the laboratory force in 1912, only one in 1913, and two in 1914. The best places to seine for them are near the mouths of the rivers flowing into the harbor. According to Coles this is one of the most abundant sharks in the Cape Lookout region during the summer months. On one occasion he captured 65 specimens, averaging about 4 feet in length, at a single haul of the seine.

17. *Cestracion tiburo* (Linnæus). Bonnet-nosed shark; shovel-headed shark.

*Remiceps tiburo*, Yarrow, 1877, p. 217; Jordan and Gilbert, 1879, p. 387.

*Sphyrna tiburo*, Jordan, 1886, p. 26; Jenkins, 1887, p. 84; Wilson, 1900, p. 355; Smith, 1907, p. 35, fig. 5; Gudger, 1907, p. 1005; id., 1912, p. 143; Coles, 1914, p. 90.

*Teeth*.—Teeth in  $\frac{29-32}{27-31}$  rows, with a like variation in form as described for *C. zygaena*, but possessing no diagnostic differences by which they may be distinguished from that species.

In a female 124 cm. long, there are no marked differences from the male of *C. zygaena*, 132 cm. in length; a female 94 cm. long has the same type of teeth but has only two rows of cusplless teeth at angles

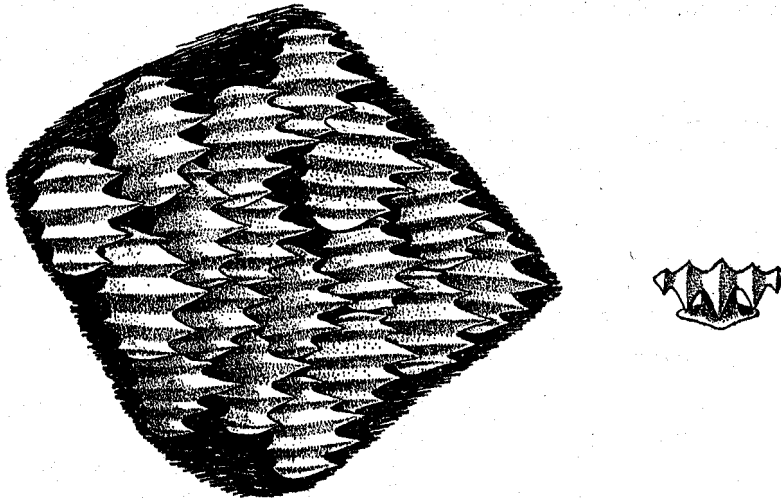


FIG. 18.—Denticles, *Cestracion tiburo*, 89.8 cm. long, from Beaufort, N. C.

in upper jaw and four in the lower. A female 147.5 cm. long has the long, pointed cusps, oblique in upper jaw, erect in the lower and compressed teeth, like those of the male of *zygaena*, 124.5 cm. long.

The average number of rows of teeth is lower in *tiburo* than in *zygaena*. The differences in the form of the teeth are not sexual. The jaws of those specimens in which the teeth are compressed, with oblique cusps in the upper jaw and erect or suberect in the lower are markedly smaller in proportion to the size of the fish than those with the pavement type in each species. As the specimens were not compared nor saved it is not known whether differences other than those of the teeth existed.

*Denticles*.—The dermal denticles are larger and not so closely imbricated, but quite similar in sculpturing to examples of *C. zygaena*, of the same size. In an example 89.8 cm. long they are about 0.27 mm. long by 0.3 mm. broad, imbricated, five-keeled, keels parallel; apical margin five-lobed, lobes acute-angled, pedicels slender, resting on a small rhomoidal basal plate.

## MEASUREMENTS OF A FEMALE 147.5 CM. (58 INCHES) LONG FROM NEWPORT RIVER, AUG. 3, 1914.

	cm.		cm.
Breadth of head.....	20.8	Length of anterior margin of second dorsal.....	7.4
Tip of snout to—		Length of posterior margin of second dorsal.....	6.5
First gill slit.....	21.4	Base of second dorsal.....	4.8
Last gill slit.....	27.3	Distance from second dorsal to base of caudal.....	9.0
Base of pectoral.....	26.0	Length of outer pectoral margin.....	19.4
Front of mouth.....	7.8	Length of inner pectoral margin.....	6.8
Depth of body at origin of first dorsal.....	18.5	Breadth of pectoral.....	12.6
Horizontal diameter of orbit.....	1.7	Axil of pectorals to origin of ventrals.....	27.5
Length of nasal aperture.....	1.7	Length of outer margin of ventrals.....	9.5
Distance between angles of mouth.....	10.0	Length of inner margin of ventrals.....	3.8
Height of—		Breadth of ventrals.....	8.3
First gill slit.....	4.9	Distance from base of ventrals to origin of anal.....	9.2
Second gill slit.....	5.6	Length of anterior margin of anal.....	6.0
Third gill slit.....	6.0	Length of posterior margin of anal.....	4.2
Fourth gill slit.....	5.8	Base of anal.....	8.0
Fifth gill slit.....	4.8	Distance from anal to base of caudal.....	7.3
Length of anterior margin of first dorsal.....	16.9	Length of upper caudal lobe.....	29.2
Length of posterior margin of first dorsal.....	4.5	Length of subcaudal lobe.....	13.0
Base of first dorsal.....	10.4	Tip of caudal to notch.....	7.7
Distance between dorsals.....	27.3		

Dorsal fin high, anterior margin slightly convex, distal margin rather deeply concave, posterior lobe short, acute angled, origin of dorsal over tip of inner pectoral lobe; second dorsal small, slightly behind origin of anal; distal margin deeply concave, upper lobe rounded, lower lobe acuminate; pectorals short, their length not much greater than their breadth; distal margin slightly concave; anal low, broad, distal margin slightly incised; caudal short, about one-fifth total length; subcaudal lobe prominent.

This individual had nine embryos, six in the left uterus and three in the right one. Of these three were males, 12.2 to 14.1 cm. long, and four females 13.4 to 14 cm. long. Another specimen, 124 cm. long, taken on Bird Shoal August 6, 1914, had four embryos in each uterus, about 17.5 to 18.5 cm. long. The embryos lie with the head at the forward end of the uterus. The placenta, which was nearly as long as the embryo, was richly supplied with villi, some of which were 25 mm. long by 3 mm. in diameter. The yolk sac at the end of the placenta was attached to the wall of the uterus and was richly supplied with blood vessels.

## SPECIMENS TAKEN DURING THE SUMMERS OF 1912 TO 1914.

Date.	Locality.	Length.	Weight.	Sex.	Stomach contents.
		cm.	grams.		
1912.					
June 27.....	Near laboratory.....	42.5	286	♂	1 shrimp ( <i>P. brasiliensis</i> ); remains of a small teleost; fragments of eel grass; bit of wood.
Do.....	do.....	49.4	474	♂	1 shrimp ( <i>P. brasiliensis</i> ).
Do.....	do.....	48.7	369	♂	1 small crab; 2 small yellow stones.
July 11.....	Near Morehead.....	95.0	3,290	♂	3 shrimps ( <i>P. brasiliensis</i> ).
Do.....	do.....	73.0	1,274	♂	Empty.
Do.....	do.....	70.0	1,161	♂	Material unidentifiable.
Do.....	do.....	70.0	1,161	♂	Do.
July 30.....	Newport River.....	47.0		♂	Empty.
Sept. 10.....	North River.....	58.7	780	♂	Do.
1913.					
July 1.....	do.....				Small blue crabs.
July 22.....	Town Creek.....	89.8		♂	1 large blue crab and other unidentifiable material.
1914.					
July 22.....	North River.....	54.0		♂	Remains of a blue crab.
Aug. 3.....	Newport River.....	94.0		♂	
Do.....	do.....	174.5		♂	Empty.
Aug. 6.....	Bird Shoal.....	97.0		♂	1 blue crab.
Do.....	do.....	124.0		♂	2 blue crabs; 1 pinfish; mass of algæ.

This species is much more abundant in the harbor than the hammer-head, and appears to enter the harbor for the purpose of giving birth to its young.

## Family GALEORHINIDÆ. The smooth dogfishes.

## Genus GALEORHINUS Blainville.

18. *Galeorhinus lævis* Valmont. Whipper-tail; dogfish; smooth dogfish.

*Mustelus canis*, Smith, 1907, p. 32; Coles, 1914, p. 89.

*Teeth*.—Teeth small, numerous, pavementlike, anterior base of tooth slightly ridged; upper teeth with a short, blunt cusplike projection on posterior margin; lower teeth similar in form, cusp less prominent, absent from teeth near angles of mouth. No sexual differences were noted between the teeth of a male 75 cm. long and a female 91 cm. long from Cape Lookout.

*Denticles*.—The denticles are large (the larger ones in a specimen 90.8 cm. long being 0.4 mm. long by 0.3 mm. wide), unequal in size, overlapping, ovate in outline, with 2 to 4 short, low, nearly parallel keels on basal portion of denticle; the length and prominence of the keels vary; rarely do they extend to the apical margin; apex acute; pedicel small, relatively high; base small.

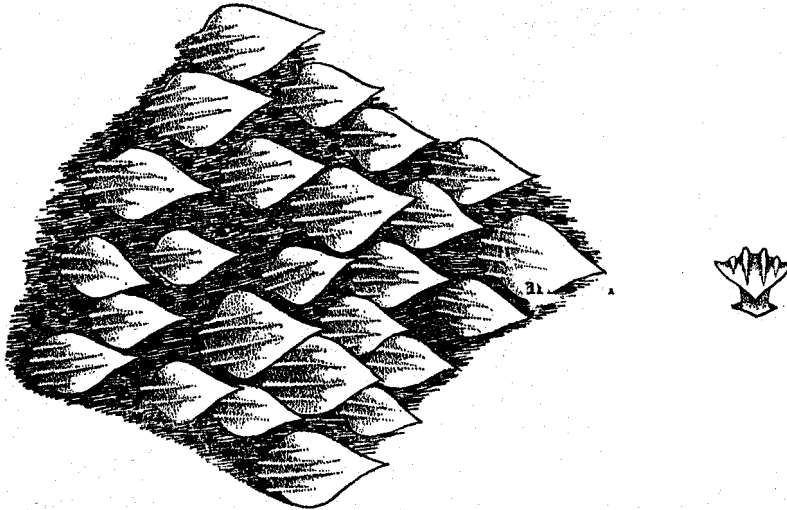


FIG. 19.—Denticles, *Galeorhinus lævis*, 91 cm. long, from Cape Lookout, N. C.

The laboratory has no record of the capture of examples of this species in Beaufort Harbor. It is abundant at Cape Lookout in the spring, but is rarely seen later than June. Individuals left by the fishermen, are common on the beaches at Cape Lookout in April. It is locally known as "whipper-tail."

## Family SQUALIDÆ. The spiny dogfishes.

## Genus SQUALUS Linnæus.

19. *Squalus acanthias* (Klein). Spiny dogfish.

*Squalus acanthias*, Gudger, 1912, p. 143; id., 1913b, p. 98; Coles, 1914, p. 92.

*Teeth*.—Teeth in  $\frac{28}{23}$  rows, regular in arrangement, similar in form in each jaw; upper smaller than lower; cutting edges transverse, nearly horizontal, ending posteriorly in a small, sharp-pointed cusp, below this a deep notch and a prominent basal shoulder; on basal portion of tooth there is a narrow median lobe of enamel, outline of base more or less concave on each side of this projection. Cutting edges of upper teeth more oblique than the lower, the cusps being more erect; two rows of teeth functioning.

*Denticles*.—The denticles are large, being about 0.46 mm. long by 0.32 mm. broad in a shark 84.5 cm. long; a high median keel widest on basal portion of denticles and projecting beyond basal margin; a low keel along each margin normally present; apical margin tridentate, median lobe prominent; pedicel stout; base large, stellate.

At Cape Lookout, Coles states that this species is very abundant in April and the first week of May. Only a single example, taken May 23, 1907, has been recorded from Beaufort Harbor. This was a female,

from which three young ones, 14.5, 15, and 15.3 cm. in length were obtained. The description of teeth and denticles is based on this specimen.

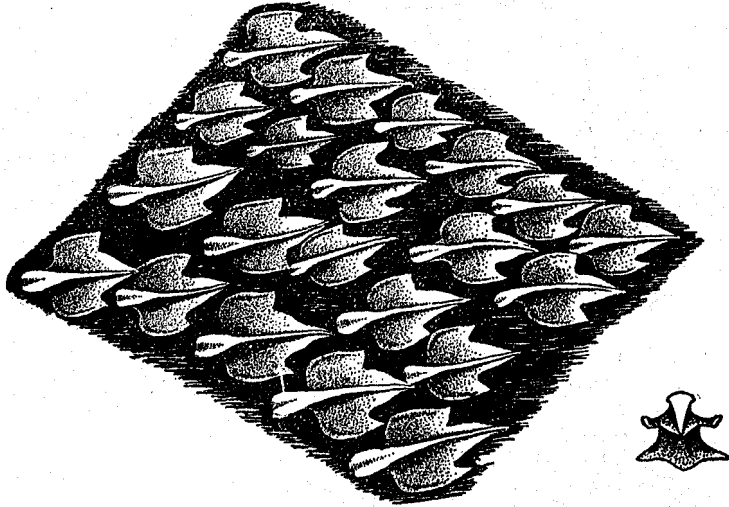


FIG. 20.—Denticles, *Squalus acanthias*, 84.5 cm. long, from Beaufort, N. C.

### Family RHINIDÆ. The angel fishes.

#### Genus RHINA Klein.

#### 20. *Rhina dumeril* (Le Sagur). Nursefish; Jackie.

*Squatina squafina*, Smith, 1907, p. 38; Gudger, 1913a, p. 10; Coles, 1914, p. 92.

Coles states that this species is a regular visitor at Cape Lookout, arriving the latter part of March and leaving about the 1st of May. As no examples of this species are at present available it is impossible to describe the teeth and armature of the skin.

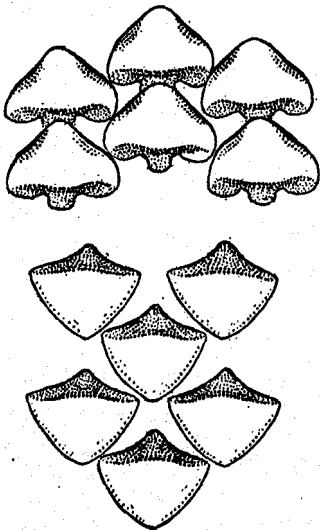


FIG. 21.—Teeth, upper and lower jaws, *Pristis pectinatus*, 71.7 cm. long, from Florida. (Same specimen as fig. 22.)

### Family PRISTIDÆ. The sawfishes.

#### Genus PRISTIS Klein in Schuplatz.

#### 21. *Pristis pectinatus* Latham. Sawfish.

*Pristis antiquorum*, Yarrow, 1877, p. 217.

*Pristis pectinatus*, Jenkins, 1885, p. 11; Jordan, 1886, p. 26; Jenkins, 1887, p. 84; Jordan and Evermann, 1898, pt. III, p. 2749, id., 1900, pl. VIII, fig. 27; Wilson, 1900, p. 355; Smith, 1907, p. 39, fig. 7; Gudger, 1912, p. 144; Coles, 1914, p. 92.

*Teeth*.—Teeth in about  $\frac{94}{90}$  rows (88 to 178 rows above and 84 to 176 below),<sup>a</sup> small, flattened, in pavement, arranged in quincunx; anterior margins rounded, posterior margins truncate; posterior basal portion of upper teeth with a short mesial projection and a slight indentation on either side of it; in the lower teeth the exposed projecting base is more pointed, margin on either side straighter.

*Denticles*.—Denticles on rostrum circular, buttonlike, close-set, sessile; on the head and trunk they vary from ovate to circular; those under first dorsal ovate; pedicel short. Description of teeth and denticles based on a specimen from Florida 71.7 cm. (28 $\frac{1}{4}$  inches) long in the United States National Museum.

"Scales on the very young with broad, rounded bases, short pedicels and leaf-shaped crowns, which latter are more or less sharp angled posteriorly on the greater portion of the body, but with age the crowns become modified, on the fin margins, about the snout and head, and appear convex and smooth, button-shaped, and sessile."<sup>a</sup>

<sup>a</sup> Garman, *The Plagiostomia*, p. 263.

This species is not rare in the Beaufort region. According to Coles it is usually found in the breakers on Lookout Shoals.

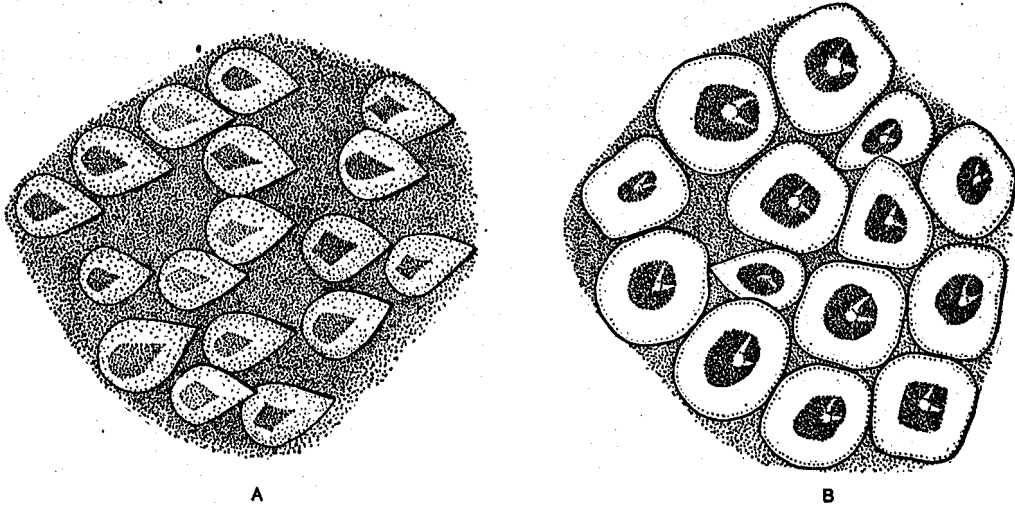


FIG. 22.—Denticles, *Pristis pectinatus*, 71.7 cm. long, from Florida. (U. S. National Museum no. 30678.) A, Denticles under first dorsal; B, denticles on upper surface of rostrum.

### Family RHINOBATIDÆ. The sharklike rays.

#### Genus RHINOBATUS Klein in Schuplatz.

#### 22. *Rhinobatus lentiginosus* Garman. Ray; clear-nose.

*Rhinobatus lentiginosus*, Smith, 1907, p. 40, fig. 8 (a and b); Coles, 1913, p. 33; id., 1914, p. 92.

**Teeth.**—Teeth in  $\frac{63}{60}$  rows in a female 53.5 cm. long and in  $\frac{56}{51}$  rows in a male 38.8 cm. long, in pavement, arranged in quincunx; similar in form in both sexes; anterior margin rounded, posterior margin of functioning surface truncate; posterior side of teeth narrowed basally to a cusplike projection at gum.

**Denticles.**—The denticles are unequal in size and vary in form on different parts of the body; on clear space on either side of rostral cartilage they are small, spear-shaped, sharp-pointed, with concave margins; on back opposite angles to pectorals they are arrow-headed, very unequal in size; on sides under first dorsal they are ovate, sharp-pointed; on ventral surface they are in pavement, subquad-rangular in outline.

There is a row of small compressed and depressed tubercles along the median line of the back; midway between the dorsals these are reduced to ridges covered by skin; a small tubercle on left shoulder and two on the right; a row in front of and above eye, ending at spiracle; five prominent tubercles on tip of snout, three small ones behind these. Description of a female 38.8 cm. long.

Examples from Beaufort agree in the main with descriptions of *lentiginosus*, but possess other characters which are said to distinguish *percellens* from this species.

Rostral cartilage narrow in the middle, broader toward tip of snout, ridges widening forward, the cartilage bearing a flange on the outer side of each near the end; groove between the rostral ridges

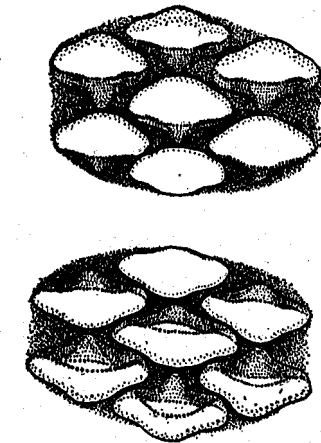


FIG. 23.—Teeth, upper and lower jaws, *Rhinobatus lentiginosus*, 53.5 cm. long. (Same specimen as fig. 24.)

narrowing regularly toward tip of snout.

Nostrils a little wider than their distance apart, the latter one-half mouth; a long, narrow median flap on front margin of nostril and a narrow auxiliary flap extending for one-half distance to inner angle of nostril; posterior margin with an inner median flap, larger than one on anterior margin and two broad flaps on outer margin. Distance between angles of mouth slightly more than one-third distance from mouth to tip of snout; length of spiracles about equal to horizontal diameter of exposed portion of orbit, with two lobes, outer larger; supraocular lobe of orbit large; outer margin of pectorals broadly curved, strongly convex near axis; dorsals subequal, base of first one-third of its distance from base of ventrals, posterior margins truncate; caudal of moderate size, subcaudal convex.

*Color in alcohol.*—Dorsal surface light grayish-olive, thickly sprinkled with small spots of lighter coloration; clear space on either side of rostral cartilage olive-buff; pectorals and ventrals margined with lighter, with traces of a narrow intramarginal band of darker coloration. Ventral surface light naph-

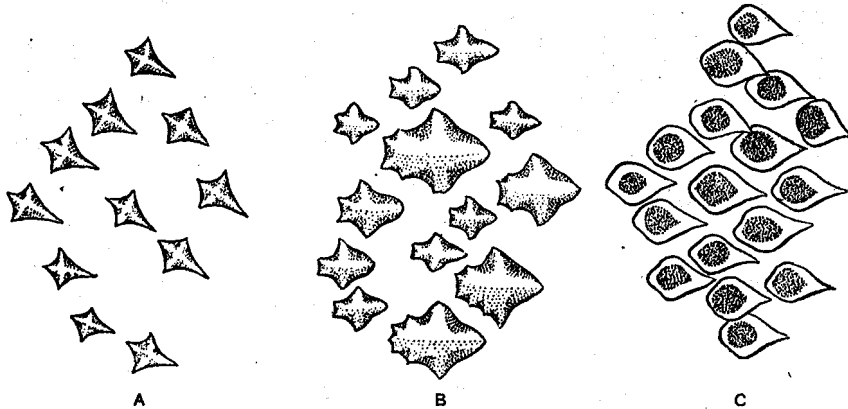


FIG. 24.—Denticles, *Rhinobatus lentiginosus*, 53.5 cm. long, from Cape Lookout, N. C. A, Denticles on clear space on either side of rostral cartilage; B, denticles on back opposite axil of pectorals; C, denticles on side of body below first dorsal fin.

thalene yellow, under surface of tip of snout dark gray; this area extends backward in a narrow, triangular patch, more than half way to front of mouth and along each side of snout to opposite nostrils. Fins slightly darker than ventral surface. The dark coloration on under side of snout is said to be characteristic of *percellens*.

#### Family NARCACIONTIDÆ. The electric rays.

##### Genus NARCINE Henle.

#### 23. *Narcine brasiliensis corallina* Garman. Shockfish; small electric ray.

! *Torpedo occidentalis*, Jenkins, 1887, p. 84 (not of Yarrow).

*Narcine brasiliensis*, Coles, 1910, p. 337, p. 347; Bean and Weed, 1911, p. 232, pl. 10, 11; Gudger, 1913a, p. 2; Coles, 1913, p. 33; id., 1914, p. 93.

*Narcine brasiliensis corallina*, Garman, 1913, p. 298, pl. 26, fig. 3.

*Teeth.*—In a male 27.7 cm. long the teeth are  $\frac{21}{21}$  rows, close-set, arranged in quincunx; dental plate narrow, folded outward; teeth small, base subcircular; posterior grinding surface ending in a narrow, pointed cusp, margin of cusp continuous with anterior margin of tooth.

In a female 34 cm. long the teeth are more flattened, grinding surface, including cusp, more nearly horizontal, cusp less prominent; teeth in  $\frac{21}{21}$  rows, less crowded than in the male. Skin smooth.

Examples from Cape Lookout appear to agree more closely in color pattern with Garman's subspecies *corallina* than either of the other forms. According to Coles this species is a regular visitor at Cape Lookout, arriving in the bight of the cape on the night of July 4 of each year.

There is no authentic record of the occurrence of the Torpedo, *Narcacion nobilianus*, on this coast. The small electric ray (*corallina*) is known to the cape fishermen as "shockfish." It therefore seems probable that the form described by Jenkins was this species and not the Torpedo.



Yarrow lists the Torpedo, but the form described in his notes, as reported by fishermen, was not a ray, but the "electric toad" (*Astroscopus y-græcum*), a form he had not seen. Coues had taken a single specimen of the latter species; this accounts for its inclusion in Yarrow's report.

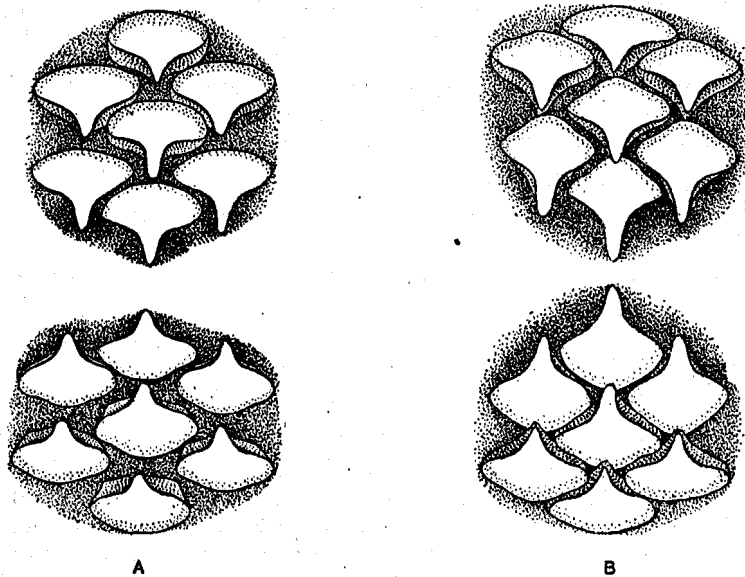


FIG. 25.—A, Teeth, upper and lower jaws, of a male, *Narcine brasiliensis*, 27.7 cm. long, Cape Lookout, N. C.; B, teeth, female, 34 cm. long, from same locality.

### Family RAJIDÆ. The Skates.

#### Genus RAJA Linnæus.

##### KEY TO THE SPECIES.

- a. Snout very blunt, broadly rounded; disk rounded, slightly broader than long; teeth in about  $\frac{44}{44}$  rows; upper surface of body with rosettes or groups of darker spots..... *ornata*.
- aa. Snout produced, angular, disk angular, much broader than long.
- b. Teeth in  $\frac{46-49}{42-47}$  rows; disk and tail rough above; upper surface with numerous dark brown elongated spots..... *eglanteria*.
- bb. Teeth in  $\frac{32-37}{32-35}$  rows; upper surface smoother than in most skates, marked with scattered, unequal, dark brown spots..... *stabuliforis*.

#### 24. *Raja ornata* Garman.

*Teeth*.—Teeth in about  $\frac{44}{44}$  rows, flat, in pavement; anterior margins rounded, posterior margins with a small median cusplike projection.

*Armature of skin*.—Entire upper surface roughened with small spines; lower surface smooth. A row of tubercles above median line of back and tail; a row on either side of these on back and two on the tail; a single spine on each shoulder in one specimen, absent in another; a series on each orbital ridge; a group on rostral ridge near tip of snout; spines along anterior margin of disk slightly larger than those on rest of disk. Descriptions of two young males 19.5 and 21 cm. long.

A female 25 cm. long differs in having three spines on each shoulder, one on forehead between eyes; a group on posterior pectoral lobe, and another near margin of disk opposite eyes.

Disk broadly rounded, with a slight concavity opposite spiracles, slightly broader than long, its length to hinder angle of pectorals 1.1 in its breadth, 2.1 to 2.3 in total length; tip of snout obtuse, not

produced; eyes prominent; interorbital narrow, about one-third snout; mouth small, waved, situated midway between tips of snout and fifth gill slit; ventrals long, narrow, outer margin rounded; tail with a thin narrow flap along lower outer margin.

*Color*.—Upper surface lilac buff, marked with regular rosettes of small black or dark brown spots, six or more around a central one; six or seven rosettes arranged at regular intervals along upper surface of tail, one of these at origin of first dorsal, another at origin of second dorsal; ventral surface white.

On September 2, 1914, the *Fish Hawk* collected a female 25 cm. long, with 8-foot beam trawl, at station 8244 in 66 fathoms of water, and two young males 19.5 and 21 cm. long at station 8245 in 100 to 111 fathoms of water. These stations were about 36 to 40 miles east-southeast of Cape Lookout Light. This species has previously been taken only in deep water off the coast of Florida.

25. *Raja eglanteria* Bosc in Lacépède. Clear-nose ray; brier ray.

*Raja laevis*, Yarrow, 1877, p. 217; Jordan and Gilbert, 1879, p. 387 (after Yarrow); Jenkins, 1887, p. 84 (after Yarrow).

*Raja eglanteria*, Smith, 1907, p. 42, fig. 9; Gudger, 1910, p. 398; id., 1913a, p. 10; Coles, 1914, p. 92.

*Teeth*.—In a male 55 cm. ( $22\frac{5}{8}$  inches) long, in  $\frac{49}{47}$  rows, arranged in regular, parallel rows across the dental plate. Teeth small with a small conical cusp, resting on a broad circular base, anterior margin of each tooth overlapping the posterior basal margin of the tooth immediately in front of it; in front of mouth the cusps are erect, rather blunt at tip; in the back of the mouth they are much longer, recurved, sharp-pointed at tip; 8 to 10 teeth in each row functioning.

Teeth in a female 43.1 cm. (17 inches) long to posterior base of first dorsal (rest of tail lost), in  $\frac{53}{47}$  rows; rows closer together, the flaring base of each tooth occupying part of the upper space between two adjacent teeth in each row, in quincunx; teeth in front of mouth with flaring edges, the margin being continuous with that of anterior basal portion of tooth, and forming a rhomboidal grinding surface; underneath, between the backward projecting cusp with its flaring basal expansion and the posterior base of the tooth there is a distinct groove into which the base of the following tooth fits; farther back on the jaws some of the teeth more closely resemble the male, except that the cusp has a slight basal expansion compressed to a sharp cutting edge which is continuous with the anterior margin of the tooth.

*Armature of the skin*.—In the male there is a patch of tentacula opposite the eyes near margin of disk, and a narrow, elongate intramarginal band at widest part of disk, tips of tentacula inclined toward median line of back; in front of and along inner margin of eye and spiracle there is a row of small tubercles; another of larger tubercles extends along the median line of the back to the second dorsal, two or three on each shoulder and a row along each side of dorsal surface of tail. Small, sharp-pointed spinules are scattered along rostral ridge; those at the tip of snout being enlarged, tuberclelike; others are present along outer pectoral margin, on shoulders, between rows of tubercles on tail and on under side of snout, backward to opposite mouth; rest of body smooth.

In a young male, 8 inches in length, the patches of enlarged tentacula opposite eyes and near outer margin of disk are absent. Tubercles over eyes, on shoulders, along median line of back and in three rows on tail prominent, sharp-pointed, recurved; dorsal surface everywhere studded with small spinules; on clear space on either side of rostral cartilage they are scatteringly present.

In the female the tentacula are absent; spinules scattered over dorsal surface; on the tail between the rows of tubercles they are enlarged, some of them nearly as large as the tubercles.

The *R. laevis* of Yarrow, reported as common, is believed to be this species. The species is common along the banks in the spring and is not rare at offshore stations at other seasons. There are no records of examples taken in the harbor.

26. *Raja stabuliforis* Garman. Smooth skate.

*Raja laevis*, Linton, 1905, p. 346; Smith, 1907, p. 41; Coles, 1914, p. 92.

*Teeth*.—Teeth in the female in  $\frac{33}{33}$  rows, exposed surface of tooth rounded, posterior margin with a small but distinct cusplike projection; in the functioning teeth the exposed surface is subcircular, the cusplike projection being entirely worn away.

Teeth in the male, in  $\frac{37}{35}$  rows, a long sharp-pointed thornlike cusp extends outward and backward from the subcircular base of each tooth; at the sides of the jaws the cusp is in the same plane as basal portion; exposed area of tooth ovate in outline.

*Armature of the skin (male).*—Tip of snout armed with small, forward projecting conical tubercles, a narrow band of these along anterior margin of disk ending in advance of outer angle of disk; a triangular intramarginal patch of large, depressed, sharp-pointed tentacula opposite the eyes; these point inward and backward; a large area of similar tentacula opposite angles, situated one-third of distance from angle to median line of back; small tubercles over eyes and behind spiracles; a more or less complete row of spinelike tubercles along median line of tail and between dorsals; a similar row along each side of tail, immediately above lateral fold; minute tubercles scatteringly present over upper surface of tail; outer ventral surface of snout armed with small recurved tubercles.

In the female the patches of tentacula are absent. The above description of teeth and denticles is based on a male 101.6 cm. (40 inches) long and a female 119.4 cm. (47 inches) long, from Woods Hole, Mass.

*Color in alcohol.*—Dorsal surface wood brown with scattered, unequal spots of clove brown, which vary in size from that of pupil to nearly that of orbit. Ventral surface cream color, pores black.

The *Fish Hawk* is reported to have collected small specimens off Cape Lookout on August 14, 1902, at station 7310 in 18 fathoms. Coles reports that the species is exceedingly rare and that he has taken specimens of a width of 4 feet on the rocks far offshore.

### Family DASYBATIDÆ. The sting rays.

#### KEY TO THE GENERA.

- a. Tail long, whiplike, with one or more serrated spines; disk subquadrangular to subcircular. . . . . *Dasybatus*.  
 aa. Tail moderate to short, with a serrated spine (sometimes absent in young).  
 b. Disk subcircular. . . . . *Urobatis*.  
 bb. Disk much broader than long, rhomboidal. . . . . *Pteroplatea*.

#### Genus DASYBATUS Klein in Schauplatz.

#### KEY TO NORTH CAROLINA SPECIES OF DASYBATUS.

- a. PASTINACHUS: Tail with a keel or winglike expansion below only; disk quadrangular, its length 1.25 in its breadth; body of the young smooth; adult with broad stellate based, conical pointed, irregularly placed bucklers on the middle of the hinder part of the back and on top and sides of tail. . . . . *marinus*.  
 aa. DASYBATUS: Tail with a low, black keel above and a broad, black winglike expansion below.  
 b. Disk quadrangular, a little broader than long; young smooth; adult with a median row of tubercles along highest part of back and one or two on each shoulder; a small light gray or white spot on median line of snout immediately in front of eyes in adult; angle of disk, 54°. . . . . *hastatus*.  
 aaa. AMPHOTISTIUS: Tail with a winglike expansion above and a larger one below.  
 c. Winglike expansions light-colored, yellowish to orange in life; disk subcircular; snout produced, pointed; in the adult the skin is more or less prickly, especially on interorbital area; a row of well-developed tubercles along median line of back and tail, one or two tubercles on each shoulder; very young smooth; angle of disk, 53°. . . . . *sabinus*.  
 cc. Winglike expansions black; disk quadrangular (narrower and more rounded than in *hastatus*); snout blunt; skin nearly or quite smooth; a few tubercles along highest part of back and one or two on shoulders in adults; angle of disk, 59°. . . . . *say*.

#### 27. *Dasybatus hastatus* (De Kay). Sting ray; stingaree.

*Dasyatis hastata*, Coles, 1910, p. 338; Gudger, 1913a, p. 4; Coles, 1914, p. 93.  
*Dasybatus hastatus*, Garman, 1913, p. 391.

*Teeth.*—In a male (length of disk, 50.8 cm.) the teeth are in about  $\frac{44}{47}$  rows, reddish-brown in color, exposed surface of upper teeth and of lower teeth except near angle of mouth leaflike, with a sharp-pointed, very slender acuminate tip; teeth near angles of lower jaw with their posterior edge rounded, ridged.

In a female 155.2 cm. long the teeth are in about  $\frac{36}{44}$  rows, in pavement, irregularly rhomboidal in outline; yellow in color.

*Armature of skin.*—Skin in the young smooth; in larger examples small tubercles are present along median line of back and a row of three or more on each shoulder; later small spinules are scatteringly present on shoulders and interorbital space; in very old examples region adjacent to median line of back is thickly sprinkled with small spinules, these are also present on the tail immediately in front of the spine and along the sides of the tail behind the spine.

MEASUREMENTS OF A MALE (NO. 1) 110.5 CM. (43.5 INCHES) LONG FROM NORTH RIVER, SEPT. 17, 1912, AND A FEMALE (NO. 2) 155.2 CM. (61.1 INCHES) LONG FROM FORT MACON, AUG. 1, 1913.

	No. 1.	No. 2.
	cm.	cm.
Tip of snout to posterior edge of pectoral.....	45.3	72.3
Tip of snout to posterior axil of pectoral.....	39.8	66.2
Tip of snout to base of spine.....	58.5	96.0
Breadth of disk.....	51.0	82.8
Length of anterior margin of disk.....	32.1	48.0
Length of posterior margin of disk.....	31.5	56.2
Tip of snout to anterior margin of orbit.....	10.8	17.9
Horizontal diameter of eye.....	2.4	2.1
Interocular space.....	8.1	13.2
Tip of snout to—		
Front of mouth.....	9.7	15.2
Inner angle of first gill slit.....	15.9	24.2
Inner angle of second gill slit.....	17.5	26.1
Inner angle of third gill slit.....	18.6	28.5
Inner angle of fourth gill slit.....	20.1	30.8
Inner angle of fifth gill slit.....	21.3	32.9
Interspace between anterior gill slits.....	9.9	15.1
Interspace between posterior gill slits.....	6.6	9.6
Tip of snout to vent.....	40.0	64.5
Length of ventrals.....	8.7	15.3
Length of claspers.....	10.7	.....
Breadth of claspers.....	2.7	.....
Breadth of mouth.....	5.5	15.3

Disk quadrangular; anterior margins nearly straight, meeting in an obtuse angle at tip of snout; posterior margins of disk slightly rounded, posterior angle rather sharp; ventrals projecting but little beyond the disk; tail with a low median keel on top behind the spine and a long cutaneous fold below.

When landed in the seine the female gave birth to three young, two females 40 and 51 cm. long and a male 48 cm. long. These were similar in form to the adult, upper surface devoid of tubercles.

The disk and ventrals are narrowly margined with white, with an intramarginal area of dark coloration, shading into body color; in adults there is a small gray or white spot on median line of snout immediately in front of eyes; sides of tail white or grayish; keel and fold of tail black. The ground color of these rays changes with change in color of background.

The females examined had been feeding on clams, shrimps, marine worms, and small teleosts. Males examined had eaten shrimps and blue crabs. An attempt was made to determine whether there was a selective difference between the sexes in the character of food which might throw some light on the differences in the form of the teeth, although several females, but none of the males examined, had been feeding on clams; sufficient material has not as yet been examined to be of value. No pieces of shell were present with the clam meat.

This species is common in the harbor, especially in North River. That their feeding habits attract them to regions where clams and oysters are to be found seems certain.

## 28. *Dasybatus sabinus* (Le Sueur). Sting ray.

*Dasyatis sabina*, Radcliffe, 1913, p. 396.

*Teeth.*—Teeth similar in form and coloration to *D. hastatus*; in a male 69.6 cm. long they are in about  $\frac{44}{44}$  rows; in a female (length of disk 39 cm., tail mutilated) in about  $\frac{36}{44}$  rows; upper teeth larger than the lower; upper jaw more strongly arched than in either of the other species of *Dasybatus*.

*Armature of skin.*—Skin in very small examples smooth, later a median row of sharp tubercles appears; in larger examples these extend as far back as spine and one or more tubercles appear on each shoulder; in adults the interorbital space is thickly sprinkled with small spinules; these are scatteringly present on the shoulder region in old individuals.

MEASUREMENTS OF A MALE 70 CM. (27 $\frac{5}{8}$  INCHES) LONG.

	cm.		cm.
Length of disk.....	27.8	Interocular space.....	3.6
Breadth of disk.....	28.0	Diameter of eye.....	1.1
Length of tail.....	47.5	Width of mouth.....	3.5
Tip of snout to—		Distance between anterior gill slits.....	6.0
Outer angle of pectoral.....	18.9	Distance between posterior gill slits.....	3.8
Eye.....	5.6	Length of claspers.....	7.5
Front of mouth.....	3.5		
First gill slit.....	10.5		
Last gill slit.....	14.2		
Vent.....	25.0		

Disk subcircular; anterior margin sinuous, concave opposite mouth, tip of snout projecting, pointed; outer angles of disk broadly rounded; posterior angle evenly rounded; ventrals broad, truncate.

This small sting ray is very abundant in the Beaufort region, being taken in greater numbers than either *hastatus* or *say*. It is readily distinguished from these species by the subcircular disk, concave anteriorly, by the pointed snout, the more prominent tubercles, and by the light coloration of the keel and winglike expansion of the tail. In old examples these are somewhat darker in coloration.

29. *Dasybatus say* (Le Sueur). Sting ray; stingaree; whip-ray.

*Trygon centrura*, Yarrow, 1877, p. 216.

*Dasybatis centrurus*, Jordan and Gilbert, 1879, p. 386.

*Dasybatis sayi*, Jordan, 1886, p. 26.

*Trygon sayi*, Jenkins, 1887, p. 84; Wilson, 1900, p. 355.

*Dasyatis say*, Linton, 1906, p. 346; Smith, 1907, p. 44; Gudger, 1912, p. 144; Coles, 1914, p. 93.

*Teeth*.—Teeth similar in form and coloration to the other species described; in about  $\frac{36}{36}$  rows in a male 90 cm. long and in about  $\frac{37}{45}$  rows in a female 76 cm. long. Upper jaw more prominently arched than in *hastatus*, not as strongly arched as in *sabinus*.

*Armature of skin*.—Skin of the young, smooth; in large examples there is a short median row of small tubercles along highest part of back, and one or two on each shoulder; in old individuals stellate tubercles are scatteringly present on shoulder region and spinules on tail.

## MEASUREMENTS OF A MALE 98 CM. (38.6 INCHES) IN LENGTH FROM NORTH RIVER.

	cm.		cm.
Length of disk.....	41.5	Tip of snout to—	
Breadth of disk.....	44.0	Inner angle of fourth gill slit.....	17.4
Length of anterior margin of disk.....	27.2	Inner angle of fifth gill slit.....	18.8
Length of posterior margin of disk.....	29.0	Distance between anterior gill slits.....	8.9
Tip of snout to—		Distance between posterior gill slits.....	6.2
Eye.....	9.1	Length of claspers.....	10.9
Front of mouth.....	7.8	Breadth of claspers.....	1.9
Inner angle of first gill slit.....	13.2	Interocular space.....	9.0
Inner angle of second gill slit.....	14.8	Breadth of mouth.....	4.8
Inner angle of third gill slit.....	16.1		

Disk subquadrangular, its length 1.15 in its width, anterior margins nearly straight, posterior margin convex; ventrals rounded, projecting well beyond posterior margin of disk.

This species is similar in form to *hastatus*, differing in having a black winglike expansion on upper side of tail behind spine; anterior margin of disk shorter in proportion to posterior margin and more evenly rounded; ventrals rounded, projecting for a greater distance beyond posterior margin of disk; upper surface smooth except in old examples; no light colored spot on middle of forehead in front of eyes; angle of snout slightly greater, about 59° as compared with 54° in *hastatus*.

A female 106 cm. long taken July 8, 1912, had the left uterus greatly enlarged, 14 by 10 cm.; the inner surface of the uterus was covered with the typical slender villi, about 2 cm. long, slightly enlarged at the free end; uterus partly filled with a yellow creamy substance which emitted a slight pungent odor. The embryos had undoubtedly been extruded during capture. Right uterus not enlarged.

This species is common throughout the harbor and at times the young are quite abundant in some localities.

## Genus UROBATUS Garman.

30. *Urobatis sloani* (Blainville).

*Urolophus jamaicensis*, Gudger, 1913a, p. 4; Coles, 1914, p. 93.

*Teeth*.—"Teeth broader than long, lozenge-shaped on the crown, sharp in males, in  $\frac{23}{21}$  rows in eight-inch specimen,  $\frac{27}{25}$  in fourteen-inch." <sup>a</sup>

*Armature of skin*.—"Skin rough with small spines on head, dorsum and top of tail to upper edge of caudal; outer portions of disk, on pectorals and ventrals, and lower surfaces are smooth." <sup>a</sup>

There is a stout spine inserted at about the middle of the tail.

Coles captured a small example at Cape Lookout in June, 1911.

## Genus PTEROPLATEA Müller and Henle.

## KEY TO THE SPECIES.

- a. Caudal spine normally absent (reported to be present in very large examples); tail about one-fourth length of body; no tentacle behind spiracle. . . . . *micrura*.  
 aa. Caudal spine present at all ages; tail larger, nearly half length of body; a tentacle behind spiracle. . . . . *altavela*.

31. *Pteroplatea micrura* (Schneider).

*Pteroplatea maclura*, Yarrow, 1877, p. 216; Jordan and Gilbert, 1879, p. 386; Jordan, 1886, p. 26; Jenkins, 1887, p. 84; Wilson, 1900, p. 355; Linton, 1905, p. 348; Smith, 1907, p. 45; Gudger, 1912, p. 148; Coles, 1914, p. 93.

*Teeth*.—In a male about 30 cm. long, the teeth are in  $\frac{77}{66}$  rows, minute, arranged in quincunx, similar in form in both jaws; outline of teeth spear-shaped, cusps narrow, elongate, sharp-pointed, curved outward and backward; broad basal portion channeled, edges curved outward, so that the anterior margin of the

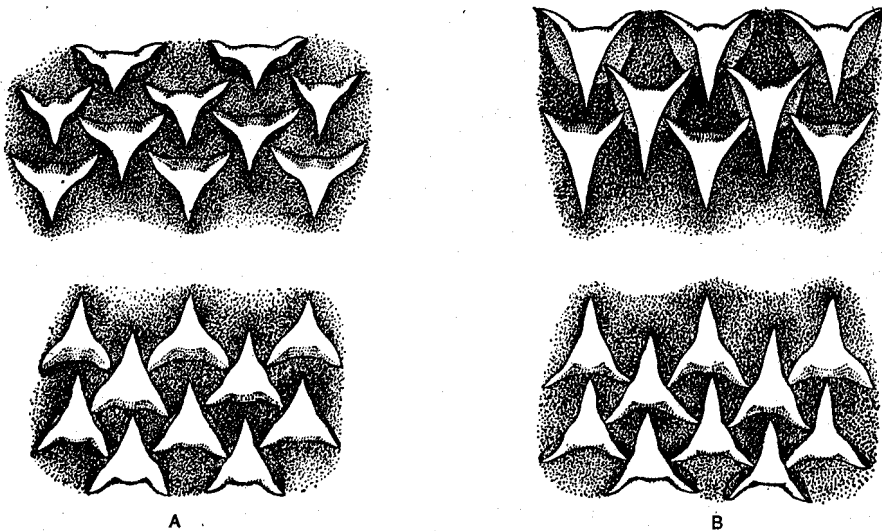


FIG. 26.—A, Teeth, upper and lower jaws, of a female, *Pteroplatea micrura*, 37 cm. long, from Beaufort, N. C.; B, teeth, upper and lower jaws, of a male, *Pteroplatea micrura*, about 30 cm. long, from Beaufort, N. C.

tooth before mucous is cleaned away appears as a concave edge with pointed outer angles, the basal portion being entirely concealed.

In a female 37 cm. long the teeth are in about  $\frac{96}{77}$  rows, in one 50.4 cm. long in about  $\frac{101}{83}$  rows. These resemble the teeth of the male except that the pointed cusp is shorter, not markedly longer than basal wings.

Skin smooth; very large examples are reported to have a caudal spine.

<sup>a</sup> Garman, *The Plagiostomia*, p. 402.

On July 24, 1914, an adult female, 50.4 cm. long was taken in a seine at the laboratory. Length of disk 39 cm.; width 65.5 cm. Each uterus contained a single embryo, apparently almost fully developed. Each embryo was rolled up into a cylindrical body, one wing of the disk being coiled up inside the other, the latter folding over the whole; tip of snout infolded. (See illustration.) One of the embryos was 10.7 cm. long; disk 8.2 cm. long by 12.3 cm. wide, posterior margin of disk truncate, nearly straight. The uterus was lined with small villi, a mass of elongate ones extended downward through the distended opening of the spiracle of the embryo into its mouth, apparently affording a more direct source of supply of food. Its intestine was greatly distended, forming a great arch on the ventral surface, the circular valve being plainly visible on the surface. The intestine was filled with a greenish liquid, presumably excrement retained until birth. The ovary contained three yellow eggs about three-fourths cm. in diameter. The stomach of the parent was empty except for a few pieces of shell. Dissection of the dorsal surface of the tail revealed no trace of spine reported to be present in old individuals.

This species is very common in the Beaufort region and is taken on the sandy beaches in shallow water. Fishermen not infrequently report seeing large individuals several feet in breadth. Whether they are this species or *altavela* has not been determined.

### 32. *Pteroplatea altavela* (Linnaeus).

*Pteroplatea altavela*, Nichols, 1914, p. 537; Coles, 1914, p. 93.

"Two grown embryos, one 17½ the other 15 inches in width, furnish probably the first definite North American record for this species.

"Mr. Coles writes that unfortunately the mother was not kept. However, the following data were secured.

"On May 22, 1914, a very large ♀ was captured. Width 6 feet 10 inches, length (snout to tip of ventrals) 3 feet 8 inches, tail 12 inches. It has two spines on the tail. This specimen contained four grown embryos, two on either side. Two of the embryos \* \* \* have each a single well-developed spine on the tail." <sup>a</sup>

Family MYLIOBATIDÆ. The eagle rays.

Genus MYLIOBATUS Cuvier.

### 33. *Myliobatis freminvillei* Le Sueur. Eagle ray.

*Myliobatis freminvillei*, Jordan and Gilbert, 1879, p. 386.

*Myliobatis freminvillei*, Jordan, 1886, p. 26; Smith, 1907, p. 46; Coles, 1913, p. 29-30, 32, 33; id., 1914, p. 94.

*Myliobatis freminvillei*, Jenkins, 1887, p. 84.

*Teeth*.—Teeth in a male 69.2 cm. long, in seven rows in each jaw, in pavement, those in the three outer rows subequal, diamond-shaped, width fore and aft greater than breadth, width of median row about one-third breadth; 10 teeth in median row in lower jaw, 6 of which function, 8 in the upper jaw; 5 functioning; functioning teeth much pitted as result of crushing shells. Skin smooth, a serrated spine behind dorsal, present.

MEASUREMENTS OF A MALE (NO. 1) 69.2 CM. (27¼ INCHES) LONG AND A FEMALE (NO. 2) 45.5 CM. (18 INCHES) LONG.

	No. 1.	No. 2.
	cm.	cm.
Length of disk from tip of cephalic appendage.....	23.4	13.0
Breadth of disk.....	33.9	20.9
Length of anterior margin of disk.....	18.4	10.7
Length of posterior margin of disk.....	15.7	9.7
Tip of snout to eye.....	3.9	2.1
Horizontal diameter of eye.....	1.3	1.0
Interocular width.....	5.5	4.0
Tip of snout to—		
Mouth.....	3.9	2.1
Inner angle of first gill slit.....	7.4	4.2
Inner angle of fifth gill slit.....	9.4	5.9
Vent.....	18.8	11.6
Length of ventrals.....	4.5	2.5
Length of claspers.....	2.1	.....
Length of caudal spine.....	6.0	2.5

<sup>a</sup> Nichols, Bull. Am. Mus. Nat. Hist., vol. XXXIII, art. XXXII, p. 537.

This small ray is not infrequently taken in this region but is apparently never taken in large numbers. Coles has taken a few nearly every year at Cape Lookout.

#### Genus *AETOBATUS* Blainville.

#### 34. *Aëtobatus narinari* (Euphrasen). Devilfish; spotted sting ray.

*Aëtobatis narinari*, Yarrow, 1877, p. 216; Jordan and Gilbert, 1879, p. 386.  
*Sloasodon narinari*, Jordan, 1886, p. 26; Jenkins, 1887, p. 84.  
*Aëtobatus narinari*, Smith, 1907, p. 46; Coles, 1910, p. 338-341; Gudger, 1912, p. 150; Coles, 1913, p. 29-32, fig. 1-2, pl. III (3 figures); Garman, 1913, p. 441, pl. 49, 54, 55, 57, 73; Gudger, 1914, p. 241, 323; Coles, 1914, p. 94.

*Teeth*.—Teeth in a single row in each jaw; dental plate of lower jaw about twice as long as the upper and about seven-ninths as wide; lower teeth strongly arched forward in the middle; upper teeth much straighter, slightly bent backward at the sides. In a male 220.3 cm. (7 feet, 2¾ inches) long, there are 14 teeth in the upper jaw, 7 functioning, and 20 in the lower jaw, 13 functioning; in a male 291 cm. (9 feet 6½ inches) long, there are 23 teeth in upper jaw, 11 functioning; 29 in the lower jaw, 19 functioning; functioning teeth more or less pitted.

Skin smooth, one or more strong serrated spines on tail behind dorsal.

Measurements and coloration of the male, 291 cm. long, taken with a dragnet by fishermen in North River, May 28, 1914, furnished by Mr. Hildebrand.

Tip of snout to posterior margin of ventrals, 134 cm.; width of disk, 185 cm.; interorbital, 23.5 cm.; eye, 3.8 cm.; snout, 22.8 cm.; width of mouth, 12 cm.; length of claspers, 40 cm.; length of dorsal base, 6.0 cm.; height of dorsal, 6.0 cm.

*Color*.—Upper surface very dark brown, almost black, with white spots or rings, or portions of rings, some of these C-shaped, others form perfect circles, still others are in pairs connected by a narrow isthmus of white; others are very close together, with only a slight stricture between them ∞. On the head and snout there are only round spots, no double spots or rings; the double spots are most numerous just back of the head; following these on posterior part of back and along posterior margin of disk are the rings; no transverse markings on body; tail plain black; ventral surface of body uniformly pale.

The stomach contents were the bodies of clams, without any of the shells.

In the specimen from Cape Lookout, 220.3 cm. long, whose length of disk to tip of ventrals was 74.3 cm., breadth of disk 106.8 cm., the jaws are barely half as large as in the specimen just described.

In small individuals the white spots on dorsal surface are all circular, smaller than eye.

This strikingly colored ray reaches a length of 12 feet or more. In the Beaufort region, where it is quite common, it feeds almost exclusively on clams which it digs from the natural beds. As to its method of getting the clams there still seems to be some difference of opinion. Owen (1840) advanced the supposition that the projecting lower jaw was used like a spade for digging the shellfish out of the sand. Coles (1910) and others state that the snout is used for this purpose. Gudger (1914) questions this use of the snout, but advances no opinion as to the probable method used.

The lower jaw projects beyond the upper, so that the front teeth of the upper jaw and the median ones of the lower are used in crushing shells, as indicated by their deeply pitted surfaces. The teeth on the projecting portion of the lower jaw are smoother than the crushing teeth. Gudger (1914) noted this difference, but offered no explanation for it. In the specimens at hand there are scratches or furrows on this smoother surface extending fore and aft as if some sharp object had scratched the surface in passing over it. The broken and irregular anterior margin of the jaw, the wearing down of the upper surface until the pits characteristic of the teeth farther back have disappeared, and the presence of the scratches convince the writer that Owen was correct and that the projecting lower jaw is used as a spade for digging up clams on which the species feed.

The stomach of the specimen 291 cm. long contained a considerable quantity of the meats of clams without any pieces of shells. Coles states that as much as a gallon of clams has been taken from the stomach of a single individual, and that the species is exceedingly destructive. The jaws of this species are highly specialized, being used to dig the clams, to crush the shells, following which the meat is separated from the shells. Coles has added some very interesting observations to our knowledge of this species, and more recently Gudger has written an extended review of the literature, together with additional data collected by himself at Beaufort and in Florida waters. This report is well illustrated.



## Family RHINOPTERIDÆ. The cow-nosed rays.

## Genus RHINOPTERA Kuhl.

35. *Rhinoptera quadriloba* (Le Sueur). Cow-nosed ray; devilfish.*Rhinoptera quadriloba*, Wilson, 1900, p. 355.*Rhinoptera bonasus*, Smith, 1907, p. 47; Gudger, 1912, p. 152; Coles, 1914, p. 94.

*Teeth*.—Teeth in a male 84.8 cm. long in 9 rows in the upper jaw and 8 in the lower, in pavement, median row in upper jaw widest, 2.6 in width of dental plate, second row on right side of wider teeth than the others, 2.5 in width of median row; with the exception of the marginal row on each side the other teeth are hexagonal; median row of lower teeth widest, four-fifths as wide as median row in upper jaw, each succeeding row smaller; 12 teeth in a row in upper jaw, 5 functioning; 13 in lower jaw, 6 functioning; functioning teeth deeply pitted. In this species the dental plates are more nearly subequal than in either of the preceding. Skin smooth, a narrow serrated spine immediately behind the dorsal fin.

MEASUREMENTS OF A FEMALE (No. 1) 60.1 CM. (23 $\frac{3}{8}$  INCHES) LONG AND A MALE (No. 2) 84.8 CM. (33 $\frac{3}{8}$  INCHES) LONG.

	No. 1.	No. 2.
	cm.	cm.
Length of disk.....	34.6	62.8
Breadth of disk.....	59.1	81.3
Length of anterior margin of disk.....	28.2	42.1
Length of posterior margin of disk.....	27.5	45.3
Snout.....	1.7	2.7
Horizontal diameter of eye.....	1.1	1.6
Interocular width.....	9.7	14.0
Preoral length of snout.....	6.4	9.3
Breadth of mouth.....	6.1	10.4
Tip of snout to vent.....	20.4	47.1
Tip of snout to inner angle of first gill slit.....	9.4	13.4
Tip of snout to inner angle of fifth gill slit.....	14.1	21.6
Interspace of anterior gill slits.....	9.9	15.1
Interspace of posterior gill slits.....	7.1	10.5
Length of ventrals.....	8.1	11.9
Length of spine.....	6.6	6.8

The stomach contained several small mollusks. This species is not uncommon in this region, apparently being a resident here. More examples of it are brought into the laboratory than any of the allied forms.

## Family MOBULIDÆ. The sea devils.

## KEY TO THE GENERA.

- a. Teeth on both jaws; mouth inferior..... *Mobula*.  
 aa. Teeth on lower jaw only; mouth anterior..... *Manta*.

## Genus MOBULA Rafinesque.

36. *Mobula hypostoma* (Bancroft). Small devilfish.*Mobula bifersi*, Coles, 1910, p. 341; Pellegrin, 1912, p. 414 (with photographs); Gudger, 1913a, p. 5; Coles, 1913, p. 33; id., 1914, p. 94.*Mobula hypostoma*, Garman, 1913, p. 453, Pl. 38, 54, 57, 59, 75.

*Teeth*.—Teeth (male) in  $\frac{57}{47}$  rows, minute; dental plate very long and narrow; teeth close-set, overlapping; posterior margin with one to five dentate prongs and with a minute cusp on the outer edge of each shoulder, a single row on upper jaw and several in the lower jaw about twice as wide as adjacent rows; teeth in lower jaw relatively wider and with shorter cusps than those in the upper.

Teeth in a female 142 cm. (56 inches) long in  $\frac{53}{48}$  rows, in pavement, arranged in quincunx, not nearly so close-set as in the male, not overlapping, rows of wider teeth present as in the male; posterior margins of teeth smooth, or with slight ridges, apparently rudiments of the prongs characteristic of the teeth of the male. Skin smooth, no caudal spine.

## MEASUREMENTS OF A FEMALE 142 CM. (56 INCHES) IN LENGTH.

	cm.		cm.
Tip of snout to origin of dorsal.....	55.0	Preoral length.....	15.3
Tip of cephalic appendage to tip of pectoral.....	72.5	Width of mouth.....	15.1
Breadth of disk.....	111.0	Height of dorsal.....	7.0
Tip of cephalic appendage to vent.....	69.3	Base of dorsal.....	7.2
Eye.....	2.5	Tip of tail to vent.....	77.0
Interorbital.....	21.0	Tip of ventral to vent.....	12.8

In this individual both uteri were equally developed, the embryos which were presumably quite young, had been extruded. The inner surface of the uterine wall was covered with the characteristic vascular villi. The uterine milk was greenish in color and more fluid than in an example of *D. say* examined.

The red corpuscles in this specimen were  $18\mu$  long by  $11\mu$  broad, the nucleus  $6.6\mu$  by  $3.6\mu$  or less.

The stomach was completely filled with countless numbers of a small Mysis-like crustacean, together with a quantity of mud. The remarkable development of the gill filaments is shown in the illustration. These are well adapted for straining out small organisms. This and the character of the teeth lead to the conclusion that its habit of feeding on small fishes, as described by Coles, is a very unusual one, and an examination of the stomach contents of individuals actually observed feeding on the fishes is desirable. The stomach contents of nine specimens taken at Cape Lookout July 10, 1913, were examined by Prof. W. P. Hay and in every case were found to contain only the Mysis-like crustacean.

Genus *MANTA* Bancroft.37. *Manta birostris* (Walbaum). Devilfish.

*Ceratoptera vampirus*, Yarrow, 1877, p. 216; Jordan and Gilbert, 1879, p. 386.

*Manta birostris*, Jordan, 1886, p. 26; Jenkins, 1887, p. 85; Wilson, 1900, p. 355; Smith, 1907, p. 47; Gudger, 1912, p. 132; Coles, 1914, p. 94.

*Teeth*.—"Teeth minute, rasplike, on the lower jaw only, occupying the entire width of the jaw, in about 100 rows separated by interspaces (on the young)."<sup>a</sup>

Body and tail rough with small tubercles. There appears to be some uncertainty as to whether there is a barbed spine on the tail.

The numbers of examples of *Mobula hypostoma* taken by Coles at Cape Lookout and the rarity of observations of the present species, lead one to suspect that in the majority of cases the earlier records were of the former species. To date, there is no authentic record of the capture of one of these huge rays in this region. That it is found here is not questioned.

<sup>a</sup> Garman, The Plagiostomia, p. 454.

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## EXPLANATIONS OF PLATES.

[The plates are all from photographs.]

### PLATE XXXVIII.

FIG. 1.—*Carcharias taurus*, lateral view of teeth in upper jaw of a shark about 152 cm. long, from Cape Lookout, N. C.

FIG. 2.—*Carcharias taurus*, lateral view of lower jaw, same specimen as fig. 1.

FIG. 3.—*Vupecula marina*, lateral view of teeth from a specimen about 457 cm. long, from Cape Lookout, N. C.

FIG. 4.—*Cetorhinus maximus*, portion of jaw of specimen from Monterey, Cal. U. S. National Museum no. 27024.

### PLATE XXXIX.

FIG. 1.—*Ginglymostoma cirratum*, teeth of lower jaw, from back. Jaws in U. S. National Museum originally from Pensacola, Fla.

FIG. 2.—*Scoliodon terra-nova*, lateral view of teeth from a female 102 cm. long, from Shackleford Banks, Beaufort, N. C.

FIG. 3.—*Aprionodon isodon*, lateral view of a female 50.8 cm. long, in the Beaufort laboratory collections.

FIG. 4.—*Carcharhinus milberti*, teeth of a female 147.3 cm. long from Woods Hole, Mass.

### PLATE XL.

FIG. 1.—*Hypoprion brevirostris*, teeth of upper jaw of a male 248.9 cm. long, from Beaufort, N. C.

FIG. 2.—*Hypoprion brevirostris*, teeth of lower jaw of same specimen as fig. 1.

FIG. 3.—*Carcharhinus limbatus*, lateral view of a female 70 cm. long, from Beaufort, N. C.

FIG. 4.—*Carcharhinus limbatus*, lateral view of same specimen as fig. 3.

### PLATE XLI.

FIG. 1.—*Carcharhinus acronotus*, teeth in upper jaw of a female 134 cm. long, from Shackleford Banks, Beaufort, N. C.

FIG. 2.—*Carcharhinus acronotus*, teeth in lower jaw of same specimen as fig. 1.

FIG. 3.—*Carcharhinus commersonii*, teeth in upper jaw of a specimen from Beaufort, N. C.

FIG. 4.—*Carcharhinus commersonii*, teeth in lower jaw of same specimen as fig. 3.

### PLATE XLII.

FIG. 1.—*Galeocerdo arcticus*, teeth of upper jaw of a specimen from Loggerhead Key, Fla. U. S. National Museum. Collections.

FIG. 2.—*Galeocerdo arcticus*, teeth in lower jaw of same specimen as fig. 1.

FIG. 3.—*Galeorhinus laevis*, teeth of a male 75 cm. long, from Cape Lookout, N. C.

FIG. 4.—*Squalus acanthias*, teeth of a female 84.5 cm. long, from Beaufort, N. C.

### PLATE XLIII.

FIG. 1.—*Cestracion zygaena*, dorsal view of a male 124.5 cm. long, from Beaufort, N. C.

FIG. 2.—*Cestracion zygaena*, teeth of a male 132 cm. long, from Beaufort, N. C.

FIG. 3.—*Cestracion zygaena*, teeth of young example 52.3 cm. long, from Beaufort, N. C.

FIG. 4.—*Cestracion zygaena*, teeth of upper jaw of a female 381 cm. long, from Beaufort, N. C.

FIG. 5.—*Cestracion zygaena*, teeth of lower jaw of same specimen as fig. 4.

## PLATE XLIV.

FIG. 1.—*Cestracion tiburo*, embryo 18 cm. long, showing placenta and villi. (Note remnant of yolk sac at end of placenta. The parent from which this specimen was taken was 124 cm. long, taken on Bird Shoal, Beaufort Harbor, August 6, 1914.)

FIG. 2.—*Cestracion tiburo*, teeth of a female 89.8 cm. long, from Beaufort, N. C.

FIG. 3.—*Cestracion tiburo*, teeth of a female 147.5 cm. long, from Beaufort, N. C.

## PLATE XLV.

FIG. 1.—*Raja eglanteria*, teeth of a male 57.5 cm. long, from Cape Lookout, N. C.

FIG. 2.—*Raja stabuliformis*, teeth of a male 101.6 cm. long, from Woods Hole, Mass.

FIG. 3.—*Raja stabuliformis*, teeth of a female 119.4 cm. long, from Woods Hole, Mass. (Note that cusps of teeth along front of jaw are entirely worn away.)

FIG. 4.—*Raja stabuliformis*, teeth in back of jaw of preceding example, showing form before cusp is worn away.

## PLATE XLVI.

FIG. 1.—*Dasybatus hastatus*, teeth of a male from Beaufort, N. C.

FIG. 2.—*Dasybatus hastatus*, teeth of a female 155.2 cm. long, from Beaufort (Fort Macon), N. C.

FIG. 3.—*Dasybatus hastatus*, a female 155.2 cm. long and young born at time of capture, from Beaufort (Fort Macon), N. C.

## PLATE XLVII.

FIG. 1.—*Pteroplatea micrura*, dorsal view of an adult female 50.4 cm. long, from Beaufort, N. C.

FIG. 2.—*Pteroplatea micrura*, dorsal view of young embryos taken from specimen fig. 1. (Note manner in which young are coiled in ovary.)

FIG. 3.—*Aëtobatus narinari*, dorsal view of a specimen from Beaufort, N. C., showing characteristic coloration of young.

FIG. 4.—*Rhinoptera quadriloba*, teeth of a male 84.8 cm. long, from Beaufort, N. C.

## PLATE XLVIII.

FIG. 1.—*Myliobatis freminvillii*, teeth of a male 69.2 cm. long, from Cape Lookout, N. C.

FIG. 2.—*Aëtobatus narinari*, teeth of a male 291 cm. long, from Beaufort, N. C.

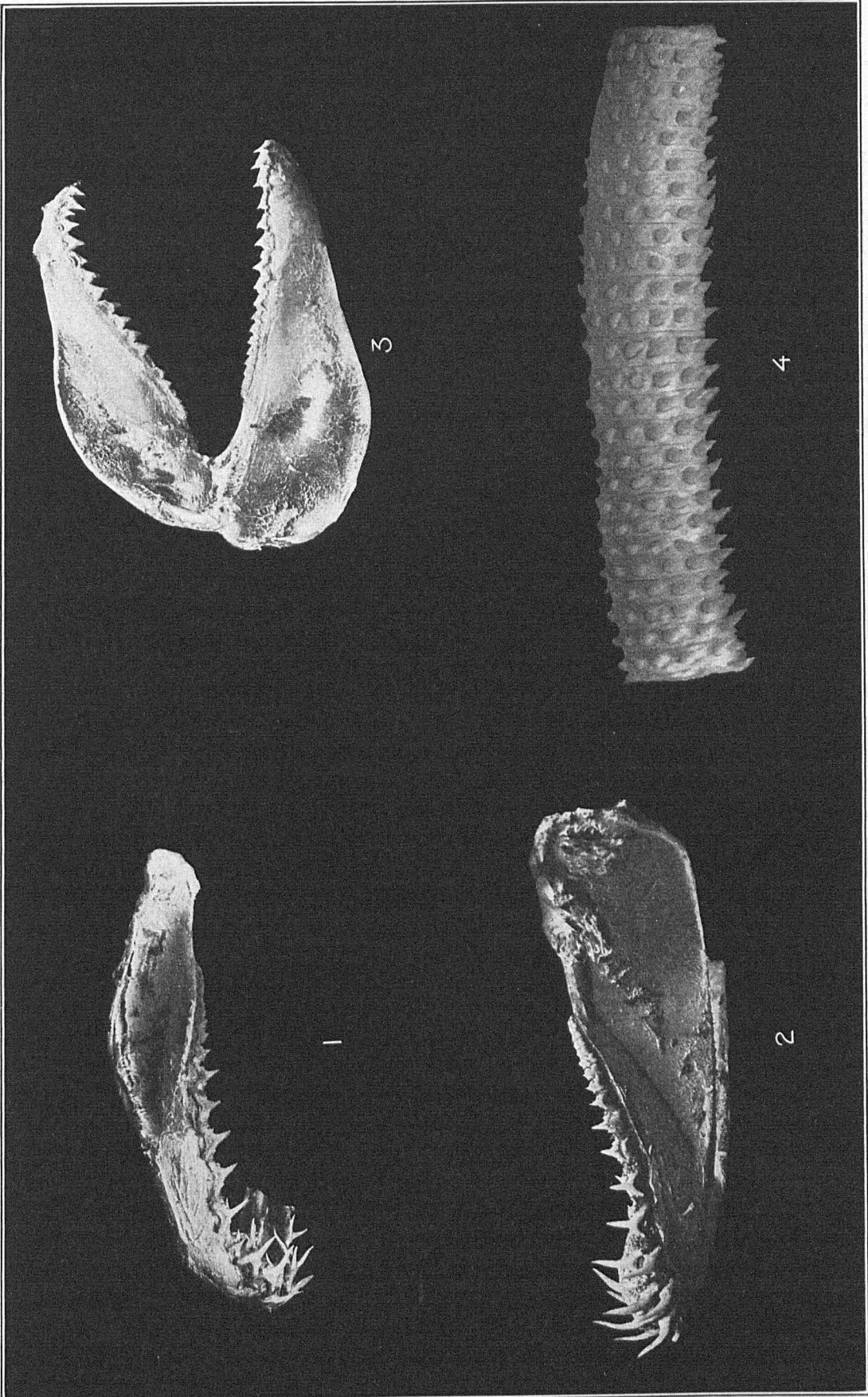
FIG. 3.—*Mobula hypostoma*, teeth of a male from Cape Lookout, N. C.

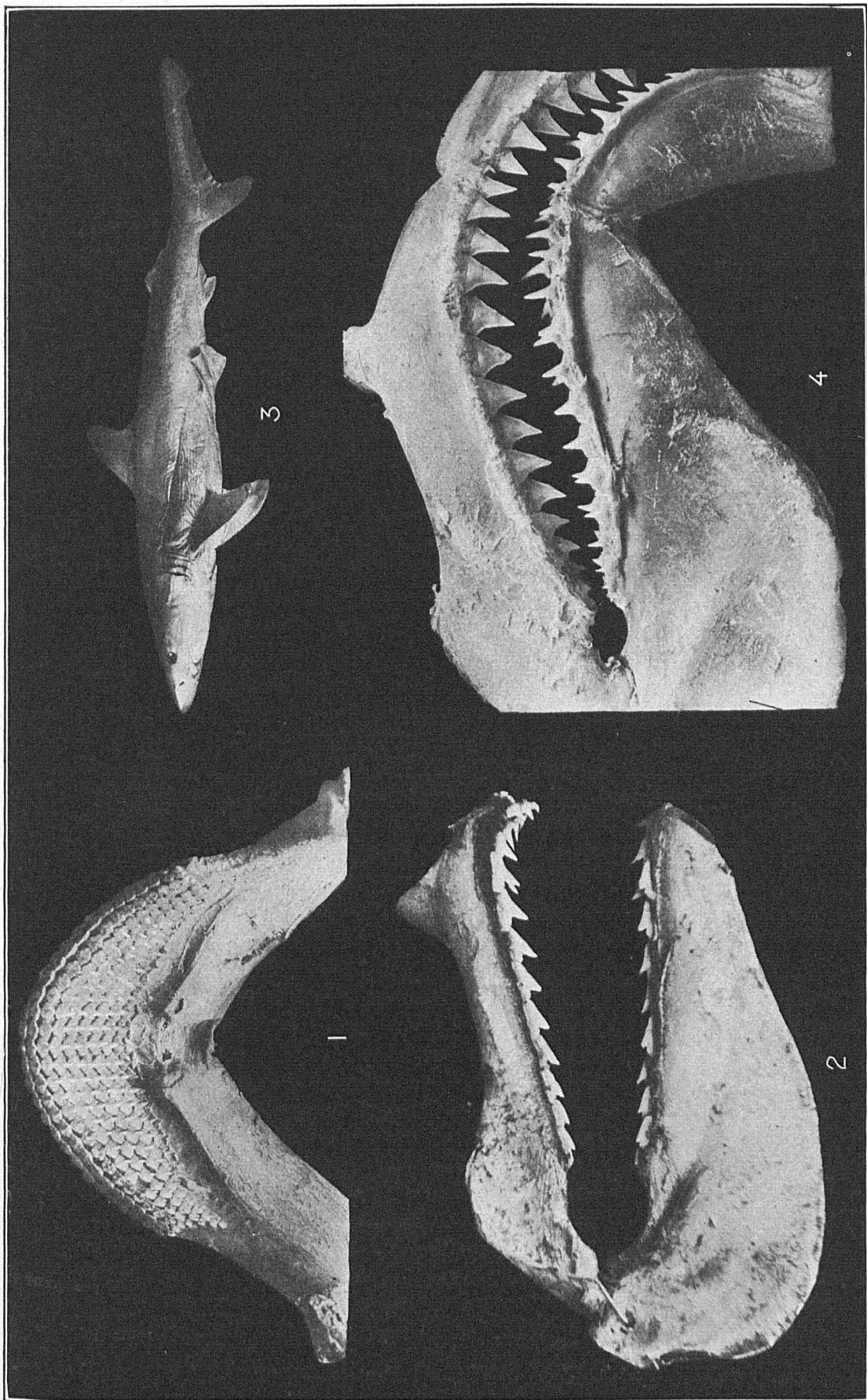
FIG. 4.—*Mobula hypostoma*, teeth of a female 142 cm. long, from Cape Lookout, N. C.

## PLATE XLIX.

FIG. 1.—*Mobula hypostoma*, gill arches, back view, of a female 142 cm. long, from Cape Lookout, N. C.

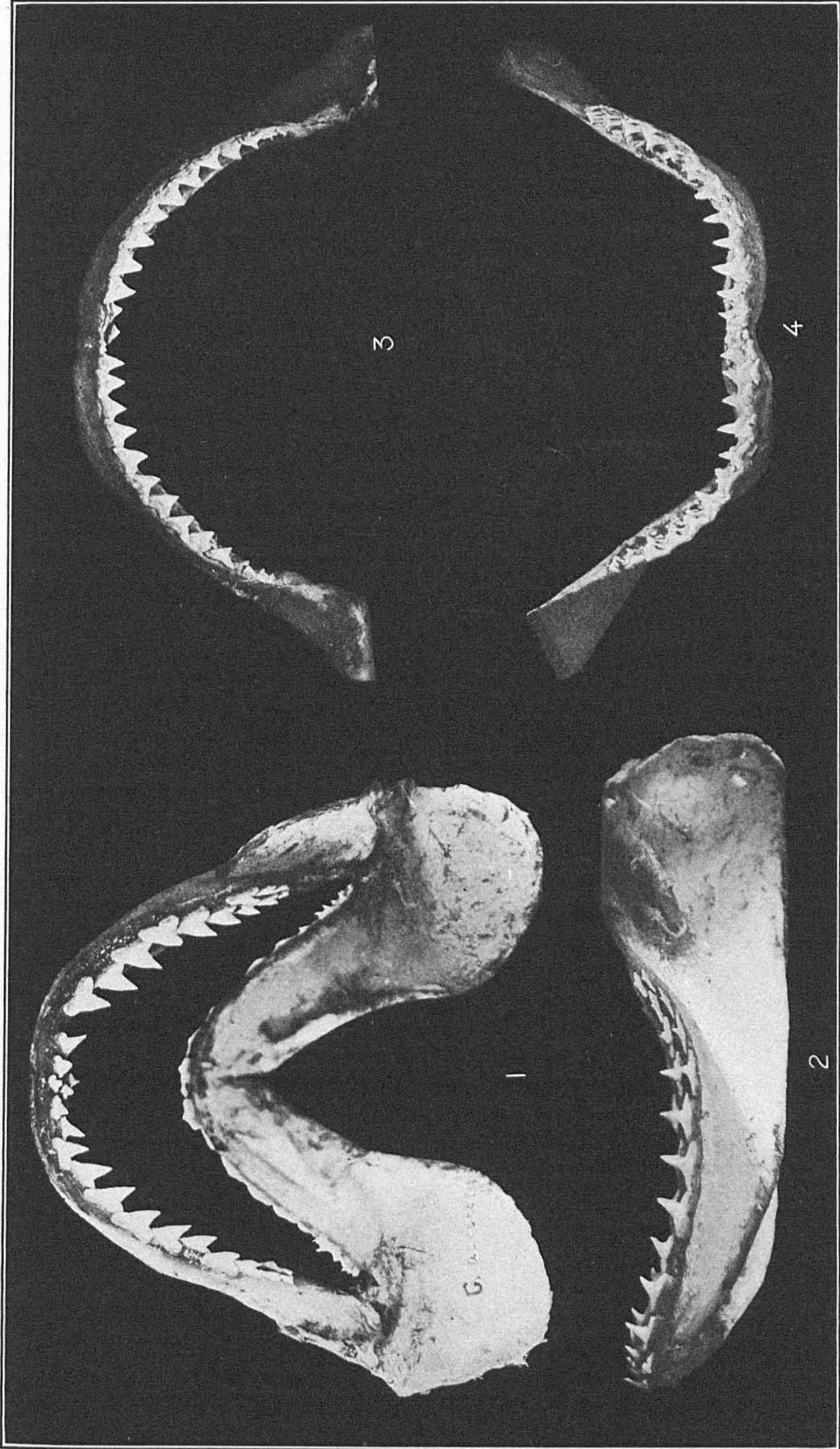
FIG. 2.—*Mobula hypostoma*, a catch of nine, taken by Mr. Russell J. Coles (second from the right) at Cape Lookout, N. C., July 10, 1913. (Photograph by Francis Harper.)

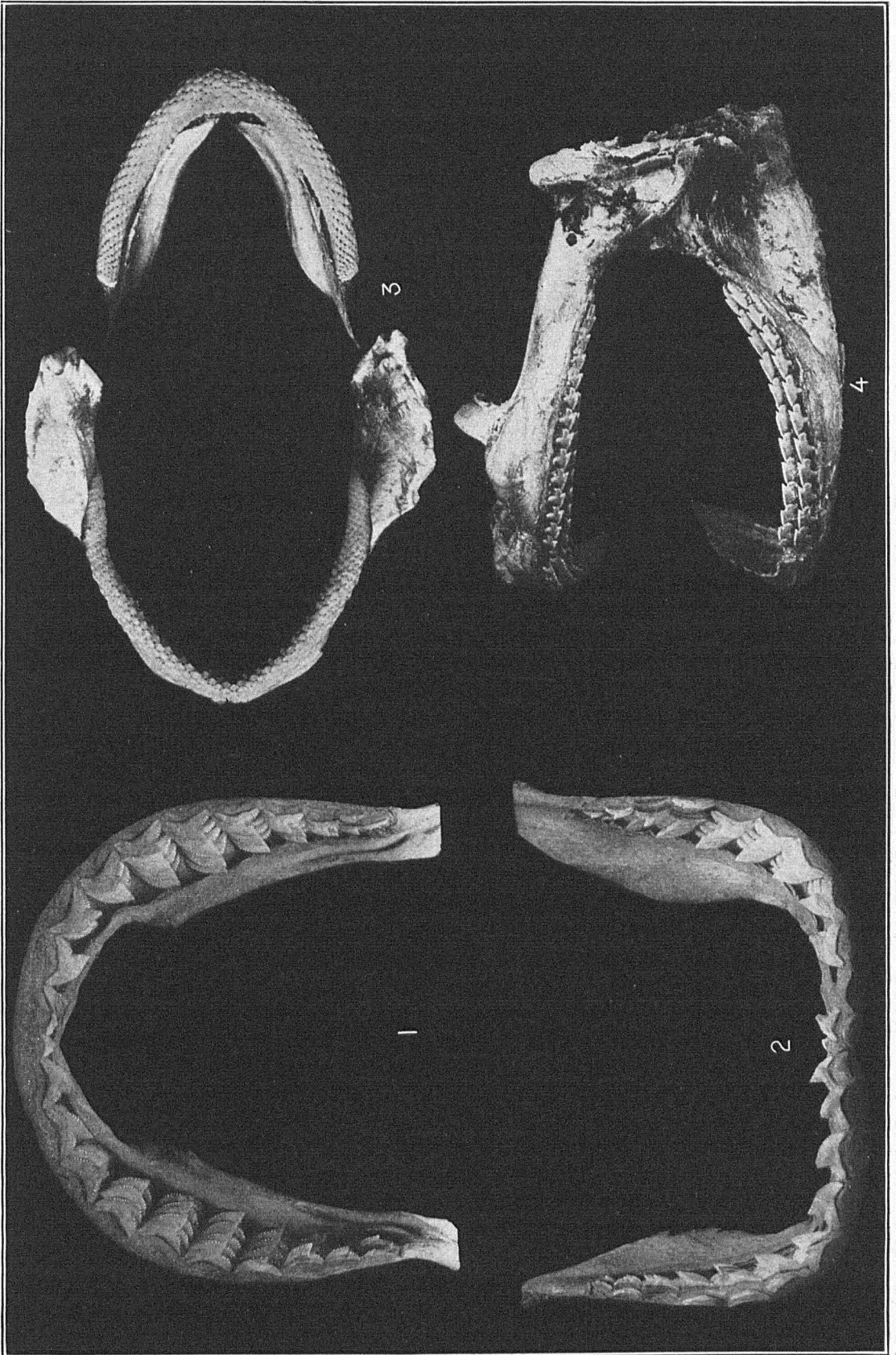


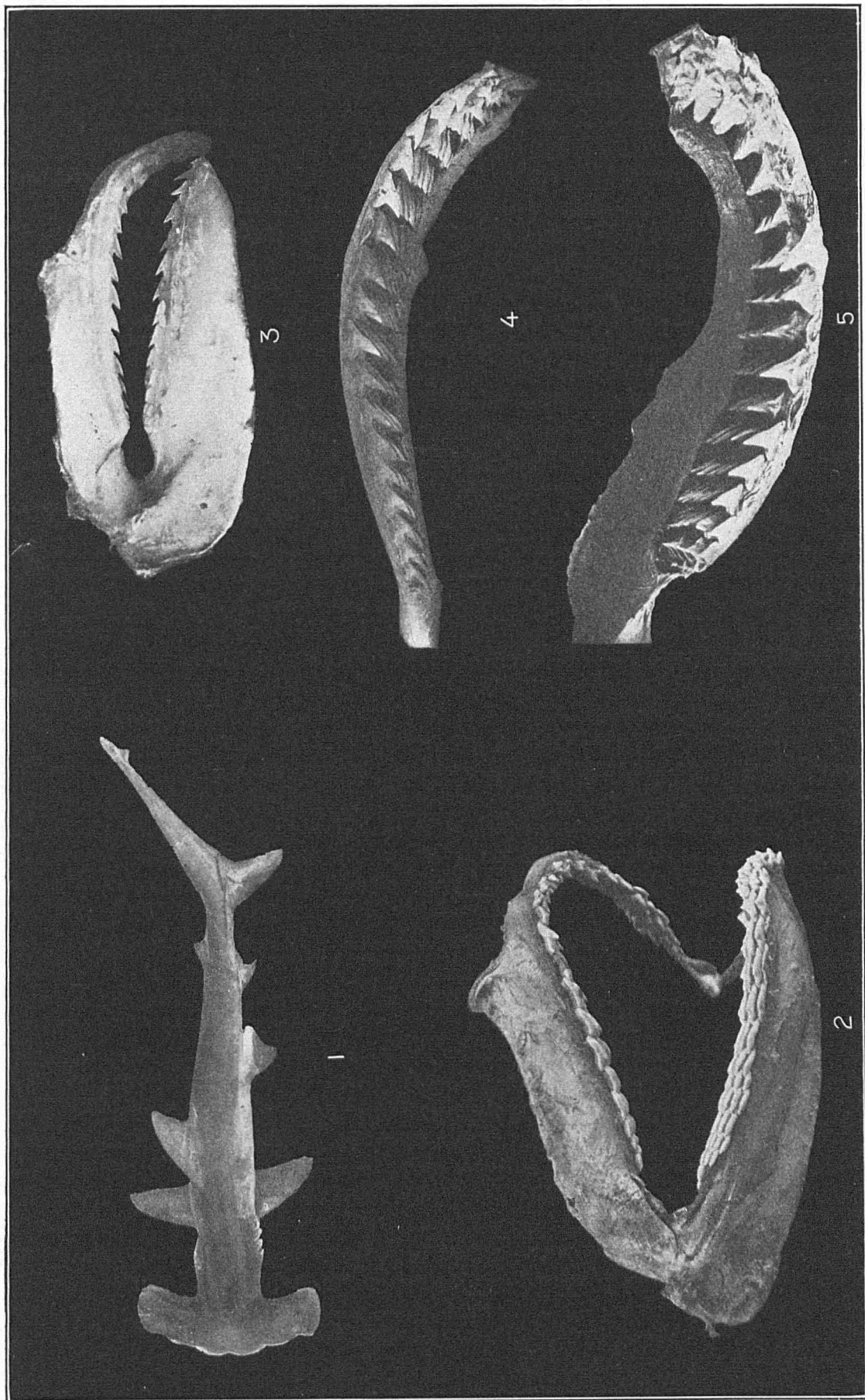


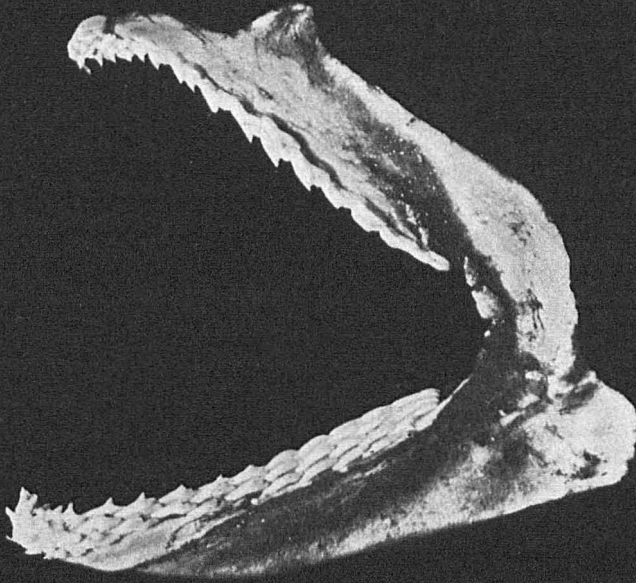
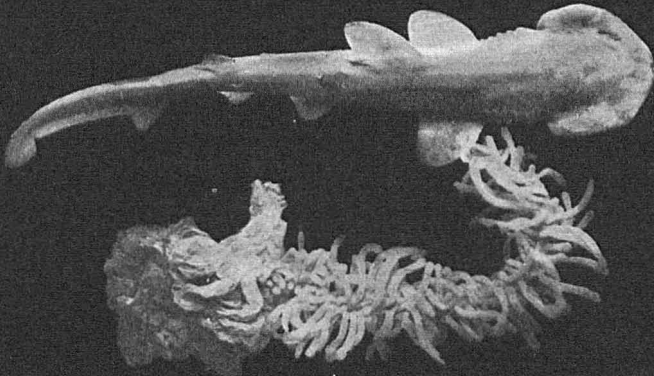












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