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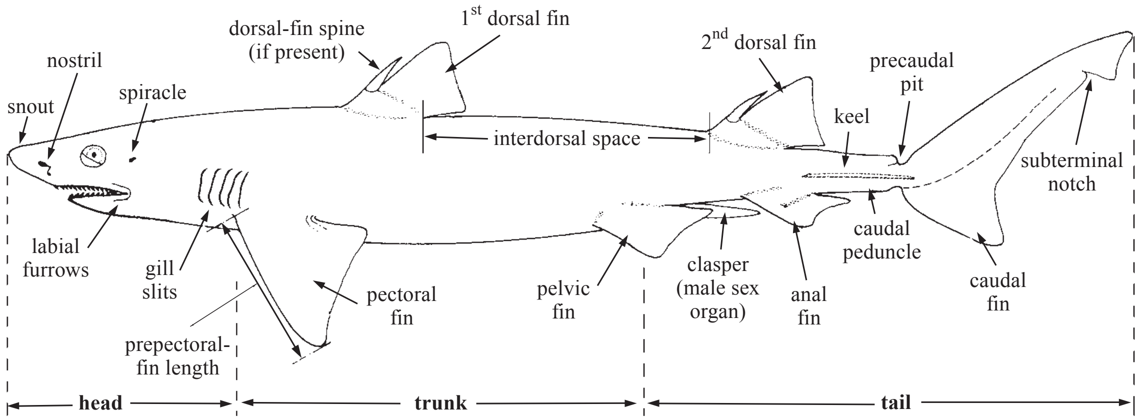
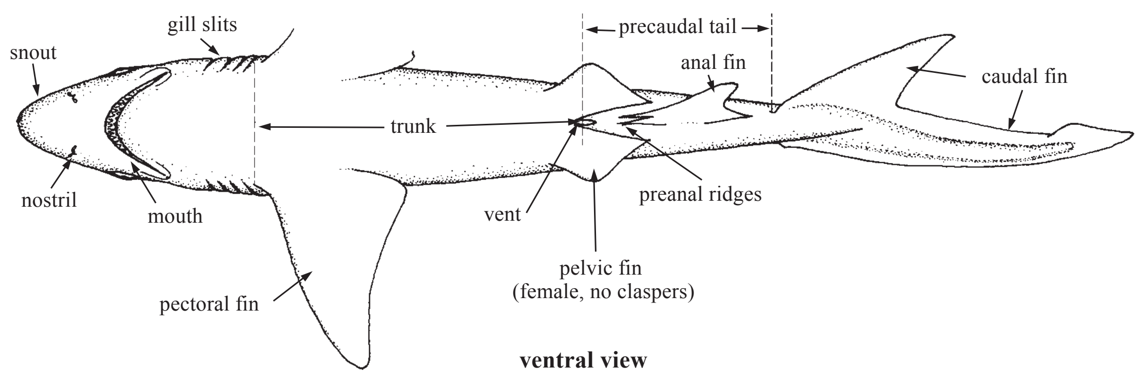
SHARKS

by L.J.V. Compagno, Shark Research Center, South African Museum, South Africa

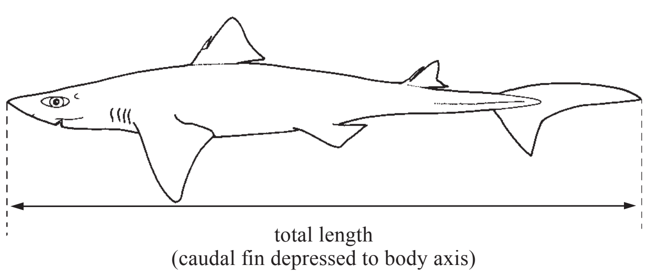
TECHNICAL TERMS AND MEASUREMENTS

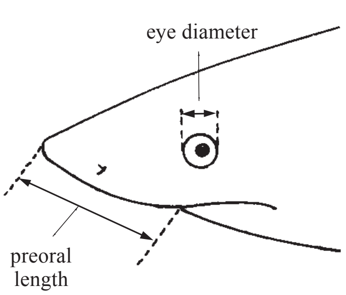
(Straight-line distances)



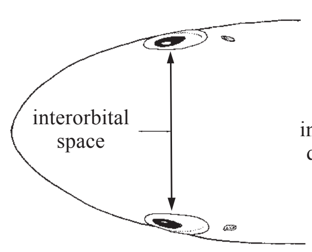


ventral view

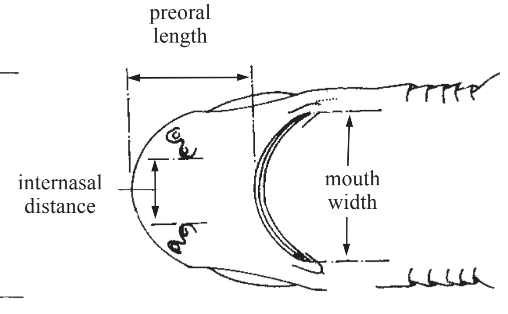




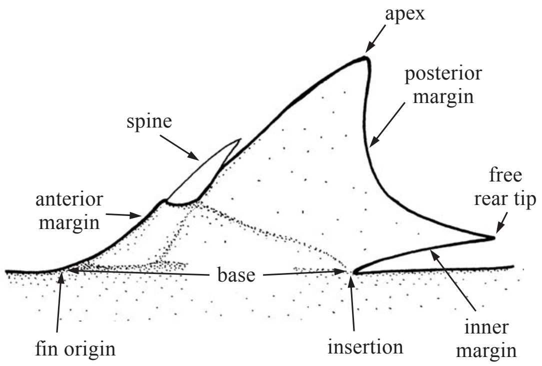
head (lateral view)



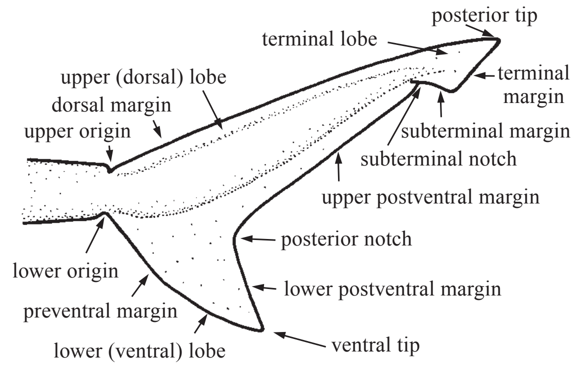
head (dorsal view)



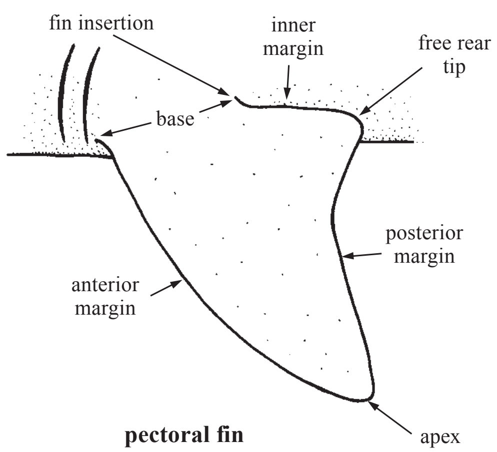
head (ventral view)



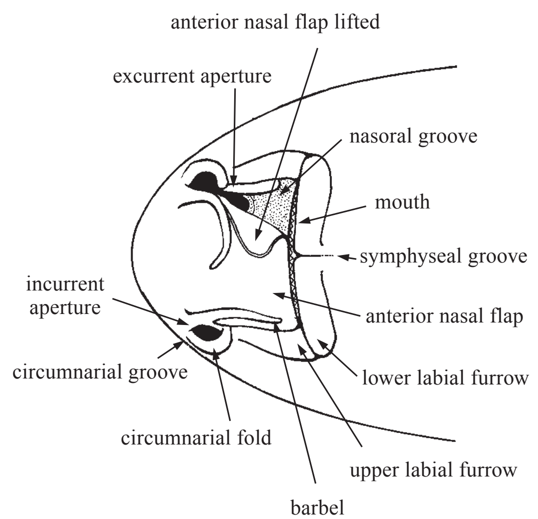
dorsal fin



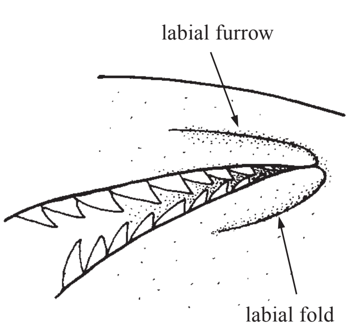
caudal fin



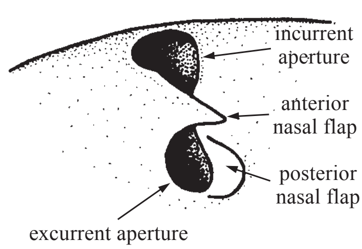
pectoral fin



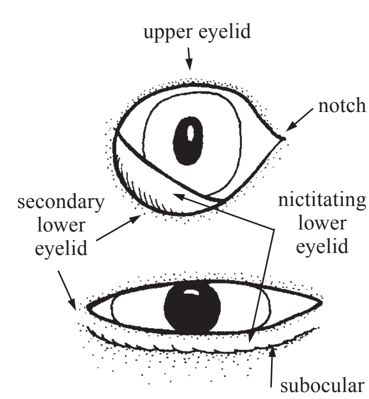
head of an orectoloboid shark (ventral view)



mouth corner



nostril



eye

GENERAL REMARKS

Sharks include a variety of cylindrical, elongated, or depressed jawed fishes with paired pectoral and pelvic fins and relatively simple internal skeletons made of cartilage and lacking internal or external bones, plate-like bony scales, and bony-fin rays. Living sharks are members of the Class Chondrichthyes (the cartilaginous fishes or shark-like fishes), which includes the Subclass Elasmobranchii (the elasmobranchs or plate-gilled fishes, including living sharks and rays, and fossil relatives), and the Subclass Holocephali (chimaeras and fossil relatives). It is traditional to classify living elasmobranchs into 2 formal taxonomic groups, sharks (Selachii) and rays (Batoidea or batoids), but modern cladistic studies show that the rays comprise a single group of highly derived and extremely diverse ‘flat’ or ‘winged’ sharks that is closest to the small group of sawsharks (Pristiophoridae) and which nests within 1 of 2 superorders of living sharks, the Squalomorphii. Hence the traditional shark-ray dichotomy is invalid phyletically, but serves for simple identification as used here and in previous FAO species identification guides for various fishing areas.

Traditional ‘sharks’, or non-batoid sharks (hereafter refered to as sharks), differ from the rays or batoids in having **lateral gill openings (or gill slits) and the pectoral fins not fused to the sides of the head over the gill openings** (both primitive characters states with derived states in rays). The greatly depressed angel sharks (Family Squatinidae) might be mistaken for rays at first sight and are the immediate relatives of the rays and sawsharks; they have large, broad, ray-like pectoral fins that extend as triangular lobes alongside the gill openings, but are not fused to the head above them.

Sharks have eyes on the dorsal surface or sides of the head. There are usually **5 gill openings on each side of the head, rarely 6 or 7**; spiracles (when present) are on the dorsal or dorsolateral surfaces of the head between the mouth and first gill openings. **The mouth is usually ventral or subterminal on the head**, but terminal or nearly so in a few species. **The teeth on the jaws are set in numerous transverse rows and are constantly replaced from inside the mouth**. Most species of sharks are more or less **covered by small (occasionally enlarged) tooth-like placoid scales or dermal denticles**. The tail and caudal fin are always well developed and propel the animal by lateral undulations; the pectoral fins are mostly not used for propulsion through the water but aid in stabilizing and steering the shark. Most sharks have **2 (rarely 1) dorsal fins**, sometimes with spines on their front edges; **an anal fin is usually present**, but missing in several families.

Male sharks have cylindrical copulatory organs or **claspers** on their pelvic fins, used for internal fertilization of eggs in females; about 1/3 of the species of sharks have females that deposit eggs in rectangular or conical capsules, formed of a horn-like material (oviparity); the remainder are livebearers (viviparous). Some live-bearing sharks, including many houndsharks (Triakidae), most requiem sharks (Carcharhinidae), and all hammerheads (Sphyrnidae) are viviparous (placental viviparous), with yolk sacs of fetuses forming a placenta with the maternal uterus for nutrient transfer; other live-bearing sharks are ovoviviparous (aplacental viviparous), without a placenta. Ovoviviparous lamnoid sharks of the families Odontaspididae, Alopiidae, and Lamnidae practice uterine cannibalism, in which one or more fetuses in each uterus resorb their yolk sacs and then devour eggs passed down the oviducts for nutriment (oophagy) and grow to considerable size with massive yolk stomachs before birth. In the Odontaspididae (*Carcharias taurus*) the largest fetus kills and eats its siblings (adelphophagy) and only 1 fetus survives in utero, while several young may cohabit the uterus in the other families.

Mature sharks vary in total length from about 15 to 19 cm (dwarf species of Etmopteridae, Dalatiidae, and Proscylliidae) to 18 m or more (whale shark, Family Rhincodontidae) and range in weight from between 10 and 20 g to at least 30 t. Most sharks are of small or moderate size; about 50% are small, between 15 cm and 1 m; 32% between 1 and 2 m; 14% between 2 and 4 m; and only 4% are over 4 m in total length.

All sharks are predators, with a wide prey range from planktonic crustaceans and benthic invertebrates to pelagic cephalopods, small to large bony fishes, other cartilaginous fishes, marine mammals, and other marine and terrestrial vertebrates. Sharks are primarily marine, but a few requiem sharks (Carcharhinidae) have broad salinity tolerances, and one species (bull shark, *Carcharhinus leucas*) is wide-ranging in tropical lakes and rivers with sea access as well as shallow inshore waters. No sharks are known to be confined to fresh water, unlike several species of stingrays (families Dasyatidae and Potamotrygonidae). Sharks are widely distributed in all oceans, from the Arctic to subantarctic islands, and from close inshore on reefs, off beaches, and in shallow, enclosed bays to the lower continental slopes, the abyssal plains, sea mounts and ridges, and the high seas. They are most diverse in continental waters of tropical and warm-temperate seas, from inshore waters down to upper continental slopes, but are less so in colder waters, at great depths (below 1 500 to 2 000 m), in the open ocean and off oceanic islands. The richest shark faunas occur in the Indo-West Pacific from South Africa and the Red Sea to Australia and Japan.

The Western Central Atlantic (Area 31) has a moderately diverse shark fauna compared to other parts of the world, but includes at least 23 families, 42 genera, and 100 species of sharks. Worldwide there are 34 families, 104 genera, and between 397 and 488 species of sharks (estimate as of 23 January 2001). Several genera and families are poorly known and require further taxonomic study. Many species of sharks are endemic to the area and have restricted ranges within it. Several species (including inshore species) are known from 1 or a few museum specimens only, and a wealth of new species have been collected in deep water, offshore continental, and even inshore habitats in the past forty years (some of which are still undescribed). Undoubtedly more new species and many records of described species will be discovered with further collecting in poorly known parts of the area. Knowledge of the coastal shark fauna of Area 31 is uneven, and some maritime countries need further surveys to determine which species occur there. The deep-water shark fauna is sketchily known in the area, except for the northern Gulf of Mexico and parts of the Caribbean where systematic deep-water exploration for fisheries resources has been underway for several decades under the auspices of the U.S. Bureau of Commercial Fisheries and National Marine Fisheries Service. Basic knowledge of the biology of many species, particularly deep-water taxa, is often very deficient or entirely lacking, and can be supplemented by new information gathered by fisheries workers in the area.

The 'shark attack' hazard has been grossly exaggerated over the past few decades, including almost universal use of the emotive term 'attack' for the minor phenomenon of sharks biting and occasionally killing people. Large carcharhinids, sphyrnids, and lamnids, and less frequently other sharks, may occasionally bite people in the water or bite or hit boats, but are not as hazardous as the water itself. The negative fascination of sharks to the public, and particularly to the news and entertainment media, elevates the perceived importance of shark-bite incidents beyond their modest reality of about 100 per year worldwide. An unusually high number of shark incidents off Florida in the summer of 2001 triggered a media 'feeding frenzy' of enormous proportions for several months.

Unfortunately, the 'shark attack' issue had tended to obscure the 'human attack' problem and its implications for shark conservation in the face of burgeoning fisheries driven by the expanding world human population, increasingly sophisticated fisheries technology, and enormous, increasing markets for shark products including meat, fins, liver oil, skins, and even cartilage. It was recognized over the past 4 decades that aspects of the life history strategy of sharks (long lives, long maturation times, and low fecundity, plus relatively large size) made them very vulnerable to overexploitation, and that several targeted shark fisheries had suddenly collapsed after recruitment had been impaired by overexploitation of the breeding stocks. However, only in the past 10 years has there been widespread concern about world trends in fisheries for sharks and other cartilaginous fishes. After the Second World War world fisheries for chondrichthyan fishes essentially tripled in reported catches to FAO, which has not kept pace with the approximately fourfold increases in total fisheries worldwide. Much of the shark catch worldwide is utilized and discarded as bycatch. These fisheries are driven by larger catches of exploitation-resistant bony fishes or other marine organisms such as crustaceans or cephalopods with far higher fecundity. More recent increases in demand and prices for shark products such as fins, cartilage, and flesh have encouraged targeted fisheries, greater utilization of bycatch, and greater utilization of fins and other shark products that were formerly discarded from sharks that were marketed for their meat.

World catches of shark-like fishes reported to FAO increased in the decade 1987 to 1997 from about 690 to 790 thousand t with an apparent leveling over the half-decade ending in 1997. This suggests that there is little scope for further increases in catches despite higher and sometimes inflated values for various shark products and greater incentives to develop targeted shark fisheries and promote greater utilization of shark bycatch. Some sharks have been accorded limited or total protection in a number of countries, and in the area are under comprehensive regulation in USA waters. On a world basis shark exploitation is mostly unregulated and out of control at present.

FAO proposed an International Plan of Action for managing and regulating shark fisheries and biodiversity in 1999 that requests Member Countries to draw up National Plans of Action for sharks in their territorial waters, which are due to be presented in 2001. Implementation of the plans will depend upon resources and will being available to the countries presenting them. A draft USA action plan was made available for comment in 2000. Ninety-seven species of shark-like fishes have been included on the IUCN Red List for 2000, with 17 being listed as endangered. Sharks have now been seriously proposed for listing under the CITES convention for regulation and banning of trade of threatened species, which has caused fierce political battles. One species, the basking shark, narrowly missed being listed by CITES in 2000. It is anticipated that in the next decade international agreements, including CITES listings and national and regional action plans for regulating shark catches, will be gradually implemented and will hopefully protect a variety of cartilaginous fishes from overexploitation.

In the Western Central Atlantic sharks are used primarily for human food in local fisheries; shark meat is marketed fresh, frozen, and especially dried-salted; fins are utilized on the oriental market for fins; sharks are utilized also for liver oil, fish meal, curios, leather, and medicinal cartilage, although details of utilization in the area are sketchy and vary with different countries. Directed shark fisheries were important in the area, particularly off the Atlantic coast of the USA and Gulf of Mexico, during the 1940s and early 1950s. These targeted large sharks for leather production and used very heavy gear, but the fishery eventually collapsed when expenses for catching sharks exceeded the value of the sharks landed. Currently, some countries in Area 31 follow the circumtropical pattern of primarily landing sharks as bycatch and also running targeted fisheries for local and international consumption, with fins and cartilage as an increasingly profitable export byproduct. The

USA is unique in utilizing shark meat as a high-priced luxury food for human consumption, as well as in having primarily targeted sharks for such products as hides, meat, fins, and sport.

The total catch of sharks reported from Area 31 is uncertain. Total reported catches of cartilaginous fishes (probably almost entirely elasmobranchs) reported to FAO between 1950 and 1998 increased from a low of 2 619 t (1952) to a high of 36 946 t (1994). This is an astonishing 14 times increase in catch in Area 31 compared to a 2.6 times increase in world catches during the same period between 1952 and 1994. The average catch in Area 31 between 1950 and 1998 was 15 120 t. There was a steady increase in catches in Area 31 from the 1950s to the 1980s, and a sharp increase to the mid-1990s, after which catches declined considerably (presumably due to overexploitation). The 1998 catch of 28 825 t included 9 000 t of sharks, 9 886 t of batoids (rays), and 9 939 t of mixed elasmobranchs. Batoids may be becoming more important than sharks in elasmobranch fisheries in the area as shark catches decline through overfishing (as in other parts of the world).

Most Area 31 countries report their catches as mixed sharks and rays without further breakdown, while some countries separate out rays and broad categories of sharks (eg., smooth dogfishes, requiem sharks). Species-specific fisheries data has been supplied by the USA and Portugal for a few Area 31 species in 1998, but species-specific data is unavailable for most countries that fish sharks in Area 31 at present.

Area 31 has a relatively small catch of shark-like fishes (about 3.7% of the world total in 1998), compared to Areas 27, 71, and 51 (with 12.4 to 18.5% in 1998). Countries such as India (8.2% of the world total), Indonesia (11.6%), Spain (11.3%), Pakistan (6.8%) and several others had much larger national catches in 1998 than the entire Area 31 catch. The most important shark fishing countries in the area are Cuba, Mexico, the USA, and Venezuela, with 3 072 to 14 805 t caught in 1998; all have had catch declines from peaks in the 1990s. Other countries landed less than 1 000 t in the area in 1998. Only Mexico has been consistently landing major catches of shark-like fishes (over 10 000 t/ year, and ranging from 12 522 to 18 508 t) in the area over the decade 1988 to 1998. Nearly all of the Area 31 catch is reported from countries in the area, with very little (about 213 t in 1998) reported from countries located outside the area (Japan, Taiwan Province of China, Republic of Korea, Portugal). Management and conservation plans for sharks are in place in the USA sector of Area 31 as part of a long-term National Marine Fisheries Service program for the entire east coast of the USA. Many USA states regulate both sport and commercial fisheries. Mexico currently runs an extensive research programme for management of their shark fisheries in Area 31 and elsewhere.

Data on gear used in the area is sketchy, but line gear (including pelagic longlines), fixed and floating gill nets, bottom trawls, fixed fish traps, and purse seines are used to target sharks or take sharks as a bycatch. Sharks are taken in artisanal fisheries, by local inshore and offshore commercial fisheries, and by international fishing fleets in offshore waters. Sports fishing for sharks is important in some countries in the area, particularly the USA. Requiem sharks (Carcharhinidae) are especially important in fisheries, but considerable numbers of threshers (Alopiidae) and makos (Lamnidae, genus *Isurus*) are fished offshore, and a number of other families, including nurse sharks (Ginglymostomatidae), sand tigers (Odontaspididae), and hammerheads (Sphyrnidae) are commonly taken in inshore fisheries. Dogfish (Family Squalidae) are caught in offshore deep-set longline fisheries targeting sharks for liver oil.

Sharks and rays are increasingly important for ecotouristic diving in the area, particularly in the Bahamas where many dive sites are known and visited by thousands of divers yearly, but also off Belize, Turks and Caicos, and the USA. At least 13 species of sharks, mostly requiem sharks (Carcharhinidae, including the bull, Caribbean reef, lemon, blue, blacktip, Caribbean sharpnose, silky, and oceanic whitetip sharks), but also hammerheads (Sphyrnidae), sand tigers (Odontaspididae), nurse sharks (Ginglymostomatidae) and whale sharks (Rhincodontidae), as well as some batoids, are regularly observed by divers in Area 31. It is likely that ecotouristic diving for sharks is far more valuable locally than fisheries catches for the same species (as shown in the Maldives), which will presumably be a factor in future conservation and fisheries management of sharks in the Area. Ecotouristic diving and responsible underwater film-making tends to demythologize sharks and gives perspective to the relatively low risk of shark bite incidents. Many of the shark species that are popular for underwater ‘shark watching’ have unsavory reputations that are belied by their largely docile and inoffensive responses to divers that treat them respectfully.

KEY TO FAMILIES OCCURRING IN THE AREA

Note: Families with an asterisk (*) are not known from Area 31 at present but are included in the key because they include wide-ranging deep-water or epipelagic species likely to be recorded in the area in the future.

1a. No anal fin . . . . *→ 2*
1b. Anal fin present . . . . *→ 10*

2a. Body strongly depressed and ray-like; pectoral fins greatly enlarged, with anterior triangular lobes that overlap gill slits; mouth terminal (Fig. 1) . . . . **Squatinidae**
2b. Body cylindrical, compressed, or slightly depressed, not ray-like; pectoral fins small, without anterior lobes; mouth ventral . . . . *→ 3*

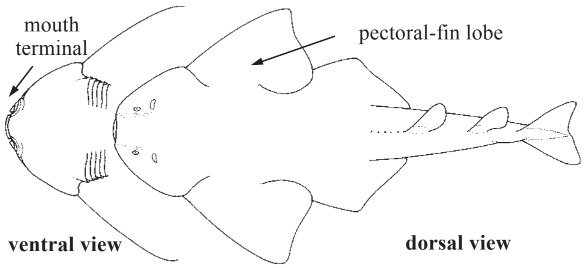


Fig. 1 Squatinidae

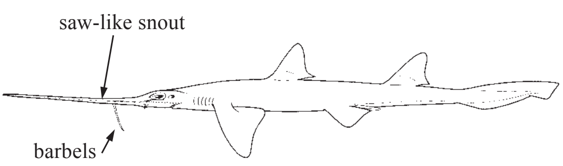


Fig. 2 Pristiophoridae

3a. Snout greatly elongated into a flat saw with large, pointed denticles on sides and a pair of long, tape-like barbels on the lower surface (Fig. 2) . . . . **Pristiophoridae**
3b. Snout normal, not saw-like; no barbels on underside of snout . . . . *→ 4*

4a. Trunk very high and compressed, triangular in section; dorsal fins very high; fin spine of first dorsal fin inclined forward (Fig. 3) . . . . **Oxynotidae**
4b. Trunk low and cylindrical, dorsal fins lower; fin spine of first dorsal fin, when present, inclined backward . . . . *→ 5*

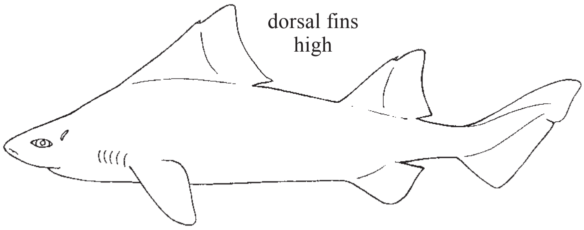


Fig. 3 Oxynotidae

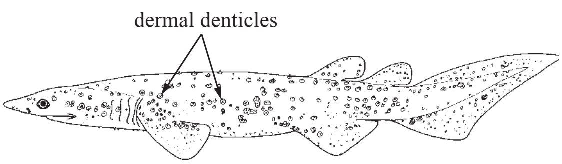


Fig. 4 Echinorhinidae

5a Body set with sparse, large, plate-like denticles; spiracles small and well behind eyes; fifth pair of gill slits abruptly longer than others; first dorsal-fin origin over or posterior to pelvic-fin origins; pelvic fins much larger than second dorsal fin (Fig. 4) . . . . **Echinorhinidae**
5b. Fifth gill slits not abruptly larger than first to fourth; spiracles larger and close behind eyes; first dorsal-fin origin well anterior to pelvic-fin origins; pelvic fins usually about as large as second dorsal fin or smaller . . . . *→ 6*

6a. Dorsal-fin spines without grooves; teeth similar and blade-like in both jaws, with a deflected horizontal cusp, a low blade, and no cusplets; caudal peduncle usually with a precaudal pit (weak or absent in *Cirrhigaleus*) and always with strong lateral caudal keels; subterminal notch absent from caudal fin (Fig. 5) . . . . **Squalidae**

6b. Dorsal-fin spines, where present, with lateral grooves; teeth variable but not similarly blade-like and without a deflected horizontal cusp in both jaws; caudal peduncle without precaudal pits and usually without lateral keels (weak ones in some dalatiids); subterminal notch usually present and well developed . . . . → *7*

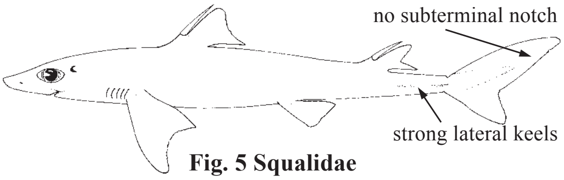


Fig. 5 Squalidae

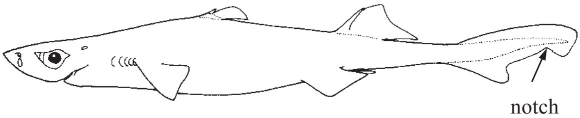


Fig. 6 Etmopteridae

7a. Upper teeth with a cusp and lateral cusplets; underside of body usually with more or less conspicuous dense black markings indicating the presence of numerous light organs (photophores) (Fig. 6) . . . . **Etmopteridae**

7b. Upper teeth with a cusp but without lateral cusplets; underside of body without conspicuous black markings and light organs . . . . → *8*

8a. Upper teeth relatively broad and blade-like, imbricated, lowers low and wide (Fig. 7) . **Centrophoridae**

8b. Upper teeth relatively narrow and not blade-like, lowers high and wide . . . . → *9*

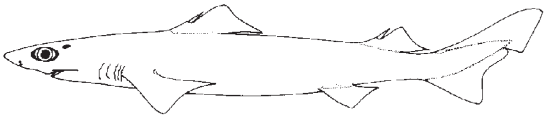


FIg. 7 Centrophoridae

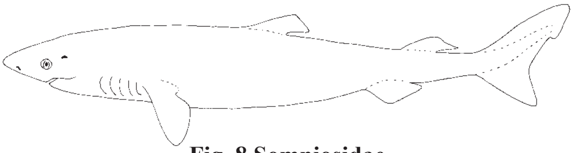


Fig. 8 Somniosidae

9a. Head moderately broad and somewhat flattened or conical; snout flat and narrowly rounded to elongate-rounded in dorsoventral view; abdomen usually with lateral ridges; both dorsal fins with low fin spines in species known from the area (absent in the extralimital *Scymnodalatias* and *Somniosus*) (Fig. 8) . . . . **Somniosidae**

9b. Head narrow and rounded-conical; snout conical and narrowly rounded to elongate-rounded in dorsoventral view; abdomen without lateral ridges; dorsal fins usually without spines (except for a small spine present on the first dorsal fin of *Squaliolus*) . . . . . **Dalatiidae**

10a. One dorsal fin, far posterior on back; 6 or 7 gill slits on each side . . . . → *11*

10b. Two dorsal fins; 5 gill slits on each side . . . . → *12*

11a. Six gill slits, with the first connected across the underside of the throat; body elongated and eel-shaped; teeth tricuspidate and similar in both jaws (Fig. 9) . . . . **Chlamydoselachidae**

11b. Six or 7 gill slits, with the first not connected across the underside of the throat; body fairly stocky, not eel-shaped; anterior teeth unicuspidate in upper jaw and comb-shaped in lower jaw (Fig. 10) . . . . **Hexanchidae**

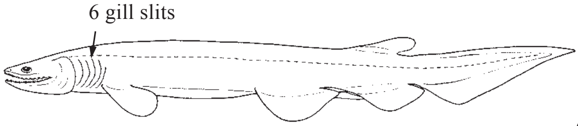


Fig. 9 Chlamydoselachidae

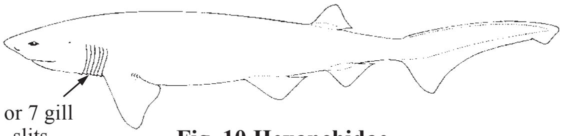


Fig. 10 Hexanchidae

12a. Head with lateral expansions or blades, like a double-edged axe (Fig. 11). . . . . **Sphyrnidae**

12b. Head normal, not expanded laterally. . . . . → *13*

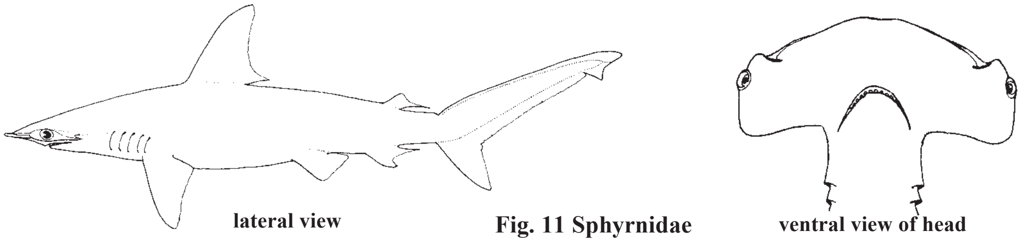


Fig. 11 Sphyrnidae

13a. Eyes behind mouth; deep nasoral grooves connecting nostrils and mouth . . . . → *14*

13b. Eyes partly or entirely over mouth; nasoral grooves absent in Western Central Atlantic representatives . . . . → *15*

14a. Mouth huge and nearly terminal; external gill slits very large, internal gill slits inside mouth cavity with filter screens; caudal peduncle with strong lateral keels; caudal fin with a strong ventral lobe, but without a strong terminal lobe and subterminal notch (Fig. 12) . . . **Rhincodontidae**

14b. Mouth smaller and subterminal; external gill slits small, internal gill slits without filter screens; caudal peduncle without strong lateral keels; caudal fin with a weak ventral lobe or none, but with a strong terminal lobe and subterminal notch (Fig. 13) . . . . . **Ginglymostomatidae**

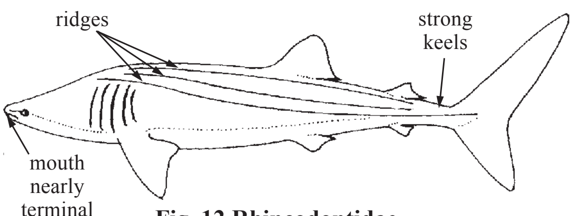


Fig. 12 Rhincodontidae

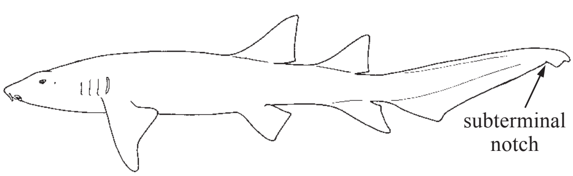


Fig. 13 Ginglymostomatidae

15a. A strong keel present on each side of caudal peduncle (Fig. 14,15); caudal fin crescentic and nearly symmetrical, with a long lower lobe . . . . → *16*

15b. No keels on caudal peduncle, or weak ones; caudal fin asymmetrical, not crescentic, with ventral lobe relatively short or absent . . . . → *17*

16a. Teeth large and few, sharp-edged; gill openings large but not extending onto upper surface of head; no gill rakers (Fig. 14) . . . . **Lamnidae**

16b. Teeth minute and very numerous, not sharp-edged; gill openings huge, extending onto upper surface of head; gill rakers present on internal gill openings in throat, sometimes absent after shedding (Fig. 15) . . . . **Cetorhinidae**

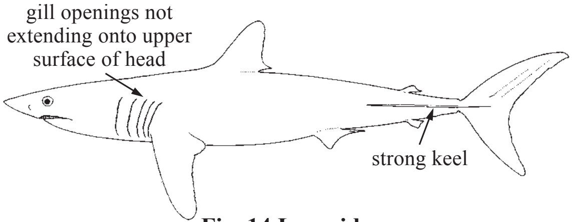


Fig. 14 Lamnidae

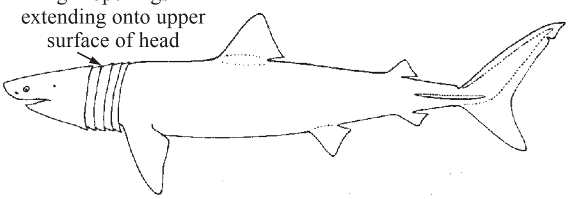


Fig. 15 Cetorhinidae

17a. Caudal fin about as long as rest of shark (Fig. 16) . . . . **Alopiidae**

17b. Caudal fin less than half the length of rest of shark . . . . → *18*

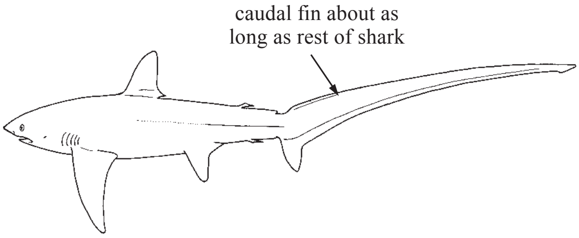


Fig. 16 Alopiidae

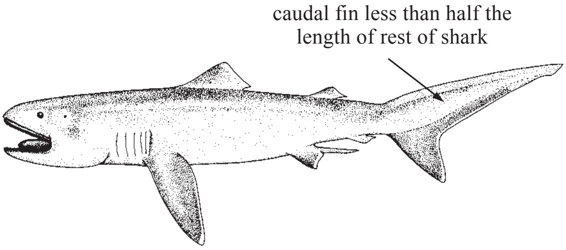


Fig. 17 Megachasmidae

18a. Mouth terminal on head, level with snout; internal gill openings screened by numerous long papillose gill rakers (Fig. 17) . . . . **Megachasmidae***

18b. Mouth subterminal on head, behind snout tip; internal gill openings either without gill rakers, or with a few low papillose gill rakers along their edges . . . . → *19*

19a. No nictitating eyelids, largest teeth in mouth are 2 or 3 rows of anterior teeth on either side of lower jaw symphysis; upper anterior teeth separated from large lateral teeth at sides of jaw by a gap that may have one or more rows of small intermediate teeth; all gill slits in front of pectoral fins . . . . → *20*

19b. Nictitating eyelids present; largest teeth in mouth are well lateral on dental band, not on either side of symphysis; no gap or intermediate teeth separating large anterior teeth from still larger lateral teeth in upper jaw; last 1 or 2 gill slits over pectoral-fin bases. . . . . → *22*

20a. Snout elongated and blade-like; anal fin much larger than dorsal fins; no precaudal pits; caudal fin without ventral lobe (Fig. 18) . **Mitsukurinidae**

20b. Snout conical or flattened, short and not blade-like; anal fin subequal to dorsal fins in size or smaller than them; upper and sometimes lower precaudal pits present; caudal fin with strong ventral lobe . . . . → *21*

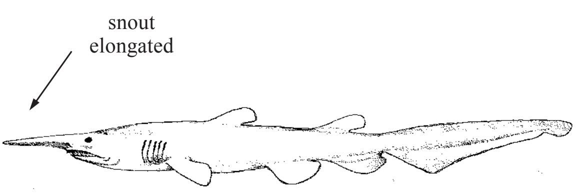


Fig. 18 Mitsukurinidae

21a. Eyes very large; gill slits extending onto upper surface of head; both upper and lower precaudal pits present; a low keel on each side of caudal peduncle (Fig. 19) . . **Pseudocarchariidae***

21b. Eyes smaller; gill slits not extending onto upper surface of head; lower precaudal pit absent; no keels on caudal peduncle (Fig. 20) . . . . **Odontaspididae**

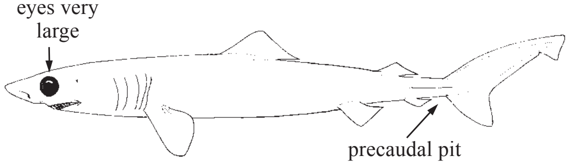


Fig. 19 Pseudocarchariidae

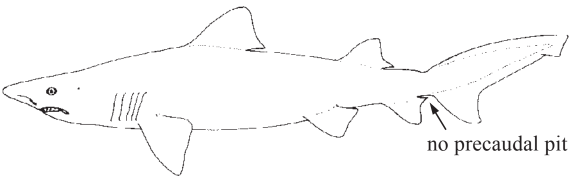


Fig. 20 Odontaspididae

22a. Origin of first dorsal fin over or behind pelvic-fin bases (Fig. 21) . . . . **Scyliorhinidae**

22b. Origin of first dorsal fin well ahead of pelvic-fin bases . . . . *→ 23*

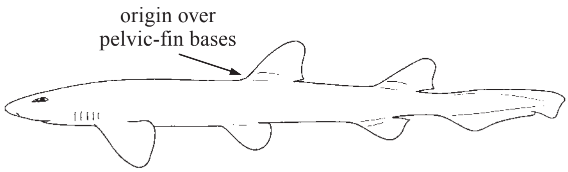


Fig. 21 Scyliorhinidae

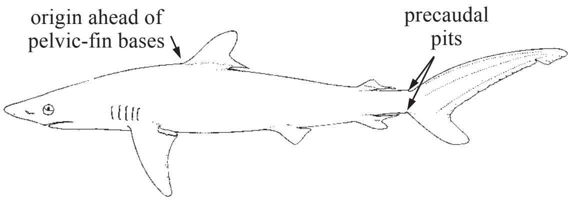


Fig. 22 Carcharhinidae

23a. Precaudal pits and rippled dorsal caudal-fin margin present; intestinal valve of scroll type (Fig. 22, 23a) . . . . **Carcharhinidae**

23b. No precaudal pits, dorsal caudal-fin margin smooth; intestinal valve of spiral type (Fig. 23b) . . . . *→ 24*

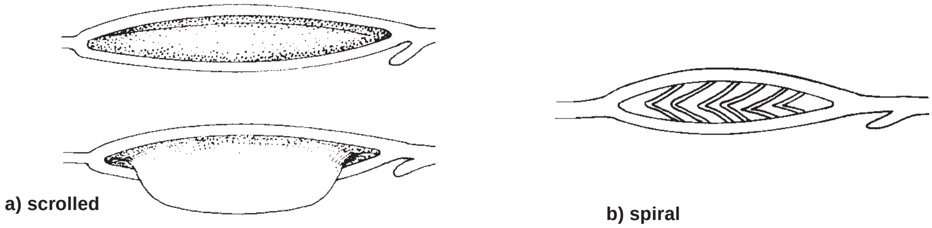


Fig. 23 intestinal valve types

24a. First dorsal fin long, about the length of caudal fin, and formed as a low, rounded keel; adults with over 200 rows of teeth in each jaw; spiracles nearly or quite as long as eyes (Fig. 24) . . . . **Pseudotriakidae***

24b. First dorsal fin short, about 2/3 of caudal fin or less, subtriangular in shape; adults with less than 110 rows of teeth in each jaw; spiracles much smaller than eyes . . . . *→ 25*

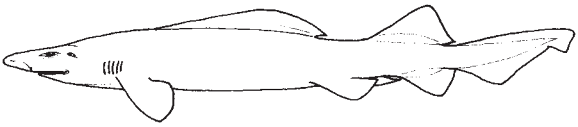


Fig. 24 Pseudotriakidae

25a. Labial furrows very short or absent, confined to extreme mouth corners; posterior teeth comb-like; base of first dorsal fin closer to pelvic-fin bases than to pectoral-fin bases (Fig. 25) . . . . **Proscylliidae**

25b. Labial furrows longer, extending anteriorly for a greater or lesser distance on lips; posterior teeth not comb-like; base of first dorsal fin either equidistant between pectoral- and pelvic-fin bases or closer to pectoral-fin bases (Fig. 26). . . . . **Triakidae**

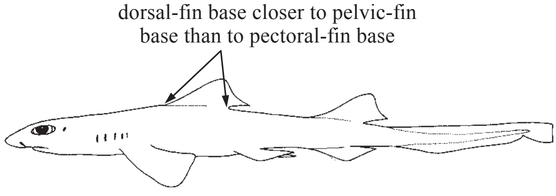


Fig. 25 Proscylliidae

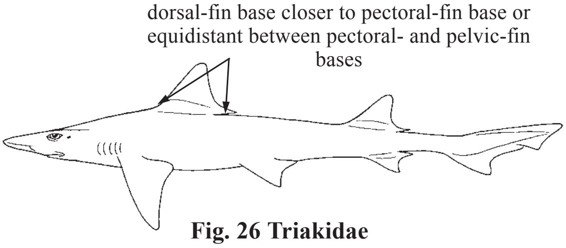


Fig. 26 Triakidae

LIST OF ORDERS, FAMILIES, AND SPECIES OCCURRING IN THE AREA

The symbol is given when species accounts are included. A question mark indicates that presence in the area is uncertain. An asterisk (*) indicates species and families that occur near Area 31 and which are likely to be recorded in the area in the future. Family accounts are not provided for the Pseudocarchariidae, Megachasmidae, and Pseudotriakidae, but they are included in the family key above in anticipation of possible records in the future.

ORDER HEXANCHIFORMES: COW AND FRILLED SHARKS

CHLAMYDOSELACHIDAE: Frilled sharks
Chlamydoselachus anguineus Garman, 1884.

HEXANCHIDAE: Sixgill and sevengill sharks, cow sharks
Heptranchias perlo (Bonnaterre, 1788).

Hexanchus griseus (Bonnaterre, 1788).
Hexanchus nakamurai Teng, 1962.

ORDER SQUALIFORMES: DOGFISH SHARKS

ECHINORHINIDAE: Bramble sharks
Echinorhinus brucus (Bonnaterre, 1788).

SQUALIDAE: Dogfish sharks
Cirrhigaleus asper (Merrett, 1973).

Squalus acanthias Linnaeus, 1758.
Squalus cubensis Howell Rivero, 1936.
Squalus mitsukurii Jordan and Snyder, in Jordan and Fowler, 1903.

CENTROPHORIDAE: Gulper sharks
Centrophorus acus Garman, 1906.
Centrophorus granulosus (Bloch and Schneider, 1801).
Centrophorus niaukang Teng, 1959.
Centrophorus squamosus (Bonnaterre, 1788).
Centrophorus sp.

Deania profundorum (Smith and Radcliffe, in Smith 1912).

ETMOPTERIDAE: Lantern sharks
Centroscyllium fabricii (Reinhardt, 1825).*

Etmopterus bigelowi Shirai and Tachikawa, 1993.
Etmopterus bullisi Bigelow and Schroeder, 1957.
Etmopterus carteri Springer and Burgess, 1985.
Etmopterus gracilispinis Krefft, 1968.
Etmopterus hillianus (Poey, 1861).
Etmopterus perryi Springer and Burgess, 1985.
Etmopterus robinsi Schofield and Burgess, 1997.
Etmopterus schultzi Bigelow, Schroeder and Springer, 1953.
Etmopterus virens Bigelow, Schroeder and Springer, 1953.

SOMNIOSIDAE: Sleeper sharks
Centroscymnus coelolepis Barbarosa du Bocage and Brito Capello, 1864.
Centroscymnus owstonii Garman, 1906.

Zameus squamulosus (Günther, 1877).

OXYNOTIDAE: Roughsharks
Oxynotus caribbaeus Cervigón, 1961.

DALATIIDAE: Kitefin sharks
Dalatias licha (Bonnaterre, 1788).

Isistius brasiliensis (Quoy and Gaimard, 1824).
Isistius plutodus Garrick and Springer, 1964.

Squaliolus laticaudus Smith and Radcliffe, in Smith 1912.

ORDER SQUATINIFORMES: ANGELSHARKS

SQUATINIDAE: Angelsharks
Squatina dumeril Lesueur, 1818.

ORDER PRISTIOPHORIFORMES: SAWSHARKS

PRISTIOPHORIDAE: Sawsharks
Pristiophorus schroederi Springer and Bullis, 1960.

ORDER LAMNIFORMES: MACKEREL SHARKS

ODONTASPIDIDAE: Sand tiger sharks
Carcharias taurus Rafinesque, 1810.

Odontaspis ferox (Risso, 1810).
Odontaspis noronhai (Maul, 1955).

MITSUKURINIDAE: Goblin sharks
Mitsukurina owstoni Jordan, 1898.

PSEUDOCARCHARIIDAE: Crocodile sharks.*
Pseudocarcharias kamoharai (Matsubara, 1936).*

MEGACHASMIDAE: Megamouth sharks *
Megachasma pelagios Taylor, Compagno, and Struhsaker, 1983.*

ALOPIIDAE: Thresher sharks
Alopias superciliosus (Lowe, 1839).
Alopias vulpinus (Bonnaterre, 1788).

CETORHINIDAE: Basking sharks
Cetorhinus maximus (Gunnerus, 1765).

LAMNIDAE: Mackerel sharks
Carcharodon carcharias (Linnaeus, 1758).

Isurus oxyrinchus Rafinesque, 1810.
Isurus paucus Guitart Manday, 1966.

Lamna nasus (Bonnaterre, 1788).

ORDER ORECTOLOBIFORMES: CARPET SHARKS

GINGLYMOSTOMATIDAE: Nurse sharks
Ginglymostoma cirratum (Bonnaterre, 1788).

RHINCODONTIDAE: Whale sharks
Rhincodon typus Smith, 1828.

ORDER CARCHARHINIFORMES: GROUND SHARKS

SCYLIORHINIDAE: Catsharks
Apristurus canutus Springer and Heemstra, in Springer, 1979.
Apristurus laurussonii (Saemundsson, 1922).
Apristurus parvipinnis Springer and Heemstra, in Springer, 1979.
Apristurus profundorum (Goode and Bean, 1896).
Apristurus riveri Bigelow and Schroeder, 1944.

Galeus arae (Nichols, 1927).
Galeus antillensis Springer, 1979.
Galeus cadenati Springer, 1966.
Galeus springeri Konstantinou and Cozzi, 1998.

Parmaturus campechiensis Springer, 1979.

Schroederichthys maculatus Springer, 1966.
Schroederichthys tenuis Springer, 1966.

Scyliorhinus boa Goode and Bean, 1896.
Scyliorhinus haeckelii (Miranda-Ribeiro, 1907).
Scyliorhinus hesperius Springer, 1966.
Scyliorhinus meadi Springer, 1966.
Scyliorhinus retifer (Garman, 1881).
Scyliorhinus torrei Howell Rivero, 1936.

PROSCYLLIIDAE: Finback catsharks
Eridacnis barbouri (Bigelow and Schroeder, 1944).

PSEUDOTRIAKIDAE: False catsharks *
Pseudotriakis microdon Brito Capello, 1868.*

TRIAKIDAE: Houndsharks
Mustelus canis (Mitchell, 1815).
Mustelus higmani Springer and Lowe, 1963.
Mustelus minicanis Heemstra, 1997.
Mustelus norrisi Springer, 1939.
Mustelus sinusmexicanus Heemstra, 1997.

CARCHARHINIDAE: Requiem sharks
Carcharhinus acronotus (Poey, 1860).
Carcharhinus altimus (Springer, 1950).
Carcharhinus brachyurus (Günther, 1870).
Carcharhinus brevipinna (Müller and Henle, 1839).
Carcharhinus falciformis (Müller and Henle, 1839).
Carcharhinus galapagensis (Snodgrass and Heller, 1905).
Carcharhinus isodon (Müller and Henle, 1839).
Carcharhinus leucas (Müller and Henle, 1839).
Carcharhinus limbatus (Müller and Henle, 1839).
Carcharhinus longimanus (Poey, 1861).
Carcharhinus obscurus (Lesueur, 1818).
Carcharhinus perezi (Poey, 1876).
Carcharhinus plumbeus (Nardo, 1827).
Carcharhinus porosus (Ranzani, 1840).
Carcharhinus signatus (Poey, 1868).

Galeocerdo cuvier (Péron and Lesueur, in Lesueur, 1822).

Isogomphodon oxyrhynchus (Müller and Henle, 1839).

Negaprion brevirostris (Poey, 1868).

Prionace glauca (Linnaeus, 1758).

Rhizoprionodon lalandii (Müller and Henle, 1839).
Rhizoprionodon porosus (Poey, 1861).
Rhizoprionodon terraenovae (Richardson, 1836).

SPHYRNIDAE: Hammerhead sharks
Sphyrna lewini (Griffith and Smith, 1834).
Sphyrna media Springer, 1940.
Sphyrna mokarran (Rüppell, 1837).
Sphyrna tiburo (Linnaeus, 1758).
Sphyrna tudes (Valenciennes, 1822).
Sphyrna zygaena (Linnaeus, 1758).

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