MACKEREL SHARKS (LAMNIFORMES)

The mackerel sharks are a small but diverse group containing seven very distinct families, 10 genera, and about 16 species of large oceanic and coastal sharks; six families, eight genera, and 11 species are found in California waters. Superficially, each of these shark families appears to be unique and perhaps unrelated, as this group contains such bizarre species as the goblin shark, with its acutely pointed snout; the giant filter-feeding megamouth shark; and the thresher sharks, with their elongated caudal fins nearly as long as their entire body trunk. The members of this order, however, are all united by a number of features, including a pointed snout, the lack of dorsal fin spines, and a similar style of dentition. This group on the whole has a wide circumglobal distribution from subpolar waters to the tropics. These sharks occupy a wide variety of habitats from nearshore coastal waters to an oceanic or deep-sea environment. They share a unique form of aplacental viviparity in which embryonic sharks feed on ovulating eggs (oophagy) and in some cases their fellow embryos within the uterus (intrauterine cannibalism).

1a Snout extremely elongated, flat, and bladelike. Precaudal pits and ventral caudal lobe absent ..... goblin sharks (Mitsukurinidae)

1b Snout short to moderate, but not greatly elongated or bladelike, and broadly rounded. Precaudal pits and ventral caudal lobe present 2

- 2a Mouth terminal, lower jaw extending to snout tip ..... megamouth sharks (Megachasmidae)
- 2b Mouth subterminal, lower jaw not extending to snout tip 3

3a Caudal fin about as long as rest of shark ..... thresher sharks (Alopiidae)

3b Caudal fin much shorter than rest of shark 4

- 4a Upper precaudal pit present; lower pit and lateral keels absent. Caudal fin heterocercal, not crescent shaped ..... sand tiger sharks (Odontaspididae)
- 4b Upper and lower precaudal pits and strong lateral keel present. Caudal fin crescent shaped 5

5a Teeth large, triangular, and bladelike. Gill slits large, but not extending onto dorsal surface of head or nearly across throat, and without internal gill rakers . . . . . mackerel sharks (Lamnidae)

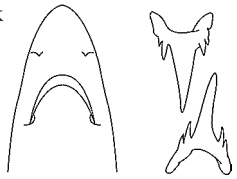
5b Teeth minute, hook shaped, but not bladelike. Gill slits extremely large, dorsally extending onto surface of head and the first nearly extending across the throat, and with internal gill rakers . . . . . basking sharks (Cetorhinidae)

Sand Tiger Sharks (Odontaspididae)

The sand tiger sharks are a small group of lamnoids composed of two genera and three or four species, one of which occurs in California waters. These sharks are characterized by a moderately stout, cylindrical body shape with a short head and a moderately long, pointed snout. The eyes, depending on the species, are small to moderately large; the mouth is large and located subterminal on the head; the teeth have a single large, long, narrow cusp flanked on either side by one or more cusplets. The teeth are an especially prominent feature of these sharks as they tend to protrude from the mouth in a viperlike fashion. Sand Tiger Sharks are a group of large sharks that range in size from 2.2 to 3.6 m in length. Depending on the species, they inhabit areas ranging from the coast, including bays and harbors, to very deep water.

SAND TIGER SHARK ***Odontaspis ferox***

DESCRIPTION: A large, stout-bodied shark with a conical to slightly flattened snout; a long mouth extending beyond the eyes; a first dorsal fin that is larger than the second dorsal and anal fins, originating over the pectoral fin free



rear-tips. The prominent teeth of this shark are long and narrow with a central cusp, flanked by two or three smaller cusplets on each side. The upper anterior and lateral teeth are separated by three to five smaller intermediate teeth. The body color is gray to brownish-gray or olive above and lighter below. Some specimens have dark reddish spots scattered over the body. Tooth count: 46–56/36–48. Vertebral count: 177–183.* Spiral valve count: 32.

HABITAT AND RANGE: The few records from California waters have been taken at a depth of 13 to 200 m, although this species is known to occur at depths of at least 420 m elsewhere. These sharks are typically found on or close to the bottom in deep water along the continental and insular shelves and upper slopes. There are several records of this species occurring pelagically in open ocean waters.

The Sand Tiger Shark is found from southern California southward along the Baja coast to the Gulf of California. There have been at least five confirmed recordings off southern California. Elsewhere it is known from a few scattered records in temperate and tropical seas in the North Atlantic, Indian, and Pacific Oceans and from the Mediterranean Sea, where it appears to be most abundant.

NATURAL HISTORY: Virtually nothing is known regarding the reproductive biology of this shark. It is assumed to be oophagous like other members of this group. Males mature at 275 cm and females at about 360 cm. The maximum reported size is 367 cm. The estimated size at birth is about 100 cm.

Sand Tiger Sharks feed mainly on small bony fishes, including rockfish, squids, and crustaceans.

HUMAN INTERACTIONS: The Sand Tiger Shark is too rare to be of any importance in California. Elsewhere this uncommon shark is taken in the Mediterranean Sea, the Gulf of California, and off Japan as a by-catch in bottom gill nets and long-lines and bottom trawls. It is used for human consumption, although its meat is considered of inferior quality. Its liver, which is very large and oily, has a high squalene content and probably serves this shark in a hydrostatic capacity.

The Sand Tiger Shark has never been implicated in an attack on humans, although care should be taken by those who may occasionally come into contact with this shark. Its large size and prominent teeth suggest that it may inflict serious injury if mishandled. The rarity of this shark in California waters combined

with its deepwater habitat make it unlikely that most people will come into contact with it.

NOMENCLATURE: *Odontaspis ferox* (Risso, 1810). The generic name derives from the Greek *Odontos,* meaning tooth, and *aspis,* meaning viper, in reference to the fearsome appearance of these sharks. The Latin name *ferox* means fierce. The common name, Sand Tiger, is in reference to this shark's rather fearsome looking appearance. Other local common names include Sand Shark, Smalltooth Sand Shark, and Ragged-tooth Shark.

The Sand Tiger Shark was first identified from California waters as *Carcharias ferox.* The use of the genus *Carcharias* was based on a ruling by the International Commission on Zoological Nomenclature in 1912. This ruling was later overturned by the Commission in favor of *Odontaspis,* which was first proposed in 1838.

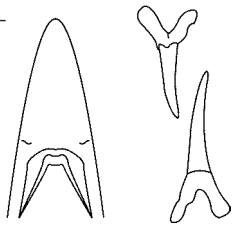
REFERENCES: Daugherty (1964); Seigel and Compagno (1986); Villavicencio-Garayzar (1996b).

Goblin Sharks (Mitsukurinidae)

The goblin sharks are an unmistakable, monotypic group, composed of a single, distinctive species. This is a bizarre looking shark with an elongated, flat, bladelike snout; a slender, soft flabby body; small eyes; and long, narrow, single-cusped teeth. The body coloration of freshly caught specimens is a pinkish-white with bluish fins, but the color fades shortly after death to a uniform brown. This is a poorly known deepwater species with a scattered distribution in both temperate and tropical seas. Goblin sharks are a fairly large species growing to nearly 4 m in length. Virtually nothing is known about their life history. The jaws are highly protrusible and most likely play an important role in the ability of this shark to catch its prey.

GOBLIN SHARK FOLLOWS ➤

GOBLIN SHARK *Mitsukurinia owstoni*



DESCRIPTION: The Goblin Shark is unmistakable, with its soft, flabby body; elongated, flat, bladelike snout; small eyes; and long narrow single-cusped teeth. The jaws of these sharks are highly protrusible. The body color of freshly caught specimens is a spectacular pinkish-white with bluish fins. Preserved specimens are uniformly brown or gray. Tooth count: 38/38. Vertebral count: 122–124.* Spiral valve count: 19.*

HABITAT AND RANGE: The Goblin Shark is a poorly known deepwater shark found on the outer continental shelf and upper slopes down to a depth of at least 1,300 m. It is known from the eastern Pacific from a single specimen caught off San Clemente Island. Elsewhere this species is known from less than 50 specimens with records scattered throughout the three major oceans. The majority of specimens have been reported from Japanese waters.

NATURAL HISTORY: This species is assumed to exhibit aplacental viviparity with oophagous embryos as in other lamnoids, but this has yet to be confirmed. Males are known to be mature at 264 cm and to reach at least 385 cm. The largest recorded female was an immature specimen that measured 373 cm. The smallest known free-swimming specimen measured 107 cm.

Goblin Sharks feed on small pelagic bony fishes, pelagic crabs, and cephalopods. Based on their main prey species the Goblin Shark appears to forage away from the bottom for its food and may in fact occupy more of a midwater habitat than is generally assumed.

The Goblin Shark, with its flabby body and small fins, is a fairly inactive swimmer and probably relies on its rather specialized features, the snout and jaws, for capturing prey. The long,

bladelike snout covered with sensory cells, combined with its protrusible jaws and grasping teeth, suggests that this shark hunts its prey by detecting electric fields. Its large oily liver makes it nearly neutrally buoyant, thus allowing it to approach an unsuspecting prey item with relatively little movement. Once a prey item has been located, the Goblin Shark probably drifts close, so that its highly protrusible jaws can be rapidly projected to capture it. The combination of these specialized features and the dark, harsh environment in which it lives suggests that the Goblin Shark is an ambush predator.

The Blue Shark is a known predator of this species.

HUMAN INTERACTIONS: The Goblin Shark is of no importance other than it is occasionally taken as a by-catch.

A rare, bizarre-looking deepwater shark, it is relatively harmless to people. Goblin Shark teeth have been found imbedded in transoceanic undersea cables.

NOMENCLATURE: *Mitsukurinia owstoni* (Jordan, 1898). The family and generic names are in honor of Kakichi Mitsukuri. The specific name is in recognition of Alan Owston, who collected the type specimen. The common name comes from the bizarre appearance of this shark.

REFERENCES: Ugoretz and Seigel (1999).

Megamouth Sharks (Megachasmidae)

The megamouth sharks are a monotypic family of filter-feeding sharks known only from a few widely scattered specimens throughout the world. This is a large, unmistakable shark with a flabby body and a huge terminal mouth with numerous short but sharply pointed teeth. Very little is known of its life history other than this epipelagic species exhibits a diurnal vertical migratory pattern following its preferred prey items. Four of the 17 reported specimens have come from California waters.

MEGAMOUTH SHARK FOLLOWS ➤

MEGAMOUTH SHARK *Megachasma pelagios*

DESCRIPTION: The Megamouth Shark has a large, flabby body, tapering posteriorly; a short, broadly rounded snout; a huge, broadly arched, terminal mouth; large gill openings; and a large, elongated caudal fin, with a long upper lobe and a prominent ventral lobe. The teeth are small, numerous, and hook shaped. Coloration is a dark blue to brownish black or gray above becoming paler on its flanks, and abruptly white below the level of the pectoral and pelvic fins. Posterior fin margins and apices are white. There is a bright white band extending along its upper jaw; the lining of the lower jaw is silvery with dark mottling. Tooth count: 55–108/75–128.* Vertebral count: 139–151.* Spiral valve count: 23–24.*

HABITAT AND RANGE: Megamouth Sharks are warm-temperate to tropical epipelagic sharks found over continental shelves, around oceanic islands, and far offshore in open waters. They have been found from the surface to a depth of at least 166 m over very deep water of up to 4,600 m; a few specimens have washed ashore.

These sharks are known in the eastern Pacific from only four specimens taken off southern California. The first California specimen was taken in a drift gill net set 8 miles off the east end of Catalina Island less than 38 m from the surface in water over 800 m deep. The second was caught in a drift gill net 7 miles west of Dana Point, a location only 20 miles from where the first was caught, in water less than 100 m deep. A third specimen caught in a drift gill net was taken 30 miles off San Diego

in water over 350 m deep. A fourth was caught in a drift gill net 42 miles northwest of San Diego in water over 850 m. All four of these specimens were taken during the autumn months of October (three) or November (one). Elsewhere, Megamouth Sharks are known from several widely scattered locations in the Atlantic, North Pacific, and Indian Oceans.

NATURAL HISTORY: Although unconfirmed, the Megamouth Shark is assumed to be oophagous as are other lamnoids. Males mature at 4 to 4.5 m and grow to at least 5.5 m. Females are mature at 5.4 m. The smallest known specimens measured 1.8 and 1.9 m in length. Mating scars have been observed on adult females, but little else is known about their reproductive biology.

Megamouth Sharks are a slow-swimming, filter-feeding species that consume mainly euphausid shrimps, copepods, and jellyfishes. This is one of the few shark species in which daily vertical depth migrations associated with light levels have been confirmed. In a study off southern California using an acoustic transmitter, a single Megamouth was found to maintain an average daytime depth of 120 to 166 m, but at dusk ascended to 12 to 25 m over very deep water.

There are no known predators of the Megamouth. However, craterlike wounds on some specimens appear to have been made by Cookiecutter Sharks. A Megamouth observed swimming at the surface in Indonesian waters was purportedly being attacked by a group of three Sperm Whales.

HUMAN INTERACTIONS: The Megamouth was perhaps one of the most spectacular shark discoveries of the twentieth century. This large, oceanic shark was first recorded in 1976 from off the northern Hawaiian Islands. Since then about 17 specimens have been either caught or photographed, four of which were from off southern California. They are of no commercial value but of considerable value to scientists studying these fascinating animals.

NOMENCLATURE: *Megachasma pelagios* (Taylor, Compagno, and Struhsaker, 1983). The generic name *Megachasma* comes from the Greek *megas,* meaning large, and *chasma,* meaning open mouth. The species name comes from the Greek *pelagios,* meaning open sea, in reference to its pelagic habitat. The common name, Megamouth, refers to its huge mouth.

REFERENCES: Lavenberg and Seigel (1985); Lavenberg (1991); Nelson et al. (1997).

Thresher Sharks (Alopiidae)

The thresher shark family consists of a single genus comprising three species, all of which occur in California waters. The most distinguishable feature of these sharks is the extremely long tail fin, which is about as long as the body trunk. The genus can be subdivided into two distinct groups. One group consists of thresher sharks with a relatively small eye, a thin tail, and no marked grooves on the top of the head; this group includes the Common and Pelagic Thresher Sharks. The second group includes thresher sharks with extremely large eyes, a broad tail, and distinct grooves on the top of the head, running from a central point over the eyes, out and back over the gill region; the sole member of this group is the Bigeye Thresher Shark. Thresher sharks have a worldwide distribution, ranging from temperate to tropical waters. They are found in nearshore coastal waters, including enclosed bays, as well as in oceanic habitats far from land. They have been taken at a depth of 500 m, but most are found within 65 m of the water's surface. All are oophagous, with small litters of two to four pups. They feed on a wide variety of schooling fishes and cephalopods. Thresher sharks use their tails to herd prey species into a tight school and then by rapidly whipping their tails they stun and kill individual fishes or squids. Threshers are the only modern sharks, other than sawsharks (Pristiophoridae), to use a structure other than their jaws and teeth to kill prey. These are one of the most commercially important groups of sharks. A substantial fishery for these sharks developed in the early 1980s in southern California. Despite their great length, half of which consists of their long tail, thresher sharks have a relatively small mouth and teeth and thus are not considered dangerous to humans. In fact, these sharks have often been observed by divers underwater without incident.

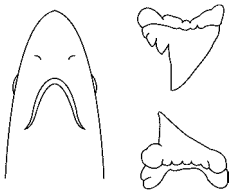
1a Head with a deep horizontal groove extending around each side. Eyes are very large, with orbits expanded onto the dorsal head surface . . . . . Bigeye Thresher Shark (*Alopias superciliosus*)

1b Head without a deep horizontal groove extending around each side. Eyes are small, with orbits not expanded onto the dorsal head surface 2

2a Flanks above pectoral and pelvic fins dark. Head is narrow and snout is elongated. Labial furrows absent. . . . . Pelagic Thresher Shark (*Alopias pelagicus*)

2b Flanks above pectoral and pelvic fins white. Head is broad and snout is short. Labial furrows present . . . . . Common Thresher Shark (*Alopias vulpinus*)

PELAGIC THRESHER SHARK *Alopias pelagicus*



DESCRIPTION: The Pelagic Thresher is the smallest thresher shark with eyes moderately large, but not extending onto the surface of the head; pectoral fins with a nearly straight anterior margin and broadly tipped apices; and a very narrow caudal fin tip. The teeth are small with a single, oblique, smooth-edged cusp, and except for the first four or five rows all have one or two lateral cusplets; the teeth are similar in both jaws. Color in life is a brilliant dark blue above and white below, which does not extend above the pectoral or pelvic fins. This color rapidly fades to gray after death. Tooth count: 37–43/38–48.* Vertebral count: 453–477.* Spiral valve count: 37–39.*

HABITAT AND RANGE: The Pelagic Thresher Shark is primarily oceanic, although individuals occasionally wander close inshore. They are found near the surface to a depth of at least 152 m. Very little is known about their population structure or movements off the southern California and Mexican coasts. The eastern North Pacific population appears to be centered off southern Baja, but shifts northward during strong El Niño events.

Pelagic Thresher Sharks are usually found off southern California during warm-water years. Because they are often

misidentified as the more abundant Common Thresher Shark, they probably have a much wider distribution than is presently known. Elsewhere they are known from scattered records throughout the tropical and warm-temperate Pacific and Indian Oceans.

NATURAL HISTORY: Oophagous, with litters of two pups per birth; one embryo develops per uterus at a time. The average sex ratio at birth is 1:1. The size at birth is 158 to 190 cm. Males mature at 267 to 276 cm with a maximum length of 347 cm. Females mature at 282 to 292 cm and grow to a maximum length of at least 383 cm. Gestation time is unknown for this species. They do not appear to have a defined breeding season as pregnant females have embryos at different developmental stages throughout the year. A single female produces about 40 young throughout her lifetime.

Males mature at seven to eight years and live about 20 years. Females mature at eight to nine years and live about 29 years. The growth rate for juveniles is moderate at 6 to 9 cm per year for the first six years but slows to less than 4 cm per year after the sharks reach maturity.

Pelagic Threshers feed on small schooling fishes and squids, but little else is known about their food habits.

HUMAN INTERACTIONS: Pelagic Threshers are of minor importance to commercial fisheries as they comprise only about 2 percent of the overall number of thresher sharks caught in California waters.

Despite their size these sharks are fairly harmless to people.

NOMENCLATURE: *Alopias pelagicus* (Nakamura, 1935). The generic name *Alopias* is derived from the Greek, meaning foxlike. The specific name *pelagicus* and the common name refer to the oceanic habitat of this species.

REFERENCES: Hanan et al. (1993).