
All About
Sharks
Eve Earls

First Edition, 2012

ISBN 978-81-323-3120-9

Published by:
Research World
4735/22 Prakashdeep Bldg,
Ansari Road, Darya Ganj,
Delhi - 110002
Email: info@wtbooks.com

Table of Contents

Chapter- 1

Shark

Sharks Fossil range: Silurian–Recent	
	
Grey reef shark *(Carcharhinus amblyrhynchos)*	
Scientific classification	
Kingdom:	Animalia
Phylum:	Chordata
Class:	Chondrichthyes
Subclass:	Elasmobranchii
Superorder:	**Selachimorpha**
Orders	
Carcharhiniformes Heterodontiformes Hexanchiformes	

Lamniformes
Orectolobiformes
Pristiophoriformes
Squaliformes
Squatiniformes
† Symmoriida
† Cladoselachiformes
† Xenacanthida (Xenacantiformes)
† Eugeneodontida
† Hybodontiformes

Sharks (superorder **Selachimorpha**) are a type of fish with a full cartilaginous skeleton and a highly streamlined body. The earliest known sharks date from more than 420 million years ago.

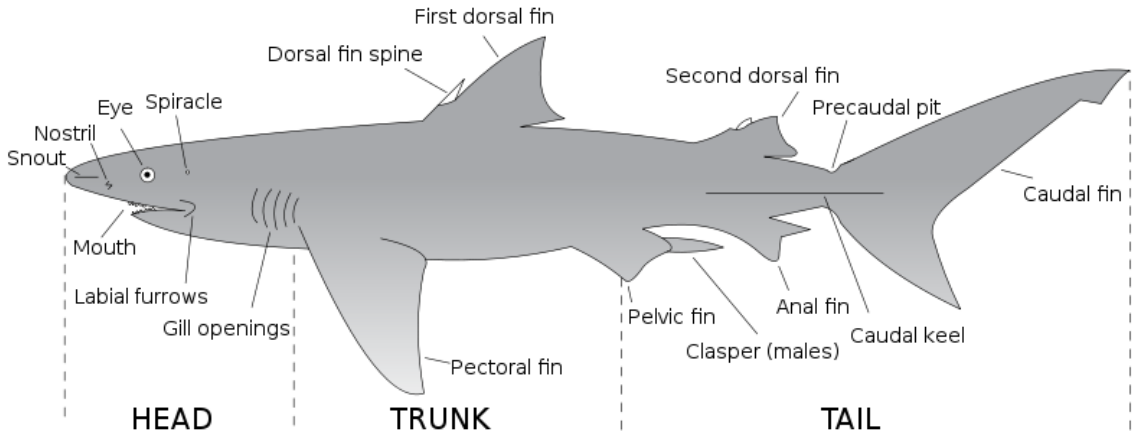
Since that time, sharks have diversified into 440 species, ranging in size from the small dwarf lanternshark, *Etmopterus perryi*, a deep sea species of only 17 centimetres (6.7 in) in length, to the whale shark, *Rhincodon typus*, the largest fish, which reaches approximately 12 metres (39 ft 4 in) and which feeds only on plankton, squid, and small fish by filter feeding. Sharks are found in all seas and are common down to depths of 2,000 metres (6,600 ft). They generally do not live in freshwater, with a few exceptions such as the bull shark and the river shark which can live both in seawater and freshwater. They breathe through five to seven gill slits. Sharks have a covering of dermal denticles that protects their skin from damage and parasites, and improves their fluid dynamics so the shark can move faster. They have several sets of replaceable teeth.

Well-known species such as the great white shark, tiger shark, and the hammerhead are apex predators, at the top of the underwater food chain. Their extraordinary skills as predators fascinate and frighten humans, even as their survival is under serious threat from fishing and other human activities.

Etymology

Until the 16th century, sharks were known to mariners as "sea dogs". According to the OED the name "shark" first came into use after Sir John Hawkins' sailors exhibited one in London in 1569 and used the word to refer to the large sharks of the Caribbean Sea, and later as a general term for all sharks. It has also been suggested to be derived from the Yucatec Maya word for shark, *xok*, pronounced 'shok'.

Anatomy



Teeth

The teeth of the tiger shark are oblique and serrated for sawing through flesh.

Shark teeth are embedded in the gums rather than directly affixed to the jaw, and are constantly replaced throughout life. Multiple rows of replacement teeth grow in a groove on the inside of the jaw and steadily move forward as in a "conveyor belt"; some sharks

lose 30,000 or more teeth in their lifetime. The rate of tooth replacement varies from once every 8–10 days to several months. In most species teeth are replaced one at a time, except in cookiecutter sharks the entire row of teeth is replaced simultaneously.

Tooth shape depends on diet: sharks that feed on mollusks and crustaceans have dense flattened teeth for crushing, those that feed on fish have needle-like teeth for gripping, and those that feed on larger prey such as mammals have pointed lower teeth for gripping and triangular upper teeth with serrated edges for cutting. The teeth of plankton-feeders such as the basking shark are smaller and non-functional.

Skeleton

Shark skeletons are very different from those of bony fish and terrestrial vertebrates. Sharks and other cartilaginous fish (skates and rays) have skeletons made of cartilage and connective tissue. Cartilage is flexible and durable, yet has about half the density of bone. This reduces the skeleton's weight, saving energy. Sharks have no rib cage and therefore on land a shark's own weight can crush it.

Jaw

Like its relatives, rays and skates, the shark's jaw is not attached to the cranium. The jaw's surface, like the shark's vertebrae and gill arches, needs extra support due to its heavy exposure to physical stress and its need for strength. It has a layer of tiny hexagonal plates called "tesserae", which are crystal blocks of calcium salts arranged as a mosaic. This gives these areas much of the same strength found in the bony tissue found in other animals.

Generally sharks have only one layer of tesserae, but the jaws of large specimens, such as the bull shark, tiger shark, and the great white shark, have two to three layers or more, depending on body size. The jaws of a large great white shark may have up to five layers. In the rostrum (snout), the cartilage can be spongy and flexible to absorb the power of impacts.

Fins

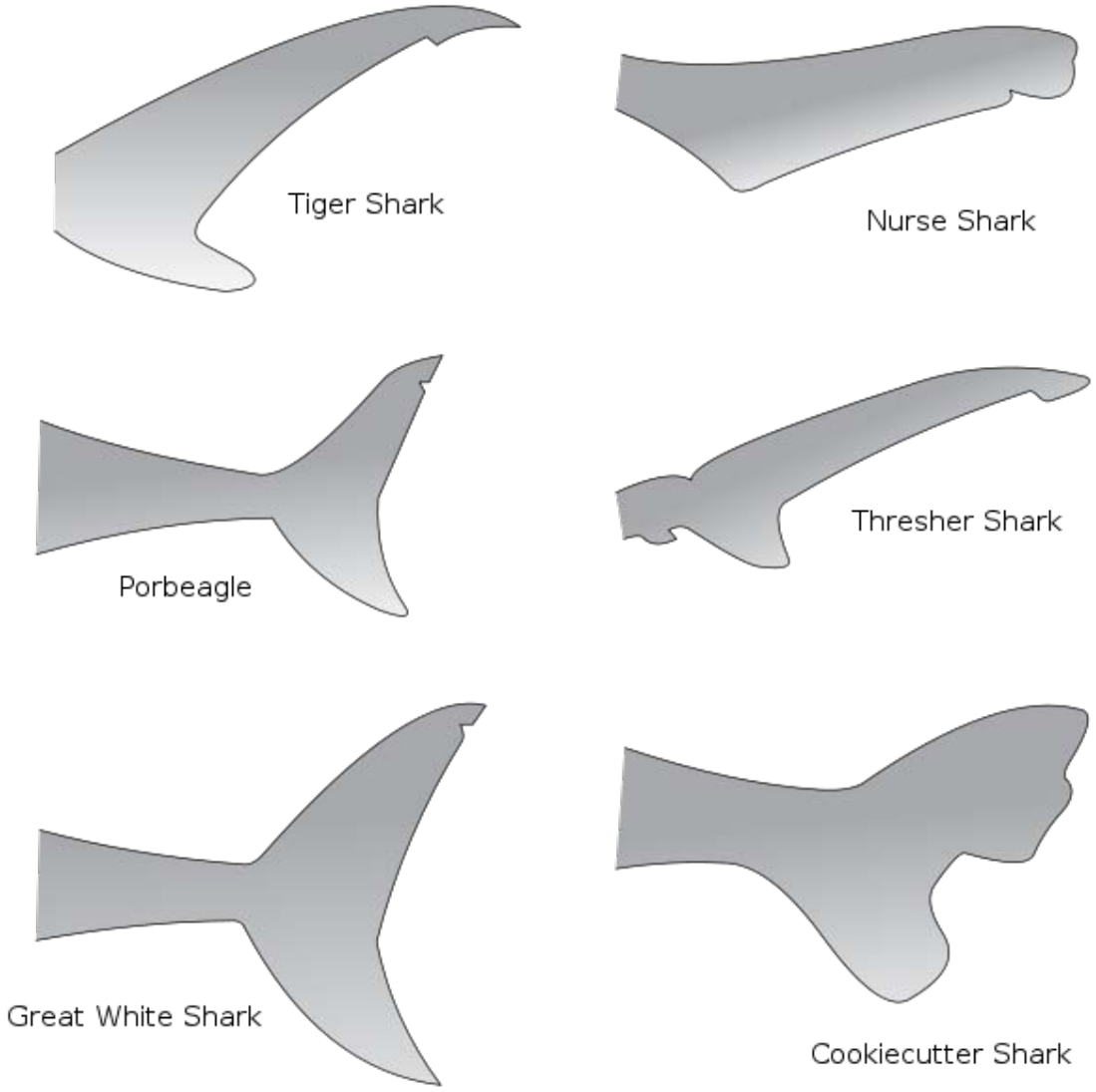
Fin skeletons are elongated and supported with soft and unsegmented rays named ceratotrichia, filaments of elastic protein resembling the horny keratin in hair and feathers. Sharks can only drift away from objects directly in front of them because their fins do not allow them to move in the tail-first direction.

Dermal denticles

Unlike bony fish, sharks have a complex dermal corset made of flexible collagenous fibers and arranged as a helical network surrounding their body. This works as an outer skeleton, providing attachment for their swimming muscles and thus saving energy. In

the past, sharkskin has been used as sandpaper. Their dermal teeth give them hydrodynamic advantages as they reduce turbulence when swimming.

Tails



The range of shark tail shapes

Varying tail shapes have evolved in sharks adapted for different environments. Tail (caudal fins) vary considerably between species. The tail provides thrust, making speed and acceleration dependent on tail shape. Sharks possess a heterocercal caudal fin in which the dorsal portion is usually noticeably larger than the ventral portion. This is because the shark's vertebral column extends into that dorsal portion, providing a greater surface area for muscle attachment. This allows more efficient locomotion among these negatively buoyant cartilaginous fishes. By contrast, most bony fishes possess a homocercal caudal fin.

The tiger shark's tail has a large upper lobe which delivers maximum power for slow cruising or sudden bursts of speed. The tiger shark must be able to twist and turn in the water easily when hunting to support its varied diet, whereas the porbeagle, which hunts schooling fish such as mackerel and herring has a large lower lobe to help it keep pace with its fast-swimming prey. Some tail adaptations have other purposes. The thresher feeds on fish and squid, which it herds and stuns with its powerful and elongated upper lobe.

Physiology

Buoyancy

Unlike bony fish, sharks do not have gas-filled swim bladders for buoyancy. Instead, sharks rely on a large liver, filled with oil that contains squalene and the fact that cartilage is about half as dense as bone. The liver constitutes up to 30% of their body mass. The liver's effectiveness is limited, so sharks employ dynamic lift to maintain depth, sinking when they stop swimming. Sand tiger sharks store air in their stomachs, using it as a form of swim bladder. Most sharks need to constantly swim in order to breathe and cannot sleep very long, if at all, without sinking. However certain shark species, like the nurse shark, are capable of pumping water across their gills, allowing them to rest on the ocean bottom.

Some sharks, if inverted or stroked on the nose, enter a natural state of tonic immobility. Researchers use this condition to handle sharks safely.

Respiration

Like other fish, sharks extract oxygen from seawater as it passes over their gills. Unlike other fish, shark gill slits are not covered, but lie in a row behind the head. A modified slit called a spiracle lies just behind the eye; the spiracle assists water intake during respiration and plays a major role in bottom–dwelling sharks. Spiracles are reduced or missing in active pelagic sharks. While the shark is moving, water passes through the mouth and over the gills in a process known as "ram ventilation". While at rest, most sharks pump water over their gills to ensure a constant supply of oxygenated water. A small number of species have lost the ability to pump water through their gills and must swim without rest. These species are *obligate ram ventilators* and would presumably asphyxiate if unable to move. Obligate ram ventilation is also true of some pelagic bony fish species.

The respiration and circulation process begins when deoxygenated blood travels to the shark's two-chambered heart. Here the shark pumps blood to its gills via the ventral aorta artery where it branches into afferent brachial arteries. Reoxygenation takes place in the gills and the reoxygenated blood flows into the efferent brachial arteries, which come together to form the dorsal aorta. The blood flows from the dorsal aorta throughout the body. The deoxygenated blood from the body then flows through the posterior cardinal

veins and enters the posterior cardinal sinuses. From there blood enters the heart ventricle and the cycle repeats.

Thermoregulation

Most sharks are "cold-blooded", or more precisely poikilothermic, meaning that their internal body temperature matches that of their ambient environment. Members of the family Lamnidae, such as the shortfin mako shark and the great white shark, are homeothermic and maintain a higher body temperature than the surrounding water. In these sharks, a strip of aerobic red muscle located near the center of the body generates the heat, which the body retains via a countercurrent exchange mechanism by a system of blood vessels called the rete mirabile ("miraculous net"). The common thresher shark has a similar mechanism for maintaining an elevated body temperature, which is thought to have evolved independently.

Osmoregulation

In contrast to bony fish, with the exception of the Coelacanth, the blood and other tissue of sharks and Chondrichthyes in general is isotonic to their marine environments because of the high concentration of urea and trimethylamine N-oxide (TMAO), allowing them to be in osmotic balance with the seawater. This adaptation prevents most sharks from surviving in fresh water, and they are therefore confined to marine environments. A few exceptions to this rule exist, such as the bull shark which has developed a way to change its kidney function to excrete large amounts of urea. When a shark dies the urea is broken down to ammonia by bacteria — because of this, the dead body will gradually start to smell strongly of ammonia.

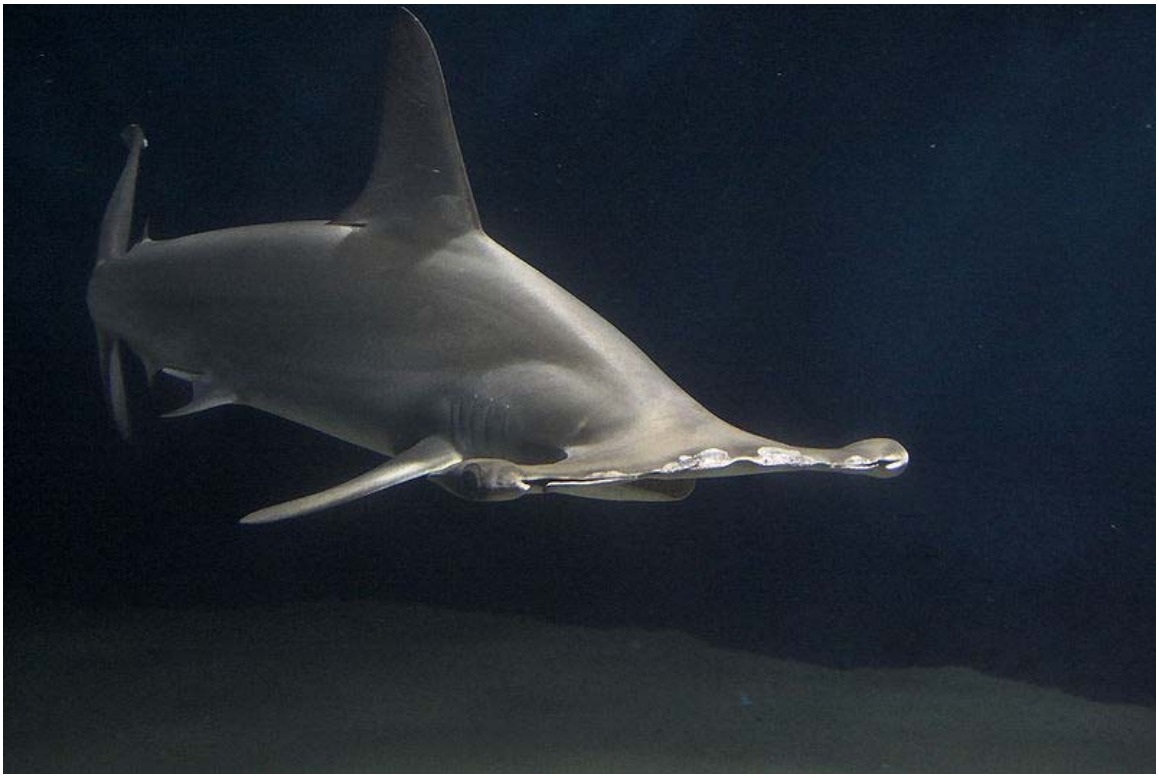
Digestion

Digestion can take a long time. The food moves from the mouth to a 'J' shaped stomach, where it is stored and initial digestion occurs. Unwanted items may never get past the stomach, and instead the shark either vomits or turns its stomachs inside out and ejects unwanted items from its mouth.

One of the biggest differences between shark and mammalian digestion is sharks' extremely short intestine. This short length is achieved by the spiral valve with multiple turns within a single short section instead of a long tube-like intestine. The valve provides a long surface area, requiring food to circulate inside the short gut until fully digested, when remaining waste products pass into the cloaca.

Senses

Smell



The shape of the hammerhead shark's head may enhance olfaction by spacing the nostrils further apart.

Sharks have keen olfactory senses, located in the short duct (which is not fused, unlike bony fish) between the anterior and posterior nasal openings, with some species able to detect as little as one part per million of blood in seawater. They are more attracted to the chemicals found in the guts of many species, and as a result often linger near or in sewage outfalls. Some species, such as nurse sharks, have external barbels that greatly increase their ability to sense prey.

Sight

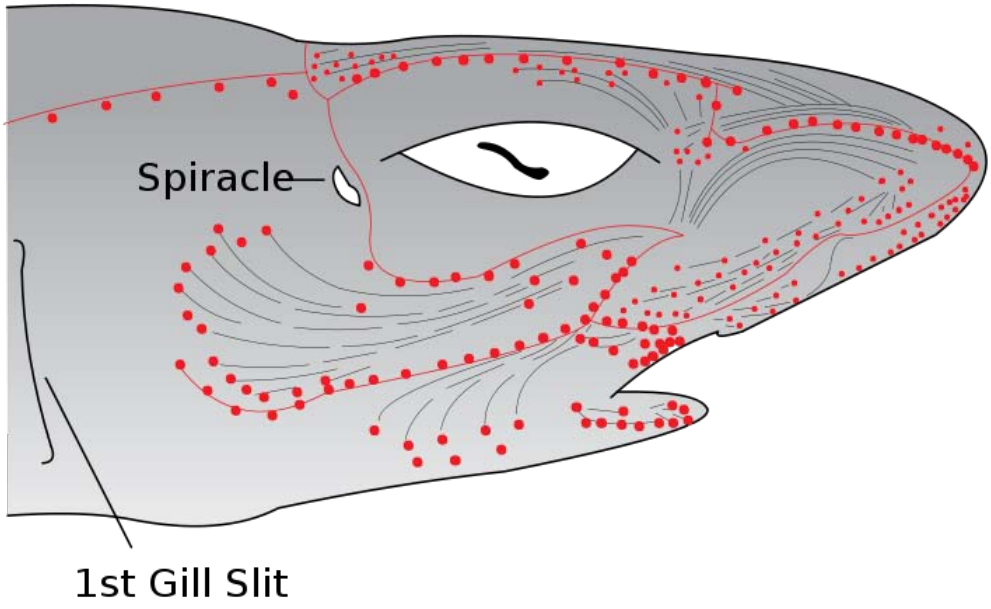
Shark eyes are similar to the eyes of other vertebrates, including similar lenses, corneas and retinas, though their eyesight is well adapted to the marine environment with the help of a tissue called tapetum lucidum. This means that sharks can contract and dilate their pupils, like humans, something no teleost fish can do. This tissue is behind the retina and reflects light back to it, thereby increasing visibility in the dark waters. The effectiveness of the tissue varies, with some sharks having stronger nocturnal adaptations. Sharks have eyelids, but they do not blink because the surrounding water cleans their eyes. To protect their eyes some species have nictitating membranes. This membrane covers the eyes while hunting and when the shark is being attacked. However, some species, including

the great white shark (*Carcharodon carcharias*), do not have this membrane, but instead roll their eyes backwards to protect them when striking prey. The importance of sight in shark hunting behavior is debated. Some believe that electro- and chemoreception are more significant, while others point to the nictating membrane as evidence that sight is important. Presumably, the shark would not protect its eyes were they unimportant. The use of sight probably varies with species and water conditions. The shark's field of vision can swap between monocular and stereoscopic at any time. Sharks are probably colorblind.

Hearing

Although it is hard to test sharks' hearing, they may have a sharp sense of hearing and can possibly hear prey many miles away. A small opening on each side of their heads (not the spiracle) leads directly into the inner ear through a thin channel. The lateral line shows a similar arrangement, and is open to the environment via a series of openings called lateral line pores. This is a reminder of the common origin of these two vibration- and sound-detecting organs that are grouped together as the acoustico-lateralis system. In bony fish and tetrapods the external opening into the inner ear has been lost.

Electroreception



Electromagnetic field receptors (Ampullae of Lorenzini) and motion detecting canals in the head of a shark

The Ampullae of Lorenzini are the electroreceptor organs. They number in the hundreds to thousands. Sharks use the Ampullae of Lorenzini to detect the electromagnetic fields that all living things produce. This helps sharks (particularly the hammerhead shark) find

prey. The shark has the greatest electrical sensitivity of any animal. Sharks find prey hidden in sand by detecting the electric fields they produce. Ocean currents moving in the magnetic field of the Earth also generate electric fields that sharks can use for orientation and possibly navigation.

Lateral line

This system is found in most fish, including sharks. It detects motion or vibrations in water. The shark can sense frequencies in the range of 25 to 50 Hz.

Life history

The claspers of male spotted wobbegong

Shark lifespans vary by species. Most live 20 to 30 years. The spiny dogfish has the longest lifespan at more than 100 years. Whale sharks (*Rhincodon typus*) may also live over 100 years.

Reproduction

Unlike most bony fishes, sharks are K-selected reproducers, meaning that they produce a small number of well-developed young as opposed to a large number of poorly developed

young. Fecundity in sharks ranges from 2 to over 100 young per reproductive cycle. Sharks mature slowly relative to many other fish. For example, lemon sharks reach sexual maturity at around age 13–15.

Sexual

Sharks practice internal fertilization. The posterior part of a male shark's pelvic fins are modified into a pair of intromittent organs called claspers, analogous to a mammalian penis, of which one is used to deliver sperm into the female.

Mating has rarely been observed in sharks. The smaller catsharks often mate with the male curling around the female. In less flexible species the two sharks swim parallel to each other while the male inserts a clasper into the female's oviduct. Females in many of the larger species have bite marks that appear to be a result of a male grasping them to maintain position during mating. The bite marks may also come from courtship behavior: the male may bite the female to show his interest. In some species, females have evolved thicker skin to withstand these bites.

Asexual

There are two documented cases in which a female shark who has not been in contact with a male has conceived a pup on her own through parthenogenesis. The details of this process are not well understood, but genetic fingerprinting showed that the pups had no paternal genetic contribution, ruling out sperm storage. The extent of this behavior in the wild is unknown, as is whether other species have this capability. Mammals are now the only major vertebrate group in which asexual reproduction has not been observed.

Scientists assert that asexual reproduction in the wild is rare, and probably a last ditch effort to reproduce when a mate is not present. Asexual reproduction diminishes genetic diversity, which helps build defenses against threats to the species. Species that rely solely on it risk extinction. Asexual reproduction may have contributed to the blue shark's decline off the Irish coast.

Brooding

Sharks display three ways to bear their young, varying by species, oviparity, viviparity and ovoviviparity.

The spiral egg case of a Port Jackson shark

Ovoviviparity

Most sharks are ovoviviparous, meaning that the eggs hatch in the oviduct within the mother's body and that the egg's yolk and fluids secreted by glands in the walls of the oviduct nourishes the embryos. The young continue to be nourished by the remnants of the yolk and the oviduct's fluids. As in viviparity, the young are born alive and fully functional. Lamniforme sharks practice *oophagy*, where the first embryos to hatch eat the remaining eggs. Grey nurse shark pups intrauterine cannibalistically take this a step further and consume other developing embryos. The survival strategy for ovoviviparous species is to brood the young to a comparatively large size before birth. The whale shark is now classified as ovoviviparous rather than oviparous, because extrauterine eggs are now thought to have been aborted. Most ovoviviparous sharks give birth in sheltered areas, including bays, river mouths and shallow reefs. They choose such areas for protection from predators (mainly other sharks) and the abundance of food. Dogfish have the longest known gestation period of any shark, at 18 to 24 months. Basking sharks and frilled sharks appear to have even longer gestation periods, but accurate data are lacking.

Oviparity

Some species are oviparous like most other fish, laying their eggs in the water. In most oviparous shark species, an egg case with the consistency of leather protects the developing embryo(s). These cases may be corkscrewed into crevices for protection.

Once empty, the egg case is known as the *mermaid's purse*, and can wash up on shore. Oviparous sharks include the horn shark, catshark, Port Jackson shark, and swellshark.

Viviparity

Finally some sharks maintain a *placental* link to the developing young, this method is called viviparity. This is more analogous to mammalian gestation than that of other fishes. The young are born alive and fully functional. Hammerheads, the requiem sharks (such as the bull and blue sharks), and smoothhounds are viviparous.

Behavior

The classic view describes a solitary hunter, ranging the oceans in search of food. However, this applies to only a few species. Most live far more sedentary, benthic lives. Even solitary sharks meet for breeding or at rich hunting grounds, which may lead them to cover thousands of miles in a year. Shark migration patterns may be even more complex than in birds, with many sharks covering entire ocean basins.

Sharks can be highly social, remaining in large schools. Sometimes more than 100 scalloped hammerheads congregate around seamounts and islands, e.g., in the Gulf of California. Cross-species social hierarchies exist. For example, oceanic whitetip sharks dominate silky sharks of comparable size during feeding.

When approached too closely some sharks perform a threat display. This usually consists of exaggerated swimming movements, and can vary in intensity according to the threat level.

Speed

In general, sharks swim ("cruise") at an average speed of 8 kilometres per hour (5.0 mph) but when feeding or attacking, the average shark can reach speeds upwards of 19 kilometres per hour (12 mph). The shortfin mako shark, the fastest shark and one of the fastest fish, can burst at speeds up to 50 kilometres per hour (31 mph). The great white shark is also capable of speed bursts. These exceptions may be due to the warm-blooded, or homeothermic, nature of these sharks' physiology.

Intelligence

Contrary to the common wisdom that sharks are instinct-driven "eating machines", recent studies have indicated that many species possess powerful problem-solving skills, social skills and curiosity. The brain- to body-mass ratios of sharks are similar to mammals and birds. In 1987, near Smitswinkle Bay, South Africa, a group of up to seven great white sharks worked together to move a partially beached dead whale to deeper waters to feed. Sharks can engage in playful activities. Porbeagle sharks have been seen repeatedly rolling in kelp and chasing an individual who trailed a piece of kelp behind it.

Sleep

Some sharks can lie on the bottom while actively pumping water over their gills, but their eyes remain open and actively follow divers. When a shark is resting, it does not use its nares, but rather its spiracles. If a shark tried to use its nares while resting on the ocean floor, it would "inhale" sand rather than water. Many scientists believe this is one of the reasons sharks have spiracles. The spiny dogfish's spinal cord, rather than its brain, coordinates swimming, so spiny dogfish can continue to swim while sleeping. It is also possible that sharks sleep in a manner similar to dolphins, one cerebral hemisphere at a time, thus maintaining some consciousness and cerebral activity at all times.

Ecology

Feeding

Like many sharks, the great white shark is an apex predator in its environment.

Most sharks are carnivorous. Some species, including tiger sharks, eat almost anything. The vast majority seek particular prey, and rarely vary their diet. Whale, basking and megamouth sharks filter feed. These three independently evolved plankton feeding using different strategies. Whale sharks use suction to take in plankton and small fishes. Basking sharks are ram-feeders, swimming through plankton blooms with their mouth wide open. Megamouth sharks make suction feeding more efficient, using luminescent tissue inside the mouth to attract prey in the deep ocean. This type of feeding requires gill rakers, long slender filaments that form a very efficient sieve, analogous to the baleen plates of the great whales. The shark traps the plankton in these filaments and swallows from time to time in huge mouthfuls. Teeth in these species are comparatively small because they are not needed for feeding.

Other highly specialized feeders include cookiecutter sharks, which feed on flesh sliced out of other larger fish and marine mammals. Cookiecutter teeth are enormous compared to the animal's size. The lower teeth are particularly sharp. Although they have never been observed feeding, they are believed to latch onto their prey and use their thick lips to make a seal, twisting their bodies to rip off flesh.

Some seabed–dwelling species are highly effective ambush predators. Angel sharks and wobbegongs use camouflage to lie in wait and suck prey into their mouths. Many benthic sharks feed solely on crustaceans which they crush with their flat molariform teeth.

Other sharks feed on squid or fish, which they swallow whole. The viper dogfish has teeth it can point outwards to strike and capture prey that it then swallows intact. The great white and other large predators either swallow small prey whole or take huge bites out of large animals. Thresher sharks use their long tails to stun shoaling fishes, and sawsharks either stir prey from the seabed or slash at swimming prey with their tooth-studded rostra.

Many sharks, including the whitetip reef shark are cooperative feeders and hunt in packs to herd and capture elusive prey. These social sharks are often migratory, traveling huge distances around ocean basins in large schools. These migrations may be partly necessary to find new food sources.

Range and habitat

Sharks are found in all seas. They generally do not live in freshwater, with a few exceptions such as the bull shark and the river shark which can swim both in seawater and freshwater. Sharks are common down to depths of 2,000 metres (7,000 ft), and some live even deeper, but they are almost entirely absent below 3,000 metres (10,000 ft). The deepest confirmed report of a shark is a Portuguese dogfish at 3,700 metres (12,100 ft).

Relation to humans

Attacks

A sign warning about the presence of sharks in Salt Rock, South Africa

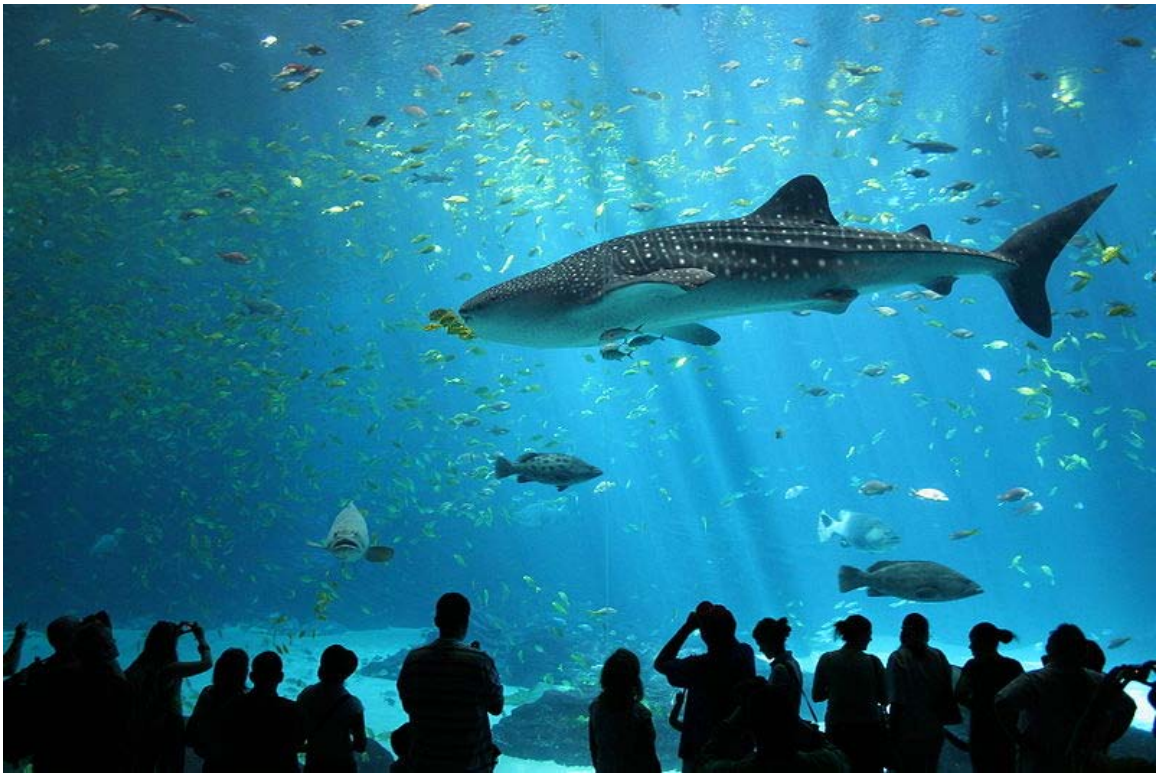
Snorkeler swims near blacktip reef shark. In rare circumstances involving poor visibility, blacktips may bite a human, mistaking it for prey. Under normal conditions they are harmless and shy.

In 2006 the International Shark Attack File (ISAF) undertook an investigation into 96 alleged shark attacks, confirming 62 of them as unprovoked attacks and 16 as provoked attacks. The average number of fatalities worldwide per year between 2001 and 2006 from unprovoked shark attacks is 4.3.

Contrary to popular belief, only a few sharks are dangerous to humans. Out of more than 360 species, only four have been involved in a significant number of fatal, unprovoked attacks on humans: the great white, oceanic whitetip, tiger, and bull sharks. These sharks, are large, powerful predators, and may sometimes attack and kill people. Despite being responsible for attacks on humans they have all been filmed without using a protective cage.

The perception of sharks as dangerous animals has been popularized by publicity given to a few isolated unprovoked attacks, such as the Jersey Shore shark attacks of 1916, and through popular fictional works about shark attacks, such as the *Jaws* film series. *Jaws* author Peter Benchley in his later years attempted to dispel the image of sharks as man-eating monsters.

In captivity



A whale shark in Georgia Aquarium

Until recently only a few benthic species of shark, such as hornsharks, leopard sharks and catsharks had survived in aquarium conditions for a year or more. This gave rise to the belief that sharks, as well as being difficult to capture and transport, were difficult to care

for. More knowledge has led to more species (including the large pelagic sharks) living far longer in captivity. At the same time, safer transportation techniques have enabled long distance movement. One shark that never had been successfully held in captivity for long was the great white. But in September 2004 the Monterey Bay Aquarium successfully kept a young female for 198 days before releasing her.

Most species are not suitable for home aquaria and not every species sold by pet stores are appropriate. Some species can flourish in home saltwater aquaria. Uninformed or unscrupulous dealers sometimes sell juvenile sharks like the nurse shark, which upon reaching adulthood is far too large for typical home aquaria. Public aquaria generally do not accept donated specimens that have outgrown their housing. Some owners have been tempted to release them. Species appropriate to home aquaria represent considerable spatial and financial investments as they generally approach adult lengths of 3 feet and can live up to 25 years.

In Hawaii

Sharks figure prominently in Hawaiian mythology. Stories tell of men with shark jaws on their back who could change between shark and human form. A common theme was that a shark-man would warn beach-goers of sharks in the waters. The beach-goers would laugh and ignore the warnings and get eaten by the shark-man who warned them. Hawaiian mythology also includes many shark gods. Among a fishing people, the most popular of all aumakua, or deified ancestor guardians, are shark aumakua. Kamaku describes in detail how to offer a corpse to become a shark. The body transforms gradually until the kahuna can point the awe-struck family to the markings on the shark's body that correspond to the clothing in which the beloved's body had been wrapped. Such a shark aumakua becomes the family pet, receiving food, and driving fish into the family net and warding off danger. Like all aumakua it had evil uses such as helping kill enemies. The ruling chiefs typically forbade such sorcery. Many Native Hawaiian families claim such an aumakua, who is known by name to the whole community.

Kamohoali'i is the best known and revered of the shark gods, he was the older and favored brother of Pele, and helped and journeyed with her to Hawaii. He was able to assume all human and fish forms. A summit cliff on the crater of K?lauea is one of his most sacred spots. At one point he had a *heiau* (temple or shrine) dedicated to him on every piece of land that jutted into the ocean on the island of Moloka'i. Kamohoali'i was an ancestral god, not a human who became a shark and banned the eating of humans after eating one herself. In Fijian mytholog, **Dakuwanga** was a shark god who was the eater of lost souls.

Popular misconceptions

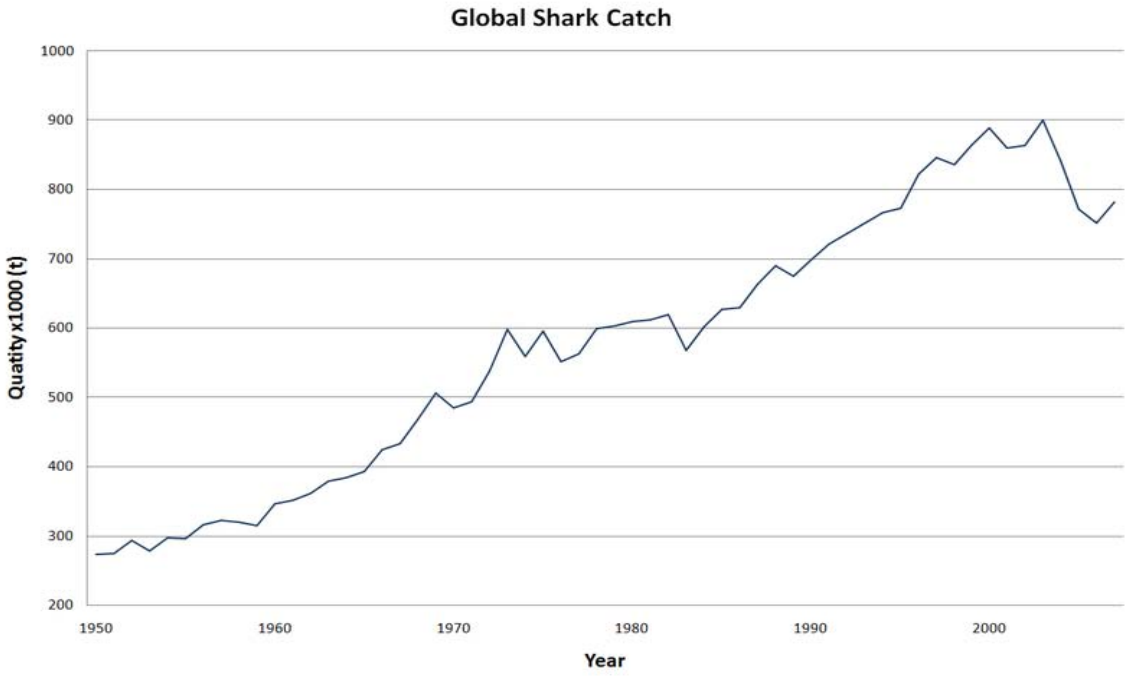
A popular myth is that sharks are immune to disease and cancer; however, this remains unproven. Sharks may get cancer. Both diseases and parasites affect sharks. The evidence that sharks are at least resistant to cancer and disease is mostly anecdotal and there have been few, if any, scientific or statistical studies that show sharks to have heightened

immunity to disease. Other apparently false claims are that fins prevent cancer and treat osteoarthritis. No scientific proof supports these claims; at least one study has shown shark cartilage of no value in cancer treatment.

Conservation

The value of shark fins for shark fin soup has led to an increase in shark catches. Usually only the fins are taken, while the rest of the shark is discarded, usually into the sea.

Fishery



The annual shark catch has increased rapidly over the last 50 years.

It is estimated that 100 million sharks are killed by people every year, due to commercial and recreational fishing. Sharks are a common seafood in many places, including Japan and Australia. In the Australian state of Victoria, shark is the most commonly used fish in fish and chips, in which fillets are battered and deep-fried or crumbed and grilled. In fish and chip shops, shark is called flake. In India, small sharks or baby sharks (called sora in Tamil language, Telugu language) are sold in local markets. Since the flesh is not developed, cooking the flesh breaks it into powder, which is then fried in oil and spices (called sora puttu/sora poratu). The soft bones can be easily chewed. They are considered a delicacy in coastal Tamil Nadu. Icelanders ferment Greenland sharks to produce hákarl, which is widely regarded as a national dish.

A 14-foot (4.3 m), 1,200-pound (540 kg) tiger shark caught in Kāneʻohe Bay, Oahu in 1966

Sharks are often killed for shark fin soup. Fishermen capture live sharks, fin them, and dump the finless animal back into the water. Finning involves removing the fin with a hot metal blade. The resulting immobile shark soon dies from suffocation or predators. Shark fin has become a major trade within black markets all over the world. Fins sell for about $300/lb in 2009. Poachers illegally fin millions each year. Few governments enforce laws that protect them. In 2010 Hawaii became the first U.S. state to prohibit the possession, sale, trade or distribution of shark fins.

Shark fin soup is a status symbol in Asian countries, and is considered healthy and full of nutrients. Sharks are also killed for meat. European diners consume dogfishes, smoothhounds, catsharks, makos, porbeagle and also skates and rays. However, the U.S. FDA lists sharks as one of four fish (with swordfish, king mackerel, and tilefish) whose high mercury content is hazardous to children and pregnant women.

Sharks generally reach sexual maturity only after many years and produce few offspring in comparison to other harvested fish. Harvesting sharks before they reproduce severely impacts future populations.

The majority of shark fisheries have little monitoring or management. The rise in demand for shark products increases pressure on fisheries. Major declines in shark stocks have been recorded—some species have been depleted by over 90% over the past 20–30 years with population declines of 70% not unusual. Many governments and the UN have acknowledged the need for shark fisheries management, but little progress has been made due to their low economic value, the small volumes of products produced and sharks' poor public image.

Other threats

Other threats include habitat alteration, damage and loss from coastal development, pollution and the impact of fisheries on the seabed and prey species. Shark finning attracts much controversy and regulations are being enacted to prevent it from occurring. The 2007 documentary, *Sharkwater* exposed how sharks are being hunted to extinction.

Protection

In 2009, the Shark Conservation Act of 2009, passed the U.S. House of Representatives. A similar bill is pending in the 2010 U.S. Senate. The bill would strengthen existing shark finning laws.

In 2010, the Convention on International Trade in Endangered Species rejected proposals from the United States and Palau that would have required countries to strictly regulate trade in several species of scalloped hammerhead, oceanic whitetip and spiny dogfish sharks. The majority, but not the required two-thirds of voting delegates, approved the proposal. China, by far the world’s largest shark market, and Japan, which battles all attempts to extend the convention to marine species, led the opposition.

In 2010, Greenpeace International added the school shark, shortfin mako shark, mackerel shark, tiger shark and spiny dogfish to its seafood red list, a list of common supermarket fish that are often sourced from unsustainable fisheries. Advocacy group Shark Trust campaigns to limit shark fishing. Advocacy group Seafood Watch directs American consumers to not eat sharks.

Evolution

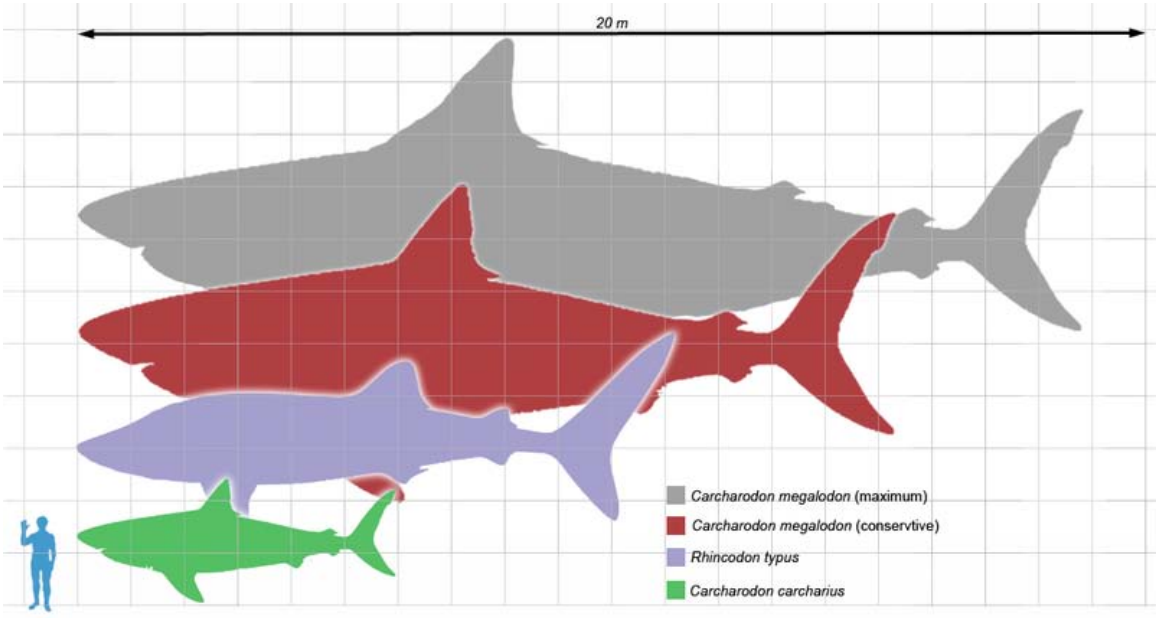
A collection of fossilized shark teeth

Evidence for the existence of sharks dates from the Ordovician period, over 450–420 million years ago, before land vertebrates existed and before many plants had colonized the continents. Only scales have been recovered from the first sharks and not all

paleontologists agree that these are from true sharks. The oldest generally accepted shark scales are from about 420 million years ago, in the Silurian period. The first sharks looked very different from modern sharks. The majority of modern sharks can be traced back to around 100 million years ago. Most fossils are of teeth, often in large numbers. Partial skeletons and even complete fossilized remains have been discovered. Estimates suggest that sharks grow tens of thousands of teeth over a lifetime, which explains the abundant fossils. The teeth consist of easily fossilized calcium phosphate, an apatite. When a shark dies, the decomposing skeleton breaks up, scattering the apatite prisms. Preservation requires rapid burial in bottom sediments.

Among the most ancient and primitive sharks is *Cladoselache*, from about 370 million years ago, which has been found within Paleozoic strata in Ohio, Kentucky and Tennessee. At that point in Earth's history these rocks made up the soft bottom sediments of a large, shallow ocean, which stretched across much of North America. *Cladoselache* was only about 1 metre (3.3 ft) long with stiff triangular fins and slender jaws. Its teeth had several pointed cusps, which wore down from use. From the small number of teeth found together, it is most likely that *Cladoselache* did not replace its teeth as regularly as modern sharks. Its caudal fins had a similar shape to the great white sharks and the pelagic shortfin and longfin makos. The presence of whole fish arranged tail-first in their stomachs suggest that they were fast swimmers with great agility.

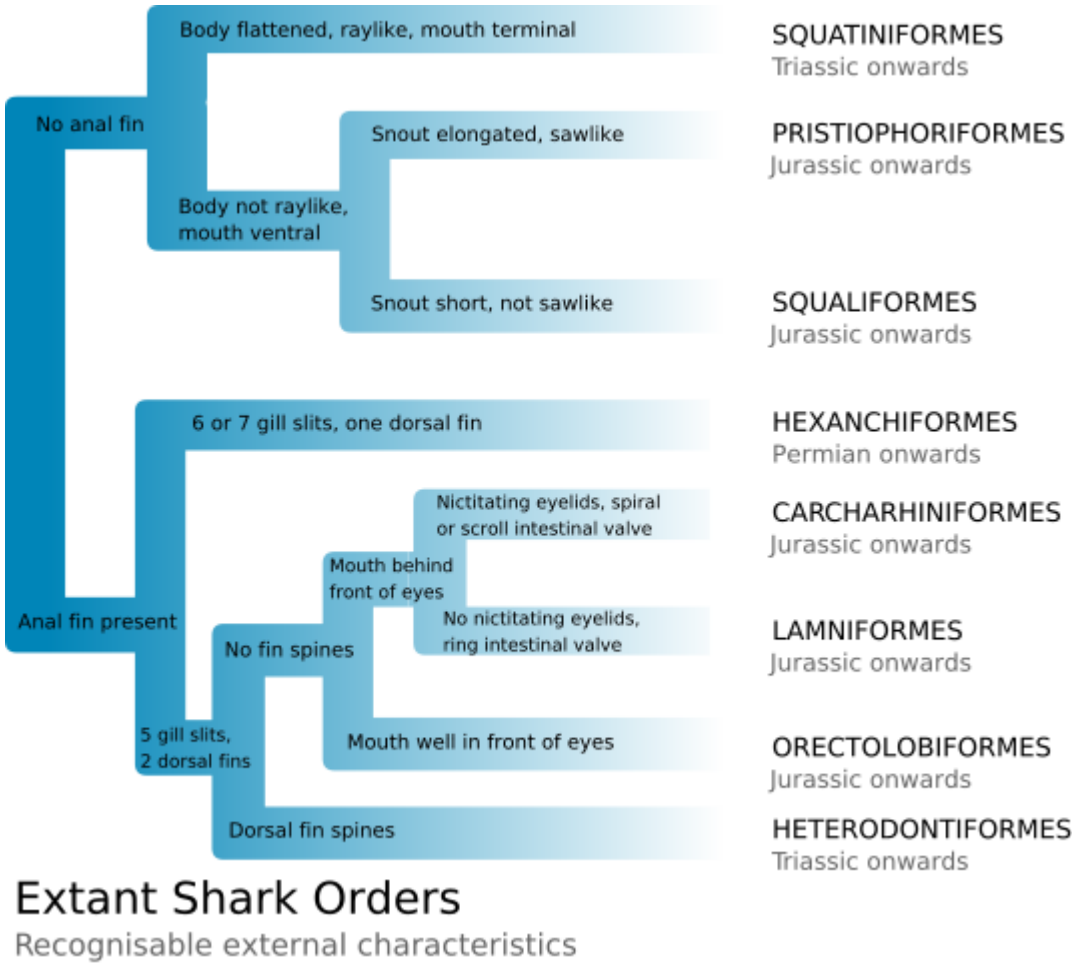
Most fossil sharks from about 300 to 150 million years ago can be assigned to one of two groups. The Xenacanthida was almost exclusive to freshwater environments. By the time this group became extinct about 220 million years ago, they had spread worldwide. The other group, the hybodonts, appeared about 320 million years ago and lived mostly in the oceans, but also in freshwater.



Megalodon with the whale shark, great white shark, and a human for scale

Modern sharks began to appear about 100 million years ago. Fossil mackerel shark teeth date to the Lower Cretaceous. One of the most recently evolved families is the hammerhead shark (family Sphyrnidae), which emerged in the Eocene. The oldest white shark teeth date from 60 to 65 million years ago, around the time of the extinction of the dinosaurs. In early white shark evolution there are at least two lineages: one lineage is of white sharks with coarsely serrated teeth and it probably gave rise to the modern great white shark, and another lineage is of white sharks with finely serrated teeth. These sharks attained gigantic proportions and include the extinct megatoothed shark, *C. megalodon*. Like most extinct sharks, *C. megalodon* is also primarily known from its fossil teeth and vertebrae. This giant shark reached a total length (TL) of more than 16 metres (52 ft). *C. megalodon* may have approached a maxima of 20.3 metres (67 ft) in total length and 103 metric tons (114 short tons) in mass. Paleontological evidence suggests that this shark was an active predator of large cetaceans.

Taxonomy



Sharks belong to the superorder Selachimorpha in the subclass Elasmobranchii in the class Chondrichthyes. The Elasmobranchii also include rays and skates; the Chondrichthyes also include Chimaeras. It is currently thought that the sharks form a

polyphyletic group: some sharks are more closely related to rays than they are to some other sharks.

The superorder Selachimorpha is divided into Galea (or Galeomorphii), and Squalea. The Galeans are the Heterodontiformes, Orectolobiformes, Lamniformes, and Carcharhiniformes. Lamnoids and Carcharhinoids are usually placed in one clade, but recent studies show the Lamnoids and Orectoloboids are a clade. Some scientists now think that Heterodontoids may be Squalean. The Squalea is divided into Hexanchoidei and Squalomorpha. The Hexanchoidei includes the Hexanchiformes and Chlamydoselachiformes. The Squalomorpha contains the Squaliformes and the Hypnosqualea. The Hypnosqualea may be invalid. It includes the Squatiniformes, and the Pristorajea, which may also be invalid, but includes the Pristiophoriformes and the Batoidea.

More than 440 species of sharks split across eight orders, listed below in roughly their evolutionary relationship from ancient to modern:

- Hexanchiformes: Examples from this group include the cow sharks, frilled shark and even a shark that resembles a marine snake.
- Squaliformes: This group includes the bramble sharks, dogfish and roughsharks, and prickly shark.
- Pristiophoriformes: These are the sawsharks, with an elongated, toothed snout that they use for slashing their prey.
- Squatiniformes: Also known as angel sharks, they are flattened sharks with a strong resemblance to stingrays and skates.
- Heterodontiformes: They are generally referred to as the bullhead or horn sharks.
- Orectolobiformes: They are commonly referred to as the carpet sharks, including zebra sharks, nurse sharks, wobbegongs and the whale shark.
- Carcharhiniformes: Commonly known as groundsharks, the species include the blue, tiger, bull, grey reef, blacktip reef, Caribbean reef, blacktail reef, whitetip reef and oceanic whitetip sharks (collectively called the requiem sharks) along with the houndsharks, catsharks and hammerhead sharks. They are distinguished by an elongated snout and a nictitating membrane which protects the eyes during an attack.
- Lamniformes: They are commonly known as the mackerel sharks. They include the goblin shark, basking shark, megamouth shark, the thresher sharks, shortfin and longfin mako sharks, and great white shark. They are distinguished by their large jaws and ovoviviparous reproduction. The Lamniformes include the extinct megalodon, *Carcharodon megalodon*.

Chapter- 2

Great White Shark (Type of Shark)

Great white shark Fossil range: 16–0 Ma Miocene to Recent

Conservation status
 Vulnerable (IUCN 3.1)
Scientific classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Chondrichthyes
Subclass:	Elasmobranchii
Order:	Lamniformes
Family:	Lamnidae

Genus:	***Carcharodon*** Smith, 1838
Species:	***C. carcharias***

Binomial name

Carcharodon carcharias
(Linnaeus, 1758)

Global range highlighted in blue

The **great white shark**, *Carcharodon carcharias*, also known as **great white**, **white pointer**, **white shark**, or **white death**, is a large lamniform shark found in coastal surface waters in all major oceans. The great white shark is very well known for its size, with the largest individuals known to have approached or exceeded 6 metres (20 ft) in length and 2,268 kilograms (5,000 lb) in weight. It reaches maturity at around 15 years of age and can have a life span of over 30 years. The great white shark is arguably the world's largest known extant macropredatory fish and is one of the primary predators of marine mammals. It is also known to prey upon a variety of other marine animals including fish, pinnipeds, and seabirds. It is the only known surviving species of its genus, *Carcharodon*.

The best selling novel *Jaws* and the subsequent blockbuster film by Steven Spielberg depicted the great white shark as a "ferocious man eater". In reality, humans are not the preferred prey of the great white shark.

The IUCN treats the great white shark as vulnerable, while it is included in Appendix II of CITES.

Etymology

Carolus Linnaeus gave the great white shark its first scientific name, *Squalus carcharias* in 1758. Sir Andrew Smith gave it the generic name *Carcharodon* in 1833, and in 1873 the generic name was identified with Linnaeus' specific name and the current scientific name *Carcharodon carcharias* was finalised. *Carcharodon* comes from the Greek words *karcharos*, which means sharp or jagged, and *odous*, which means tooth.


SHARKS
NO
SWIMMING

Top: Megalodon tooth with two great white shark teeth and a U.S. quarter for size comparison
Bottom: A 4 cm tall fossil *C. carcharias* tooth from Miocene sediments in the Atacama Desert of Chile

Ancestry and fossil record

The great white shark came into existence during the Mid-Miocene epoch. The earliest known fossils are about 16 million years old. However, the phylogeny of the great white is still in dispute. The original hypothesis for the great white's origins is that it shares a common ancestor with a prehistoric shark, *C. megalodon*. Similarities among the physical remains and the extreme size of both the great white and *C. megalodon* led many scientists to believe that these sharks were closely related, and the name *Carcharodon*

megalodon was applied to the latter. However, a new hypothesis proposes that *C. megalodon* and the great white are distant relatives (albeit sharing the family Lamnidae), and that the great white is more closely related to an ancient mako shark, *Isurus hastalis*, than to *C. megalodon*. In addition, the new hypothesis assigns *C. megalodon* to the *Carcharocles* genus, which also comprises other megatoothed sharks, and *Otodus obliquus* is the ancient representative of the extinct *Carcharocles* lineage.

Distribution and habitat

White shark at Isla Guadalupe, Mexico

Great white sharks live in almost all coastal and offshore waters which have water temperature between 12 and 24 °C (54 and 75 °F), with greater concentrations in the United States (Atlantic Northeast and California), South Africa, Japan, Australia (especially New South Wales and South Australia), New Zealand, Chile, and the Mediterranean. One of the densest known populations is found around Dyer Island, South Africa where much shark research is conducted.

It is an epipelagic fish, observed mostly in inland tributaries in the presence of rich game like fur seals, sea lions, cetaceans, other sharks, and large bony fish species. It is an open-ocean dweller and has been recorded at depths of around 1,220 m (4,000 ft). These findings challenge the traditional notion about the great white as being a coastal species.

According to a recent study, California great whites have migrated to an area between Baja California and Hawaii known as White Shark Café, to spend at least 100 days before migrating back to Baja. On the journey out, they swim slowly and dive down to around 900 m (3,000 ft). After they arrive, they change behavior and do short dives to about

300 m (1,000 ft) for up to 10 minutes. Another white shark tagged off the South African coast swam to the southern coast of Australia and back within the year. This refuted traditional theories that white sharks are coastal territorial predators and opens up the possibility of interaction between shark populations that were previously thought to be discrete. Why they migrate and what they do at their destination is still unknown. Possibilities include seasonal feeding or mating.

A similar study tracked a great white shark from South Africa swimming to Australia's northwestern coast and back, a journey of 20,000 km (12,000 mi; 11,000 nmi) in under 9 months.

Anatomy and appearance

The great white shark has a robust large conical snout. The upper and lower lobes on the tail fin are approximately the same size (like some mackerel sharks).

Great whites display countershading, having a white underside and a grey dorsal area (sometimes in a brown or blue shade) that gives an overall "mottled" appearance. The coloration makes it difficult for prey to spot the shark because it breaks up the shark's outline when seen from the side. From above, the darker shade blends with the sea and from below it exposes a minimal silhouette against the sunlight.

Great white sharks, like many other sharks, have rows of serrated teeth behind the main ones, ready to replace any that break off. When the shark bites it shakes its head side to side, helping the teeth saw off large chunks of flesh.

Size

Males reach maturity at 3.5–4.0 metres (11–13 ft), and females at 4.5–5.0 metres (15–16 ft). Adults on average are 4–5.2 metres (13–17.1 ft) long and have a mass of 680–1,100 kilograms (1,500–2,400 lb). Females are generally larger than males. It is widely accepted that the great white shark can approach 6.1 m (20 ft) in length and 1,900 kg (4,200 lb) in weight. However, the maximum size is still subject to hot debate because such reports are often rough estimations or speculations performed under questionable circumstances.

For several decades, many ichthyological works, as well as the *Guinness Book of World Records*, listed two great white sharks as the largest individuals: a 10.9 m (36 ft) great white captured in Southern Australian waters near Port Fairy in the 1870s, and a 11.3 m (37 ft) shark trapped in a herring weir in New Brunswick, Canada in the 1930s. Some researchers question these measurements' reliability, noting they were much larger than any other accurately reported sighting. The New Brunswick shark may have been a misidentified basking shark, as the two have similar body shapes. The question of the Port Fairy shark was settled in the 1970s, when J. E. Randall examined the shark's jaws and "found that the Port Fairy shark was of the order of 5 m (17 ft) in length and

suggested that a mistake had been made in the original record, in 1870, of the shark's length".

According to J. E. Randall, the largest white shark reliably measured was a 6.0 m (19.7 ft) individual reported from Ledge Point, Western Australia in 1987. Another great white specimen of similar size has been verified by the Canadian Shark Research Center: a female caught by David McKendrick of Alberton, Prince Edward Island in August 1988 in the Gulf of St. Lawrence off PEI. This female great white was 6.1 m (20 ft) long. However, a larger great white shark specimen was verified by T. C. Tricas and J. E. McCosker in 1984. This specimen was 6.4 m (21 ft) long and had a body mass of about 3,324 kg (7,330 lb).

Great white shark caught off Hualien County, Taiwan on May 14, 1997. It was reportedly almost 7 m (23 ft) in length, with a mass of 2,500 kilograms (5,500 lb).

Several great white sharks caught in modern times have been estimated to be more than 7 m (23 ft) long, but these claims have received some criticism. However, J. E. Randall believed that great white shark may have exceeded 6.1 m (20 ft) in length. A great white shark was captured near Kangaroo Island in Australia on April 1, 1987. This shark was estimated to be more than 7 m (23 ft) long by Peter Resiley, and has been designated as KANGA. Another great white shark was caught in Malta by Alfredo Cutajar on April 16, 1987. This shark was also estimated to be around 7.13 m (23.4 ft) long by John Abela and has been designated as MALTA. However, criticism occurred — Cappo used shark size estimation methods proposed by J. E. Randall to suggest that KANGA specimen was 5.8–6.4 m (19–21 ft) long. In the similar fashion, I. K. Fergusson also used shark size estimation methods proposed by J. E. Randall to suggest that MALTA specimen was 5.3–5.7 m (17–19 ft) long. However, photographic evidence suggested that these specimens were larger than the size estimations yielded through Randall's methods. Thus, a team of scientists, H. F. Mollet, G. M. Cailliet, A. P. Klimley, D. A. Ebert, A. D. Testi, and L. J.

V. Compagno, reviewed the cases of KANGA and MALTA specimens in 1996 to resolve the dispute by conducting a comprehensive morphometric analysis of the remains of these sharks and re-examination of photographic evidence in an attempt to validate the original size estimations and their findings were consistent with them. The findings indicated that estimations by P. Resiley and J. Abela are reasonable and cannot be ruled out.

A close contender in size is the Tiger shark, *Galeocerdo cuvier*, with largest specimen reported to have been 7.4 metres (24 ft) in length along with a mass of 3,110 kilograms (6,900 lb). Some other macropredatory sharks such as Greenland Shark, *Somniosus microcephalus*, and Pacific sleeper shark, *Somniosus pacificus*, are also known to rival these sharks in length. The question of maximum weight is complicated by the unresolved question of whether or not to include the shark's stomach contents when weighing the shark. With a single bite a great white can take in up to 14 kg (31 lb) of flesh, and can consume several hundred kilograms of food.

The largest great white recognized by the International Game Fish Association (IGFA) is one landed by Alf Dean in south Australian waters in 1959, weighing 1,208 kg (2,660 lb). Several larger great whites caught by anglers have since been verified, but were later disallowed from formal recognition by IGFA monitors for rules violations.

Adaptations

A great white shark swimming

Great white sharks, like all other sharks, have an extra sense given by the Ampullae of Lorenzini, which enables them to detect the electromagnetic field emitted by the movement of living animals. Every time a living creature moves it generates an electrical field and great whites are so sensitive they can detect half a billionth of a volt. Even heart beats emit a very faint electrical pulse. If close enough, the shark can detect even that faint electrical pulse. Most fish have a less-developed but similar sense using their body's lateral line.

Great white shark biting into the fish head teaser bait next to a cage in False Bay, South Africa

To more successfully hunt fast and agile prey such as sea lions, the great white has adapted to maintain a body temperature warmer than the surrounding water. One of these adaptations is a "rete mirabile" (Latin for "wonderful net"). This close web-like structure of veins and arteries, located along each lateral side of the shark, conserves heat by warming the cooler arterial blood with the venous blood that has been warmed by the working muscles. This keeps certain parts of the body (particularly the stomach) at temperatures up to 14 °C (25 °F) above that of the surrounding water, while the heart and gills remain at sea-temperature. When conserving energy the core body temperature can drop to match the surroundings. A great white shark's success in raising its core temperature is an example of gigantothermy. Therefore, the great white shark can be considered an endothermic poikilotherm, because its body temperature is not constant but is internally regulated.

Bite force

A 2007 study from the University of New South Wales in Sydney, Australia, used CT scans of a shark's skull and computer models to measure maximum bite force. The study reveals the forces and behaviors its skull is adapted to handle and resolves competing theories about its feeding behaviour. In 2008, a team of scientists led by Stephen Wroe conducted an experiment to determine great white shark's jaw power and findings indicated that a specimen more than 6.1 m (20 ft) long could exert a bite force of over 18,000 newtons (4,000 lbf).

Ecology and behavior

A great white shark turns onto its back while hunting tuna bait

This shark's behavior and social structure is not well understood. In South Africa, white sharks have a dominance hierarchy depending on size, sex and squatter's rights: Females

dominate males, larger sharks dominate smaller sharks, and residents dominate newcomers. When hunting, great whites tend to separate and resolve conflicts with rituals and displays. White sharks rarely resort to combat although some individuals have been found with bite marks that match those of other white sharks. This suggests that when another shark approaches too closely, great whites react with a warning bite. Another possibility is that white sharks bite to show dominance.

The great white shark is one of only a few sharks known to regularly lift its head above the sea surface to gaze at other objects such as prey; this is known as "spy-hopping". This behaviour has also been seen in at least one group of blacktip reef sharks, but this might be learned from interaction with humans (it is theorized that the shark may also be able to smell better this way, because smell travels through air faster than through water). The white sharks are generally very curious animals, display intelligence and may also turn to socializing if situation demands such. At Seal Island, white sharks have been observed arriving and departing in stable "clans" of two to six individuals on a yearly basis. Whether clan members are related is unknown, but they get along peacefully enough. In fact, the social structure of a clan is probably most aptly compared to that of a wolf pack: each member has a clearly established rank, and each clan has an alpha leader. When members of different clans meet, they establish social rank nonviolently through any of a fascinating variety of interactions.

Diet

Great white shark off Guadalupe Island, Mexico

Great white sharks are carnivorous, and prey upon fish (e.g. tuna, rays, other sharks), cetaceans (i.e., dolphins, porpoises, whales), pinnipeds (e.g. seals, fur seals, and sea lions), sea turtles, sea otters, and seabirds. Great whites have also been known to eat objects that they are unable to digest. Upon approaching a length of nearly 4 metres (13 ft), great white sharks begin to target predominately marine mammals for food. These sharks prefer prey with a high content of energy-rich fat. Shark expert Peter Klimley used a rod-and-reel rig and trolled carcasses of a seal, a pig, and a sheep to his boat in the South Farallons. The sharks attacked all three baits but rejected the sheep carcass.

Great white sharks' reputation as ferocious predators is well-earned, yet they are not (as was once believed) indiscriminate "eating machines". They are ambush hunters, taking prey by surprise from below. Near the now famous Seal Island, in South Africa's False Bay, shark attacks most often occur in the morning, within 2 hours after sunrise, when visibility is poor. Their success rate is 55% in the first 2 hours, falling to 40% in late morning, after which hunting stops. The Great White Shark is an apex predator.

Hunting techniques vary by prey species. Off Seal Island the shark ambush cape fur seals from below at high speeds, hitting the seal mid-body. They go so fast that they can completely leave the water. The peak burst speed of these sharks is largely accepted in the scientific community to be above 40 kilometres per hour (25 mph). However further precision is still speculative. They have also been observed chasing prey after a missed attack. Prey is usually attacked at the surface.

Off California, sharks immobilize northern elephant seals with a large bite to the hindquarters (which is the main source of the seal's mobility) and wait for the seal to bleed to death. This technique is especially used on adult male elephant seals which can be as large or larger than the hunter and are potentially dangerous adversaries. Prey is normally attacked sub-surface. Harbour seals are simply grabbed from the surface and pulled down until they stop struggling. They are then eaten near the bottom. California sea lions are ambushed from below and struck mid-body before being dragged and eaten.

White sharks attack dolphins and porpoises from above, behind or below to avoid being detected by their echolocation. Targeted species include dusky dolphins, Risso's dolphins, bottlenose dolphins, Humpback dolphins, harbour porpoises, and Dall's porpoises. Close encounters between dolphins and predatory sharks often result in evasive responses by the dolphins. However, in rare cases, a group of dolphins may chase a single predatory shark away in an act of defense. White shark predation on some species of whales have also been observed — white sharks often attack and prey upon pygmy sperm whales, *Kogia breviceps*, in the Mediterranean Sea. In addition, white sharks also attack and prey upon beaked whales.

A beachcomber looking at bite marks from a great white shark

Even though the great whites are known to generally avoid conflicts with each other, the phenomenon of cannibalism is not alien to this species. Large individuals may aggressively interact intraspecifically with small individuals. A 3 m (9.8 ft) long great white shark was nearly bitten into two by a reportedly 6 m (20 ft) long great white shark in Stradbroke Island, near Brisbane in Australia.

White sharks also scavenge on whale carcasses. In one such documented incident, white sharks were observed scavenging on a whale carcass alongside tiger sharks.

Reproduction

Little is known about great white shark behaviour in the way of mating habits. Birth has never been observed, but pregnant females have been examined. Great white sharks are ovoviviparous (eggs develop and hatch in the uterus, and continue to develop until birth). The great white has an 11 month gestation period. The shark pup's powerful jaws begin to develop in the first month. The unborn sharks participate in intrauterine-cannibalism: stronger pups consume their weaker womb-mates. Delivery is in spring and summer.

Almost nothing is known about mating behavior. Some evidence points to the near-soporific effect of a large feast (such as a whale carcass) possibly inducing mating.

Great white sharks reach sexual maturity at around 15 years of age. Maximum life span is believed to be more than 30 years.

Natural threats

Although the great white is typically regarded as an apex predator in the wild, it is in rare cases, preyed upon by the larger orca (also known as a killer whale). Interspecific competition between the great white shark and the orca is probable in regions where dietary preferences of both species may overlap. An incident was documented on October 4, 1997 in the Farallon Islands off California. An estimated 4.7–5.3-metre (15–17 ft) female orca was seen purposely inducing tonic immobility in a great white shark. The orca held the shark upside down to induce the tonic immobility, and kept the shark still for fifteen minutes, causing it to suffocate and then proceeded to eat the dead shark's liver. Another similar attack apparently occurred there in 2000, but its outcome is not clear. After both attacks, the local population of about 100 great whites vanished. Following the 2000 incident, a great white with a satellite tag was found to have immediately submerged to depth of 500 m and swum to Hawaii. Prior to the evolution of orcas, great whites may have similarly avoided the much larger shark, *C. megalodon*.

Relationship with humans

Shark attacks

More than any documented attack, Peter Benchley's best selling novel *Jaws* and the subsequent 1975 film adaptation directed by Steven Spielberg provided the great white shark with the image of a "man eater" in the public mind. While great white sharks have killed humans, they typically do not target them: for example, in the Mediterranean Sea there have been 31 confirmed attacks against humans in the last two centuries, most non-fatal. Many incidents seem to be "test-bites". Great white sharks also test-bite buoys, flotsam, and other unfamiliar objects, and might grab a human or a surfboard to identify it.

The great white shark is one of only four kind of sharks that have been involved in a significant number of fatal unprovoked attacks on humans

Other incidents seem to be cases of mistaken identity, in which a shark ambushes a bather or surfer from below, believing the silhouette is from a seal. Many attacks occur in waters with low visibility, or other situations which impair the shark's senses. The species appears to not like the taste of humans, or at least finds the taste unfamiliar. Further research shows that they can tell in one bite whether or not the object is worth attacking. Humans, for the most part, are too bony for their liking. They much prefer a fat, protein-rich seal.

However, some researchers have hypothesized that the reason the proportion of fatalities is low is not because sharks do not like human flesh, but because humans are often able to escape after the first bite. In the 1980s John McCosker noted that divers who dove solo

and were attacked by great whites were generally at least partially consumed, while divers who followed the buddy system were generally rescued by their buddy. Tricas and McCosker suggest that a standard pattern for great whites is to make an initial devastating attack, and then wait for the prey to weaken before consuming the wounded animal. Humans' ability to move out of reach with the help of others, thus foiling the attack, is unusual for a great white's prey.

Humans, in any case, are not appropriate prey because shark's digestion is too slow to cope with the human's high ratio of bone to muscle and fat. Accordingly, in most recorded attacks, great whites broke off contact after the first bite. Fatalities are usually caused by blood loss from the initial limb injury rather than from critical organ loss or from whole consumption.

A shark conservationist, Jimmy Hall, reported and documented his personal encounter with a very large great white shark, nicknamed as Schatzi, in December, 2005, in waters off Hawaii. This encounter received worldwide attention as it remained entirely peaceful. J. Hall was first cautious but later on swam with this shark without cage protection and touched it repeatedly while filming it simultaneously.

Great white shark between a cage and a boat

Attacks on boats

Great white sharks infrequently attack and sometimes even sink boats. Only 5 of the 108 authenticated unprovoked shark attacks reported from the Pacific Coast during the 20th

century involved kayakers. In a few cases they have attacked boats up to 10 metres (33 ft) in length. They have bumped or knocked people overboard, usually 'attacking' the boat from the stern. In one case in 1936, a large shark leapt completely into the South African fishing boat *Lucky Jim*, knocking a crewman into the sea. Tricas and McCosker's underwater observations suggest that sharks are attracted to boats due to the electrical fields they generate.

Great white sharks in captivity

Great white shark in the Monterey Bay Aquarium in September, 2006

Prior to August 1981, no great white shark in captivity lived longer than 11 days. In August 1981, a shark survived for 16 days at SeaWorld San Diego before being released. The idea of containing a live great white at SeaWorld Orlando was used in the 1983 film *Jaws 3-D*.

In 1984, shortly before its opening day, the Monterey Bay Aquarium in Monterey, California, housed its first great white shark, which died after 10 days. In July 2003, Monterey researchers captured a small female and kept it in a large netted pen near Malibu for five days. They had the rare success of getting the shark to feed in captivity before its release. Not until September 2004 was the aquarium able to place a great white on long-term exhibit. A young female, who was caught off the coast of Ventura, was kept in the aquarium's massive 3,800,000-litre (1,000,000 US gal) Outer Bay exhibit for 198 days before she was released in March 2005. She was tracked for 30 days after release. On the evening of August 31, 2006 the aquarium introduced a juvenile male caught

outside Santa Monica Bay His first meal as a captive was a large salmon steak on September 8, 2006 and as of that date, he was estimated to be 1.72 metres (68 in) and to weigh approximately 47 kilograms (100 lb). He was released on January 16, 2007 after 137 days in captivity.

In addition, Monterey Bay Aquarium housed a third great white, a juvenile male, for 162 days between August 27, 2007 through February 5, 2008. On arrival, he was 1.4 metres (4 ft 7 in) long and weighed 30.6 kilograms (67 lb). He grew to 1.8 metres (5 ft 11 in) and 64 kilograms (140 lb) at release. A juvenile female came to the Outer Bay Exhibit on August 27, 2008. While she swam well, the shark fed only one time during her stay and was tagged and released on September 7. Another juvenile female was captured near Malibu on August 12, 2009, introduced to the Outer Bay exhibit on August 26, and successfully released to the wild on November 4, 2009.

Probably the most famous captive was a 2.4 metres (7.9 ft) female named "Sandy", which in August 1980 became the only great white to be housed at the California Academy of Sciences' Steinhart Aquarium in San Francisco, California. She was released because she would not eat and constantly bumped against the walls.

Shark tourism

Putting chum in the water

A great white shark approaches divers in a cage off Dyer Island, Western Cape, South Africa

A great white shark approaches a cage

Their infamous reputation gives sharks great appeal for tourists. While it is safe to dive near sharks of most species, diving with great whites requires great care. One common approach is for divers to stay within a steel cage.

Cage diving is most common off the coasts of Australia, South Africa, and Guadalupe Island off the coast of Baja California, which great whites frequent. Cage diving & swimming with sharks is a focus for a booming tourist industry due to its popularity. A common practice is to chum the water with pieces of fish to attract sharks. These practices may make sharks more accustomed to people in their environment and to associate human activity with food—a potentially dangerous situation. By drawing bait on a wire towards the cage, tour operators lure the shark to the cage, possibly striking it, exacerbating this problem. Other operators draw the bait away from the cage, causing the shark to swim past the divers.

At present, hang baits are illegal off Isla Guadalupe and reputable dive operators do not use them. Operators in South Africa and Australia continue to use hang baits and pinniped decoys.

Companies object to being blamed for shark attacks, pointing out that lightning tends to strike humans more often than sharks bite humans. Their position is that further research needs to be done before banning practices such as chumming, which may alter natural behaviour.

One compromise is to only use chum in areas in which whites actively patrol anyway, well away from human leisure areas. Also, responsible dive operators do not feed sharks; only sharks that are willing to scavenge follow the chum trail, and if they find no food at the end then the shark soon swims off and does not associate chum with a meal. It has been suggested that government licensing strategies may help enforce these suggested advisories.

The shark tourist industry has some financial leverage in conserving this animal. A single set of great white jaws can fetch a one-time price of up to £20,000. However, that is a fraction of the tourism value of a live shark, a more sustainable economic activity. For example, the dive industry in Gaansbai, South Africa, consists of six boat operators with each boat guiding 30 people each day. With fees between £50 to £150 per person, a single live shark that visits each boat can create anywhere between £9,000 and £27,000 of revenue daily.

Conservation status

It is unclear how much a concurrent increase in fishing for great white sharks has caused the decline of great white shark populations from the 1970s to the present. No accurate population numbers are available, but the great white shark is now considered endangered. Sharks taken during the long interval between birth and sexual maturity never reproduce, preventing population recovery.

The IUCN notes that very little is known about the actual status of the great white shark, but as it appears uncommon compared to other widely distributed species, it is considered vulnerable. It is included in Appendix II of CITES, meaning that international trade in the species requires a permit.

Fishermen target many sharks for their jaws, teeth, and fins, and as game fish in general. The great white shark, however, is rarely an object of commercial fishing, although its flesh is considered valuable. If casually captured (it happens for example in some tonnare in the Mediterranean), it is misleadingly sold as *smooth-hound shark*.

From April 2007 great white sharks were fully protected within 370 kilometres (200 nmi) of New Zealand and additionally from fishing by New Zealand-flagged boats outside this range. The maximum penalty is a $250,000 fine and up to six months in prison.

Chapter- 3

Crested Bullhead Shark (Type of Shark)

Crested bullhead shark

Conservation status

Least Concern (IUCN 3.1)
Scientific classification
Kingdom: Animalia
Phylum: Chordata
Class: Chondrichthyes
Subclass: Elasmobranchii
Order: Heterodontiformes
Family: Heterodontidae
Genus: *Heterodontus*

Species: ***H. galeatus***

Binomial name

Heterodontus galeatus
(Günther, 1870)

Range of the crested bullhead shark

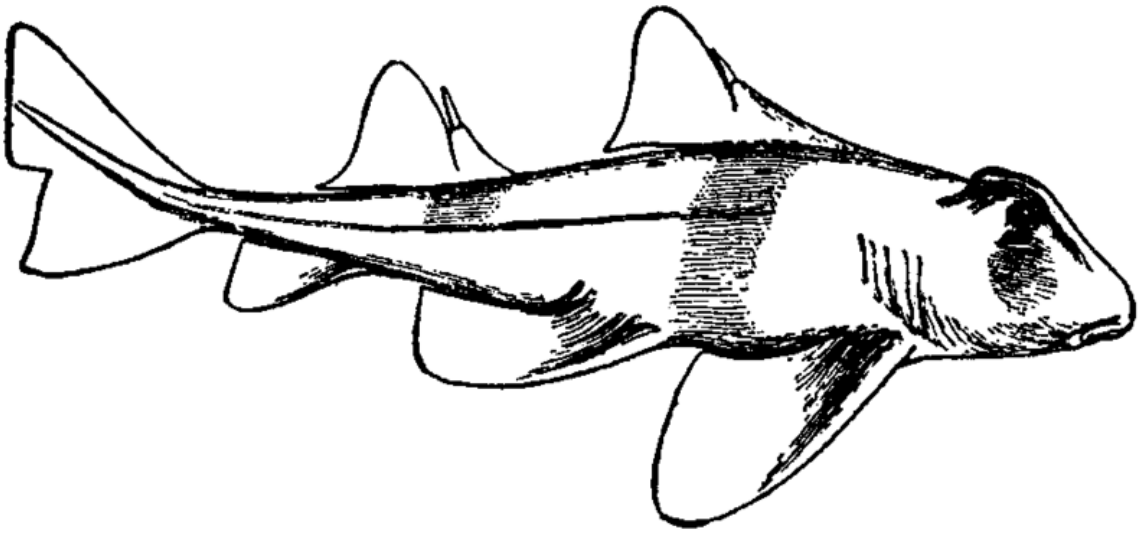
Synonyms

Cestracion galeatus Günther, 1870

The **crested bullhead shark** (*Heterodontus galeatus*) is an uncommon species of bullhead shark, family Heterodontidae, occurring off eastern Australia from the coast to a depth of 93 m (305 ft). This shark can be distinguished from other members of its family by the large size of the ridges above its eyes and by its color pattern of large dark blotches. It typically attains a length of 1.2 m (3.9 ft).

Nocturnal and bottom-dwelling, the crested bullhead shark favors rocky reefs and vegetated areas, where it hunts for sea urchins and other small organisms. It is oviparous, with females producing auger-shaped egg capsules that are secured to seaweed or sponges with long tendrils. Sexual maturation is slow, with one female in captivity not laying eggs until almost 12 years of age. The International Union for Conservation of Nature (IUCN) has assessed this harmless shark as of Least Concern; it is of no economic interest and suffers minimal mortality from bycatch, recreational fishing, and shark nets.

Taxonomy

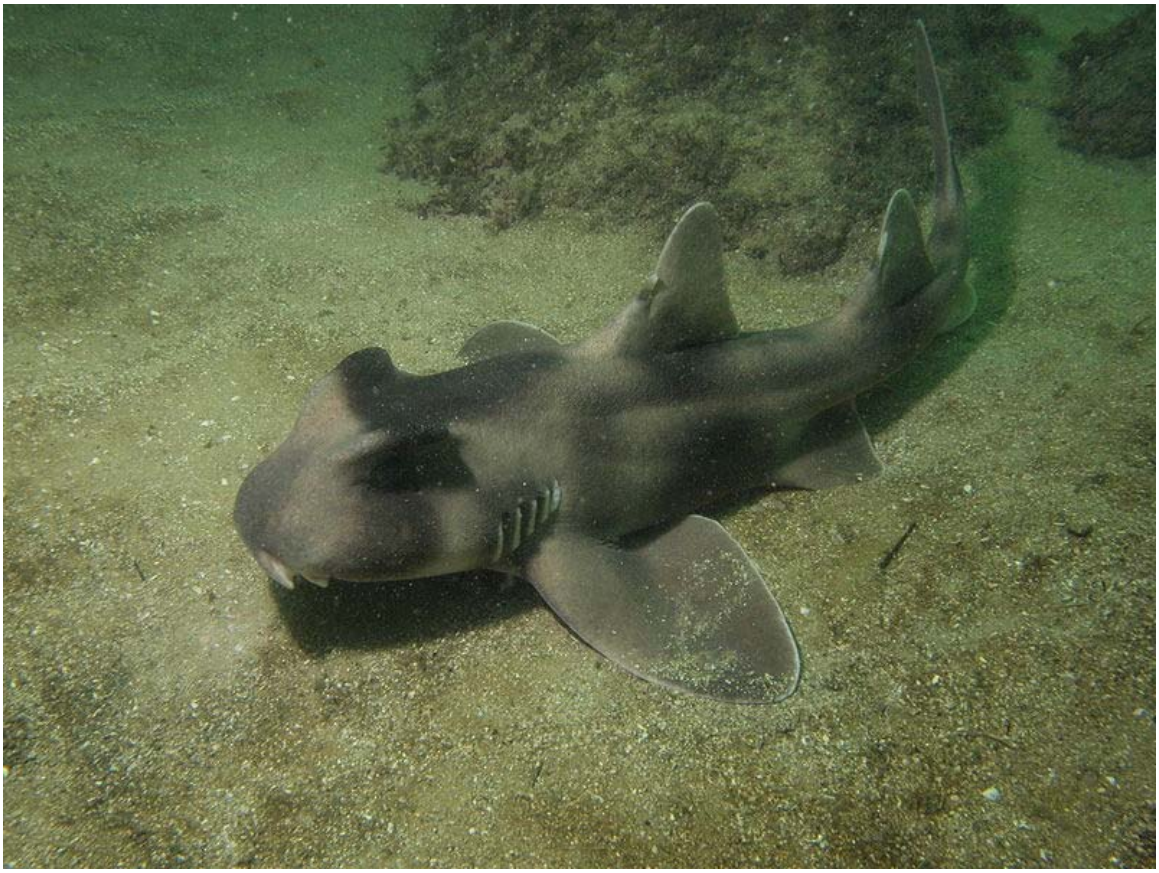


Early illustration of a crested bullhead shark.

British zoologist Albert Günther originally described the crested bullhead shark as *Cestracion galeatus* in the 1870 eighth volume of *Catalogue of the Fishes in the British Museum*. He chose the specific epithet *galeatus* from the Latin for "helmeted", referring to the prominent ridges above the shark's eyes that also give it its common name.

Subsequent authors moved this species to the genera *Gyropleurodus* and *Molochophrys* before placing it in *Heterodontus*. The type specimen is a 68 cm (27 in) long female caught off Australia. This shark may also be referred to as crested shark, crested bull shark, crested horn shark, and crested Port Jackson shark.

Distribution and habitat



The crested bullhead shark is found on or near the bottom.

The range of the crested bullhead shark is restricted to the warm temperate waters along the eastern coast of Australia, from Cape Moreton, Queensland to Batemans Bay, New South Wales. There are also dubious records of this species from off Cape York Peninsula in the north and Tasmania in the south. This species co-occurs with the related Port Jackson shark (*H. portusjacksoni*) across much of its range, but is generally much rarer except off southern Queensland and northern New South Wales, where it tends to replace the other species.

Bottom-dwelling in nature, the crested bullhead shark is found over the continental shelf from the intertidal zone to a depth of 93 m (305 ft), being more common in deeper waters. It prefers rocky reefs, mats of seaweed, and seagrass beds.

Description

The high ridges above the eyes of the crested bullhead shark are its most distinctive feature.

The head of the crested bullhead shark is short and wide, with a blunt, pig-like snout. The eyes are placed high on the head and lack nictitating membranes. The supraorbital ridges above the eyes of this species are larger than any other member of its family. The nostrils are separated into incurrent and excurrent openings by a long flap of skin that reaches the mouth. A furrow encircles the incurrent opening and another furrow runs from the excurrent opening to the mouth, which is located nearly at the tip of the snout. The teeth at the front of the jaws are small and pointed with a central cusp and two lateral cusplets, while those at the back of the jaws are wide and molar-like. There are deep furrows at the corners of the mouth, extending onto both jaws.

The pectoral fins are large and rounded, while the pelvic and anal fins are smaller and more angular. The first dorsal fin is moderately tall with a rounded to angular apex and a stout spine on the leading margin, originating behind the pectoral fins. The second dorsal fin resembles the first and is almost as large, and is located between the pelvic and anal fins. The caudal fin is broad, with a strong ventral notch near the tip of the upper lobe. The dermal denticles are large and rough, especially on the flanks. The coloration consists of five brown to black, diffusely edged saddles on a light tan background. There are dark marks on top of the head between the crests and below each eye. Most crested bullhead sharks measure no more than 1.2 m (4 ft) long, but a few may reach 1.5 m (5 ft).

Biology and ecology

A crested bullhead shark feeding on an egg case of the Port Jackson shark.

The crested bullhead shark is a slow-moving, nocturnal species often seen wedging its head between rocks in search of food. It feeds primarily on the sea urchins *Centrostephanus rodgersii* and *Heliocardis erythrogramma*, but has also been known to take a variety of other invertebrates and small fishes. A steady diet of sea urchins may stain the teeth of this shark pinkish purple. The crested bullhead shark is also a major predator of the eggs of the Port Jackson shark, which are seasonally available and rich in nutrients. Individual sharks have been observed taking the egg capsules in their mouths and chewing on the tough casing, rupturing it and allowing the contents to be sucked out; egg capsules may also be swallowed whole. Unlike the Port Jackson shark, the crested bullhead shark is not known to form large aggregations.

Crested bullhead sharks are oviparous with a possibly annual reproductive cycle. Females produce 10–16 eggs per year during late winter in July and August, though Michael (1993) noted that egg laying may continue year-round. The egg cases measure around 11 cm (4.3 in) in length, with a pair of thin flanges spiraling 6–7 times around the outside and two slender tendrils up to 2 m (6.6 ft) long at one end, used to attach the capsule to seaweed or sponges. The capsules are usually deposited at a depth of 20–30 m (66–98 ft), much deeper than the Port Jackson shark, though there is a single record of an egg being found only 8.6 m (28 ft) down. The time to hatching has been variously reported as 5 and

8–9 months; the newly emerged young measure 17–22 cm (6.7–8.7 in) long and resemble the adults. Last and Stevens (1994) gave the lengths at maturity for males and females at 60 cm (24 in) and 70 cm (28 in) respectively, though mature males as small as 53.5 cm (21.1 in) long were later found off Queensland. Growth and aging has been documented for one captive female at the Taronga Park Aquarium, which grew an average of 5 cm (2.0 in) per year and did not lay eggs until she was almost 12 years old.

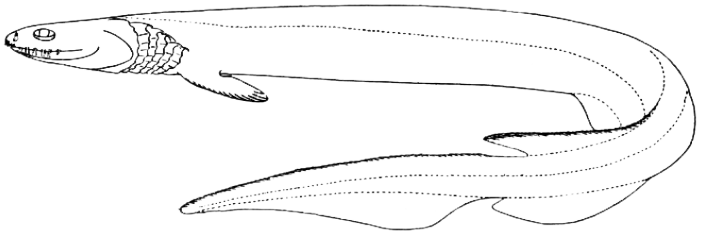
Human interactions

Innocuous towards humans, the crested bullhead shark is of little interest to recreational or commercial fisheries. It is seldom caught on hook-and-line, but is sometimes targeted by spear fishers. Commercial bottom trawl prawn fisheries operating off Queensland and New South Wales take this species as bycatch; the impact of these activities on the population is uncertain as this species is not recorded separately from the Port Jackson shark. However, most bullhead sharks caught in these fisheries survive to be released alive. Crested bullhead sharks are likely also caught in mesh shark nets used to protect beaches; again, most are able to survive the experience. Because of the limited mortality suffered by this species from various human activities, the International Union for Conservation of Nature (IUCN) has assessed this species as of Least Concern, albeit also recommending that it be carefully monitored given its restricted distribution and overall uncommonness. The range of the crested bullhead shark overlaps with several Marine Protected Areas (MPAs); additionally it was listed as a Declared Animal in Schedule 3 of the 1997 Queensland Marine Parks (Moreton Bay) Zoning Plan, which regulates its collection in Moreton Bay Marine Park.

Chapter- 4

Hexanchiformes (Type of Shark)

Hexanchiformes Fossil range: Middle Jurassic–Recent



Frilled shark, *Chlamydoselachus anguineus*

Scientific classification	
Kingdom:	Animalia
Phylum:	Chordata
Class:	Chondrichthyes
Subclass:	Elasmobranchii
Superorder:	Selachimorpha
Order:	**Hexanchiformes** de Buen, 1926

Families
Chlamydoselachidae
Hexanchidae

Hexanchiformes is the order consisting of the most primitive types of sharks, and numbering just five extant species. Fossil sharks that were apparently very similar to modern sevengill species are known from Jurassic specimens.

Hexanchiform sharks have only one dorsal fin, either six or seven gill slits, and no nictitating membrane in the eyes.

The frilled shark, *Chlamydoselachus anguineus*, is very different from the cow sharks, and it has been proposed that it be moved to its own order Chlamydoselachiformes.

Classification

Extant species

Family Chlamydoselachidae

- *Chlamydoselachus*
  - Frilled shark, *Chlamydoselachus anguineus* (Garman, 1884)
  - Southern African frilled shark, *Chlamydoselachus africana*

Family Hexanchidae (cow sharks)

- *Heptranchias*
  - Sharpnose sevengill shark, *Heptranchias perlo* (Bonnaterre, 1788)
- *Hexanchus*
  - Bluntnose sixgill shark, *Hexanchus griseus* (Bonnaterre, 1788)
  - Bigeyed sixgill shark, *Hexanchus nakamurai* (Teng, 1962)
- *Notorynchus*
  - Broadnose sevengill shark or spotted sevengill shark, *Notorynchus cepedianus* (Péron, 1807)

Extinct species

Family Chlamydoselachidae

- *Chlamydoselachus*
  - *Chlamydoselachus bracheri* Pfeil, 1983
  - *Chlamydoselachus gracilis* Antunes & Cappetta, 2001
  - *Chlamydoselachus goliath* Antunes & Cappetta, 2001
  - *Chlamydoselachus fiedleri* Pfeil, 1983
  - *Chlamydoselachus lawleyi* Davis, 1887
  - *Chlamydoselachus thomsoni* Richter & Ward, 1990
  - *Chlamydoselachus tobleri* Leriche, 1929
- *Thrinax*
  - *Thrinax baumgartneri* Pfeil, 1983

Family Hexanchidae

- *Heptranchias*
  - *Heptranchias ezoensis* Applegate & Uyeno, 1968
  - *Heptranchias howelii* (Reed, 1946)
  - *Heptranchias tenuidens* (Leriche, 1938)
- *Hexanchus*

    - *Hexanchus arzoensis* (Debeaumont, 1960)
    - *Hexanchus agassizi*
    - *Hexanchus collinsonae* Ward, 1979
    - *Hexanchus gracilis* (Davis, 1887)
    - *Hexanchus griseus "andersoni" "gigas"* (Bonaterre, 1788)
    - *Hexanchus hookeri* Ward, 1979
    - *Hexanchus microdon "agassizii"* (Agassiz, 1843)
    - *Hexanchus nakamurai "vitulus"* Teng, 1962
- *Notidanoides*
- *Notidanodon*
    - *Notidanodon antarcti* Grande & Chatterjee, 1987
    - *Notidanodon brotzeni* Siverson, 1995
    - *Notidanodon dentatus* (Woodward, 1886)
    - *Notidanodon lanceolatus* (Woodward, 1886)
    - *Notidanodon loozi* (Vincent, 1876)
    - *Notidanodon pectinatus* (Agassiz, 1843)
- *Notorynchus*
    - *Notorynchus aptiensis* (Pictet, 1865)
    - *Notorynchus intermedius* Wagner
    - *Notorynchus lawleyi* Ciola & Fulgosi, 1983
    - *Notorynchus munsteri* (Agassiz, 1843)
    - *Notorynchus serratissimus* (Agassiz, 1844)
    - *Notorynchus serratus* (Agassiz, 1844)
- *Paraheptranchias*
    - *Paraheptranchias repens* (Probst, 1879)
    - *Paranotidanus "Eonotidanus" contrarius* (Munster, 1843)
    - *Paranotidanus intermedius* (Wagner, 1861)
    - *Paranotidanus munsteri* (Agassiz, 1843)
    - *Paranotidanus serratus* (Fraas, 1855)
- *Pseudonotidanus*
    - *Pseudonotidanus semirugosus* Underwood & Ward, 2004
- *Weltonia*
    - *Weltonia ancistrodon* (Arambourg, 1952)
    - *Weltonia burnhamensis* Ward, 1979

Family ?Mcmurdodontidae

- *Mcmurdodus*
    - *Mcmurdodus featherensis* White, 1968
    - *Mcmurdodus whitei* Turner, & Young, 1987

Chapter- 5

Carpet Shark (Type of Shark)

Carpet sharks Fossil range: Late Jurassic–Recent

Spotted wobbegong, *Orectolobus maculatus*
Scientific classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Chondrichthyes
Subclass:	Elasmobranchii
Superorder:	Selachimorpha
Order:	**Orectolobiformes** Applegate, 1972

The **carpet sharks** are an order, **Orectolobiformes**, of sharks, so called because many members have ornate patterns reminiscent of carpets.

Carpet sharks have two dorsal fins, without spines, and a small mouth that is forward of the eyes. Many have barbels and small gill slits, with the fifth slit overlapping the fourth. The upper lobe of the caudal fin tends to be mostly in line with the body, while the lower lobe is poorly developed, except in the case of the whale shark. While many in the order are small, the whale shark is the largest living fish.

Classification

The order is small, with only around 40 species in seven families in 13 genera:

Order Orectolobiformes

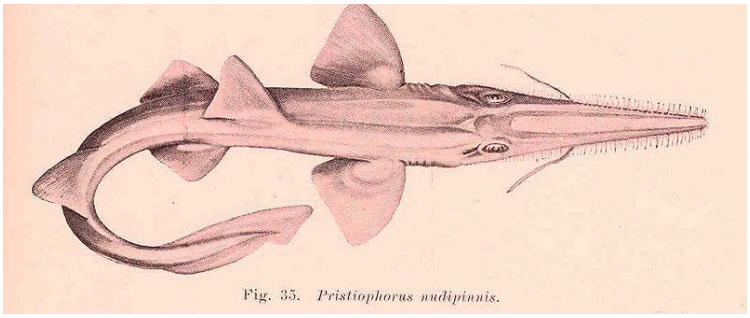
- Family Brachaeluridae (Blind sharks)
  - Genus *Brachaelurus*
    - Blind shark, *Brachaelurus waddi* (Bloch & Schneider, 1801)
  - Genus *Heteroscyllium*
    - Bluegrey carpetshark, *Heteroscyllium colcloughi* (Ogilby, 1908)
- Family Ginglymostomatidae (Nurse sharks)
  - Genus *Ginglymostoma*
    - Nurse shark, *Ginglymostoma cirratum* Bonnaterre, 1788
  - Genus *Nebrius*
    - Tawny nurse shark, *Nebrius ferrugineus* Lesson, 1831
  - Genus *Pseudoginglymostoma*
    - Short-tail nurse shark, *Pseudoginglymostoma brevicaudatum* Günther, 1867
- Family Hemiscylliidae (Bamboo sharks)
  - Genus *Chiloscyllium*
    - Arabian carpetshark, *Chiloscyllium arabicum* Gubanov, 1980
    - Burmese bamboo shark, *Chiloscyllium burmensis* Dingerkus & DeFino, 1983
    - Bluespotted bamboo shark, *Chiloscyllium caerulopunctatum* Pellegrin, 1914
    - Grey bamboo shark, *Chiloscyllium griseum* Müller & Henle, 1838
    - Hasselt's bamboo shark, *Chiloscyllium hasseltii* Bleeker, 1852
    - Slender bamboo shark, *Chiloscyllium indicum* (Gmelin, 1789)
    - Whitespotted bamboo shark, *Chiloscyllium plagiosum* (Bennett, 1830)
    - Brownbanded bamboo shark, *Chiloscyllium punctatum* Müller & Henle, 1838
  - Genus *Hemiscyllium*
    - Indonesian speckled carpetshark, *Hemiscyllium freycineti* (Quoy & Gaimard, 1824)
    - *Hemiscyllium galei* Allen & Erdmann, 2008
    - Papuan epaulette shark, *Hemiscyllium hallstromi* Whitley, 1967
    - *Hemiscyllium henryi* Allen & Erdmann, 2008
    - Milne Bay epaulette shark, *Hemiscyllium michaeli* Allen & Dudgeon, 2010

        - Epaulette shark, *Hemiscyllium ocellatum* (Bonnaterre, 1788)
        - Hooded carpetshark, *Hemiscyllium strahani* Whitley, 1967
        - Speckled carpetshark, *Hemiscyllium trispeculare* Richardson, 1843
- Family Orectolobidae (Carpet sharks)
    - Genus *Eucrossorhinus*
        - Tasselled wobbegong, *Eucrossorhinus dasypogon* (Bleeker, 1867)
    - Genus *Orectolobus*
        - Floral banded wobbegong, *Orectolobus floridus* Last & Chidlow, 2008
        - Banded or Gulf wobbegong, *Orectolobus halei* Whitley, 1940.
        - Western wobbegong, *Orectolobus hutchinsi* Last, Chidlow & Compagno, 2006.
        - Japanese wobbegong, *Orectolobus japonicus* Regan, 1906
        - Spotted wobbegong, *Orectolobus maculatus* (Bonnaterre, 1788)
        - Ornate wobbegong, *Orectolobus ornatus* (De Vis, 1883)
        - Dwarf spotted wobbegong, *Orectolobus parvimaculatus* Last & Chidlow, 2008
        - Network wobbegong, *Orectolobus reticulatus* Last, Pogonoski & White, 2008
        - Northern wobbegong, *Orectolobus wardi* Whitley, 1939
    - Genus *Sutorectus*
        - Cobbler wobbegong, *Sutorectus tentaculatus* (Peters, 1864)
- Family Parascylliidae (Collared carpet sharks)
    - Genus *Cirrhoscyllium* Smith & Radcliffe in Smith , 1913
        - Barbelthroat carpetshark, *Cirrhoscyllium expolitum* Smith & Radcliffe, 1913
        - Taiwan saddled carpetshark, *Cirrhoscyllium formosanum* Teng, 1959
        - Saddle carpetshark, *Cirrhoscyllium japonicum* Kamohara, 1943
    - Genus *Parascyllium* Gill , 1862
        - Collared carpetshark, *Parascyllium collare* Ramsay & Ogilby, 1888
        - Elongate carpetshark, *Parascyllium elongatum* Last & Stevens, 2008
        - Rusty carpetshark, *Parascyllium ferrugineum* McCulloch, 1911
        - Ginger carpetshark, *Parascyllium sparsimaculatum* Goto & Last, 2002
        - Necklace carpetshark, *Parascyllium variolatum* (Duméril, 1853)
- Family Rhincodontidae (Whale sharks)
    - Genus *Rhincodon*
        - Whale shark, Rhincodon typus
- Family Stegostomatidae (Zebra sharks)
    - Genus *Stegostoma*
        - Zebra shark, Stegostoma fasciatum

Chapter- 6

Sawshark and Squaliformes (Types of Shark)

Sawshark

Sawsharks Fossil range: Upper Jurassic–Recent

Shortnose sawshark, *Pristiophorus nudipinnis*
Scientific classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Chondrichthyes
Subclass:	Elasmobranchii
Superorder:	Selachimorpha
Order:	**Pristiophoriformes** Berg, 1958
Family:	**Pristiophoridae** Bleeker, 1859

Genera

- *Pliotrema* Regan, 1906

- *Pristiophorus* Müller & Henle, 1837

The **sawsharks** or **saw sharks** are an order (**Pristiophoriformes**) of sharks bearing long blade-like snouts edged with teeth, which they use to slash and disable their prey. Most occur in waters from South Africa to Australia and Japan, at depths of 40 metres (130 ft) and below; in 1960 the Bahamas sawshark was discovered in the deeper waters (640 m to 915 m) of the northwestern Caribbean.

Description and biology

Sawsharks have a pair of long barbels about halfway along the snout. They have two dorsal fins, but lack anal fins, and range up to 170 centimetres (5.6 ft) in length. Genus *Pliotrema* has six gill slits, and *Pristiophorus* the more usual five. The teeth of the saw typically alternate between large and small.

The sharks typically feed on fish, squid, and crustaceans, depending on species. They cruise the bottom, using the barbels and ampullae of Lorenzini on the saw to detect prey in mud or sand, then hit victims with side-to-side swipes of the saw, crippling them.

Although they are similar in appearance, sawsharks are distinct from sawfish. Sawfish have a much larger maximum size, lack barbels, have evenly sized rather than alternating sawteeth, and have gill slits on their undersurface rather than on the side of the head.

Genera and species

There are seven described (and two undescribed) species of sawshark known, in two genera. Two species, *Pristiophorus delicatus* and *Pristiophorus peroniensis*, were only described in 2008.

Pliotrema

This genus consists of a single species, the sixgill sawshark, distinguished from *Pristiophorus* by having six pairs of gill slits. In addition, their rostral sawteeth have prominent transverse ridges on the basal ledges, and the large teeth have posterior serrations.

- Sixgill sawshark, *Pliotrema warreni* Regan, 1906

Pristiophorus

Members of this genus have five gill slits. Their rostral sawteeth lack prominent transverse ridges on the basal ledges, and the large teeth are not posteriorly serrated.

- Longnose sawshark, *Pristiophorus cirratus* (Latham, 1794)

- Tropical sawshark, *Pristiophorus delicatus* Yearsley, Last & White, 2008
- Japanese sawshark, *Pristiophorus japonicus* Günther, 1870
- Shortnose sawshark, *Pristiophorus nudipinnis* Günther, 1870
- Eastern Australian sawshark, *Pristiophorus peroniensis* Yearsley, Last & White, 2008
- Bahamas sawshark, *Pristiophorus schroederi* Springer & Bullis, 1960
- Philippine sawshark, *Pristiophorus* sp. C
- Dwarf sawshark, *Pristiophorus* sp. D

Squaliformes

Squaliformes **Fossil range: Late Jurassic–Recent**

Etmopterus spinax
Scientific classification

Kingdom:	Animalia
Phylum:	Chordata
Class:	Chondrichthyes
Subclass:	Elasmobranchii
Superorder:	Selachimorpha
Order:	**Squaliformes** Goodrich, 1909

Squaliformes is an order of sharks that includes about 80 species in seven families.

Members of the order have two dorsal fins, which usually possess spines, no anal fin or nictitating membrane, and five gill slits. In most other respects, however, they are quite variable in form and size. They are found worldwide, from polar to tropical waters, and from shallow coastal seas to the open ocean.

Classification

Family Centrophoridae (gulper sharks)

- Genus *Centrophorus*
- Genus *Deania*

Family Dalatiidae (kitefin sharks) (Gray, 1851)

- Genus *Euprotomicroides*
- Genus *Heteroscymnoides*
- Genus *Mollisquama*
- Tribe Dalatiini
    - Genus *Dalatias*
    - Genus *Isistius*
- Tribe Euprotomicrini
    - Genus *Euprotomicrus*
    - Genus *Squaliolus*

Family Echinorhinidae (bramble sharks)

- Genus *Echinorhinus*

Family Etmopteridae (lantern sharks) Fowler, 1934

- Genus *Aculeola*
- Genus *Centroscyllium*
- Genus *Etmopterus*
- Genus *Miroscyllium*
- Genus *Trigonognathus*

Family Oxynotidae (rough sharks) Gill, 1872

- Genus *Oxynotus*

Family Somniosidae (sleeper sharks) Jordan, 1888

- Genus *Centroscymnus*
- Genus *Scymnodalatias*
- Genus *Scymnodon*
- Genus *Somniosus*

Family Squalidae (dogfish sharks)

- Genus *Cirrhigaleus*
- Genus Squalus

Chapter- 7

Prehistoric Sharks

Anomotodon

Anomotodon **Fossil range: Early Cretaceous to Eocene**	
Scientific classification	
Kingdom:	Animalia
Phylum:	Chordata
Class:	Chondrichthyes
Subclass:	Elasmobranchii
Superorder:	Selachimorpha
Family:	Mitsukurinidae
Genus:	***Anomotodon*** Arambourg, 1952

Anomotodon is an extinct genus of shark related to the extant goblin shark (*Mitsukurina owstoni*). The distribution of *Anomotodon* fossils is worldwide, in formations indicating that members of the genus lived from the Early Cretaceous epoch through the Eocene epoch, and perhaps through the Oligocene as well. Described species include *A. novus*, *A. plicatus*, *A. principalis*, and *A. multidenticula*.

Carcharocles angustidens

Angustidens **Fossil range: Oligocene - Miocene**	
Scientific classification	
Kingdom:	Animalia
Phylum:	Chordata
Class:	Chondrichthyes
Subclass:	Elasmobranchii
Order:	Lamniformes
Family:	Disputed; either Lamnidae or **Otodontidae**
Genus:	Disputed; either *Carcharodon* or ***Carcharocles***
Binomial name	
Disputed; either *Carcharodon angustidens* or *Carcharocles angustidens* For *Carcharodon angustidens,* Agassiz, 1843	

Carcharocles angustidens is a prehistoric megatoothed shark, which lived during the Oligocene and Miocene epochs approximately about 35 to 22 million years ago. This shark is believed to be closely related to another extinct megatoothed shark, *C. megalodon*. However, just as in the case of *C. megalodon*, the classification of this species is also under dispute.

Fossil record

As is the case with most extinct sharks, this species is also known from fossil teeth and some fossilized vertebral centra. Shark skeleton is composed of cartilage and not bone, and cartilage rarely gets fossilized. Hence, fossils of *C. angustidens* are generally poorly preserved. To date, the best preserved specimen of this species have been excavated from New Zealand, which comprises 165 associated teeth and about 35 associated vertebral centrum. This specimen is around 26 million years old. *C. angustidens* teeth are noted for their triangular crowns and small side cusps that are fully serrated. The serrations are very sharp and very well pronounced. *C. angustidens* was a widely distributed species with fossils found in North America, South America, Europe, Africa, New Zealand, Japan, Australia, and Malta.

Size estimation

Like other known megatooth sharks, the fossils of *C. angustidens* indicate that it was considerably larger than the extant great white shark, *Carcharodon carcharias*. The well preserved specimen from New Zealand is estimated at 9.3 metres (31 ft) in length. This specimen had teeth measuring up to 9.87 cm (3.9 inch) in diagonal length, and vertebral centra of around 1.10 cm (4.33 inch) in diameter. However, there are reports of larger *C. angustidens* fossils.

Dentition

The dental formula for *C. angustidens* is:

Dentition

2.1.5.4

3.0.6.3

Diet

C. angustidens was an apex predator and likely preyed upon penguins, fish, dolphins, and baleen whales.

Classification dispute

Even after decades of scrutinizing fossils, *C. angustidens* remains a disputed genus. A Swiss naturalist, Louis Agassiz, first identified this shark as a species of *Carcharodon* genus, in 1835.

In 1964, shark expert, L. S. Glikman recognized the transition of *Otodus obliquus* to *C. auriculatus* and moved *C. angustidens* to genus *Otodus*.

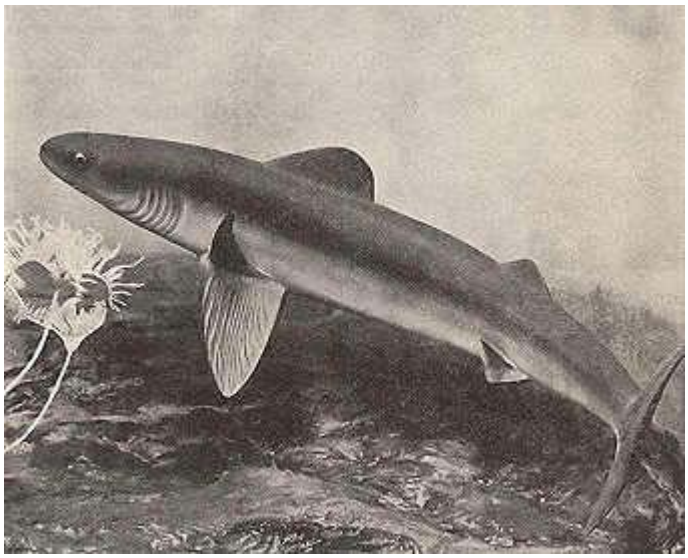
However, in 1987, shark expert, H. Cappetta realized the *C. auriculatus* - *C. megalodon* lineage and placed all related megatooth sharks along with these species in the genus, *Carcharocles*. For the first time, the complete *Otodus obliquus* to *C. megalodon* transition became clear and since have gained acceptance of many other experts with passage of time.

Within the *Carcharocles* lineage; *C. angustidens* is the succeeding species of *C. sokolovi* and is exceeded by *C. chubutensis*.

However, in 2001, a discovery of a best preserved *C. angustidens* specimen to date by two scientists, M. D. Gottfried, and R. Ewan Fordyce, have been presented by the team as an evidence for its close morphological ties with the extant great white shark and the team argued that *C. angustidens* along with all other related megatooth sharks (including *C. megalodon*) deserve to be assigned to *Carch' genus as done before by Louis Agassiz.*

Cladoselache

Cladoselache
Fossil range: Late Devonian



Scientific classification

Kingdom: Animalia
Phylum: Chordata
Class: Chondrichthyes
Order: Cladoselachiformes
Family: Cladoselachidae
Genus: ***Cladoselache***

Species

- *Cladoselache clarkii*
- *Cladoselache elegans*
- *Cladoselache fyleri*
- *Cladoselache kepleri*
- *Cladoselache magnificus*
- *Cladoselache mirabilis*
- *Cladoselache newmani*
- *Cladoselache pattersoni*

Cladoselache is a genus of extinct shark. It appeared in the Devonian period.

Cladoselache fyleri

This primitive shark grew to be up to 6 feet (1.8 m) long and roamed the oceans of North America. It is known to have been a fast moving and fairly agile predator due to its streamlined body and deep forked tail. *Cladoselache* is one of the best known of the early sharks in part due to the well preserved fossils that were discovered on the 'Cleveland Shale' on the south shore of Lake Erie. In addition to the skeleton, the fossils were so well preserved that they included traces of skin, muscle fibres, and internal organs, such as the kidneys.

Appearance

Cladoselache exhibited a combination of derived and ancestral characteristics. It had anatomical features similar to the current mackerel sharks of the family Lamnidae.

It had a streamlined body, from five to seven gill slits, and a short, rounded snout that had a terminal mouth opening at the front of the skull. It had a very weak jaw joint compared with modern-day sharks, but it compensated for that with very strong jaw-closing muscles. Its teeth were multi-cusped and smooth-edged, making them suitable for grasping, but not tearing or chewing. *Cladoselache* therefore probably seized prey by the tail and swallowed it whole.

Its sturdy but light-weight fin spines were composed of dentine and enamel. *Cladoselache* also had a blade-like structure which was positioned in front of the dorsal fins. These anatomical features made swimming easier and faster.

Unlike most sharks, *Cladoselache* was almost entirely devoid of scales with exception of small cusped scales on the edges of the fins, mouth and around the eyes. It also had powerful keels that extended onto the side of the tail stalk and a semi-lunate tail fin, with the superior lobe about the same size as the inferior. This combination helped with its

speed and agility which was useful when trying to outswim its probable predator, the heavily armored 10 metres (33 ft) long placoderm fish *Dunkleosteus*.

Palaeobiology

Members of the *Cladoselache* genus were predatory sharks, and the well preserved fossils found on the Cleveland Shale revealed a significant amount regarding their eating habits. Within the gut of most *Cladoselache* fossils were remnants of their stomach contents. These remains included mostly small ray-finned bony fishes, as well as shrimp-like fish and hagfish-like proto-vertebrates. Some of the fish remains were found tail first within the stomach, indicating that *Cladoselache* was a fast and agile hunter.

A mystery that has yet to be resolved is its method of reproduction. *Cladoselache* lacked claspers, organs found in modern sharks that are responsible for the transfer of sperm during reproduction. This is peculiar given that most other early shark fossils show evidence of claspers. While they may have used internal fertilization, this has yet to be demonstrated.

Chapter- 8

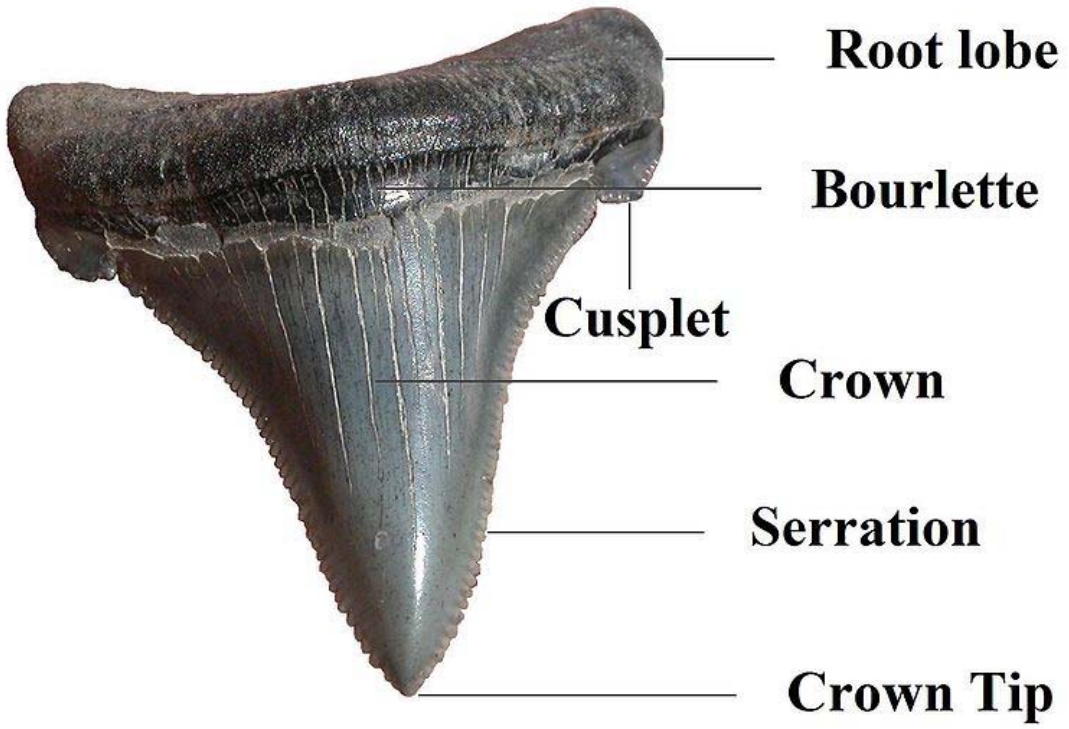
Shark Tooth

Shark teeth are relics of shark evolution and biology, and as they are often the only part of the shark to survive fossilisation, represent much of the Selachimorpha fossil record, extending back hundreds of millions of years. The most ancient types of sharks date back to 450 million years ago during the Late Ordovician period, and they are mostly known from their fossilised teeth. The most common, however, are from the Cenozoic (65 million years ago). Sharks continually shed their teeth, and some Carcharhiniformes can shed approximately 35,000 teeth in a lifetime.

Anatomy and function of shark's teeth

The teeth of the tiger shark are oblique and serrated for sawing through flesh.

Sharks, as well as other Chondrichthyes, have a polyphydont dentition, in which old teeth are shed continually throughout the fish's lifetime, and new ones are rotated into place on a conveyor belt-like structure. Shark teeth, through the same mechanism as the scales on sharks' skin, develop along the inner surface of the jaw cartilage, and are attached to the dental membrane. When the tooth forms in the gum tissue, the crown cap develops first, followed by the root. The resulting teeth are composed of a dentine root and core, covered by a layer of enamel. The root and the enamel of the blade may sometimes be separated by a thin band of enamel, known as the bourlette or chevron. Depending on the species of shark, the blade of the tooth may or may not be serrated, and may exhibit coarse or fine, irregular or regular serrations. Again depending on the species of shark, cusplets may be present on one or both sides of the blade.



Anatomy of a shark's tooth

The teeth of sharks are not attached to the jaw, but embedded in the flesh, and in many species are constantly replaced throughout the shark's life. When they lose a working tooth it will be replaced by the next tooth behind it. All sharks have multiple rows of teeth along the edges of their upper and lower jaws. New teeth grow continuously in a groove just inside the mouth and move forward from inside the mouth on a "conveyor belt" formed by the skin in which they are anchored. Typically a shark has two to three working rows of teeth with 20 to 30 teeth in each row, although a whale shark has about 300 teeth in each row. The replacement rate has not been measured in most sharks but normally the teeth seem to be replaced every two weeks. The lemon shark replaces its

teeth every 8–10 days, and the great white shark replaces its teeth about every 100 days for young sharks and about every 230 days for old sharks. Most sharks shed individual teeth, but the cookiecutter shark sheds the whole lower jaw at once.

The shape of a shark's tooth depends on its diet; those that feed on mollusks and crustaceans have dense flattened teeth for crushing, those that feed on fish have needle-like teeth for gripping, and those that feed on larger prey such as mammals have pointed lower teeth for gripping and triangular upper teeth with serrated edges for cutting. The teeth of plankton-feeders such as the basking shark are greatly reduced and non-functional.

Fossil shark teeth

History of discovery

Nicolaus Steno's depiction of a shark head from *The Head of a Shark Dissected*

The oldest known records of fossilized shark teeth being found, are by Pliny the Elder, in which he believed that these triangular objects fell from the sky during lunar eclipses. According to Renaissance accounts, large, triangular fossil teeth often found embedded in

rocky formations were once believed to be petrified tongues, called tongue stones or glossopetrae, of the dragons and snakes. *Glossopetrae*, were commonly thought to be able to be a remedy or cure for various poisons and toxins, including helping in the treatment of snake bites. Due to this ingrained belief, many noblemen and royalty wore these "tongue stones" pendants or kept them in their pockets as good-luck charms.

This interpretation was corrected in 1667 by a Danish naturalist Nicolaus Steno, who recognized them as ancient shark teeth and famously produced a depiction of a shark's head bearing such teeth. He mentioned his findings in a book, *The Head of a Shark Dissected*, which also contained an illustration of a *C. megalodon* tooth, previously considered to be a tongue stone.

Transitional teeth

As one species evolves into another, its teeth may become difficult to classify, exhibiting characteristics of both species. For example, teeth from *Carcharocles auriculatus* as it evolved into *C. angustidens*, are difficult to definitively identify as coming from either species.

A commonly referred to transition is the evolution of *Isurus hastalis*, the Extinct Giant Mako, into the Great White shark, *Carcharodon carcharias*. There exist teeth which are believed to represent the transition between the two species. These teeth, from *Carcharodon sp.* are characterised by the wider, flatter crowns of the Extinct Giant Mako. However, they also exhibit partial, fading serrations which are more pronounced near the root, and disappear towards the tip of the tooth - serrations being found in Great Whites but not Extinct Giant Makos.

Megalodon teeth

C. megalodon teeth are the largest of any shark, extinct or living, and are among the most sought after types of shark teeth in the world. This shark lived during the **late** Oligocene epoch and Neogene period, roughly about 25 to 1.5 million years ago. The smallest teeth are only 1.2 cm (0.5 in) in maximum height, while the largest teeth are in excess of 17.7 cm (7.0 in) in maximum height. These teeth are in extremely high demand by collectors and private investors, and they can fetch steep prices.

Deposits

Scapanorhynchus texanus, Menuha Formation (Upper Cretaceous), southern Israel.

Shark teeth cannot be collected from any type of rock. Any fossils, including fossil shark teeth, are preserved in sedimentary rocks. Shark teeth are most commonly found between Upper Cretaceous and Tertiary periods. Fossilized shark teeth can often be found in or near river bed banks, sand pits, and beaches. These teeth are typically worn, because they were frequently moved and redeposited in different areas repeatedly before settling down. Other locations, however, yield perfect teeth that were hardly moved during the ages. These teeth are typically fragile, and great care should be taken while excavating them. Phosphate pits, containing mostly fossil bones and teeth, or kaoline pits, are ideal places to look for fossil shark teeth. One of the most notable phosphate mines is in Central Florida, Polk County, and is known as **Bone Valley**. Near New Caledonia, up until the practice was banned, fishermen and commercial vessels used to dredge the sea floor for megalodon teeth.

Tool use by humans

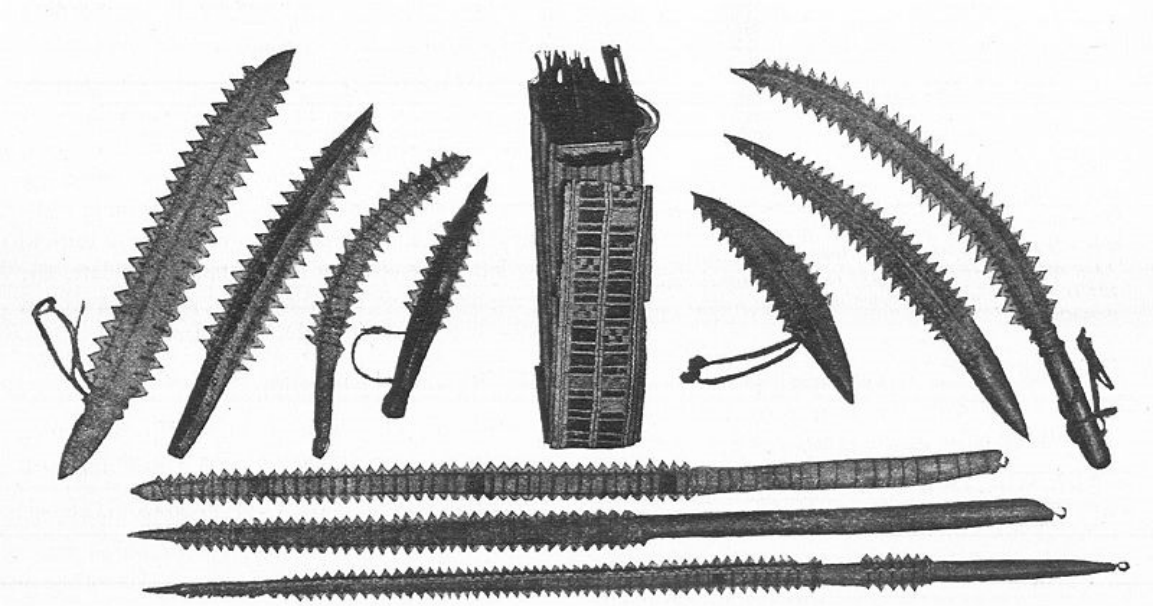


FIGURE 780. *Tebutje. Shark's tooth weapons from the Kingsmill Islands. Peabody Museum, Salem.*

Gilbertese weapons edged with shark teeth.

In Oceania and America, shark teeth were commonly used for tools, especially weapons such as clubs and daggers, but also to carve wood and as tools for food preparation. For example, various weapons edged with shark teeth were used by the Native Hawaiians, who called them leiomano. Some types were reserved for royalty. The Guaitaca (Weittaka) of coastal Brazil tipped their arrows with shark teeth. The remains of shark tooth-edged weapons, as well as chert replicas of shark teeth, have been found in the Cahokia mounds of the upper Mississippi River valley, more than 1,000 km (620 mi) from the ocean. It is reported that the rongorongo tablets of Easter Island were first shaped and then inscribed using a hafted shark tooth.

Chapter- 9

Shark Attack

Shark attack

A sign warning about the presence of sharks off Salt Rock, South Africa.

ICD-10	W56
ICD-9	E906.3 E906.3

A **shark attack** is an attack on a human by a shark. Every year around 60 shark attacks are reported worldwide, although death is quite unusual. Despite the relative rarity of shark attacks, the fear of sharks is a common phenomenon, having been fueled by the occasional instances of serial attacks, such as the Jersey Shore shark attacks of 1916, and by horror fiction and films, such as the *Jaws* series. Many shark experts feel that the danger presented by sharks has been exaggerated, and even the creator of the *Jaws* phenomenon, the late Peter Benchley, attempted to dispel the myth of sharks being man-eating monsters in the years before his death.

Statistics

The great white shark is one of only four kinds of sharks that have been involved in a significant number of fatal unprovoked attacks on humans

In 2000, the year with the most recorded shark attacks, there were 79 shark attacks reported worldwide, 11 of them fatal. In 2005 and 2006 this number decreased to 61 and 62 respectively, while the number of fatalities dropped to only four per year. Of these attacks, the majority occurred in the United States (53 in 2000, 40 in 2005, and 39 in 2006). *The New York Times* reported in July 2008 that there had been only one fatal attack in the previous year. Despite these reports, however, the actual number of fatal shark attacks worldwide remains uncertain. For the majority of third world coastal nations there exists no method of reporting suspected shark attacks therefore losses and fatalities at near-shore or sea there often remain unsolved or unpublicized.

The United States has had more reported shark attacks than any other country, with a total of 1,049 attacks (49 fatal) during the past 339 years (1670–2009). According to the International Shark Attack File, the states in the U.S. where the most attacks have occurred in are Florida, Hawaii, California, Texas, and the Carolinas, though attacks have occurred in almost every coastal state. Outside the U.S., Australia and South Africa have had the most attacks.

As of 2009, the ISAF recorded a total of 2,251 attacks worldwide since 1580, with 464 attacks being fatal. The location with the most recorded shark attacks is New Smyrna Beach, Florida. First world nations such as the United States, Australia, both high income countries, and to some extent South Africa, an upper middle income country, facilitate more thorough documentation of shark attacks on humans than poorer coastal countries.

The Florida Museum of Natural History compares these statistics with the much higher rate of deaths from other, less feared causes. For example, an average of more than 38 people die annually from lightning strikes in coastal states, while less than 1 person per year is killed by a shark.

Even considering only people who go to beaches, a person's chance of getting attacked by a shark is 1 in 11.5 million, and a person's chance of getting killed by a shark is less than 1 in 264.1 million. In the United States, the annual number of people who drown is 3,306, whereas the annual number of shark fatalities is 1.

Species involved in incidents

A blacktip reef shark. In rare circumstances such as bad visibility, blacktips may bite humans, mistaking them for prey. Under normal conditions, however, they are harmless and often even quite shy.

Contrary to popular belief, only a few sharks are dangerous to humans. Out of more than 360 shark species, only four have been involved in a significant number of fatal unprovoked attacks on humans: the great white, tiger, bull and the oceanic whitetip. These sharks, being large, powerful predators, may sometimes attack and kill people; however, they have all been filmed in open water by unprotected divers. The 2010 French film Oceans shows footage of humans swimming next to sharks deep in the ocean. It is possible that the sharks are able to sense the presence of unnatural elements on or about the divers, such as polyurethane diving suits and air tanks, which may lead them to accept temporary outsiders as more of a curiosity than prey. Uncostumed humans, however, such as those surfboarding, light snorkeling, or swimming, present a much greater area of open meaty flesh to carnivorous shark predators. In addition the presence of even small traces of blood, recent minor abrasions, cuts, scrapes, or bruises, may convince sharks to attack a human in their environment. Some sharks such as the Hammerhead seek out prey through electromagnetic detection, an unpreventable transmission relative to natural human intervention in an oceanic environment. Most of the oceanic whitetip shark's attacks have not been recorded, unlike the other three species mentioned above. Famed oceanographic researcher Jacques Cousteau described the oceanic whitetip as "the most dangerous of all sharks".

Watson and the Shark by J.S. Copley, based on an attack on a swimmer in Havana in 1749

Modern day statistics show the oceanic whitetip shark as being seldom involved in unprovoked attacks. However, there have been a number of attacks involving this species, particularly during World War I and World War II. The oceanic whitetip lives in the open sea and rarely shows up near coasts, where most recorded incidents occur. During the world wars many ship and aircraft disasters happened in the open ocean, and due to its former abundance the oceanic whitetip was often the first species on site when such a disaster happened.

Infamous examples of oceanic whitetip attacks include the sinking of the *Nova Scotia*, a steamship carrying 1000 people, that was sunk near South Africa by a German submarine in World War II. Only 192 people survived, with many deaths attributed to the oceanic whitetip shark. Another example was the torpedoing of the USS *Indianapolis* on 30 July 1945, giving a minimal figure of 60–80 killed by oceanic whitetips. Some survivors stated that tiger sharks were involved too.

Incidents involving the oceanic whitetip total in the thousands worldwide

In addition to the four species responsible for a significant number of fatal attacks on humans, a number of other species have attacked humans without being provoked, and have on extremely rare occasions been responsible for a human death. This group includes the shortfin mako, hammerhead, Galapagos, gray reef, blacktip reef, lemon, silky, and blue sharks. These sharks are also large, powerful predators which can be provoked simply by being in the water at the wrong time and place, but they are normally considered less dangerous to humans than the previous group.

A few other shark species do attack people every year, producing wounds that can potentially kill, but this occurs either specifically because they have been provoked, or through mistaken identity due to water conditions or the like. But every year only an average of 41 people are killed by sharks, while over 100 million sharks are killed every year, a portion of which due to the demand for shark fin soup.

Types of attacks

Scientists have defined 2 types of shark attacks (one of which has 3 subcategories):

- Provoked attack – the human touches the shark, pokes it, teases it, or otherwise aggravates/provokes it in some way.
- Unprovoked attack
    - Hit-and-run attack – Usually non-fatal, the shark bites and then leaves; most victims do not see the shark.
    - Sneak attack – Victim will not usually see the shark, they may receive repeated deep bites. This is the most fatal kind of shark attack.
    - Bump-and-bite attack – The shark bumps before biting and then normally swims away.

Reasons for attacks

While one should be very cautious with great white sharks, they do not target humans as prey.

Sharks are apex predators in their environment, and thus have little fear of any creature they cross paths with. Like most sophisticated hunters, they are curious when they encounter something unusual in their territories. Lacking any limbs with sensitive digits such as hands or feet, the only way they can explore an object or organism is to bite it; these bites are known as exploratory bites. Generally, shark bites are exploratory, and the animal will swim away after one bite. For example, exploratory bites on surfers are thought to be caused by the shark mistaking the surfer for the shape of prey. Nonetheless, a single bite can grievously injure a human if the animal involved is a powerful predator like a great white or tiger shark.

Despite a few rare exceptions, it has been concluded that feeding is not a reason sharks attack humans; as stated on Howstuffworks.com, "Humans are not on the menu. In fact, humans don't provide enough high-fat meat for sharks, which need a lot of energy to power their large, muscular bodies".

Sharks normally make one swift attack and then retreat to wait for the victim to die or exhaust itself before returning to feed. This protects the shark from injury from a wounded and aggressive target; however, it also allows humans time to get out of the

water and survive. Shark attacks may also occur due to territorial reasons or as dominance over another shark species, resulting in an attack.

Sharks are equipped with sensory organs called the Ampullae of Lorenzini that detect the electricity generated by muscle movement; another theory is that the shark's electrical receptors, which pick up movement, pick up the signals like those emitted by wounded fish from someone who is fishing or spearfishing, and thus attack the person by mistake.

George Burgess, director of the International Shark Attack File, said the following regarding why people are attacked: "Attacks are basically an odds game based on how many hours you are in the water".

Prevention

While there is no way to completely eliminate the possibility of a shark attack when you are in the water, one may take precautions such as:

- avoiding the water at dawn, dusk, or night, when sharks tend to feed;
- avoiding areas where sharks generally locate themselves, such as murky waters and steep drop-offs
- avoiding swimming alone, always being near a group of people, and if possible, avoiding being at the edge of the group;
- refraining from excess splashing or movement;
- preventing pets from entering the water;
- avoiding shiny jewelry, tan lines and bright clothing, all of which can attract sharks;
- avoiding entering water if bleeding from an open wound or if menstruating;
- avoiding areas where the remains of fish have been discarded into the water, such as near fishermen cleaning their catch.

Dolphins' protection

There are many documentations of dolphins protecting humans from shark attacks, such as an attack on a surfer in northern California in August 2007. It was also documented off the coast of New Zealand in 2004. Typically, dolphins form a ring around humans who are injured. However, in spite of years of scientific study, there has been no conclusive explanation given for this behavior; as mentioned in the *Journal of Zoology*, "The importance of interactions between sharks and cetaceans has been a subject of much conjecture, but few studies have addressed these interactions". In some cases, sharks have been seen attacking, or trying to attack dolphins. As stated by ISAF: "Remember that sightings of porpoises do not indicate the absence of sharks — both eat the same food".

Chapter- 10

Shark Finning

NOAA agent counting confiscated shark fins

Shark finning refers to the removal and retention of shark fins and the discarding at sea of the carcass. Shark finning takes place at sea so the fishers only have to transport the fins.

Shark finning is widespread, and largely unmanaged and unmonitored. Shark finning has increased over the past decade largely due to the increasing demand for shark fins for Chinese shark fin soup and traditional cures, improved fishing technology, and improved market economics.

Some researchers reckoned that from 1996 to 2000, 26 to 73 million sharks were traded yearly. The annual median for the period was 38 million, nearly four times more than the UN estimates but considerably lower than those of many conservationists. Shark fins are a billion dollar industry.

Process

According to wildlife conservation much of the sharks' fin trade uses fins cut from living sharks, called **finning**. Because shark meat is worth much less, the now finless and often still-living sharks are thrown back into the sea to make room for more of the valuable fins. In the ocean, the sharks either die from suffocation or are eaten because they are unable to move normally.

Impact and reporting

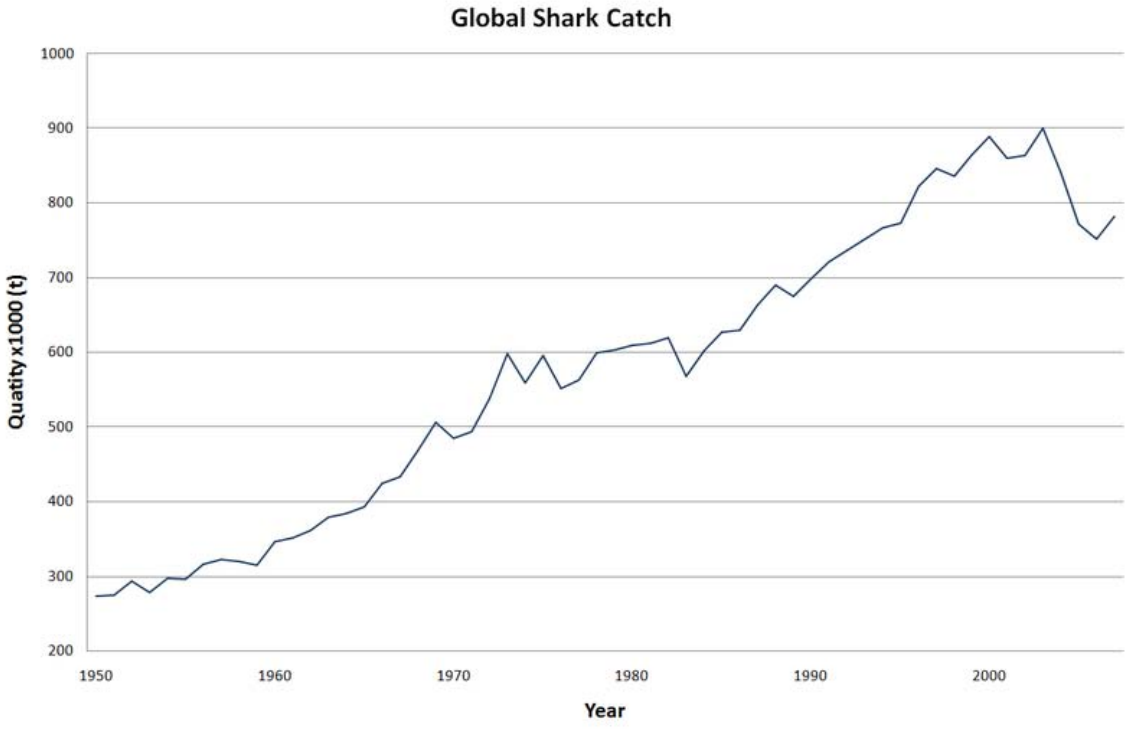


Chart showing shark fishing on the rise, from 1950 to 2004

According to Giam Choo Hoo, the longest serving member of The Convention on International Trade in Endangered Species of Wild Fauna and Flora Animals Committee, "The perception that it is common practice to kill sharks for only their fins - and to cut them off whilst the sharks are still alive - is wrong.... The vast majority of fins in the market are taken from sharks after their death." However, some researchers dispute this claim after extensive examination of fin sourcing and fisheries data; one study of sharks harvested for their valuable fins estimates that between 26-73 million sharks are killed each year worldwide, which is almost three times higher than official Food and Agriculture Organization estimates.

The crew of the conservation vessel Ocean Warrior witnessed and photographed industrial-scale finning within Costa Rica's Cocos Island National Park protected marine area. The practice is featured in the documentary *Sharks: Stewards of the Reef*, which contains footage from Western Australia and Central America and also examines shark finning's cultural, financial and ecological impacts. Underwater photographer Richard Merritt also has witnessed finning of living sharks in Indonesia where he saw immobile finless sharks lying on the sea bed still alive below the fishing boat. Finning has been witnessed and filmed within a protected marine area in the Raja Ampat islands of Indonesia.

Dorsal fin of a shark

Animal welfare groups vigorously oppose finning on moral grounds and also because it is one cause for the rapid decline of global shark populations. On the IUCN red list there are 39 species of elasmobranches (sharks and rays) listed as threatened species (Critically Endangered, Endangered or Vulnerable). CITES lists three sharks in Appendix II: the basking shark, the great white shark, and the whale shark. Appendix II lists those species that are not in danger of extinction, but which require controls on international trade to maintain their populations. It is estimated that 10–100 million sharks are slaughtered each year for their fins with a median figure of 38 million. The industry is valued at US$1.2 billion; because of the lucrative profits, there are allegations of links to organized crime. They also raise questions on the medical harm from the consumption of high levels of toxic mercury reportedly found in shark fins.

Shark fin fishing boat off the Galapagos, Ecuador

Numbers of some shark species have dropped as much as 80% over the last 50 years. Some organizations claim that shark fishing or bycatch (the unintentional capture of species by other fisheries) is the reason for the decline in some species' populations and that the market for fins has very little impact – bycatch accounts for an estimated 50% of all sharks taken – others that the market for shark fin soup is the main reason for the

decline. Tommy Cheung, the legislator representing Hong Kong's catering sector, said: "I don't believe sharks are an endangered species. Some species of shark may be, but not all shark's fin comes from certain species. There are a lot of species that are plentiful." There is no reliable count for the numbers taken in the shark fin trade and thus it is hard to prove the claims on either side of the argument.

According to Giam's article, "sharks are caught virtually all parts of the world. Despite the strongly declared objectives of the Fisheries Commission in Brussels, there are very few restrictions on fishing for sharks in European waters. The meat of dogfishes, smoothhounds, cat sharks, skates and rays is in high demand by European consumers...The situation in Canada and the United States is similar: the blue shark is sought after as a sport fish while the porbeagle, mako and spiny dogfish are part of the commercial fishery...the truth is this: Sharks will continue to be caught and killed on a wide scale by the more organized and sophisticated fishing nations...targeting shark's fin soup will not stop this accidental catch. The fins from these catches will be thrown away or turned into animal feed and fertilizers if shark's fin soup is shunned."

International reaction

Many countries now prohibit finning; however, many international waters are unregulated. International fishing authorities are considering banning shark fishing (and finning) in the Atlantic Ocean and Mediterranean Sea. Finning is banned in the Eastern Pacific, but shark fishing and finning continues unabated in most of the Pacific and Indian Ocean. In countries such as Thailand and Singapore, public awareness advertisements on finning have reportedly reduced consumption by 25%. In 2007, Canadian filmmaker and biologist Rob Stewart created a film, *Sharkwater*, which exposes the shark fin industry in detail.

China

A dried shark fin on display with dried sea cucumbers and abalone

NBA All-Star Yao Ming pledged to stop eating shark fin soup at a news conference on August 2, 2006. Yao's comments were largely unreported in the Chinese media and drew a reproach from Chinese seafood industry associations. Ironically, shark fin soup was on Yao Ming's wedding dinner menu. U.S. basketball player Tracy McGrady, a team mate of Yao's, reportedly said that he was impressed by the soup when he tried it for the first time, but was criticized by the Hong Kong branch of the World Wide Fund for Nature for his remark. Late Australian naturalist Steve Irwin was known to walk out of Chinese restaurants if he saw shark fin soup on the menu. The Chinese-American chef, Ken Hom, sees the West doing little to protect stocks of cod and caviar-producing sturgeon despite

the outcry over shark-finning, but he also stresses the wastefulness of harvesting only the fins.

Hong Kong

Hong Kong Disneyland dropped shark fin soup from its wedding banquet menu after international pressure from environmental groups, who threatened to boycott its parks worldwide despite the high demand for the delicacy in China. The University of Hong Kong has banned shark fin on campus.

Malaysia

On September 15, 2007, Malaysia's Natural Resources and Environment Ministry Azmi Khalid banned shark's fin soup from official functions committing to the Malaysian Nature Society (for conservation of shark species).

New Zealand

The great white sharks have been given full protection in the territorial waters of New Zealand but shark finning is legal on other shark species if the shark is dead. The Royal Forest and Bird Protection Society of New Zealand are campaigning to raise awareness of shark finning and a number of foodies have fronted the campaign.

Palau

In 2009, the Republic of Palau created the world's first shark sanctuary. It is illegal to catch sharks within Palau's EEZ, which covers an area of 230,000 square miles (600,000 km^2). This is an area about the size of France. President Johnson Toribiong also called for a ban on global shark finning, stating: "These creatures are being slaughtered and are perhaps at the brink of extinction unless we take positive action to protect them."

United States

Bill Clinton banned finning in the United States and with U.S.-registered vessels, but not foreign-registered vessels. Shark fins cannot be imported into the U.S. without the associated carcass. In 1991, the percentage of sharks killed by U.S. longline fisheries in the Pacific Ocean for finning was approximately 3%. By 1998, that percentage had grown to 60%. Between 1991 and 1998, the number of sharks retained by the Hawaii-based swordfish and tuna longline fishery had increased from 2,289 to 60,857 annually, and by 1998, an estimated 98% of these sharks were killed for their fins.

In January 2009, the United States House of Representatives passed the Shark Conservation Act of 2009 to close loopholes in the US finning ban. The measure is pending in the United States Senate.

In 2010, Hawaii became the first state to ban the possession, sale and distribution of shark fins. The law will take effect on July 1, 2011.

In January 2011, President Barack Obama signed the Shark Conservation Act into law to close the loopholes of the 2000 Shark Finning Prohibition Act. Specifically, the new law prohibits any boat to carry shark fins without the corresponding number and weight of carcasses, and all sharks must be brought to port with their fins attached.

Chapter- 11

Shark Fin Trading in Costa Rica

Confiscated shark fins

Shark fin trading in Costa Rica, or shark finning, is an illegal practice in the country. It poses a serious problem with shark populations and organized crime within Costa Rica. The trade in Costa Rica is vigorously controlled by the Taiwanese mafia because of the high value of shark fins in restaurants in the Pacific Rim countries such as Taiwan, Hong Kong and China where Shark fin soup can cost up to $100 a serving in top restaurants. Some 95% of shark fin trading activity in Costa Rica culminates in the docks of Puntarenas on the western coast, notably Inversiones Cruz Dock and Harezan Dock, which are often privately run by the Taiwanese. The industry in Costa Rica took off from the 1970s as a result of the growth in demand from the emerging wealthy Tiger economies of the Asia-Pacific for shark fin as a delicacy. By the 1990s, the shark fin industry in Costa Rica had become one of the world's most important in shark finning, especially as a major cargo-unloading point for international fleets because of lax laws and government corruption in cracking down on the trade.

However, there is environmental awareness of the consequences of fin trade exploitation which could result in shark extinction. Prompted by WildAid's campaigns, in East Asia, high profile politicians and their kin, film personalities, industrial establishments and committed individuals took voluntary "No shark fin" pledge. In January 2011, it was reported that British chef Gordon Ramsay and his TV crew were held at gunpoint and soaked with petrol when filming a documentary about the illegal trade in Costa Rica.

Practice

According to Ramsay, shark finning in Costa Rica is "A multi-billion dollar industry, completely unregulated. We traced some of the biggest culprits to Costa Rica. These gangs operate from places like forts, with barbed wire and gun towers." In response to poor incomes and pressure, local fisherman are forced into harvesting shark fins, despite only getting about one dollar per pound on an average, less than a third of its total retail value. Corrupt politicians are silenced with a fee to ignore government regulations. The practice involves sharks being caught by a horizontal drag line with many baited hooks, known as longline fishing. According to biologist Jorge Ballestero of the Costa Rican Sea Turtle Restoration Project (Pretoma) "Costa Rica has become intricately linked to this trade for two reasons: It has the biggest longliner fleet in the hemisphere, and it allows international vessels dedicated to the exploitation and trade of shark fins to land here."

The Taiwanese mafia dominate the shark finning industry in Costa Rica, although Indonesian gangs also have a foothold in the market. The Taiwanese and Indonesian mafia operate private docks in the Puntarenas area, notably Inversiones Cruz Dock and Harezan Dock and several others where some 95% of all catches are brought in, transported by truck to San José and flown mostly to Hong Kong. According to the Costa Rican customs adviser Omar Jiminez, at least three boats full of shark fins enter the ports in Puntarenas every week.Kaohsiung in Taiwan is one of the biggest ports in the world for importing shark fins. They are brought in from overseas and are placed out to dry in the sun on residential rooftops near the port.

However, it should be noted that various shark cartilage industries in the country exist, depending on the import of cartilages from other countries. Costa Rica is mentioned as one such country where a leading processing plant is said to be purchasing raw cartilages from any source in the world to carry out semi or primary processing before exporting it, particularly to the USA. The USA then markets it worldwide in the processed shark cartilage powder form, in four or five brand names.

History

In the 1970s, mass local and reef fishing off the Central America coasts had a profound effect on coastal shark populations throughout the Americas. FAO initiated action in 1999 to introduce a "Voluntary Plan of Action for sharks."

In 1982, the National Learning Institute of Costa Rica received technical support and financing from the Taiwanese government to modernize its fishing fleet according to Pretoma. This had a major impact on the finning industry in Costa Rica, which subsequently took off in the 1980s (especially after 1986). Due to low shark populations on the coasts, the updated vessels could now venture further out to sea and use longline technology to greatly increase their catches. Meeting the increasing demand in the Tiger economies of the Pacific Rim countries for shark fins brought about their economic growth and increased wealth in the 1980s and 1990s. By the late 1990s, Costa Rica had become established as a major cargo-unloading point for international fleets and thus became a key component in the global finning industry.

In May 2003, a young Costa Rican Coast Guard official, Manuel Silva, reported the landing of a Taiwanese fishing vessel with 30 tons of shark fins on board. Not only were the Taiwanese vessels ignored by the four agencies charged with checking incoming cargos but the Costa Rican Fishing Institute (Incopesca) also failed to take action following his report.

In 2006/2007, Canadian director Rob Stewart went to Costa Rica and the Galapagos to shoot what he thought would be an innocent documentary after sharklife underwater in the film *Sharkwater*. However, shortly into filming, they stumbled across the Taiwanese mafia, the illegal shark fin trade and, feared for their lives when chased by gunboats. They managed to secretly capture footage of the traders in the film.

Today, Costa Rica is one of the world's most important participants in the shark-fin trade.

Demand

Top: Shark fin in a Japanese health store. Bottom: Shark fin soup

In Hong Kong restaurants, where the market has traditionally been strong, Shark fin soup can fetch up to $100 a serving in the top restaurants. However, the demand from Hong Kong natives has reportedly dropped, but this has been more than balanced by an increase in demand from the Chinese mainland, fueled by its growing economy and increased wealth, as the economic growth of China has put this expensive delicacy within the reach of a growing middle class. This increase in demand, combined with the importance of this top predator in the ocean, has the potential to significantly alter oceanic ecosystems. The high price of the soup means that is often used as a way to impress guests or at celebrations. Shark fin is also incorrectly perceived by some as having high nutritional value, as well as cancer and osteoarthritis fighting abilities. Based on information gathered from the Hong Kong trade in fins, the market is estimated to be

growing by 5% a year. In 1998, China imported a reported 4,240 tonnes of shark fins worth US$24.7 million, but Costa Rica competed with Japan, Spain, Singapore, Indonesia, Hong Kong, Vietnam, Norway, Ecuador, Peru and Fiji in providing for the Chinese market. In China, shark fins are increasingly being used in less extravagant items such as cakes, cookies, bread and even cat food.

In the South Asian region, use of shark cartilage in preparing soups is considered a health tonic. Hong Kong imports it from North and South American countries, particularly for use in either a cooked format or to prepare boiled soup, as a health fad, by mixing it with herbals supplements.

Another large demand for shark cartilage is for manufacture of "Shark Cartilage Powder" or pills as a cure for cancer. The anti cancer claims of such powders marketed in many parts of the world has been discounted by the US Food and Drug Administration and Federal Trade Commissions. In spite of such injunctions, the trade in this powder continues and the shark cartilage powder is still widely marketed as a cancer cure, stated to be selling at US$145 per gram. It is also stated that in Costa Rica, one single firm alone processed 235,000 sharks every month to manufacture cartilage pills.

Environmental concerns

Hammerhead shark off Cocos Island, Costa Rica where illegal shark activities are difficult to deter because of limited manpower.

Since the late 1980s populations of northwest Atlantic coastal and oceanic shark have dropped by an average of 70%, and in 2003 the World Conservation Union (IUCN) estimated that tens of millions of sharks are finned and discarded at sea every year. However, estimates are muddy given the fact that the sharks and their fins cross-cut different fishing markets (not to mention that the vast majority of sharks are exploited in the Pacific coast of Costa Rica as opposed to the Atlantic coast). The major environmental problem facing Costa Rican waters by mass shark finning is that the fishermen involved in the practice of killing sharks for their fins pay no attention to the age, gender, size, or even the species of shark. Young shark may be killed off, drastically affecting the ability to breed. A further biological complication is that sharks are naturally slow to breed and mature, which makes the possibility of extinction for many shark species in Costa Rican waters becoming increasingly ominous.

As far back as 1999, FAO initiated action to introduce a "Voluntary Plan of Action for sharks." The response, though not spontaneous, received support from 15 countries including Costa Rica. Even in the early 2000s, the fin trade market's influence on over exploitation of fins was realized, with many countries imposing ban on fishing of these species. Goaded by WildAid's campaigns in East Asia, high profile politicians and their kin, film personalities, industrial establishments and committed individuals took voluntary "No shark fin" pledge and many personalities hosted banquets with "shark free" announcements. There is now constant publicity in the media in this regard in eastern Asia.

Crackdown

Chen Shui-Bian, together with Abel Pacheco, launched a crackdown on shark finning, with little success.

Former Costa Rican president Abel Pacheco, a noted environmentalist, and his Taiwanese counterpart, Chen Shui-Bian began a crackdown on shark finning in the early 2000s. However, enforcement is nearly impossible because of corrupt politicians and the terror created by the Taiwanese mafia preventing officials from making a stand against the trading. A reform bill has been proposed in Congress since the late 1990s in which a law would be passed entailing a prison term of up to two years for any perpetrator involved in the trafficking of fins that have been cut from sharks' bodies before the catch has reached the dock. In this context, Pretoma has obtained a petition of over 20,000 signatures calling for the suspension of landing permits for foreign fishing vessels. Although the opposition to the trading is high and indeed illegal, effectively cracking down on the industry will be difficult as long as law enforcement and monitoring of fishing vessels is slack and corruption and poverty remain. The Taiwanese and Indonesian mafia even run their own private docks in Puntarenas which are known to the government and the Costa Rican police but incoming vessels are rarely inspected in a climate of fear. The port of Puntarenas, as of 2003, only had three inspectors allocated to the inspection of hundreds of vessels and generally only examines about 20% of them. As of 2003, no full-scale government investigation has been instituted into the port of

Puntarenas, widely known to be the linch-pin of the illegal Costa Rican shark fin trading industry. In 2007, Costa Rica was again internationally criticized for its handling of sharkfinning.

Gordon Ramsay incident

In early January, 2011, British chef Gordon Ramsay and his TV crew were threatened at gunpoint and with petrol while filming for his episode of the new Channel 4 show, *Big Fish Fight*. Ramsay said of the incident, "Back at the wharf, there were people pointing rifles at us to stop us filming. A van pulled up and these seedy characters made us stand against a wall. The police came and advised us to leave the country. They said, 'If you set one foot in there, they'll shoot you.' At one point, I managed to shake off the people keeping us away, ran up some stairs to a rooftop and looked down to see thousands of fins, drying on rooftops as far as the eye could see. When I got back downstairs, they tipped a barrel of petrol over me."