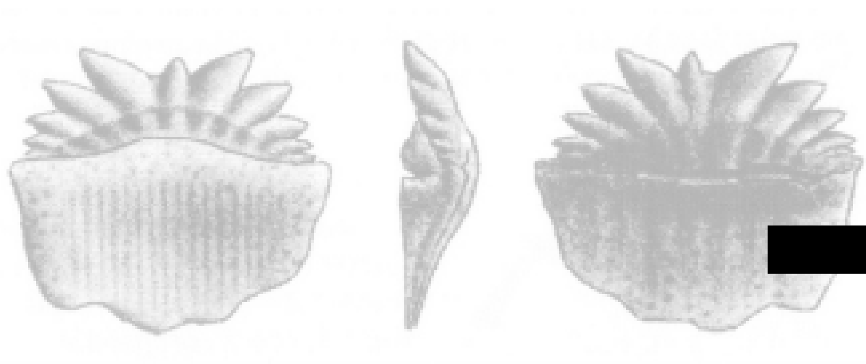

Fossil Shark Teeth

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Fossil Shark Teeth

For over 300 years fossil shark teeth have been objects of both curiosity and study. They are common vertebrate fossils in rocks ranging in age from the Devonian time to the last Ice Age (spanning about 400 million years). About 200 hundred years ago, European paleontologists began the scientific study of shark teeth. The great diversity of tooth forms they found spurred them into naming many questionable species. All of these supposed species caused much confusion about the evolution of sharks. In the paragraphs that follow, you will read why shark teeth are common, how they form and grow, how they vary, how paleontologists are now resolving the problems of shark nomenclatural and evolutionary history, and finally a brief history of fossil sharks.

The abundance of shark teeth as fossils is due their denseness and mineral composition and to their rapid, continual replacement in the shark's jaws. Modern studies of living sharks indicate that they shed and replace their teeth every 7 days; this rate of replacement may slow in large adults to once or twice a year. At any one time, most species of living sharks have between 50 and 100 biting or functional teeth. Old teeth drop from their jaws to the sea floor where they are often buried by sediments. This is why shark teeth are common as fossils.

Unlike other vertebrates, whose teeth grow in alveoli or "sockets" or are firmly fused to the jaw bone, shark teeth develop outside the inner surface of the jaw in the gum tissue; for each functional tooth, there are five to six teeth in differing stages of formation behind it forming a tooth row. The teeth are held in their positions by connective tissue until they are shed. The teeth grow from the tip down with the root being completed as the tooth approaches a functional position. Each tooth has the same form as and will be slightly taller than the one preceding it. The growing teeth push the older ones toward the edge of the jaw where they are shed.

Shark teeth may exhibit several types of variation. The teeth of a single species often change shape from prenatal development into adulthood, which is called ontogenetic heterodonty. They can gain or lose serrations (sawtoothed cutting edges) or lateral cusplets. They may go from being erect to strongly curved toward the angle of the jaws or vice versa. In some sharks, the juvenile teeth are narrow and robust (in cross section), and in adults, they become broader and thinner. In some species, the teeth of males are different from those of females, which is called sexual heterodonty. Since female sharks are usually larger than males, they have larger teeth. Some species, such as

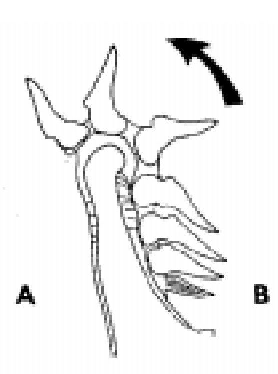

Figure 1. Cross Section of *Lamna* jaw. A:lip side. B: throat side. Arrow: direction of movement. Adapted from James (1953).

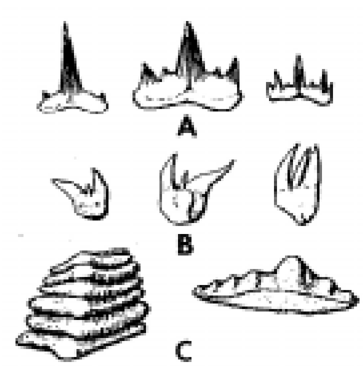

Figure 2. Paleozotc shark teeth: A.Cladodus, B.Pleuracanth, C. Orodus. Adapted from Romer (1966).

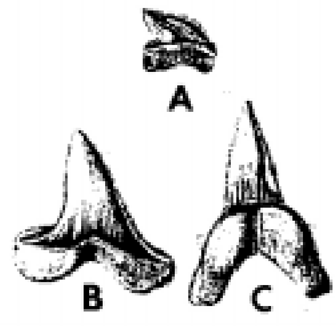

Figure 3. Cretaceous shark teeth: A.*Squalicorax*, B. *Cretoxyrhina*, C.*Cretodus*.

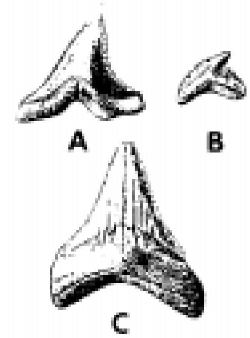

Figure 4. Tertiary Shark teeth: A. Hemipristis, B. Galeocerdo, C. Carcharodon. Adapted from Eastman (1904).

in lemon and tiger sharks, may have teeth that are alike in the upper and lower jaws, which is called homodonty. In species such as in the bull and dusky sharks, the upper teeth may be broad blades while the lower teeth are narrow and pointed, which is called dignathic heterodonty. Many lamnoid sharks, which include the mako, sandtiger, and great white sharks, have elongate anterior teeth, smaller lateral teeth, and very small posterior teeth, which is called monognathic heterodonty. Thus, shark teeth of a single species can vary between individuals of different sizes, different sexes, between jaws, and within jaws. Variability is the rule for shark teeth.

Until recently, scientists were hampered in their study of fossil sharks because of the lack of large samples of dentitions from living species; paleontologists did not know that tooth form varies widely within a species. Now, paleontologists studying this variation in the living species are discovering that many fossil species are invalid duplicate names and that fossil shark species cannot be identified on the basis of isolated teeth. Therefore, a new method for studying them had to be found.

Because associated dentitions are rarely found, paleontologists decided to reconstruct tooth sets of fossil shark species based on comparisons to those of living related species. This approach is greatly reducing the number of species names needed for fossil sharks, has shown that a shark species may survive for up to 15 million years, and is revising our view of their evolutionary history. The associated dentitions found occasionally are important tests for this new way of studying fossil sharks.

In the fossil record, the cartilaginous skeletons of sharks are rarely preserved. With the exception of a few Paleozoic and Mesozoic species, fossil shark species are known only from their teeth. The following is a sketch of the history those teeth reveal.

According to Maisey (1996), the oldest fossil shark remains are scales from the Late Ordovician Period (445 million years ago); however, sharks were not common until Early Devonian time (about 400 million years ago). In form their teeth were multicusped, single cusped with small cusplets on each side of the main cusp, or pavement teeth. Shark tooth forms changed little until the time of dinosaurs (Mesozoic Era), and the teeth remained small until Cretaceous time (about 145 million years ago).

During the Mesozoic, the first modern sharks (Neoselache) appeared and they became the dominant sharks before the end of Cretaceous time. Some of these sharks had large teeth 1 to 3 inches in height. These include *Cretodus*, which had teeth with a large main cusp and small, triangular cusplets, *Cretoxyrhina*, which had teeth with a larg main cusp and no cusplets, and *Squalicorax*, which had sickle-like, serrated teeth. These sharks ate large fish and large marine reptiles, such as mosasaurs and plesiosaurs; bones of these animals were discovered with tooth marks and pieces of shark teeth embedded in them. Before the last dinosaur died at the end of the Cretaceous, representatives of all the living orders of sharks were present in the sea.

Many Cretaceous sharks survived the Cretaceous extinction event and are present in Lower Tertiary rocks. Of these, only the sandtigers survived beyond Eocene time, and they live in today's seas.

The first white sharks, *Carcharodon*; are known from Paleocene fossils. In the Eocene, a giant-toothed form split off from the small-toothed form. The giant-toothed line persisted until the Late Pliocene or Early Pleistocene time. By Pliocene time, they attained a size of about 50 feet, and the teeth in the front of the jaws measure greater than 6 inches in height. These large teeth are commonly found in association with fossil marine mammal remains; some of these remains bear the tooth marks of these great sharks.

Most families of living sharks are found in the Eocene fossil record. In sediments of this age, paleontologists have found teeth of large mako and tiger sharks and an abundance of sandtiger shark teeth. By Oligocene time, sandtiger teeth were less abundant, and requiem or carcharhiniform teeth become more common. In today's oceans, the requiem sharks are the most common species.

During Tertiary time, climate and shark geographic distributions changed. With the advent of circumpolar circulation in the Antarctic in the Late Eocene, the oceans and climate began to cool. Warm seas that previously extended to polar regions slowly retreated equatorward. By Pleistocene (Ice Age) time (about 1.6 million years ago), many warm water sharks had retreated from the Atlantic Ocean, which was cooler than the Pacific and Indian oceans. Others, however, such as the Greenland and mackerel sharks evolved adaptations to cold water.

Today, as paleontologists learn more about living sharks, they reexamine the evolutionary history of fossil sharks. In the light of new data, they are beginning to understand variation in fossil species. Paleontologists are also looking at the distribution of fossil sharks in rocks and comparing these distributions with those of living sharks. As more of this research is completed, we will gain a more accurate understanding of the evolutionary history of fossil sharks.

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