Beachcombing for fossils

If you have ever taken a field trip to a natural history museum or an aquarium, you may have noticed in the gift shop a display of fossil shark teeth for sale. Often, these teeth can be as old as 65 million years (however, they typically range from 2 to 23 million years). Yet, it’s likely that there is an entire bin of teeth available for purchase. Where did these teeth come from? How are the ages of these teeth known? How is it possible to have so many fossils available? Can I find such teeth on my own and, if so, where? These are questions that people of all ages often ask while marveling at these beautiful relics from eons past, and these are the questions we answer in this month’s After the Bell.

Anatomy of the shark

Sharks, stingrays, and skates all belong to a class of fish called Chondrichthyans. All the fish in the class Chondrichthyans have cartilaginous skeletons; that is, they have no bones (although some species will have some vertebrae that are calcified). They do, however, have teeth composed of calcium, but these teeth are not fused to the jaws. Though sharks’ teeth vary in size and shape, nearly all grow along rows and are continually replaced as old teeth break or fall out. Actually, shark teeth are a modified placoid scale. Analogous to scales on some boney fish, placoid scales cover the skin of sharks. Indeed, if you were to look at shark skin under the microscope, you would see what appears to be row after row of tiny scales shaped like teeth. And, like the placoid scales found on the skin, those modified scales in the mouth called shark teeth grow in abundance. Over the course of a lifetime, a single shark may grow and lose tens of thousands of teeth. With sharks swimming in Earth’s oceans for nearly 400 million years, that’s quite a lot of lost teeth!

Stingrays

Stingrays (order Myliobatiformes) and their relatives, including skates (order Rajiformes) and guitarfishes (family Rhinobatidae), like sharks, are also fish within the class Chondrichthyans. As such, these fish do not have bones. Similar to sharks, their placoid scales are modified for various functions, such as for service as teeth and dorsal spines, including the notorious venomous spine of some rays.

The fossilization process

A fossil is any trace or remains of a living species that is generally older than 10,000 years. Not all fossils are petrified remains of living organisms. There are cases in which fossils are preserved remains of soft tissue and skins. Woolly mammoths, for example, have been found preserved in ice, while insects have been preserved in amber. Nonetheless, in many instances, the processes associated with fossilization (a rapid burial in loose, dry, or moist sediment and protection from weathering conditions) result in the preservation of hard parts such as bones and teeth. In the absence of bones, shark fossils are most often found in the form of teeth. While some teeth can be permineralized (permineralization is a process in which organic material is replaced by inorganic minerals), in many cases the preserved specimens of these ancient marine animals are the actual teeth!

When choosing from the gift store bin of shark teeth, you may have noticed that not all teeth are the same hue. These differences in coloration, varying from light to dark to black, are a function of the color of the sediment in which the teeth were buried or the mineral content (chemistry) of the sediment. Fossil shark and ray teeth are commonly black with a shade of gray on the root due to the dark phosphates in the sediments.

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The ancient environment

To begin a discussion of the places fossil shark teeth are found, we start with a brief overview of the geologic time scale. Paleontologists have separated Earth’s history in which life was present into three major divisions (eras). They include the Paleozoic era (543 to 248 million years before the present), the Mesozoic era (248 to 65 million years before the present), and the Cenozoic era (65 million years before the present to present time). There are further divisions of the Cenozoic era into periods and epochs (see Figure 1). Incidentally, the era before life appeared is known as the Precambrian. While sharks have been around for hundreds of millions of years, the most commonly found fossil teeth are those falling within the Cenozoic era. Warm, shallow waters largely covered the North American continent during the Miocene epoch. The present day East Coast was submerged, as were the Gulf Coast and the Great Valley of California. Sharks and other marine animals were abundant in these waters.

During the Miocene epoch, several factors contributed to the abundant preservation of shark teeth including: (1) the prolific generation (and loss of) teeth over the lifetime of the shark, (2) the hardness of shark’s teeth, (3) large numbers of sharks in those ancient seas, and (4) an environment conducive to preservation (marine environments with moist sandy floors and frequent turbulence due to storms and waves that often lead to quick burial). Over millions of years, the seas retreated, Earth surfaces were exposed, and thick deposits of sediments in some areas were eroded. Today, the fossiliferous, sedimentary beds containing shark teeth can be eroded by rivers and streams and even rising oceans. Alternatively, these fossil sites can be exposed through road cuts as streets and highways are built.

Beachcombing for shark and ray teeth

Fossil shark teeth can be commonly found along ocean beaches. We have found the beaches of North Carolina, for example, to be great places to beachcomb for shark and ray teeth. The best time to look for these teeth is at low tide, closest to the water’s edge within the surf zone (the area between high tide and low tide). Wave actions and littoral currents (running parallel to the beach) tend to cause some low spots and high spots along the sandy shore. In the lower areas (depressions along the beach where wave actions have scooped away small-sized sediments), denser and heavier beach debris such as stones, shells, and, yes, fossil teeth accumulate, while the finer grains of sand are carried away. These are the areas you want to beachcomb for shark teeth. It helps to use a homemade sieve to scoop up small piles

FIGURE 1

Divisions of the Cenozoic Era*

<table>
<thead>
<tr>
<th>Era</th>
<th>Period</th>
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</tr>
<tr>
<td></td>
<td></td>
<td>Paleocene</td>
<td></td>
</tr>
</tbody>
</table>

*Note: The Neogene and Paleogene periods are sometimes grouped and labeled as the “Tertiary period.”

FIGURE 2

Fossil shark teeth

These teeth were found near Booneville, Mississippi. They are around 60 million years old.

FIGURE 3

Stingray teeth

The teeth of stingrays are modified for crushing the hard shells of crustaceans such as crabs and lobsters. These teeth are around 60 million years old and were found near Booneville, Mississippi.
Beachcombing for teeth. A kitchen colander serves as a simple sieve when sorting through shells, sand, and other beach debris.

of unsorted debris, but we like to use a simple kitchen colander. Like panning for gold, shake the partially filled colander to move the rocks and shells around.

Typically, one should search for objects that are either dark and triangular (shark teeth) or rectangular and dark (ray teeth). See Figure 3 for a picture of fossil stingray teeth. One can see that unlike shark teeth, stingray teeth are generally flat and rectangular (sometimes rounded), usually rimmed with small ridges. These teeth are perfect for crushing the shells of crabs and other crustaceans that the rays prey upon. With practice, it becomes easier to distinguish between the very small fossil teeth of sharks and rays and those shells and small rocks that can look awfully similar. However, there will be little chance that you mistakenly identify some of the larger teeth.

The National Science Education Standards (Life Science Content Standard C and Earth’s History Content Standard D) and the Benchmarks for Science Literacy (The Living Environment; Evolution of Life) both identify important content knowledge that can be addressed through a fossil hunt and follow-up activity with students. For example, we like to get students thinking about how fossils provide clues into the evolution of life, the diversity and adaptation of organisms, and the changes that Earth’s surface undergoes by having them write a narrative about their fossil specimens. Using the geological evidence at the site and the fossil records they have found, students construct a narrative to describe the ecosystem that existed at the places where the original teeth were deposited.

**Fossiliferous sites**

There are numerous areas around the United States where fossil shark and ray teeth are found. The Maryland Geological Survey reports, for example, that Miocene shark teeth are abundant in Calvert County along the shore of the Chesapeake Bay. The cliffs of Calvert are reported to be some of the richest, fossil-bearing sites along the eastern seaboard. The site is also known for other marine-species fossils, including whales, fish, and dolphins.

Most people have trouble imagining a marine fossil site in northern Mississippi, yet fossil shark and ray teeth are abundant in the Booneville area. Located about 75 miles southeast of Memphis, Tennessee, this area falls within the Mississippi Embayment, a portion of the Mississippi Valley covered by a shallow sea more than 65 million years ago. In the early 1990s, during the construction of a new highway, an extremely fossiliferous layer of Cretaceous sands was exposed. Today, shark teeth can be found in and around the area and in the streambed of Twenty Mile Creek.

There are a number of sites in North Carolina in which fossiliferous beds containing Miocene shark teeth are exposed. Mining sites in Aurora are among those most notable; however, many collectors report that access to those sites may be limited and requires special permission of the landowners.

Naturally, many of the beaches along the Atlantic Coast are also great places to look for specimens. For example, in North Carolina the beaches along Wilmington through Morehead City are particularly rich in fossils. New Jersey has a number of sites containing shark teeth, including Kirkwood (Miocene), Shark River (Eocene), Manasquan (Eocene), Vincentown (Paleocene), Hornerstown (Cretaceous to Paleocene), Navesink/Mount Laurel (Late Cretaceous), and Marshalltown/Wenonah (Late Cretaceous). Shark teeth (as well as other marine fossils) can be found in the rivers/creeks cutting into these exposures. These are just a few of the more notable sites where amateur fossil hunters can go to look for shark and ray teeth. You can count on finding many more after exploring on your own.

**Where to go for more information**

There are many resources one can investigate for further information on shark teeth, including your state geological field office, local amateur fossil clubs, museums in your area, state university extension services, and regional colleges. Additionally, internet resources are abundant, including
the Shark Research Institute website, an interdisciplinary organization founded in 1991 at Princeton University. Their mission is to educate people, through research and education, as to the valuable role sharks play in the ecosystem. Another helpful site is maintained by the Florida Museum of Natural History. This site offers a variety of scientific information on many shark species and provides an array of links to research consortia dedicated to the study and preservation of sharks (see Resources).

A simple search for books on sharks results in a plethora of choices. NSTA Press publishes a book geared for middle school teachers, *Adventures in Paleontology: 36 Classroom Fossil Activities* (Hansen and Slesnick 2006). This book offers investigations to engage students in learning about the process of fossilization, collecting fossils, and how fossils inform scientists. If you are interested in reading more about shark teeth, we recommend the book *Fossil Shark Teeth of the World* by Joe Cocke (2002). If you need to brush up on your knowledge of sharks in general, we invite you to read the book *Sharks of the World* by the director of the Shark Research Institute, Leonard Compagno, and his colleagues, Marc Dando and Sarah Fowler (2005), and *The Encyclopedia of Sharks* by Steve and Jane Parker (1999). For the younger folk, an alphabet book entitled *Sharkabet: A Sea of Sharks From A to Z* by Ray Troll (2002) may spark curiosity and further the hunt for shark teeth. As one can see, sharks create much fodder for the written word and many more great titles are available for all ages and interests.

**References**


**Resources**
