Time Scale Card: Earliest Sharks

You are a *paleoichthyologist*, an expert in fossil fish! You and your research group are investigating a rock layer in Brazil that is about 400 million years old. Your group finds a tooth and quickly makes a drawing of the front and back to send to an expert at the nearby university for identification.

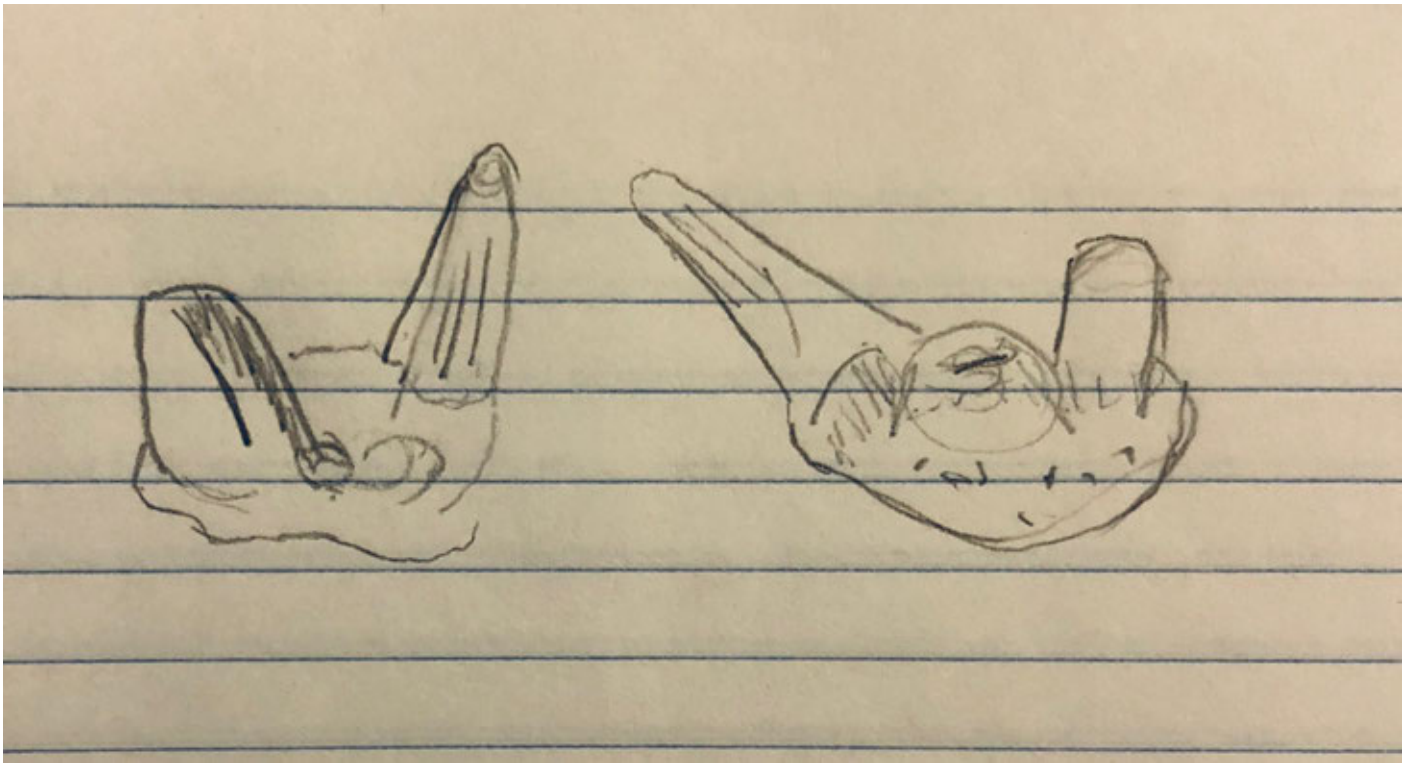


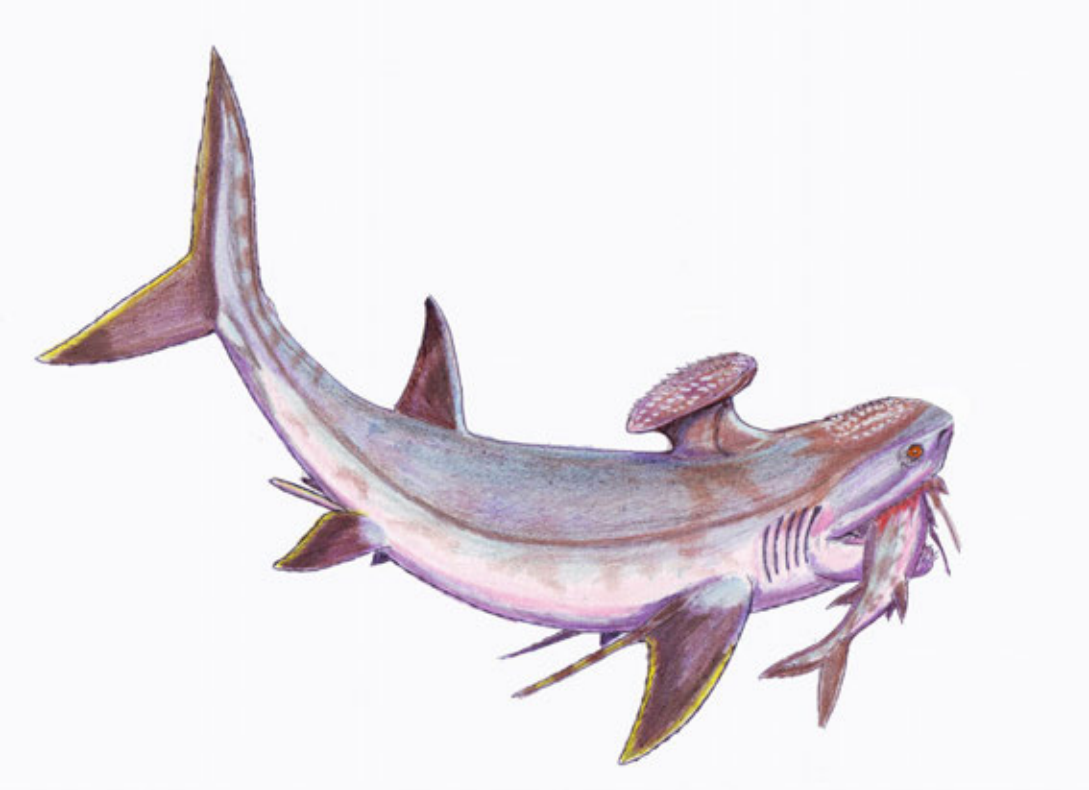
Image by Jill Grace via WestEd [CC BY-NC-SA 4.0]

Your expert replies and identifies the fossil as *Xenacanthus* (gr. *xenos*, lat. *acathos* = "strange spine"), the earliest known shark tooth fossil. These fossils are very rare; not many of these have been found. Your colleague wonders out loud, "Does that mean there were not many sharks living on earth?" Another asks, "Can the number of sharks living at that time be determined?" You are curious about what other life was like during this time, so you pull up your geologic time scale and write "**Earliest Sharks**" to indicate when they first appeared.

Source: Pauliv, V. E., Dias, E. V., Sedor, F. A., & Ribeiro, A. M. (2014)

Time Scale Card: Ancient Sharks

You and your research group are working in a natural history museum, and come across artist sketches of what some early sharks may have looked like, based on rare imprint fossils found in soft shale. The fossils were found in Montana and Scotland in rock layers that are between 360 and 286 million years old. You know that during this time sharks were found all over the world. The fossil record indicates that this was a period of diversification of sharks. *Stethacanthus* are the earliest sharks in the fossil record with dermal denticles (rather than smooth skin). There were even more shark families than there are today! Some of these types of sharks, like *Stethacanthus* pictured below, survived through the Triassic Period. Is it possible to know how many sharks were alive at that time?



Stethacanthus

Image by Dmitry Bogdanov via Wikimedia Common [CC BY-SA 3.0]

You are curious what other life was like during this time, so you pull up your geologic time scale and write "**Ancient Sharks**" to indicate when they first appeared.

Sources: Martin, R. A. (2003), and University of Florida (2018)

Time Scale Card: Origin of Modern Sharks

As a paleoichthyologist specializing in ancient shark identification, you receive a photo of a rare imprint fossil as well as some fossilized teeth.

Hybodus fraasi

Image by Haplochromis via Wikipedia Commons: [CC BY-SA 3.0]

Hybodus plicatilis

Image by Ghedoghedo via Wikipedia Commons: [CC BY-SA 4.0]

You immediately recognize the fossil and teeth as belonging to the genus *Hybodus*, a very common genus found worldwide that were largely marine, but some lived in freshwater. You know that the earliest fossils were found in rocks that are about 280 million years old. You recall that the youngest *Hybodus* fossils (about 66 million years old) were found in the famous Dinosaur Park Formation in southern Alberta, Canada. No fossils have been found that are younger than that.

You decide to place "**Origin of Modern Sharks**" on your timeline, indicating when they first appeared, 280 million years ago. You realize that this species survived the greatest mass extinction of all time—the Permian–Triassic extinction! Approximately 99% of marine species disappeared. How did *Hybodus* survive? You recall that not having food available was the major reason species disappeared. You realize that *Hybodus* probably was able to dive deeper and was able to eat a variety of food, allowing it to survive. Knowing that *Hybodus* has been found in rock layers over a time period of 214 million years (modern people have been on Earth for less than 2 million years), can you determine how many sharks there were during this time?

Sources: Averianov, A. (2014), Discovery Channel (2018), Martin, R. A. (2003), and National Aquarium (2017)

Time Scale Card: Rise of Modern Sharks

A friend recently posted these images after digging around on the internet for images of fossil sharks. She claimed that there was no way they could be fossils! The left image looks just like a ray her family caught while fishing off the pier, and the one on the right looks like a shark she recently saw at the aquarium.

Heliobatis radians

Image by Daderot via Wikipedia Commons [CC0 1.0]

Galeorhinus cuvieri

Image by Ghedoghedo via Wikipedia Commons [CC BY- SA 3.0]

She wrote to you because she knows you are an expert in shark fossils.

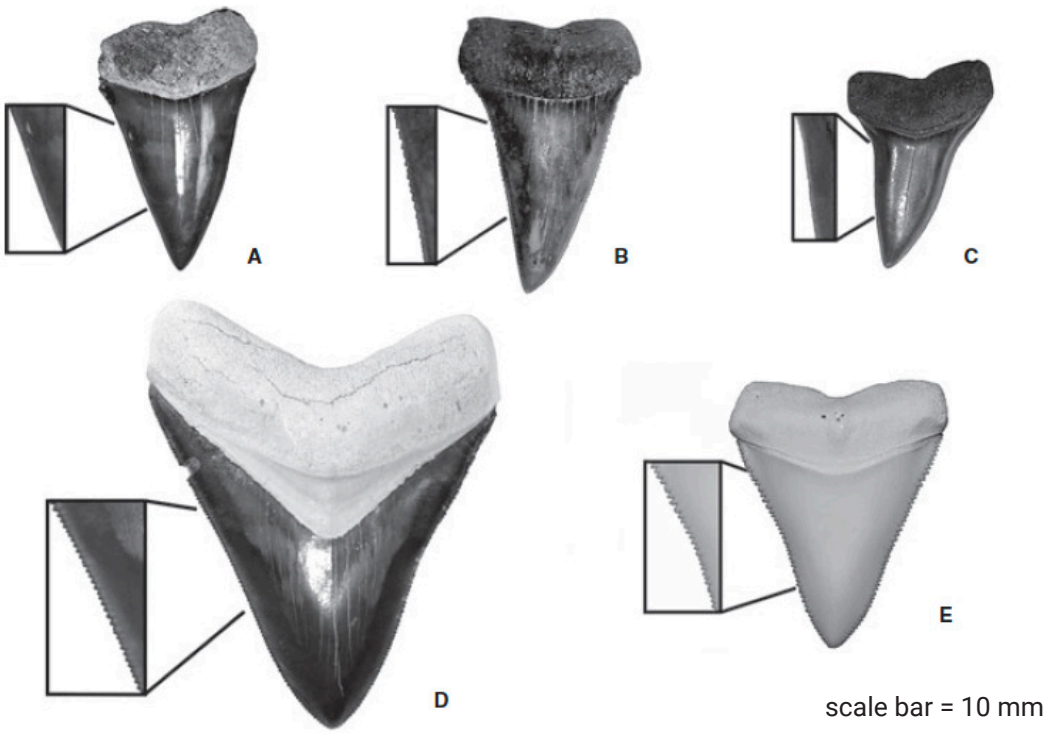
Her question was, "These look like modern animals. The one on the left looks like a ray; the one on the right looks like a typical sand shark. Could they really be fossils?"

You wrote back, assuring her that yes, they really were fossils. You explained that these were some of the first modern sharks. Even though the one on the left lived about 200 million years ago and would be considered one of the oldest modern sharks, and the one on the right around 55 million years ago, today's sharks have not changed very much from these now extinct relatives. You decide to add "**Rise of Modern Sharks**" to your timeline.

Sources: Fanti, F., Minelli, D., Conte, G. L., & Miyashita, T. (2016) and Martin, R. A. (2003)

Time Scale Card: White Shark Evolution

As a paleoichthyologist, you often get strange images sent to you. Today is no exception. A colleague came across this figure and was wondering if you knew what it was:



Comparison of Serration Types

Image by Palaeontology, 2012 Wiley [Used with permission]

Of course you recognized it immediately! It is a figure from a study trying to resolve the hotly debated evolutionary history of white sharks. The **earliest white shark** fossils date to about 65 million years ago. It's taken a lot of work to piece together the history after that.

There is a hypothesis that the ancestor of those white sharks is the megatooth shark (image D) because of similar tooth characteristics with the white shark (image E). But a discovery of a new fossil (nearly complete set of teeth, jaw, and some hardened vertebrae) in 2012 is uprooting that, suggesting that an extinct shark (image A) is the ancestor of modern mako sharks and modern white sharks and that the new fossil find (image B) is the intermediate between the ancestor (image A) and modern white sharks (image E). Using several lines of evidence such as teeth characteristics, relative dating of sediment layers, and absolute dating of mollusks found at the site, this **modern white shark** fossil (image B) is between 9.5–6.5 million years old.

Source: Ehret, D. J., Et al. (2012)