

From *The Rostrum*, Volume 26, Number 6, November, 2017:

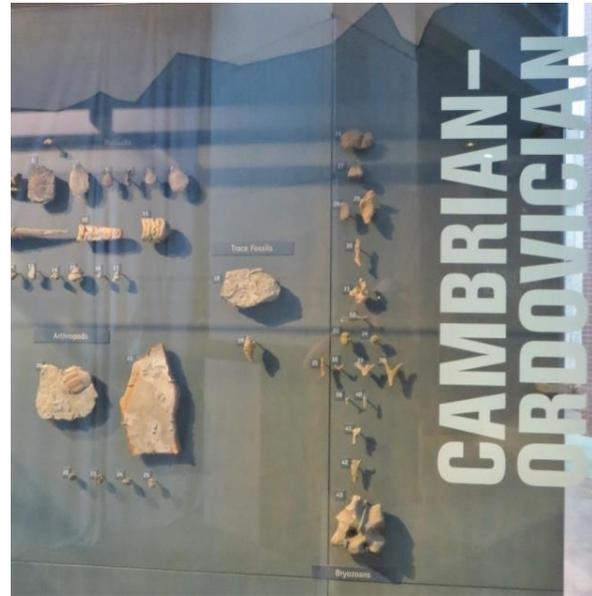
The "Ancient Seas" Exhibit at the Indiana State Museum

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In an upcoming article covering my recent trip to Indianapolis, IN, I will be describing the "Ice Age Graveyards" Exhibit at the Indiana State Museum, a special exhibit focused on Pleistocene mammals. In this article, I focus on the "Ancient Seas" Exhibit, which is located on the first floor of the museum. This permanent exhibit features fossils ranging from the Cambrian through the Pennsylvanian periods, revealing a long history of life in the region.

The state of Indiana reached its current geographical position around 100 million years ago (mya) as the earth's crust shifted along slow moving tectonic plates. These movements, along with consequent changes in elevation and other factors, also caused sea levels to rise and fall, and for much of its geological history, Indiana was covered by salt water. Around 300 mya, the water receded and the landscape transformed into a tropical swampland filled with plants and other terrestrial creatures, most of which are extinct today. During millions of years of geological history, erosion, flooding and deposition of sediments on the ocean floor and on land covered both living and dead organisms, thus creating the conditions for fossilization. The story is now told in the sedimentary limestone, shale and sandstone formations located across the state.

Part of the Cambrian-Ordovician section in the Ancient Seas Exhibit at the Indiana State Museum in Indianapolis.

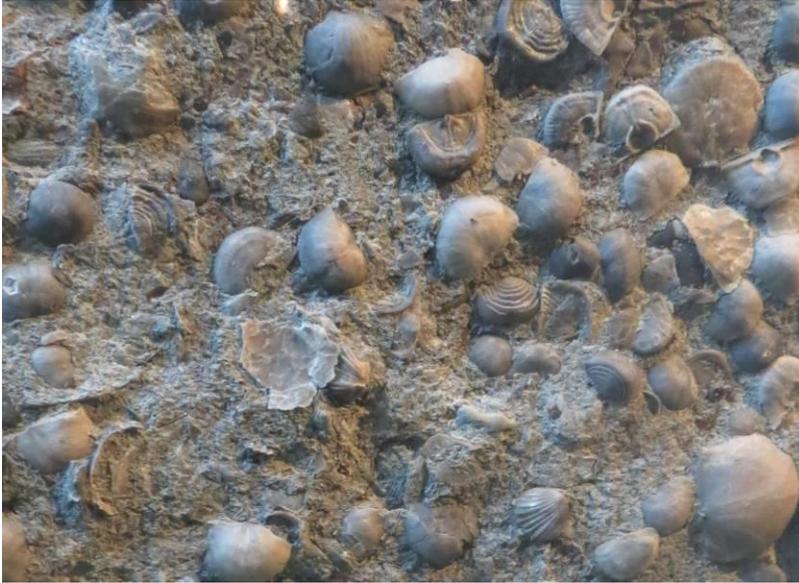


The exhibit is arranged in chronological order, first exhibiting fossils from the Cambrian and Ordovician Periods, ranging from 542 to 488 mya and 488 to 433 mya, respectively. The exhibits featured many types of trilobites and a variety of invertebrates, such as bryozoans and corals. Trilobites were ancient arthropods, a now extinct group of organisms that were characterized by multiple body segments and jointed legs. With some 20,000 described species and more being discovered annually, they were among the most diverse organisms on earth.

Ordovician fossils were formed in south eastern Indiana's Dillsboro Formation when violent storms stirred up mixes of organisms and sediments in shallow water. These "tempestivities", some 600 feet deep, formed when sediments and fossils eventually solidified into alternating layers of limestone and shale and eroded over millions of years. Organisms present in these shallow, warm seas included brachiopods, bryozoans, corals and other marine creatures.

*The trilobite, *Isotelus maximus*, a common species in Indiana from the upper and middle Ordovician Period.*





A portion of a Dillsboro slab produced by the churing of shallow Ordovician seas.

During the Silurian (443-416 mya) and Devonian (416-359 mya) Periods, huge reefs, formed by corals and stromatoporoids (marine invertebrates most closely related to sponges, Phylum Porifera), built up around the Indiana and Michigan Basins. These rich, underwater habitats exploded with life, including brachiopods, gastropods, nautiloids, and trilobites. Jawed fish emerged during this time, eventually becoming the most common predator

in the reef ecosystem. On land, we see the emergence of primitive plants and invertebrates. Indiana's reefs are preserved in limestone and dolomite today, but dolomite is poor at preserving fossils. Often, they dissolve, leaving just an outline of their shape.

Silurian estuaries were home to eurypterids or sea scorpions, predatory arthropods that hunted fish and other organisms. Larger eurypterids, like *Pterygotus* shown below, probably used their tails and paddle-like limbs to chase and catch prey. Larger species grew up to six feet in length. Smaller species likely were not fast swimmers, preferring to lie in wait and ambush their prey. Eurypterid tracks (trace fossils) found along shorelines suggest that these creatures sometimes ventured out of water.



A Silurian eurypterid, Pterygotus (left) and nautiloid (ammonite) from the Ancient Seas Exhibit at the Indiana State Museum.

During Indiana's Devonian Period, reef ecosystems were exploding with life in the warm seas. Corals became very diverse and fish became much more diverse and common. The Devonian has often been called The Age of Fishes. Other marine species proliferated, including bryozoans, mollusks, crinoids, brachiopods, stromatoporoids and others. Eventually, however, the reefs disappear.



Devonian horn corals from the Indiana State Museum.

During the Late Devonian Period, little sunlight penetrated the shallow seas, as a dense mat of marine plants covered the water's surface. The New Albany Shale Formation preserves what is known about this period of the state's geological history, where low oxygen levels created harsh conditions for marine life. Only a few species, such as brachiopods and vast numbers of tiny mollusks were able to survive these stagnant seas. However, these same conditions allowed for preservation during fossilization by protecting plant and animal remains from decay.

One of the best known Devonian sites in Indiana is at the Falls of the Ohio, where the Ohio River has cut through several layers of bedrock, exposing a treasure trove of fossils, including more than 200 species of corals. These deposits are known to extend

nearly 1,000 miles from southern Indiana to New York.

During the Mississippian Period (359-318 mya), a time known as the Age of Crinoids, an ancient river flowed westward across Indiana, eventually draining into the sea. This mix of fresh and salt water provided an ideal habitat for crinoids that were fossilized in great numbers as their habitats were covered by silt on an ocean platform just below the delta. This area, now known as the Borden Delta, is one of the world's best preserved and most spectacular locations for crinoid fossils. The area around Crawfordsville has yielded more than 100 different species.

With long, stem-like stalks and arms, crinoids or sea lilies look like plants attached to the ocean floor; however, they are actually echinoderms-- invertebrate animals related to starfish and sea urchins. These animals feed on small organisms suspended in the water by trapping them in mucus-covered grooves on their arms. Underwater currents carry their food to them, making movement unnecessary.

A slab of extremely well-preserved crinoid fossils from the Mississippian Period of Indiana.



The final geologic period covered in the Ancient Seas Exhibit is the Pennsylvanian (318-299 mya). During this time, ocean levels repeatedly rose and fell in the Illinois Basin, with the constantly shifting shoreline creating a situation where new landscapes were created and then alternately flooded, exposed or covered with sediment. Tropical swamps of this period created ideal habitats for a variety of plants, such as ferns, lycopods (clubmosses) and sphenophytes (horsetails), many of which were quite large, the size of modern trees.



Plant fossils (left-fern and right-lycopod) from Indiana's Pennsylvanian Period.

Indiana's Pennsylvanian deposits are found in the Shelborn Formation. This period's patterns of flooding and runoff created conditions that led to both the formation of shale and coal deposits, with the balance of organic matter present determining whether one or the other was formed. Large amounts of decaying plants with little sediment led to the formation of coal, while large amounts of sediment with comparatively little organic material led to the formation of shale. Other conditions determined the type of coal formed. For example, environments dominated by salt water produced high sulfur coal, whereas those dominated by freshwater produced low sulfur coal, which is more desirable from a commercial and environmental perspective.

During the Pennsylvanian Period, frequent flooding of coastal areas often inundated the tropical forests of Indiana. During these times, sharks and other fish inhabited shallow inland pools. During dry periods, these pools shrank and desperate sharks turned on each other for food, becoming cannibalistic in the process. Over time, sediment in these muddy pools formed black shales now found in western Indiana. These shales have preserved evidence of thousands of nearly complete shark and fish fossils, proving the occurrence of mass deaths. In some cases, these shales also preserved "gastric residue masses"—evidence of sharks vomiting up food which they could not digest. Some of these masses contained the remains of sharks of the same species.

I greatly enjoyed my time at the Indiana State Museum and would recommend visiting whenever you are in the area. Admission was \$14.95 for adults, \$13.95 for seniors, and \$9.95 for children. Children under 3 years of age can enter for free and college students are \$12.95 with valid student ID. The museum is open every day, except some holidays, from Monday-Saturday from 10:00 am-5:00 pm and on Sundays from 11:00 am-5:00 pm. (All photographs by Michael Hutchins).