



## THE PERMIAN PERIOD: Fossils from an ancient reef. (286 – 230 million years before present)

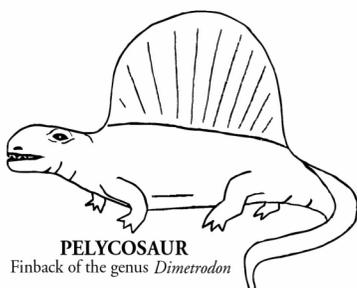


The rocks and fossils of Carlsbad Caverns National Park tell a story of the area during the Permian Period when the landscape was dramatically different from what we see today. Carlsbad Caverns National Park contains some of the world’s best examples of marine fossils from the Permian period of earth’s history. The Permian period of geologic history began without a great deal of environmental change from the preceding Carboniferous period. The Carboniferous/Permian rock boundary is marked only by the appearance in the fossil record of a new genus of single- celled fusulinids and a new plant genus. In general, the land and marine life from the late Carboniferous to the early Permian periods were quite similar. However, by the end of the Permian period, the earth had experienced monumental changes in its geography, climate, and terrestrial and ocean life.

### Paleogeography

The reconstructed Permian globe is characterized by large areas of land and water. By the beginning of this period the movement of the earth’s crustal plates fused landmasses into a single supercontinent called Pangea which extended from pole to pole. The rest of the earth’s surface was covered by a single ocean called Panthalassa.

### Permian Life



With the formation of Pangea, land area exceeded oceanic area for the first time in history. This continental configuration allowed for an increasing diversity of land animals. Although dinosaurs had not yet appeared, reptiles dominated the Permian landscape. Pelycosaur were the top carnivore of Permian terrestrial life. Some had a fin along their back to help regulate their internal temperature according to its orientation to the sun. These Pelycosaur became extinct late in the Permian period. A group of reptiles called Therapsids began to develop mammal- like traits near the close of the Permian. Their

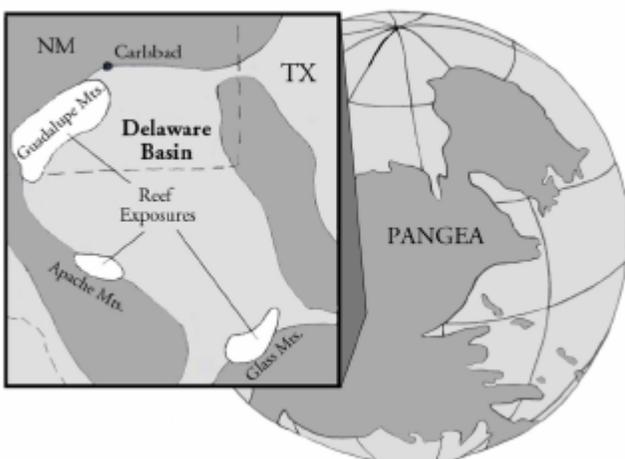
skull structure, dog- like teeth and jaws, warm body temperature, and leg positions indicate that the Therapsids may be the ancestors to mammals. Thriving since the Carboniferous period, amphibians suffered declines due to climatic drying in the Permian. Insects such as beetles and cicadas continued to evolve. Sharks and bony fish inhabited marine and freshwater environments during this time too.



**THERAPSID skull**  
The genus *Titanophonus* replaced the finbacked pelycosaur in the late Permian only to become extinct themselves at the end of the period.

In the southern hemisphere of Pangea, the seed- fern *Glossopteris* with its distinctive elongate leaves was the dominant plant. Newly evolved conifers came into prominence in the northern hemisphere.

The Permian Globe



### Climate

Evidence shows that thick glaciers covered the polar regions of Pangea, but retreated throughout the rest of the Permian period. The vast continental interiors were dry with seasonal fluctuations due to the lack of the moderating effect of nearby water bodies. Shallow inland seas occupied the continental shelf region of many continents. The Permian period is characterized by the growth of massive reefs associated with the expanses of water surrounding immense landmasses. The best- studied of these Permian coastlines is that of the Delaware basin and Guadalupe Mountains of west Texas and southeastern New Mexico.

## The Delaware Basin

Today's rocky, desert landscape reveals the evidence of the Delaware Basin. A large horseshoe-shaped reef about 400 miles long grew off the coastline of the Delaware Sea by the accumulation of the remains of calcareous sponges, bryozoans, algae, and other organisms. Shallow and more saline lagoons were found behind the reef area. A great diversity of marine life inhabited the Delaware Basin and reef. However, by the end of the Permian the reef died and the sea eventually evaporated. The basin was later filled with salts and sediments thereby preserving the entire spectrum of sediments from shallow to deep water. Mountain building and faulting episodes much later uplifted the reef area to form the Guadalupe, Apache, and Glass mountains. The last major uplift occurred 4- 6 million years ago, but the area still experiences minor tectonic activity today. The rocks now found in the Park were formed by sediments associated with the Delaware Basin and reef during the Permian period.

The close of the Permian period 230 million years ago marked the end of the Paleozoic ("ancient life") era with the largest recorded mass- extinction in earth's history. Perhaps as many as ninety percent of earth's species were eradicated for reasons not yet fully understood. Marine organisms suffered the most dramatic declines and the majority of the reef- builders became extinct. Today, fossils of Permian organisms bear witness to that time, helping geologists to reconstruct the Delaware Basin environment 250 million years ago. Only Permian marine fossils are found within this Capitan limestone formation of the Carlsbad Caverns National Park.

### Permian Marine Fossils of the Delaware Basin Region



SPONGE

*Sponges* were important constituents of the Permian reef. These primitive organisms are a conglomeration of cells that filter water through pores. They have no head, brain, true muscles, digestive systems, or other internal organs. They are immobile and attach to the sea floor or other objects. Sponges are still common today.



HORN CORAL

*Bryozoans* are microscopic "moss animals" that were reef- builders that formed encrusting mats on the sea floor, a rock, or the shell of another animal. Only the skeleton is preserved, but when alive each box- like chamber was occupied by individual animals called zooids. The colony fed by entrapping floating organisms. The bryozoan pictured resembles a lacy fan.



BRYOZOAN

Unlike modern reefs, coral in the Permian reefs were rare. Solitary *horn coral* were present in this area although relatively uncommon. Internal plates (septa) are arranged radially like the spokes of a wheel. This type of coral became extinct at the end of the Permian.

*Brachiopods* have one of the longest histories and best fossil record of all invertebrates. Here they lived in or near the reef, filter- feeding on organic particles brought by currents. Most were attached to a surface by a fleshy stalk that protruded through a hole at the shells' hinge. Shells exhibit a wide variety of shapes. Most species disappeared near the end of the Permian.



BRACHIOPOD



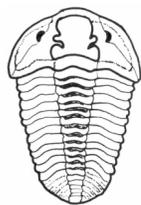
NAUTILOID

*Nautiloids* are related to the modern squid and octopus. They were swimming predators that used their tentacles with suction disks to hunt and their mouths had a sharp "beak" to tear their prey. Nautiloids had well- developed eyes and sensory organs. A distinguishing characteristic of nautiloid fossils are their chambered shells. Most nautiloids died off at the end of the Permian.

*Gastropods* are snails with soft bodies and unchambered calcium carbonate shells. Permian gastropods lived on the sea floor or in the hyper- saline backreef area. Most of them were probably grazers. Almost all gastropod species that ever existed are still around today. Their mobility probably contributed to their evolutionary success and their survival of the Permian extinction.



GASTROPOD



TRILOBITE

With thousands of species, *trilobites* were among the dominant life forms of the Paleozoic era. Nonetheless, they were in decline in the Permian and were extinct by the end of the period. These arthropods had a hard exoskeleton divided into three lobes: head, thorax, and tail. They could thrive in a variety of marine habitats. Most here probably lived on the floor of the Delaware Sea.

*Crinoids* are related to starfish and sea urchins, and are commonly called sea lilies, but are actually animals. They have long stems which are anchored to the sea floor. At the top of the stem is a cup with usually five arms. They often occurred in large groups waving their arms to catch water- borne food particles. Individual stem plates are stacked like a roll of coins. Stem sections are the most common crinoid fossils in the Park. Crinoids underwent a major crisis in the Permian period when most species died out.



CRINOID

Please do not disturb or collect fossils or any other objects from Carlsbad Caverns National Park.