Evidence #1: Trilobites were small animals that lived at the bottom of the ocean. They fed on organic matter in sediment on the ocean floor. Because trilobite fossils are so abundant and well preserved in the limestone and shale rock of Ohio, they were officially named the state fossil.

Figure 1. Trilobite fossils found in Ohio. Credit: Wright Seneres based on Fossilera (2018).

Limestone is a sedimentary rock that is formed at the bottom of the ocean. Shells and skeletons of ocean organisms are deposited on the ocean floor and become compacted over millions of years, creating limestone from the pressure of the ocean water.

Trilobites are sea creatures that lived more than 250 million years ago. As trilobites died, their hard body parts were deposited on the ocean floor. Large (15 inch) trilobite fossils have been found in limestone and shale rock in southern Ohio, which is more than 500 miles from the ocean. The figure above shows the location of Ohio.

Evidence #2: Leaf fossils from Wyoming found in a deep rock layer show a climate that is cooler than that of the fossils found above it.

At Bighorn Basin, Wyoming, leaf fossils found in deep rocks show an average climate of 61°F. Leaf fossils found in shallower rock layers that formed 10,000 years later show an average climate of 71°F. This change in climate is estimated using a technique called leaf margin analysis.

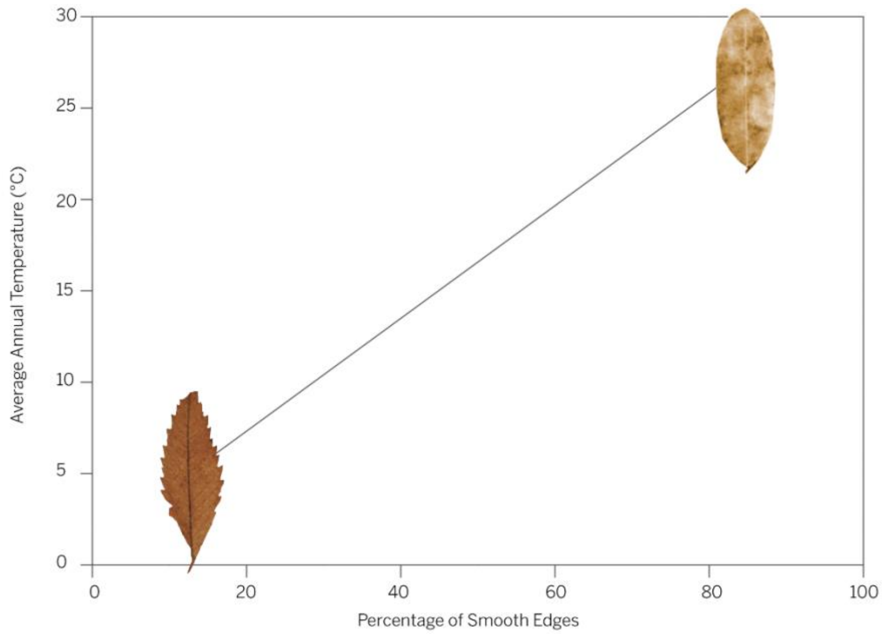

Figure 1. Leaf margin analysis at Bighorn Basin, Wyoming. Credit: Wright Seneres based on Smithsonian (2009).

Scientists study the shape of leaves to learn about environments. Leaf margin analysis uses the ratio of smooth to toothed fossil leaf edges to determine average temperatures of a region. The edges or “margins” of leaves may be toothed or smooth. The figure above shows that more toothed-edged leaves are associated with the cooler temperature. Toothed-edged leaves are able to begin photosynthesis early in the spring, making them better adapted to cooler climates. However, toothed edges result in a loss of water vapor, which is a disadvantage in a warm climate.

Therefore, there is usually a higher ratio of smooth to toothed-edged leaves in warmer climates. In this way the ratio of fossilized smooth to toothed edges of leaves in a region can act as a fossil thermometer and tell us about past climates.

Evidence #3: The Svalbard forest in Arctic Norway is filled with fossils of tropical trees, called Lycopsid. These trees lived hundreds of millions of years ago.

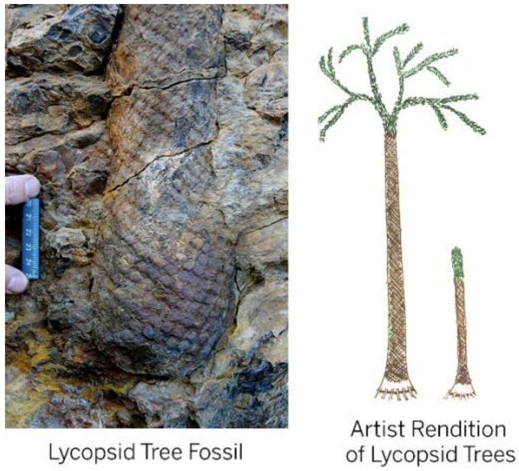

Figure 1. Tropical Lycopsid trees in the Svalbard forest in Arctic Norway. Credit: Wright Seneres based on Weisberger (2015).

The Svalbard forest in Arctic Norway is filled with fossils of tropical trees known as Lycopsid. Figure 1 shows the fossils and what the trees may have looked like. These trees appeared 380 million years ago and were mostly known as “club mosses.” In Svalbard, Lycopsid these tropical trees grew to a height of nearly 13 feet (4 meters) in dense, crowded forests.

Figures 2 and 3 below are two climate graphs. Figure 2 is for the current climate of the Svalbard Forest, and another for a region that has a tropical climate today. The one for the Svalbard Forest shows that Arctic Norway has short, cool summers, but long and extremely cold winters, which is very different from the climate graph of a tropical ecosystem (Figure 3).

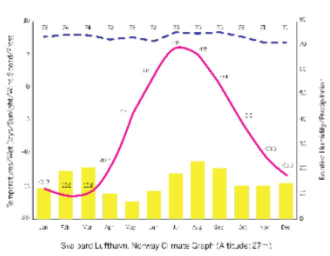

Figure 2. Climate graph for the Svalbard Forest in the tundra biome. Credit: Wright Seneres

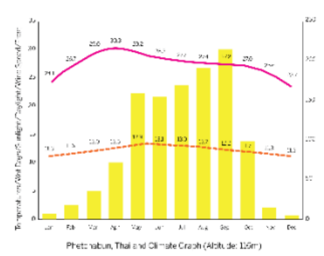

Figure 3. Climate graph for Thailand, which is in a tropical biome. Credit: Wright Seneres

Evidence #4: *Mesosaurus* is an ancient, large, lizard-like creature. These fossils have only been found in two places on Earth, the southern tip of Africa and eastern South America.

Mesosaurus is a large, lizard-like creature that lived 380 million years ago. *Mesosaurus* had a long skull and long teeth. The teeth are angled outwards, especially those at the tips of the jaws.

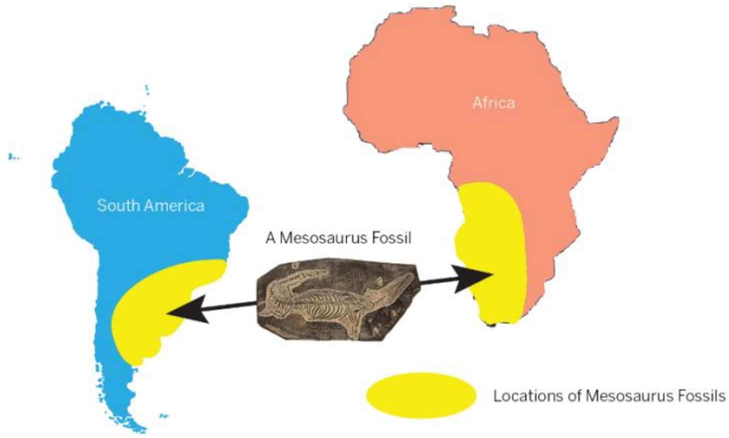

Figure 1. Locations of *Mesosaurus* fossils. Credit: Wright Seneres

Figure 1 above shows that fossils of the *Mesosaur* can have only been found along the southern tip of South Africa and along eastern South America, which are two regions separated by thousands of miles of ocean today. Because *Mesosaurus* was a non-swimming animal that lived along the coast, it is unlikely to have crossed the Atlantic Ocean. The distribution of these fossils suggest that the two continents were once joined together (Figure 2).

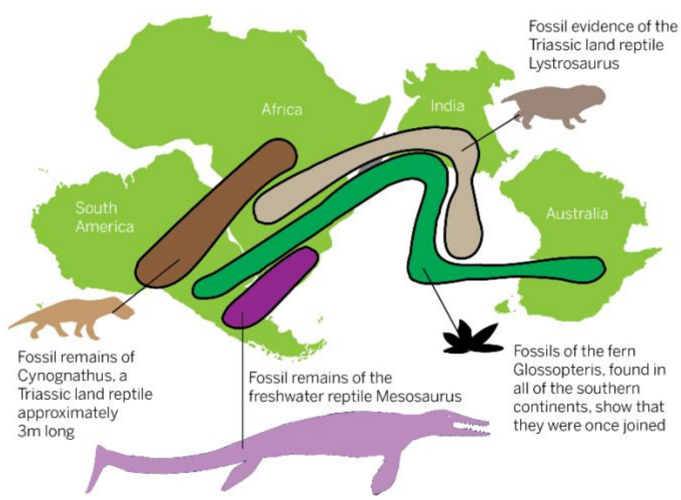

Figure 2. Continents before continental drift occurred. Credit: Wright Seneres

Evidence #5: Fossils of coral reefs have been found in deep water off the coast of Texas. Coral reefs require sunlight to form. Sunlight cannot reach deep water. These coral reefs are about 19,000 years old.

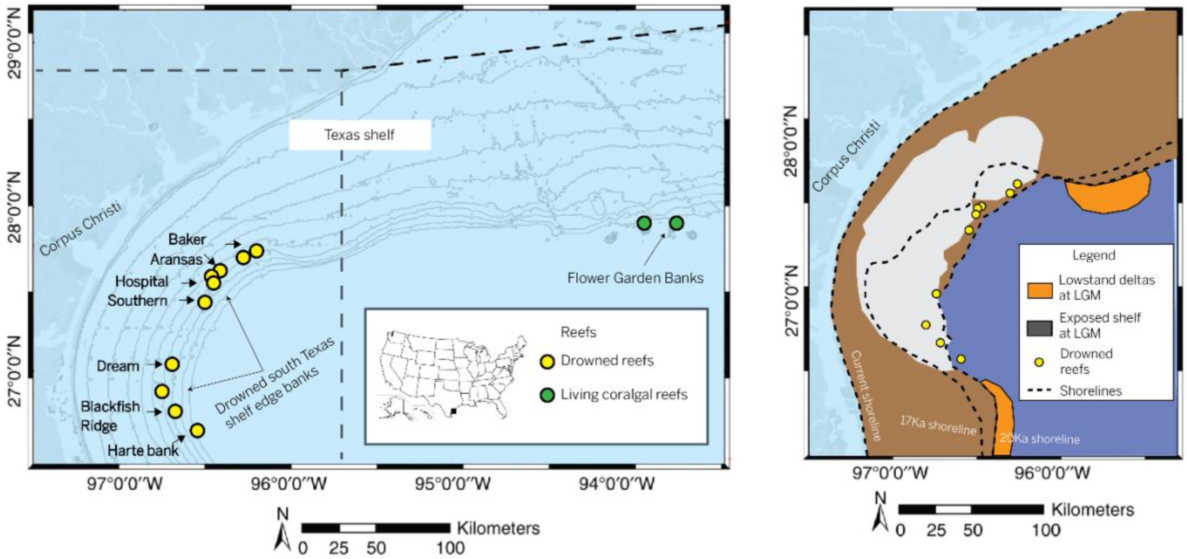

Figure 1. Shallow waters where coral reefs can grow. Credit: Wright Seneres based on Khanna et al. (2017).

Tropical coral reefs can form at ocean depths of up to 160 feet (50 meters). Algae that forms in the tissues of coral require sunlight for photosynthesis. Below that depth there is not enough sunlight for corals to form.

Figure 1 shows that thirty miles off the coast of Texas, in water depths of more than 195 feet, there are fossils of coral reefs. Evidence collected in 2012 shows that these reefs are about 19,000 years old.

Evidence #6: North Dakota is in a temperate grassland biome. Fossils found in the Hell Creek rock formation include pollen from ground ferns and palm trees, which grow in a tropical ecosystem.

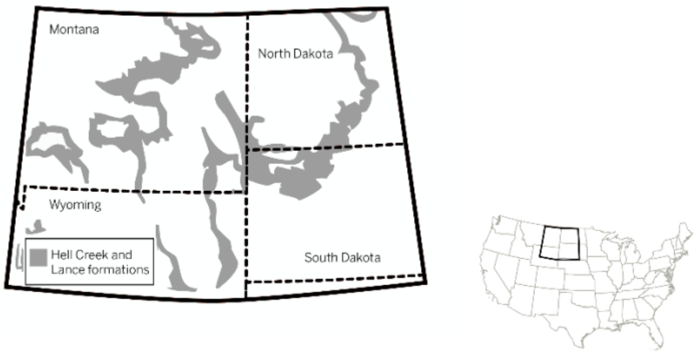

Figure 1. Map view of where fossils are found at Hell Creek, North Dakota. Credit: Wright Seneres based on Smithsonian (2014).

Figure 1 shows that North Dakota is in the northern central United States, bordering Canada. The site of the Hell Creek Formation that dates back 70 million years is near Marmarth, which has an average temperature of 57°F in the summer and 28°F in the winter. An average of 34 inches of snow falls each year in Marmarth.

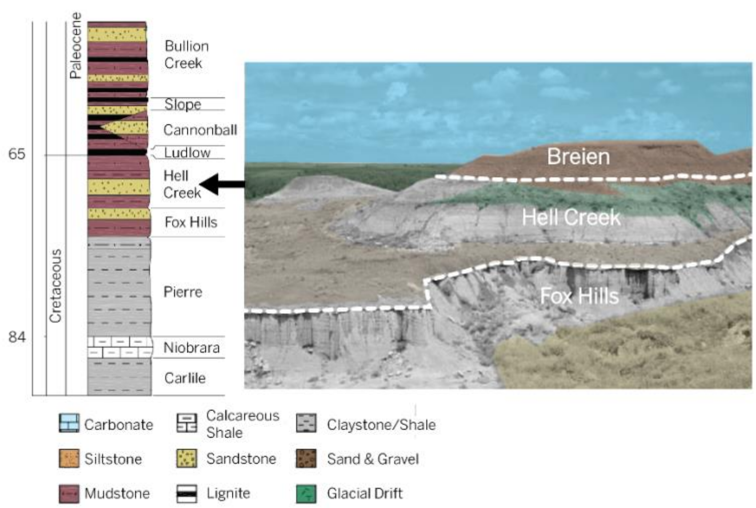

Figure 2. Cross section showing where fossils are found in Hell Creek, North Dakota. Credit: Wright Seneres based on North Dakota Geological Survey (2006).

Figure 2 shows fossils found at the Hell Creek Formation. These fossils include palm trees and ground ferns, from tropical plants that lived in the Cretaceous period, 70 million years ago. Tropical vegetation grows in a much warmer climate and can be found in environments where temperatures range from 70°F to 85°F.

Evidence #7: Many large geographic areas, like the Blue Ridge and Piedmont regions in Georgia, are made up of metamorphic and igneous rock. Fossils are not usually found in these types of rock.

About 20% of Earth's surface is either igneous or metamorphic rock. Igneous rock does not contain fossils, and metamorphic rock *usually* does not. About 80% of Earth's surface is sedimentary rock, which can contain fossils.

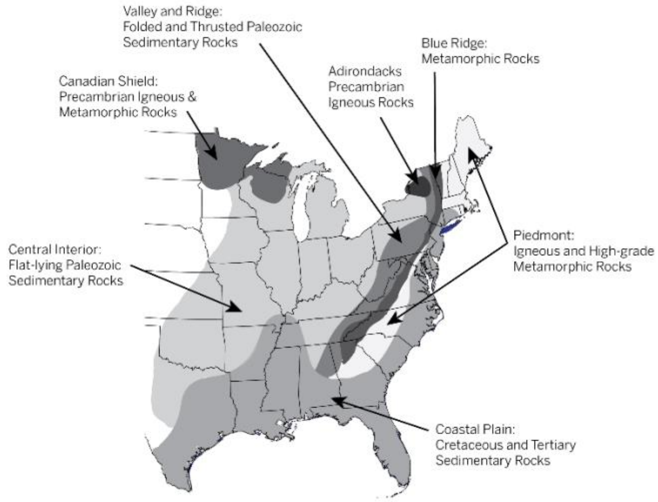

Figure 1. Metamorphic rocks along the East coast and Midwest. Credit: Wright Seneres .

Figure 1 shows mountain belts containing uplifted metamorphic and igneous rock that are found in locations such as the Blue Ridge and Piedmont regions of Northern Georgia. Figure 2 shows there are no fossils in these areas that could provide evidence of Earth's past.

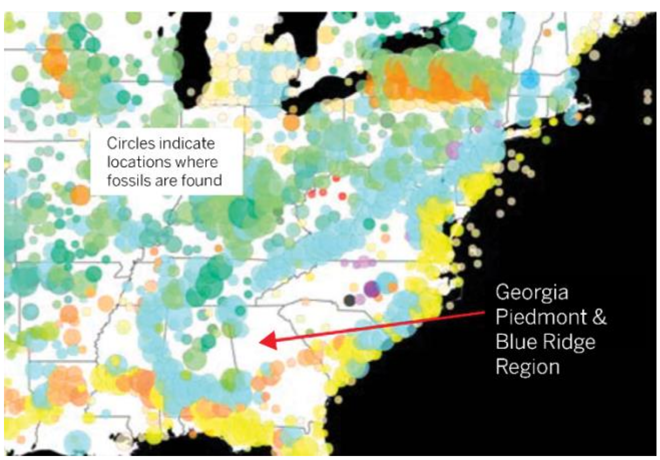

Figure 2. Location of Georgia Piedmont and Blue Ridge Region. Credit: Wright Seneres.

Evidence #8: *Hallucigenia* is a fossil that was first discovered in the 1970's. Recent discoveries show that scientists pictured this organism upside down and backwards for years.

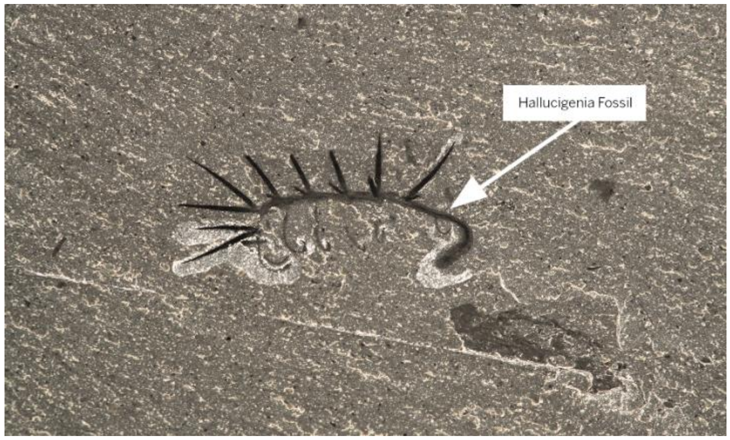

Figure 1. Fossilized *Hallucigenia*. Credit: Wright Seneres based on Duhaime (2015).

Fossils of *Hallucigenia* were first discovered in the 1970's in Canada's Burgess Shale deposits. Figure 1 shows an image of this fossil. The spines on this creature's back were mistaken for legs, and a stain at the tail end of the organism in the initial fossil was thought to be its head. Recently new specimens of this organism were found in China. Scientists realized that there were legs underneath the spines, meaning that it had been interpreted as upside down. Further evidence from looking at these fossils under an electron microscope showed eyes and a mouth at the opposite end of the body from where they thought the head was. From this new evidence, scientists created a new computer image of *Hallucigenia*, shown below (Figure 2).

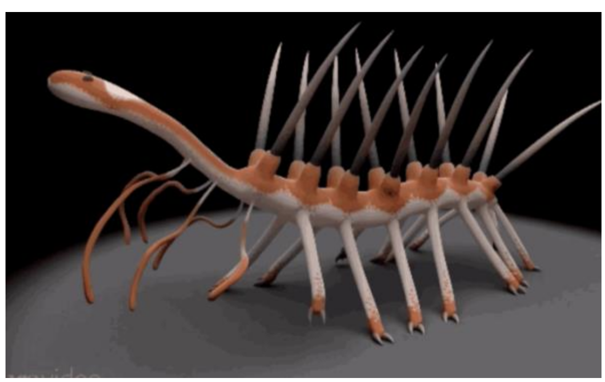

Figure 2. Computer-generated image of *Hallucigenia*. Credit: Wright Seneres based on Duhaime (2015).