The Importance of Fossils in Understanding Earth

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Throughout history, people have believed nearly everything about fossils but the truth. Fossils have been mistaken for rock formations that just happen to resemble bones and shells, the bones of giants from early Biblical times, signs of the devil, and harbingers of magic. A few, including Leonardo da Vinci, had some idea of what they were and happened to be spot on, but they lacked the equipment and other scientific theories to adequately prove their ideas (Lull 1-2). Fossils are actually either remains, imprints, or trace evidence of animals or plants that have been buried and trapped in sediments and preserved over time until they are discovered by scientists for study.

Fossils, in fact, are our only record of living things from the past. Rocks themselves can leave clues to the landscape and climatic changes, but they cannot tell the people of the present anything about the type of creatures that lived in those areas. The study of fossils and their significance is called paleontology. Through the study of the bones, shells, tracks, and eggs left behind, scientists can gather a working knowledge of the life of Earth's past. Fossils have helped prove the theories of evolution and tectonic drift (Lull 3).

The word *fossil* comes from the Latin *fossilis*, which in turn comes from *fodere*, meaning "to dig up" (Lull 4). Credit for the term is usually given to Georgius Agricola, the author of a book entitled *De natura fossilium lib.* (On the nature of fossils) in 1546 (Paul l). Most fossils are indeed dug up, otherwise they are exposed through forces of the earth and sometimes forces of man, since natural burial is a requirement for making a fossil. Fossils also need something that preserves them, such as tree sap that hardens to amber, oil, ice, or soft ground that becomes rock. Regardless of what some people think, fully preserved bodies found in ice fields and other places also count as fossils – better fossils, in fact, than the bones and shells that are usually brought to mind at that word. And of course, they must be dead. Other fossils include footprints, teeth marks, egg shells, and constructed homes of any creatures that existed in the past (Lull 4-5).

When fossils are found embedded in rocks, they are more difficult to fully study than when they have been separated from the rock itself. Scientists have developed many methods for doing this. The most commonly used method is called the bulk maceration technique. This requires placing a rock containing a fossil in acid to dissolve the rock matrix around the fossil. The most common acid for this is hydrochloric acid, because it is most effective on sand and shale, which are the most common fossil containing sediments. Once the acid dissolves away the surrounding rock, the fossilized remains of the plant or animal are much easier to study with microscopes and other equipment.

Rarely are complete animal bodies found, though. Usually only the hard sections of the body – the bones, shells, teeth – are found because of disintegration. Tissues and muscles are too soft to survive exposed before burial, and usually are completely gone in a few days to two months. Skeletons with many parts will fall apart if disturbed, as there is nothing to hold them together anymore, as will mollusk and bivalve shells. Skeletons found in one piece were almost certainly buried very soon after death, but those conditions are rare on land and even rarer in the sea. A few fish have enough bone mass in relation to their flesh that their skeleton stays in one piece even after death, but again, those animals are rare (Paul 14-15). Animals are not the only fossils, either. Wood can be petrified by substituting ions in the molecular structure, preserving a record of forest life rarely seen (Paul 18) .

South Carolina and most of the eastern United States was under water for a period of time after the separation of Pangaea, the supercontinent, accounting for the abundance of marine fossils found in the area. One type of marine fossil that is common enough to be sold in some museum gift shops is a trilobite. While not being the high rung on the evolutionary ladder at their time, they were undoubtedly the most prolific and enduring. Classified as crustaceans and distantly related to today's lobsters, shrimp, and crabs, they dominated the Cambrian period (sometimes called "The Age of the Trilobites") partially because of sheer endurance and partially because they ate just about everything. Some were blind, as though they lived in the dark areas of the sea or were nocturnal, but most had well-developed eyes. But in the evolutionary chain, they existed before the vertebrates – which possibly evolved in running fresh water before sea water (Lull 48-49).

The Devonian is known as "The Age of Fishes" because of all the fossils preserved both on land and in sea. Sharks, sometimes called "living fossils" for their apparent lack of evolution since that time, had already come into being, and several types of armored fishes existed as well. Almost all these fish were fresh water specimens and, surprisingly, had the ability to process atmospheric oxygen for various periods of time when there wasn't enough oxygen available in the water. While their soft inner organs haven't survived, their bones – some of the first backbones – are left in the rocks for scientists to study today (Lull 52).

One of the major marine fossils found is that of the ichthyosaur (*fish-lizard* in Latin), a type of dinosaur that was one of the major marine predators of the Jurassic, much like the dolphin of modern times. While greatly resembling a fish, an ichthyosaur was a reptile and a dinosaur, though their fossils indicate that they developed – and went extinct – earlier than their land-walking cousins (Paul 14-15, 23). An ichthyosaur's fin was not as developed for swimming and propulsion as a fish's, yet they dominated the oceans for at least one period of the dinosaurs' lifetime, existed in the other two, and before them as well (Degus online).

Some fossils, however, are plant remains that have been fossilized over time and are now studied by paleobotanists. Originally, it was believed that plant life did not evolve until well after the Cambrian era had begun. Later studies of fossils, however, confirm that early plant life began during the Precambrian era. Fossils found in the Fig Tree shale in South Africa are believed to be the remains of algae dating back more than three billion years. These algae are believed to be related to modern day Chroococcales, a blue-green algae. If these fossilized algae really are related to the Chroococcales of today, then they suggest that photosynthesis was occurring when the algae was deposited over three billion years ago.

Some fossils are neither animals nor plants though. These are called trace fossils because they are evidence of certain animals existing without being the fossilized bones or imprint of bones of that animal. For instance, in the sandy, intertidal regions of the Carolinas, trace fossils can be found of tunnels and escape routes of animals that existed hundreds of thousands of years ago (Crimes 143). These environments are extremely conducive to fossilization because rivers carry quartz sand and other sediments to these areas and deposit them on top of animals such as sea anemones. These anemones, such as the Actinian Anemone, then burrow up or down, forming conical tunnels. The surrounding sediments then harden, preserving these tunnels as trace fossils of the anemones that existed so long ago.

The study of fossils is extremely important in understanding how life on earth has evolved. One of the best examples of how an understanding of fossils has led to a better understanding of life in both the past and in today's modern world was Georges Cuvier's *Memoir on the Species of Elephants, Both Living and Fossil* (Rudwick, 18), . Cuvier had worked at the National Museum of Natural History in Paris, France and had studied the bones of the Indian and African elephants. At the time, the two elephants were considered to be of the same species. However, after studying the bones and teeth of the Indian elephant, the African elephant, and the "fossil elephant or 'mammoth,'" Cuvier proved that all three were anatomically different, and therefore of different species (Rudwick, 16). Only the Cuvier's diligent study of fossils of these different creatures was able to finally settle the debate as to whether or not all elephants belong to the same species.

This idea that fossils could be used to identify and study extinct species was not new. However, paleontology eventually paved the way to Darwin's theory of evolution. As Darwin traveled the globe studying animals of different species, he began to formulate his hypothesis that life on earth had evolved from certain common ancestors. At first, the idea that modern life had evolved from ancient, more primitive forms of life seemed ridiculous, but after further study of the fossil record, the idea began to make more and more sense. Since Darwin first published his theory of evolution, more and more scientists have found fossils that seem to back up his theory. Fossilized remains have shown a steady progression of the evolution of man from the Neanderthals of ancient times to modern day humans.

Another key use of fossils is radiometric dating. Scientists can test the radioactive minerals in the rocks surrounding the fossils and determine how long ago the fossil was buried. This, in turn, gives a relatively accurate age for the fossil itself. For example, if the rock surrounding a fossilized dinosaur bone contains a certain amount of uranium (^{238}U) and lead (^{206}Pb), it is then possible to determine how old the rock is base on the radioactive half-life of the uranium, thereby determining the approximate age of the dinosaur bone.

Fossils are a key component to understanding both the history of the earth and the present. Without studying the fossilized remains of plants and animals, we would have no knowledge of the earth's history and the place from which we as humans come. We also would not fully understand the different geologic periods of earth's history because we would not have any evidence of prehistoric life or a way of determining how old a certain form of life is. Without fossils, life on earth would be a completely insolvable mystery.

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