

Summary

The Puzzle of Life's Diversity

The theory of evolution can explain the diversity of life on Earth. Evolution, or change over time, is the process by which modern organisms have descended from ancient organisms. A scientific theory is an explanation of natural events that is supported by evidence and can be tested with new evidence.

Charles Darwin contributed more than any other scientist to our understanding of evolution. During his trip on the *Beagle*, Darwin made many observations and collected a great deal of evidence. He observed tremendous diversity of organisms. He also noticed that many plants and animals were very well suited to their environment. Darwin collected fossils, or the preserved remains of ancient organisms. Some of the fossils were unlike any creatures he had ever seen. He wondered why the species represented by the fossils had disappeared.

Darwin's observations on the Galápagos Islands influenced him the most. The islands are close together but have different climates. Darwin noticed that the traits of many organisms—such as the shell shapes of tortoises—varied from island to island. Darwin wondered if animals living on different islands had once been members of the same species.

Ideas That Shaped Darwin's Thinking

In Darwin's day, most Europeans believed that Earth and all its life forms had been created just a few thousand years earlier. They also believed that species did not change through time. Several scientists who lived around the same time as Darwin began to challenge these ideas. These scientists had an important influence on the development of Darwin's theory of evolution.

Geologists James Hutton and Charles Lyell argued that Earth is many millions of years old. They also argued that the

processes that changed Earth in the past were the same as the processes that are still changing Earth in the present. Knowing that Earth could change over time helped Darwin realize that life might change as well. Knowing that Earth was very old convinced Darwin that there had been enough time for life to evolve.

Jean-Baptiste Lamarck was one of the first scientists to recognize that evolution has occurred and that organisms are adapted to their environment. To explain evolution, Lamarck hypothesized that an organism could gain or lose traits during its lifetime by using or not using organs. He also hypothesized that these changes could be passed on to the organism's offspring and eventually change the species. Scientists now know that some of Lamarck's hypotheses about evolution are incorrect. However, his general ideas about evolution and adaptation are correct, and they influenced Darwin.

Another important influence on Darwin was the economist Thomas Malthus. Malthus thought that if the human population continued to grow unchecked, it would run out of living space and food. Darwin realized that this was true of all organisms and not just humans.

Darwin Presents His Case

Darwin was reluctant to publish his ideas because they were so radical. When he realized that another scientist, Alfred Russel Wallace had the same ideas, Darwin finally published *On the Origin of Species* in 1859. In the book, Darwin provided evidence that evolution has occurred. He also explained his theory for how evolution comes about.

Darwin's theory was based on artificial selection. In artificial selection, animal breeders select for breeding only animals with the desired traits. For example, they select only the largest hogs or only the cows

that produce the most milk. These traits are then passed on to the next generation.

Darwin thought that a process similar to artificial selection occurs in nature. He called this process natural selection. Darwin's theory of evolution by natural selection can be summed up as follows. Individuals differ, and some of the differences can be passed on to their offspring. More offspring are produced than can survive and reproduce. There is competition for limited resources, or a struggle for existence. Individuals best suited to their environment survive and reproduce most successfully. In other words, there is survival of the fittest. Fitness is the ability to survive and reproduce in a specific environment. It results from adaptations, or inherited characteristics that increase an organism's chance of survival. Only the fittest organisms pass on their traits. Because of this, the species changes over time.

Darwin argued that species alive today are descended, with modification, from ancestral species that lived in the past. Darwin also introduced the principle of common descent. According to this principle, all species come from common ancestors. The principle of common descent links all organisms on Earth into a single tree of life.

Darwin presented four types of evidence in support of evolution: the fossil record, the geographical distribution of living species, homologous structures of living organisms, and similarities in early development, or embryology. Comparing fossils from older and younger rock layers documents the fact that evolution has occurred. The presence of similar but unrelated organisms in similar environments suggests the operation of natural selection. Homologous structures have different mature forms but develop from the same embryonic tissues. They provide strong evidence that organisms have descended, with modifications, from common ancestors. Some homologous structures no longer serve important functions in descendants. If the structures are greatly reduced in size, they are called vestigial organs. The early stages, or embryos, of many animals are very similar. These similarities also provide evidence that the animals share common ancestors.

Scientific advances have supported most of Darwin's hypotheses. Today, evolutionary theory is called the "grand unifying theory of the life sciences." It gives insights to all biological and biomedical sciences.