Charles Robert Darwin is one of the greatest naturalists who ever lived. He was not only the father of evolution but also a remarkable scientist whose ideas and discoveries about the earth's history resulted in new areas for ongoing research in geology, paleontology, biology, and anthropology. His contributions to science, particularly concerning organic evolution, were possible because he would eventually embrace the vast temporal framework that was being argued for in the emerging disciplines of historical geology and comparative paleontology. Taking both time and change seriously was crucial for the young Darwin, as it resulted in his rejecting the fixity of species and, instead, accepting the mutability of life forms throughout the biological history of this planet.

Darwin's intellectual life evolved from his being a part-time naturalist, interested especially in geology, to his becoming a full-time scientist devoted primarily to biology. He developed a comprehensive orientation in geobiology, and his life was a long series of fortuitous coincidences that collectively propelled him to make major discoveries in the natural sciences. Whether speculating on the formation of coral reefs or reflecting on the similarities between the human species and the apes, Darwin came to see both geological structures and biological forms slowly changing due to the influences of natural forces on them over immense periods of time. His conceptual revolution of organic evolution also challenged the entrenched ideas of Aristotelian philosophy and the dogmatic beliefs of Thomistic theology. Consequently, as a result of Darwin's dynamic worldview, the modern thinker would never again see the earth, life forms, or humankind itself in terms of eternal fixity.
Before Darwin

Aristotle, the father of biology who contributed to embryology and taxonomy, had taught that plant and animal species are eternally fixed within nature. In accordance with his claim that experience reveals reality, it appeared to him that forms of life are static. Likewise, for Aristotle, the same species have always been and always will be on this planet, with none of them ever changing into a different form of life or becoming extinct. He held that, because nature is forever the same, no new species will appear on the earth. However, Aristotle maintained that the human intellect is capable of organizing biological types into a natural hierarchy of ever-increasing complexity and sensitivity; he referred to this order of species as the Great Chain of Being. Although he classified hundreds of organisms and was interested in the embryonic and postnatal development of animals, it never occurred to Aristotle that, through time and change, one species could evolve into a new species. The idea that life forms are eternally fixed dominated Western thought until the scientific writings of Charles Darwin.

Organic evolution was glimpsed in the thoughts of the Roman philosopher Lucretius, geological history was pondered by the Renaissance artist Leonardo da Vinci, and the fact that a species may produce varieties of itself was admitted by the biologist Carolus Linnaeus. Because these three thinkers held ideas that were outside the Aristotelian worldview, however, their concepts on time and change were not taken seriously.

The first major evolutionist was Jean-Baptiste de Lamarck (1744-1829). After long consideration of the geological column with its fossil record, he eventually concluded that the empirical evidence (admittedly incomplete) demonstrated that species had evolved throughout the earth's history. He presented his heretical interpretation of life in the book *Philosophy of Zoology* (1809), which first appeared in the year of Charles Darwin's birth. However, Lamarck was unable to give a satisfactory explanation for the mutability of species. His speculations on organic evolution were grounded in both the inheritance of acquired characteristics (through use and disuse), as well as a form of vitalism. However, there were no facts to support either explanation. As a result, Lamarck was unable to convince any other naturalist that species have evolved over time throughout the history of this planet.

Early Influences on Darwin

As a curious youngster, Charles Darwin had been interested in rocks and insects. He enjoyed taking nature walks into the English countryside, studying rocks, and collecting beetles. His inquisitive mind was inspired by these experiences, and it remained open to new ideas and challenging perspectives throughout his life. As a result of his activities in nature, Darwin continued to develop his acute powers of observation, description, and speculation. Years later, these mental powers would allow him to meticulously analyze organisms (e.g., barnacles, orchids, and worms) and synthesize vast amounts of empirical evidence. He was then able to derive both brute facts and those meaningful generalizations that are needed to explain complex phenomena in nature. Furthermore, over time, Darwin developed a disciplined imagination that would eventually allow him to envision the earth's history in terms of millions of years and, as a result, to accept the counterintuitive scientific truth of organic evolution.

Despite his studies in medicine at Edinburgh University and then in theology at Christ's College of the University of Cambridge, Darwin had no desire to become either a countryside minister or a medical doctor. He remained interested in geology and entomology. Like most naturalists at the
time, Darwin thought that species were fixed and immutable throughout the earth's history. Although somewhat religious, he had not taken his theological studies seriously. Even so, Darwin found William Paley's *Natural Theology* (1802) to be intriguing in its argumentation. However, a few years later, he would reject its theistic premise in light of his own evolutionary explanation for life that replaced the assumed permanent design in nature. For Darwin, the alleged design in the world would be seen to be merely a temporary order rather than the manifestation of a preestablished divine plan. Of special consequence, Darwin was fascinated by the writings of the naturalist Alexander von Humboldt (1729-1781), who had made extensive travels in South America. Within only 7 years, as a result of his own trip to the southern hemisphere, Darwin's early conceptions of time and life would be turned upside down: Pervasive change would replace eternal fixity.

**A Voyage of Discovery**

After having accepted an invitation to join the H.M.S. *Beagle* on its 5-year voyage around the world to survey and chart the coastlines of South America, Charles Darwin anticipated studying rock strata, collecting fossil specimens, and describing wild organisms in their natural habitats. He could not have foreseen how his own view of time would radically change during this exceptional scientific journey of extraordinary discoveries. The major influence on his conception of earth history came to Darwin as a result of his reading Charles Lyell's three-volume work *Principles of Geology* (1831-1833). Lyell claimed that this planet is millions of years old, and over vast periods of time, natural forces have slowly altered its geological structures. The empirical evidence was so compelling and the rational arguments so convincing that Darwin came to accept Lyell's new interpretation of geological history. Furthermore, as climates and environments are always changing, Lyell's dynamic view of the earth's history in terms of geology now suggested to Darwin a dynamic view of the earth in terms of biology.

If, for Darwin, his voyage on the *Beagle* was the single most important event in his scientific life, then his acceptance of Lyell's geological perspective was the pivotal moment during this trip. Over the coming years, Darwin's piercing insights and a convergence of evidence would result in a paradigm shift in natural science from fixity to evolution.

Giving priority to science and reason, Darwin eventually rejected the age for this planet that had been determined through a strict, literal interpretation of the biblical story of Genesis. He now held the age of the earth to be in the millions of years (rather than being only a few thousand years old). Within this extraordinary time framework, Darwin was able to imagine the sweeping process of organic evolution.

As the *Beagle* sailed along the coastlines of South America, it frequently made stops at major ports. Some landings offered Darwin the opportunity to explore inland. In Brazil, he was delighted by the lush tropical jungles with their incredible diversity of insects. Next, in Argentina, working with crew members, Darwin helped to unearth the fossil remains of now-extinct giant mammals. Yet, these fossil specimens resembled a few of those mammals that were still living on the continent. This uncanny resemblance between past and present forms of life suggested to Darwin that there had been a historical continuity in life from prehistoric organisms to extant species (with extinctions occurring throughout the history of life on Earth). He subsequently wrote about the complex web of evolving life.

Captain Robert FitzRoy of the *Beagle*, a biblical fundamentalist, dogmatically believed the age of the earth to be no more than 10,000 years old; despite growing evidence to the contrary, he never
doubted his religious opinion. In sharp contrast, for Darwin, several crucial experiences gave
scientific evidence to support Lyell's dynamic interpretation of historical geology. In Chile, Darwin
saw those geological changes that had recently been caused by earthquakes, tidal waves, and
volcanic eruptions. These alterations to rock structures gave credence to Lyell's immense temporal
framework, as it would take enormous periods of time for natural forces to significantly change the
geological surface of the earth. Furthermore, Darwin had found seashells and fossil fish in the top
rock strata of the Andes. He correctly reasoned that these geological layers must have once been
below the surface of the Pacific Ocean and that slowly, over millions of years, natural forces had
elevated these rock strata to form the mountain range of today.

For Darwin, however, the most important event of the *HMS Beagle* voyage was a 5-week stay on
the Galapagos Islands in 1835. This unique archipelago consists of 15 major volcanic islands located
near the equator, about 600 miles west of Ecuador. In his journal, Darwin wrote: “Hence, both in
space and time, we seem to be brought somewhat near to that great fact—that mystery of
mysteries—the first appearance of new beings on this earth.” He was able to explore several
islands, carefully describing and interpreting their geology and biology. He was surprised to
discover that different species of finches, mockingbirds, iguanas, and tortoises lived on this group of
islands. Moreover, these species resembled species on the mainland of South America.
Nevertheless, he did not appreciate the far-reaching implications of these facts for evolution until
after he had critically reflected on all the evidence from these islands when he was back in England
after the trip had been completed. He concluded that the ancestors of the Galapagos species had
managed to reach this archipelago from elsewhere ages ago, where they then speciated over time
into different forms for different habitats. It had become obvious to Darwin that there is a direct
relationship between the biological characteristics and behavior patterns of an organism and its
environment in terms of adaptation, survival, reproduction, and evolution (or extinction). Even the
Galapagos Islands and their unusual life forms have been changing throughout time.

**The Theory of Evolution**

It is very unlikely that Darwin would have developed his scientific theory of organic evolution
without having read Lyell and taken the voyage on the *HMS Beagle*. When Darwin returned to
England, he was convinced that species are mutable. The overwhelming scientific evidence,
especially from paleontology and biogeography, clearly attested to the adaptive evolution of life
forms throughout organic history on the earth; Darwin’s biological framework supplemented Lyell’s
geological perspective. Darwin acknowledged both the creative and destructive aspects of organic
evolution. Unfortunately, he still lacked an explanatory mechanism to account for the dynamic
divergence and often extinction of species over unimaginable periods of planetary time.

In 1838, by chance, Darwin read Thomas Robert Malthus's monograph *An Essay on the Principle of
Population* (1798, 1803). Suddenly, Malthus’s description of life as a “struggle for existence” gave to
Darwin his primary principle of natural selection, which would help to explain biological evolution.
Despite being elated, the ailing and introverted naturalist had no plans to rush a volume on his
controversial theory of evolution into print. Instead, he focused on those notes he had written
during his groundbreaking trip and published them in *The Voyage of the Beagle* (1839). Furthermore,
he wrote a 35-page abstract on evolution in 1842 and expanded it into a 230-page manuscript in
1844. Neither the abstract nor the manuscript was published.

The scientific philosopher Herbert Spencer (1820-1903) referred to natural selection as “the survival
of the fittest,” a phrase that Darwin himself would use and come to prefer in his later writings. Unlike

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Darwin, however, Spencer extended the evolutionary framework to include everything from the history of the entire universe to the development of human societies and ethics.

As a scientific theory, organic evolution by natural selection had enormous explanatory power. It accounted for the diversity of species on the Galapagos Islands. Organisms in different habitats required different physical characteristics and behavior patterns in order to adapt, survive, and reproduce. Over time, from a common ancestry, species would radiate into different varieties (or new species) to fill different environments. If conditions suddenly changed, then organisms were threatened with extinction; the fossil record shows the complete demise of trilobites and dinosaurs after their millions of years of successful adaptive evolution. All plants and animals, including the human species, are products of biological history in terms of organic evolution. Darwin's own interpretation of this ongoing process was mechanistic and materialistic; it rejected vitalism, essentialism, teleology, spiritualism, and a divine plan, as well as the fixity of species. For Darwin, the process of biological evolution had no meaning, purpose, direction, or final goal. He was correct in fearing that a bitter controversy would ensue over his theory of “descent with modification” (as he called it). For 20 years, his attention focused on numerous research projects ranging from domesticated pigeons to insectivorous plants, while his theory of evolution remained in the background.

The Evolution Controversy

In 1858, Darwin received a letter and manuscript from Alfred Rüssel Wallace (1823-1913), a naturalist who was living in Indonesia. Like Darwin, Wallace had read Lyell and Malthus and had spent time studying the biology of oceanic islands. Reading the manuscript, Darwin was shocked to learn that Wallace had independently discovered the theory of evolution by natural selection. Even so, on July 1, the members of the Linnean Society in London gave priority to Darwin for having fathered the scientific theory of organic evolution 20 years earlier.

Darwin finished his book on evolution On the Origin of Species, which was published on November 24, 1859. In this volume, he deliberately refrained from discussing human evolution and its disturbing ramifications. Darwin had only written: “Light will be thrown on the origin of man and his history.” Nevertheless, anyone reading the Origin of Species could easily see that the theory of evolution should also be extended to account for the origin and history of the human species. As such, one may argue that the controversy over evolution was actually due to a topic that Darwin himself had consciously avoided including in his major work. As Darwin had feared, serious issues over evolution emerged in both academic and public circles. Of special significance was the 1860 confrontation held at the University Museum Library in Oxford (neither Darwin nor Wallace was present). Bishop Samuel Wilberforce (“Soapy Sam”) pontificated on the biblical account of the 6 days of Creation, while the anatomist Thomas Henry Huxley (“Darwin's bulldog”) defended organic evolution and its geological framework. Especially because of Huxley's informative and persuasive arguments, it was held that Darwin had won the day for evolution, science, and reason.

Along with Huxley in England, the biologist and philosopher Ernst Haeckel in Germany and the botanist Asa Gray at Harvard University in the United States championed the evolutionary perspective. However, interpretations of organic evolution ranged from materialism to spiritualism. Despite the ongoing controversy between science and religion, it was becoming increasingly difficult for other naturalists, as well as philosophers and theologians, to ignore the accumulating evidence for both the immense age of this planet and the great antiquity of the human species.
No radiometric dating techniques were available in the 19th century. Therefore, most naturalists did not share Darwin's sweeping geological perspective, which held that the earth must be at least 600 million years old. Darwin reasoned that his theory of evolution needed an awesome amount of time to account for the staggering diversity of life forms that had emerged throughout organic history. The slow evolution of vision, from a mere sensitive spot in a primordial organism to the complex eye in the human species, would take millions upon millions of years to accomplish through the gradual accumulation of slight but favorable individual variations and the mechanism of natural selection.

**Human Evolution**

Twelve years after his *Origin* volume appeared, Darwin published *The Descent of Man* (1871). Finally, the now world-renowned naturalist focused on the evolution of the human species; Huxley and Haeckel had already written on this contentious subject several years earlier. Darwin wrote that the human animal is closest to the two African great apes (chimpanzee and gorilla), with which it shares a common primate ancestor in the remote past. Furthermore, he reasoned that this common ancestor would be found in the fossil record of African rock strata. His rigorous consideration of comparative biology led him to claim that humans differ from apes merely in degree rather than in kind. For many thinkers, the philosophical implications and theological consequences of human evolution were disquieting. In fact, Darwin himself found his own pervasive materialism to be upsetting in its stark implications for human existence.

Darwinian evolution had dealt a serious blow to the alleged uniqueness of the human being; humans were now thought to be evolved apes rather than fallen angels. Consequently, as a result of scientific discoveries in the 20th century, the biological history of the human species was extended back millions of years to the apelike forms in the remote fossil record. Moreover, anthropologists also compared the genes, behavior patterns, and mental activities of humans with those of the living great apes. The results clearly demonstrated that humans are closer to the apes than Huxley or Haeckel or even Darwin himself could have imagined at the end of the 19th century.

For Darwin, even human feelings and emotions had their origin in the feelings and emotions of fossil apes. As such, he also grounded human morality in the distant past. Thus, from biology to psychology, humans are linked to the living apes through organic evolution. A remaining question about human evolution concerns when, in the early history of apelike forms, the successful split had occurred that resulted in a crucial distinction between the ongoing evolution of apes and the emergence of those proto-hominids that were ancestral to the appearance of true hominids, who were capable of both sustained bipedal locomotion and the making of stone implements.

**After Darwin**

After his return from the southern hemisphere, Darwin never made another trip outside of England. He spent his time thinking, writing, and doing research at Down House in Kent, near Bromley. Twice each day, Darwin would stroll the Sandwalk, a path through the woods and fields behind his residence. No doubt, during these walks, he reflected on his fortuitous voyage around the world on the *HMS Beagle* and his own theory of organic evolution. Lyell's persuasive thoughts had introduced the young Darwin to geological history with its awesome temporal framework. Subsequently, Darwin's own scientific theory had given the enlightened world an evolutionary perspective with its overwhelming views of time and change in terms of biological history. The complexity and unity of life on Earth are the result of organic evolution, and this ongoing process
has encompassed millions of years. Even profound ideas, cherished beliefs, and social values have an evolutionary history. Nothing escapes the Darwinian revolution.

In his *Autobiography*, written in 1876 and published posthumously in 1887, Darwin admitted that his theory of evolution challenged the theology of Christianity. He did not speculate on the origin or the end of this universe. Furthermore, an explanation for the beginning of life eluded him, as did envisioning the distant future of the human species and the end of all life. Darwin’s own mechanistic and materialistic interpretation of organic evolution was atheistic, while his cosmology remained agnostic. He simply left the philosophical questions and theological issues surrounding the fact of evolution for other thinkers to grapple with. One may argue that Darwin’s crisis of faith, due to his own pervasive materialism, resulted in a failure of nerve, since he did not share his final thoughts on religion and theology during his lifetime. Unfortunately, not until 1958 was an unexpurgated edition of his *Autobiography* made available to the public; his devoutly religious wife had intentionally deleted all of Darwin’s opinions on God and Christianity from the original manuscript before its first publication. For sure, there was a glaring contrast between Darwin’s scientific understanding of evolutionary time and his wife’s religious commitment to the biblical account of divine creation.

When Darwin died in 1882, he was buried in Westminster Abby near the tomb of Isaac Newton. Over the following years, his theory of evolution has been strengthened by ongoing advances in science and technology. New dating techniques have determined the age of the planet Earth to be 4.6 billion years old, and human-like fossils are now dated back over 4 million years. The discovery of endless specimens in the fossil record of the geological column has revealed both evolutionary patterns and periods of extinction throughout the vastness of biological history. Moreover, ongoing comparative studies in biology, from biochemistry and genetics to embryology and morphology, have shed new light on taxonomic relationships and common ancestries. Continuing studies in the biogeography of both plants and animals reveal the complex adaptive relationships between organisms and their environments. And, modern computers generate dynamic models of the phylogenetic histories of species, filling in the gaps of an admittedly incomplete fossil record. With all this growing empirical evidence, it is becoming more and more difficult for enlightened thinkers to ignore the fact of evolution and its obvious inferences for time and change.

Supplementing historical geology, organic evolution has greatly expanded the concept of time in terms of the origin and history of life forms on Earth (including all aspects of our own species, from religions to technologies). In the mid-20th century, with the discovery of the DNA molecule, scientists developed the so-called synthetic theory of organic evolution, which added genetic variations or mutations, found in dynamic populations, to Darwin’s fundamental concept of natural selection. Furthermore, the evolutionary framework was extended to include the history of this universe. And, there is the probability that life forms, including intelligent beings, are evolving on planets elsewhere in other solar systems among the countless stars. In fact, the concept of time itself has come under rigorous scrutiny by scientists, philosophers, and theologians. No doubt, Charles Darwin would be surprised at, and delighted with, the modern awareness of time concerning both cosmic and biological levels of existence.

**See also**


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