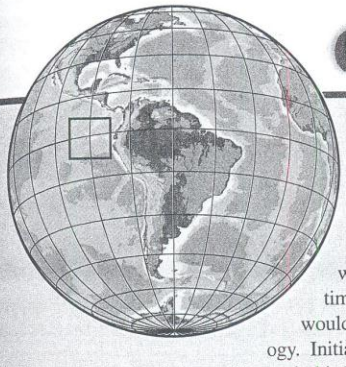

Case Study Darwin's Voyage of Discovery

Charles Darwin was only 22 years old when he set out in 1831 on his epic five-year, around-the-world voyage aboard the H.M.S. *Beagle* (fig. 4.1). It was to be the adventure of a lifetime, and would lead to insights that would revolutionize the field of biology. Initially an indifferent student, Darwin had found inspiring professors in his last years of college. One of them helped him get a position as an unpaid naturalist on board the *Beagle*. Darwin turned out to be a perceptive observer, an avid collector of specimens, and an extraordinary scientist.

As the *Beagle* sailed slowly along the coast of South America, mapping coastlines and navigational routes, Darwin had time to go ashore on long field trips to explore natural history. He was amazed by the tropical forests of Brazil and the fossils of huge, extinct mammals in Patagonia. He puzzled over the fact that many fossils looked similar, but not quite identical, to contemporary animals. Could species change over time? In Darwin's day, most people believed that everything in the world was exactly as it had been created by God only a few thousand years earlier. But Darwin had read the work of Charles Lyell (1797–1875), who suggested that the world was much older than previously thought, and capable of undergoing gradual, but profound, change over time.

After four years of exploring and mapping, Darwin and the *Beagle* reached the Galápagos Islands, 900 km (540 mi) off the coast of Ecuador. The harsh, volcanic landscape of these remote islands (see opposite page) held an extraordinary assemblage of unique plants and animals. Giant land tortoises fed on tree-size cacti. Sea-going iguanas scraped algae off underwater shoals. Sea birds were so unafraid of humans that Darwin could pick them off their nests. The many finches were especially interesting: Every island had its own species, marked by distinct bill shapes, which graded from large and parrot-like to small and warbler-like. Each bird's anatomy and behavior was suited to exploit specific food sources available in its habitat. It seemed obvious that these birds were related, but somehow had been modified to survive under different conditions.

Darwin didn't immediately understand the significance of these observations. Upon returning to England, he began the long process of cataloging and describing the specimens he had collected. Over the next 40 years, he wrote important books on a variety of topics including the formation of oceanic islands from coral reefs, the geology of South America, and the classification and natural history of barnacles. Throughout this time, he puzzled about how organisms might adapt to specific environmental situations.

A key in his understanding was Thomas Malthus's *Essay on the Principle of Population* (1798). From Malthus, Darwin saw that most organisms have the potential to produce far more offspring than can actually survive. Those individuals with superior attributes are more likely to live and reproduce than those less well-endowed. Because the more fit individuals are especially successful in passing along their favorable traits to their offspring, the whole population will gradually change to be better suited for its particular environment. Darwin called this process *natural selection* to distinguish it from the artificial selection that plant and animal breeders used to produce the wide variety of domesticated crops and livestock.

Darwin completed a manuscript outlining his theory of **evolution** (gradual change in species) through natural selection in 1842, but he didn't publish it for another 16 years, perhaps because he was worried about the controversy he knew it would provoke. When his masterpiece, *On the Origin of Species,* was finally made public in 1859, it was both strongly criticized and highly praised. Although Darwin was careful not to question the existence of a Divine Creator, many people interpreted his theory of gradual change in nature as a challenge to their faith. Others took his theory of survival of the fittest much further than Darwin intended, applying it to human societies, economics, and politics.

FIGURE 4.1 Charles Darwin, in a portrait painted shortly after the voyage on the *Beagle*.

One of the greatest difficulties for the theory of evolution was that little was known in Darwin's day of the mechanisms of heredity. No one could explain how genetic variation could arise in a natural population, or how inheritable traits could be sorted and recombined in offspring. It took nearly another century before biologists could use their understanding of molecular genetics to put together a modern synthesis of evolution that clarifies these details.

An overwhelming majority of biologists now consider the theory of evolution through natural selection to be the cornerstone of their science. The theory explains how the characteristics of organisms have arisen from individual molecules, to cellular structures, to tissues and organs, to complex behaviors and population traits. In this chapter, we'll look at the evidence for evolution and how it shapes species and biological communities. We'll examine the ways in which interactions between species and between organisms and their environment allow species to adapt to particular conditions as well as to modify both their habitat and their competitors. For related resources, including Google Earth™ placemarks that show locations where these issues can be explored via satellite images, visit http://EnvironmentalScience-Cunningham.blogspot.com.

For more information, see

Darwin, Charles. *The Voyage of the* Beagle (1837) and *On the Origin of Species* (1859).

Stix, Gary. 2009. Darwin's living legacy. *Scientific American* 300(1): 38–43.