Natural Selection is Discovered

The actual mechanism for evolution was independently conceived and described by two naturalists, Charles Darwin and Alfred Russell Wallace, in the mid-nineteenth century. Both individuals spent time, separately, exploring the natural world on expeditions to the tropics. From 1831 to 1836, Darwin traveled around the world on *H.M.S. Beagle*, visiting South America, Australia, and the southern tip of Africa (Figure 11.2). Wallace traveled to Brazil to collect insects in the Amazon rainforest from 1848 to 1852 and to the Malay Archipelago from 1854 to 1862. Both Darwin's and Wallace's journeys included stops at several island chains.

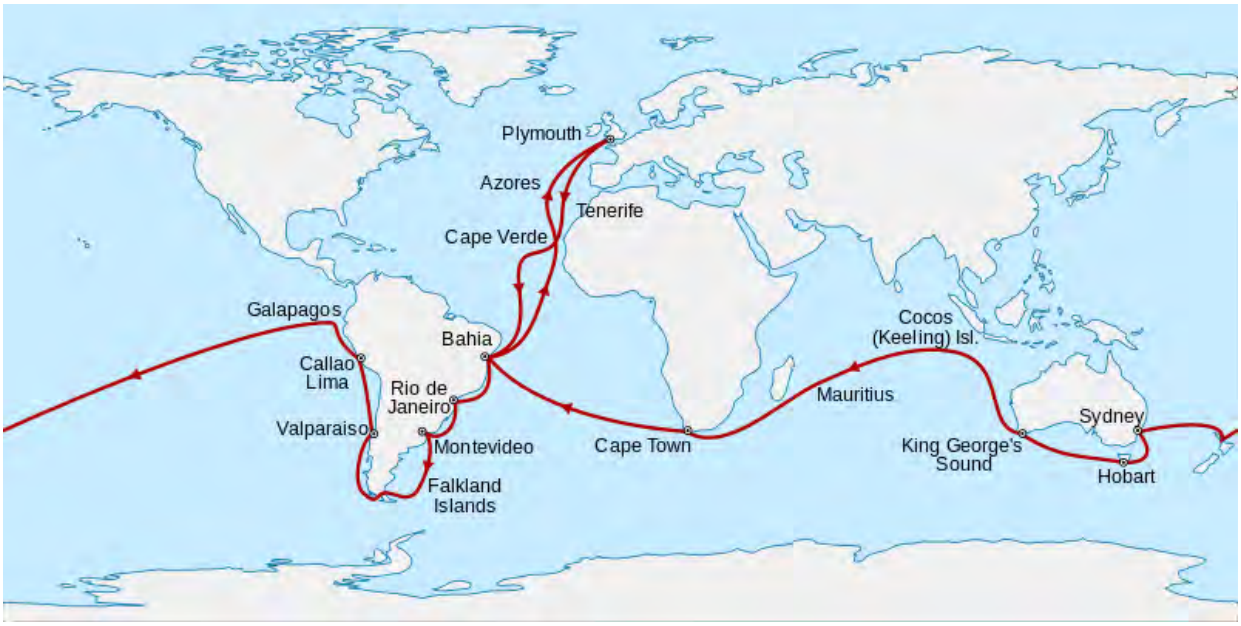

Figure 11.2 Darwin's voyage on the Beagle (credit: Semhur / Wikimedia commons SA)

Darwin's exploration of the Galápagos Islands, located west of Ecuador, led to many observations which helped provide data that supports the theory of evolution. On these islands, Darwin observed organisms that were clearly similar yet had distinct differences. For example, Darwin observed many different species of ground finches inhabiting the Galápagos Islands. Although they shared similarities, Darwin noted that each species had a different beak size and shape. (Figure 11.3). Darwin also realized that the finches on the Galápagos Islands closely resembled another finch species located on the mainland of South America. Darwin hypothesized that the island species might all be descendants from one original mainland species. He hypothesized that the beak of the ancestral species would have changed over time due to different environmental conditions. These adaptations allowed the finches to acquire different food sources on the islands and explained the differences he was seeing in beak size and shape. In 1860, he wrote, "Seeing this gradation and diversity of structure in one small, intimately related group of birds, one might really fancy that from an original paucity of birds in this archipelago, one species had been taken and modified for different ends."[2]

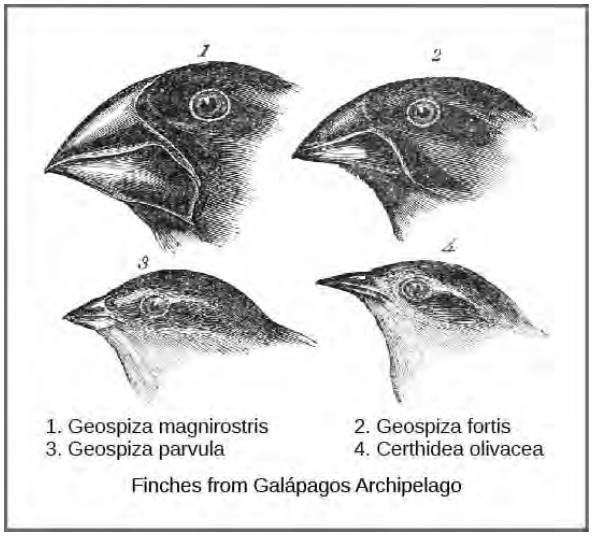

Figure 11.3 Darwin observed that beak shape varies among finch species. This illustration shows the beak shapes for four species of ground finch: 1. *Geospiza magnirostris* (the large ground finch), 2. *G. fortis* (the medium ground finch), 3. *G. parvula* (the small tree finch), and 4. *Certhidea olivacea* (the green-warbler finch). (credit: Fowler et al. / Concepts of Biology OpenStax)

Both Alfred Wallace and Charles Darwin independently observed similar patterns of change in different organisms. Based on their observations, each independently conceived a mechanism to explain how and why such changes could occur. Darwin called this mechanism natural selection. **Natural selection**, Darwin argued, was an inevitable outcome based on three principles that he felt were occurring in nature. First, the characteristics of organisms are inherited, or passed from parent to offspring. Second, more offspring are produced than are able to survive. In other words, resources for survival and reproduction are limited. The capacity for reproduction in all organisms exceeds the availability of resources to support their numbers. Thus, there is a competition for those resources in each generation. Third, offspring vary among each other in regard to their characteristics and those variations are inherited. Out of these three principles, Darwin and Wallace reasoned that offspring with inherited characteristics that allow them to best compete for limited resources would be able to survive and have more offspring than those individuals with variations that are less able to compete. Because characteristics are inherited, the traits of the successful individuals will be represented in a higher proportion in the next generation. This will lead to changes in populations over generations in a process that Darwin called "descent with modification."

Darwin and Wallace (Figure 11.4) both wrote papers presenting their ideas on natural selection. Their papers were read together in 1858 before the Linnaean Society in London. The following year Darwin's book, *On the Origin of Species,* was published, which outlined in considerable detail his arguments for evolution by natural selection.

Figure 11.4 (a) Charles Darwin and (b) Alfred Wallace wrote scientific papers on natural selection that were presented together before the Linnean Society in 1858. (credit: Fowler et al. / Concepts of Biology OpenStax)

Darwin's finishes are one of the best documented examples of evolution. The work done by Darwin in the 1830's was continued by two scientists by the names of Peter and Rosemary Grant. The Grants and their colleagues have studied Galápagos finch populations every year since 1976 and have provided important examples of the process of natural selection. The Grants observed evolutionary events in which the beak shape of the medium ground finch changed from one generation to the next. The medium ground finch feeds on seeds. The birds have inherited variation in the bill shape with some individuals having wide, deep bills and others having thinner bills. Large-billed birds feed more efficiently on large, hard seeds, whereas smaller billed birds feed more efficiently on small, soft seeds. During 1977, a drought period altered vegetation on the Galápagos Island of Daphne Major. After this period, the number of seeds declined dramatically. The decline in small, soft seeds was greater than the decline in large, hard seeds. The large-billed birds were able to survive better than the small-billed birds the following year. When the Grants measured beak sizes in the year following the drought, they found that the average bill size was larger (Figure 11.5). This was clear evidence that supported evolution by natural selection. Based on the availability of seed sizes, finches with larger beak sizes were being naturally selected for. Continued research done by the Grants over several decades demonstrated additional natural selection events. These events led to the subsequent evolution of bill size in response to changing conditions on the island.

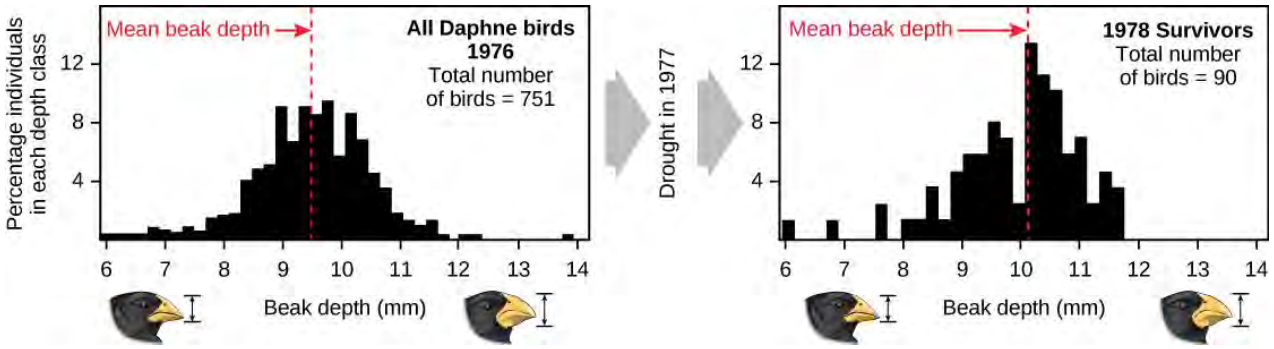

Figure 11.5 A drought on the Galápagos island of Daphne Major in 1977 reduced the number of small seeds available to finches, causing many of the small-beaked finches to die. This caused an increase in the finches' average beak size between 1976 and 1978. (credit: Fowler et al. / Concepts of Biology OpenStax)