Natural selection

In the mid-nineteenth century, two naturalists, Charles Darwin and Alfred Russel Wallace, independently conceived and described the actual mechanism for evolution. Importantly, each naturalist spent time exploring the natural world on expeditions to the tropics. From 1831 to 1836, Darwin travelled around the world on H.M.S. Beagle, including stops in South America, Australia and the southern tip of Africa. Wallace travelled to Brazil to collect insects in the Amazon rainforest from 1848 to 1852 and to the Malay Archipelago from 1854 to 1862. Darwin's journey, like Wallace's later journeys to the Malay Archipelago, included stops at several island chains, the last being the Galápagos Islands west of Ecuador.

On these islands, Darwin observed species of organisms on different islands that were clearly similar, yet had distinct differences. For example, the ground finches inhabiting the Galápagos Islands comprised several species with a unique beak shape. The species on the islands had a graded series of beak sizes and shapes with very small differences between the most similar. He observed that these finches closely resembled another finch species on the South American mainland. Darwin imagined that the island species might be species modified from one of the original mainland species. Upon further study, he realised that each finch's varied beaks helped the birds acquire a specific type of food. For example, seed-eating finches had stronger, thicker beaks for breaking seeds, and insect-eating finches had spear-like beaks for stabbing their prey.

Wallace and Darwin both observed similar patterns in other organisms and they independently developed the same explanation for how and why such changes could take place. Darwin called this mechanism natural selection. Natural selection, or "survival of the fittest", is the more prolific reproduction of individuals with favourable traits that survive environmental change because of those traits. This leads to evolutionary change.

For example, Darwin observed a population of giant tortoises in the Galápagos Archipelago to have longer necks than those that lived on other islands with dry lowlands. These tortoises were "selected" because they could reach more leaves and access more food than those with short necks. In times of drought, when fewer leaves would be available, those that could reach more leaves had a better chance to eat and survive than those that could not reach the food source. Consequently, long-necked tortoises would be more likely to be reproductively successful and pass the long-necked trait to their offspring. Over time, only long-necked tortoises would be present in the population.

Natural selection, Darwin argued, was an inevitable outcome of three principles that operated in nature. First, most characteristics of organisms are inherited, or passed from parent to offspring. Although no one, including Darwin and Wallace, knew how this happened at the time, it was a common understanding. Second, more offspring are produced than are able to survive, so resources for survival and reproduction are limited. The capacity for reproduction in all organisms outstrips the availability of resources to support their numbers. Thus, there is competition for those resources in each generation. Both Darwin and Wallace's understanding of this principle came from reading economist Thomas Malthus' essay that explained this principle in relation to human populations. Third, offspring vary among each other in regard to their characteristics and those variations are inherited. Darwin and Wallace reasoned that offspring with inherited characteristics which allow them to best compete for limited resources will survive and have more offspring than those individuals with variations that are less able to compete. Because characteristics are inherited, these traits will be better represented in the next generation. This will lead to change in populations over generations in a process that Darwin called descent with modification. Ultimately, natural selection leads to greater adaptation of the population to its local environment. It is the only mechanism known for adaptive evolution.

LIVEWORKSHEETS

In 1858, Darwin and Wallace presented papers at the Linnean Society in London that discussed the idea of natural selection. The following year, Darwin's book, *On the Origin of Species*, was published. His book outlined in considerable detail his arguments for evolution by natural selection.

It is difficult and time-consuming to document and present examples of evolution by natural selection, but the Galápagos finches are an excellent example. Researchers Peter and Rosemary Grant – a husband-and-wife team – first travelled to Daphne Major in the Galápagos Islands in 1973 to study the finch populations there. They had initially planned to study them over a two-year period, but it evolved into a 40-year research project that has provided important evidence of natural selection. Much of the Grants' research focused on the medium ground finch.

The island of Daphne Major saw only 24 millimetres of rainfall in early 1977, a time of year that was not supposed to be so dry. Finches with larger beaks survived because they were able to crack open the larger, tougher seeds that remained, but most of those with smaller beaks succumbed to starvation. In 1978, the Grants returned to Daphne Major to document the effect on the next generation of medium ground finches, discovering that the offspring had measurably larger beaks. However, the endless deluge of 1982–83 reversed the trend. There was a marked shift in the types of vegetation growing on the island, which gave finches with smaller beaks an advantage over their counterparts with larger beaks. In the following years, the Grants measured beak sizes and found that the average beak size had nudged lower. Over the course of just a few years, the Grants had witnessed natural selection in action. Their findings and insights have become iconic in the field of evolutionary biology.

Questions 1 – 3

Complete the flow-chart. Write **ONE WORD ONLY** from the text in each gap.

The Grants' research

In early 1977, more [1] had been expected.

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[2] killed many finches.

↓

The next generation had larger beaks.

↓

The island's [3] changed in 1982–3.

↓

There were smaller beaks in subsequent generations.

LIVEWORKSHEETS