13.3 Natural Selection

Natural selection explains how a population changes in response to its environment. Those changes are called *adaptations*. Adaptations are inherited, therefore they must be carried on genes. Since Darwin developed his theory before Gregor Mendel's experiments, he knew nothing about genes. In this section, you will learn about the connection between natural selection and heredity.

Mutations

What causes genetic variation?

Since Darwin's time, there has been a growing body of knowledge about heredity. That knowledge explains many of Darwin's observations and supports the theory of evolution. For example, Darwin observed that individuals in a population show variation in their traits. Today, scientists know that variations in the population of a species are caused by random mutations in genes.

Random mutations in genes produce variations of traits in a population.

Mutations lead to alleles

Recall that alleles are different forms of a gene. A gene mutation leads to different alleles of that gene which in turn, leads to variations of a trait. Mutated alleles may cause favorable and unfavorable adaptations.

Favorable alleles are selected

Imagine a population of brown squirrels that has a single gene that determines fur color. A mutated allele causes white fur instead of brown fur. The squirrels with brown fur can hide from predators better than squirrels with white fur (Figure 13.12). Most of the squirrels that survive to reproduce are brown. Since brown fur is a favorable adaptation, the allele for brown fur is selected over the allele for white fur. What would happen to the frequency of the brown fur allele if the climate changed and the ground became covered in snow for most of each year?

STUDY SKILLS

Reviewing past topics will help you understand the concepts in this chapter. Below are topics and the page number in the text where you will find them. For each topic, go back and reread the page. Then, write down how that topic relates to what you are currently learning.

Species (definition) - page 47
Populations - page 95
Bacteria and evolution - page 181
Alleles - page 218
Mutations - page 242

Figure 13.12: *Squirrels with brown fur are better adapted than squirrels with white fur.*

The importance of genetic variation

Helpful mutations

You have learned that some mutations are harmful because they cause genetic disorders. Mutations may also be helpful because they contribute to genetic variation. **Genetic variation** refers to the variety of alleles in a population. **Genetic variation is necessary for natural selection and ensures that a population has a better chance of survival should the environment change**.

Changing environment

Because our fictional squirrel population carries an allele for white fur, it may have a better chance of surviving a change to a colder climate. The allele for white fur may be selected over the brown if the ground is covered in snow for most of each year. Over many generations, the frequency of the white fur allele may increase in the population while brown decreases.

Natural selection in action

Scientists have observed natural selection in species that produce new generations quickly. An example is pesticide resistance in the potato beetle. Farmers routinely spray pesticides to prevent this pest from destroying their crops. Each time they spray, a few of the beetles survive. The survivors carry a mutated allele that resists the pesticide. The survivors pass the resistant allele to their offspring. Because generations multiply quickly, it does not take long for a population of pesticide-resistant beetles to evolve (Figure 13.13).

VOCABULARY

genetic variation - the variety of alleles in a population.

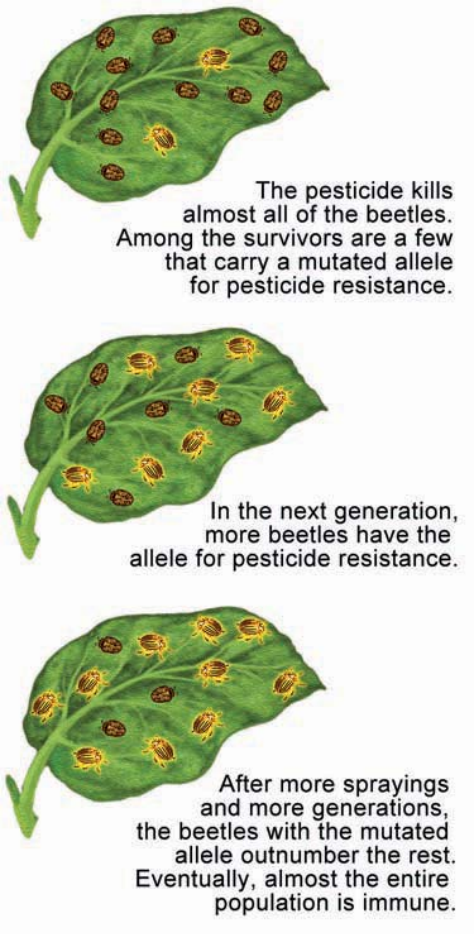


Figure 13.13: *How a population of potato beetles changes over time.*

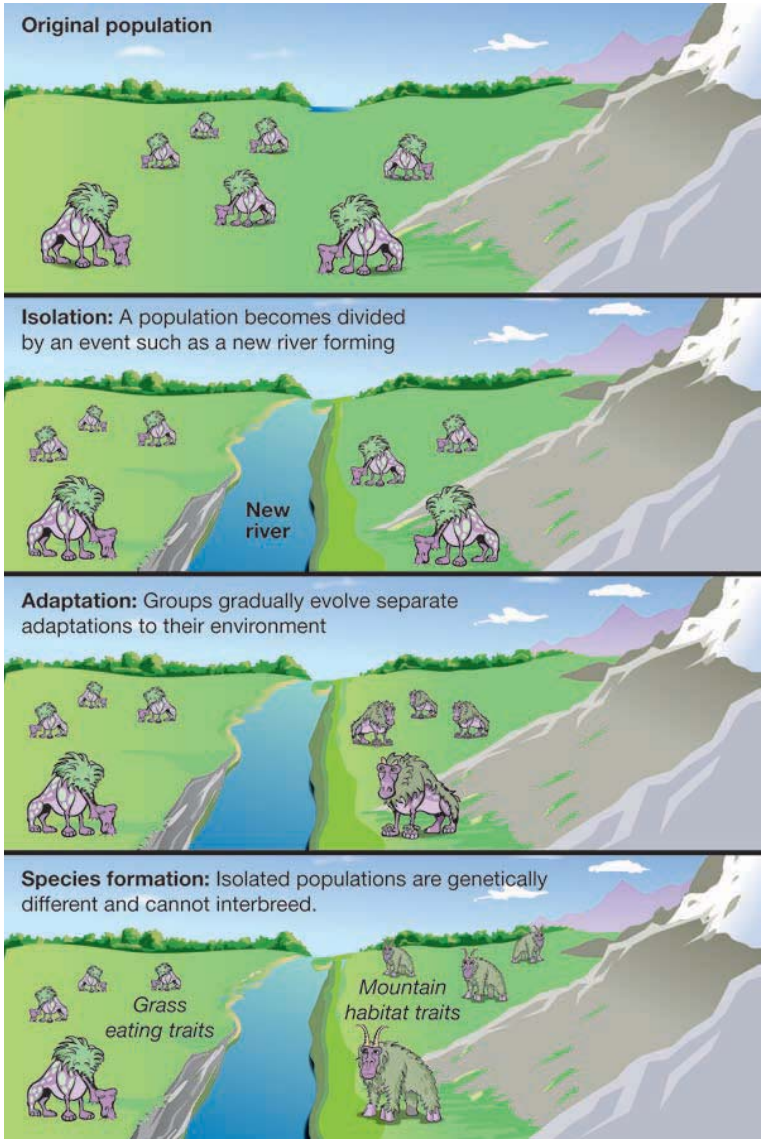
How a new species evolves

How does a new species evolve? Scientists theorize that natural selection leads to the formation of new species. Recall that a *species* is an isolated population of similar organisms that interbreed and produce fertile offspring. One way for a new species to evolve happens in three steps: *isolation*, *adaptation*, and *species formation*.

Isolation *Isolation* happens when a population becomes divided by an event. Possible events include floods, volcanic eruptions, mountain formation, earthquakes, and storms. The original population becomes divided into smaller populations. Each population is physically and reproductively isolated from the others.

Adaptation *Adaptation* happens through natural selection. The event that causes isolation may also change the environment. As the environment changes, the population that lives there undergoes natural selection. Over time, each separated population may become adapted to their environment. If the environments are different, each population will have different adaptations.

Species formation *Species formation* happens when the isolated populations become so different that they can no longer interbreed, even if they could unite again. Over many generations, the isolated populations become genetically different from each other. Each population may have different allele frequencies. Random mutations in each population may create new alleles and thus new traits. As a result, one or more new species are formed.



Extinction of a species

What is extinction?

Extinction occurs when the environment changes and the adaptations of a species are no longer sufficient for its survival. Changes may include increased competition with other species, newly introduced predators, loss of habitat, and catastrophes. Based on the fossil record, scientists think most of the species that once lived on Earth are now extinct.

An example of extinction

The dodo bird is an example of how human impact may contribute to extinction. The dodo was first sighted around 1600 on Mauritius, an island in the Indian Ocean (Figure 13.14). It was a flightless bird with a stubby body and tiny wings (Figure 13.15). Scientists believe that the dodo evolved from a bird capable of flight. When an ancestor of the dodo landed on Mauritius, it found a habitat with plenty of food and no predators. It had no reason to fly and eventually evolved into a flightless bird.

The cause of the dodo's extinction

The dodo was extinct less than eighty years after its discovery. Some of the birds were eaten by the Dutch sailors who discovered them. Also, domestic pigs and cats destroyed their nests which were built on the ground. But the main cause of their extinction was the human destruction of their habitat.

The importance of genetic variation

One reason the dodo may have become extinct is the lack of genetic variation. As a species' population gets smaller, its genetic variation may decrease. Natural selection requires genetic variation. Therefore, a small population may be more susceptible to extinction than a large population if their environment changes. If genetic variation is not present, the population may not have enough favorable adaptations to survive changes in the environment. Scientists study extinctions like the dodo's in hope of preventing future extinctions.

Figure 13.14: *Mauritius is located off the coast of Madagascar.*

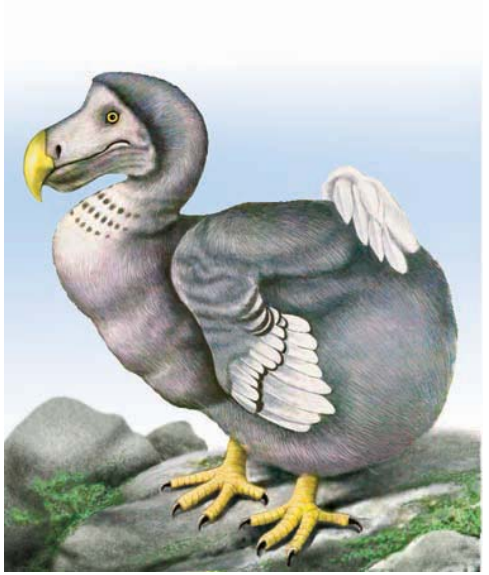


Figure 13.15: *The dodo was a flightless bird.*

13.3 Section Review

1. Why are mutations beneficial to the process of evolution?
2. Many species of animals carry an allele for albinism (lack of pigmentation). Albinos are usually pale or white in color. Explain why the allele for albinism is present at a lower frequency than the allele for having pigments. What conditions would be necessary for the albino allele to be more frequent?
3. Why is genetic variation necessary for natural selection to occur?
4. Construct a concept map that shows how a population of bacteria can develop resistance to antibiotics.
5. Describe how a new species evolves.
6. What is meant by the term *extinction*? List three causes of extinction.
7. Cheetahs are the largest of the small cats. The cheetah population once covered all of Africa and Asia. Now cheetahs are an endangered species. Loss of habitat, commercial farming, and development are major causes of its decline. Today, there are fewer than 12,000 cheetahs left on the planet. Explain, using your knowledge of natural selection, why it may be difficult to stop the decline of the cheetah population.

VOCABULARY

From previous page:

extinction - occurs when the environment changes and the adaptations of a species are no longer sufficient for its survival.

CHALLENGE

A cactus is a plant that lives in very hot and dry habitats. The spines of a cactus are modified leaves. The stem of a cactus is thickened and stores water. Explain how cactus leaves and stems may have changed over time through the process of natural selection.