SECTION 3

Natural Selection in Action

Have you ever had to take an antibiotic? Antibiotics are supposed to kill bacteria. But sometimes, bacteria are not killed by the medicine. Do you know why?

A population of bacteria might develop an adaptation through natural selection. Most bacteria are killed by the chemicals in antibiotics. But in some cases, a few bacteria are naturally *resistant* to the chemicals, so they are not killed. These survivors are then able to pass this adaptation to their offspring. This situation is an example of how natural selection works.

READING WARM-UP

Objectives

- Give three examples of natural selection in action.
- Outline the process of speciation.

Terms to Learn

generation time
speciation

READING STRATEGY

Prediction Guide Before reading this section, write the title of each heading in this section. Next, under each heading, write what you think you will learn.

Changes in Populations

The theory of natural selection explains how a population changes in response to its environment. If natural selection is always taking place, a population will tend to be well adapted to its environment. But not all individuals are the same. The individuals that are likely to survive and reproduce are those that are best adapted at the time.

Adaptation to Hunting

Changes in populations are sometimes observed when a new force affects the survival of individuals. In Uganda, scientists think that hunting is affecting the elephant population. In 1930, about 99% of the male elephants in one area had tusks. Only 1% of the elephants were born without tusks. Today, as few as 85% of the male elephants in that area have tusks. What happened?

A male African elephant that has tusks is shown in **Figure 1.** The ivory of an elephant's tusks is very valuable. People hunt the elephants for their tusks. As a result, fewer of the elephants that have tusks survive to reproduce, and more of the tuskless elephants survive. When the tuskless elephants reproduce, they pass the tuskless trait to their offspring.

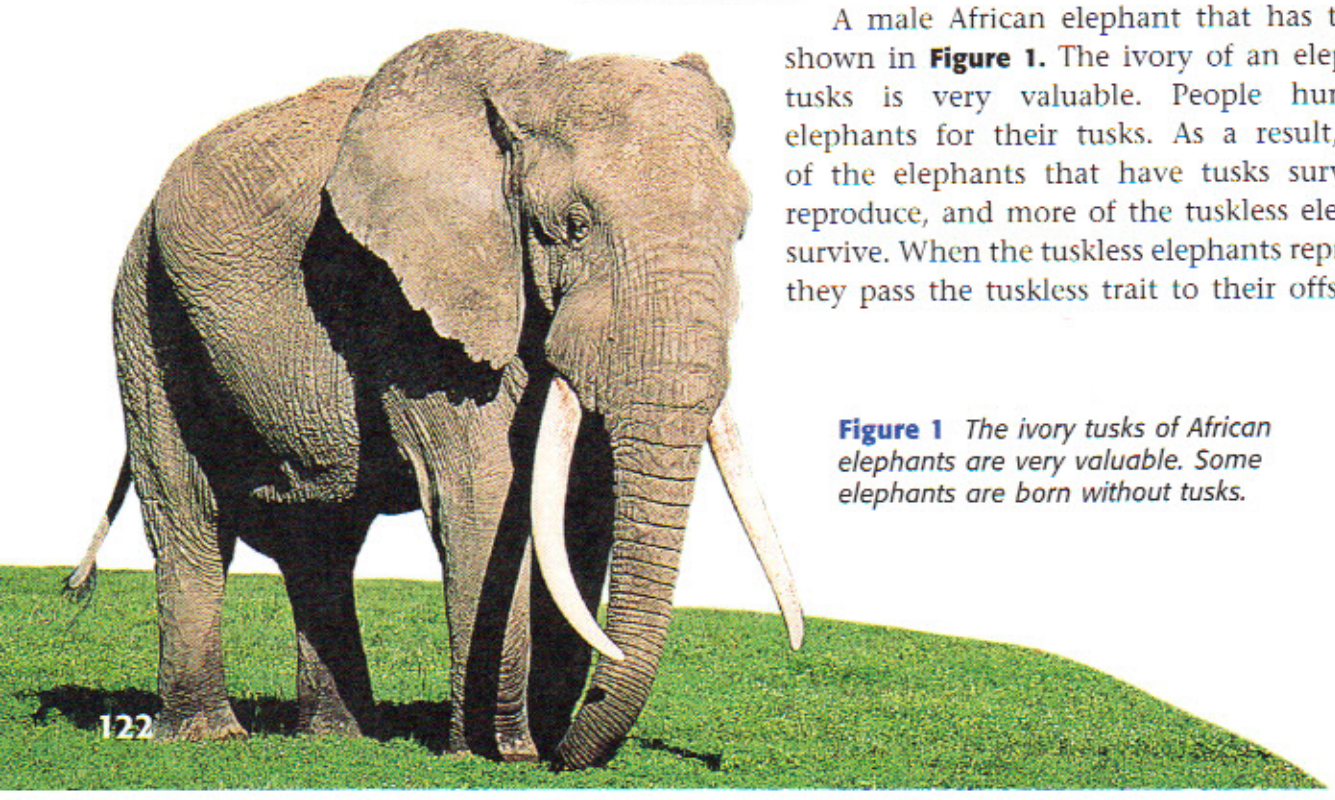


Figure 1 *The ivory tusks of African elephants are very valuable. Some elephants are born without tusks.*

Figure 2 **Natural Selection of Insecticide Resistance**

1. An insecticide will kill most insects, but a few may survive. These survivors have genes that make them resistant to the insecticide.

2. The survivors then reproduce, passing the insecticide-resistance genes to their offspring.

3. In time, the replacement population of insects is made up mostly of individuals that have the insecticide-resistance genes.

4. When the same kind of insecticide is used on the insects, only a few are killed because most of them are resistant to that insecticide.

Insecticide Resistance

People have always wanted to control the insect populations around their homes and farms. Many insecticides are used to kill insects. But some chemicals that used to work well do not work as well anymore. Some individual insects within the population are resistant to certain insecticides. **Figure 2** shows how a population of insects might become resistant to common insecticides.

More than 500 kinds of insects are now resistant to certain insecticides. Insects can quickly develop resistance because they often produce many offspring and have short generation times. **Generation time** is the average time between one generation of offspring and the next.

generation time the period between the birth of one generation and the birth of the next generation

Reading Check **Why do insects quickly develop resistance to insecticides?** *(See the Appendix for answers to Reading Checks.)*

Competition for Mates

In the process of evolution, survival is simply not enough. Natural selection is at work when individuals reproduce. In organisms that reproduce sexually, finding a mate is part of the struggle to reproduce. Many species have so much competition for mates that interesting adaptations result. For example, the females of many bird species prefer to mate with males that have certain types of colorful feathers.

Forming a New Species

Sometimes, drastic changes that can form a new species take place. In the animal kingdom, a *species* is a group of organisms that can mate with each other to produce fertile offspring. A new species may form after a group becomes separated from the original population. This group forms a new population. Over time, the two populations adapt to their different environments. Eventually, the populations can become so different that they can't mate anymore. Each population may then be considered a new species. The formation of a new species as a result of evolution is called **speciation** (SPEE shee AY shuhn). **Figure 3** shows how new species of Galápagos finches may have formed. Speciation may happen in other ways as well.

speciation the formation of new species as a result of evolution

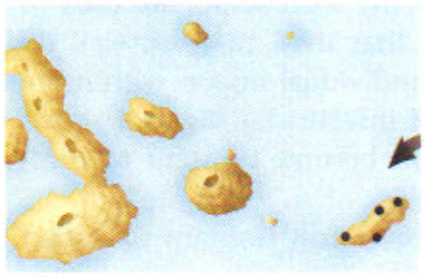
Separation

Speciation often begins when a part of a population becomes separated from the rest. The process of separation can happen in several ways. For example, a newly formed canyon, mountain range, or lake can divide the members of a population.

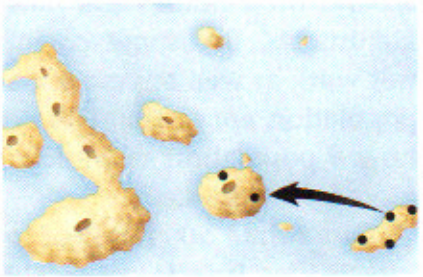
Reading Check How can parts of a population become separated?

Figure 3 The Evolution of Galápagos Finch Species

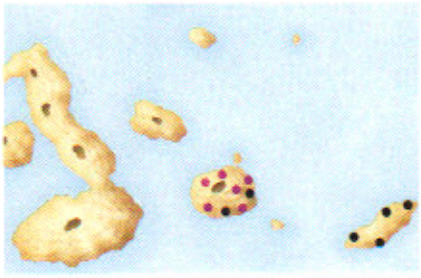
1 Some finches left the mainland and reached one of the islands (separation).



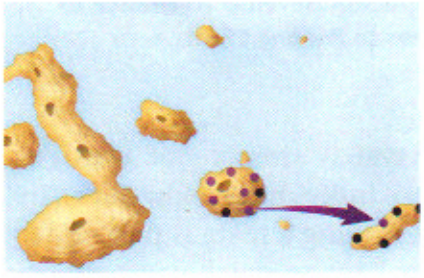
2 The finches reproduced and adapted to the environment (adaptation).



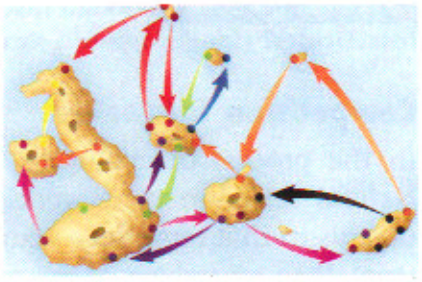
3 Some finches flew to a second island (separation).



4 The finches reproduced and adapted to the different environment (adaptation).



5 Some finches flew back to the first island but could no longer interbreed with the finches there (division).



6 This process may have occurred over and over again as the finches flew to the other islands.

Adaptation

Populations constantly undergo natural selection. After two groups have separated, natural selection may act on each group in different ways. Over many generations, the separated groups may evolve different sets of traits. If the environmental conditions for each group differ, the adaptations in the groups will also differ.

Division

Over many generations, two separated groups of a population may become very different. Even if a geographical barrier is removed, the groups may not be able to interbreed anymore. At this point, the two groups are no longer the same species.

Figure 4 shows another way that populations may stop interbreeding. Leopard frogs and pickerel frogs probably had the same ancestor species. Then, at some point, some of these frogs began to mate at different times during the year.

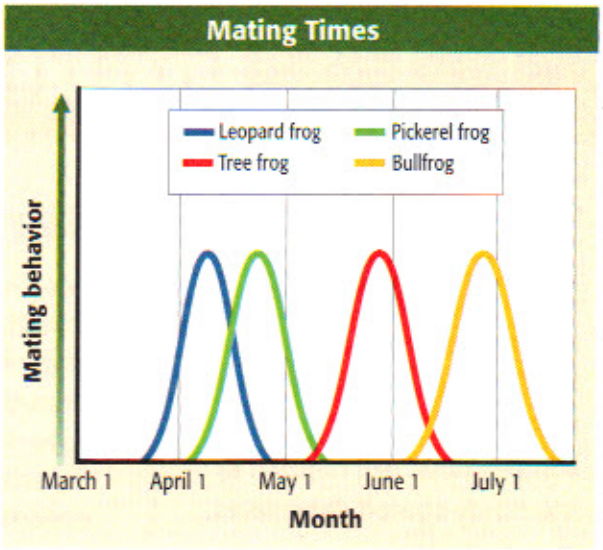


Figure 4 *The leopard frog and the pickerel frog are similar species. However, leopard frogs do not search for mates at the same time of year that pickerel frogs do.*

SECTION Review

Summary

- Natural selection explains how populations adapt to changes in their environment. A variety of examples of such adaptations can be found.
- Natural selection also explains how one species may evolve into another. Speciation occurs as populations undergo separation, adaptation, and division.

Using Key Terms

1. In your own words, write a definition for the term *speciation*.

Understanding Key Ideas

2. Two populations have evolved into two species when
   - **a.** the populations are separated.
   - **b.** the populations look different.
   - **c.** the populations can no longer interbreed.
   - **d.** the populations adapt.
3. Explain why the number of tuskless elephants in Uganda may be increasing.

Math Skills

4. A female cockroach can produce 80 offspring at a time. If half of the offspring produced by a certain female are female and each female produces 80 offspring, how many cockroaches are there in the third generation?

Critical Thinking

5. **Forming Hypotheses** Most kinds of cactus have leaves that grow in the form of spines. The stems or trunks become thick, juicy pads or barrels. Explain how these cactus parts might have evolved.
6. **Making Comparisons** Suggest an organism other than an insect that might evolve an adaptation to human activities.

Chapter Review

USING KEY TERMS

Complete each of the following sentences by choosing the correct term from the word bank.

adaptation
evolution
generation time
species
speciation
fossil record
selective breeding
natural selection

1. When a single population evolves into two populations that cannot interbreed anymore, ___ has occurred.
2. Darwin's theory of ___ explained the process by which organisms become well-adapted to their environment.
3. A group of organisms that can mate with each other to produce offspring is known as a(n) ___.
4. The ___ provides information about organisms that have lived in the past.
5. In ___, humans select organisms with desirable traits that will be passed from one generation to another.
6. A(n) ___ helps an organism survive better in its environment.
7. Populations of insects and bacteria can evolve quickly because they usually have a short ___.

UNDERSTANDING KEY IDEAS

Multiple Choice

8. Fossils are commonly found in
   - **a.** sedimentary rock.
   - **b.** all kinds of rock.
   - **c.** granite.
   - **d.** loose sand.
9. The fact that all organisms have DNA as their genetic material is evidence that
   - **a.** all organisms undergo natural selection.
   - **b.** all organisms may have descended from a common ancestor.
   - **c.** selective breeding takes place every day.
   - **d.** genetic resistance rarely occurs.
10. Charles Darwin puzzled over differences in the ___ of the different species of Galápagos finches.
    - **a.** webbed feet
    - **b.** beaks
    - **c.** bone structure of the wings
    - **d.** eye color
11. Darwin observed variations among individuals within a population, but he did not realize that these variations were caused by
    - **a.** interbreeding.
    - **b.** differences in food.
    - **c.** differences in genes.
    - **d.** selective breeding.

Short Answer

12 Identify two ways that organisms can be compared to provide evidence of evolution from a common ancestor.

13 Describe evidence that supports the hypothesis that whales evolved from land-dwelling mammals.

14 Why are some animals more likely to survive to adulthood than other animals are?

15 Explain how genetics is related to evolution.

16 Outline an example of the process of speciation.

CRITICAL THINKING

17 **Concept Mapping** Use the following terms to create a concept map: *struggle to survive, theory, genetic variation, Darwin, overpopulation, natural selection,* and *successful reproduction.*

18 **Making Inferences** How could natural selection affect the songs that birds sing?

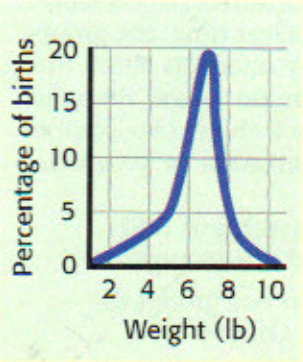
19 **Forming Hypotheses** In Australia, many animals look like mammals from other parts of the world. But most of the mammals in Australia are marsupials, which carry their young in pouches after birth. Few kinds of marsupials are found anywhere else in the world. What is a possible explanation for the presence of so many of these unique mammals in Australia?

20 **Analyzing Relationships** Geologists have evidence that the continents were once a single giant continent. This giant landform eventually split apart, and the individual continents moved to their current positions. What role might this drifting of continents have played in evolution?

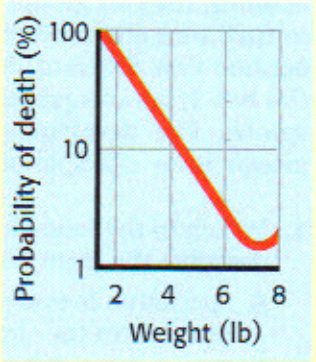
INTERPRETING GRAPHICS

The graphs below show information about the infants that are born and the infants that have died in a population. The weight of each infant was measured at birth. Use the graphs to answer the questions that follow.

Infant Births by Birth Weight



Infant Deaths by Birth Weight



21 What is the most common birth weight?

22 At which birth weight is an infant most likely to survive?

23 How do the principles of natural selection help explain why there are more deaths among babies whose birth weights are low than among babies whose birth weights are average?