Limiting Factors

When the living conditions in an area are good, a population will generally grow. But eventually some environmental factor will cause the population to stop growing. A **limiting factor** is an environmental factor that causes a population to decrease. **Some limiting factors for populations are food and water, space, and weather conditions.**

Food and Water Organisms require food and water to survive. Since food and water are often in limited supply, they are often limiting factors. Suppose a giraffe must eat 10 kilograms of leaves each day to survive. The trees in an area can provide 100 kilograms of leaves a day while remaining healthy. Five giraffes could live easily in this area, since they would only require a total of 50 kilograms of food. But 15 giraffes could not all survive—there would not be enough food. No matter how much shelter, water, and other resources there were, the population would not grow much larger than 10 giraffes.

The largest population that an area can support is called its **carrying capacity.** The carrying capacity of this giraffe habitat would be 10 giraffes. A population usually stays near its carrying capacity because of the limiting factors in its habitat.

Space Space is another limiting factor for populations. Gannets are seabirds that are usually seen flying over the ocean. They come to land only to nest on rocky shores. But the nesting shores get very crowded. If a pair does not find room to nest, they will not be able to add any offspring to the gannet population. So nesting space on the shore is a limiting factor for gannets. If there were more nesting space, more gannets would be able to nest, and the population would increase.

Space is also a limiting factor for plants. The amount of space in which a plant grows determines whether the plant can obtain the sunlight, water, and soil nutrients it needs. For example, many pine seedlings sprout each year in a forest. But as the seedlings grow, the roots of those that are too close together run out of space. Branches from other trees may block the sunlight the seedlings need. Some of the seedlings then die, limiting the size of the pine population.

Weather Weather conditions such as temperature and the amount of rainfall can also limit population growth. A cold snap in late spring can kill the young of many species of organisms, including birds and mammals. A hurricane or flood can wash away nests and burrows. Such unusual events can have long-lasting effects on population size.

Reading Checkpoint

What is one weather condition that can limit the growth of a population?

Adapting to the Environment

Each organism in the saguaro community has unique characteristics. These characteristics affect the individual's ability to survive in its environment.

Natural Selection A characteristic that makes an individual better suited to its environment may eventually become common in that species through a process called **natural selection.** Natural selection works like this: Individuals whose unique characteristics are best suited for their environment tend to survive and produce offspring. Offspring that inherit these characteristics also live to reproduce. In this way, natural selection results in **adaptations,** the behaviors and physical characteristics that allow organisms to live successfully in their environments.

Individuals with characteristics that are poorly suited to the environment are less likely to survive and reproduce. Over time, poorly suited characteristics may disappear from the species.

Niche **Every organism has a variety of adaptations that are suited to its specific living conditions.** The organisms in the saguaro community have adaptations that result in specific roles. The role of an organism in its habitat, or how it makes its living, is called its **niche.** A niche includes the type of food the organism eats, how it obtains this food, and which other organisms use the organism as food. A niche also includes when and how the organism reproduces and the physical conditions it requires to survive.

FIGURE 12
Saguaro Community
The organisms in the saguaro community are well adapted to their desert environment.
Observing *Identify two interactions taking place in this scene.*

Cape May Warbler
This species feeds at the tips of branches near the top of the tree.

Bay-Breasted Warbler
This species feeds in the middle part of the tree.

Yellow-Rumped Warbler
This species feeds in the lower part of the tree and at the bases of the middle branches.

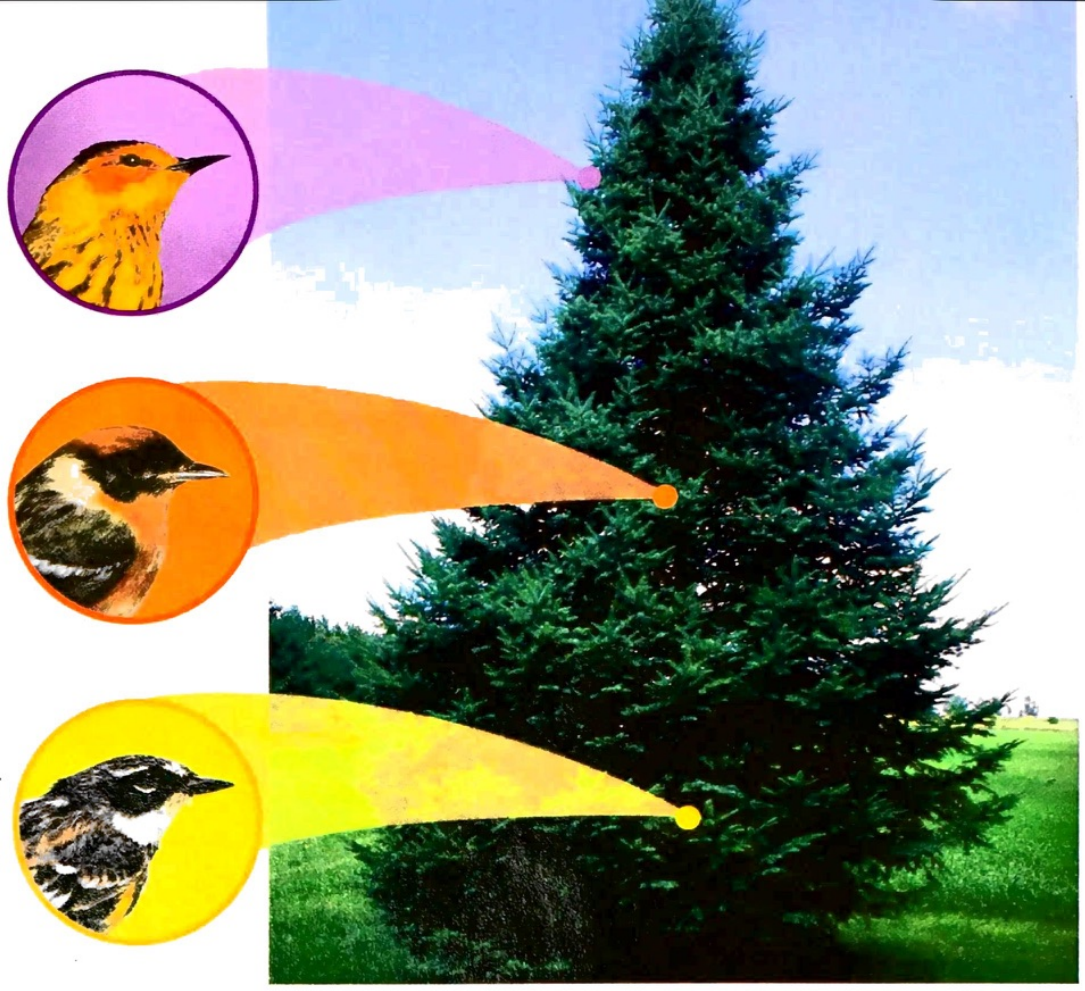


FIGURE 13
Niche and Competition
Each of these warblers occupies a different niche in its spruce tree habitat. By feeding in different areas of the tree, the birds avoid competing for food.
Comparing and Contrasting
How do the niches of these three warblers differ?

Competition

During a typical day in the saguaro community, a range of interactions takes place among organisms. **There are three major types of interactions among organisms: competition, predation, and symbiosis.**

Different species can share the same habitat and food requirements. For example, the roadrunner and the elf owl both live on the saguaro and eat insects. However, these two species do not occupy exactly the same niche. The roadrunner is active during the day, while the owl is active mostly at night. If two species occupy the same niche, one of the species will eventually die off. The reason for this is competition, the struggle between organisms to survive as they attempt to use the same limited resource.

In any ecosystem, there is a limited amount of food, water, and shelter. Organisms that survive have adaptations that enable them to reduce competition. For example, the three species of warblers in Figure 13 live in the same spruce forest habitat. They all eat insects that live in the spruce trees. How do these birds avoid competing for the limited insect supply? Each warbler "specializes" in feeding in a certain part of a spruce tree. This is how the three species coexist.

Reading Checkpoint **Why can't two species occupy the same niche?**

Predation

A tiger shark lurks below the surface of the clear blue water, looking for shadows of albatross chicks floating above. The shark spots a chick and silently swims closer. Suddenly, the shark bursts through the water and seizes the albatross with one snap of its powerful jaw. This interaction between two organisms has an unfortunate ending for the albatross.

An interaction in which one organism kills another for food is called **predation.** The organism that does the killing, in this case the tiger shark, is the **predator.** The organism that is killed, in this case the albatross, is the **prey.**

The Effect of Predation on Population Size Predation can have a major effect on the size of a population. Recall from Section 2 that when the death rate exceeds the birth rate in a population, the size of that population usually decreases. So if there are many predators, the result is often a decrease in the size of the population of their prey. But a decrease in the number of prey results in less food for their predators. Without adequate food, the predator population starts to decline. So, generally, populations of predators and their prey rise and fall in related cycles.

FIGURE 14
Predation
This green tree python and mouse are involved in a predator-prey interaction.

FIGURE 15
Predator Adaptations
This greater horseshoe bat has adaptations that allow it to find prey in the dark. The bat produces pulses of sound and locates prey by interpreting the echoes.
Inferring *What other adaptations might contribute to the bat's success as a predator?*

Predator Adaptations Predators have adaptations that help them catch and kill their prey. For example, a cheetah can run very fast for a short time, enabling it to catch its prey. A jellyfish's tentacles contain a poisonous substance that paralyzes tiny water animals. Some plants, too, have adaptations for catching prey. The sundew is covered with sticky bulbs on stalks—when a fly lands on the plant, it remains snared in the sticky goo while the plant digests it.

Some predators have adaptations that enable them to hunt at night. For example, the big eyes of an owl let in as much light as possible to help it see in the dark. Insect-eating bats can hunt without seeing at all. Instead, they locate their prey by producing pulses of sound and listening for the echoes. This precise method enables a bat to catch a flying moth in complete darkness.

Prey Adaptations How do organisms avoid being killed by such effective predators? Organisms have many kinds of adaptations that help them avoid becoming prey. The alertness and speed of an antelope help protect it from its predators. And you're probably not surprised that the smelly spray of a skunk helps keep its predators at a distance. As you can see in Figure 16, other organisms also have some very effective ways to avoid becoming a predator's next meal.

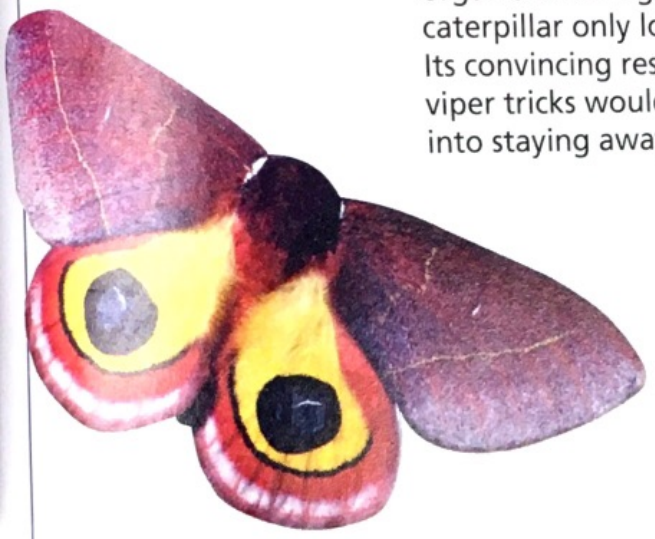
Reading Checkpoint **What are two predator adaptations?**

FIGURE 16

Defense Strategies

Organisms display a wide array of adaptations that help them avoid becoming prey.

Mimicry ▶
If you're afraid of snakes, you'd probably be terrified to see this organism staring at you. But this caterpillar only looks like a snake. Its convincing resemblance to a viper tricks would-be predators into staying away.

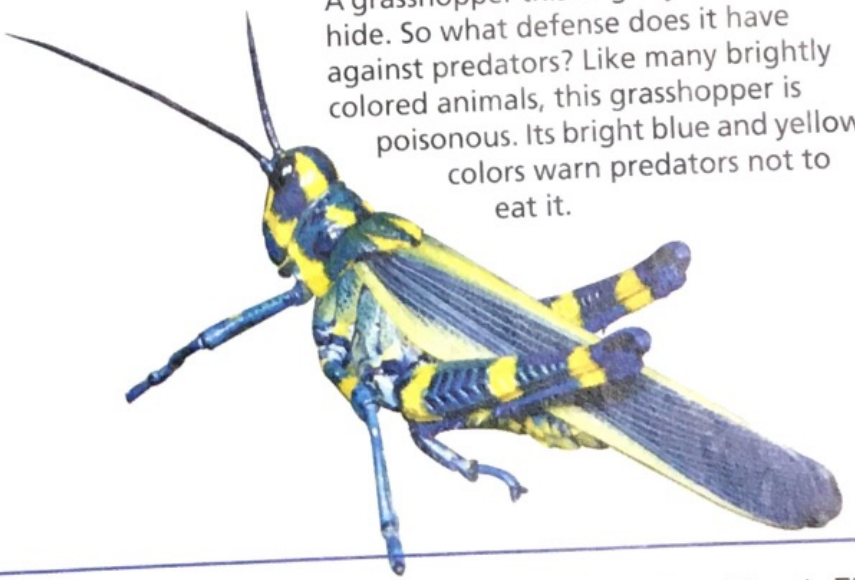


False Coloring ▲
If you saw this moth in a dark forest, you might think you were looking into the eyes of a large mammal. The large false eyespots on the moth's wings scare potential predators away.

Protective Covering ▼
Have you ever seen a pine cone with a face? This organism is actually a pangolin, a small African mammal. When threatened, the pangolin protects itself by rolling up into a scaly ball.

Camouflage ▲
Is it a leaf? Actually, it's a walking leaf insect. But if you were a predator, you might be fooled into looking elsewhere for a meal.

Warning Coloring ▼
A grasshopper this brightly colored can't hide. So what defense does it have against predators? Like many brightly colored animals, this grasshopper is poisonous. Its bright blue and yellow colors warn predators not to eat it.



Lab zone Skills Activity

Classifying

Classify each interaction as an example of mutualism, commensalism, or parasitism. Explain your answers.

- A remora fish attaches itself to the underside of a shark without harming the shark, and eats left-over bits of food from the shark's meals.
- A vampire bat drinks the blood of horses.
- Bacteria living in cows' stomachs help them break down the cellulose in grass.

Symbiosis

Many of the interactions in the saguaro community you read about are examples of symbiosis. **Symbiosis** (sim bee OH sis) is a close relationship between two species that benefits at least one of the species. **The three types of symbiotic relationships are mutualism, commensalism, and parasitism.**

Mutualism A relationship in which both species benefit is called **mutualism** (MYOO choo uh liz um). The relationship between the saguaro and the long-eared bats is an example of mutualism. The bats benefit because the cactus flowers provide them with food. The saguaro benefits as its pollen is carried to another plant on the bat's nose.

In some cases of mutualism, two species are so dependent on each other that neither could live without the other. This is true for some species of acacia trees and stinging ants in Central and South America. The stinging ants nest only in the acacia tree, whose thorns discourage the ants' predators. The tree also provides the ants' only food. The ants, in turn, attack other animals that approach the tree and clear competing plants away from the base of the tree. To survive, each species needs the other.

Commensalism A relationship in which one species benefits and the other species is neither helped nor harmed is called **commensalism** (kuh MEN suh liz um). The red-tailed hawks' interaction with the saguaro is an example of commensalism. The hawks benefit by having a place to build their nest, while the cactus is not affected by the hawks.

Commensalism is not very common in nature because two species are usually either helped or harmed a little by any interaction. For example, by creating a small hole for its nest in the cactus stem, the elf owl slightly damages the cactus.

FIGURE 17
Mutualism
Three yellow-billed oxpeckers get a cruise and a snack aboard an obliging hippopotamus. The oxpeckers eat ticks living on the hippo's skin. Since both the birds and the hippo benefit from this interaction, it is an example of mutualism.

Parasitism Parasitism (PA ruh sit iz um) involves one organism living on or inside another organism and harming it. The organism that benefits is called a **parasite,** and the organism it lives on or in is called a **host.** The parasite is usually smaller than the host. In a parasitic relationship, the parasite benefits from the interaction while the host is harmed.

Some common parasites are fleas, ticks, and leeches. These parasites have adaptations that enable them to attach to their host and feed on its blood. Other parasites live inside the host's body, such as tapeworms that live inside the digestive systems of dogs, wolves, and some other mammals.

Unlike a predator, a parasite does not usually kill the organism it feeds on. If the host dies, the parasite loses its source of food. An interesting example of this rule is shown by a species of mite that lives in the ears of moths. The mites almost always live in just one of the moth's ears. If they live in both ears, the moth's hearing is so badly affected that it is likely to be quickly caught and eaten by its predator, a bat.