SECTION 1

Everything Is Connected

An alligator drifts in a weedy Florida river, watching a long, thin fish called a *gar*. The gar swims too close to the alligator. Then, in a rush of murky water, the alligator swallows the gar whole and slowly swims away.

It is clear that two organisms have interacted when one eats the other. But organisms have many interactions other than simply "who eats whom." For example, alligators dig underwater holes to escape from the heat. After the alligators abandon these holes, fish and other aquatic organisms live in the holes during the winter dry period.

What You Will Learn

- Distinguish between the biotic and abiotic parts of the environment.
- Explain how populations and communities are related.
- Describe how the abiotic parts of the environment affect ecosystems.

Vocabulary

ecology
biotic
abiotic
population
community
ecosystem
biosphere

READING STRATEGY

Reading Organizer As you read this section, create an outline of the section. Use the headings from the section in your outline.

Studying the Web of Life

All living things are connected in a web of life. Scientists who study the web of life specialize in the science of ecology. **Ecology** is the study of the interactions of organisms with one another and with their environment.

The Two Parts of an Environment

An organism's environment consists of all the things that affect the organism. These things can be divided into two groups. All of the organisms that live together and interact with one another make up the **biotic** part of the environment. The **abiotic** part of the environment consists of the nonliving factors, such as water, soil, light, and temperature. How many biotic parts and abiotic parts do you see in **Figure 1?**

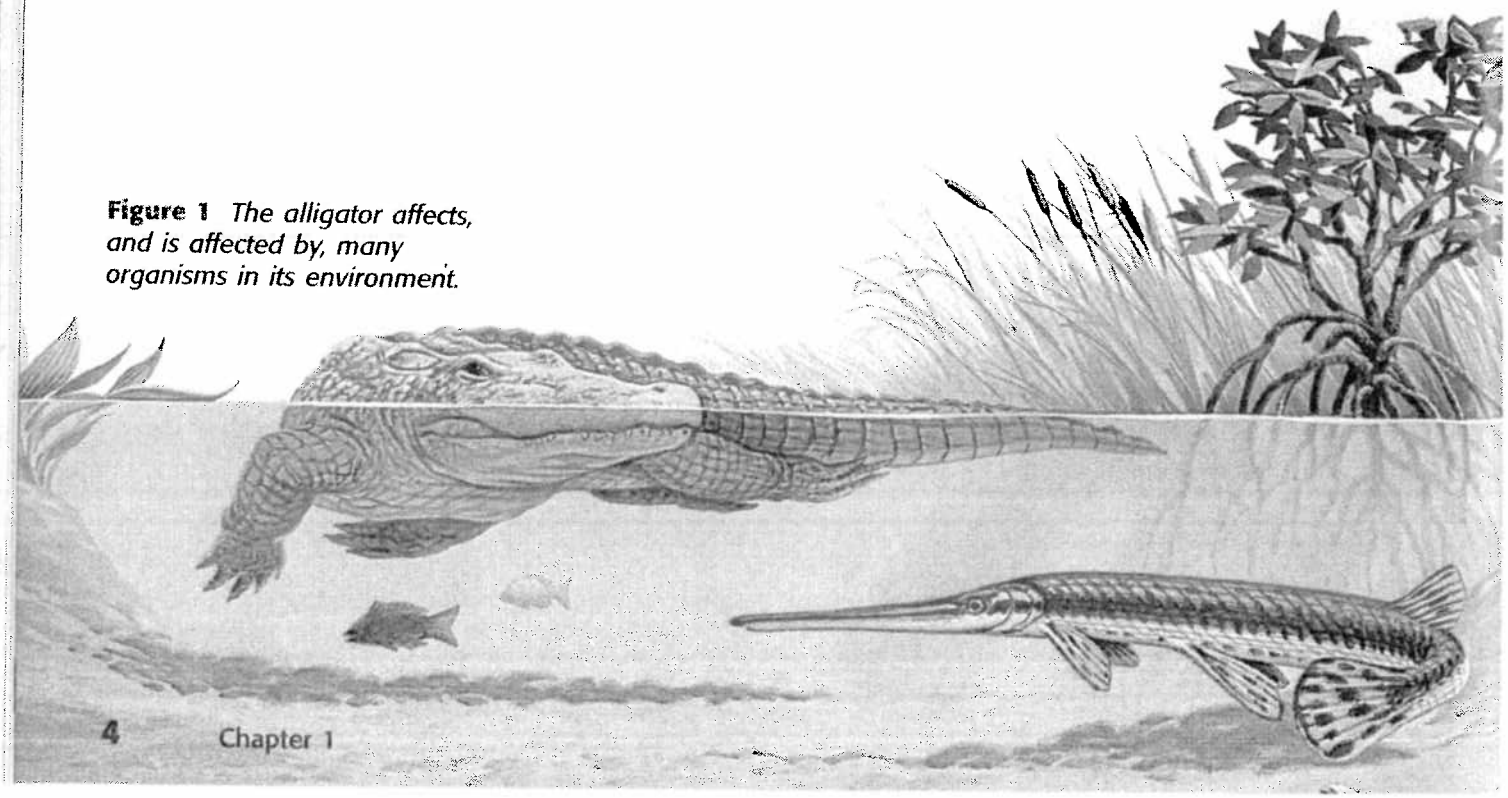


Figure 1 *The alligator affects, and is affected by, many organisms in its environment.*

Organization in the Environment

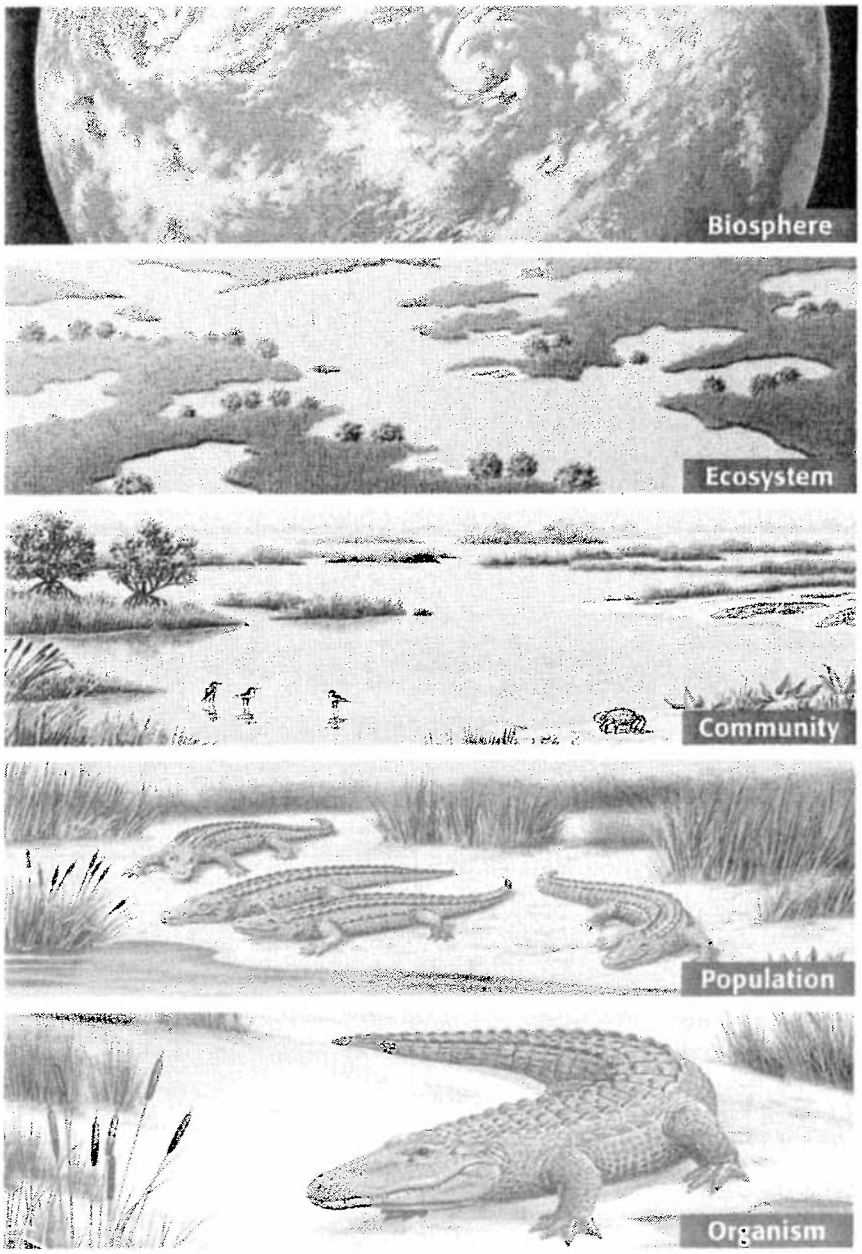
At first glance, the environment may seem disorganized. However, the environment can be arranged into different levels, as shown in **Figure 2.** The first level is made of an individual organism. The second level is larger and is made of similar organisms, which form a population. The third level is made of different populations, which form a community. The fourth level is made of a community and its abiotic environment, which form an ecosystem. The fifth and final level contains all ecosystems, which form the biosphere.

ecology the study of the interactions of living organisms with one another and with their environment

biotic describes living factors in the environment

abiotic describes the nonliving part of the environment, including water, rocks, light, and temperature

Figure 2 The Five Levels of Environmental Organization



Meeting the Neighbors

1. Explore two or three blocks of your neighborhood.
2. Draw a map of the area's biotic and abiotic features. For example, map the location of sidewalks, large rocks, trees, water features, and any animals you see. Remember to approach all plants and animals with caution. Use your map to answer the following questions.
3. How are the biotic factors affected by the abiotic factors?
4. How are the abiotic factors affected by the biotic factors?

Populations

population a group of organisms of the same species that live in a specific geographical area

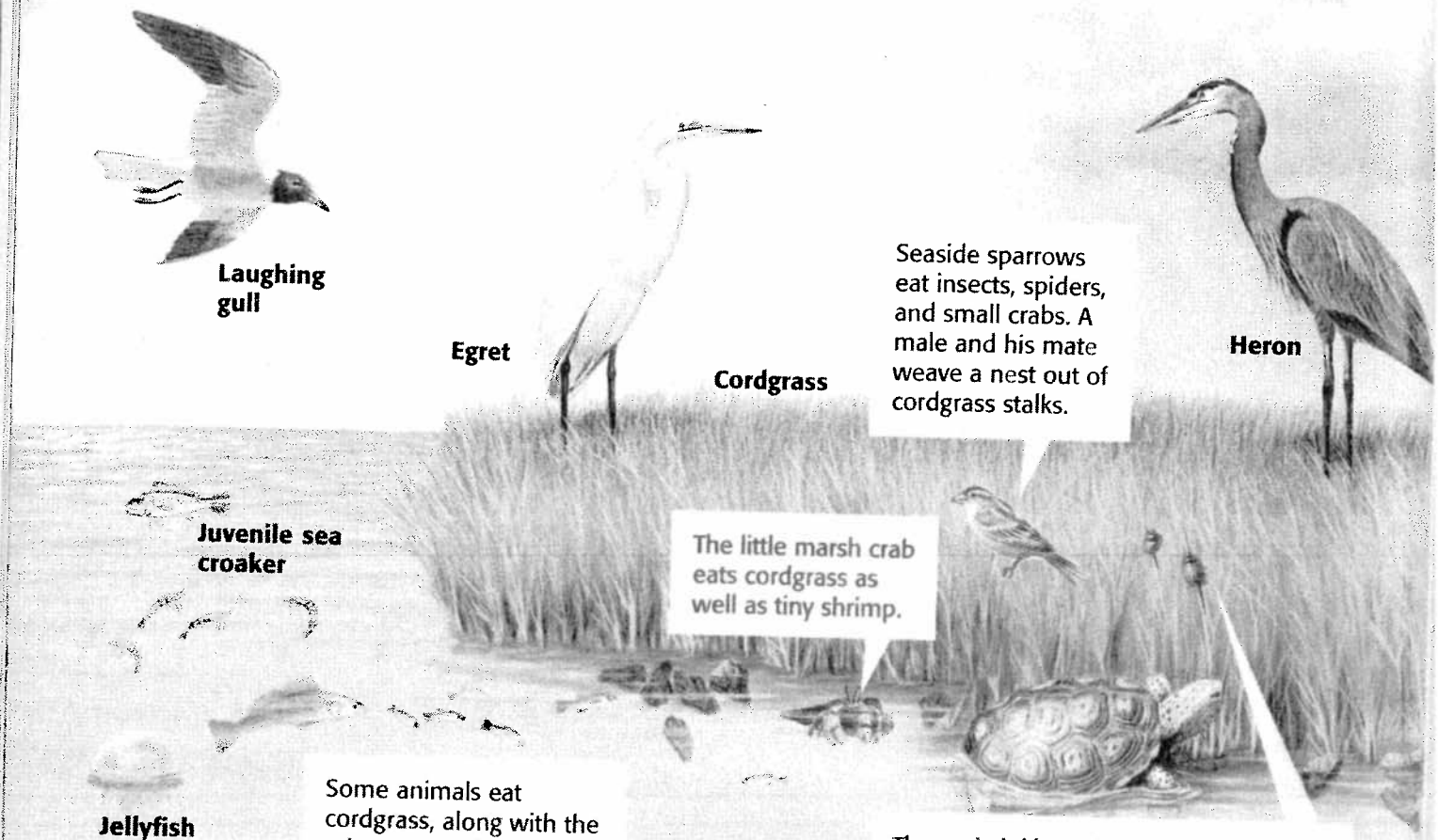
community all the populations of species that live in the same habitat and interact with each other

A salt marsh, such as the one shown in **Figure 3,** is a coastal area where grasslike plants grow. Within the salt marsh are animals. Each animal is a part of a **population,** or a group of individuals of the same species that live together. For example, all of the seaside sparrows that live in the same salt marsh are members of a population. The individuals in the population often compete with one another for food, nesting space, and mates.

Communities

A **community** consists of all of the populations of species that live and interact in an area. The animals and plants you see in **Figure 3** form a salt-marsh community. The populations in a community depend on each other for food, shelter, and many other things.

Figure 3 *Examine the picture of a salt marsh. Try to find examples of each level of organization in this environment.*



Ecosystems

An **ecosystem** is made up of a community of organisms and the abiotic environment of the community. An ecologist studying the ecosystem could examine how organisms interact as well as how temperature, precipitation, and soil characteristics affect the organisms. For example, the rivers that empty into the salt marsh carry nutrients, such as nitrogen, from the land. These nutrients affect the growth of the cordgrass and algae.

The Biosphere

The **biosphere** is the part of Earth where life exists. It extends from the deepest parts of the ocean to high in the air where plant spores drift. Ecologists study the biosphere to learn how organisms interact with the abiotic environment—Earth's atmosphere, water, soil, and rock. The water in the abiotic environment includes fresh water and salt water as well as water that is frozen in polar icecaps and glaciers.

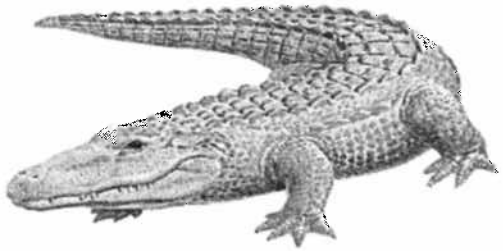
Reading Check **What is the biosphere?** (*See the Appendix for answers to Reading Checks.*)

ecosystem a community of organisms and their abiotic environment

biosphere the part of Earth where life exists

INTERNET ACTIVITY

For another activity related to this chapter, go to **go.hrw.com** and type in the keyword **HL5INTW.**



SECTION Review

Summary

- All living things are connected in a web of life.
- The biotic part of an environment is made up of all of the living things found within it.
- The abiotic part of an environment is made up of all of the nonliving things found within it, such as water and light.
- An ecosystem is made up of a community of organisms and its abiotic environment.

Using Key Terms

1. In your own words, write a definition for the term *ecology.*
2. Use the following terms in the same sentence: *biotic* and *abiotic.*

Understanding Key Ideas

3. Which one of the following is the highest level of environmental organization?
   a. ecosystem **c.** population
   b. community **d.** organism
4. What makes up a community?
5. Give two examples of how abiotic factors can affect an ecosystem.

Math Skills

6. From sea level, the biosphere goes up about 9 km and down about 19 km. What is the thickness of the biosphere in meters?

Critical Thinking

7. **Analyzing Relationships** What would happen to the other organisms in the salt-marsh ecosystem if the cordgrass suddenly died?
8. **Identifying Relationships** Explain in your own words what people mean when they say that everything is connected.
9. **Analyzing Ideas** Do ecosystems have borders? Explain your answer.

SCILINKS NSTA
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For a variety of links related to this chapter, go to www.scilinks.org
Topic: Biotic and Abiotic Factors; Organization in the Environment
SciLinks code: HSM0164; HSM1079

SECTION 2

Living Things Need Energy

Do you think you could survive on only water and vitamins? Eating food satisfies your hunger because it provides something you cannot live without—energy.

Living things need energy to survive. For example, black-tailed prairie dogs, which live in the grasslands of North America, eat grass and seeds to get the energy they need. Everything a prairie dog does requires energy. The same is true for the plants that grow in the grasslands where the prairie dogs live.

What You Will Learn

- Describe the functions of producers, consumers, and decomposers in an ecosystem.
- Distinguish between a food chain and a food web.
- Explain how energy flows through a food web.
- Describe how the removal of one species affects the entire food web.

Vocabulary

herbivore
carnivore
omnivore
food chain
food web
energy pyramid

READING STRATEGY

Reading Organizer As you read this section, make a table comparing producers, consumers, and decomposers.

The Energy Connection

Organisms, in a prairie or any community, can be divided into three groups based on how they get energy. These groups are producers, consumers, and decomposers. Examine **Figure 1** to see how energy passes through an ecosystem.

Producers

Organisms that use sunlight directly to make food are called *producers*. They do this by using a process called *photosynthesis*. Most producers are plants, but algae and some bacteria are also producers. Grasses are the main producers in a prairie ecosystem. Examples of producers in other ecosystems include cordgrass and algae in a salt marsh and trees in a forest. Algae are the main producers in the ocean.

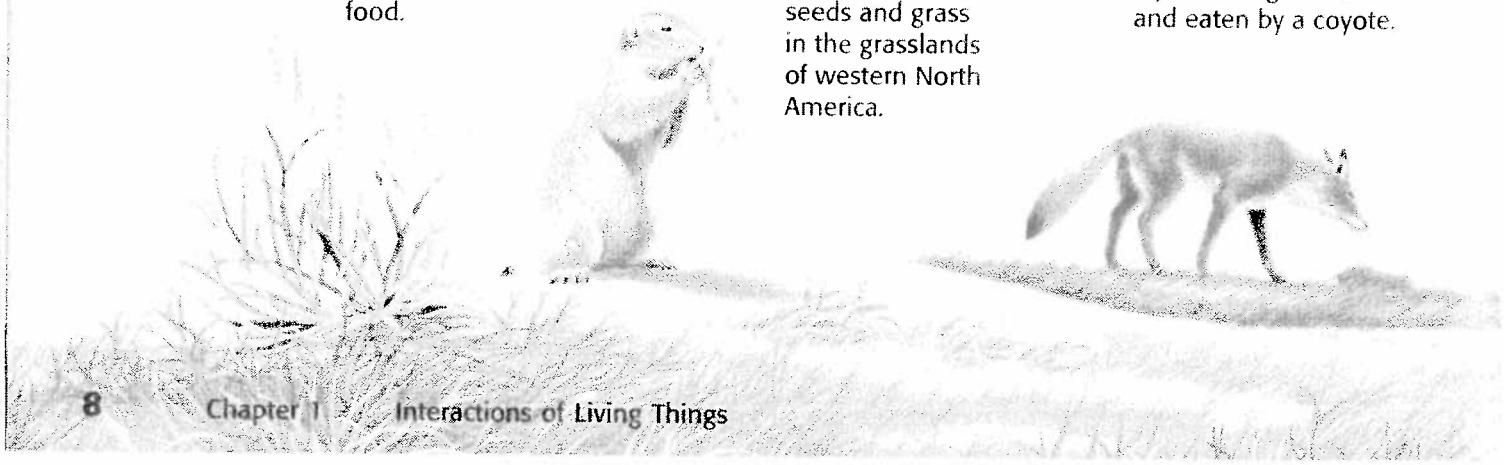
Figure 1 *Living things get their energy either from the sun or from eating other organisms.*

Energy Sunlight is the source of energy for almost all living things.

Producer Plants use the energy in sunlight to make food.

Consumer The black-tailed prairie dog (herbivore) eats seeds and grass in the grasslands of western North America.

Consumer All of the prairie dogs in a colony watch for enemies, such as coyotes (carnivore), hawks, and badgers. Occasionally, a prairie dog is killed and eaten by a coyote.



Consumers

Organisms that eat other organisms are called *consumers*. They cannot use the sun's energy to make food like producers can. Instead, consumers eat producers or other animals to obtain energy. There are several kinds of consumers. A consumer that eats only plants is called a **herbivore.** Herbivores found in the prairie include grasshoppers, prairie dogs, and bison. A **carnivore** is a consumer that eats animals. Carnivores in the prairie include coyotes, hawks, badgers, and owls. Consumers known as **omnivores** eat both plants and animals. The grasshopper mouse is an example of an omnivore. It eats insects, lizards, and grass seeds.

Scavengers are omnivores that eat dead plants and animals. The turkey vulture is a scavenger in the prairie. A vulture will eat what is left after a coyote has killed and eaten an animal. Scavengers also eat animals and plants that have died from natural causes.

herbivore an organism that eats only plants

carnivore an organism that eats animals

omnivore an organism that eats both plants and animals

Reading Check **What are organisms that eat other organisms called?** (*See the Appendix for answers to Reading Checks.*)

Decomposers

Organisms that get energy by breaking down dead organisms are called *decomposers*. Bacteria and fungi are decomposers. These organisms remove stored energy from dead organisms. They produce simple materials, such as water and carbon dioxide, which can be used by other living things. Decomposers are important because they are nature's recyclers.

SCHOOL to HOME

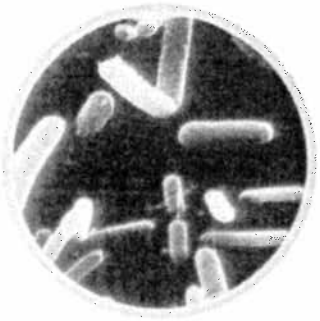
A Chain Game

With the help of your parent, make a list of the foods you ate at your most recent meal. Trace the energy of each food back to the sun. Which foods on your list were consumers? How many were producers?

ACTIVITY

Consumer A turkey vulture (scavenger) may eat some of the coyote's leftovers. A scavenger can pick bones completely clean.

Decomposer Any prairie dog remains not eaten by the coyote or the turkey vulture are broken down by bacteria (decomposer) and fungi that live in the soil.



Food Chains and Food Webs

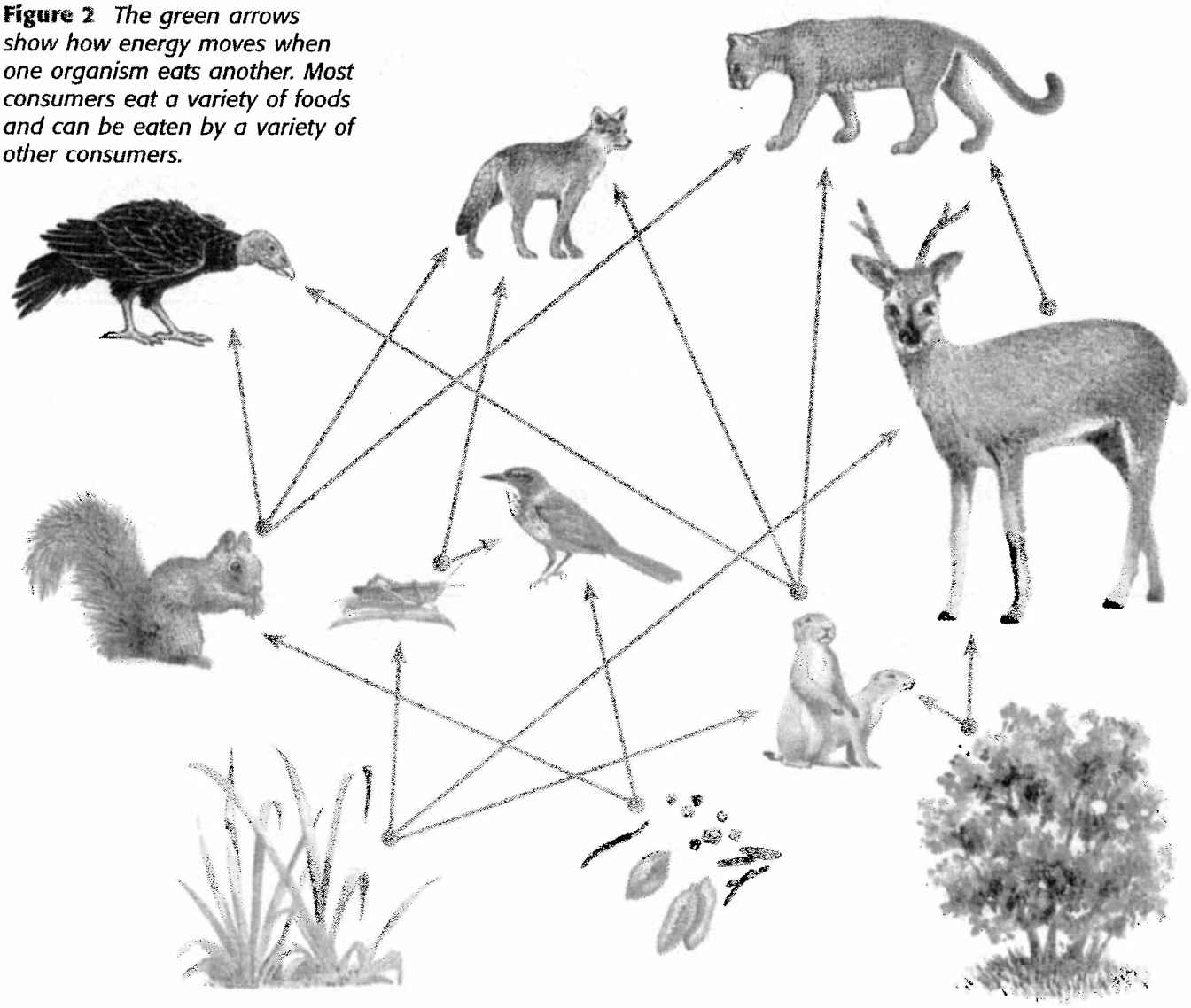
food chain the pathway of energy transfer through various stages as a result of the feeding patterns of a series of organisms

food web a diagram that shows the feeding relationships between organisms in an ecosystem

Figure 1 on the previous page, shows a food chain. A **food chain** is a diagram that shows how energy in food flows from one organism to another. Because few organisms eat just one kind of food, simple food chains are rare.

The energy connections in nature are more accurately shown by a food web than by a food chain. A **food web** is a diagram that shows the feeding relationships between organisms in an ecosystem. **Figure 2** shows a simple food web. Notice that an arrow goes from the prairie dog to the coyote, showing that the prairie dog is food for the coyote. The prairie dog is also food for the mountain lion. Energy moves from one organism to the next in a one-way direction, even in a food web. Any energy not immediately used by an organism is stored in its tissues. Only the energy stored in an organism's tissues can be used by the next consumer. There are two main food webs on Earth: a land food web and an aquatic food web.

Figure 2 *The green arrows show how energy moves when one organism eats another. Most consumers eat a variety of foods and can be eaten by a variety of other consumers.*



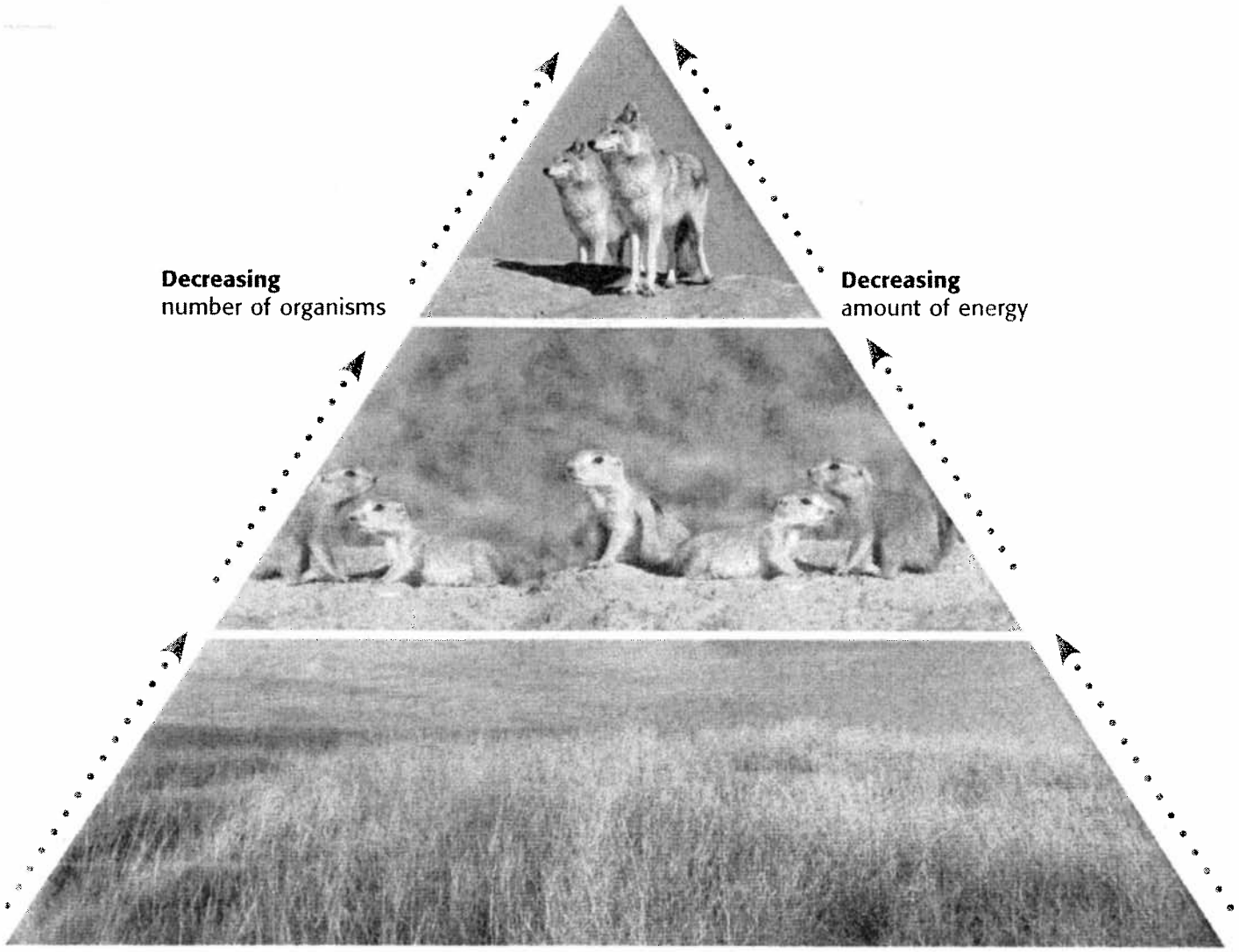


Figure 3 *The pyramid represents energy. As you can see, more energy is available at the base of the pyramid than at its top.*

Energy Pyramids

Grass uses most of the energy it gets from sunlight for its own life processes. But some of the energy is stored in the grass' tissues. This energy is used by the prairie dogs and other animals that eat the grass. Prairie dogs use most of the energy they get from eating grass and store only a little in their tissues. Therefore, a population of prairie dogs can support only a few coyotes. In the community, there must be more grass than prairie dogs and more prairie dogs than coyotes.

The energy at each level of the food chain can be seen in an energy pyramid. An **energy pyramid** is a diagram that shows an ecosystem's loss of energy. An example of an energy pyramid is shown in **Figure 3.** You can see that the energy pyramid has a large base and a small top. Less energy is available at higher levels because only energy stored in the tissues of an organism can be transferred to the next level.

energy pyramid a triangular diagram that shows an ecosystem's loss of energy, which results as energy passes through the ecosystem's food chain

Reading Check What is an energy pyramid?

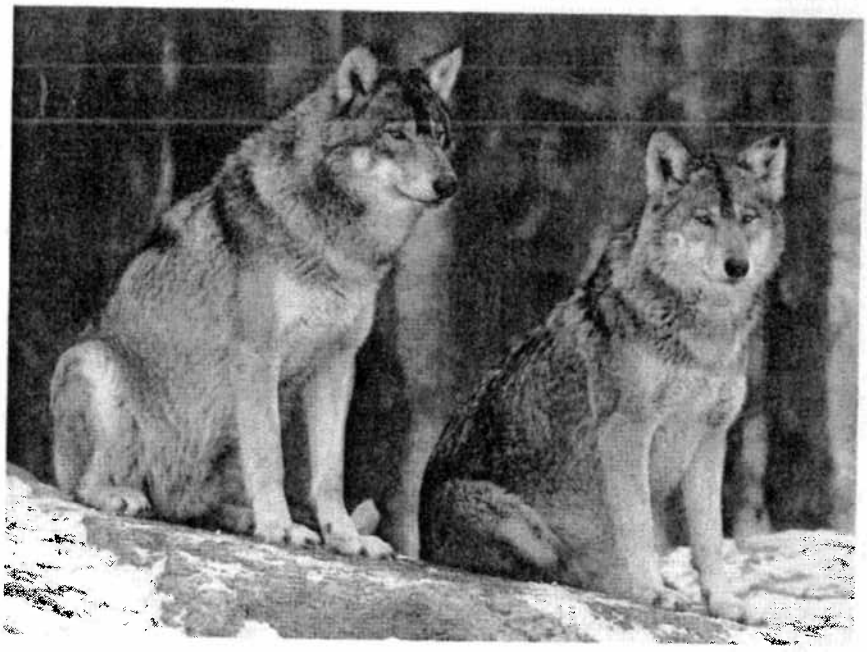


Figure 4 *As the wilderness was settled, the gray wolf population in the United States declined.*

Wolves and the Energy Pyramid

One species can be very important to the flow of energy in an environment. Gray wolves, which are shown in **Figure 4,** are consumers that control the populations of many other animals. The diet of gray wolves can include anything from a lizard to an elk. Because gray wolves are predators that prey on large animals, their place is at the top of the food pyramid.

Once common throughout much of the United States, gray wolves were almost wiped out as the wilderness was settled. Without wolves, some species, such as elk, were no longer controlled. The overpopulation of elk in some areas led to overgrazing. The overgrazing left too little grass to support the elk and other populations who depended on the grass for food. Soon, almost all of the populations in the area were affected by the loss of the gray wolves.

Reading Check **How were other animals affected by the disappearance of the gray wolf?**

Gray Wolves and the Food Web

Gray wolves were brought back to Yellowstone National Park in 1995. The reintroduced wolves soon began to breed. **Figure 5** shows a wolf caring for pups. The U.S. Fish and Wildlife Service thinks the return of the wolves will restore the natural energy flow in the area, bring populations back into balance, and help restore the park's natural integrity.

Not everyone approves, however. Ranchers near Yellowstone are concerned about the safety of their livestock. Cows and sheep are not the natural prey of wolves. However, the wolves will eat cows and sheep if they are given the chance.

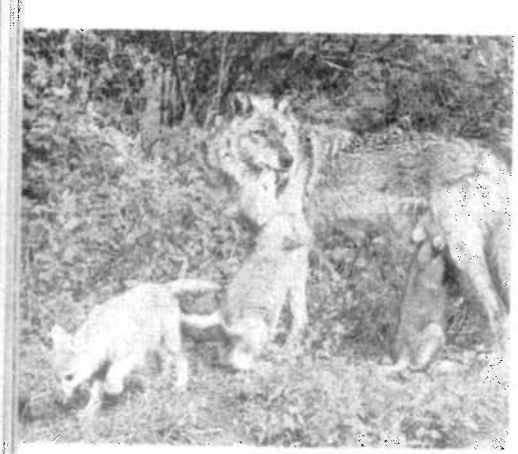


Figure 5 *In small wolf packs, only one female has pups. They are cared for by all of the males and females in the pack.*

Balance in Ecosystems

As wolves become reestablished in Yellowstone National Park, they kill the old, injured, and diseased elk. This process is reducing the number of elk. The smaller elk population is letting more plants grow. So, the numbers of animals that eat the plants, such as snowshoe hares, and the animals that eat the hares, such as foxes, are increasing.

All organisms in a food web are important for the health and balance of all other organisms in the food web. But the debate over the introduction of wolves to Yellowstone National Park will most likely continue for years to come.

MATH PRACTICE

Energy Pyramids

Draw an energy pyramid for a river ecosystem that contains four levels—aquatic plants, insect larvae, bluegill fish, and a largemouth bass. The plants obtain 10,000 units of energy from sunlight. If each level uses 90% of the energy it receives from the previous level, how many units of energy are available to the bass?

SECTION Review

Summary

- Producers use the energy in sunlight to make their own food.
- Consumers eat producers and other organisms to gain energy.
- Food chains represent how energy flows from one organism to another.
- All organisms are important to maintain the balance of energy in the food web.
- Energy pyramids show how energy is lost at each food chain level.

Using Key Terms

1. Use each of the following terms in a separate sentence: *herbivores, carnivores,* and *omnivores.*
2. In your own words, write a definition for each of the following terms: *food chain, food web,* and *energy pyramid.*

Understanding Key Ideas

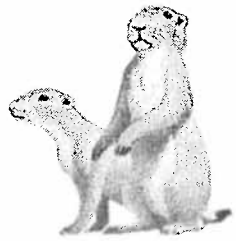
3. Herbivores, carnivores, and scavengers are all examples of
   a. producers. **c.** consumers.
   b. decomposers. **d.** omnivores.
4. Explain the importance of decomposers in an ecosystem.
5. Describe how producers, consumers, and decomposers are linked in a food chain.
6. Describe how energy flows through a food web.

Math Skills

7. The plants in each square meter of an ecosystem obtained 20,810 Calories of energy from sunlight per year. The herbivores in that ecosystem ate all the plants but obtained only 3,370 Calories of energy. How much energy did the plants use?

Critical Thinking

8. **Identifying Relationships** Draw two food chains, and depict how they link together to form a food web.
9. **Applying Concepts** Are consumers found at the top or bottom of an energy pyramid? Explain your answer.
10. **Predicting Consequences** What would happen if a species disappeared from an ecosystem?



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For a variety of links related to this chapter, go to www.scilinks.org

Topic: Food Chains and Food Webs
SciLinks code: HSM0594

SECTION 3

Types of Interactions

Look at the seaweed forest shown in **Figure 1** below. How many fish do you see? How many seaweed plants do you count? Why do you think there are more members of the seaweed population than members of the fish population?

In natural communities, the sizes of populations of different organisms can vary greatly. This variation happens because everything in the environment affects every other thing. Populations also affect every other population.

What You Will Learn

- Explain the relationship between carrying capacity and limiting factors.
- Describe the two types of competition.
- Distinguish between mutualism, commensalism, and parasitism. Give an example of coevolution.

Vocabulary

carrying capacity
prey
predator
symbiosis
mutualism
commensalism
parasitism
coevolution

READING STRATEGY

Reading Organizer As you read this section, make a concept map by using the terms above.

Interactions with the Environment

Most living things produce more offspring than will survive. A female frog, for example, might lay hundreds of eggs in a small pond. In a few months, the population of frogs in that pond will be about the same as it was the year before. Why won't the pond become overrun with frogs? An organism, such as a frog, interacts with biotic and abiotic factors in its environment that can control the size of its population.

Limiting Factors

Populations cannot grow without stopping, because the environment contains a limited amount of food, water, living space, and other resources. A resource that is so scarce that it limits the size of a population is called a *limiting factor*. For example, food becomes a limiting factor when a population becomes too large for the amount of food available. Any single resource can be a limiting factor to a population's size.

Figure 1 *This seaweed forest is home to a large number of interacting species.*

Carrying Capacity

The largest population that an environment can support is known as the **carrying capacity.** When a population grows larger than its carrying capacity, limiting factors in the environment cause individuals to die off or leave. As individuals die or leave, the population decreases.

carrying capacity the largest population that an environment can support at any given time

For example, after a rainy season, plants may produce a large crop of leaves and seeds. This large amount of food may cause an herbivore population to grow. If the next year has less rainfall, there won't be enough food to support the large herbivore population. In this way, a population may become larger than the carrying capacity, but only for a little while. A limiting factor will cause the population to die back. The population will return to a size that the environment can support.

Interactions Between Organisms

Populations contain individuals of a single species that interact with one another, such as a group of rabbits feeding in the same area. Communities contain interacting populations, such as a coral reef with many species of corals trying to find living space. Ecologists have described four main ways that species and individuals affect each other: competition, predators and prey, symbiotic relationships, and coevolution.

Reading Check **What are four main ways organisms affect one another?** (*See the Appendix for answers to Reading Checks.*)

Competition

When two or more individuals or populations try to use the same resource, such as food, water, shelter, space, or sunlight, it is called *competition*. Because resources are in limited supply in the environment, their use by one individual or population decreases the amount available to other organisms.

Competition happens between individuals *within* a population. The elks in Yellowstone National Park are herbivores that compete with each other for the same food plants in the park. This competition is a big problem in winter when many plants die.

Competition also happens *between* populations. The different species of trees in **Figure 2** are competing with each other for sunlight and space.

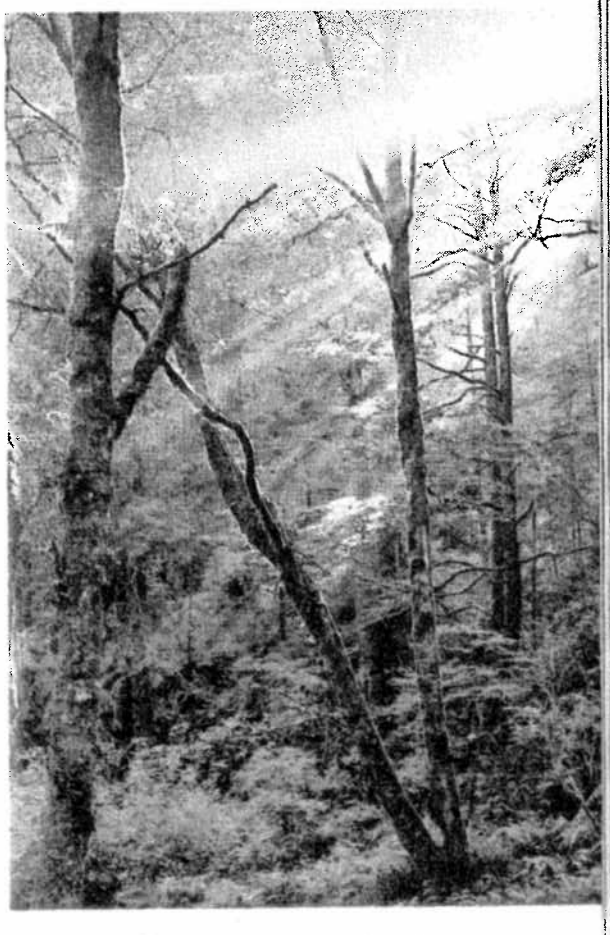


Figure 2 *Some of the trees in this forest grow tall to reach sunlight, which reduces the amount of sunlight available to shorter trees nearby.*

Predators and Prey

prey an organism that is killed and eaten by another organism

predator an organism that eats all or part of another organism

Many interactions between species consist of one organism eating another. The organism that is eaten is called the **prey.** The organism that eats the prey is called the **predator.** When a bird eats a worm, the worm is prey and the bird is the predator.

Predator Adaptations

To survive, predators must be able to catch their prey. Predators have a wide variety of methods and abilities for doing so. The cheetah, for example, is able to run very quickly to catch its prey. The cheetah's speed gives it an advantage over other predators competing for the same prey.

Other predators, such as the goldenrod spider, shown in **Figure 3,** ambush their prey. The goldenrod spider blends in so well with the goldenrod flower that all it has to do is wait for its next insect meal to arrive.

Figure 3 *The goldenrod spider is difficult for its insect prey to see. Can you see it?*

Prey Adaptations

Prey have their own methods and abilities to keep from being eaten. Prey are able to run away, stay in groups, or camouflage themselves. Some prey are poisonous. They may advertise their poison with bright colors to warn predators to stay away. The fire salamander, shown in **Figure 4,** sprays a poison that burns. Predators quickly learn to recognize its *warning coloration.*

Many animals run away from predators. Prairie dogs run to their underground burrows when a predator approaches. Many small fishes, such as anchovies, swim in groups called *schools.* Antelopes and buffaloes stay in herds. All the eyes, ears, and noses of the individuals in the group are watching, listening, and smelling for predators. This behavior increases the likelihood of spotting a potential predator.

Figure 4 *Many predators know better than to eat the fire salamander! This colorful animal will make a predator very sick.*

Camouflage

One way animals avoid being eaten is by being hard to see. A rabbit often freezes so that its natural color blends into a background of shrubs or grass. Blending in with the background is called *camouflage*. Many animals mimic twigs, leaves, stones, bark, or other materials in their environment. One insect, called a walking stick, looks just like a twig. Some walking sticks even sway a bit, as though a breeze were blowing.

Reading Check **What is camouflage, and how does it prevent an animal from being eaten?**

Defensive Chemicals

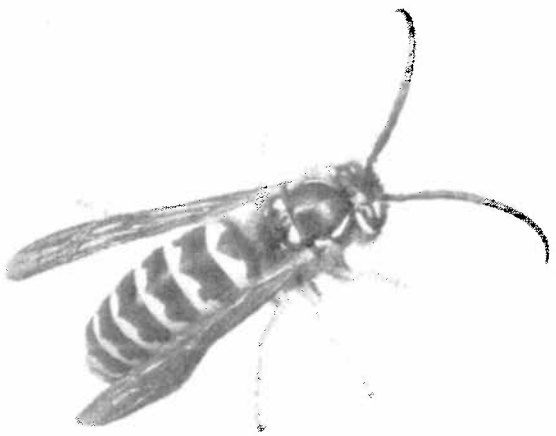
The spines of a porcupine clearly signal trouble to a potential predator, but other defenses may not be as obvious. Some animals defend themselves with chemicals. The skunk and the bombardier beetle both spray predators with irritating chemicals. Bees, ants, and wasps inject a powerful acid into their attackers. The skin of both the poison arrow frog and a bird called the *hooded pitohui* contains a deadly toxin. Any predator that eats, or tries to eat, one of these animals will likely die.

CONNECTION TO Environmental Science

Pretenders Some animals are pretenders. They don't have defensive chemicals. But they use warning coloration to their advantage. The Scarlet king snake has colored stripes that make it look like the poisonous coral snake. Even though the Scarlet king snake is harmless, predators see its bright colors and leave it alone. What might happen if there were more pretenders than there were animals with real defensive chemicals?

Warning Coloration

Animals that have a chemical defense need a way to warn predators that they should look elsewhere for a meal. Their chemical weapons are often advertised by warning colors, as shown in **Figure 5.** Predators will avoid any animal that has the colors and patterns they associate with pain, illness, or unpleasant experiences. The most common warning colors are bright shades of red, yellow, orange, black, and white.



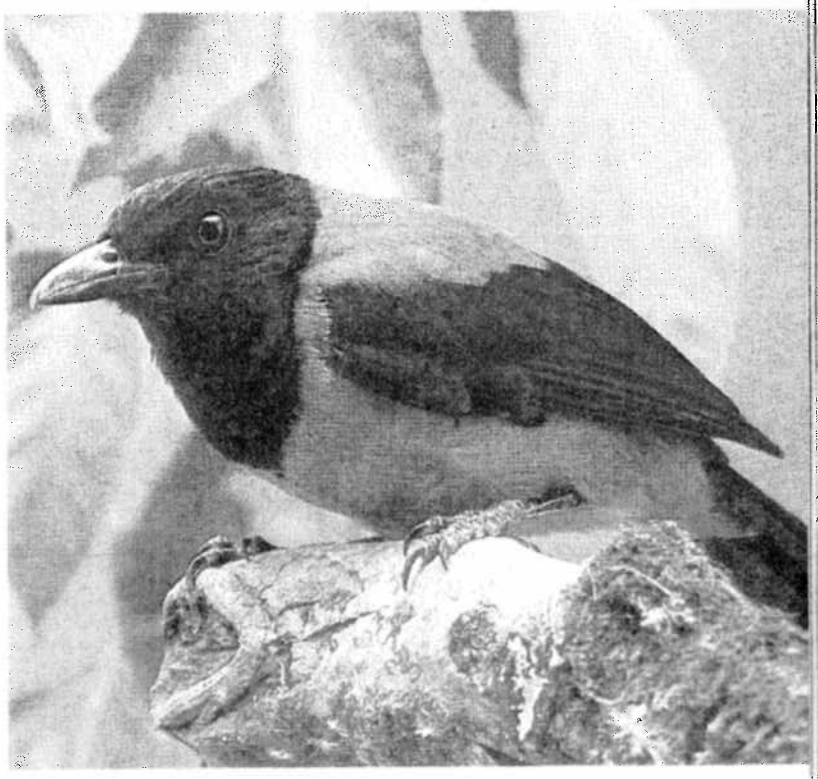


Figure 5 *The warning coloration of the yellow jacket (left) and the pitohui (above) warns predators that they are dangerous.*

Symbiosis

symbiosis a relationship in which two different organisms live in close association with each other

mutualism a relationship between two species in which both species benefit

commensalism a relationship between two organisms in which one organism benefits and the other is unaffected

Some species have very close interactions with other species. **Symbiosis** is a close, long-term association between two or more species. The individuals in a symbiotic relationship can benefit from, be unaffected by, or be harmed by the relationship. Often, one species lives in or on the other species. The thousands of symbiotic relationships in nature are often classified into three groups: mutualism, commensalism, and parasitism.

Mutualism

A symbiotic relationship in which both organisms benefit is called **mutualism** (MYOO choo uhl IZ uhm). For example, you and a species of bacteria that lives in your intestines benefit each other! The bacteria get food from you, and you get vitamins that the bacteria produce.

Mutualism also occurs between some corals and the algae living inside those corals. In this relationship, a coral receives the extra food that the algae make by photosynthesis. In turn, these algae also receive a place to live, as **Figure 6** shows. These algae also receive some nutrients from the coral. Both organisms benefit from this relationship.

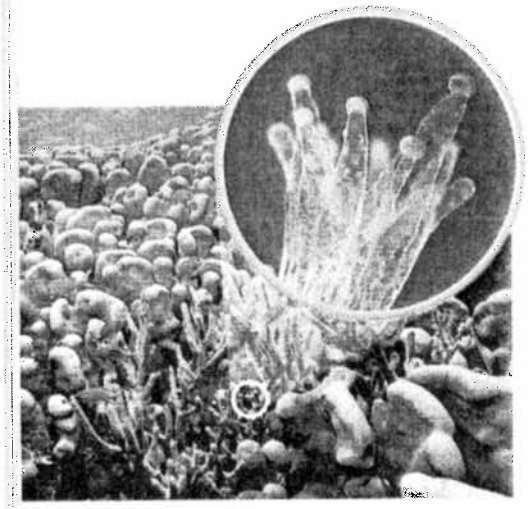


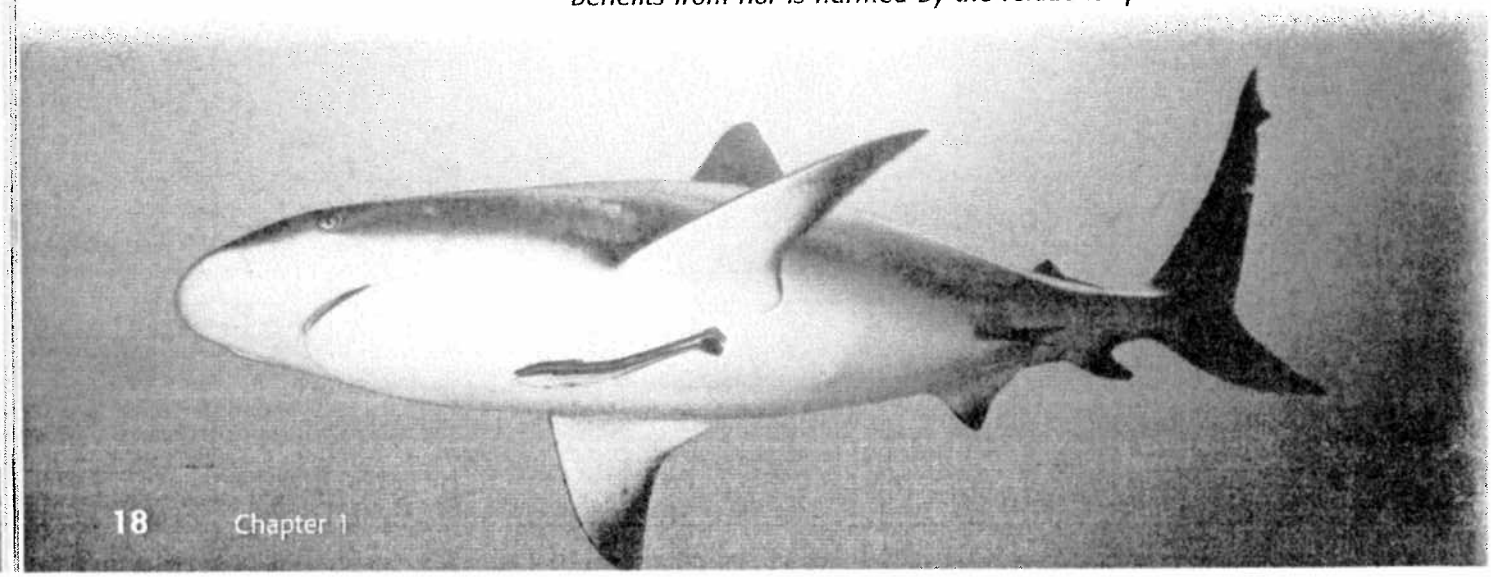
Figure 6 *In the smaller photo above, you can see the gold-colored algae inside the coral.*

Reading Check **Which organism benefits in mutualism?**

Commensalism

A symbiotic relationship in which one organism benefits and the other is unaffected is called **commensalism.** One example of commensalism is the relationship between sharks and smaller fish called *remoras*. **Figure 7** shows a shark with a remora attached to its body. Remoras "hitch a ride" and feed on scraps of food left by sharks. The remoras benefit from this relationship, while sharks are unaffected.

Figure 7 *The remora attached to the shark benefits from the relationship. The shark neither benefits from nor is harmed by the relationship.*



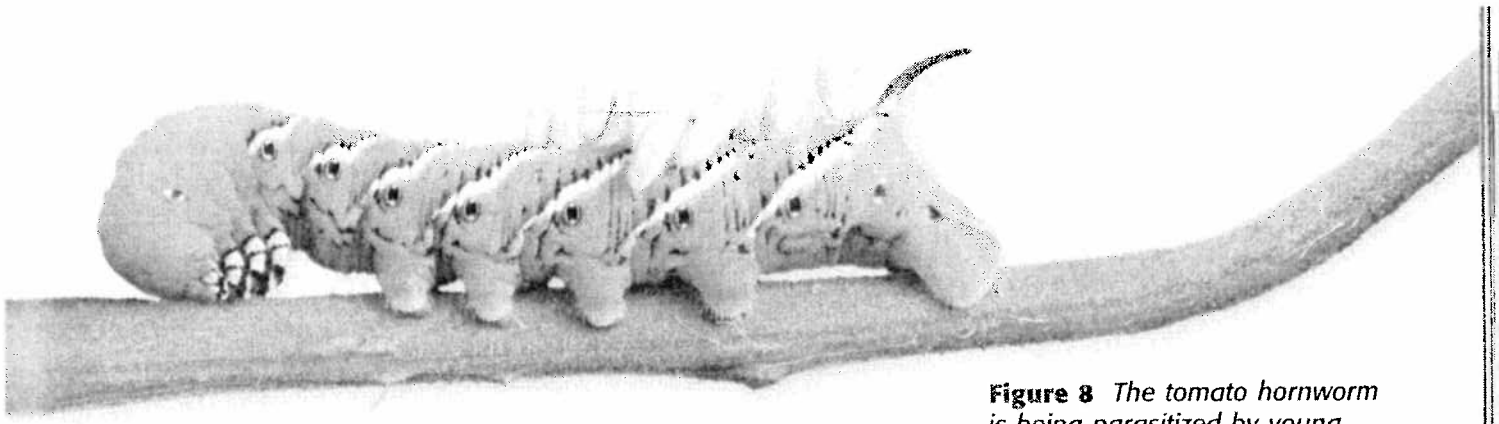


Figure 8 *The tomato hornworm is being parasitized by young wasps. Do you see their cocoons?*

Parasitism

A symbiotic association in which one organism benefits while the other is harmed is called **parasitism** (PAR uh SIT IZ uhm). The organism that benefits is called the *parasite*. The organism that is harmed is called the *host*. The parasite gets nourishment from its host while the host is weakened. Sometimes, a host dies. Parasites, such as ticks, live outside the host's body. Other parasites, such as tapeworms, live inside the host's body.

Figure 8 shows a bright green caterpillar called a *tomato hornworm*. A female wasp laid tiny eggs on the caterpillar. When the eggs hatch, each young wasp will burrow into the caterpillar's body. The young wasps will actually eat the caterpillar alive! In a short time, the caterpillar will be almost completely eaten and will die. When that happens, the adult wasps will fly away.

In this example of parasitism, the host dies. Most parasites, however, do not kill their hosts. Most parasites don't kill their hosts because parasites depend on their hosts. If a parasite were to kill its host, the parasite would have to find a new host.

parasitism a relationship between two species in which one species, the parasite, benefits from the other species, the host, which is harmed

coevolution the evolution of two species that is due to mutual influence, often in a way that makes the relationship more beneficial to both species

Coevolution

Relationships between organisms change over time. Interactions can also change the organisms themselves. When a long-term change takes place in two species because of their close interactions with one another, the change is called **coevolution.**

The ant and the acacia tree shown in **Figure 9** have a mutualistic relationship. The ants protect the tree by attacking other organisms that come near the tree. The tree has special structures that make food for the ants. The ants and the acacia tree may have coevolved through interactions between the two species. Coevolution can take place between any organisms that live close together. But changes happen over a very long period of time.

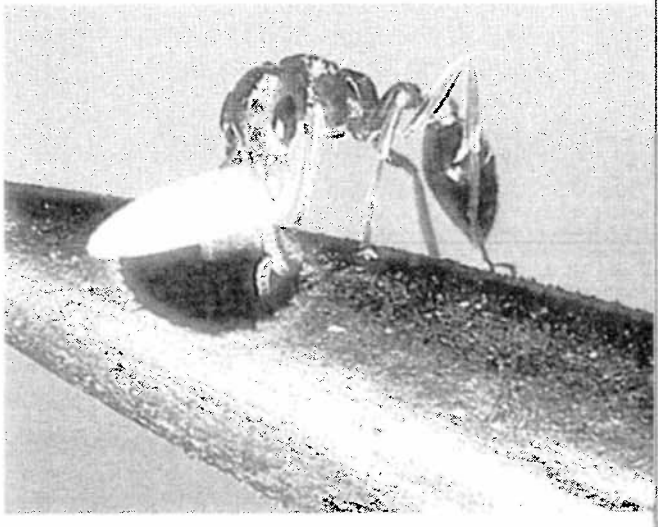


Figure 9 *Ants collect food made by the acacia tree and store the food in their shelter, which is also made by the tree.*

Coevolution and Flowers

A *pollinator* is an organism that carries pollen from one flower to another. Pollination is necessary for reproduction in most plants.

Flowers have changed over millions of years to attract pollinators. Pollinators such as bees, bats, and hummingbirds can be attracted to a flower because of its color, odor, or nectar. Flowers pollinated by hummingbirds make nectar with the right amount of sugar for the bird. Hummingbirds have long beaks, which help them drink the nectar.

Some bats, such as the one shown in **Figure 10,** changed over time to have long, thin tongues and noses to help them reach the nectar in flowers. As the bat feeds on the nectar, its nose becomes covered with pollen. The next flower it eats from will be pollinated with the pollen it is gathering from this flower. The long nose helps it to feed and also makes it a better pollinator.

Because flowers and their pollinators have interacted so closely over millions of years, there are many examples of coevolution between them.

Reading Check **Why do flowers need to attract pollinators?**

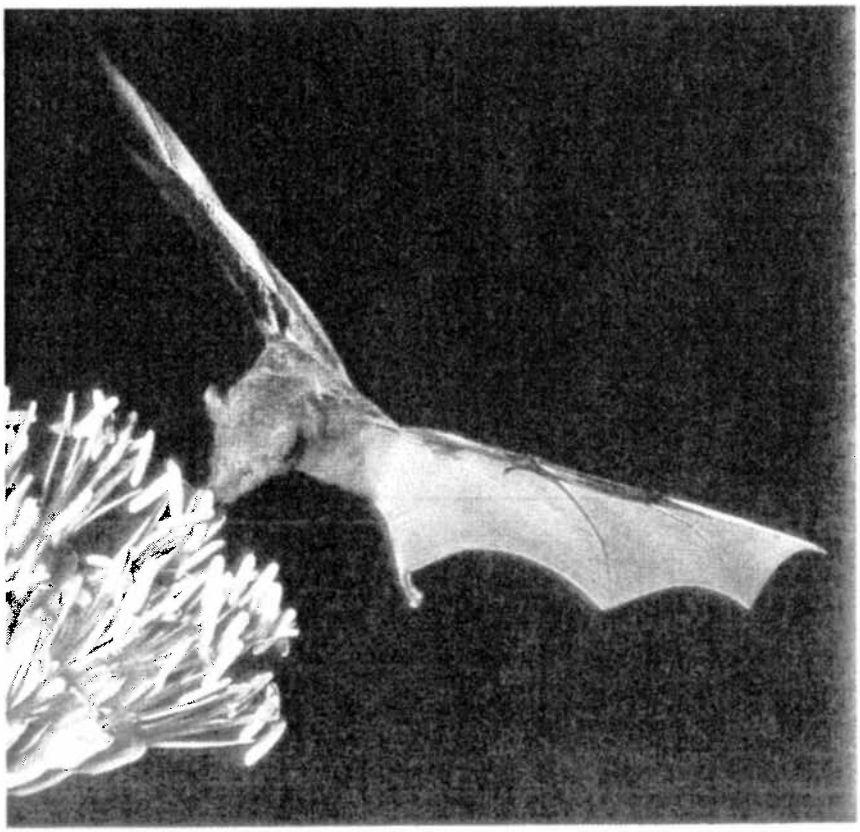
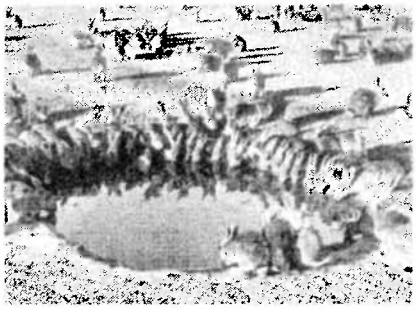


Figure 10 *This bat is drinking nectar with its long, skinny tongue. The bat has coevolved with the flower over millions of years.*

CONNECTION TO Social Studies



Rabbits in Australia In 1859, settlers released 12 rabbits in Australia. There was plenty of food and no natural predators for the rabbits. The rabbit population increased so fast that the country was soon overrun by rabbits. Then, the Australian government introduced a rabbit virus to control the population. The first time the virus was used, more than 99% of the rabbits died. The survivors reproduced, and the rabbit population grew large again. The second time the virus was used, about 90% of the rabbits died. Once again, the rabbit population increased. The third time the virus was used, only about 50% of the rabbits died. Suggest what changes might have occurred in the rabbits and the virus.