

B.1.39 Reading

What Shapes an Ecosystem?

Biotic and Abiotic Factors



Ecosystems are influenced by a combination of biological and physical factors. The biological, or living, influences on organisms within an ecosystem are called **biotic factors**. These include all of the living things with which an organism might interact, including birds, trees, mushrooms, and bacteria—in other words, the ecological community. Biotic factors that influence a groundhog, for example, might include the plants and insects that it eats, the coyotes that eat them, and other

species that compete with the groundhog for food or space.

Nonliving factors that shape ecosystems are called **abiotic factors** (ay-by-AHT-ik). Abiotic factors include such things as temperature, precipitation, wind, nutrient availability, soil, and sunlight. Together, biotic and abiotic factors determine the survival and growth of an organism and the productivity of the ecosystem in which the organism lives. The area where an organism lives is called its **habitat**. A habitat includes both biotic and abiotic factors.

The Niche

If an organism's habitat is its address, its niche is its occupation. A **niche** (NITCH) is the full range of physical (nonliving) and biological (living) conditions in which an organism lives and the way in which the organism uses those conditions. For instance, part of the description of an organism's niche includes its place in the food web. Another part of the description might include the range of temperatures that the organism needs to survive. The combination of biotic and abiotic factors in an ecosystem often determines the number of different niches in that ecosystem.



A niche includes the type of food the organism eats, how it obtains this food, and which other species use the organism as food. For example, a mature bullfrog catches insects, worms, spiders, small fish, or even mice. Predators such as herons, raccoons, and snakes prey on bullfrogs.

The physical conditions that the bullfrog requires to survive are part of its niche. Bullfrogs spend their lives in or near the water of ponds, lakes, and slow-moving streams. A bullfrog's body temperature varies with that of the surrounding water and air. As winter approaches, bullfrogs burrow into the mud of pond or stream bottoms to hibernate.

The bullfrog's niche also includes when and how it reproduces. Female bullfrogs lay their eggs in water during the warmer months of the year. The young frogs, called tadpoles, live in the water until their legs and lungs develop.

As you will see, no two species can share the same niche in the same habitat. However, different species can occupy niches that are very similar. For instance, three species of North American warblers live in the same spruce trees but feed at different elevations and in different parts of those trees. The species are similar, yet each warbler has a different niche within the forest.

Community Interactions

When organisms live together in ecological communities, they interact constantly. These interactions help shape the ecosystem in which they live. **Community interactions, such as competition, predation, and various forms of symbiosis, can powerfully affect an ecosystem.**

Competition

Competition occurs when organisms of the same or different species attempt to use an ecological resource in the same place at the same time. The term **resource** refers to any necessity of life, such as water, nutrients, light, food, or space. In a forest, for example, broad-leaved trees such as oak or hickory may compete for sunlight by growing tall, spreading out their leaves, and blocking the sunlight from shorter trees. Similarly, two species of lizards in a desert might compete by attempting to eat the same type of insect.

Direct competition in nature often results in a winner and a loser—with the losing organism failing to survive. A fundamental rule in ecology, the **competitive exclusion principle**, states

that no two species can occupy the same niche in the same habitat at the same time. Look again at the distribution of the warblers in the figure at right. Can you see how this distribution avoids direct competition among the different warbler species?

Predation

An interaction in which one organism captures and feeds on another organism is called **predation** (pree-DAY-shun). The organism that does the killing and eating is called the predator (PRED-uh-tur), and the food organism is the prey. Cheetahs are active predators with claws and sharp teeth. Their powerful legs enable them to run after prey. Other predators, such as anglerfishes, are more passive. An anglerfish has a fleshy appendage that resembles a fishing lure, which it uses to draw unsuspecting prey close to its mouth.

Symbiosis

Any relationship in which two species live closely together is called **symbiosis** (sim-by-OH-sis), which means “living together.” Biologists recognize three main classes of symbiotic relationships in nature: mutualism, commensalism, and parasitism. Examples of these three relationships are shown in the photographs.

Mutualism

In **mutualism** (MYOO-choo-ul-iz-um), both species benefit from the relationship. Many flowers, for example, depend on certain species of insects to pollinate them. The flowers



A. Mutualism

Nuridsemy et Perennour / Photo Researchers, Inc.



B. Commensalism

Kenneth Fink / Photo Researchers



C. Parasitism

Anthony Bannister/Corbis Images/CORBIS

provide the insects with food in the form of nectar, pollen, or other substances, and the insects help the flowers reproduce.

Commensalism

In **commensalism** (kuh-MEN-sul-iz-um), one member of the association benefits and the other is neither helped nor harmed. Small marine animals called barnacles, for example, often attach themselves to a whale's skin. The barnacles perform no known service to the whale, nor do they harm it. Yet, the barnacles benefit from the constant movement of water past the swimming whale, because the water carries food particles to them.

Parasitism

In **parasitism** (PAR-uh-sit-iz-um), one organism lives on or inside another organism and harms it. The parasite obtains all or part of its nutritional needs from the other organism, called the host. Generally, parasites weaken but do not kill their host, which is usually larger than the parasite. Tapeworms, for example, are parasites that live in the intestines of mammals. Fleas, ticks, and lice live on the bodies of mammals, feeding on the blood and skin of the host.

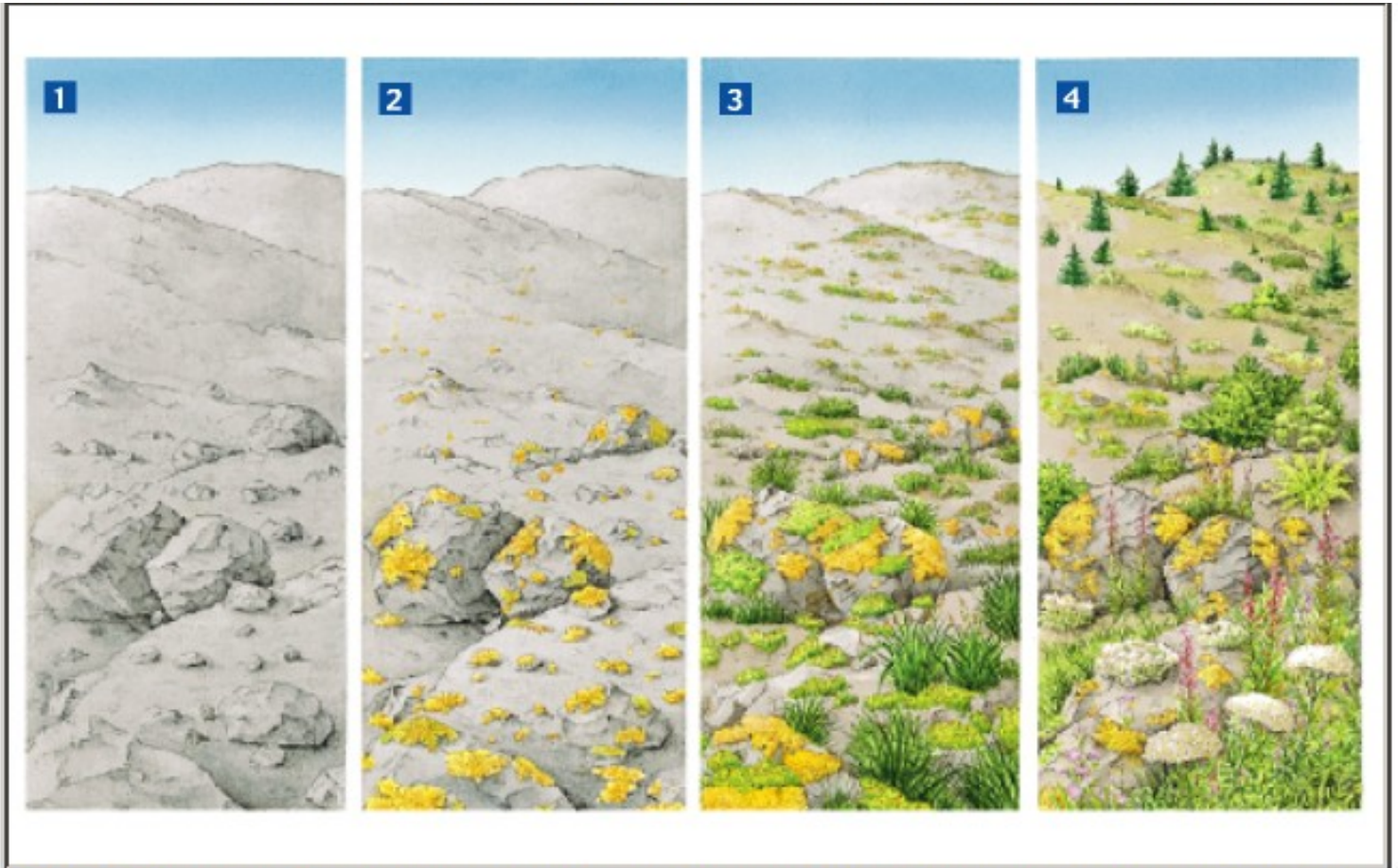
Ecological Succession

On the time scale of a human life, some ecosystems may seem stable. The appearance of stability is often misleading, because ecosystems and communities are always changing. Sometimes, an ecosystem changes in response to an abrupt disturbance, such as a severe storm. At other times, change occurs as a more gradual response to natural fluctuations in the environment. **Ecosystems are constantly changing in response to natural and human disturbances. As an ecosystem changes, older inhabitants gradually die out and new organisms move in, causing further changes in the community.** This series of predictable changes that occurs in a community over time is called **ecological succession**. Sometimes succession results from slow changes in the physical environment. A sudden natural disturbance from human activities, such as clearing a forest, may also be a cause of succession.

Primary Succession

On land, succession that occurs on surfaces where no soil exists is called **primary succession**. For example, primary succession occurs on the surfaces formed as volcanic eruptions build new islands or cover the land with lava rock or volcanic ash. Primary succession also occurs on bare rock exposed when glaciers melt.

In the figure at right, you can follow the stages of primary succession after a volcanic eruption. When primary succession begins, there is no soil, just ash and rock. The first species to populate the area are called **pioneer species**. The pioneer species on volcanic rocks are often lichens (LY-kunz). A **lichen** is made up of a fungus and an alga and can grow on bare rock. As lichens grow, they help break up the rocks. When they die, the lichens add organic



Primary Succession Primary succession occurs on newly exposed surfaces, such as this newly deposited volcanic rock and ash. A volcanic eruption destroys the previous ecosystem (1). The first organisms to appear are lichens (2). Mosses soon appear, and grasses take root in the thin layer of soil (3). Eventually, tree seedlings and shrubs sprout among the plant community (4). **Predicting** *What types of animals would you expect to appear at each stage, and why?*

material to help form soil in which plants can grow.

Secondary Succession

Components of an ecosystem can be changed by natural events, such as fires, or by human activities, such as farming. These changes may affect the ecosystem in predictable or unpredictable ways. When the disturbance is over, community interactions tend to restore the ecosystem to its original condition through **secondary succession**. For example, secondary

succession occurs after wildfires burn woodlands and when land cleared for farming is abandoned. In fact, fires set by lightning occur in many ecosystems, and some plants are so adapted to periodic fires that their seeds won't sprout unless exposed to fire!

Ecologists used to think that succession in a given area always proceeded through predictable stages to produce the same stable **climax community**. Old-growth forests in the Pacific Northwest, for example, were considered climax communities. But natural disasters, climate change, and human activity such as introduction of nonnative species profoundly affect these communities today. Healthy ecosystems usually recover from natural disturbances because of the way components of the system interact. Ecosystems may or may not recover from long-term, human-caused disturbances.