



Chapter 7 Community Ecology



“It’s A Small World After All”

Outline

Community Structure and Species Diversity

- A. Ecologists use three characteristics to describe a biological community:
1. Physical appearance- the relative sizes, stratification, and distribution of its populations and species
 - a. Large terrestrial communities are patchy
 - b. Transition occurs around the edges, where two community types interact.
 - c. Increased edge area may be harmful due to habitat fragmentation; many species become more vulnerable to predators, loss of colonization ability.
 2. Species diversity- is a combination of numbers of different species (richness) and abundance of individuals within each species (species evenness)
 3. Niche structure- the number of ecological niches, their resemblance or difference from each other, and interaction of species with each other
 - a. High species richness often is correlated with low species evenness (few numbers per species)
 - b. Two major factors affect diversity of species in a community: latitude in terrestrial communities and pollution in aquatic systems.
- B. The number of species on an island is determined by how fast new species arrive, old species become extinct, the size of the island and distance from the mainland.
1. The species equilibrium model, or the theory of island biogeography was proposed in the 1960’s to explain differences in species richness with island size.
 - a. Balance between two factors is important in this model: rate of immigration of species and rate of extinction of existing species
 - b. Two island features are important: size and distance from mainland
 2. This model has been expanded to include habitat islands in protected areas such as national parks.

Types of Species

Species in a community play many different roles in its ecology.

A. Types of Species

1. Native species are those whose original home is in this particular ecosystem.
 2. Non-native species originally evolved in a different ecosystem and migrated or were introduced to a new ecosystem.
 3. Indicator species alert us to harmful changes taking place in biological communities.
 - a. Birds are excellent biological indicators because they are everywhere and are quickly affected by environmental change.
 - b. Some amphibians are, also, considered indicator species.
 - 1) Their disappearance may be a warning of serious declining environmental quality.
 - 2) Vulnerability in different parts of an amphibian life cycle suggests degrees of environmental decline/disruption.
 - a) They are born and live in water and prey to water-born pollutants.
 - b) As adults they live on land; they are unprotected because their skins readily absorb pollutants.
 - c) Frogs as a threatened species are harmed by habitat loss, drought, pollution, parasitism, disease, over hunting, ultraviolet radiation, etc.
 4. The importance of amphibian species’ becoming extinct rests on three likelihoods.
 - a. This extinction suggests that the health of the environment is deteriorating.
 - b. Adult amphibians play important ecological roles in the world community.
 - 1) Extinction of one species leads to extinction of other species.
 - 2) Their biological niche controls insect populations.
 - c. Amphibians represent the possibility of hundreds of potential pharmaceutical products.
- B. Keystone species help ecological communities run smoothly; they determine the type and number of community species.
1. Keystone species have a larger effect on both the types and number of other species in a

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- community.
- 2. Keystone species fill important ecological roles: pollinating and regulating populations of other species.
- 3. Loss of a keystone species has far-reaching ramifications for other species in a community.
Example: alligators
- C. Foundation species shape communities by creating and enhancing habitat that benefits other species.
 - 1. Elephants, in breaking and uprooting trees, create forest openings in African savanna grasslands and woodlands.
 - 2. Grazing species benefit from the new growth of grasses and other forage plants.
 - 3. The rate of nutrient cycling is increased.

Species Interactions: Competition and Predation

Five basic species interactions are competition, predation, parasitism, mutualism and commensalism.

- A. Competition between species for food, sunlight, water, soil, space, nest sites, etc. is interspecific competition.
 - 1. With intense competition for limited resources, one species must migrate; shift its feeding habits/behavior or face extinction.
 - 2. As humans take more and more space, other species are compromised.
- B. In competitive situations, some species evolve adaptations which reduce/avoid competition for resources.
 - 1. Over a long time, species evolve more specialized traits that allow them to use shared resources at different times or in different ways or in different places; this is termed resource partitioning. An example is that of insect-eating warblers in Maine forests that eat insects in specific parts of a spruce tree. Owls hunt at night; hawks hunt during the day.
 - 2. Predator-prey relationships define one species (the predator) feeding/preying on another. Individually prey is harmed, but predation can help the population by eliminating the sick, weak and old.
 - 3. Predators have a variety of ways to capture prey. Herbivores feed on immobile plant species; carnivores use pursuit of prey or ambush to capture prey. Some predators use camouflage and others use chemical warfare (venom) to capture prey or deter predators.
 - 4. Prey species escape predators in a number of different ways such as swift movement, protective shells, camouflage or use of chemicals to repel or poison.

Species Interactions: Parasitism, Mutualism, and Commensalism

- A. Parasites live on or in another species. The host of this arrangement is obviously harmed by it but the parasite can contribute to biodiversity by controlling the size of specific species populations.
- B. Mutually beneficial interactions also exist in ecological environments.
 - 1. Mutualism is a relationship which benefits both species; these benefits can be in dispersing pollen and seeds for reproduction, in receiving food or in receiving protection.
 - 2. Mutualism is not cooperation; each species exploits the other.
 - a. Birds & African buffalo, elephants and rhinoceroses
 - b. Clownfish and anemones
 - c. Fungi and plant root associations called mycorrhizae
- C. Some species interaction helps one species but does nothing for the other; this is commensalism. Examples of this are the bromeliads and orchids (epiphytes)

Ecological Succession: Communities in Transition

- A. With new environmental conditions, community structures can change; one group of species is replaced by another.
 - 1. Ecological succession is the gradual change in species composition of a given area.
 - 2. Primary ecological succession is the gradual establishment of biotic communities on lifeless ground; in the soil there is no terrestrial community; in an aquatic community, there is no bottom sediment. This process generally takes a very long time.
 - a. Pioneer species attach themselves to patches of bare rock to begin the process. Lichens and

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- moss begin the building of soil particles.
- b. Early successional plants include tiny annuals that reseed, followed by small perennial grasses, herbs and ferns and grow close to the ground
 - c. Mid-successional plants include low shrubs and trees that require more soil and lots of sunlight. This process takes hundreds of years.
 - d. Late successional plant species are generally tree species that create shade and can tolerate shade to become a complex forest community.
 - e. Primary succession can also take place in newly created small ponds that over a long period of time will be transformed to a marsh and finally to dry land.
3. Secondary ecological succession defines a series of communities with different species developing in places with soil or bottom sediment. The soil or sediment remains after the natural community of organisms has been disturbed, removed or destroyed.
- a. Forest fires or deforestation, for example, can convert a particular stage of succession to an earlier stage.
 - b. Changes in vegetation during secondary succession also change the numbers and types of animals and decomposers also.
- B. The classic view of ecological succession is that it is an orderly sequence, each stage leading to the next, more stable stage until a climax community is reached. Such a community would represent the balance of nature, one dominated by a few long-lived plant species that is in balance with its environment. Three factors have been identified that affect how and at what rate succession occurs:
1. facilitation (an area is made suitable for a second species by the actions of the first)
 2. inhibition (early species delay establishment of later species),
 3. tolerance (later species are unaffected by plants at earlier stages of succession).
- C. Changes in environmental conditions that disrupt a community can set back succession.
1. Disturbances such as fire, drought, mining, plowing climate change, etc. can set back succession to an earlier stage.
 2. Large catastrophic disturbances can devastate a community, but in the long run such disturbances create unfilled niches and may encourage greater biodiversity.
 3. The intermediate disturbance hypothesis contends that infrequent, moderate disturbances are large enough to create openings for colonizing species, but mild enough for the survival of some mature species in undisturbed areas. There is some evidence to support this hypothesis, but not enough to state that this applies to all types of communities.
- D. Scientists can’t predict the course of a given succession in a community toward a stable climax community in balance with its environment.
1. The equilibrium model of succession was thought of as the balance of nature.
 2. Ecologists now view a community as a continuous change with instability rather than equilibrium.
 3. Succession reflects a struggle for each species to obtain food, light, nutrients and space to gain an advantage by occupying much of its fundamental niche as possible.
 4. The term biotic change better describes the changes occurring than does succession, and mature community fits better than climax community when describing a relatively stable community with a mosaic of vegetation patches.

Ecological Stability, Complexity, and Sustainability

Living systems maintain some degree of stability or sustainability through constant change in response to changing environmental conditions.

- A. All systems, from the smallest to the largest, are constantly changing in response to changing environmental conditions. There are a series of positive and negative loops that interact to provide stability or sustainability over the life span of a system. There are three aspects of stability or sustainability in living systems.
1. A system that resists being disturbed or altered is said to have persistence or inertia.
 2. A population that can keep its numbers within limits imposed by the resources shows constancy.
 3. A system that is able to repair damage after a moderate external disturbance shows resilience.
- B. Some communities obtain ecological stability or sustainability by having many different species

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present.

1. One measure of a community’s biodiversity is to consider the complexity, or number of species present at each trophic level of the community. Exceptions to this view of stability have been found.
 2. There is a minimum threshold of species diversity since no community can survive without some producers and decomposers.
 3. Recent research indicates that communities with more species tend to have a higher net primary productivity
 4. How much biodiversity is needed to maintain stability is still being debated. Part of the problem lies in the disagreement on how to define stability.
 5. Populations, communities, ecosystems are rarely in a state of equilibrium.
- C. We should take precautionary measures to prevent serious harm even if some of the cause-and-effect relationships have not been established.
1. Some developers feel there is no good reason to maintain biological diversity if it does not necessarily lead to ecological stability.
 2. Ecologists point out that environmental degradation is and has been occurring due to human disturbances. This has disrupted some of the environmental services that support and sustain all life and all economies.
 3. The wise course is to use caution regarding the making of potentially harmful changes to communities and ecosystems.
 4. The precautionary principle can be taken too far. Some risk is necessary in order to discover what works and what doesn’t. We must consider possible short- and long-term expected and unintended effects.
 5. Interactions of organisms in a community determine their abundance and distributions and serve as natural selection on won another through coevolution.

Summary

1. Two major factors affect the number of species in a community: the latitude in terrestrial communities and pollution in aquatic systems.
2. Species play different roles in a community. Native species sustain the ecosystem in which they are a part. Some nonnative species will crowd out native species. Indicator species alert us to harmful changes in the community. Keystone species play ecological roles in the specific community: they may assist in pollination help regulate populations. Foundation species affect the community’s habitat to benefit other species.
3. Species interact with each other in these different ways: interspecific competition, predation, parasitism, mutualism, and commensalism.
4. As environmental conditions change, one species may be replaced by other groups of species. This gradual change in the composition of species in a given area is called ecological succession.
5. A community has three aspects of sustaining itself: its persistence, the ability to resist being altered, its constant population, and its resilience in repairing damage. High biodiversity may give a community some edge in surviving but we do not know this for certain.

Objectives

1. Describe the three characteristics that describe a biological community.
2. Distinguish among the following roles played by species and give one example of each: *native species*, *nonnative species*, *indicator species*, and *keystone species*. Explain why these labels are important.

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3. Distinguish among the following species interactions and give one example of each: *interspecific competition*, *predation*, and *symbiosis*. Distinguish between *interference competition* and *exploitation competition*. Summarize the competitive exclusion principle. List two strategies species use to reduce competition.
4. List two strategies that predators use to capture their prey. List at least five strategies that prey use to defend themselves against predators.
5. Distinguish among three forms of symbiotic relationships and give one example of each: *parasitism*, *mutualism*, and *commensalism*.
6. Define *succession*. Distinguish between primary and secondary succession. Describe how humans affect communities.

Key Terms (Terms are listed in the same font style as they appear in the text.)

<p>alien species (p. 145) <i>balance of nature</i> (p. 158) <i>behavioral strategies</i> (p. 153) <i>camouflage</i> (p. 152) <i>carnivores</i> (p. 152) <i>chemical warfare</i> (p. 152) <i>climax community</i> (p. 158) commensalism (p. 155) constancy (p. 158) <i>dung beetle</i> (p. 148) <i>early successional plant species</i> (p. 156) ecological succession (p. 155) <i>epiphytes</i> (p. 155) <i>facilitation</i> (p. 155) foundation species (p. 149) <i>gut inhabitant mutualism</i> (p. 155) <i>herbivore poisons</i> (p. 152) <i>herbivore repellants</i> (p. 152) <i>host</i> (p. 153) indicator species (p. 146) inertia (p. 158) <i>intermediate disturbance hypothesis</i> (p. 157) resilience (p. 158) resource partitioning (p. 150) secondary succession (p. 155) species diversity (p. 145)</p>	<p>interspecific competition (p. 150) invasive species (p. 145) keystone species (p. 148) <i>late successional plant species</i> (p. 156) <i>midsuccessional plant species</i> (p. 156) <i>mimicry</i> (p. 153) mutualism (p. 154) native species (p. 145) <i>niche structure</i> (p. 145) nonnative species (p. 145) <i>parasite</i> (p. 153) parasitism (p. 153) persistence (p. 158) <i>physical appearance</i> (p. 145) <i>Piaster orchaceus</i> (p. 148) <i>pioneer species</i> (p. 156) <i>pollination</i> (p. 148) predation (p. 151) <i>predator</i> (p. 151) <i>predator-prey relationship</i> (p. 151) <i>prey</i> (p. 151) primary succession (p. 155) species evenness (p. 145) species richness (p. 145) <i>top predator</i> (p. 148) <i>warning coloration</i> (p. 152)</p>
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