Community Ecology
Chapter 56
Biological Communities

• In communities, species respond independently to changing environmental conditions
• Community composition changes gradually across landscapes
• Abundance of tree species along a moisture gradient in the Santa Catalina Mountains of Southeastern Arizona
• Each line represents the abundance of a different tree species
• Community composition changes continually along the gradient
Biological Communities

• Sometimes the abundance of species in a community does change geographically in a synchronous pattern

• Ecotones: places where the environment changes abruptly
Ecological Niche

• Niche: the total of all the ways an organism uses the resources of its environment
  – Space utilization
  – Food consumption
  – Temperature range
  – Appropriate conditions for mating
  – Requirements for moisture and more
Ecological Niche

• Interspecific competition
  – Occurs when two species attempt to use the same resource and there is not enough resource to satisfy both

• Interference competition
  – Physical interactions over access to resources

• Exploitative competition
  – Consuming the same resources
Ecological Niche

- **Fundamental niche**
  - Entire niche that a species is capable of using, based on physiological tolerance limits and resource needs

- **Realized niche**
  - Actual set of environmental conditions, presence or absence of other species, in which the species can establish a stable population

- **Other causes of niche restriction**
  - Predator absence or presence
  - Absence of pollinators
  - Presence of herbivores
Ecological Niche

J.H. Connell’s classical study of barnacles

Chthamalus
- Chthamalus realized niche
- Chthamalus fundamental niche

Semibalanus
- Semibalanus realized niche
- Semibalanus fundamental niche

S. balanoides and C. stellatus competing

C. stellatus fundamental and realized niches are identical when S. balanoides is removed.
Ecological Niche

• Principle of competitive exclusion
  • If two species are competing for a limited resource, the species that uses the resource more efficiently will eventually eliminate the other locally

• G.F. Gause’s classic experiment on competitive exclusion using three Paramecium species shows this principle in action
Data from Begon et al., Ecology, 1996. After: W.B. Clapham, Natural Ecosystems, Clover, Macmillan

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Ecological Niche

• *Paramecium caudatum* and *P. bursaria*
  – Expected same results – one winner
  – Both species survived by dividing resources

• Realized niche did not overlap too much
• Resource partitioning among sympatric lizard species
• Subdivided niche to avoid direct competition
Predator–Prey

- Predation
  - Consuming of one organism by another
- Predation strongly influences prey populations
Predator–Prey

• Prey populations can have explosions and crashes
  – White-tailed deer in Eastern U.S.
  – Introduction of rats, dogs, cats on islands

• Predation and coevolution
  – Predation provides strong selective pressure on the prey population
  – Features that decrease the probability of capture are strongly favored
  – Coevolution race may ensue
Predator–Prey

- Plants adapt to predation (herbivory) by evolving mechanisms to defend themselves
  - Chemical defenses: secondary compounds
    - Oils, chemicals to attract predators to eat the herbivores, poison milky sap, and others
  - Herbivores coevolve to continue eating the plants
• Chemical defenses in animals
  – Monarch butterfly caterpillars feed on milkweed and dogbane families
  – Monarchs incorporate cardiac glycosides from the plants for protection from predation
  – Butterflies are eaten by birds, but the Monarch contains the chemical from the milkweed that makes the birds sick
Predator–Prey

Poison-dart frogs of the family Dendrobatidae produce toxic alkaloids in the mucus that covers their brightly colored skin.
• Defensive coloration
  – Insects and other animals that are poisonous use warning coloration
  – Organisms that lack specific chemical defenses are seldom brightly colored
    • Camouflage or cryptic coloration help nonpoisonous animals blend with their surroundings
    • Camouflaged animals do not usually live together in groups
Predator–Prey

• Mimicry allows one species to capitalize on defensive strategies of another
  – Resemble distasteful species that exhibit warning coloration
  – Mimic gains an advantage by looking like the distasteful model
  – Batesian mimicry
    • Mimics look like distasteful species
  – Müllerian mimicry
    • Several unrelated but poisonous species come to resemble one another
Mimicry

a. Batesian mimicry: Pipevine swallowtail butterfly (*Battus philenor*) is poisonous; Tiger swallowtail (*Papilio glaucus*) is a palatable mimic.

b. Müllerian mimicry: Two pairs of mimics; all are distasteful.
Species Interactions

• Symbiosis
  – 2 or more kinds of organisms interact in more-or-less permanent relationships
  – Potential for coevolution
  – Three major types of symbiosis
    • Commensalism
    • Mutualism
    • Parasitism
Species Interactions

• Commensalism benefits one species and is neutral to the other
  – Spanish moss: an epiphyte hangs from trees
Species Interactions

• Mutualism benefits both species
  – Coevolution: flowering plants and insects
  • Ants and acacias
    – Acacias provide hollow thorns and food
    – Ants provide protection from herbivores
Mutualism

Ants of the genus Pseudomyrmex live within the hollow thorns of certain species of acacia trees in Latin America.
Species Interactions

• Parasitism benefits one species at the expense of another
  – External parasites
    • Ectoparasites: feed on exterior surface of an organism
    • Parasitoids: insects that lay eggs on living hosts
      – Wasp, whose larvae feed on the body of the host, killing it
Species Interactions

• Internal parasites
  – Endoparasites live inside the host
  – Extreme specialization by the parasite as to which host it invades
  – Structure of the parasite may be simplified because of where it lives in its host
  – Many parasites have complex life cycles involving more than one host
Species Interactions

- *Dicrocoelium dendriticum* is a flatworm that lives in ants as an intermediate host with cattle as its definitive host.
- To go from the ant to a cow, it changes the behavior of the ant.
- Causes the ant to climb to the top of a blade of grass to be eaten with the grass.
Species Interactions

• Ecological processes have interactive effects
  – Predation reduces competition
    • Predators’ choice depends partly on relative abundance of the prey options
    • Superior competitors may be reduced in number by predation
    • This allows other species to survive when they could have been outcompeted
Starfish eat barnacles, allowing other species to thrive instead of being crowded out by the explosive population of barnacles.
Species Interactions

• Keystone species
  – Species whose effects on the composition of communities are greater than one might expect based on their abundance
  – Sea star predation on barnacles greatly alters the species richness of the marine community
  – Keystone species can manipulate the environment in ways that create new habitats for other species
• Beavers
Beavers construct dams and transform flowing streams into ponds, creating new habitats for many plants and animals.
Succession and Disturbance

• Succession
  – Communities have a tendency to change from simple to complex
    • Primary succession occurs on bare, lifeless substrate
      – Open water
      – Rocks
      – Organisms gradually move into an area and change its nature
Nitrogen Concentration (g/m² of surface)

- Year 1: Pioneer Mosses
- Year 100: Invading Alders
- Year 200: Alder Thickets
- Spruce Forest

Nitrogen in forest floor
Nitrogen in mineral soil

a.

b - d: © Tom Bean
Succession and Disturbance

• Secondary succession
  – Occurs in areas where an existing community has been disturbed but organisms still remain
    • Field left uncultivated
    • Forest after a fire
• Succession happens because species alter the habitat and the resources available in ways that favor other species entering the habitat
Succession and Disturbance

• Three dynamic concepts in the process
  – Tolerance: early successional species are characterized by $r$-selected species tolerant of harsh conditions
  – Facilitation: early successional species introduce local changes in the habitat. $K$-selected species replace $r$-selected species
  – Inhibition: changes in the habitat caused by one species inhibits the growth of the original species
Succession and Disturbance

Succession after a volcanic eruption

a-b: © Studio Carlo Dani/Animals Animals – Earth Scenes