CHAPTER 25: COMMUNITY ECOLOGY

CHAPTER SYNOPSIS

Among the most complex concepts of populations is that of the niche. Niche is not synonymous with habitat as it includes behavioral and seasonal factors. The principle of competitive exclusion can be restated in terms of the niche; two species cannot occupy the same niche indefinitely. They can coexist while competing for the same resources, but at least one feature of their niches will differ.

Interspecific competition limits population size when two kinds of organisms use the same resource limited in supply. The principle of competitive exclusion states that when two species compete for the same limited resource, one will utilize the resource more efficiently which results in the elimination of the other. Continued competition between species rarely occurs. Either one or the other species is driven out or natural selection reduces the competition between them. Competition is also avoided through geographical partitioning. Although sympatric species live in the same area, they utilize different resources. Character displacement occurs when co-occurring species exhibit greater morphological differences and resource use. It is often hard to determine interspecific competition without constructing complex experiments. Even then, interpretations suggesting negative results do not always indicate competition. Detailed studies of ecological requirements often best explain interspecific interactions.

Predators have major effects on prey populations. Predation limits population size and is an important form of biological control. It places selective pressure on prey often causing an evolutionary arms race. Many plants produce physical structures or chemicals to dissuade animals from eating them. Such chemicals are called secondary compounds to differentiate them from primary chemicals involved in normal metabolic pathways. Many animals adapt secondary plant compounds for their own defense. The distastefulness of the monarch butterfly is perhaps the best known example. Its taste results from eating alkaloid-producing milkweed as a larva. Larvae that do not feed on these plants are quite tasty to birds. Animals develop defenses against predators, often by defensive coloration or chemical defenses. The monarch is an excellent example of aposematic coloration, bright warning coloration that tells predators to stay away. They advertise their toxicity to increase their survival. Cryptic coloration, on the other hand, allows an animal to blend in with its surrounding; its survival depends on hiding. The viceroy butterfly is a Batesian mimic that depends on its similarity to the toxic monarch for survival. Muellerian mimics are frequently unrelated species that all look alike, providing a sort of group defense.

Organisms evolve in a positive manner as well. An excellent example is the coevolution that has occurred between flowering plants and their pollinators. Among the best known symbiotic relationships are those found in lichens, mycorrhizae, and legumes. If the one partner benefits with no change to the other, the relationship is commensalism. If both participants benefit, it is mutualism. If one benefits and the other is harmed, the relationship is parasitic. Gray areas exist among these relationships as it is often difficult to determine whether a partner truly benefits by the actions of the other. Both commensalism and mutualism can readily turn into parasitism if even the slightest, unintentional damage occurs to the non-benefitting partner. Parasites that eliminate their source of food, that is kill their host, are not successful since they cause their own demise as well. Organisms that cause lethal disease are similarly not successful. Both predation and parasitism may counter the effects of competition by influencing the outcome of interspecific interactions.

The plants and animals that make up ecosystems change over time as the physical nature of the ecosystem changes. Secondary succession occurs in inhabited areas that are disturbed in some manner: Such disturbances are often initiated by humans. Primary succession occurs in areas made devoid of all life. It is readily seen on new volcanic islands, but also occurred millions of years ago when glaciers retreated from the northern hemisphere.

CHAPTER OBJECTIVES

- Explain how an organism's theoretical niche differs from its actual niche and how they both compare to the organism's habitat.
- Discuss the effects of interspecific competition and how it leads to competitive exclusion or species adaptation.
- Understand how predation affects prey population and evolution.
- Understand the process of coevolution and its advantages to both participants.
- Describe the various ways in which plants defend themselves against being consumed by herbivores.
- Explain how some animals use plant secondary compounds in their own defense from predators.
- Differentiate between cryptic and aposematic coloration in terms of appearance, social habits, and selective advantages to other organisms.
- Differentiate between Batesian and Muellerian mimicry.
- Give examples of the various forms of symbiotic relationships and identify the category into which each should be placed.
- Understand why it is difficult to differentiate between commensalism and mutualism even though they are clearly different from one another by definition.
- Describe the intricacies of a parasitic relationship.
- Differentiate between primary and secondary succession and give examples of each.
- Describe and understand the importance of a keystone species.

KEY TERMS

aposematic coloration
Batesian mimicry
character displacement
climax community
coevolution
commensalism
competitive exclusion
cryptic coloration
ectoparasite
endoparasite
eutrophic
exploitive competition
fundamental niche
habitat
indirect effect
interference competition
interspecific competition
keystone species
morphology
morphological defense
Müellerian mimicry
mutualism
niche
oligotrophic
parasitism
parasitoid
predation
primary succession
principle of competitive exclusion
realized niche
secondary chemical compounds
secondary succession
succession
symbiotic relationship
sympatric species
warning coloration

CHAPTER OUTLINE

25.0 Introduction

I. A COMMUNITY CONTAINS ALL ORGANISMS IN A PLACE THAT LIVE TOGETHER

A. Different Species Make Complex Adjustments to Community Living — fig 25.1

B. Competition and Cooperation Play Key Roles

25.1 Interactions among competing species shape ecological niches

I. THE REALIZED NICHE

A. Description of a Niche
1. Sum total of all ways an organism uses resources of its environment
2. Includes space, food, temperature, conditions for mating, moisture
3. Niche is not synonymous with habitat
   a. Habitat is a place
   b. Niche is a pattern of living

B. Description of Competition
1. Competition keeps an organism from using all of its niche
2. Struggle between two organisms to use same resources, if not enough for both
   a. Interspecific competition: Interactions between individuals of different species
   b. Interference competition: Fighting over resources
   c. Exploitative competition: Consuming shared resources

C. Different Types of Niches
1. Fundamental niche: Entire niche an organism is theoretically capable of using
2. Realized niche: Actual niche of an organism, smaller due to the presence of competitors
3. Example: Connell study of barnacle species fig 25.2
   a. Investigated competitive interactions between two species
      1) *Chthamalus stellatus* lives in shallower water
      2) *Semibalanus balanoides* lives in deeper water
   b. In deeper zone, *Semibalanus* always outcompeted *Chthamalus*
   c. If *Semibalanus* removed, *Chthamalus* inhabited deep regions
   d. *Semibalanus* conversely could not survive in shallow waters
   e. Fundamental niche of *Chthamalus* included niche of *Semibalanus*
   f. Realized niche of *Chthamalus* was narrower than fundamental niche
   g. Realized niche and fundamental niche of *Semibalanus* nearly identical
4. Realized niche restricted by other processes
   a. St. John's wort plant introduced and spread in open rangelands in California
   b. Beetle introduced to control plant
   c. Plant now found only in shade where beetle cannot live
5. Absence of another species can produce smaller realized niche
   a. Plants in North America need honeybee for pollination
   b. Honeybee populations presently declining
   c. If it completely disappears niche of plant species will decrease or disappear

II. GAUSE AND THE PRINCIPLE OF COMPETITIVE EXCLUSION

A. Classic Experiments with *Paramecium*
1. Three species grew well when grown in single culture fig 25.3a
2. *P. aurelia* versus *P. caudatum* fig 25.3b
   a. *P. caudatum* always declined to extinction
   b. *P. aurelia* grew faster than *P. caudatum*
   c. Better utilized limited available resources
3. Formulation of principle of competitive exclusion
   a. If two species are competing for a resource
   b. The one that uses the resource better will locally eliminate the other
   c. No two species with the same niche can coexist

B. Niche Overlap
1. Gause challenged *P. caudatum* with *P. bursaria* fig 25.3c
   a. Expected same result as before, one surviving, other dying out
   b. Both species survived
      1) *P. caudatum* dominated upper, high oxygen portion of tubes, ate bacteria
      2) *P. bursaria* favored growth in lower, oxygen poor portion, ate yeast
   c. Fundamental niche of both species was whole culture tube
   d. Realized niche for each species was a different portion of the tube
   e. Niches did not overlap too much
2. Both species had triple densities if grown without competitor

C. Competitive Exclusion
1. Restatement of Gause's principle of competitive exclusion
2. No two species can occupy the same niche indefinitely when resources limited
   a. Coexist while competing for the same resources
   b. One or more features of niche will always differ
3. Extinction of one species is inevitable

III. RESOURCE PARTITIONING

A. Persistent Competition Between Species Is Rare
1. One species drives out other, or natural selection reduces competition
2. Example: Five species of warblers studied by MacArthur
   a. All five initially appeared to be competing for same resources
   b. With closer observation, each feeds in different part of tree
   c. Each species thus eats different subset of insects
   d. Species not truly in competition
   e. Subdivided the niche to avoid direct competition

B. Competition Also Avoided by Geographical Partitioning
1. Sympatric species live in same area
   a. Avoid competition by living in different part of habitat
   b. Utilize different food or other resources fig 25.4
2. May result from selection causing similar species to diverge in resource use
3. Comparison of species with partially overlapping ranges
   a. Species exhibit greater morphological differences and resource use than allopatric populations
   b. Called character displacement
   c. Differences evident between sympatric species favored by natural selection
   d. Facilitates habitat partitioning and reduces competition
4. Example: Darwin's finches fig 25.5
   a. Have bills of same size when finches are allopatric
   b. When species are sympatric they evolved beaks of different shape and size

IV. DETECTING INTERSPECIFIC COMPETITION

A. Determining Competition Between Species Is Difficult
1. Using same resources not important if they are plentiful
2. When size is negatively correlated, competition may not occur
   a. One population large, other population small, resources limited
   b. Differences in numbers may be species responding to environmental feature
      1) One thrives in warm conditions
      2) Other thrives in cool conditions

B. Experimental Studies of Competition
   1. Construct experiments comparing species alone vs. species together
   2. Example: Seed-eating rodents in Chihuahuan Desert
      a. Setup enclosures to see effect of kangaroo rat on other rodents
      b. Kangaroo rats removed from half of enclosures
      c. Holes between enclosures, small rodents can pass, not kangaroo rats
      d. Monitored populations over three years — fig 25.6
      e. Results: Other rodent numbers higher when kangaroo rats absent
   3. Interspecific competition exists between many plant and animal species
      a. Effects seen in population sizes, behavior, and individual growth rates
      b. Example: *Anolis* lizards on St. Maarten Island
         1) *A. gingivinus* alone grows faster, perches lower in trees
         2) *A. pogus* competes with it

C. Caution Is Necessary
   1. Experimental studies have limitations
   2. Must take care in interpreting field experiments
      a. Negative effects do not always indicate competition
      b. Example: Similar-sized fish living together
         1) Have negative effect, but not due to competition
         2) Due to adults of one species preying on young of other species
         3) Presence of one species attracts predators that also feed on second species
   3. Studies must be combined with examination of mechanisms causing negative effects
   4. Experimental studies not always feasible
      a. Coyote populations increasing, grey wolf populations decreasing
      b. Competition studies between coyotes and gray wolves not practical
         1) Related to size of animals and large geographical areas
         2) Fenced areas with variety of animals not practical
      c. Could take centuries of study to show competition in slow-growing trees
      d. Detailed studies of ecological requirements best explain interspecific interactions

25.2 Predators and their prey coevolve

I. BASIC UNDERSTANDING OF PREDATION

A. In predation one organism consumes another
   1. Leopard captures and eats antelope
   2. Deer graze on spring grass

B. Interactions between Predator and Prey
   1. Under experimental conditions — fig 25.7
      a. Predator exterminates prey
      b. Predator becomes extinct due to starvation
   2. Provide refuges for prey
      a. Population drops but not to extinction
      b. Levels too low for predators, their populations drop
      c. Level of prey then recover

II. PREDATION AND PREY POPULATIONS

A. Predators Have Major Effect on Prey Populations
   1. Dramatic examples seen when humans add or eliminate predator
      a. Loss of large carnivores in eastern U.S. caused explosion of white-tailed deer
      b. Near elimination of otters on west U.S. Coast caused increase in sea urchins

2. Deleterious effect of introduction of rats, cats, and dogs onto islands
    a. Galápagos tortoises endangered as eggs and young are eaten
    b. Bird and reptile species on New Zealand eliminated, found on offshore islands
    c. Single cat killed all Stephen island wrens
3. Introduction of prickly pear cactus to Australia is classic example
    a. Lacking predators, cactus spread uncontrollably
    b. Cattle ranching difficult due to hordes of spiny cacti
    c. Introduced moth to control cactus

B. Predation and Evolution
1. Predation provides strong selective pressure on prey
    a. Strongly favors features that decrease possibility of capture
    b. Plants and animals evolved many defense mechanisms
2. Evolution of features cause natural selection to favor counter adaptations in predators
    a. Causes coevolutionary arms race
    b. Prey evolve better defense
    c. Predators evolve means of circumventing defenses
3. Example: Mesozoic mollusks and their predators
    a. Fish and crustaceans evolved that could crush or open mollusk shells
    b. Mollusks evolved shells that were thicker, spiny, or extremely smooth
    c. Predators have further evolved adaptations and tactics to eat mollusks

III. PLANT DEFENSES AGAINST HERBIVORES

A. Plants Are Prey to Herbivores
1. Plants attempt to limit being eaten by herbivores
2. Developed morphological defenses
    a. Thorns, spines, and prickles limit activities of browsers
    b. Plant hairs with glandula, sticky tips
    c. Deposition of silica toughens plant parts

B. Chemical Defenses
1. Produce secondary chemical compounds
    a. Distinguish from primary chemical compounds
    b. Primary compounds normally formed in metabolic pathways
    c. Secondary compounds not formed in metabolic pathways
    d. Chemicals are toxic, or disturb herbivore metabolism and/or development
2. Examples
    a. Mustard family produces mustard oils
    b. Milkweed/dogbane families produce milky sap containing cardiac glycosides

C. The Evolutionary Response of Herbivores
1. Some feed on restricted group of plants
    a. Group frequently produces secondary compounds
        1) Example: Cabbage butterflies fig 25.8
        2) Example: Monarch butterflies and milkweed/dogbane
2. Evolution of plant/herbivore interaction (cabbage butterfly)
    a. Plant evolves secondary compound (mustard oils), not eaten by herbivores
    b. Herbivores (butterfly) evolve ability to break down compound
    c. Herbivores lack competition from other herbivores
    d. May evolve sense organs to specifically detect chemical
3. Relationship formed between species is called coevolution

IV. ANIMAL DEFENSES AGAINST PREDATORS

A. Extra Benefits Derived From Ingesting Secondary Compounds
1. Monarch butterfly caterpillars concentrate and store cardiac glycosides
    a. Stored through chrysalis stage, to adult, even adults' eggs
    b. Cardiac glycosides protect Monarch from predators fig 25.9
    c. Predator regurgitates ingested butterfly
    d. Avoids conspicuously colored prey in future
2. Some predators acquire tolerance to chemical, such birds eat monarchs

B. Defensive Coloration
1. Insects feeding on milkweed are often brightly colored, advertize poisonous nature
2. Strategy called warning or aposematic coloration
3. Animals lacking defenses possess cryptic coloration
    a. Blends in with surroundings, hides animal from predators fig 25.10
    b. Camouflaged animals do not usually live in groups
    c. If one discovered, predator gains clues to presence of others

C. Chemical Defenses
1. Animals manufacture a variety of poisonous chemicals
    a. Many arthropods use chemicals for defence and to kill prey
    b. Marine animals and vertebrates have evolved various chemical defenses
2. Example: Poison dart frogs fig 25.11
    a. Produce toxic alkaloids in mucous secreted from brightly colored skin
    b. Only a few micrograms can kill a human
    c. Over 200 alkaloids isolated from secretions
    d. Many are important in neuromuscular research
3. Current investigation of other organisms for new anticancer drugs, antibiotics

V. MIMICRY

A. Batesian Mimicry
1. Related but unprotected species resemble protected ones
    a. Unprotected specimen is the mimic
    b. Protected specimen is the model
2. Unprotected must be fewer in number than protected species
    a. Mimics must live with models
    b. If in greater numbers, predators learn that most are edible
3. Most common examples include butterflies and moths
    a. Predators use visual cues to hunt for prey, may use other cues as well
    b. Models usually have caterpillars that feed on plants that produce toxins
    c. Mimic caterpillars do not feed on such plants, aren't protected
4. Example: Viceroy butterfly fig 25.12a
    a. Viceroy resembles poisonous monarchs
    b. Caterpillars feed on willow, cottonwoods, not thought to be distasteful
    c. Batesian mimicry does not extend to caterpillar stage
    d. Viceroy caterpillars camouflaged on leaves as bird droppings
    e. Distasteful monarch caterpillar very conspicuous

B. Müellerian Mimicry
1. Unrelated, but protected species resemble one another
    a. Examples include wasps and bees fig 25.12b
    b. Strengthens the distastefulness and provides a group defense
2. Behavior is imitated in both types of mimicry as well

25.3 Evolution sometimes fosters cooperation

I. COEVOLUTION AND SYMBIOSIS

A. Organisms Living Together Change and Adjust to One Another
1. Example: Flowering plants and pollinators fig 25.13
   a. Plants evolve in relation to dispersal of gametes by animals
   b. Animals evolve special traits to obtain resources from plants
   c. Seeds have features to make them more dispersable
2. Interactions are examples of coevolution

B. Symbiosis Is Widespread
1. Symbiotic relationships involve two or more organisms
   a. Often elaborate, generally permanent relationships
   b. Carry potential for coevolution between organisms involved
2. Examples
   a. Lichens = fungus and alga
   b. Mycorrhizae = fungus and plant root
      1) Fungus expedites plant's absorption of certain nutrients
      2) Plant provides fungus with carbohydrates
   c. Legumes = plant root and nitrogen-fixing bacteria
   d. Leaf cutter ants and fungi
      1) Ants cut leaves off plants in area
      2) Collect bits underground, inoculate with fungi
      3) Fungi specifically cultivated by ants, grow and reproduce
      4) Ants feed on fungi
      5) Example of symbiosis

C. Kinds of Symbiosis
1. Commensalism: One partner benefits, other neither benefits nor is harmed
2. Mutualism: Both participants benefit
3. Parasitism: One partner benefits, other is harmed, a kind of predation

II. COMMENSALISM

A. Benefits One Species, Other Not Affected
1. Individuals of one species often physically attached to individuals of another species
2. Examples
   a. Epiphytic plants growing on other plants
      1) Host plant unharmed
      2) Epiphytes growing on it benefit
   b. Barnacles attached to marine animals
      1) Carried passively from place to place
      2) Protected from predation
      3) Gain new food sources
      4) Increased water circulation
      5) Greater distribution of gametes

B. Examples of Commensalism
1. Sea anemones and clownfishes fig 25.14
   a. Fish live among stinging tentacles of anemones
   b. Tentacles paralyze other fish
   c. Fish feed on detritus left by anemones

2. Certain birds clean parasites off grazing animals
   a. Birds spend much time clinging to animals
   b. Pick off parasites, other insects

C. When Is Commensalism Commensalism?
1. Difficult to ascertain if second partner benefits or not
2. Gray boundary between commensalism and mutualism
3. Commensalism often really mutualism
   a. May benefit anemone to have food particles removed
   b. Herd mammals benefit by having parasites and insects removed
   c. Birds benefit by gaining food source
4. Commensalism may also transform into parasitism
   a. Oxpeckers also peck scabs off hosts, drink blood from wound
   b. Continued "attack" can weaken herbivore, especially in bad conditions

III. MUTUALISM

A. Relationship in Which Both Partners Benefit
1. Have fundamental importance in determining structure of biological communities
2. Spectacular examples between flowering plants and pollinators
   a. Characteristics of plants evolved to fit characteristics of animals
   b. Animals obtain food from flowers, additionally spread pollen to other flowers
   c. Animals become more specialized to feed on particular kinds of flowers
3. Example: Ants and aphids
   a. Aphids suck plant juices
   b. Ants protect and herd aphids like cattle
   c. Utilize aphid honeydew as food

B. Ants and Acacias
1. Mutualism occurs between Latin American *Acacia* and *Pseudomyrmex* ants
   a. Acacia leaf stipules modified as pair of hollow thorns
   b. Thorns inhabited by stinging ants fig 25.15
   c. Thorns deter herbivores
   d. Trees inhabited by ants produce food for them
      1) Protein-rich Beltian bodies
      2) Nectar at base of leaves
   e. Ants and larvae protected by thorns of tree
   f. Ants assist plant in return
      1) Attack all other herbivores
      2) Cut away branches of competing plants
      3) Wastes provide source of nitrogenous fertilizer
2. Different ant-acacia mutualism in Africa
   a. Several species of acacia ants in Kenya, only one occurs on trees
   b. *Crematogaster nigriceps* competitively inferior to two other species
   c. *C. nigriceps* prunes branches of acacia to prevent invasion by other ants
   d. Behavior is beneficial to ant, damaging to tree
      1) Destroys tissues that produce flowers
      2) Sterilizes tree
   e. Mutualistic interaction becomes parasitic

IV. PARASITISM

A. Special Form of Symbiosis
   1. Parasite much smaller than prey
   2. Parasite in close association with prey
   3. Harmful to prey organism, beneficial to parasite
   4. Sometimes difficult to distinguish from predation

B. External Parasites
   1. Ectoparasites feed on exterior surface of an organism — fig 25.16
      a. Example: Lice are parasites, live on bodies of vertebrates
      b. Mosquitos are not considered parasites, interaction with host is brief
   2. Parasitoids: Insects that lay eggs on living hosts
      a. Common wasp behavior
      b. Larvae feed on host, often kill it

C. Internal Parasites
   1. Endoparasites are found inside the host
   2. Some animal examples are readily identifiable, while others are not
      a. Vertebrates have animal or protist parasites
      b. Bacteria and viruses are not considered parasites
   3. Internal parasites more specialized than external ones
      a. More closely linked to host
      b. Morphology and behavior more greatly modified over time
      c. Bodily structure of parasite quite simplified

D. Brood Parasitism
   1. Few birds lay eggs in nests of other species
   2. Host parents raise baby as if it were their own — fig 25.17
      a. Parasite baby often requires greater investment in care
      b. Reduces reproductive success of foster parents
      c. Evolution favors recognition of parasite eggs with resulting rejection

V. INTERACTIONS AMONG ECOLOGICAL PROCESSES

A. Predation Reduces Competition
   1. If resources limited, superior competitor can eliminate another species
   2. Predators can change competitive exclusion
      a. Prevent or greatly reduce it
      b. Reduce number of individuals of competing species
   3. Predator feeds on several species within a community
      a. Predator's choice of prey depends on relative abundance of a species
      b. Feeds on species *A* until it becomes rare, switches to species *B*
   4. Prey species may become food source for many predators when it is abundant
   5. Superior competitors prevented from outcompeting other species

B. Parasitism May Counter Competition
   1. Affect sympatric species differently
   2. Influence outcome of interspecific interactions
      a. Example: Tribolium flower beetles and Adelina parasite
         1) Without parasite, *T. castaneum* dominant, *T. confusum* nears extinction
         2) With parasite, opposite results *T. castaneum* perishes

b. Example *Anolis* lizards on St. Maarten
    1) Inferior species resistant to malaria, other species susceptible
    2) Species coexist only where malaria parasite present

C. Indirect Effects
1. Two species don't interact directly, but are affected through third species
2. Example: Rodents and ants in Chihuahuan Desert
    a. Both rodents and ants eat seeds
    b. Rodents removed from enclosures, no holes to allow them back in
    c. Ant populations first increase, then decline fig 25.19
    d. Ecosystems are very intricate fig 25.20
        1) Rodents prefer large seeds, ants small ones
        2) Plants with large seeds competitively superior to small-seed plants
        3) Rodents removed, large-seed plants flourish, small-seed plants diminish
        4) Lacking their preferred food source, ant populations decline
        5) Direct negative effect of rodents on ants
        6) Indirect, positive effect mediated by plants

D. Keystone Species
1. Species that have strong effect on community composition
2. Often are predators
    a. Prevent one species from outcompeting another
    b. Maintain high levels of species richness
3. Wide variety of other types of keystone species
    a. Some manipulate environment to create new habitats for others
    b. Beaver changes running water to small pond habitats fig 25.21
    c. Alligators dig deep holes in lake bottom where water persists during droughts

25.4 Ecological succession may increase species richness

I. ECOSYSTEMS CHANGE EVEN WHEN CLIMATES ARE STABLE

A. Change from Simple to Complex Is Succession

B. Familiar Process

II. SUCCESSION

A. Primary vs Secondary Succession
1. Secondary succession
    a. Cleared wooded area left alone will be reclaimed by original woods
    b. Occurs in areas where existing community is disturbed

B. Primary Succession
1. Occurs in areas devoid of all life
    a. Areas after retreat of glaciers fig 25.22
    b. New volcanic islands
    c. Glacial moraines fig 25.23
        1) Lichens grow first, acid secretions break down rock
        2) Mosses colonize pockets of soil, build up nutrients
        3) Next colonizers include alder shrubs
        4) Finally form dense spruce forests
2. Succession also occurs in open water communities
    a. Oligotrophic lake is poor in nutrients

b. Eutrophic lake is rich in nutrients
c. Oligotrophic lake may become eutrophic through accumulation of organic matter
3. Climax vegetation (climax community)
a. Characteristic vegetation may be associated with climate of region
b. Term no longer useful as once presumed
1) Climates keep changing
2) Process of succession is very slow
3) Nature of a region's vegetation affected by human activities

C. Why Succession Happens
1. Species alter habitat and resources to favor other species
2. Tolerance
a. Early successional stages characterized by weedy, *r*-selected species
b. Do not compete well in established communities
c. Tolerant of harsh, abiotic conditions of barren areas
3. Facilitation
a. Weedy species introduce changes that favor less-weedy species
b. In glacier example
1) Mosses fix nitrogen to allow alder survival
2) Alders lower soil pH, allow for invasion of spruce
4. Inhibition
a. Changes from one species favor growth of other species
b. May also inhibit growth of first species
c. Example: Alders do not grow well in acidic soil that they produce
5. With maturation of ecosystems
a. More *K*-selected species replace *r*-selected ones
b. Greater species richness in mature ecosystems than in immature ecosystems

III. THE ROLE OF DISTURBANCE

A. May Interrupt Succession of Plant Communities
1. Community may revert to earlier stage
a. With extreme disturbance may revert to earliest stage
b. Severe disruptors include forest fires, drought, floods
2. Animals also cause disruption
a. Gypsy moth destruction of forests
b. Also includes overgrazing of forests by deer or pastures by cattle

B. Intermediate Disturbance Hypothesis
1. Disturbance may increase area's species richness
2. Moderate disturbance may leave community with higher species richness
a. Patches of habitat at different successional stages exist
1) Species diversity high, full range of species exists
2) Example: Gaps produced in rain forest when tree falls fig 25.24
b. Disturbance may prevent achievement of final successional stage
1) In final stage, few dominant competitors
2) Most other species eliminated
3. Substantial disturbance causes community to be in early stage with low species richness
4. Disturbance is normal in many communities
a. Successional progression to climax community no longer widely accepted
b. Future state of community difficult to predict

INSTRUCTIONAL STRATEGY

PRESENTATION ASSISTANCE:

Many students may not realize that a vast majority of medicinal compounds were initially extracted from plants, *i.e.* aspirin from willow bark. Humans have used secondary plant compounds to their benefit as have other animals. Traditional medicine of the Appalachian peoples and of China is being studied to determine the active ingredients behind the many beneficial folk treatments. These compounds may be isolated and synthesized commercially. Unfortunately many traditional remedies fail, not because they are inherently bad, but because the plant chemicals are not always produced, or are not produced in uniform amounts. A great amount of variation is dependent on seasonal temperature and rainfall as well as natural soil conditions.

Many insects have evolved unique behaviors to cope with the stimulated production of plant chemicals. Some nip the midrib to keep them from entering the leaf they are eating, others chew circles on the leaves, eating only the inside.

Recent research shows that plants communicate over great distances, presumably by airborne chemicals. Thus a tree may begin to produce secondary compounds even though it is far removed from the actual herbivore attack. Tobacco plants, for example, produce salicylic acid (aspirin) to alert their immune system to fight an infection of TMV. Some of the acid is converted to methyl salicylate and evaporates from the damaged plants. When this air wafts over non-infected tobacco plants, the salicylate is absorbed and turned into salicylic acid.

Many frogs in the Amazon are poisonous, though they possess absolutely no poisons on their skins when they are born. They only secrete the poisons as adults. Examination of the stomachs of these frogs revealed the presence of ants. The ants contain up to 20 different toxic alkaloids. The most dangerous of these frogs, *Dendrobates auratus* has a diet that is 70% toxic ants!

Use hypothetical social examples to explain various forms of coloration and mimicry. One of the best ways to avoid being mugged is to act slightly crazy – similar to aposematic coloration. The use of camouflage in hunting is obvious. There are increasing numbers of pan-handlers in most cities; as residents discover that many are actually making a decent living from such activity, they are less likely to give money to anyone – similar to Batesian mimicry.

Another example of brood parasitism occurs in a species of mouth brooding catfish. Another species of fish (analogous to the catbird) presents its young near the catfish mother, who sucks them up as though they were her own young. Over time her true young and the intruders both grow and develop. Unfortunately, the catfish young provide an additional food source for the intruders who grow to much greater proportions. After the normal brooding period, the catfish mother releases her "young" which turn out to be only a few individuals of the brood parasite species. She has expended substantial energy to raise another species and has no new generation of her own species!

VISUAL RESOURCES:

Slides of various forms of mimicry are a necessity. One can include various poisonous animals, including rattlesnakes and coral snakes and the others that mimic them (hognose snake and scarlet king snake respectively).

The coevolution of flowers and their pollinators is especially interesting and highly specialized. Among the most specific relationships are between wasps and tropical orchids. As a result of intense coevolution, the extinction of one partner will likely result in the extinction of the other. This is especially true if the extinction is caused by humans and happens over a short time span. Under natural circumstances the second partner might have the time and opportunity to evolve less dependency on the first partner.

The animated film Antz has a really cute part where the worker and soldier ants are in an ant "bar" and the worker ant (Woody Allen's voice) refuses the glob of "honeydew" commenting it doesn't drink stuff that comes out of another insect's anus!