CHAPTER FIFTY-FOUR: Community Ecology

54.1 Community interactions are classified by whether they help, harm, or have no effect on the species involved

- interspecific interactions - competition, predation, herbivory, symbiosis, facilitation
  → interactions w/ individuals of other species

I. Competition

- interspecific competition - (−/−) interaction occuring when individuals of different species compete for resource that limits their growth/survival

1. Competitive Exclusion

- two species competing for same limiting resources cannot coexist permanently
- competitive exclusion - local elimination of the inferior competitor
  → slight reproductive advantage

2. Ecological Niches and Natural selection

- ecological niche - sum of a species' use of biotic and abiotic resources in its enviro.
- differences in niche allow for coexistence
- resource partitioning - differentiation of niches enabling similar species to coexist
  → indirect evidence of earlier interspecific competition resolved by evolution of niche
- *fundamental niche*: niche potentially occupied by a species
- *realized niche*: portion of its fundamental niche that it actually occupies in a particular environment
- nocturnal → diurnal as a result of competition

3. Character Displacement

- character displacement - tendency for characteristics to diverge more in sympatric than allopatric populations of two species

II. Predation

- predation - +/- interaction in which the predator kills & eats the prey
- adaptations for catching & killing
- adaptations for hiding & alarm
- cryptic coloration - camouflage
- mechanical & chemical defenses exist also
- aposematic coloration - warning coloration
  → animals w/ effective chemical defense
- Batesian mimicry - palatable/harmless species mimics an unpalatable/harmful one
  → can involve appearance & behavior
- Müllerian mimicry - two or more unpalatable species resemble each other
  → predators learn to avoid

III. Herbivory

- herbivory - +/- interaction in which an organism eats part of a plant or alga
- specialized adaptations for eating
- plants can't run or hide so they may have chemical toxins, spines, or thorns

IV. Symbiosis

- symbiosis - individuals of two or more species live in direct and intimate contact with one another
  → harmful, helpful, or neutral

1. Parasitism

- parasitism - +/- symbiotic interaction in which parasite derives nourishment from another organism, the host, who is harmed in the process
- endoparasites - parasites that live w/in body of host
- ectoparasites - parasites feeding on external surface of host
- parasites can modify host behavior
- can affect survival, reproduction, density of host population

2. Mutualism

- mutualism - interspecific interaction that benefits both species (+/+)
- obligate mutualism: at least one species lost ability to survive w/o partner
- facultative mutualism: both species can survive alone
- coevolution of related adaptations in both species
  → affect both as well

3. Commensalism

- commensalism - interaction benefitting one, but neither harming or helping the other (+/0)
  → barnacles on whales

V. Facilitation

- facilitation - species may have positive/neutral effects of another species w/o real symbiosis
- certain animals or plants can make certain environment more hospitable for another species

54.2 Diversity and trophic structure characterize biological communities

I. Species Diversity

- species diversity - variety of different kinds of organisms that make up community
  - → species richness - number of different species
  - → relative abundance - proportion each species represents of all individuals there
- Shannon diversity - index of community diversity symbolized by H, where A, B, C are species, p is relative abundance, and ln is the natural logarithm

$$H = -(p_A \ln p_A + p_B \ln p_B + p_C \ln p_C \ldots)$$

  - → higher H value = more diversity
- measuring diversity is challenging

II. Diversity and Community Stability

- higher diversity → more productivity
- invasive species - organisms that become established outside their native range
- higher diversity → less chance for survival of an invasive species

III. Trophic Structure

- trophic structure - feeding relationships between organisms in a community
- food chain - transfer of food energy up the trophic levels

1. Food Webs

- food webs - interconnected feeding relations
- who eats whom relationships
- "nonexclusive" consumers

2. Limits on Food Chain Length

- most webs have food chains w/ 5 or fewer links
- energetic hypothesis - length of food chain limited by inefficiency of energy transfer along the chain (10%)
- biomass - total mass of all individuals in a population
- dynamic stability hypothesis - long food chains are less stable than short ones
  - → population fluctuation magnifies at higher levels, causing local extinction
  - → unpredictable environment = short chain
- energetic hypothesis supported by research on tiny communities

IV. Species with a Large Impact

1. Dominant Species

- dominant species - most abundant species or that w/ the highest collective biomass
  - → competitively superior
  - → avoidance of disease/predation
- affect some, not other species

2. Keystone Species and Ecosystem Engineers

- keystone species - not usually abundant
  - → exert strong control by pivotal ecological roles
- food chains influenced and changed
- ecosystem engineers - species that drastically change their environment
  - → i.e. beaver
  - → may be positive or negative for others

V. Bottom-Up and Top-Down Controls

- V → H : more vegetation = more herbivores
  → herbivores limited by vegetation
- V ← H : more herbivores = less vegetation
- V ↔ H : feedback flows in both directions
- bottom-up model - unidirectional influence from lower to higher trophic levels

  N → V → H → P

  nutrients veg herbivores predators
- top-down model - trophic cascade model that shows predation controlling community organization

  N ← V ← H ← P

  → moving down trophic structure is +/−
- biomanipulation - approach applying top-down model to alter ecosystem characteristics
  → to help purify water
  → removing/altering higher-level consumers

54.3 Disturbance influences species diversity and composition

- *stability*: community's tendency to reach/maintain a relatively constant composition of species
- *climax community*: one state of equilibrium, controlled by climate; species function as integrated unit
- disturbance - event that changes a community by removing organisms from it or altering resource availability
  → storm, fire, drought, overgrazing, humans
- nonequilibrium model - most communities as constantly changing after being affected by disturbances

I. Characterizing Disturbance

- intermediate disturbance hypothesis
  - → moderate levels of disturbance foster greater species diversity than low/high levels of disturbance
  - → can open up habitat for less competitive species
  - → supported by studies
- small & large disturbances still often have important effects on community structure
- land-use change & droughts are increasing frequency & intensity of catastrophic forest fires
- loss of certain species of trees (fruit ones) leads to decline in animal species

II. Ecological Succession

- ecological succession - transition in species composition following a disturbance
- primary succession - occurs in an area where there were no organisms and no soil
- secondary succession - occurs when an existing community was cleared, but soil stays
  - → area could go back to natural state
- early arrivals **facilitate** appearance of later species by making environment favorable
- early species may **inhibit** later species so later ones colonize successfully in spite of early ones
- early species may be completely independent of later species, which **tolerate** conditions but are not helped or hindered by them
- glacial moraines
  - → pH of soil important & nitrogen content
  - → pioneer plants permit new plants to grow

III. Human Disturbance
- agriculture.
- logging, clearing, mining, farming
  → huge beautiful forests destroyed
  → weedy, shrubby vegetation then dominates
- tropical rain forests disappearing
- ocean trawling is like clear-cutting a forest at the bottom of the ocean
- severity is understated by the book.

54.4 Biogeographic factors affect community diversity

I. Latitudinal Gradients
- life more abundant/diverse in the tropics
- evolutionary history & climate
  → factors in latitudinal gradients of species richness
- intervals between speciation events are shorter in the tropics
- solar energy input & H_2O availability
  → high in tropics
- evapotranspiration - evaporation of H_2O from the soil plus transpiration from plants
  → high in hot, rainy areas
- potential evapotranspiration: measure of potential water loss assuming that H_2O is readily available
  → determined by solar radiation & temp.
  → species richness correlates w/ both measures of evapotranspiration

II. Area Effects

diversity increases w/ area

- species-area curve - the larger the geographic area of a community, the more species it has (all other factors being equal)

III. Island Equilibrium Model
- including habitat islands (i.e. lake)
- number of species determined by rates of immigration and extinction
  → both affected by number of species already present
- size and distance from mainland of the island affect immigration/extinction rates
- small island, lower immigration
- small island, higher extinction
- closer island, higher immigration
- *island equilibrium model*
  → an equilibrium will eventually bereached where rate of immigration equals rate of extinction
  → dynamic; rates continue; species composition may change over time
  → MacArthur & Wilson's studies support prediction that diversity ↑ w/ size
- abiotic disturbances intervene and alter species comp. & community structure

54.5 *Pathogens alter community structure locally and globally*

I. Pathogens and Community Structure
- coral reef communities affected newly
- sudden oak death (SOD) influences forests
- human activities transport pathogens
- certain species die b/c of tree death
- new species become dominant in reef area
- pathogens spread & may have no cure
- humans contribute to suffering

II. Community Ecology and Zoonotic Diseases

- zoonotic pathogens - transferred to humans from other animals
- vector - intermediate species that can transmit disease
  → often parasites like ticks or mosquitoes
- community interactions can spread pathogens
- avian flu by bird feces and saliva
- community ecology provides foundation for understanding life cycles of pathogens & their interactions
- ecosystem perspective