Chapt. 53 – Community Ecology

Community – the populations that co-occur in a given place at a given time **[Fig. 53.11]**
Important **static properties** of a community:
Species richness = the number of species
Relative abundance = relative commonness vs. rarity of species
Species diversity = an integrated measurement of species richness plus relative abundance

Community Ecologists study communities by asking:
What ecological and evolutionary processes organize and structure communities (*e.g.*, what types of species are present and what types of interactions exist among species)?
Why do communities vary in species composition, species diversity, and other aspects of community organization and structure?

Individualistic vs. Integrated Structure
A debate raged in the early 20th century between **Gleason's "individualistic" hypothesis** vs. **Clements' "integrated" hypothesis [Fig. 53.29]**

Gleason's "individualistic" hypothesis:
Species occur in a given area because they share similar abiotic (*e.g.*, habitat) requirements

Clements' "integrated" hypothesis:
Species are locked into communities through mandatory biotic interactions
Communities viewed as "superorganisms"

Gleason's "individualistic" hypothesis for community organization has received the most support from field-based studies
Nevertheless, species interactions are important components of community dynamics

INTERSPECIFIC INTERACTIONS **[See Table on pg. 5 of the chapter outline]**

Mutualism (+/+) *E.g.*, ant-acacias and acacia-ants
Traits of species often evolve as a result of **interspecific interactions**
One species may evolve traits that benefit that species in its interactions with another species
Coevolution occurs when two species reciprocally evolve in response to one another

Pollination (+/+) (Usually a type of mutualism)

Frugivory & Seed Dispersal (+/+) (Usually a type of mutualism)

Predation (+/-) Striking adaptations often characterize predators and their prey

Crypsis Predators may evolve cryptic morphology; prey may evolve cryptic morphology

Aposematism Prey may evolve **aposematic** (**warning**) morphology

Mimicry Organisms may evolve to look like other organisms

Batesian mimicry – innocuous **mimic** evolves to look like harmful **model**
E.g., monarch and viceroy

Mullerian mimicry – two harmful mimics evolve convergently toward a common morphology, *e.g.*, cuckoo bee and yellow jacket

Herbivory (+/-) Feeding (sometimes predation) by animals on plants

Parasitism (+/-)
Parasites derive nourishment from their **hosts**, whether they live inside their **hosts** (**endoparasites**, *e.g.*, tapeworm) or feed from the external surfaces of their **hosts** (**ectoparasites**, *e.g.*, tick)

Parasitoidism (+/-)
Parasitoids lay eggs on living hosts and their larvae eventually kill the host

Commensalism (+/0) *E.g.*, mites hitching a ride on a beetle

Amensalism (-/0)
Common, but not considered an important process structuring communities; *e.g.*, elephant stepping on ants

Neutralism (0/0)
Common, but not considered an important process structuring communities; *e.g.*, hummingbirds and earthworms (they never interact with one another)

Competition (-/-) Organisms often compete for limiting resources
E.g., smaller plants are shaded by larger plants
E.g., barnacles compete for space on rocky intertidal shores **[Fig. 53.2]**

Fundamental niche – an organism's "address" (**habitat**) and "occupation" in the absence of biotic enemies
Realized niche – an organism's "address" (**habitat**) and "occupation" in the presence of biotic enemies
Competitive Exclusion Principle
Two species cannot coexist if they occupy the same niche
"Close competitors cannot coexist"; *e.g.*, the barnacles **[Fig. 53.2]** do not coexist where their fundamental niches overlap
Competition between two species with identical niches results either in **competitive exclusion** or the evolution of **resource partitioning**

Resource partitioning may result from **character displacement [Fig. 53.3 & 53.4]**

Food Chains

Species interact through **trophic** (**food**) **chains [Fig. 53.12]**

"So, the naturalists observe, the flea,
Hath smaller fleas that on him prey;
And these have smaller still to bite 'em;
And so proceed, *ad infinitum*"
Jonathan Swift (1667-1745)

"Great fleas have little fleas
Upon their backs to bite 'em
And little fleas have lesser fleas,
And so *ad infinitum*"
DeMorgan (1915)

The length of food chains is rarely > 4 or 5 trophic levels long **[Fig. 53.15]**
The main reason follows from the Laws of Thermodynamics:
Energy transfer between trophic levels is only ~10% efficient

Food Webs

Food chains combine into **food webs [Fig. 53.13]**: Who eats whom in a community?

Relative Abundance, Dominance, and Keystone Species

Relative abundance = relative **commonness** vs. **rarity**
Dominance = relative contribution to the **biomass** of a community
Sometimes **exotic species** become deleteriously dominant
Keystone species influence community composition more than expected by their relative abundance or biomass
Removing a keystone species has a much greater effect on community structure than expected by its relative abundance or biomass **[Fig. 53.16]**

Top-Down vs. Bottom-Up Control

Debates continue regarding the relative importance of top-down vs. bottom-up control on community organization **[Fig. 53.12]**
Both are important influences in most communities

Disturbance

A discrete event that damages or kills resident organisms
e.g., **non-catastrophic** treefall gap
e.g., **catastrophic** volcanic eruption
e.g., fire **[Figs. 53.21 & 53.22]**
e.g., anthropogenic habitat destruction

Ecological Succession

Changes in species composition following a disturbance in which organisms good at dispersing and growing quickly are replaced by organisms good at surviving under crowded (competitive) conditions

Primary Succession

Begins from a virtually lifeless starting point (a **catastrophic disturbance**)

Secondary Succession

Follows a **non-catastrophic disturbance**

Example of primary succession: retreating glaciers in Alaska **[Figs 53.23 & 53.24]**

Early species may **inhibit** later species; *e.g.*, plant toxins
Early species may **facilitate** later species; *e.g.*, nitrogen-fixing plants
Early species may **tolerate** later species; *i.e.*, the early species neither help nor hinder the colonization of later species

Species diversity generally increases as ecological succession proceeds
Successional stage differences give rise to differences in species diversity from place-to-place

Intermediate Disturbance Hypothesis (IDH)

Another reason for species diversity differences from place-to-place is the disturbance regime
IDH postulates highest levels of diversity in places with intermediate levels of disturbance

Species-Area Relationship

The larger the geographic area sampled, the more species found; primarily because larger areas offer a greater diversity of **habitats** and **microhabitats** **[Fig. 53.26]**
Characterizes **island archipelagos** **[Fig. 53.28]**
Characterizes **habitat "islands"**

The influence of both **area** and **isolation** on species richness

Larger area = more species
Less isolation = more species

Island Biogeography Theory E. O. Wilson & Robert MacArthur (1967) **[Fig. 53.27]**

The **immigration-extinction balance** on islands contributes to the species-area relationship
Smaller islands have fewer species than larger islands, since immigration rates are lower, and extinction rates are higher on smaller islands
More isolated islands have fewer species than less isolated islands, since immigration rates are lower on more isolated islands

Diversity Gradients

Species diversity generally increases as one moves from the poles towards the equator
Historical explanations concern latitudinal gradients in biogeographic history
Current-day process explanations concern latitudinal gradients in ecological processes

Diversity-Productivity Relationship

Current-day processes that create a latitudinal gradient in energy availability appear to contribute to the latitudinal gradient in diversity **[Fig. 53.25]**

INTERSPECIFIC INTERACTIONS