Community Structure and Biodiversity

AP Biology:

Chapter 46

Key Concepts:

- **A habitat is the type of place where individuals of a species normally live**
- **Every species in the community has its own niche**
- **Community structure starts with the adaptive traits that allow response to a habitat**
- **Interactions among species influence the structure of a community**

Key Concepts:

- **Community structure depends on the location, size of habitat, rates of member arrival and disappearance, and physical disturbance to a habitat**
- **The first species to occupy a habitat are replaced by others**
- **Different stages of succession often exist in the same habitat**

Impacts, Issues

Fire Ants in the Pants

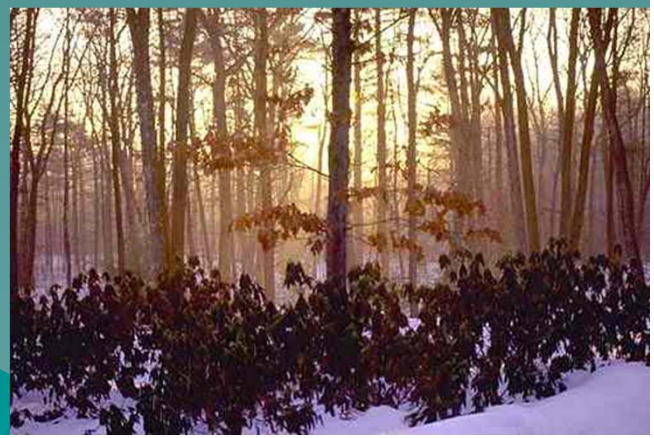
- Imported fire ants disturb community structures; in the US, phorid flies are being introduced to control them – tipping the balance once again

PLAY VIDEO

Community

- All the populations that live together in a habitat
- Type of habitat shapes a community's structure
- Factors shaping community structure:
  - Climate and topography
  - Kinds and amounts of food and other resources
  - Species' adaptations to habitat conditions
  - Species interactions
  - Timing and history of disturbances

Woodland community



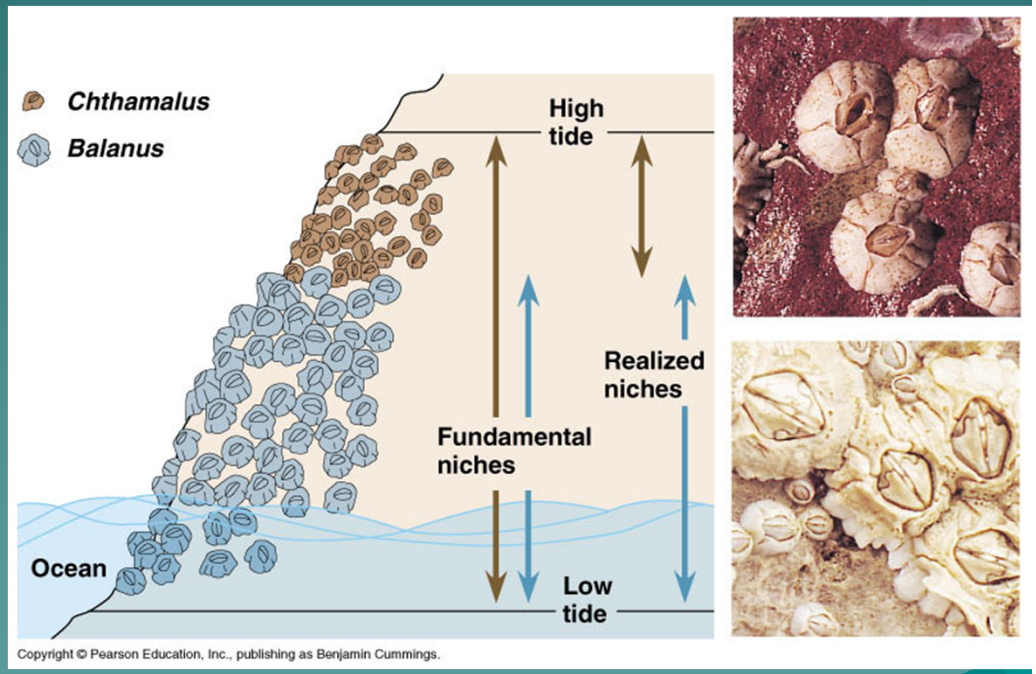
Niche

- **Sum of activities and relationships in which a species engages to secure and use resources necessary for survival and reproduction.**

Decomposer niche

Realized & Fundamental Niches

- **Fundamental niche**
  - **Theoretical niche occupied in the absence of any competing species**
- **Realized niche**
  - **Niche a species actually occupies**
- **Realized niche is some fraction of the fundamental niche**



Factors that Shape Community Structure

- **Habitat**
- **Community**
- **The niche**

Type of Interaction	Species 1	Species 2
Commensalism	+	0
Mutualism	+	+
Interspecific Competition	-	-
Predation	+	-
Parasitism	+	-

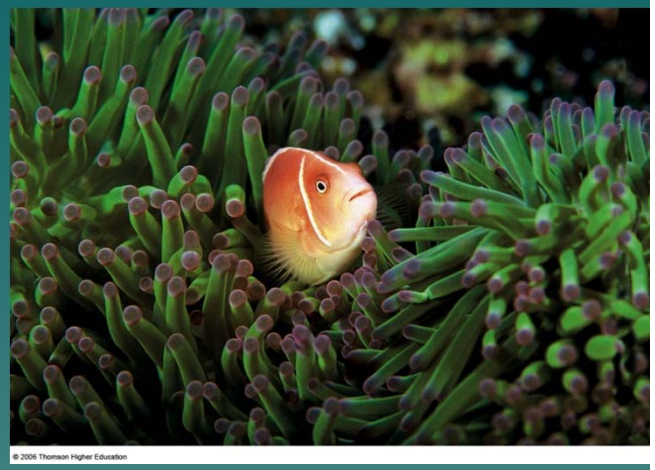
- **Interactions**
  - **Commensalism**
  - **Mutualism**
  - **Interspecific competition**
  - **Predation**
  - **Parasitism**

Key: 0 = no direct effect
+ = positive effect
- = negative effect

Commensalism

- Commensalism
  - A symbiotic relationship in which one species benefits and the other is indifferent
  - Many supposed examples may turn out to be mutualism or parasitism
    - Cattle egret and cattle
    - Sharks and remoras
    - Spanish moss and trees

Mutualism



- Both species benefit
- Some are obligatory
  - partners depend upon each other
    - Yucca plants and yucca moth
    - Mycorrhizal fungi and plants
    - Sea anemone and pink anemone fish

Forms of Competition

- Competitors may have equal access to a resource; compete to exploit resource more effectively
- One competitor may be able to control access to a resource, to exclude others

Interference Competition

- **Least chipmunk is excluded from piñon pine habitat by the competitive behavior of yellow pine chipmunks (interspecific competition)**
- **Golden eagle gently discourages a red fox to abandon the moose carcass they both have discovered.**

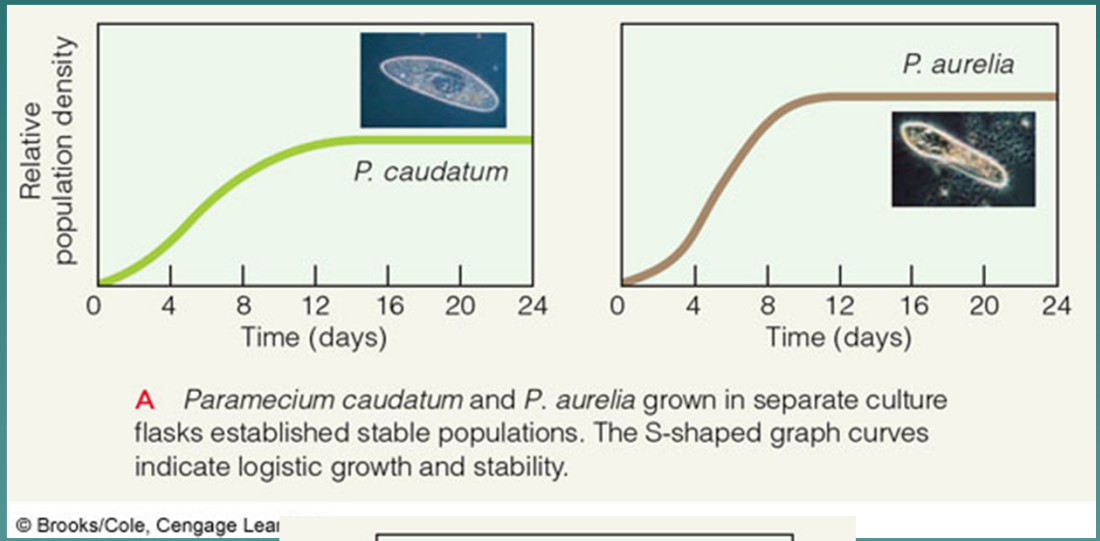
Least Chipmunk

Yellow Pine Chipmunk

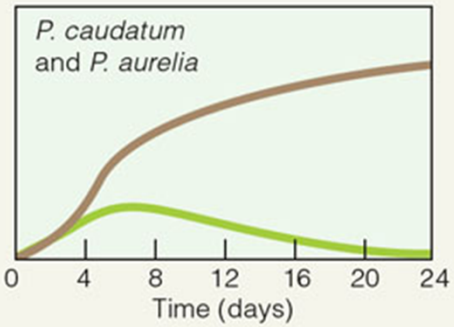
Competitive Exclusion

- **Competitive exclusion (Gause's Principle)**

When two species compete for identical resources, one will be more successful and will eventually eliminate the other



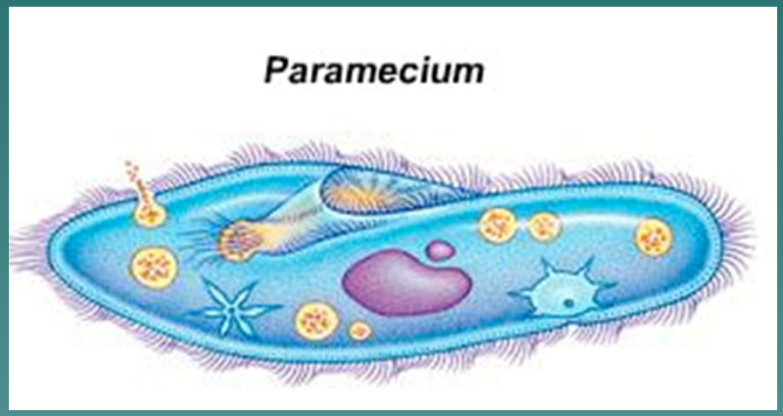
A *Paramecium caudatum* and *P. aurelia* grown in separate culture flasks established stable populations. The S-shaped graph curves indicate logistic growth and stability.



B For this experiment, the two species were grown together. *P. aurelia* (*brown* curve) drove *P. caudatum* toward extinction (*green* curve).

Two species of Paramecia competing for exactly the same resources.

Gause's Experiment

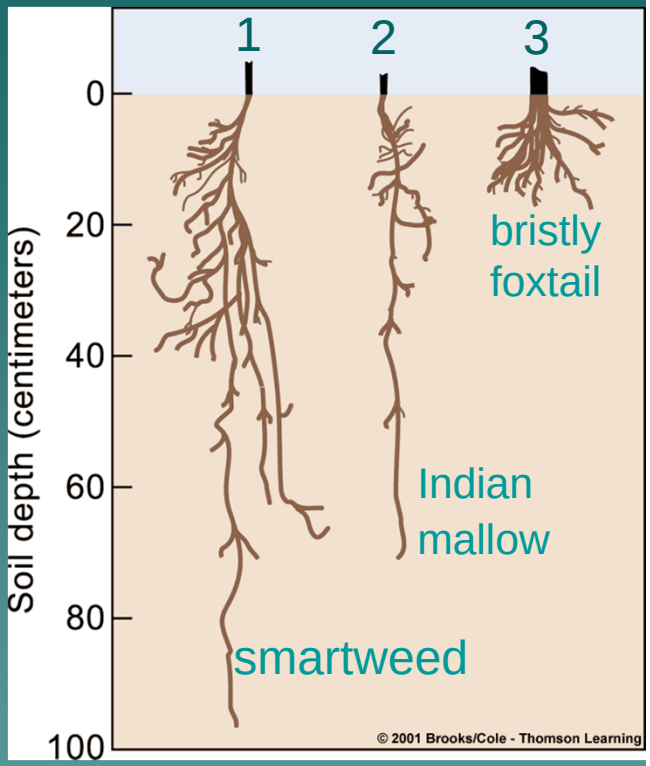


Competitive exclusion

PLAY ANIMATION

Resource Partitioning

- **Apparent competitors may have slightly different niches**
- **May use resources in a different way or time**
- **Minimizes competition and allows coexistence**



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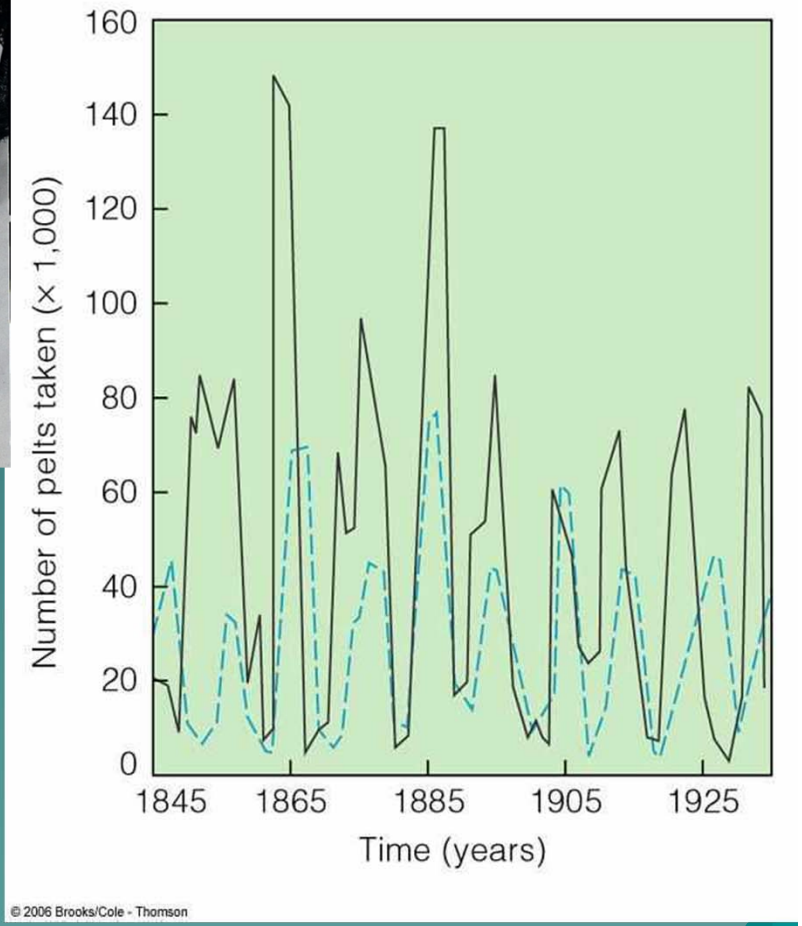
- *All three of these species require water and the same mineral ions.*
- *They coexist by each exploiting a different portion of the habitat.*

Predation and Coevolution

- **Predation**
  - **Predators & Prey**
    - **Predators are free-living (can be herbivores)**
  - **Parasites & Hosts**
    - **Parasites take up residence in/on prey**
- **Coevolution**
  - **Selective pressure = joint evolution**



Lynx - dash lines
Snowshoe Hare - solid line
3rd level interaction– involves plants (see pix above)

Coevolution Arms Race -Prey Defenses

- **Camouflage**
  - Body shape, color pattern and behavior that make an individual blend in with its surroundings
- **Warning coloration**
  - Many toxic or unpalatable species have bright colors and patterns that predators learn to avoid
- **Mimicry**
  - One species resembles another species

Plants?

What bird?

Which is the mimic?

Coevolution Arms Race -Prey Defenses

- **Moment-of-truth defense**

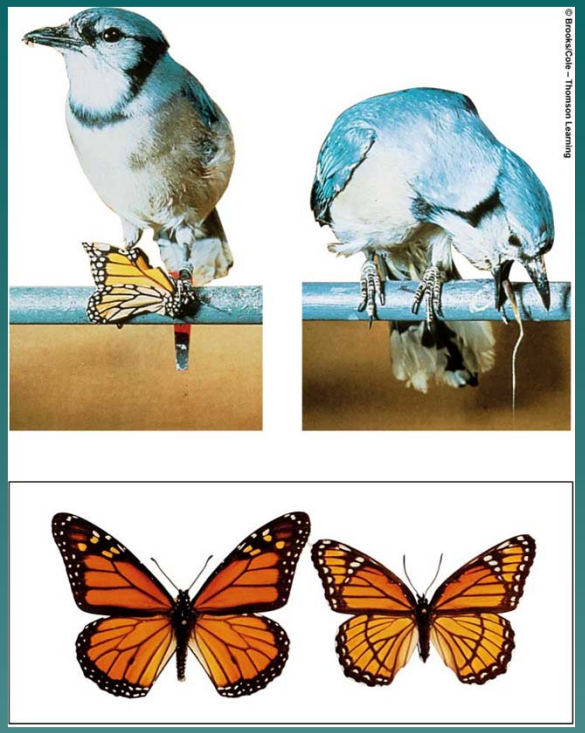
- **Adaptive responses of predators**

When cornered this beetle sprays noxious chemicals

This mouse seems to have no problem – plunges the posterior into the ground!

Mimicry

- **Batesian mimicry**
  - **harmless species look like dangerous ones**



Monarch butterfly

Viceroy butterfly

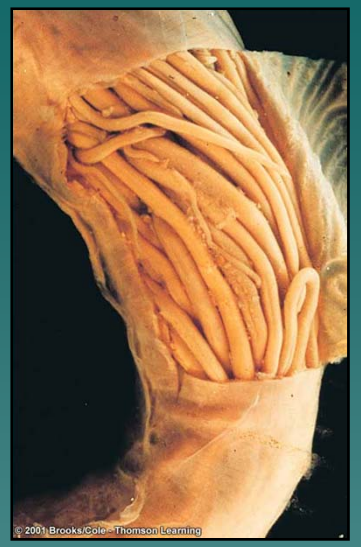
- **Mullerian mimicry**
  - **2 or more dangerous species look alike — stronger response in predators**

bee

wasp

Parasitic Interactions

- **Parasites drain nutrients from their hosts and live on or in their bodies**
- **Natural selection favors parasites that do not kill their host too quickly**
- **Micro-parasites – bacteria, viruses, protists**
- **Macro-parasites – flatworms & roundworms**
- **Social parasites ex. cuckoo, cowbird**
- **Biological control agents**



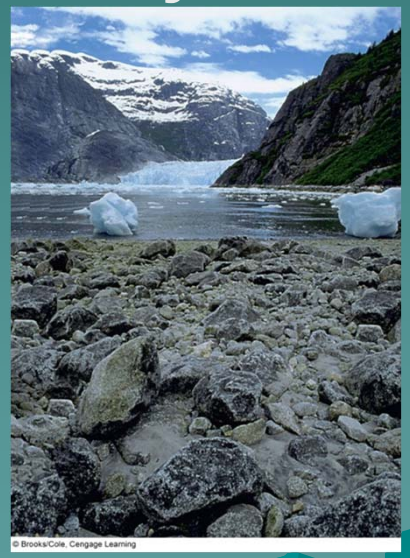
Dodder – a parasitic plant

Wasp controlling aphid population

Forces Contributing to Community Stability – Ecological Succession

- **Change in the composition of species over time**
- **Classical model describes a predictable sequence with a stable climax community**
  - **Primary succession**
    - **New environments**
  - **Secondary succession**
    - **Communities destroyed or displaced**
- **Cyclic-non-directional changes**
  - Tree falls cause local patchiness in tropical forests
  - Fires periodically destroy underbrush in sequoia forests

Glacier retreating



Ecological Succession

- **Pioneer species**
  - Species that colonize barren habitats
  - Lichens, small plants with brief life cycles
  - Improve conditions for other species who then replace them
- **Climax community**
  - Stable array of species that persists relatively unchanged over time
  - Succession does not always move predictably toward a specific climax community; other stable communities may persist

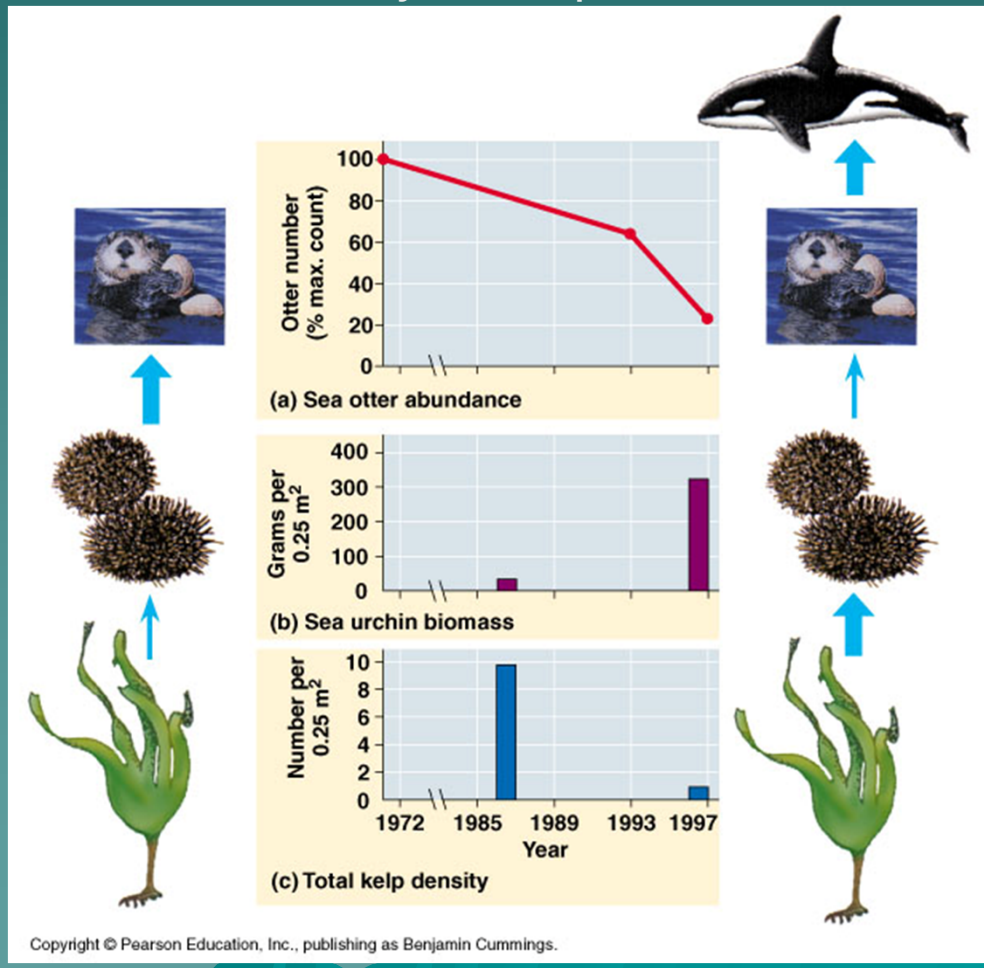
Secondary succession will follow this fire.

Community Instability

- Disturbances can cause a community to change in ways that persist even if the change is reversed
- **Keystone species** - species that can dictate community structure
- Removal can cause dramatic changes in community

PLAY ANIMATION

Sea otters as keystone predators in NW



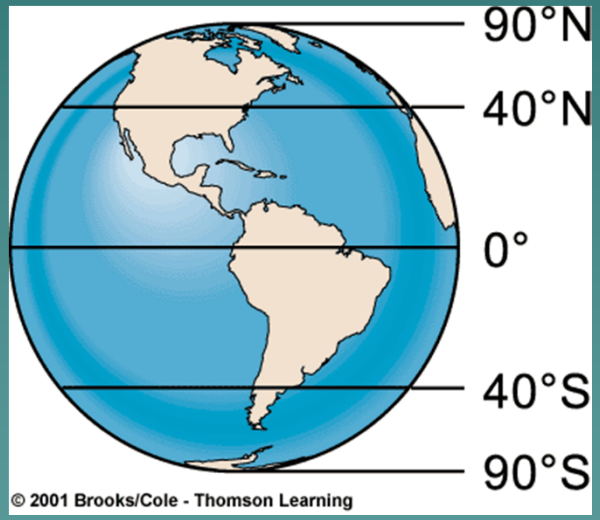
Community Instability

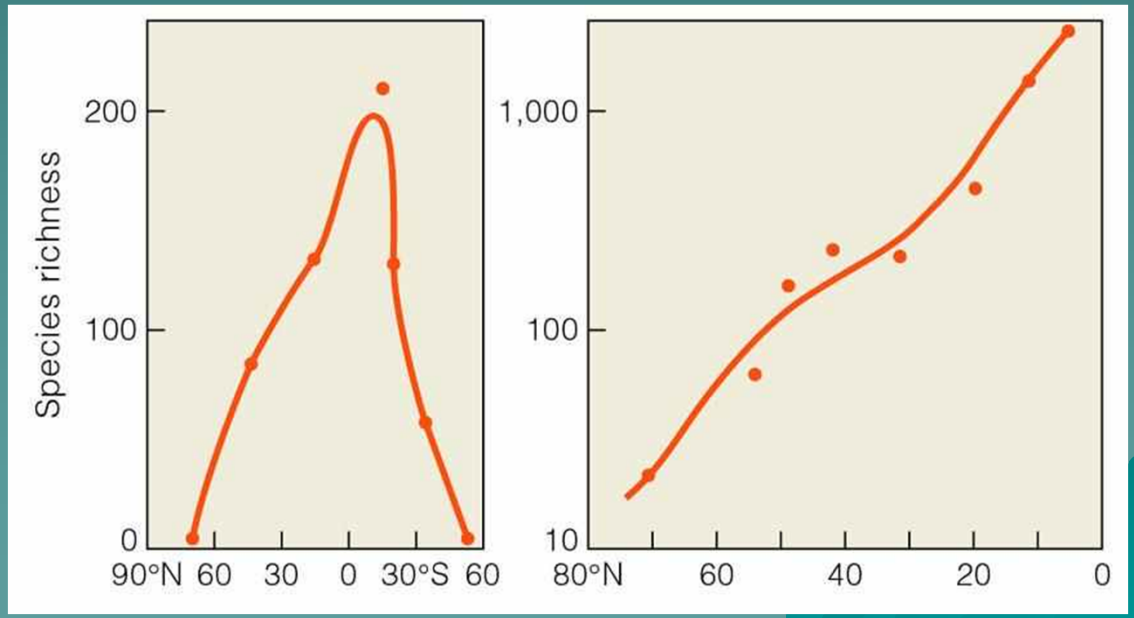
- **New species introduced – usually invasive**
  - **Non-indigenous species can decimate a community**
  - **No natural enemies or controls**
  - **Can outcompete native species**
  - **Jump dispersal – organisms transported over great distances**
    - **Some US Problems:**
      - **Gypsy moths, Argentina fire ants, house sparrow, Japanese beetle, kudzu, lionfish (video)**
    - **Most famous case: rabbits in Australia**

Kudzu vine

Diversity by Latitude

- Diversity of most groups is greatest in tropics; declines toward poles



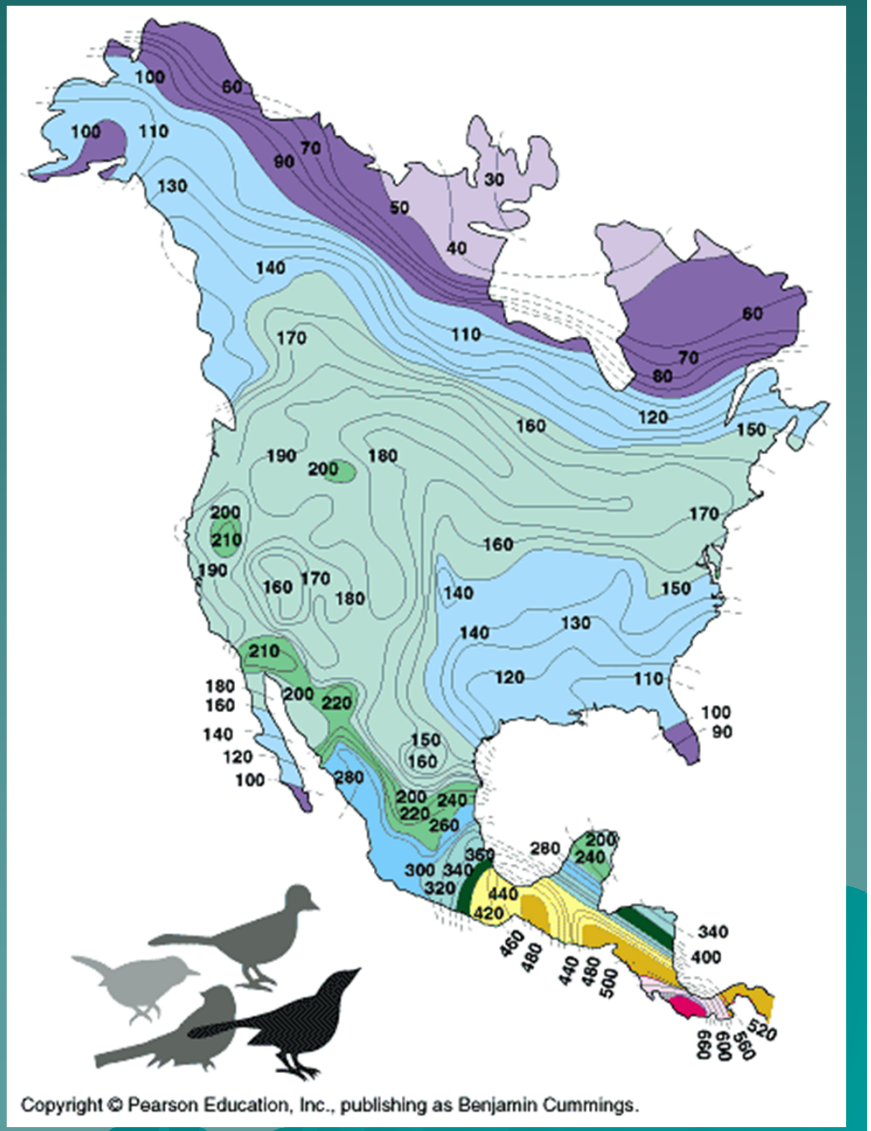


Ant diversity

Breeding birds diversity

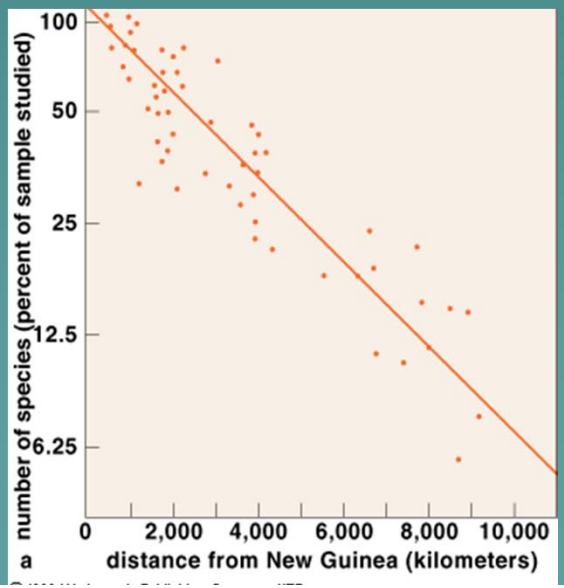
Mainland and Marine Patterns

- **Tropics**
  - **Greatest number of coexisting species**
  - **Resource availability is greatest**
- **Species diversity might be self-reinforcing**
- **Rates of speciation in the tropics have exceeded those of background extinction**

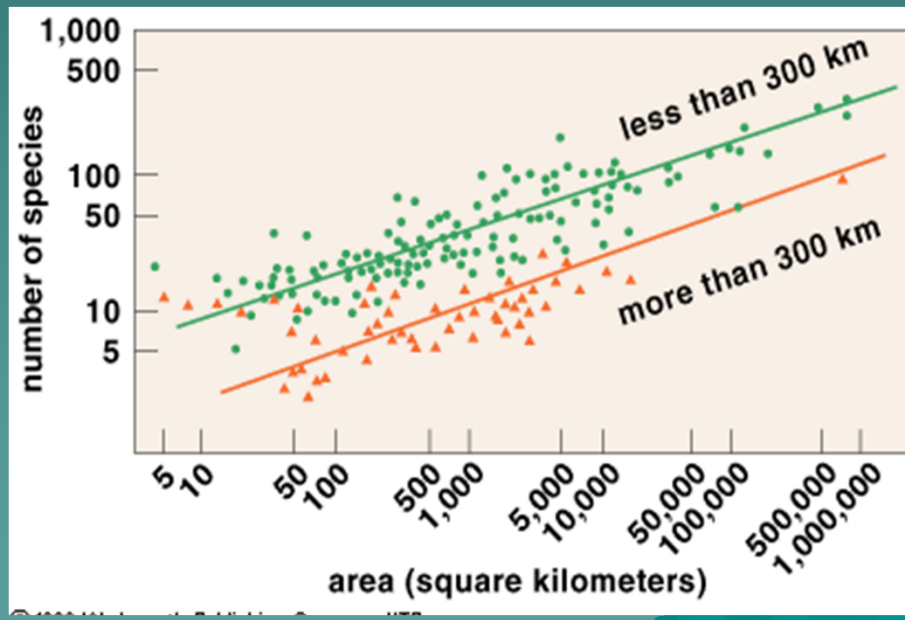


Island Patterns

- **Distance Effect**
  - The farther an island is from a mainland, the fewer species
  - Closer islands receive more immigrants
  - Species that reach islands far from mainland are adapted for long-distance dispersal and can move on



- **Area Effect**
  - Larger island supports more species than smaller islands



46.1 Key Concepts

Community Characteristics

- *A community consists of all species in a habitat*
- *Each species has a niche—the sum of its activities and relationships*
- *A habitat's history, its biological and physical characteristics, and the interactions among species in the habitat affect community structure*

46.2-46.7 Key Concepts

Types of Species Interactions

- *Commensalism, mutualism, competition, predation, and parasitism are types of interspecific interactions*
- *They influence the population size of participating species, which in turn influences the community's structure*

46.8-46.10 Key Concepts

Community Stability and Change

- *Communities have certain elements of stability, as when some species persist in a habitat*
- *Communities also change, as when new species move into the habitat and others disappear*
- *Physical characteristics of the habitat, species interactions, disturbances, and chance events affect how a community changes over time*

46.11 Key Concepts

Global Patterns in Community Structure

- *Biogeographers identify regional patterns in species distribution*
- *They have shown that tropical regions hold the greatest number of species, and also that characteristics of islands can be used to predict how many species an island will hold*