Chapt. 50 – An Introduction to Ecology and the Biosphere

Ecology

The branch of biology that concerns interactions between **organisms** and their **environments**

Ecology is not the same as **environmentalism**…

Environmentalism

Having concern for, or acting in favor of, the environment

Levels of Biological Organization

- Biomolecule
- Organelle
- Cell
- Tissue
- Organ
- Organ System
- Organism
- Population
- Community
- Ecosystem
- Biosphere

(Organism through Biosphere:) Within the purview of ecology

Two principal **pattern-based questions** are:

- Where do organisms live?
- How common or rare are they?

Ecologists then try to figure out **why**, by asking **mechanistic questions**, *e.g.*:

- What factors determine the **distribution** of a species?
- What factors determine the **abundance** of a species?

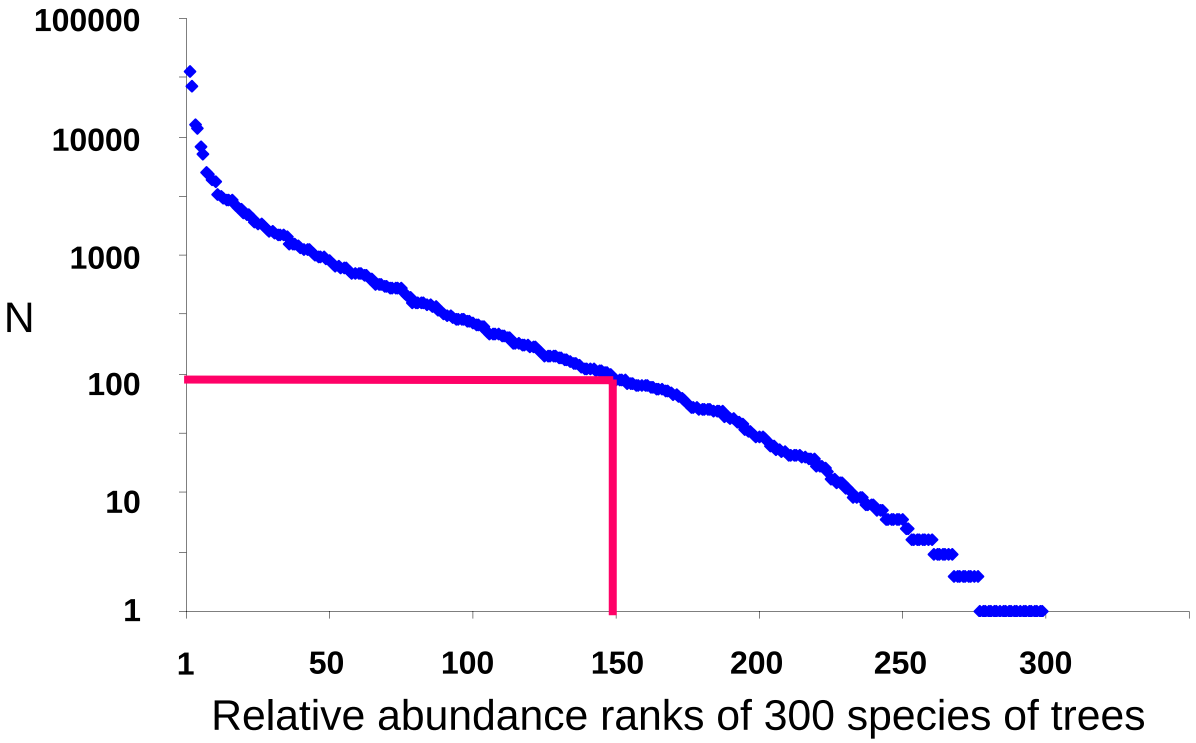
Examples of **ecological patterns**:

Global **distribution** and **abundance**, *e.g.*, red kangaroos **[Fig. 50.2]**

Distribution patterns may be characterized at a variety of **spatial scales**, *e.g.*, *Tetraphis* moss

Range sizes – few species are widespread (and **common**); most species have small ranges (and are **rare**)

Dominance-diversity curve for a 50-ha forest plot in Panama



The environment of an organism includes both **abiotic** and **biotic components**

- **Abiotic components** = nonliving chemical and physical properties of an individual's environment (*e.g.*, temperature, light, water, nutrient availability, *etc.*)
- **Biotic components** = all of the organisms that are part of an individual's environment (*e.g.*, predators, prey, competitors, mutualists)
- Both **abiotic** and **biotic factors** may influence the **distribution** and **abundance** of a given species

Consider this example: abundance of seaweed near Sydney, Australia **[Fig. 50.8]**

- **Abiotic factors** dictate that the abundance on dry land is 0% (not shown in the figure)
- Herbivore-removal experiments supported the hypothesis that in the intertidal zone sea urchins are the main **biotic factors** that limit the seaweed's abundance

Historical factors may also contribute to the current **distribution** and **abundance** of a given species **[See an example in Fig. 50.7; African honey bees are another example]**

- For example, there do not appear to be **abiotic** or **biotic factors** that would keep African honey bees out of Brazil, yet there were no African honey bees in Brazil before 1950
- In 1950 why were there no African honey bees in Brazil?
  1. None had ever naturally dispersed to the Americas from Africa
  2. None had ever been introduced to the Americas by humans

Flowchart of factors limiting **geographic distribution** **[Fig. 50.6]**

Biogeography

Biogeographic realms or **provinces** delineate continental-scale regions that are relatively isolated from one another **[Fig. 50.5]**

Isolation has important consequences for evolution, so **biogeographic realms** encompass areas with broadly similar evolutionary histories

Macroevolution & Phylogeny

- **Continental drift** is responsible for many **biogeographic distribution patterns** **[Fig. 26.20]**
    - *E.g.*, Proteaceae – a plant family that originated in Gondwana
    - *E.g.*, Marsupials originated on the supercontinent that became Australia, Antarctica, and South America

Global Climate Patterns

Regions of the globe can also be characterized by their abiotic conditions (*e.g.*, **climate**)

Climate broadly determines the **traits** of organisms found in a given location

This **climograph** identifies major kinds of **ecosystems** (known as **biomes**) in North America **[Fig. 50.18]**

See the *Atlas of the Biosphere* website for excellent graphics related to global climate patterns: http://www.sage.wisc.edu/atlas/

- The tropics are warm; the poles are cold
- The tropics are generally the wettest, latitudes around 30° are generally the driest, latitudes around 60° are wet, and polar latitudes are dry

Three main physical attributes of the Earth determine global climate patterns **[See Fig. 50.10]**

1. **Shape** of the Earth. Causes unequal heating (energy per area) with latitude
   Differential heating and cooling causes rising and sinking air masses: **Hadley cells**

2. **Revolution** of the Earth on a **tilted axis**, which causes Hadley cells to change latitude with the seasons

3. **Rotation** of the Earth about its axis, which results in characteristic air and water currents
   Currents are deflected to the right in the Northern Hemisphere
   Currents are deflected to the left in the Southern Hemisphere

Local Abiotic Conditions **[Fig. 50.12]**

Local factors, such as topography, proximity to water bodies, and *etc*., superimpose their effects on the **climate** of a terrestrial region to produce local abiotic conditions (*e.g.*, **weather**)

Aquatic Biomes [Fig. 50.15]

Occupy the largest proportion of Earth's surface
Freshwater (< 1% salt) and **marine** (~ 3% salt)

Freshwater: Lakes (standing water) **[Fig. 50.16a]**

- **Lake zonation**
  - **Photic zone** – sufficient light penetrates for photosynthesis
  - **Aphotic zone –** insufficient light penetrates for photosynthesis
  - **Benthic zone –** the substrate
  - **Littoral zone –** shallow, well-lit waters close to shore
  - **Limnetic zone –** well-lit surface waters farther from shore

Freshwater: Rivers (flowing water)

Wetlands (marshes, swamps, bogs, *etc*.)
- Areas covered for at least part of the year by water, and that support aquatic plants

Estuaries (*e.g.*, Sabine, Atchafalaya, Mississippi, Pearl)
- The area where a freshwater river merges with the ocean; often bordered by wetlands (mudflats and salt marshes)

Marine biomes account for 75% of Earth's surface **[Fig. 50.16b]**

- **Marine zonation (some zones also found in lakes; cf. Fig. 50.16a)**
  - **Intertidal zone –** where land meets sea; from highest high-tide mark to lowest low-tide mark
  - **Neritic zone –** shallow regions over the continental shelves
  - **Oceanic zone –** regions beyond the continental shelves
  - **Pelagic zone** – open water of any depth
  - **Abyssal zone –** the deepest benthos

Marine Biome: Intertidal zones
- Alternately submerged and exposed by twice-daily cycle of tides
- The **vertical zonation** of organisms is common

Marine Biome: Coral reefs
- Warm, tropical waters near continents or islands (neritic zone) often support coral reefs (built by the cnidarians that give this biome its name)

Marine Biome: Oceanic Pelagic
- Open ocean waters usually have lower nutrient concentrations than neritic waters, that phytoplankton – at the base of the food chain – nevertheless exploit

Marine Biome: Benthic Abyssal

Abyssal organisms are generally few and far between, except where nutrient concentrations are high, *e.g.*, whale carcasses (ephemeral) and hydrothermal vents (more permanent)

Terrestrial Biomes [Fig. 50.19]

Warm, wet conditions correspond to high productivity, whereas cold or dry conditions result in low productivity

Tropical forest

Tropical forests accounts for ~7% of the Earth's terrestrial surface area

Even so, >90% of Earth's species may inhabit tropical forests

Savanna

Both tropical... and temperate

Rainfall is insufficient to support closed-canopy forest, and fire is often a characteristic agent of natural disturbance

Desert

Arid conditions generally prevent high productivity

Chaparral

Midlatitudinal coastal areas with mild, rainy winters and long, hot, dry summers

Vegetation is dominated by shrubs and small trees

Temperate grassland

The key to the persistence of grasslands is seasonal drought, occasional fires, and grazing by large ungulates

Temperate broadleaf (deciduous) forest

Temperate broadleaf forests are found at midlatitudes where there is sufficient rainfall to support dense stands of trees

Temperate broadleaf trees lose their leaves in winter

Most temperate broadleaf forests in North America are secondary (regrowth) forests that returned after logging in the 19th and 20th centuries

Coniferous forest

Large expanses of evergreen, coniferous forests are found at high latitudes where winters are cold and long

Tundra (both **arctic** & **alpine**)

Permafrost (permanently frozen subsoil), cold temperatures, and high winds exclude most tall plants