Biogeography

Learning Objectives

- How climate, bedrock, and soils affect the geography of life.
- What biotic province and biomes are and how they differ.
- What are the geographic patterns of the Earth's 17 major biomes.
- How people affect biogeography of life.

BIOGEOGRAPHY

Geography of Life: Occurrence of different species at different parts of the world

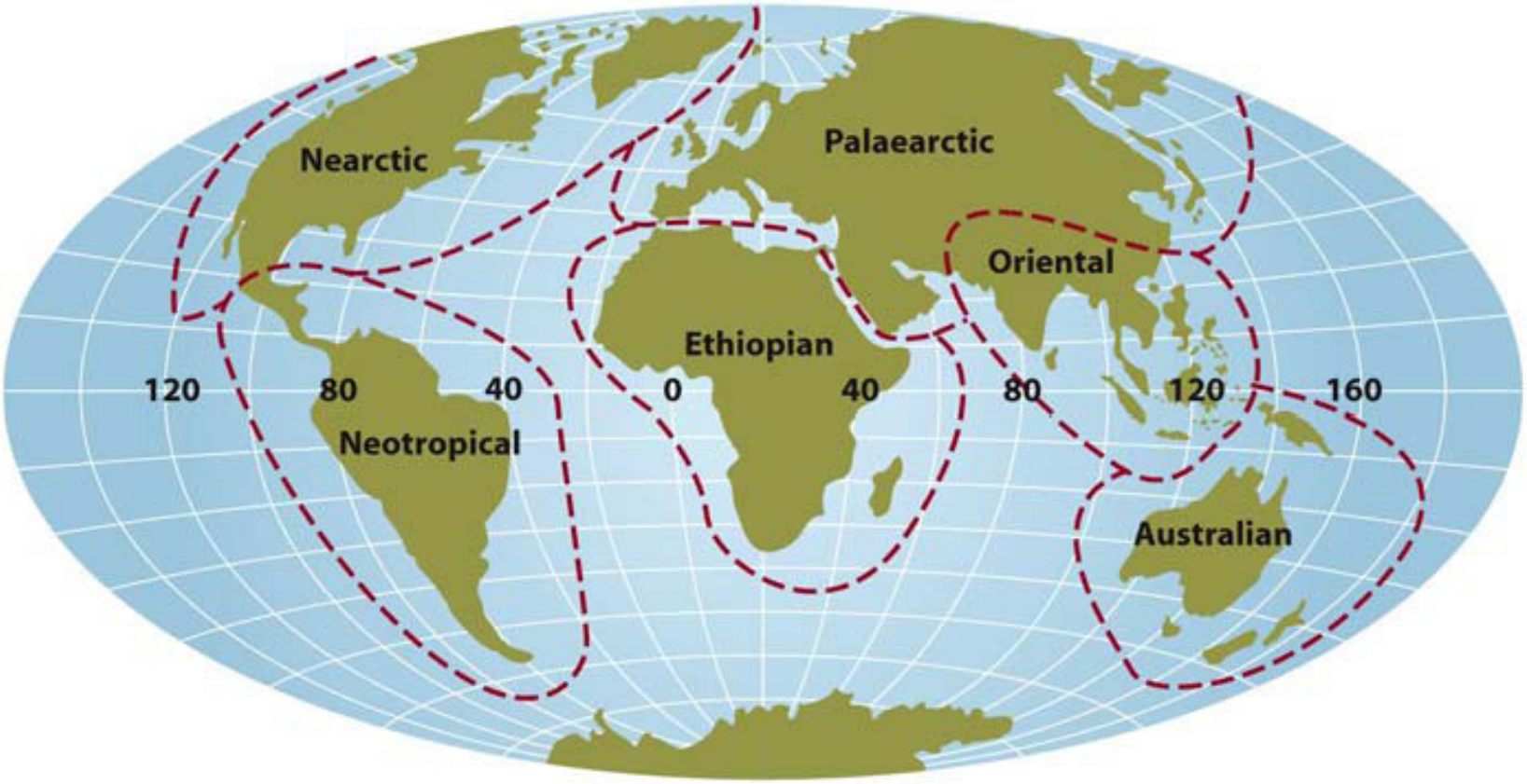
Biomes – Ecosystems or Life Zones, consisting of similar climatic, topographic, soil conditions (abiotic components) and similar biological communities (biotic components).

- Defined first by climate zone, then by major plant type.
- Temperature and precipitation are most important determinants in biome distribution.
- Most terrestrial biomes are identified by the dominant plants of their communities.

Wallace's Realms: Biotic Provinces

- In 1876 great British biologist Alfred Russell Wallace divided the world into six biogeographic regions on the basis of fundamental features of the animals found in those areas. Wallace referred to these regions as realms and named them:
    1. Neartic (North America),
    2. Neotropical (Central and South America),
    3. Palaearctic (Europe, Northern Asia, and Northern Africa),
    4. Ethiopian (Central and Southern Africa),
    5. Oriental (The Indian Subcontinent and Malaysia), and
    6. Australian.

WALLACE'S REALMS



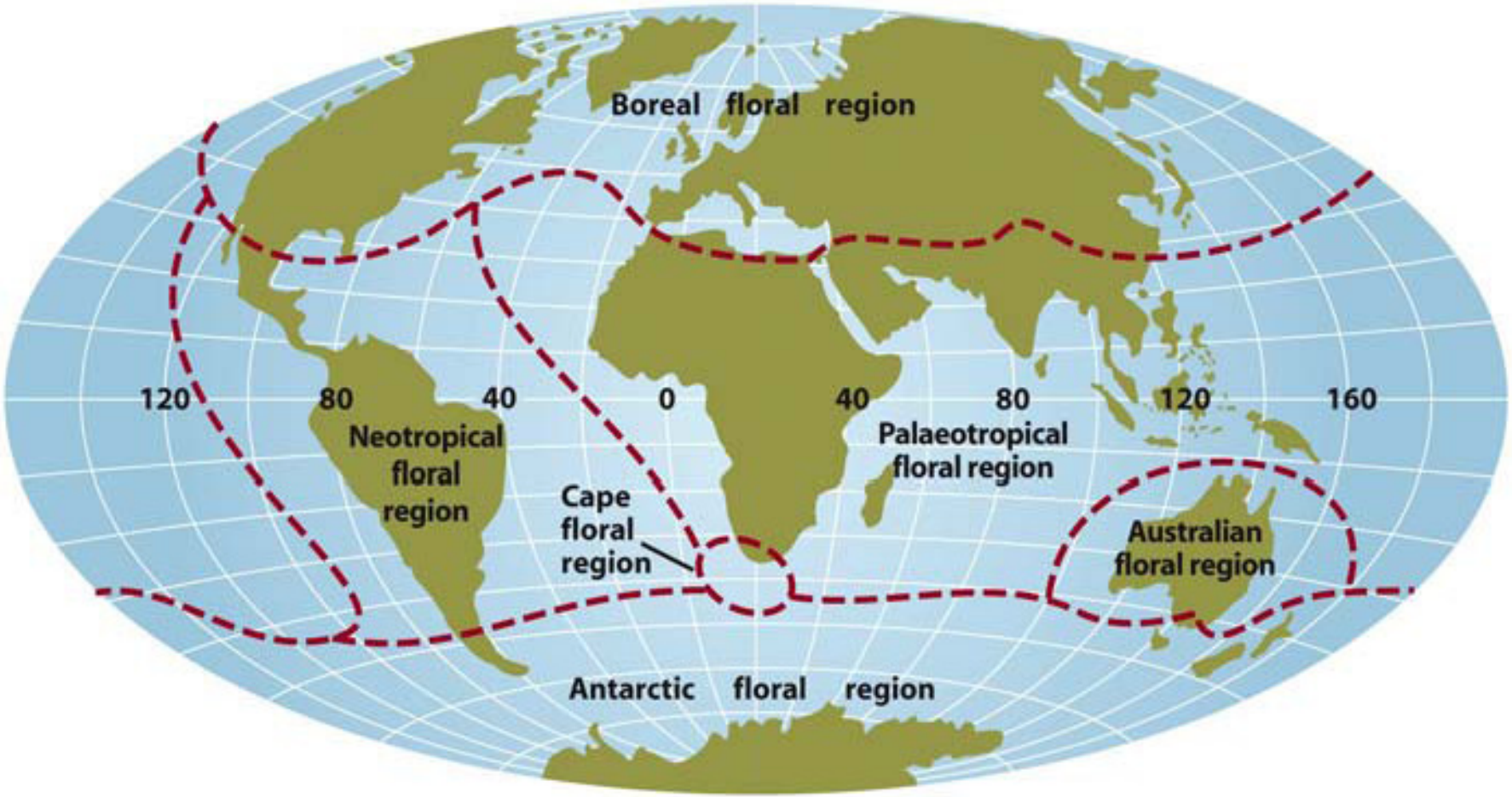
The main biogeographic realms for animals are based on genetic factors.
E.g. within each realm, the vertebrates filling each realm are more similar to each other than other vertebrates filling similar niches in other realms.

Taxa

- Based on evolutionary relationship or similarity of characters all living organisms are classified into groups named **Taxa.**
- In each geographic realm certain families or orders of animals are dominant.
- Animals filling the same ecological niches in each realm are of different genetic stock from those in the other realms.

Biotic Province

- This basic concept of the regions known as Wallace realm's (suggested in 1876) are now referred to as **biotic provinces**.
  - A biotic province is based on who is related to who (characteristic set of taxa).
  - Species within a biotic province are more closely related to each other than to species within other provinces.
  - In two different biotic provinces, the same ecological niche will be filled with species that perform the same function and may look similar but may have different genetic ancestries.



The major vegetation realms are also based on genetic factors

Biomes

- A **biome** is a kind of ecosystem based on **climatic similarity**, such as a desert, tropical rain forest, or grassland.
- **The rule of climatic similarity**
  - Similar environments lead to the evolution of similar organisms in terms of form and function and to similar ecosystems.

Climate and Biomes

- There is a strong relationship between climate and biome. So if we know the climate of an area, then we can easily predict-
  - What biome will be found there
  - What its approximate biomass,
  - What the production will be, and
  - What the dominant kinds of organisms will be.

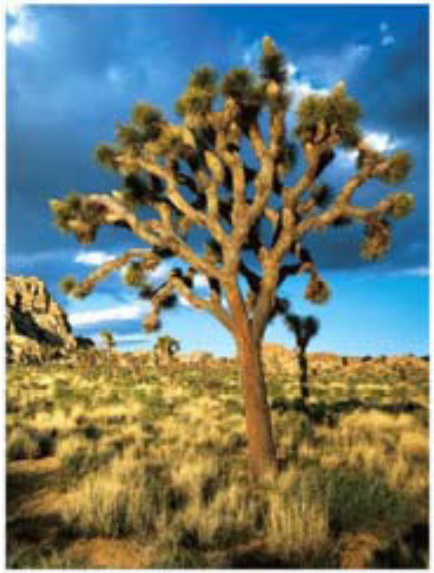
Evolution

- Two types:
  - Convergent
  - Divergent

Evolution

- **Convergent Evolution**
  - The process by which species evolve in different places and times with different genetic heritages but with similar external forms and structures as a result of adaptation to similar environments

Biomes: Convergent Evolution-



Joshua tree

Saguaro cactus

Euphorbia of East Africa

Given sufficient time and similar climates in different areas, species similar in shape and form will tend to occur.

Evolution

- **Divergent Evolution**
  - Organisms with the same ancestral genetic heritage migrate to different habitats and evolve into species with different external forms and structures, but continue to have the same niche

Biomes: Divergent Evolution

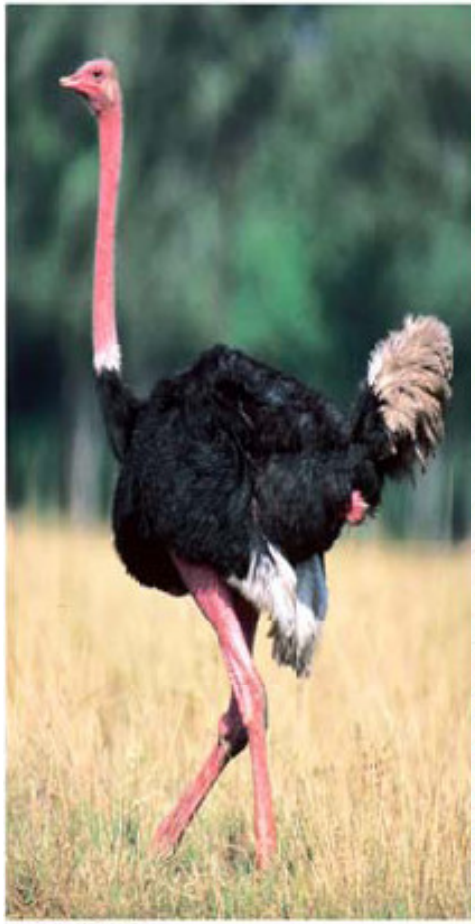


Figure 8-7a Botkin - Env. Sci. 6/e

Figure 8-7b Botkin - Env. Sci. 6/e

Figure 8-7c (Botkin - Env. Sci. 6/e

Ostrich in Africa **Rhea in South America** **Emu in Australia**

Earth's Biomes

- **The Earth has 17 biomes , each with its own characteristic dominant shapes and forms of life.**

1. Tundras

- treeless plains that occur in the harsh climates of low rainfall and low average temperature
- two types: artic tundra and alpine tundra
- parts have permafrost: permanently frozen ground

2. Taiga or Boreal Forests

- includes the forests of the cold climates of high latitudes and high altitudes
- dominant life forms including moose and other large mammals, small flowering plants and trees

3. Temperate Dedicious Forests

- occur in warmer climates than the boreal forest

Earth's Biomes (Cont.)

4. Temperate Rainforest

- moderate temperatures, over 250 cm/year of rain

5. Temperate Woodlands

- Slightly drier climate than the deciduous forests
- fire is common and species adapt to it

6. Temperate Shrublands

- also called chaparral: miniature woodlands

7. Temperate Grasslands

- include many North American prairies

Earth's Biomes (Cont.)

8. Tropical Rain Forests

- high average temperature and rainfall

9. Tropical Seasonal Forest and Savannas

- high average temperature, low latitudes, abundant but seasonal rainfall

10. Deserts

- The driest region that vegetation can survive.

11. Wetlands

- Include freshwater swamps, marshes and bogs – all have standing water

12. Freshwaters

- Have phytoplankton and estuaries

Earth's Biomes (Cont.)

13. Intertidal Areas

- Areas exposed to alternately to air during low tide and high tide

14. Open Ocean

- Also called the pelagic region

15. Bethos

- Bottom portion of the ocean

16. Upwellings

- Upward flows of ocean water

17. Hydrothermal Vents

- Occur in the deep ocean were plate tectonic processes create vents

Latitude Diversity Gradients

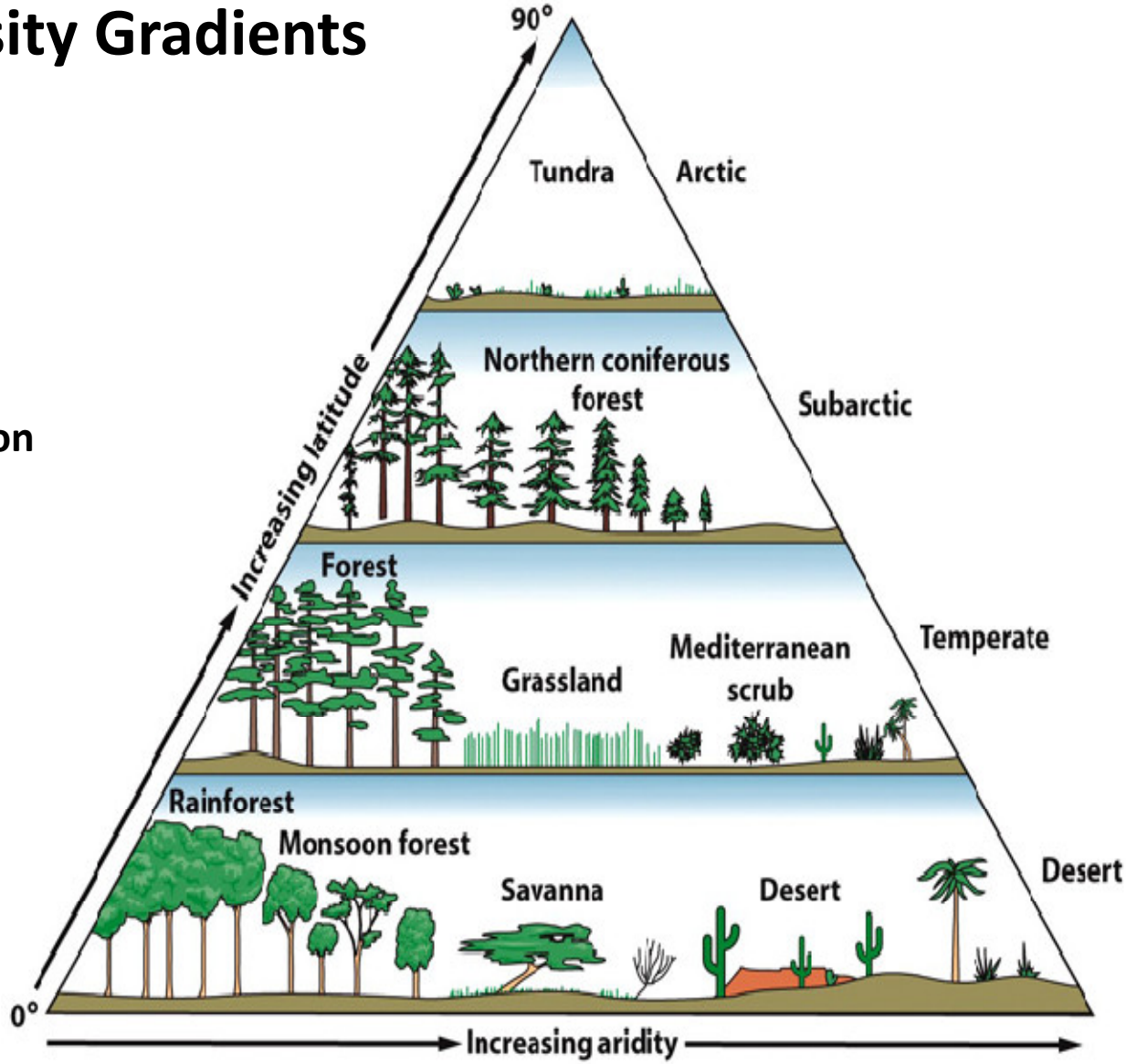
Gradients due to interrelation of:

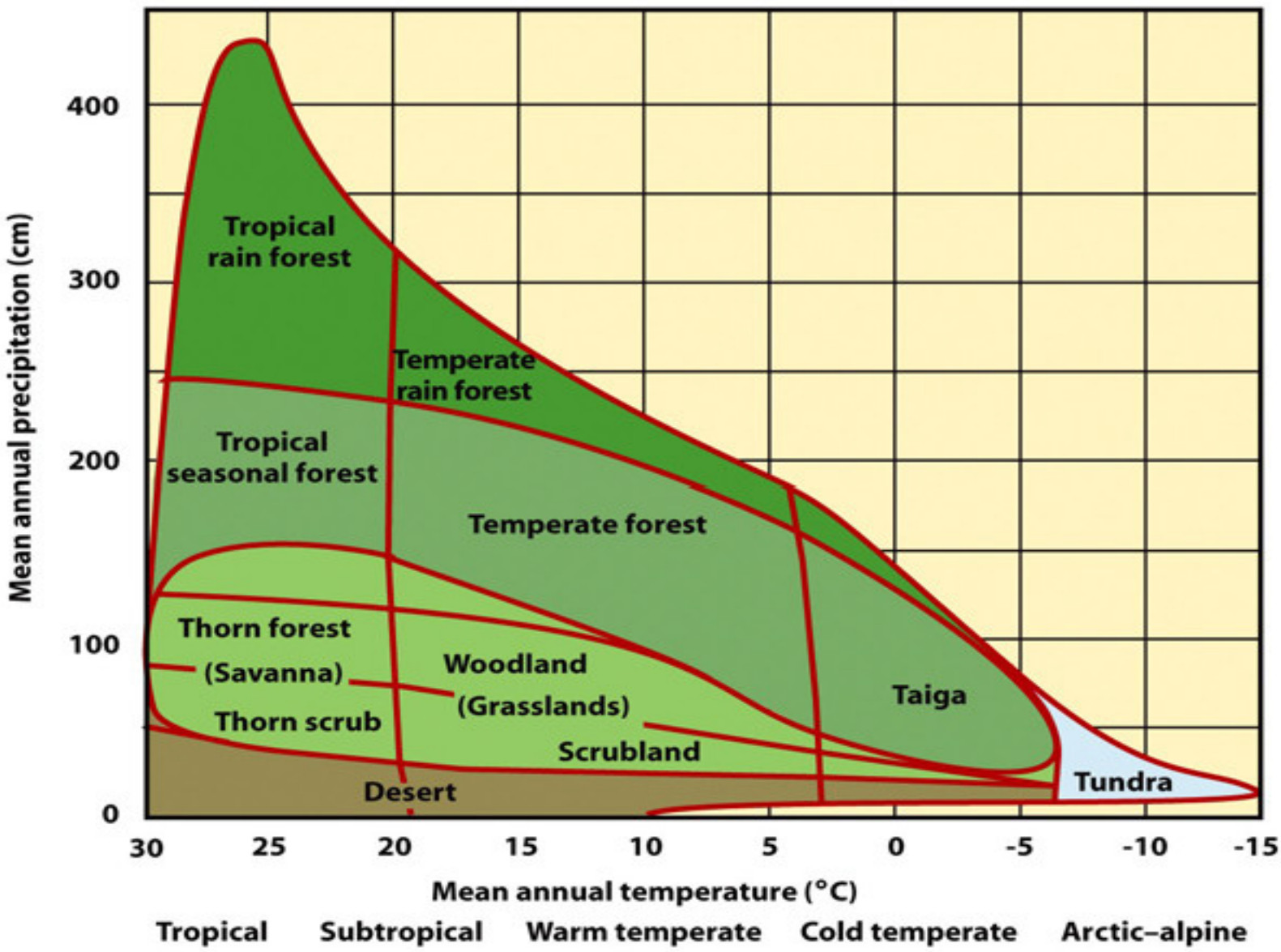
1)Environmental stability

2)Community age

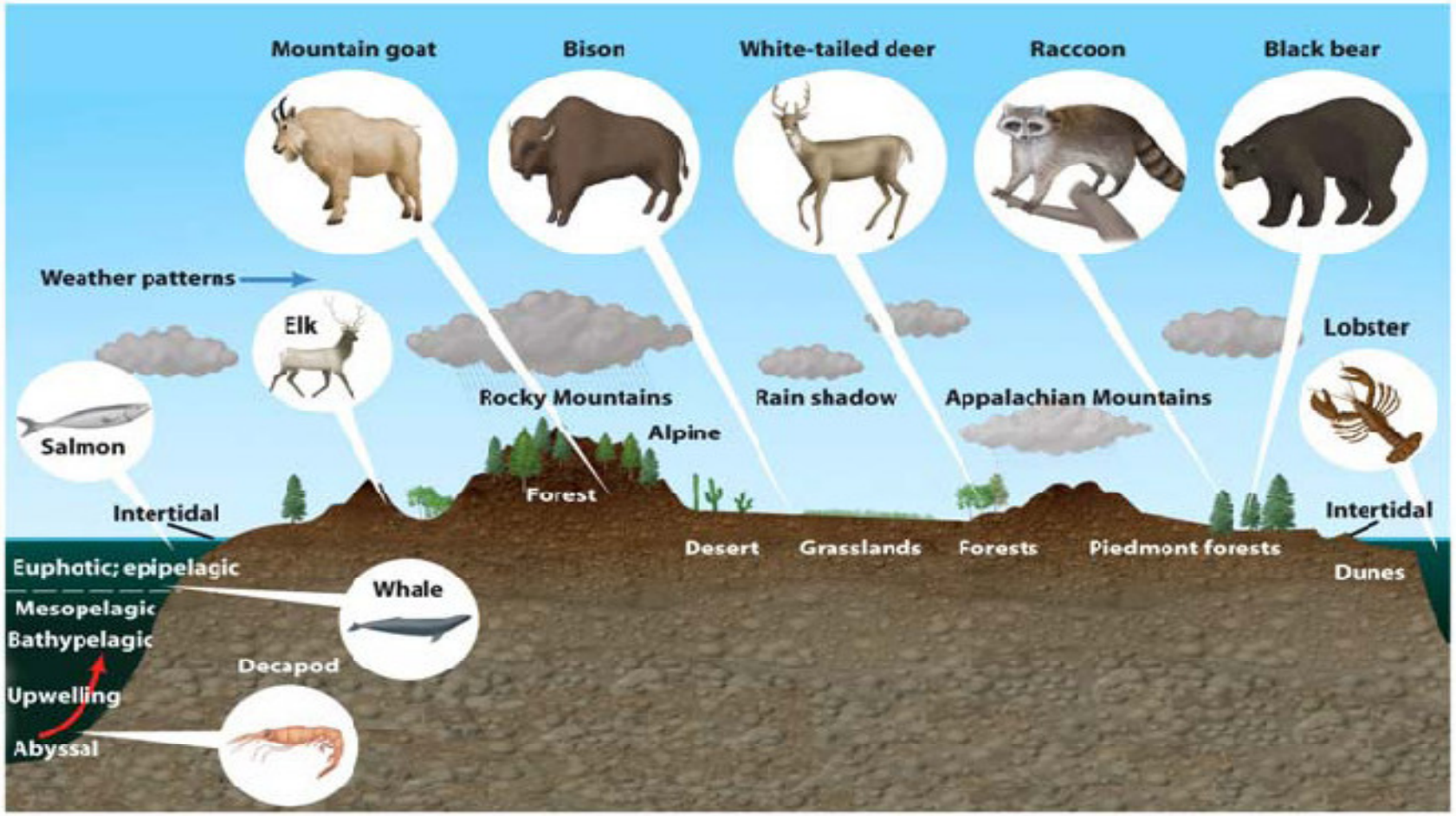
3)Length of growing season

4)Supply of nutrients

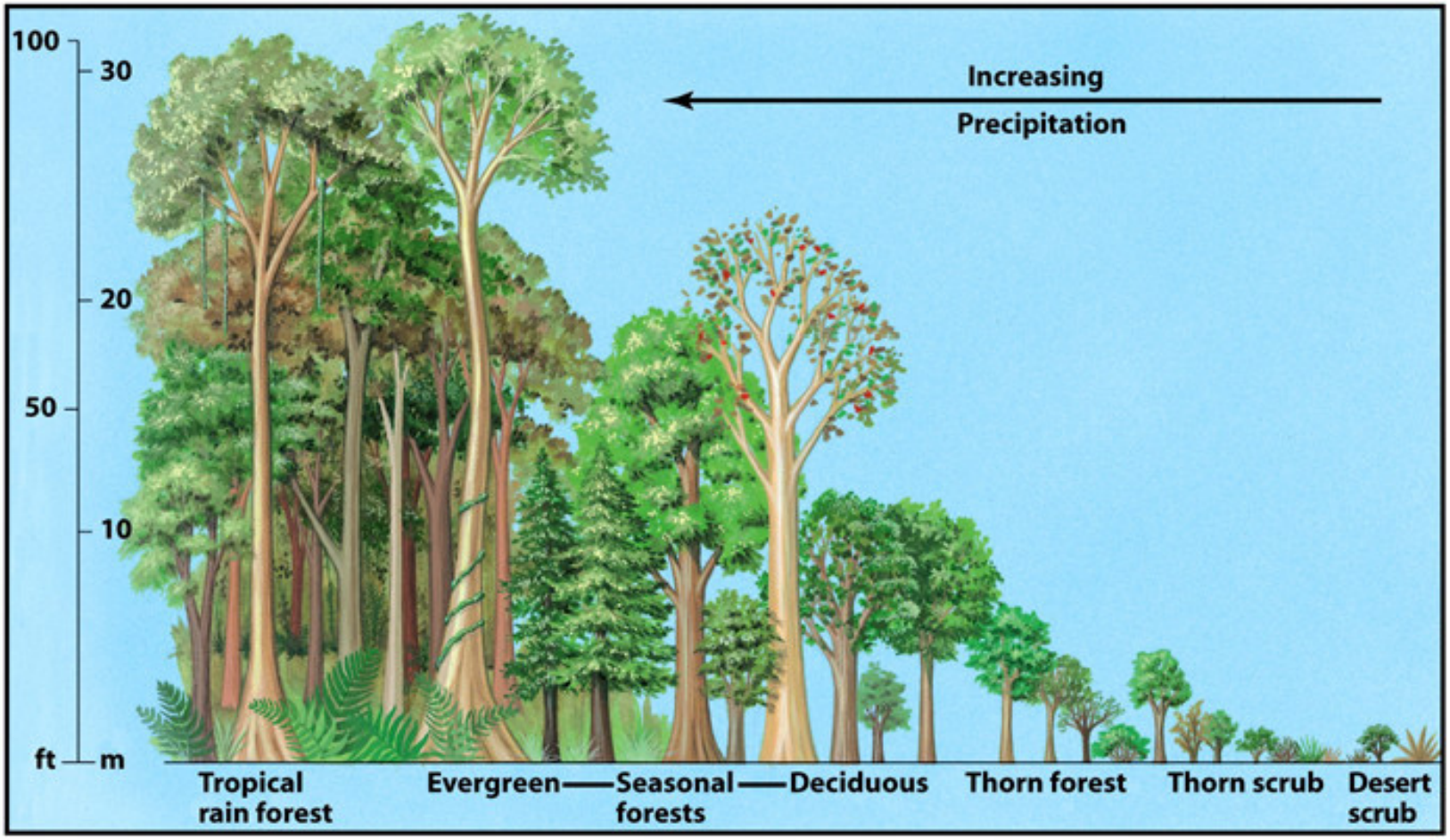



Mean annual precipitation (cm)
400
300
200
100
0
Tropical rain forest
Temperate rain forest
Tropical seasonal forest
Temperate forest
Thorn forest
(Savanna)
Thorn scrub
Woodland
(Grasslands)
Scrubland
Taiga
Tundra
Desert
30
25
20
15
10
5
0
-5
-10
-15
Mean annual temperature (°C)
Tropical
Subtropical
Warm temperate
Cold temperate
Arctic–alpine

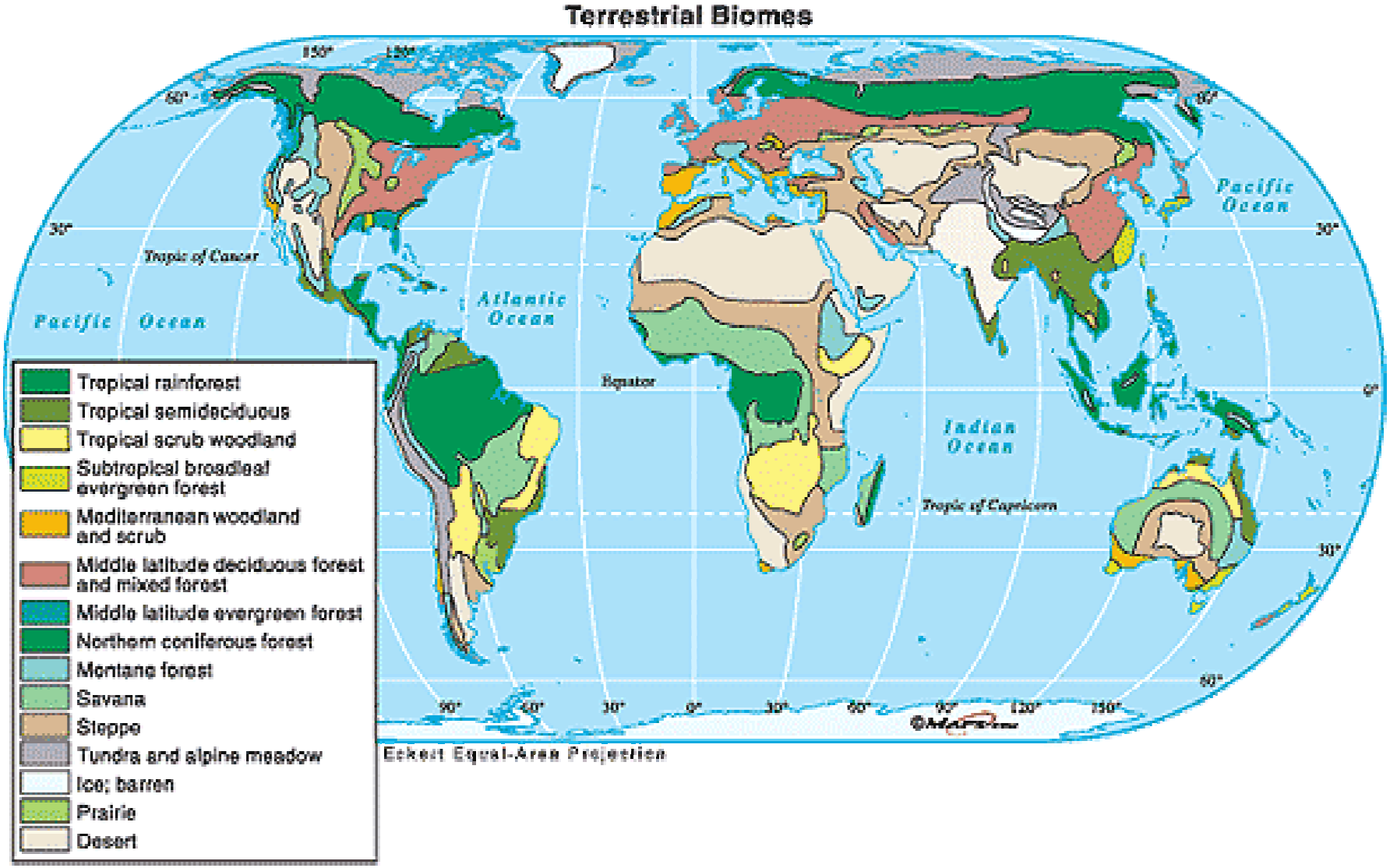
Geographic Patterns of Life within Continent



Biogeographical Cross Section of North America



World Biomes based on Vegetation Type



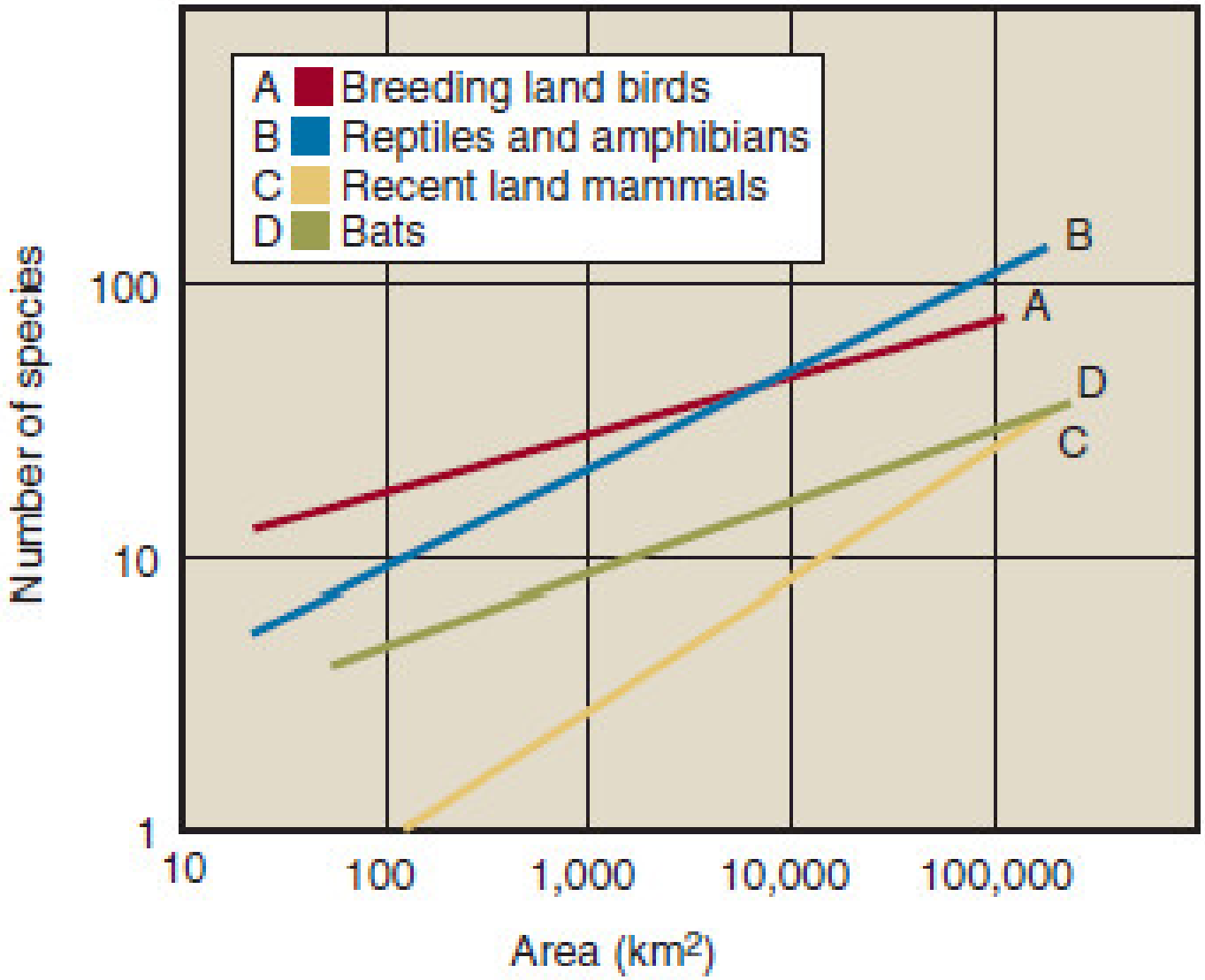
Island Biogeography

- Islands have fewer species than continents.

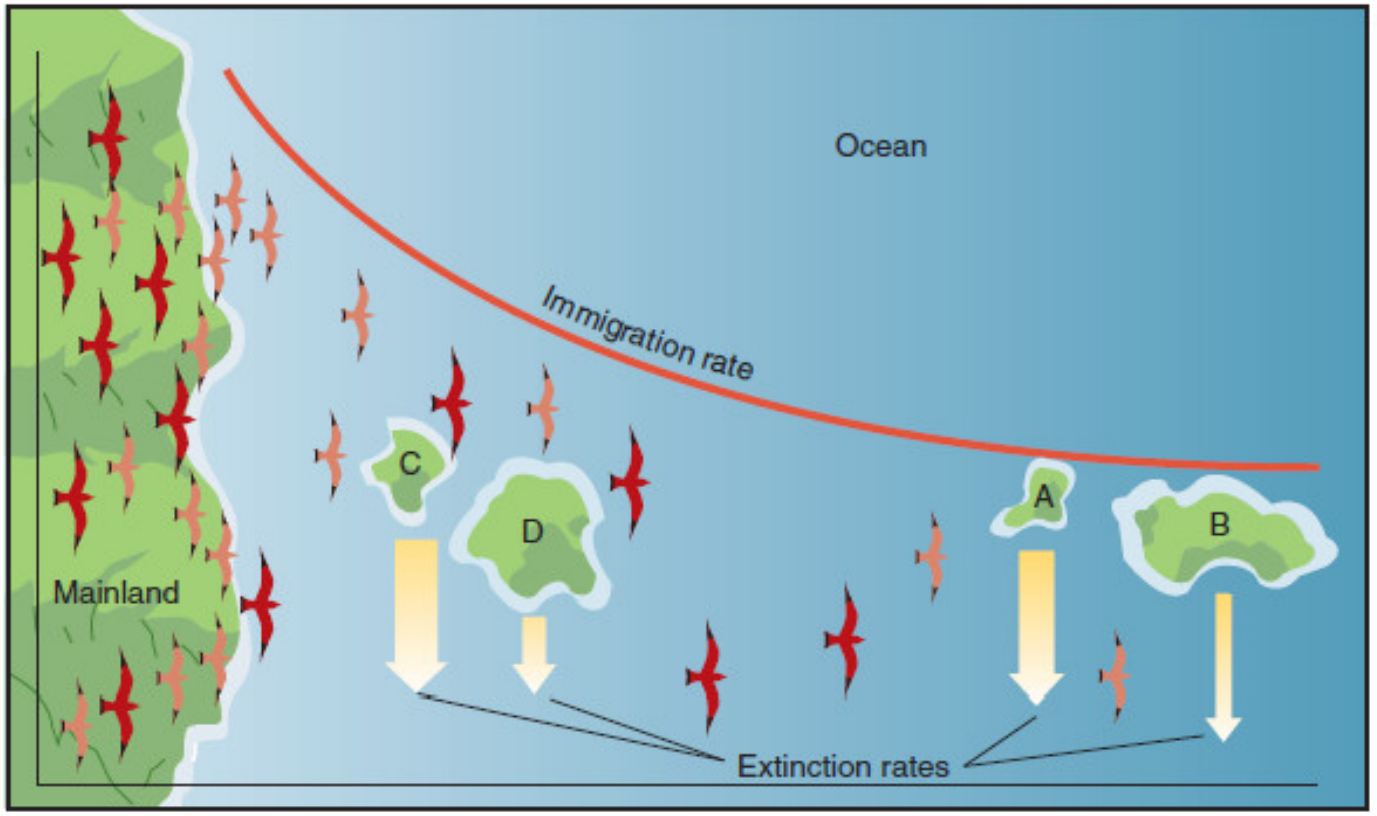
- Sources of new species on an island are migration from the mainland and evolution of new species in place.

- The smaller the island, the fewer the species, as can be seen in the number of reptiles and amphibians in various West Indian islands.

- The farther the island is from a mainland (continent), the fewer the species.



Islands have fewer species than do main lands. The larger the island, the greater the number of species. This general rule is shown by the graph of the number of species of birds, reptiles and amphibians, recent land mammals, and bats for islands in the Caribbean. (Modified from B. Wilcox, ed., [Gland, Switzerland: IUCN, 1988].)



Idealized relation of an island's size, distance from the mainland, and number of species. The nearer an island is to the mainland, the more likely it is to be found by an individual, and thus the higher the rate of immigration. The larger the island, the larger the population it can support and the greater the chance of persistence of a species—small islands have a higher rate of extinction. The average number of species therefore depends on the rate of immigration and the rate of extinction. Thus, a small island near the mainland may have the same number of species as a large island far from the mainland. The thickness of the arrow represents the magnitude of the rate. (*Source:* Modified from R.H. MacArthur and E.O. Wilson, *The Theory of Island Biogeography* [Princeton, NJ: Princeton University Press,1967].)

Biogeography and People

Benefits of Biological Invasions

- People in Europe used to import exotic species to decorate gardens, homes, and parks and formed the basis of much of the commercial forestry in the region. Example of commercial forestry is the famous gardens of the Alhambra in Granada

Problems of Biological Invasions

- Invasive pets can introduce disease-causing microbes in a new area or country.
- Invasive pets or animals can have serious impact on ecosystem and biodiversity.