CHAPTER 18:

THE GEOGRAPHY OF EVOLUTION

DEFINITIONS:

1. **Biogeography:** The geographic distributions of organisms (Historical biogeography+ ecological biogeography)
2. **Wallace line:** a faunal boundary that is transitional between Asia and Australia.
3. **Biogeographic realms:** major regions that have characteristic animal and plant taxa.
4. **Disjunction distributions:** their distributions have gaps
5. **Vicariance:** the separation of populations of a widespread species by barriers arising from changes in geology, climate, or habitat.
6. **Phylogeography:** the description and analysis of the processes that govern the geographic distribution of lineages of genes, especially within specie and among closely related species.
7. **Fundamental ecological niche:** the set of all those environmental conditions in which a species can have a positive population growth.
8. **Competitive exclusion principle:** species that are too similar in their use of food or other limiting resources cannot coexist indefinitely.
9. **Fundamental ecological niche:** the set of all those environmental conditions in which a species can have positive population growth.

BIOGEOGRAPHIC EVIDENCE FOR EVOLUTION

TABLE 17.1 The geological time scale

The Cenozoic era embraces seven epochs, Paleocene through Holocene. The older literature refers to the first five epochs (66–2.58 Mya) as the Tertiary period, and to the Pleistocene and Holocene (or Recent) (2.58 Mya–present) as the Quaternary period. Geologists now recognize, instead, the Paleogene (Paleocene through Oligocene, 66–23 Mya), Neogene (Miocene through Pliocene, 23–2.58 Mya), and Quaternary periods.

Era	Period (abbreviation)	Epoch	Millions of years from start to present	Major events
CENOZOIC	Quaternary (Q)	Holocene	0.012	Continents in modern positions; repeated glaciations and changes of sea level; shifts of geographic distributions; extinctions of large mammals and birds; evolution of *Homo sapiens*, spread out of Africa; rise of agriculture and civilizations
		Pleistocene	2.58	
	Neogene (Ng)	Pliocene	5.33	Continents nearing modern positions; increasingly cool, dry climate; grasslands spread; modern families of mammals and birds; first apes
		Miocene	23.03	
	Paleogene (Pg)	Oligocene	33.9	Radiation of mammals, birds, snakes, angiosperms, pollinating insects, bony fishes
		Eocene	56.0	
		Paleocene	66.0	
MESOZOIC	Cretaceous (K)		145	Most continents separated; continued radiation of dinosaurs; increasing diversity of angiosperms, mammals, birds; mass extinction at end of period, including last ammonoids and nonavian dinosaurs
	Jurassic (J)		201	Continents separating; diverse dinosaurs and other reptiles; first birds; diverse mammals; gymnosperms dominant; evolution of angiosperms; ammonoid radiation; Mesozoic marine revolution
	Triassic (Tr)		252	Continents begin to separate; marine diversity increases; gymnosperms become dominant; diversification of reptiles, including first dinosaurs; transitional mammal-like forms; modern corals, teleost fishes

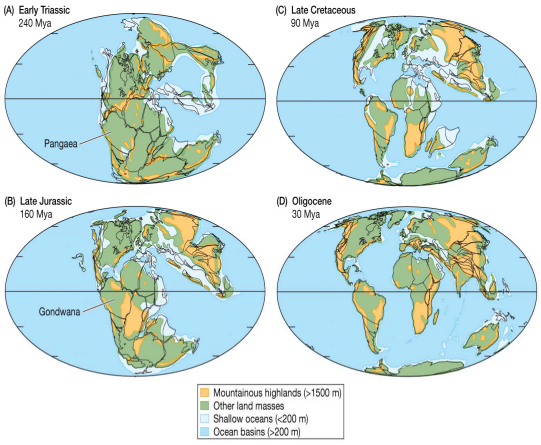


TABLE 17.2 Six major transitions in the history of evolution leading to higher-level formations, or groups

Major transition	Group formed	Group transformation
Separate replicators (genes) and formation of cell membranes → genome within cell	Compartmentalized genomes	Evolution of large, complex genomes
Separate unicells → symbiotic unicell	Eukaryotic cells	Evolution of symbiotic organelle and nuclear genomes; transfer of genes between them; formation of "hybrid genomes"
Asexual unicells → sexual unicells	Zygote (sexually reproducing organism)	Evolution of meiosis and (often obligate) sexual reproduction
Unicells → multicellular organism	Multicellular organisms	Evolution of cell and tissue differentiation and of somatic vs. germ cells
Multicellular organisms → eusocial societies	Origin of societies (in only a few lineages)	Evolution of reproductive and nonreproductive castes (e.g., social insects)
Separate species → interspecific mutualistic associations	Origin of interspecific mutualisms	Evolution of physically conjoined partners (e.g., endosymbioses)

- Geographic distributions of organisms provided Darwin and Wallace with inspiration and evidence that evolution had occurred.
- Wallace- father of biogeography
- On the origin of species: Showed that many biogeographic facts that make little sense under the hypothesis of special creation make sense if a species:

1. Has a definite site or region of origin
2. Achieves a broader distribution by dispersal
3. Becomes modified and gives rise to descendent species in the various region to where it disperses.

Darwin highlighted the following points:

I. Neither the similarity nor the dissimilarity of the inhabitants of various regions can be accounted for by climatal and other physical conditions.
II. Barriers of any kind, or obstacles to free migration, are related in a close and important manner to the differences between the organisms of various regions.
III. Inhabitants of the same continent or sea are related, although the species themselves differ from place to place.

- For Darwin it was important to show that species had not been created in different places BUT had a single region of origin and had spread from there – compelling evidence from islands.

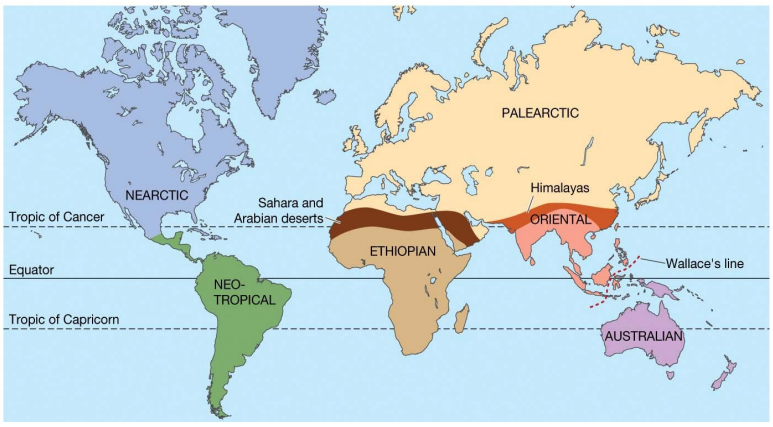
1. Remote oceanic islands generally have the organisms that are capable of long-distance and dispersal (Only native mammals on many islands are bats – Island species with poor dispersal ability such as dodo's are closely related to strong flyers and descended from them)
2. Many continental plant and animal species have flourished on oceanic islands which humans have transported them to.
3. Most of the species on the islands are clearly related to species on the mainland, thus implying that this was their source

MAJOR PATTERNS OF DISTRIBUTION

- The geographic distribution of almost every species is limited to some extent, and many higher taxa are likewise restricted (endemic) to a particular geographic region.
- Wallace and other biogeographers= many higher taxa have roughly similar distributions, and that the taxonomic composition of the biota is more uniform within certain regions than between them.

BIOGEOGRAPHIC REALMS:

- Palearctic: Eurasia and Northern Africa
- Nearctic: North America
- Neotropical: Central and South America
- Ethiopian: Sub-Saharan Africa
- Oriental: India and Southeast Asia
- Australian: Australia, New Guinea, New Zealand and nearby islands.



- Wallace's line separates islands that despite their close proximity and similar climate differ greatly in their fauna.