Zoogeography

- studying animal distributions (animal geography)
- father of animal geography/biogeography
- co-discoverer of theory of natural selection

"...every species comes into existence coincident in time and space with a preexisting closely allied species." (1855)

Zoogeography

- Studying animal distributions
  1) Map distributions
  2) Explain distributions

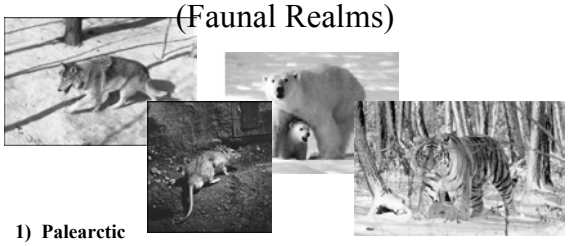
endemic taxon: taxon unique to a specific location; found nowhere else

Zoogeographic Realms (Faunal Realms)

1) Palearctic

- Largest region
- Includes Europe, north Africa, much of Middle East, most of Asia (except south-southeastern Asia)
- Diverse biomes: polar ice (N) to desert (S)

Zoogeographic Realms (Faunal Realms)



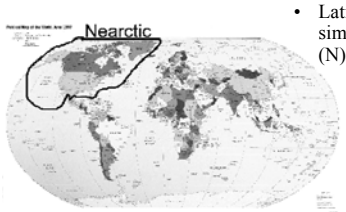
1) Palearctic

- 42 mammal families
  - gray wolf, Siberian tiger, caribou, Norway rat, polar bear
- 0 endemic family

Zoogeographic Realms (Faunal Realms)

2) Nearctic

- Most of North America, Greenland
- Latitudinal biome diversity similar to Palearctic; polar ice (N) to desert & subtropical (S)



Zoogeographic Realms (Faunal Realms)

2) Nearctic

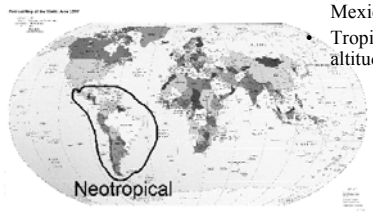
- 37 mammal families
  - peccary, polar bear, pronghorn antelope, musk ox, porcupine
- 2 endemic family
  - Aplodontidae
  - Antilocapridae)

***Palearctic & Nearctic collectively called <u>Holarctic Region</u>**

Zoogeographic Realms (Faunal Realms)

3) Neotropical

- S. Hemisphere New World (S.America; Central Amer., S. Mexico)
- Tropical (N) to desert (S); altitudinal diversity with mts.



Zoogeographic Realms (Faunal Realms)



3) Neotropical

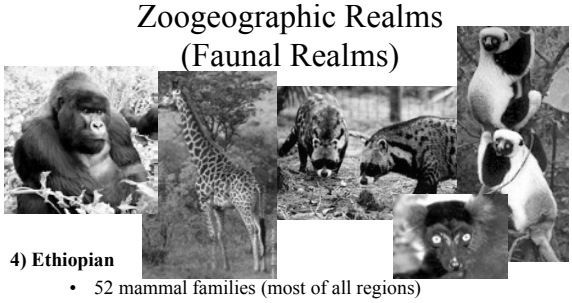
- 50 mammal families
  - Sloth, howler monkey, tapir, capybara
- 19 endemic families (most of all regions)
  - bats, primates, xenarthrans, rodents

Zoogeographic Realms (Faunal Realms)

4) Ethiopian

- Madagascar, Africa (except N. Africa), & south tip Middle East
- savanna

Zoogeographic Realms (Faunal Realms)



4) Ethiopian

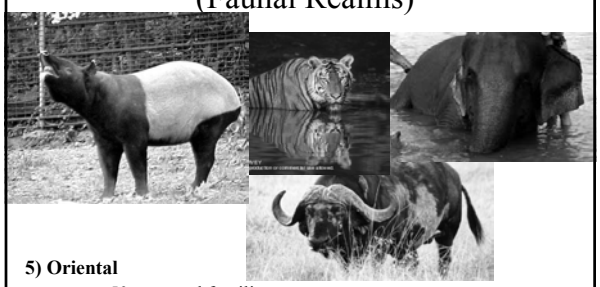
- 52 mammal families (most of all regions)
  - mountain gorilla, African elephant, giraffe, aardvark, numerous lemur spp. (Madagascar), many viverrids (civets)
- 17 endemic families
  - Giraffidae
  - Lemuridae

Zoogeographic Realms (Faunal Realms)

5) Oriental

- India, south China, Indochina, portions of Indonesia
- Tropical forest; deserts in western portion

Zoogeographic Realms (Faunal Realms)



5) Oriental

- 50 mammal families
  - Malay tapir, Indian tiger, water buffalo, Indian elephant

Zoogeographic Realms (Faunal Realms)




5) Oriental

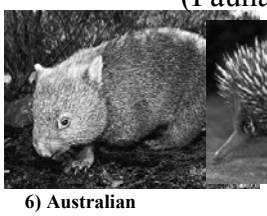
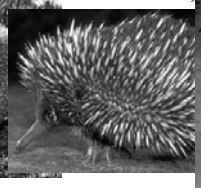
- 3 endemic families
  - Tupaiidae (tree shrews)
  - Cynocephalidae (colugos)
  - Tarsiidae (tarsiers)

Zoogeographic Realms (Faunal Realms)

6) Australian

- Australia, Tasmania, portions of Indonesia
- Tropical forest to savanna to desert
- island realm

Zoogeographic Realms (Faunal Realms)


6) Australian

- 28 mammal families
  - wombat, kangaroo, bandicoot, echidna
- 12 endemic families
  - marsupials, e.g., Macropodidae
  - monotremes
  - bats

Zoogeographic Realms (Faunal Realms)

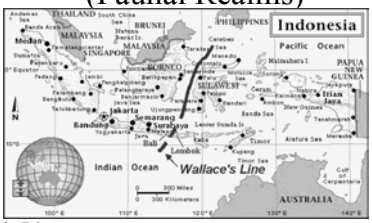
6) Australian

- Endemic species….

Tasmanian Devil

Thylacine (Tasmanian "wolf" or "tiger" – extinct 19th/20th centuries)

Zoogeographic Realms (Faunal Realms)



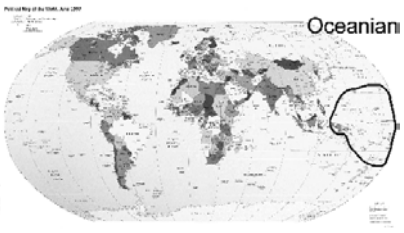
Wallace's Line

- **imaginary line separating Oriental & Australian faunal realms**
- **Alfred Wallace voyage in area**
- **Limit of region & provinces noticed because of sharp difference in taxa at boundary**
- **Borneo & Sulawesi**

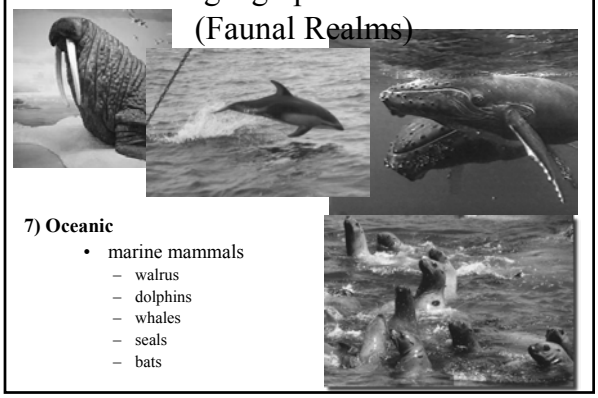
Zoogeographic Realms (Faunal Realms)

7) Oceanic

- major oceans of Earth & isolated islands (New Zealand)



Zoogeographic Realms (Faunal Realms)



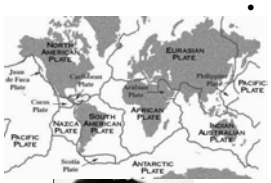
7) Oceanic

- marine mammals
  - walrus
  - dolphins
  - whales
  - seals
  - bats

Matrix Comparing Faunal Regions

Region	Percentage of families also found in					
	PA	NA	NT	ET	OR	AU
Palearctic (PA)	---	**46**	24	**54**	**76**	32
Nearctic (NA)	**40**	---	**60**	25	30	18
Neotropical (NT)	28	**81**	---	21	24	18
Ethiopian (ET)	**67**	35	22	---	**66**	32
Oriental (OR)	**90**	40	24	**63**	---	**57**
Australian (AU)	21	13	10	17	**32**	---

Zoogeography

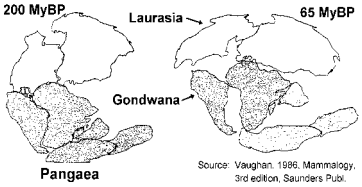


- **Continental Drift Theory & Mammals**

Continental drift: theory postulating that Pangaea split and resultant land masses drifted over the earth

- 1750's German minister, Lilienthal, coasts with congruent shape
- 1915 Wegener proposed theory of that continents drift
- 1950's DuToit proposed modern view of theory with 1 historic land mass (puzzle fit N.W/O.W.)

Zoogeography

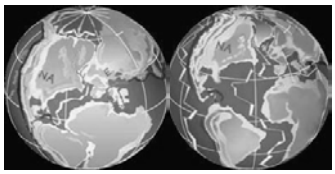


- **Continental Drift Theory & Mammals**

  ***Sequence of Events*:**

  1) Triassic Period = Pangaea
  2) Jurassic Period = splitting of Pangaea into N & S land masses = Laurasia & Gondwanaland, respectively

Zoogeography



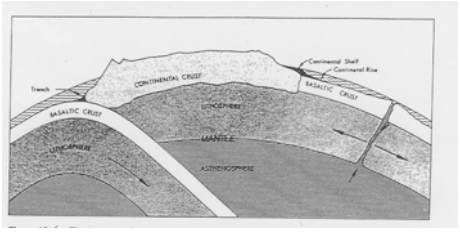
Cretaceous

- **Continental Drift Theory & Mammals**

  ***Sequence of Events*:**

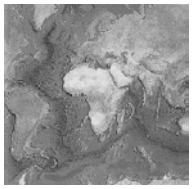
  3) End of Cretaceous Period = S. America drifts westward breaking from Africa
  4) Cenozoic Era = continued drift yielding current continental spatial arrangement

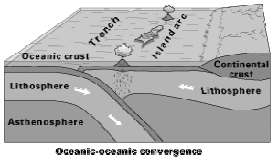
Zoogeography



- **What caused (causes!) continental drift?**
  - sea floor spreading moves tectonic plates of the earth's crust (lithosphere)
  - system of movement of the earth's crust = **plate tectonics**

Zoogeography



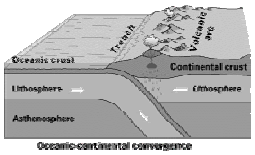


Oceanic-oceanic convergence

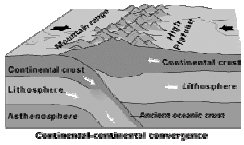
Continental Drift:

- **How?**
  - **Convection currents cause upswelling of molten material to earth surface (e.g., ocean floor)**
  - **Form chains of underwater volcanic mts. ("spreading ridges")**
  - **New sea floor formed & pushed away from upswelling as new molten material appears**

Zoogeography



Oceanic-continental convergence

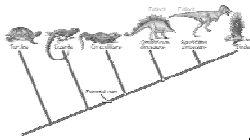


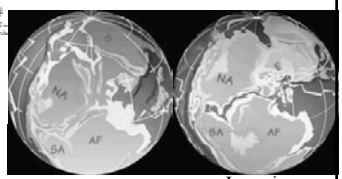
Continental-continental convergence

Continental Drift:

- **How?**
  - **At opposite edge of a given tectonic plate plunges back toward earth's core and is destroyed (forms deep troughs or trenches)**
  - **Continental land masses are carried along with this movement at ~5-10 cm per yr**

Zoogeography



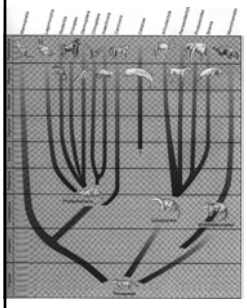


Triassic Jurassic

Mammalian Diversity vs. Reptilian Diversity:

- Key appears to be related to continental drift
- Reptiles evolved when continents more closely connected; may have allowed greater interchange = less diverse

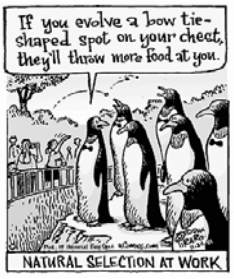
Zoogeography



Mammalian Diversity vs. Reptilian Diversity:

- Key appears to be related to continental drift
- Mammals evolved on numerous, isolated land masses = more diverse via speciation (i.e., macroevolution)

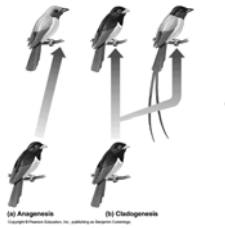
Evolution

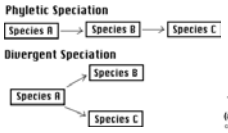


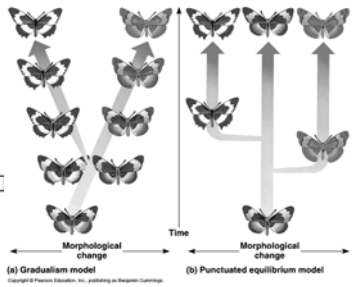
- **What is evolution?**
- **Microevolution**: survival through the inheritance of favorable characteristics
  - mutations
  - selection
- **Macroevolution**: progression of biodiversity through geological time
  - speciation
  - extinction

Evolution

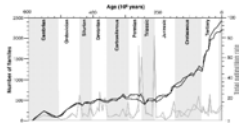
- **How does it occur?**



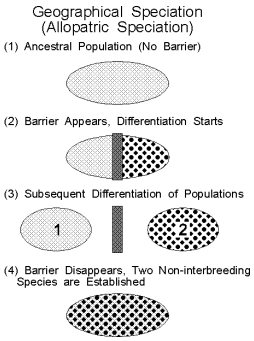




Evolution

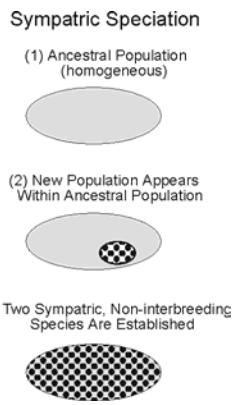


- **Species** – group of potentially interbreeding natural populations capable of producing viable offspring
- **Speciation** (through reproductive isolation)
  - division of populations (**allopatric speciation**)
  - barriers to reproduction (**sympatric speciation**)



Evolution

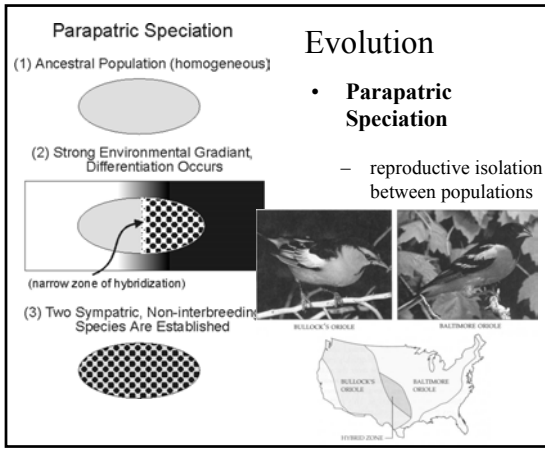
- **Allopatric Speciation**
  - Geographic separation leads to reproductive isolation



Evolution

- **Sympatric Speciation**
  - reproductive isolation within randomly mating population

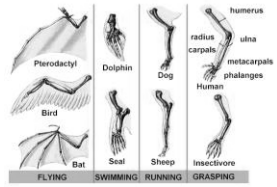
?

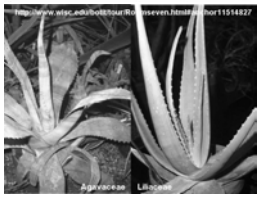


Evolution

- **Parapatric Speciation**
  - reproductive isolation between populations

?





Evolution

- "All life comes from life"
  - Modification of previously existing structures (**homologous**) – mammal forelimb structure
  - Increasing resemblance of organs or organisms serving the same function (**analogous**)
    - insect wings *vs.* bird wings (mimicry)
    - spurges *vs.* cacti
    - aloes *vs.* agaves
    - via Convergence

ISOLATION AND CONVERGENT EVOLUTION

Convergence

- **Myrmecophages**

anteaters, aardvark, aardwolf, numbat, pangolins

ISOLATION AND CONVERGENT EVOLUTION

Convergence

- **Cursorial herbivores**
  - **pronghorn, capybara, guanaco, kangaroos**
  - **digestive tract, dentition, elongated limbs**



ISOLATION AND CONVERGENT EVOLUTION

Convergence

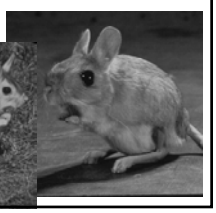
- **Fossorial mammals**
  - **pocket gophers, Palestine mole rats, mole rats**
  - **reduced eyes, forelimbs, claws, incisors**


ISOLATION AND CONVERGENT EVOLUTION

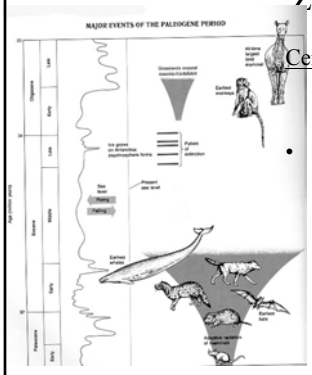
Convergence

- **Bipedal, saltatory mammals**
  - **kangaroo rats, jerboas, spring hare**
  - **long tails, elongated hind feet, richochetal locomotion**





Zoogeography

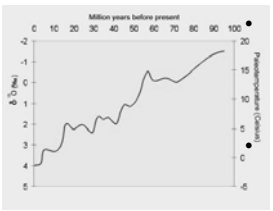


Cenozoic Era, Climate Changes, and Mammal Distribution:

- Cenozoic Era = period of sweeping climatic changes; effects on distribution of plant communities and thus mammal distributions

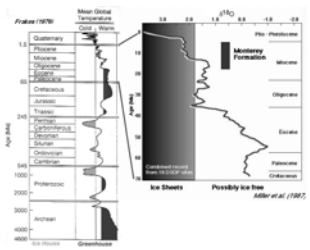
Zoogeography

Cenozoic Era, Climate Changes, and Mammal Distribution:



- First half of Cenozoic Era = relative uniform climate; subtropical Alaska
- Second half of Cenozoic Era = more seasonal climates; fluctuations in temps, cooling

Zoogeography

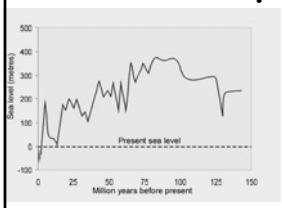


Cenozoic Era, Climate Changes, and Mammal Distribution:

- Why appearance of seasonality?

Zoogeography

Cenozoic Era, Climate Changes, and Mammal Distribution:



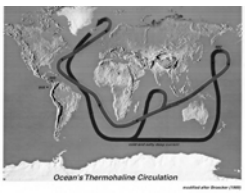
- Some possible explanations:

1) Related to shifting patterns of land & water

- 2nd half of Cenozoic = withdrawal of many epicontinental seas, e.g., sea subdividing N.Amer. And also in Asia

Zoogeography

Cenozoic Era, Climate Changes, and Mammal Distribution:

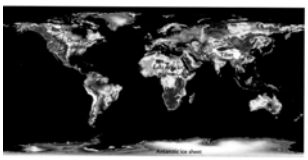


Some possible explanations:

1) Related to shifting patterns of land & water

- hotter, drier summers / colder, wetter winters in core of land masses

Zoogeography



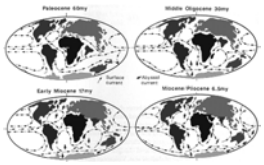
Cenozoic Era, Climate Changes, and Mammal Distribution:

- Some possible explanations:

2) Also, formation of major world mountain ranges
e.g., Rocky Mts. reach present heights in Cenozoic
Cascades appear over last 5 million yrs., Himalayas appear in last 2 million yrs.

Zoogeography

<u>Cenozoic Era, Climate Changes, and Mammal Distribution</u>:



Some possible explanations:

2) Also, formation of major world mountain ranges
   -collection points for ice & snow; divert wind patterns

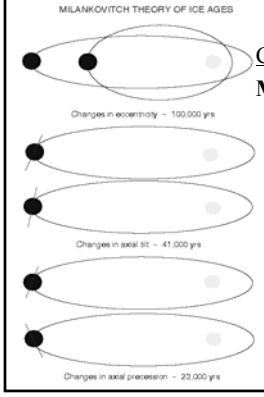
Zoogeography

<u>Pleistocene Epoch (Ice Ages)</u>:

1.5 mybp to 10,000 ybp

- High climatic variability
- Recurring periods of glaciation separated by warm periods (glacial retreat)

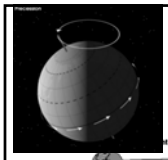
Zoogeography



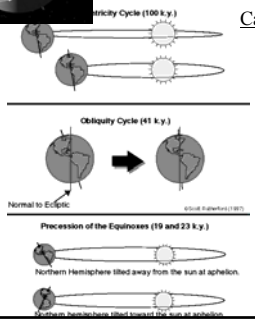
<u>Causes of Glaciation?</u>

Milankovitch Theory

1) Formation of polar ice caps reduced amount of energy retained by the earth (high albedo)
2) Earth's elliptical orbit around sun
   - Orbit varies from near circular to strongly elliptical (~100,000 yr cycle)



Zoogeography



Causes of Glaciation?

3) Tilt of earth's axis relative to sun
   - also influences seasonality (40,000 yr cycle)
4) Shifting of earth's axis around its tilt angle
   - Influences seasonality (21,000 yr cycle)

Zoogeography

Glacial Stages in North America

1) Kansan ~500,000+ ybp
2) Illinoian ~250,000 ybp
3) Wisconsinian ~10-12,000 ybp

- General decrease in southward advancement of glaciers from Kansan to Wisconsin Glaciations

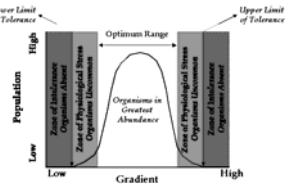
Zoogeography

Glacial Stages in North America

- Major extinctions of mammals:
  e.g., North America

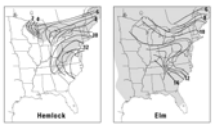
elephants	musk oxen
camels	ground sloths
giant beavers	cave bears
saber-tooth cats	horses

Zoogeography



Glacial Stages in North America

- But how did species survive the Ice Ages?
  - One hypothesis = species are adapted to certain thermal regimes and habitat types and they should shift their geographic distributions to remain within these evolutionary constraints

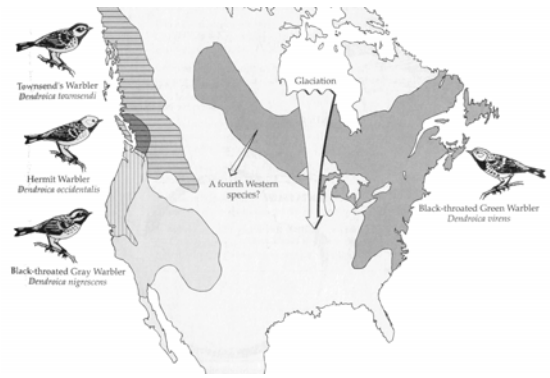


Zoogeography

Glacial Stages in North America

- Plant communities shifted geographically with advancing and retreating glaciers
- Mammals followed shifting of plant communities

Musk ox to central France



Caribou to Alabama & Georgia

Zoogeography

Glacial Stages in North America

- Southward expansion of boreal mammals during glacial advances
  - Remnants left in refugia

Zoogeography

Glacial Stages in North America

Hippos in Britain

- Northward expansion of subtropical & desert mammals during interglacial periods (glacial retreat)
- Isolation of plant & animal communities contributes to further speciation (natural selection, gene mutations, genetic drift, etc…)
  - e.g., unglaciated regions

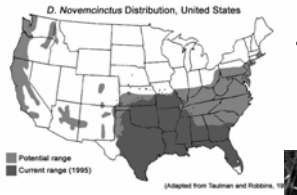
Zoogeography

Glacial Stages in North America

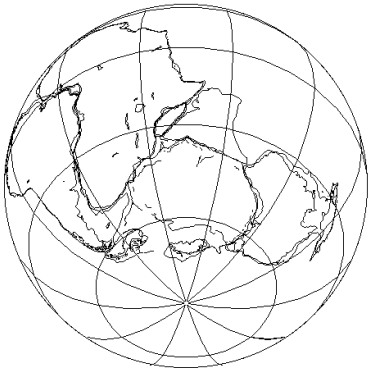
- Current northward expansion of mammals
  - e.g., opossum expanding into southern Ontario over the last 10 y

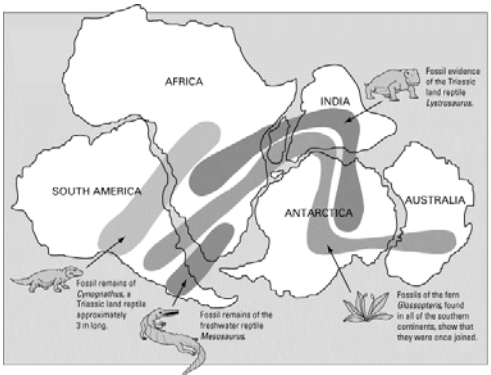
Zoogeography

Glacial Stages in North America



- Current northward expansion of mammals
  - e.g., nine-banded armadillo





Biogeography

Zoogeography

- Animal Movements
  (More on "Ecology of…" to come!)

Dispersal: uni-directional movement; move from place of origin to new area, perhaps colonizing that new area
  - Dependent on dispersal ability (vagility/mobility function of body size), presence & kinds of barriers, and tolerance for environmental conditions

Zoogeography

- Animal Movements

Migration: round trip movement; move from starting point and later return

Zoogeography

- Faunal Interchange
  - animal exchange between realms/regions…

corridor: path through which animal movement may occur with relative ease

Zoogeography

- Faunal Interchange
  - animal exchange between realms/regions…

filter route: pathway allowing some animals to move & restricting others from moving through

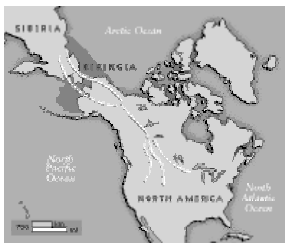
e.g., mountains, deserts, grasslands, land bridges (continuous land or stepping stone islands)

Zoogeography

- **filter routes & agricultural land use / habitat fragmentation**

Zoogeography

- **filter route**



Beringian land bridge – connects Palearctic to Nearctic

Some mammal families using this route:

Cervidae
Felidae > PA to NA
Camelidae - NA to PA

Zoogeography

- **filter route**

Panamanian land bridge – connects Nearctic to Neotropical

Some mammal families using this route:

Cervidae, Equidae, Camelidae > NA to NT

Cebidae, Erethizontidae > NT to NA

Zoogeography

Young bull moose.

- Faunal Interchange
  - animal exchange between realms/regions…

sweepstakes route: pathway allowing very few individual animals; large numbers of any animal restricted; animal generally must swim, fly, or raft (oceanic islands)

*could include stepping stone land bridges

Zoogeography

- **sweepstakes route**
  - Madagascar = excellent example of sweepstakes route; African mammals dispersing across ocean