Speciation
Macroevolution

Speciation & Natural Selection

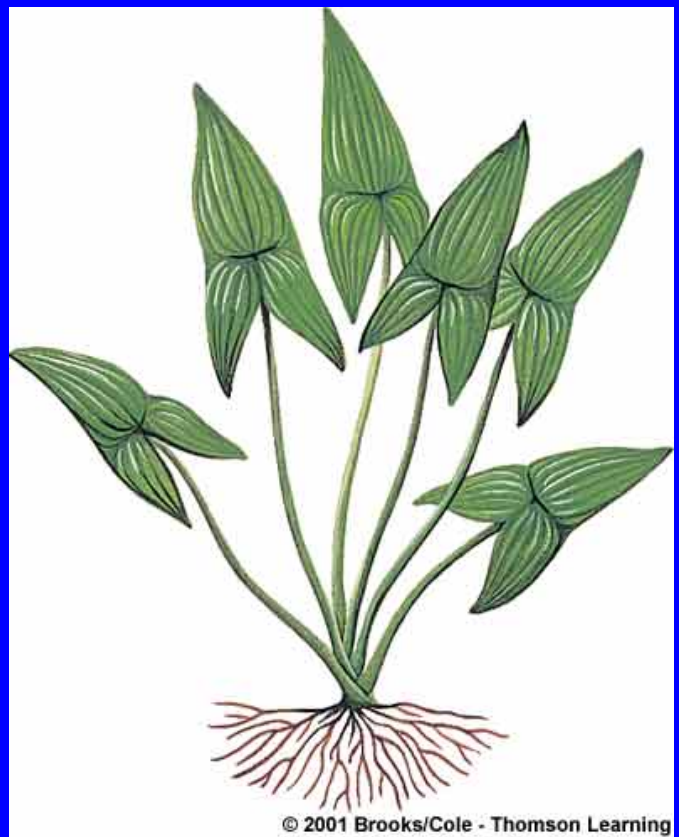
- Speciation may result from
  - Natural selection
  - Genetic drift
  - Mutation

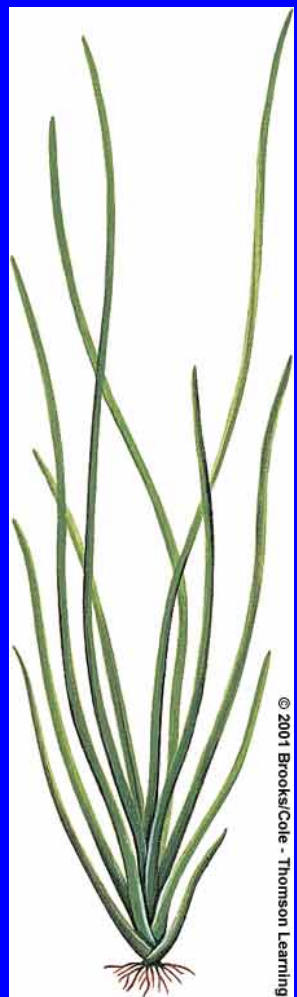
Morphology & Species

- Morphological traits may not be useful
  - environmental conditions cause individual differences
  - age and sex
  - Different species can appear identical

Variable Morphology

Grown in water





Grown on land

Biological Species Concept

"Groups of interbreeding natural populations that are reproductively isolated from other groups."

Ernst Mayr

Reproductive Isolation

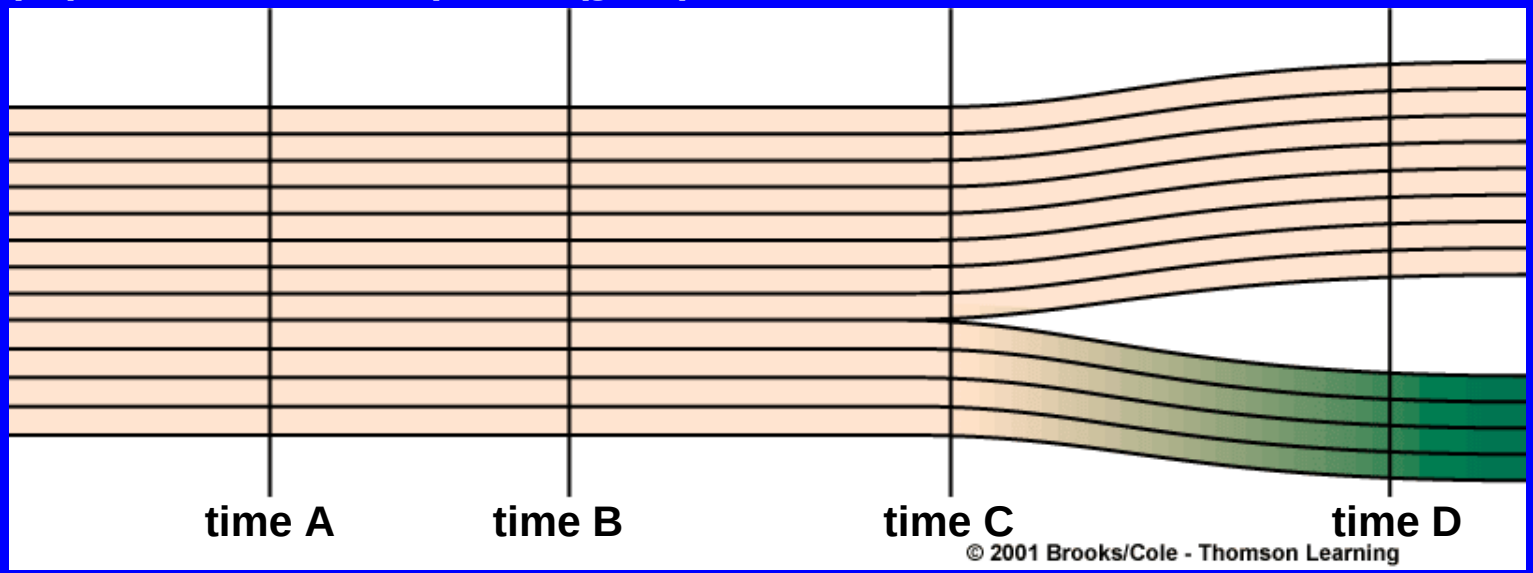
- Cornerstone of the biological species concept
- Reproductive isolation a by-product of genetic change

Genetic Divergence

- Gradual accumulation of differences in gene pools
- Natural selection, genetic drift, and mutation contribute to divergence
- Gene flow counters divergence

Genetic Divergence

populations of one species (*gold*)



populations of a daughter species (*green*)

Six Reproductive Isolating Mechanisms

Ecological Isolation

Temporal Isolation

Behavioral Isolation

Mechanical Isolation

Gametic Mortality

Hybrid Inviability or Infertility

Mechanisms of Speciation

- Allopatric speciation
- Sympatric speciation
- Parapatric speciation

Allopatric Speciation

- Geographically isolated populations
- Probably most common
- Some sort of barrier prevents gene flow
- Effectiveness of barrier varies with species

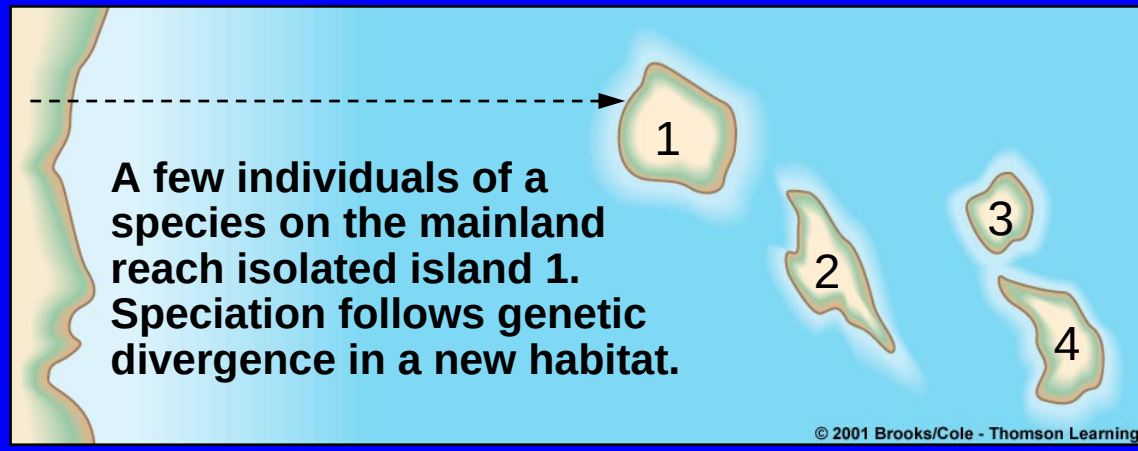
Allopatric Speciation in Wrasses

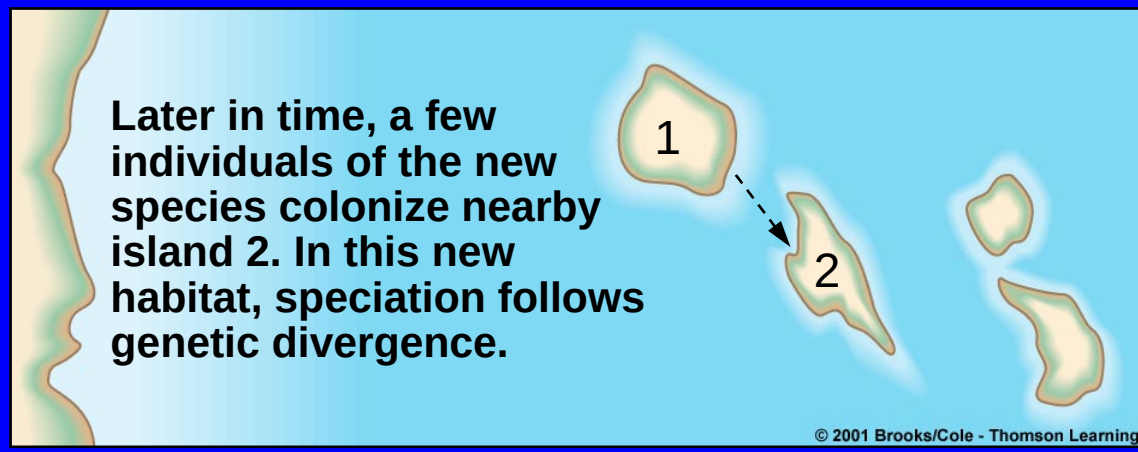
- Isthmus of Panama separated wrasses in Atlantic and Pacific
- Genes for certain enzymes have diverged in structure
- Divergence may be evidence of speciation in progress

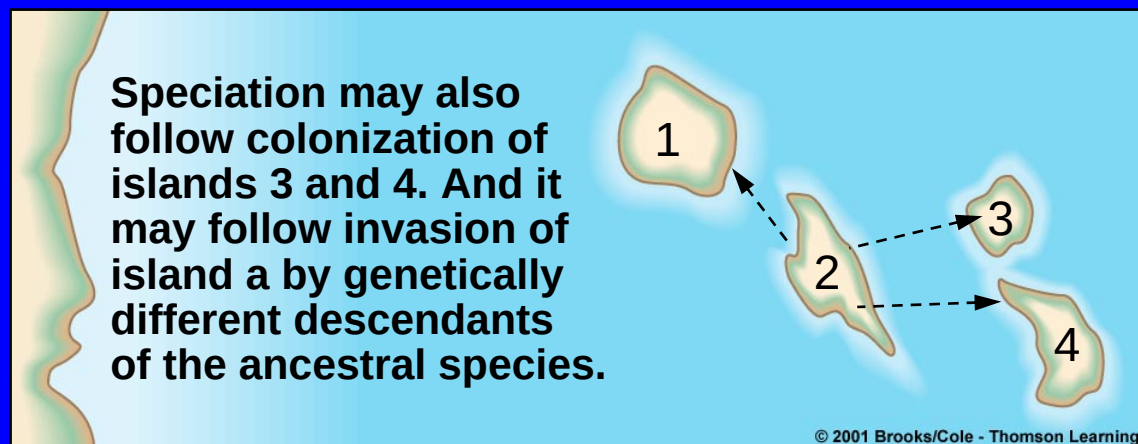
Archipelagos

- Island chains some distance from continents
  - Galapagos Islands
  - Hawaiian Islands
- Colonization of islands followed by genetic divergence

Speciation on an Archipelago

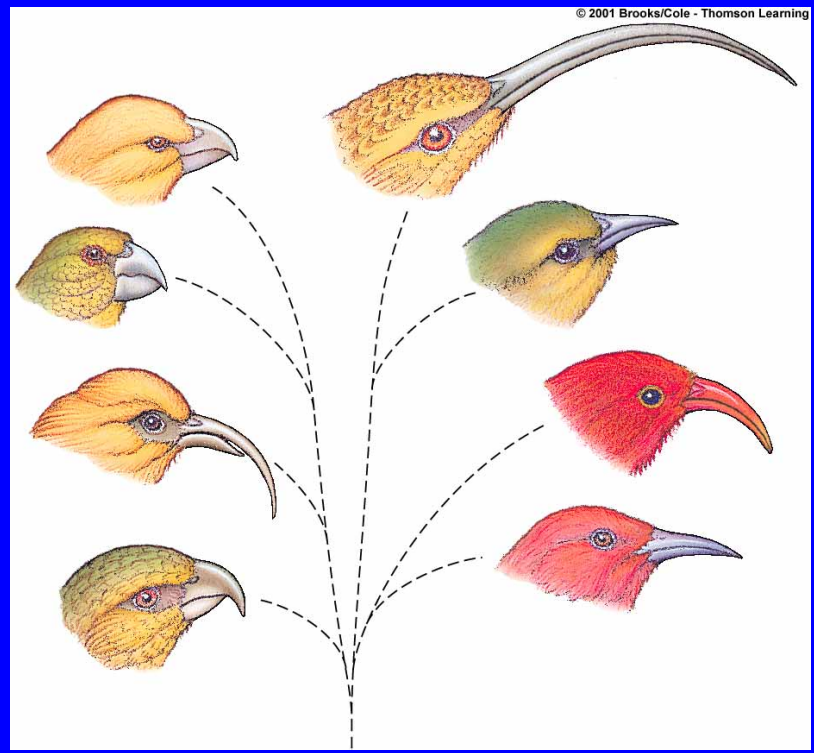






Hawaiian Islands

- Volcanic origins, variety of habitats
- Adaptive radiations:
  - Honeycreepers - Other bird species absent, they radiated to fill numerous niches



Speciation without a Barrier

- Sympatric speciation
  - Species forms within the home range of the parent species

Sympatric Speciation in African Cichlids

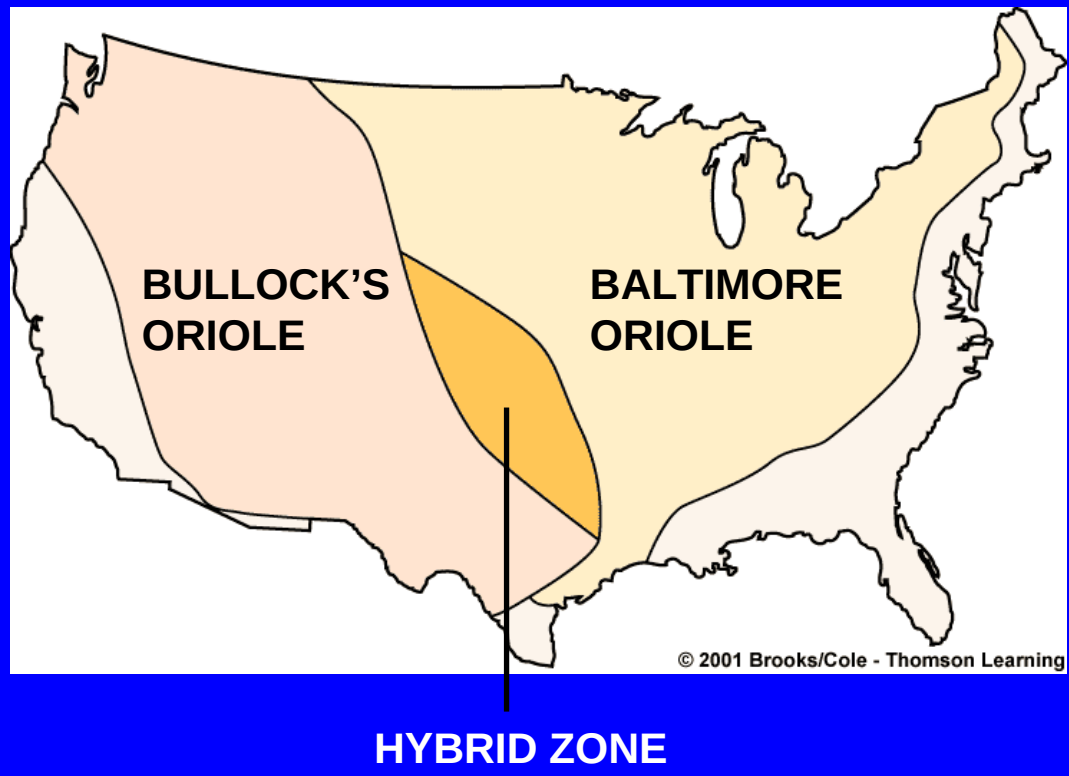
- Several species most likely descended from single ancestor
- No barriers within lake
- Some ecological separation but species in breed in sympatry

Parapatric speciation

- Neighboring populations become distinct species while maintaining contact along a common border

Parapatric Speciation

Adjacent populations evolve into distinct species while maintaining contact along a common border



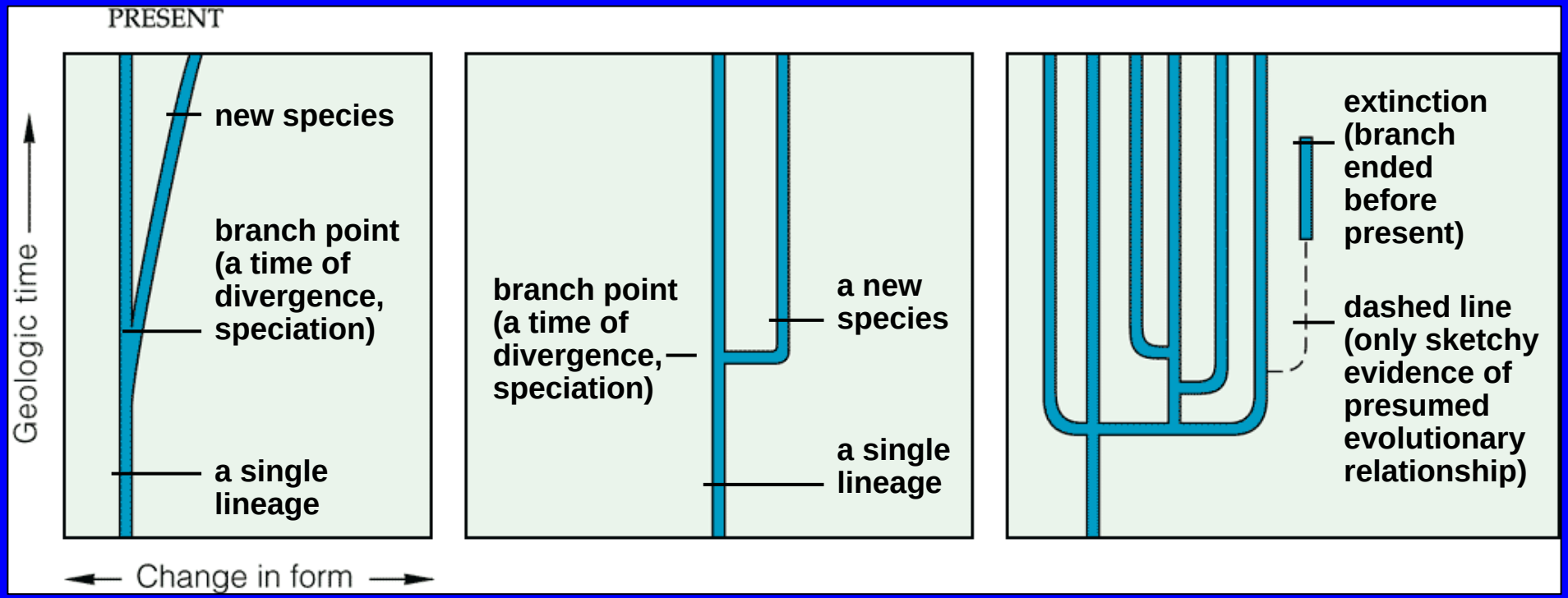
We’re All Related

- All species are related by descent
- Share genetic connections that extend back in time to the prototypical cell

Patterns of Change in a Lineage

- Cladogenesis
  - Branching pattern
  - Lineage splits, isolated populations diverge

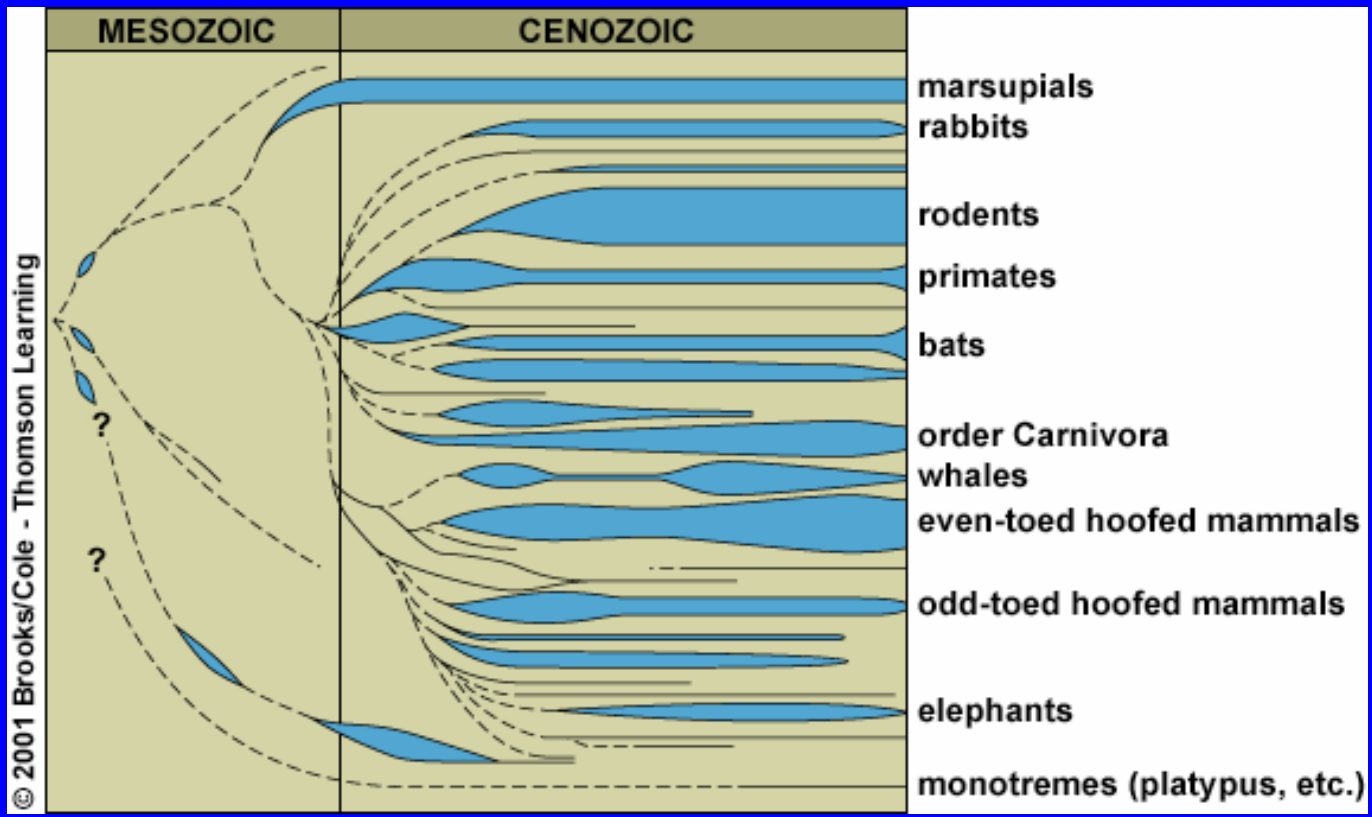
Evolutionary Trees



Adaptive Radiation

- Burst of divergence
- Single lineage gives rise to many new species
- New species fill vacant adaptive zone
- Adaptive zone is “way of life”

Adaptive Radiation



Extinction

- Irrevocable loss of a species
- Mass extinctions have played a major role in evolutionary history
- Fossil record shows 20 or more large-scale extinctions
- Reduced diversity is followed by adaptive radiation

Who Survives?

- Species survival is to some extent random
- Asteroids have repeatedly struck Earth destroying many lineages
- Changes in global temperature favor lineages that are widely distributed