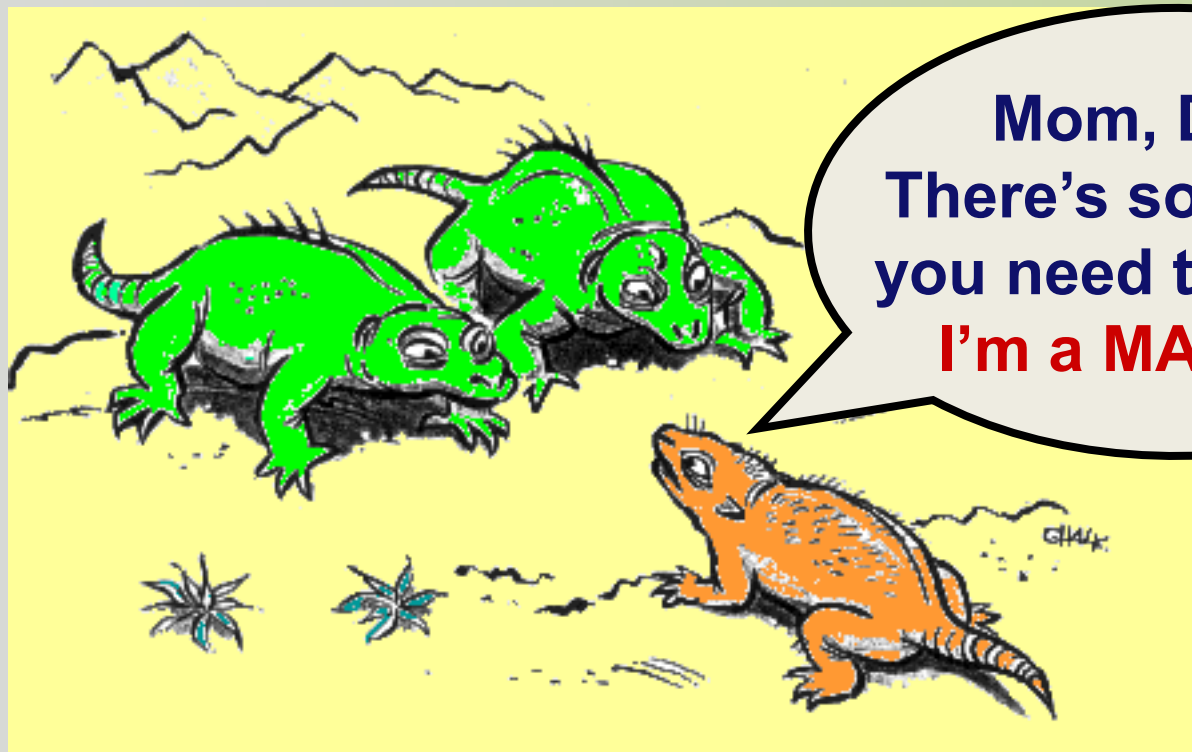
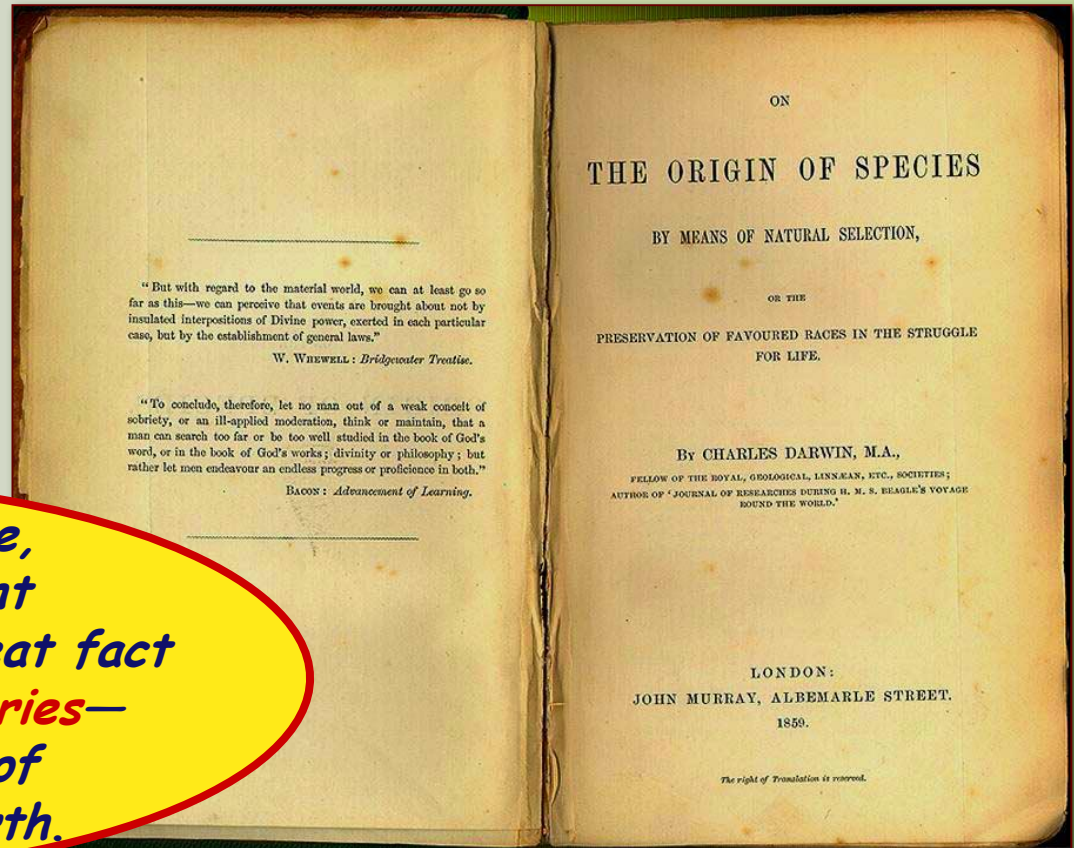
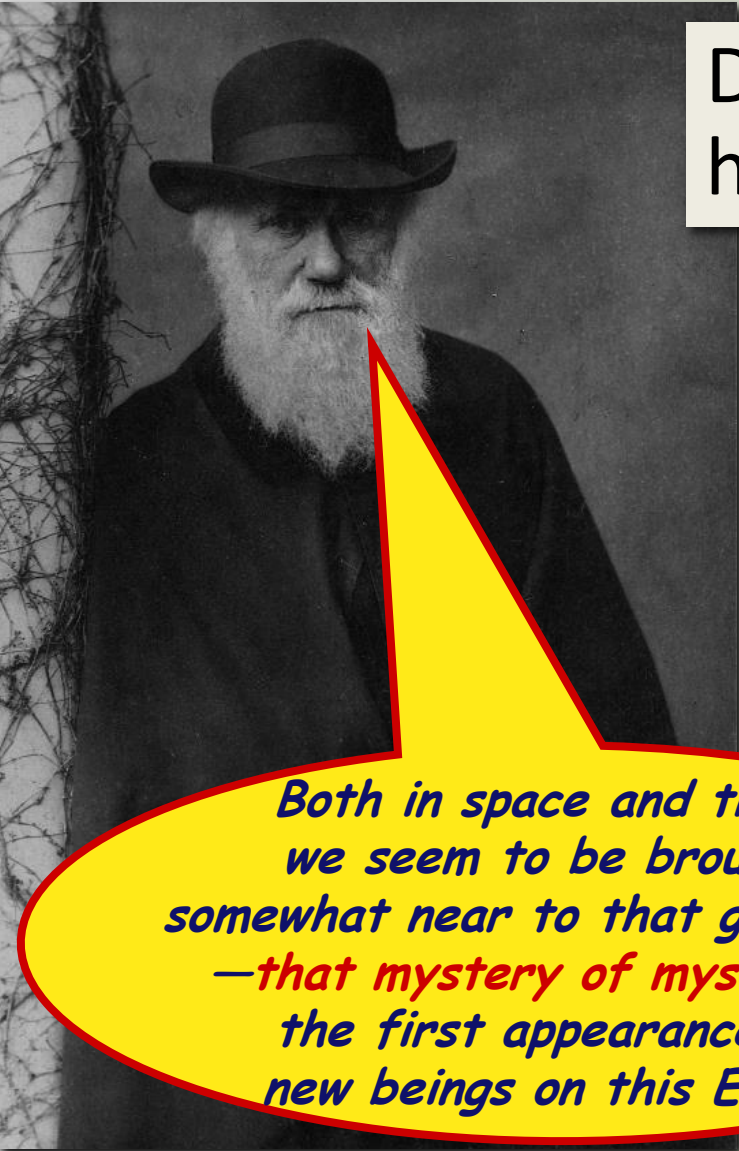


The Origin of Species (Ch. 14)



“That mystery of mysteries...”

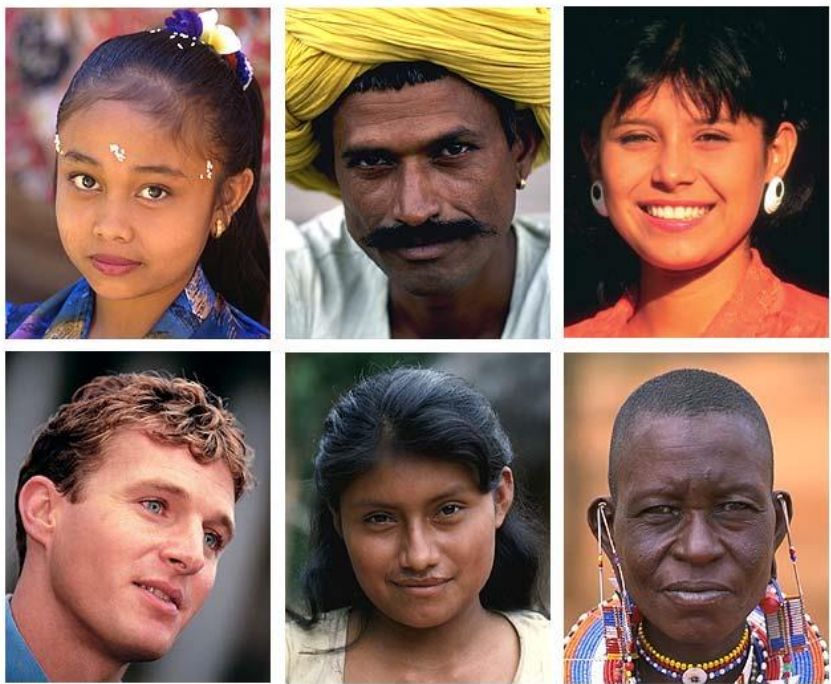
Darwin never actually tackled
how new species arose...



*Both in space and time,
we seem to be brought
somewhat near to that great fact
—that mystery of mysteries—
the first appearance of
new beings on this Earth.*

So...what is a species?

- Biological species concept
 - defined by Ernst Mayr
 - population whose members can interbreed & produce viable, fertile offspring



**Distinct species:
songs & behaviors are different
enough to prevent interbreeding**



Eastern Meadowlark



Western Meadowlark

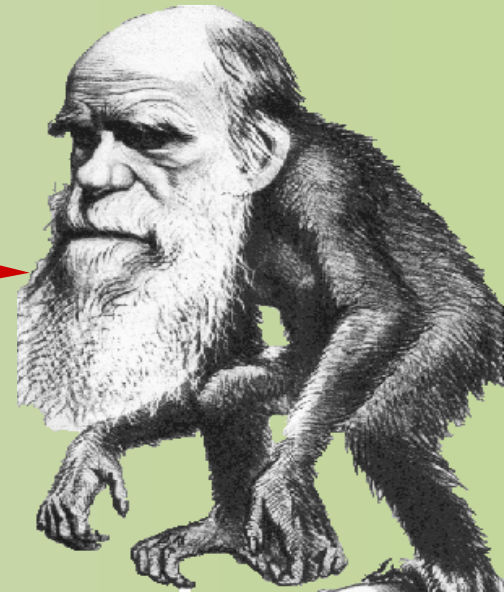
- Definition doesn't work for:
 - Asexually reproducing organisms
 - Fossils
 - Ring Species

Not the only “species”

Other species definitions:

- Morphological
- Ecological
- Paleological

Why are these
necessary?



How and why do new species originate?

- Species are created by a series of evolutionary processes
 - populations become isolated
 - geographically isolated
 - reproductively isolated
 - isolated populations evolve independently
- Isolation
 - allopatric
 - geographic separation
 - sympatric
 - still live in same area

The flightless cormorant (*Nannopterum harrisi*), one of many new species that have originated on the isolated Galápagos Islands





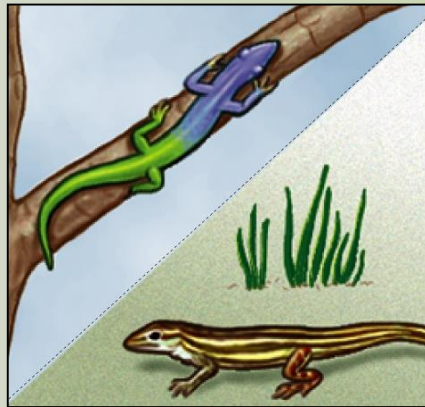


PRE-reproduction barriers

- Obstacle to mating or to fertilization if mating occurs



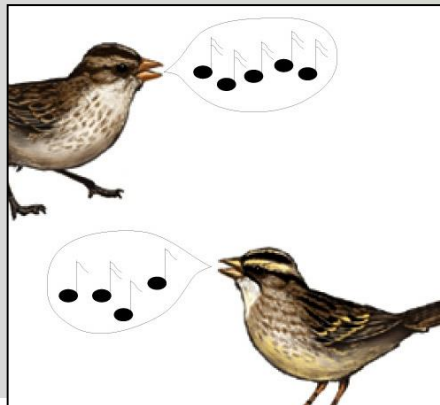
geographic isolation



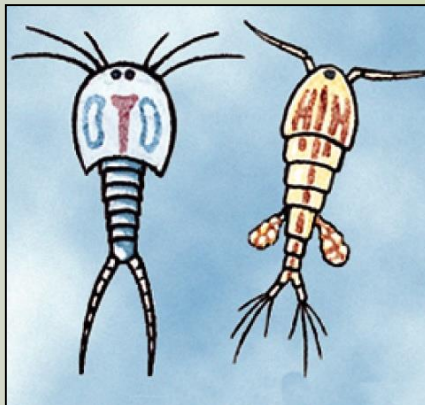
ecological isolation



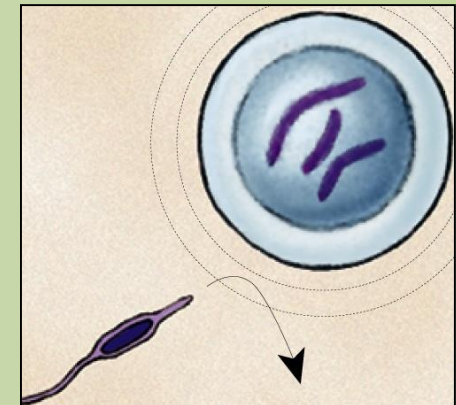
temporal isolation



behavioral isolation



mechanical isolation



gametic isolation

Geographic isolation

- Species occur in different areas
 - physical barrier
 - allopatric speciation
 - “other country”



Harris's antelope squirrel inhabits the canyon's south rim (L). Just a few miles away on the north rim (R) lives the closely related white-tailed antelope squirrel

Ecological isolation

- Species occur in same region, but occupy different habitats so rarely encounter each other
 - reproductively isolated

2 species of garter snake, *Thamnophis*, occur in same area, but one lives in water & other is terrestrial



(a)



lions & tigers could hybridize, but they live in different habitats:

- lions in grasslands
- tigers in rainforest

Temporal isolation

- Species that breed during different times of day, different seasons, or different years cannot mix gametes
 - reproductive isolation
 - sympatric speciation
 - “same country”

Eastern spotted skunk (L) & western spotted skunk (R) overlap in range but eastern mates in late winter & western mates in late summer



sympatric speciation?

Behavioral isolation

- Unique behavioral patterns & rituals isolate species
 - identifies members of species
 - attract mates of same species ☐
 - courtship rituals, mating calls



Blue footed boobies mate only after a courtship display unique to their species



**courtship display of
Gray-Crowned Cranes, Kenya**

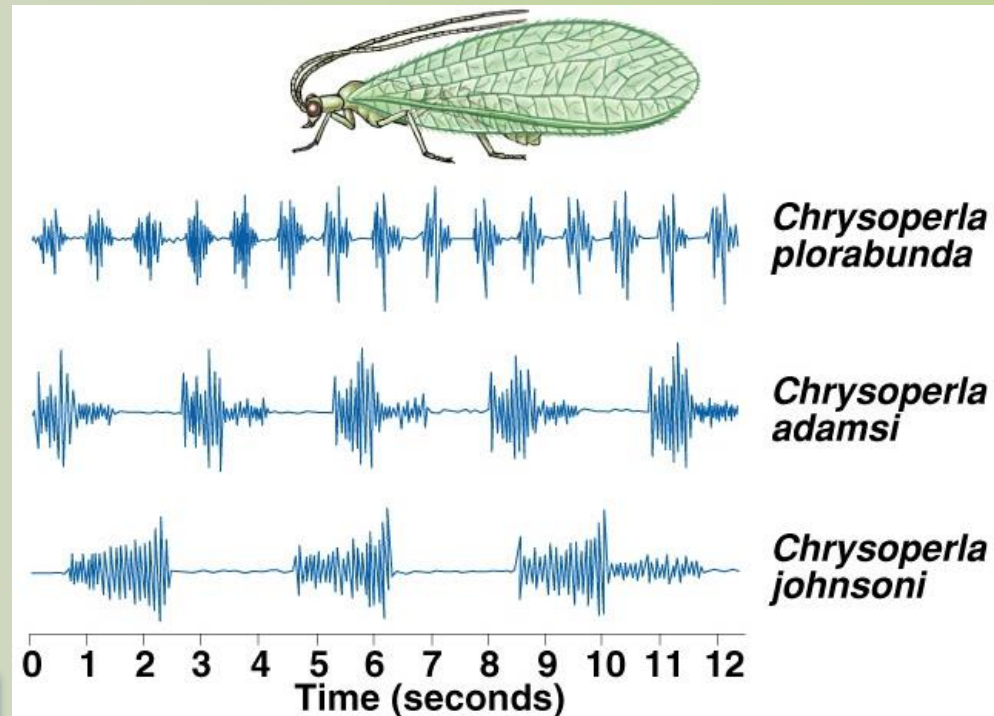


firefly courtship displays



Recognizing your own species

**courtship songs of sympatric
species of lacewings**



Mechanical isolation

- Morphological differences can prevent successful mating

Even in closely related species of plants, the flowers often have distinct appearances that attract different pollinators. These 2 species of monkey flower differ greatly in shape & color, therefore cross-pollination does not happen.



Plants



Mechanical isolation

- For many insects, male & female sex organs of closely related species do not fit together, preventing sperm transfer
 - lack of “fit” between sexual organs:

Animals



I can't even imagine!



Damselfly penises

Gametic isolation

sympatric speciation?

- Sperm of one species may not be able to fertilize eggs of another species
 - mechanisms
 - **biochemical barrier** so sperm cannot penetrate egg
 - receptor recognition between egg & sperm
 - **chemical incompatibility**
 - sperm cannot survive in female reproductive tract

Sea urchins release sperm & eggs into surrounding waters where they fuse & form zygotes. Gametes of different species— **red & **purple** —are unable to fuse.**



POST-reproduction barriers

- Prevent hybrid offspring from developing into a viable, fertile adult
 - reduced hybrid viability
 - reduced hybrid fertility
 - hybrid breakdown



zebroid



Reduced hybrid viability

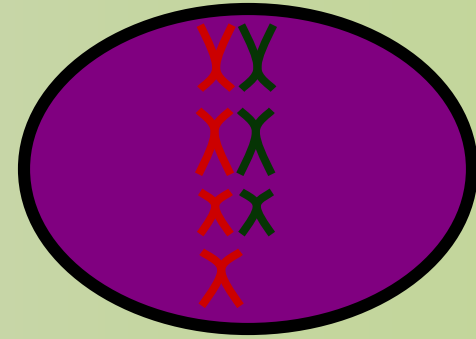
- Genes of different parent species may interact & impair the hybrid's development

Species of salamander genus, *Ensatina*, may interbreed, but most hybrids do not complete development & those that do are frail.



Reduced hybrid fertility

- Even if hybrids are vigorous they may be sterile
 - chromosomes of parents may differ in number or structure & meiosis in hybrids may fail to produce normal gametes



**Mules are vigorous,
but sterile**



**Horses have 64
chromosomes
(32 pairs)**

Mules have 63 chromosomes!



**Donkeys have 62
chromosomes
(31 pairs)**

sympatric speciation?

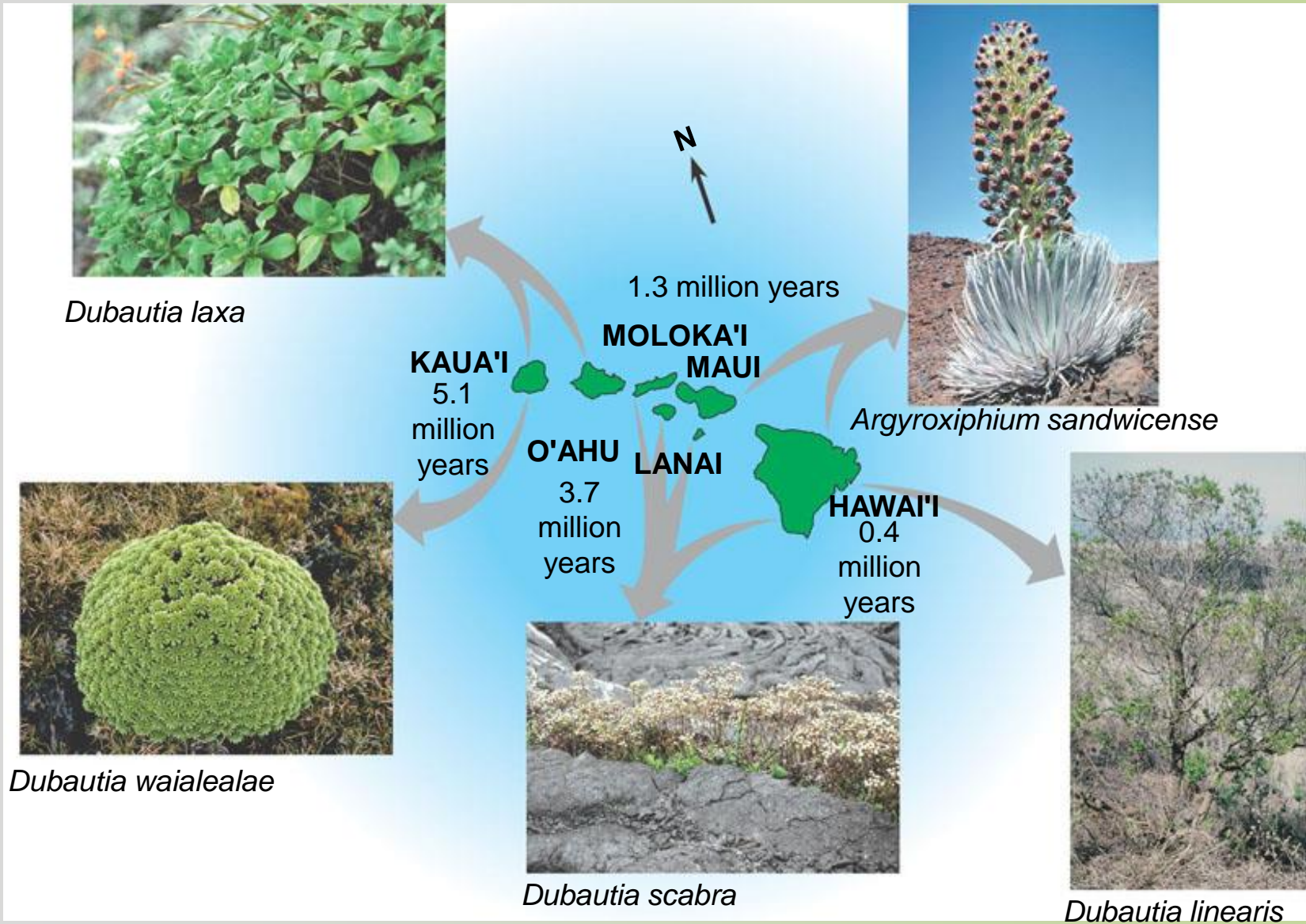
Hybrid breakdown

- Hybrids may be fertile & viable in first generation, but when they mate offspring are feeble or sterile

In strains of cultivated rice, hybrids are vigorous but plants in next generation are small & sterile. On path to separate species.



Adaptive radiation



KONA
FINCH
extinct



KAUAI AKIALAOA



LAYSAN
FINCH



AMAKIHI



AKIAPOLAAU



IIWI



MAUI
PARROTBILL



APAPANE

fruit and seed eaters

insect and nectar eaters

FOUNDER SPECIES

Rate of Speciation

- Current debate:

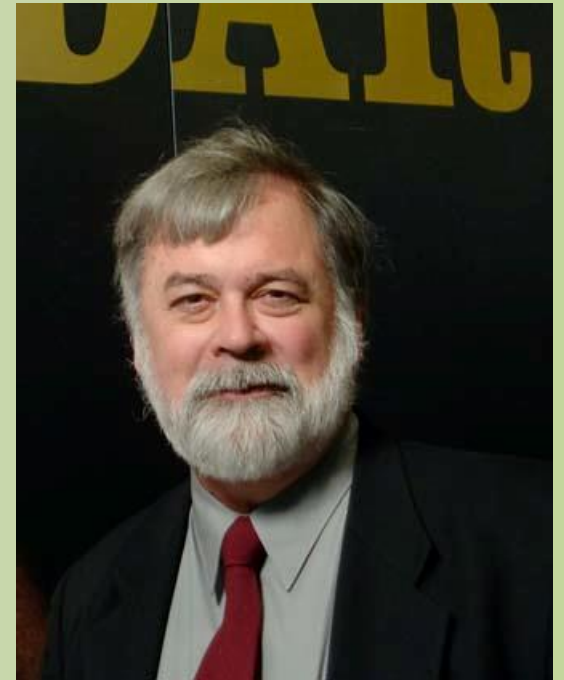
Does speciation happen gradually or rapidly?

- Gradualism

- Charles Darwin
- Charles Lyell

- Punctuated equilibrium

- Stephen Jay Gould
- Niles Eldredge

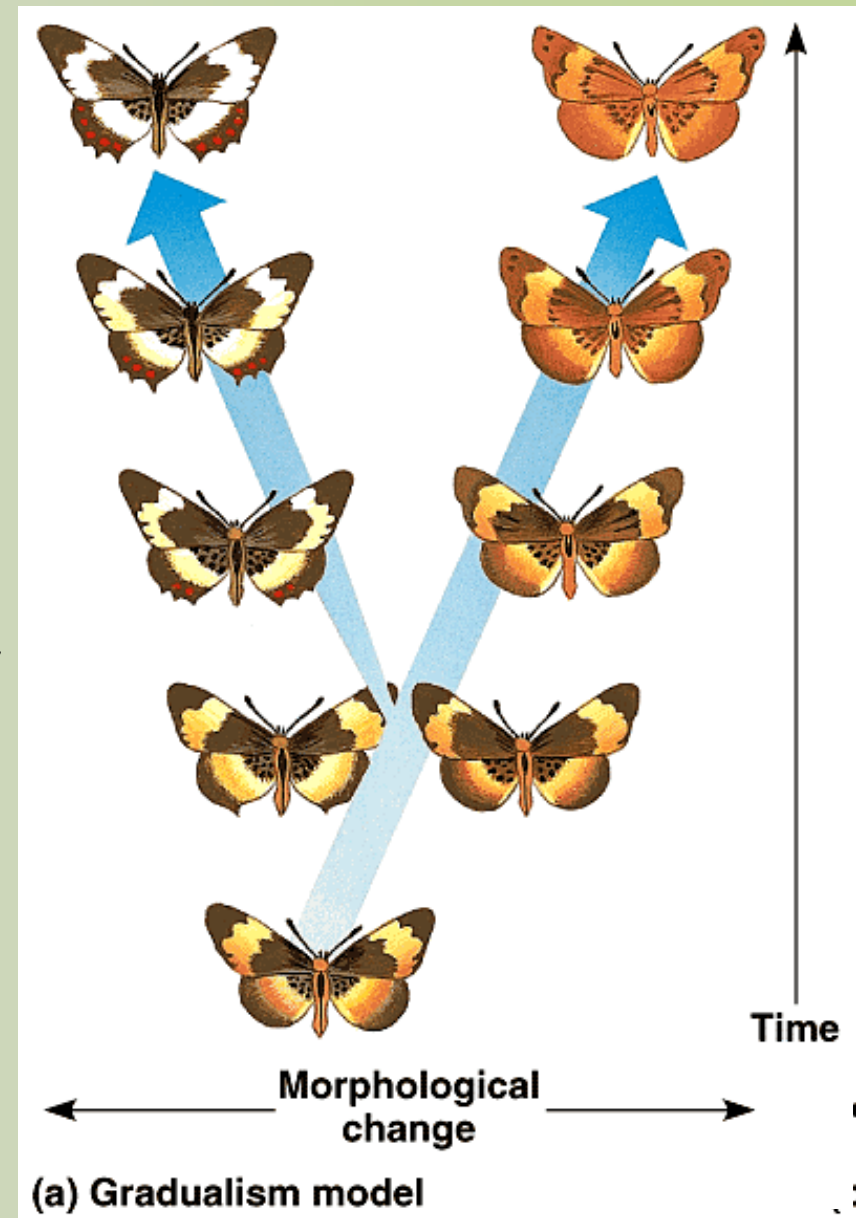


Niles Eldredge
Curator

American Museum of Natural History

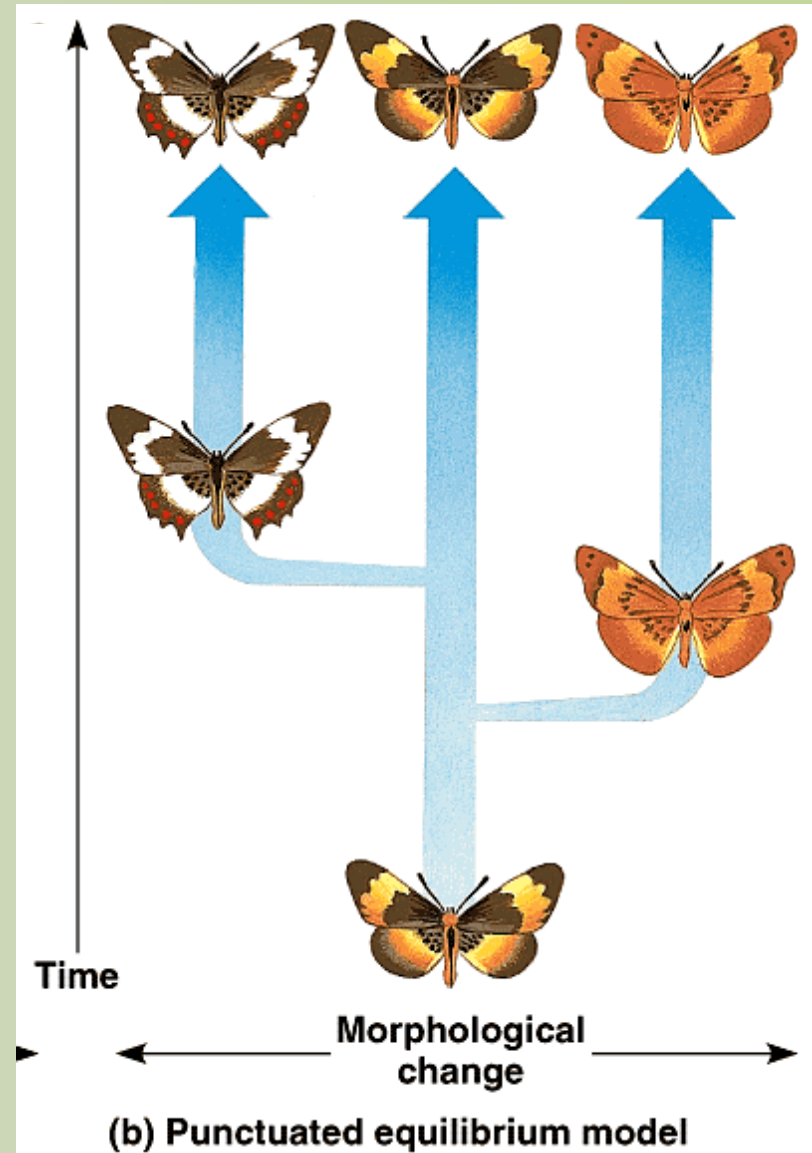
Gradualism

- Gradual divergence over long spans of time
 - assume that big changes occur as the accumulation of many small ones



Punctuated Equilibrium

- Rate of speciation is not constant
 - rapid bursts of change
 - long periods of little or no change
 - species undergo rapid change when they 1st bud from parent population



Review Questions

1. A biologist discovers two populations of wolf spiders whose members appear identical. Members of one population are found in the leaf litter deep within the woods. Members of the other population are found in the grass at the edge of the woods. The biologist decides to designate the members of the two populations as two separate species. Which species concept is this biologist most closely utilizing?

- A. Ecological
- B. Biological
- C. Morphological
- D. Pluralistic
- E. genealogical

2. The formation of a land bridge between North and South America about three million years ago should have resulted in which of the following?
- I. allopatry of marine populations that were previously sympatric
 - II. sympatry of marine populations that were previously allopatric
 - III. sympatry of terrestrial populations that were previously allopatric
- A. I only
 - B. II only
 - C. III only
 - D. I and II
 - E. I and III

For each of the following situations, choose the best answer from the following types of isolating mechanisms:

- A. Geographical isolation
- B. Behavioral isolation
- C. Mechanical isolation
- D. Temporal isolation
- E. Reproductive isolation

- 3. Two species of rats live on different islands.
- 4. Refers to all species that adhere to the biological definition.
- 5. Two species of fruit fly have different courtship rituals.
- 6. The pollen from a Dogwood tree can not penetrate the pine cone of a Douglas Fir.