Species

Biospecies

- An array of populations which are actually or potentially interbreeding to produce viable offspring, and which are reproductively isolated from other such arrays under natural conditions

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So the essence of a species is…gene flow

Scandinavian Y chromosome haplotype

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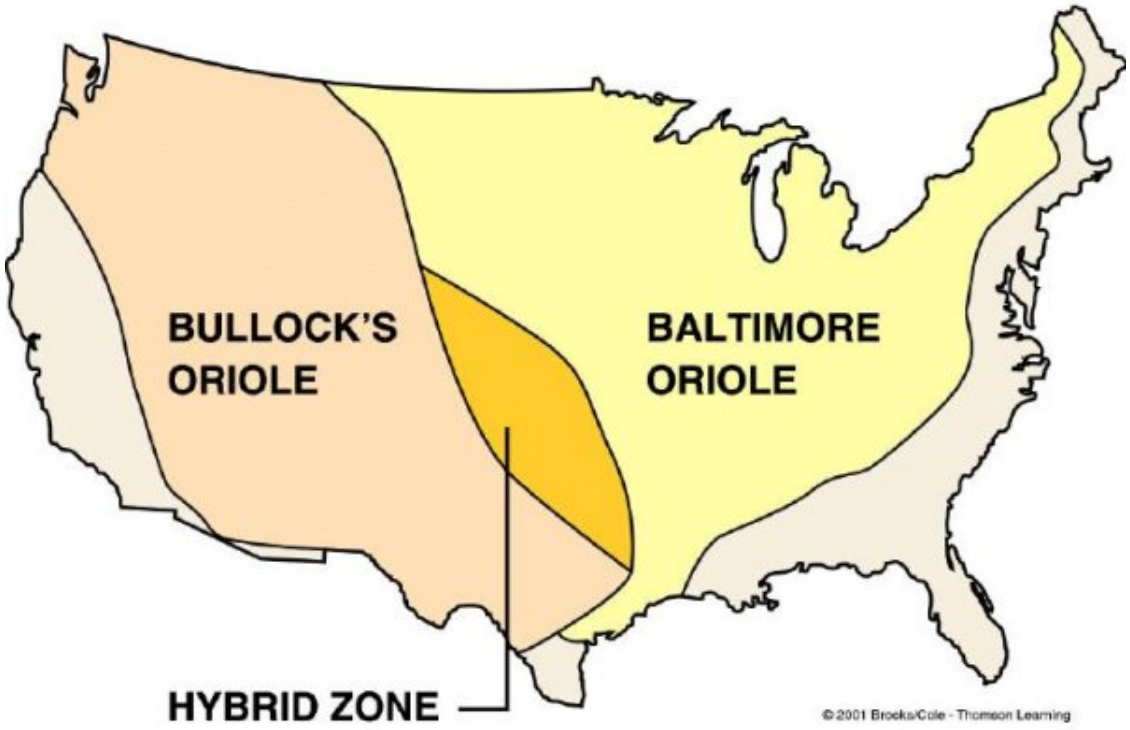
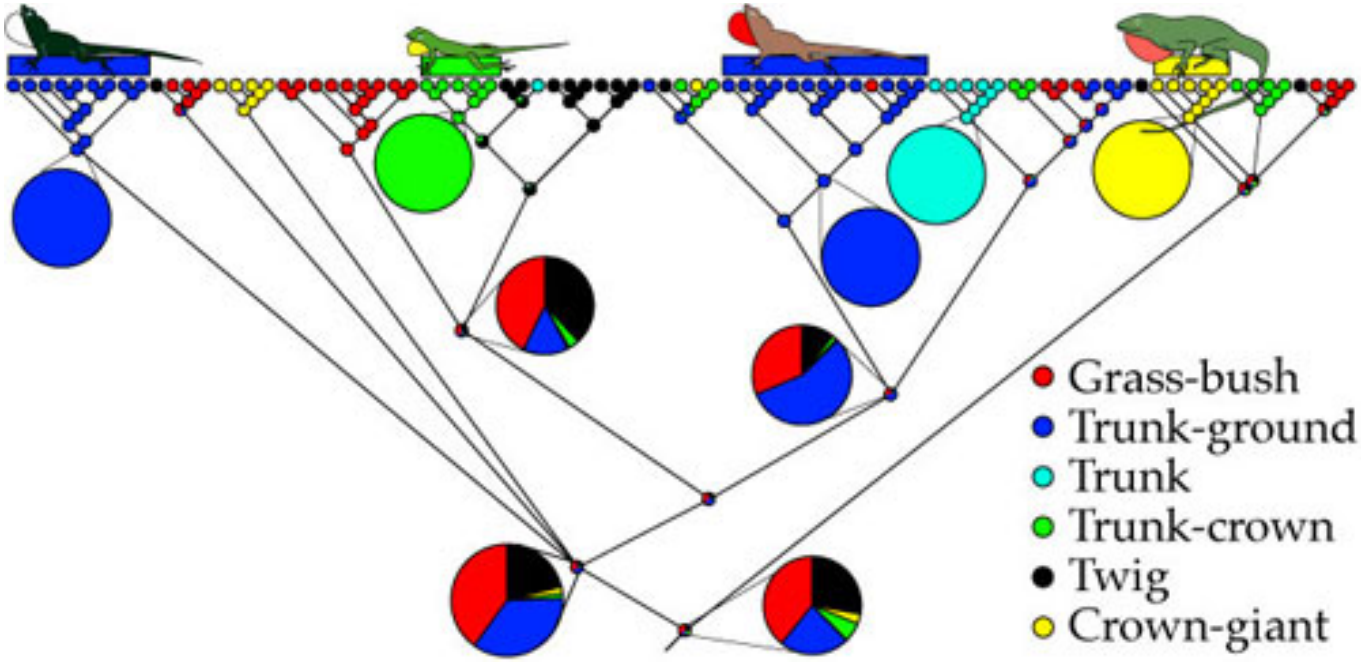
Mechanisms of reproductive isolation

- Geographic separation:



Ecological differences

- Similar organisms use environment differently (e.g., time of day, specific locations) and so do not encounter each other



http://www.rochester.edu/college/bio/professors/glor

Structural differences in reproductive anatomy

Flowers put pollen on bees in different places.

http://nathistoc.bio.uci.edu/hymenopt/Osmia.htm

This little bee (*Osmia* sp.) is able to pollinate two different species of Chinese Houses (*Collinsia*) because they put the pollen in slightly different places.

They may have originally been the same species of Collinsia, but a mutation changed the shape of the flower, so the pollen was not delivered to the female organs in the original species.

Chromosomal differences: mules

- Some species with different numbers of chromosomes can mate, but produce sterile offspring - the babies can’t make “normal” gametes
- Zebroids: horses have 66 chromosomes; zebras have 44-64 depending on species
- Same phenomenon in ducks and geese

Chemical differences: pheromones and other scent receptors

Anise swallowtail: attracted to anise and related plants, and citrus

Tiger swallowtail: attracted to cottonwoods and willows

Behavioral differences

- Organisms have specific mating behaviors

Biospecies

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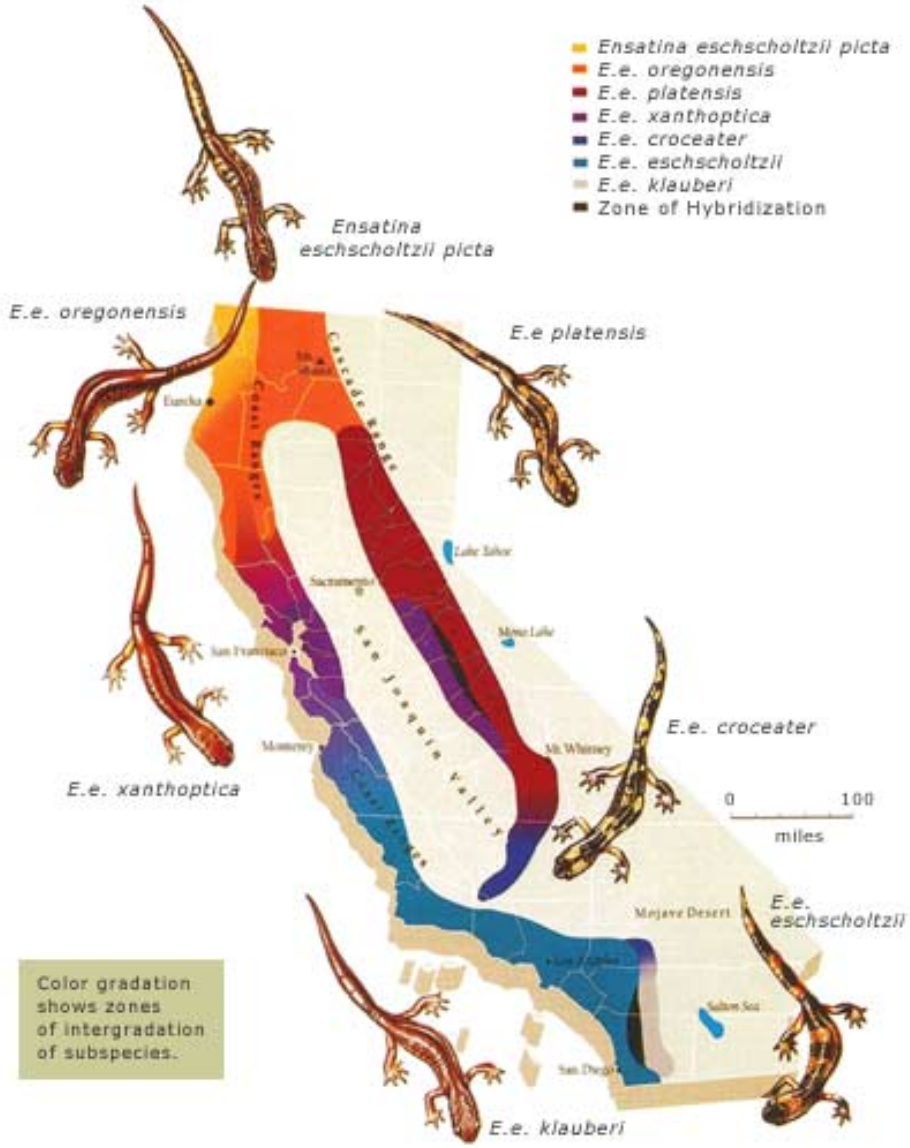
Native to southeastern U.S. -
Is it a distinct species, or just a remnant of the grey wolf left behind as its range was destroyed by development?

Biospecies Challenges

- Clines: gradients in characteristics



http://3.bp.blogspot.com/-AqjleeMWbtc/TxFx3T-R02I/AAAAAAAAAr0/U0sxgr9EFmo/s640/l_052_05_l.jpg

Ring species:
Cline that's circular

http://en.wikipedia.org/wiki/
File:Rings_species_example.png

Morphospecies

- A diagnosable cluster of individuals within which there is a pattern on ancestry and descent, and beyond which there is not
- In practice - critters that look alike

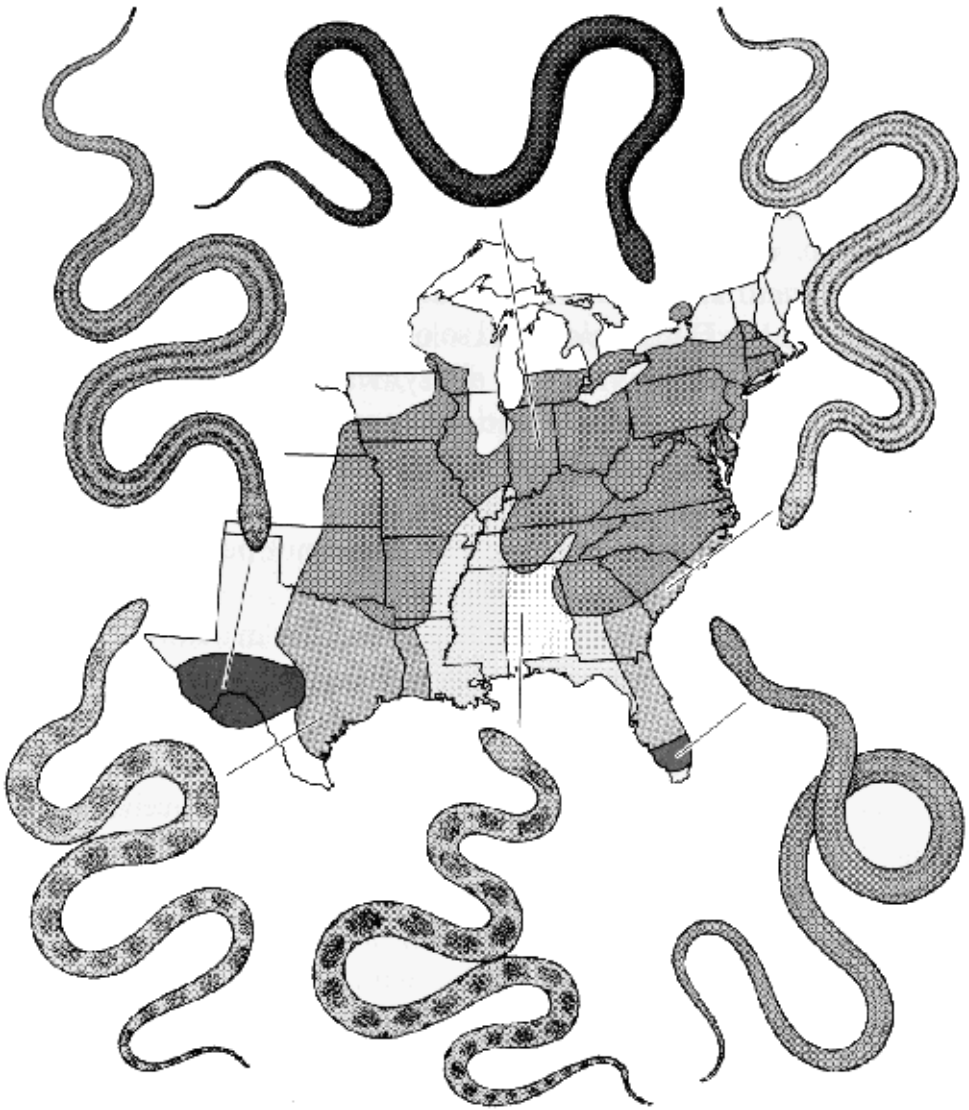
Applying morphospecies concept to fossils

- No behavioral evidence left behind
- Lost morphological characters, e.g. color

coneshell.net

Applying morphospecies

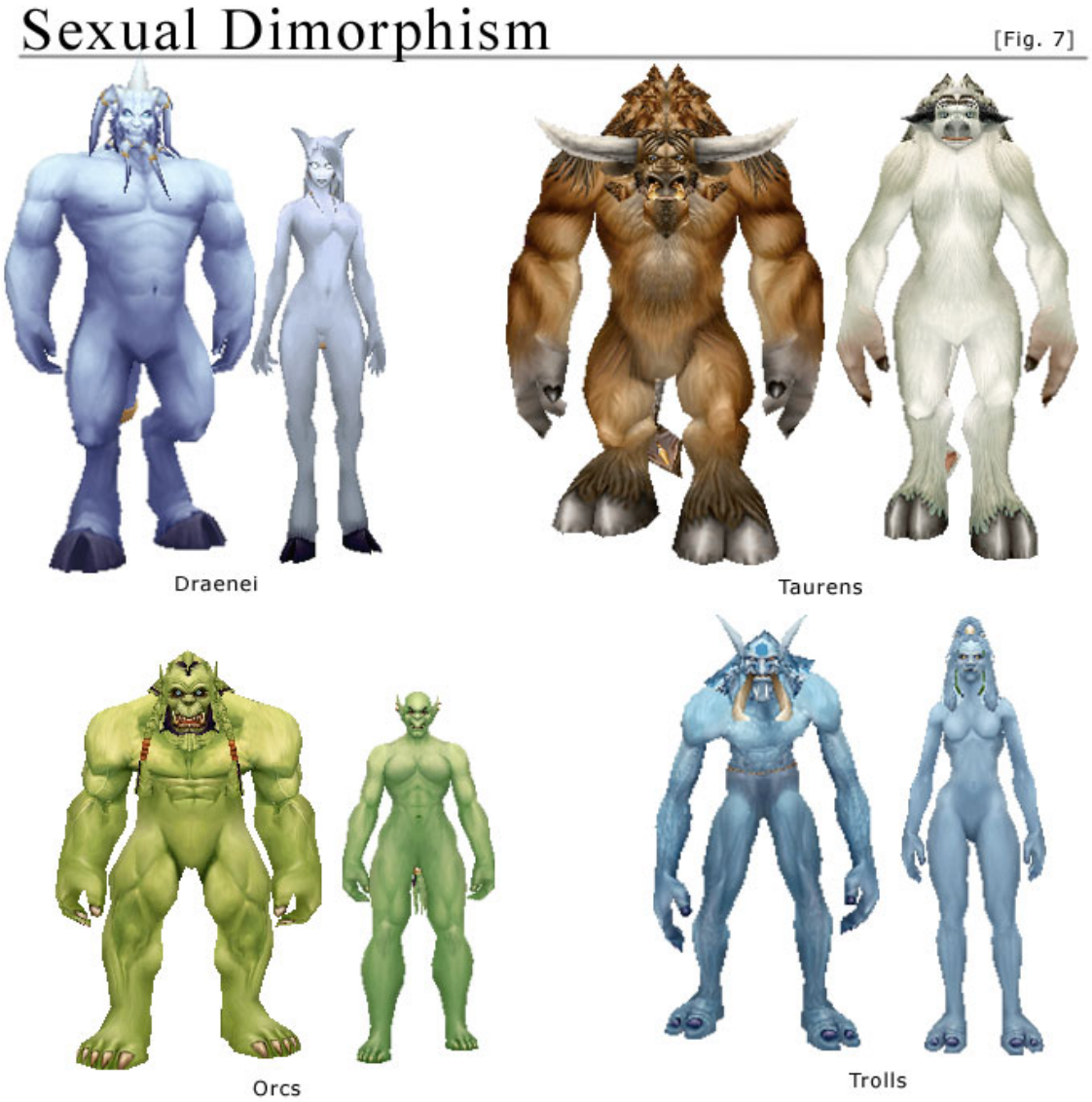
- Distinguishing variation in species from overlapping species



http://palaeos-blog.blogspot.com/2013_05_01_archive.html

Applying morphospecies

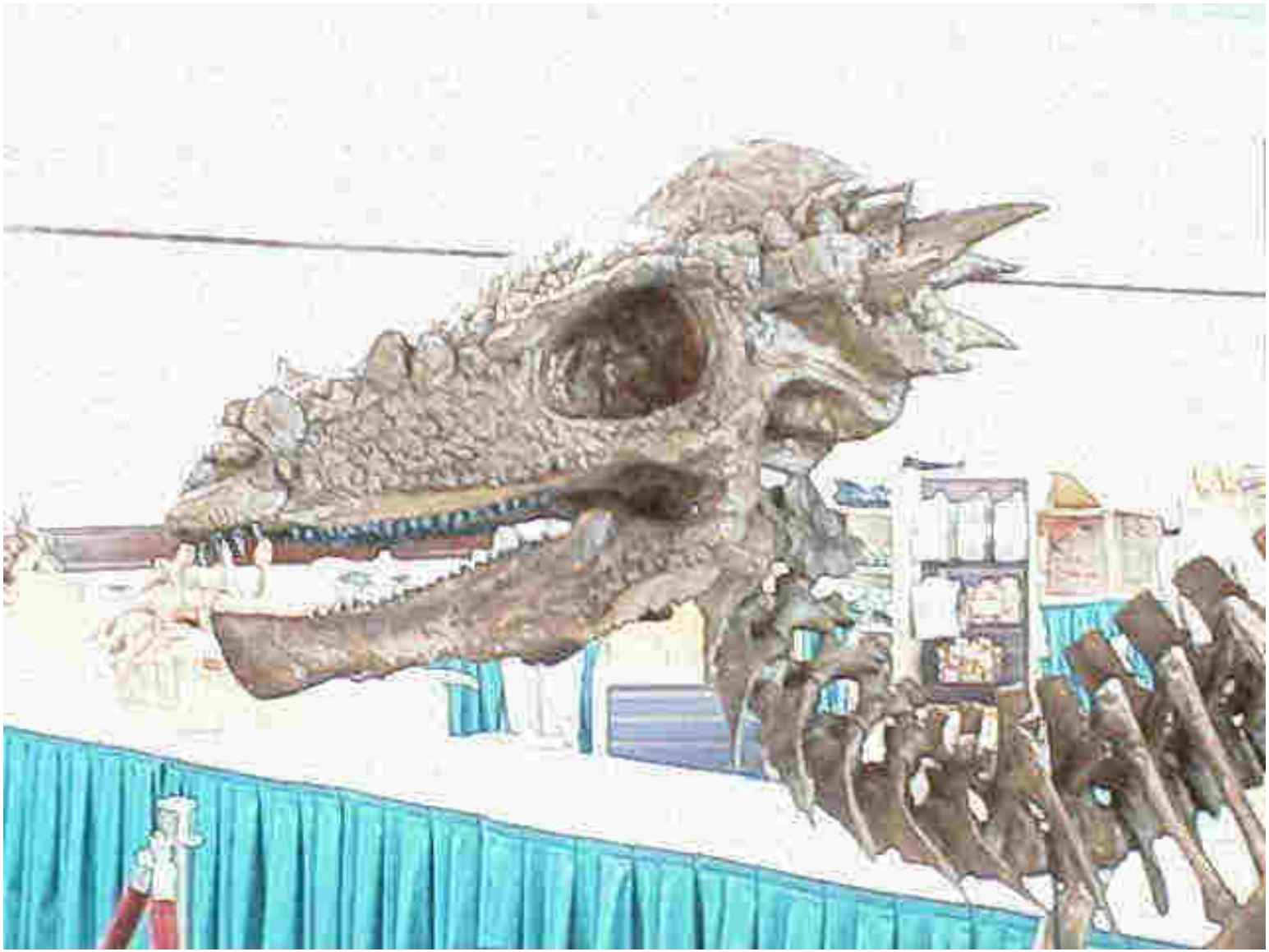
- Recognizing sexual dimorphism -
  - When the sexes are a different size and shape
  - Usually females are larger
  - Male morphology may be driven by sexual selection



http://sunniersartofwar.com/images/2011/10/31/dimorphism.jpg

http://static.kienthuc.net.vn:81/Images/dataimages/201206/original/images930127_chim_Tri.jpeg

http://static.republika.co.id/uploads/images/detailnews/kura-kura-diamondback-terrapin-_110630093455-666.jpg

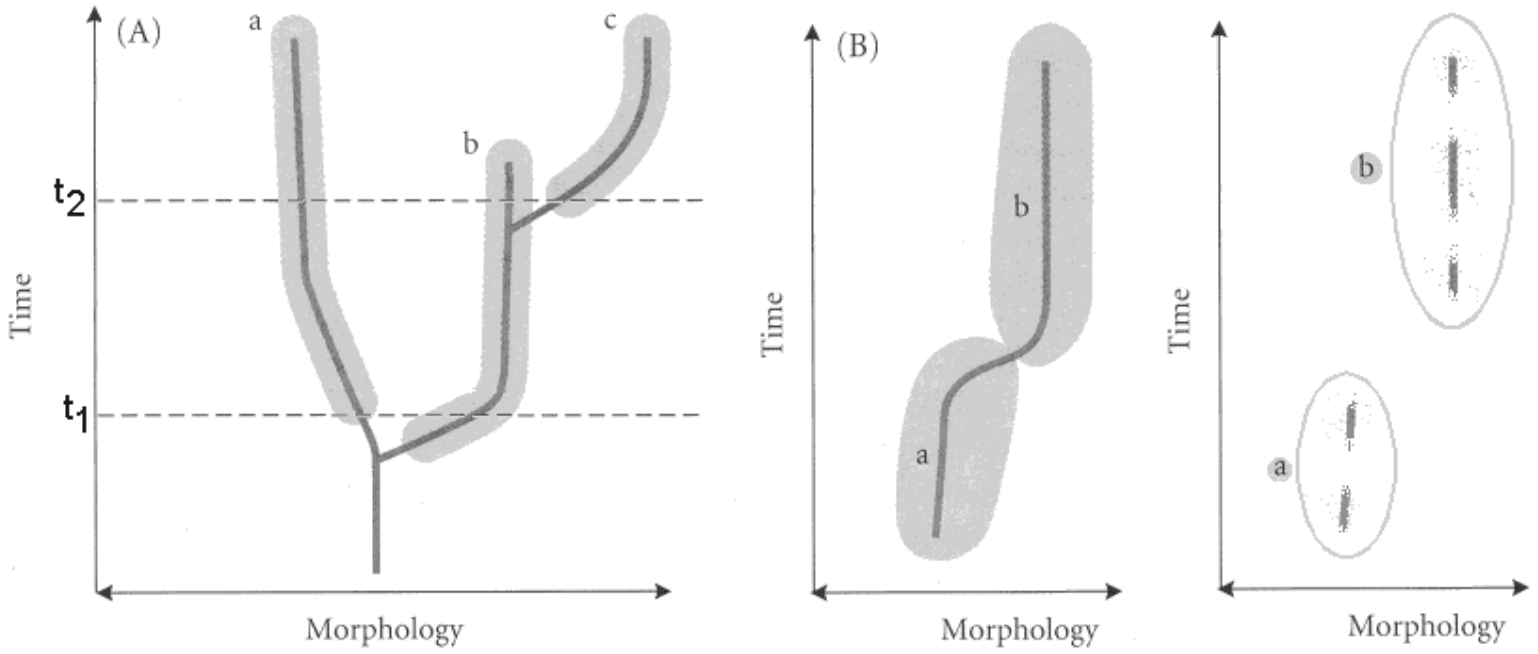


http://www.gate.net/~mcorriss/P1.htm


www.fossilmall.com

Applying morphospecies

- Recognizing evolutionary species - where do you draw the line?



http://www.mun.ca/biology/scarr/Fut_15_04_chronospecies_4.gif

Defining morphospecies

- Choosing the type
  - Must be one specimen that defines the species (holotype)
  - Useful to have other specimens that illustrate variation (paratypes)

Speciation

- When a population becomes reproductively isolated and persists
- The speciation event is NOT typically a product of natural selection, but some kind of geographic or biologic accident
- After the event the species may diverge by natural selection or other mechanisms

Speciation Mechanisms

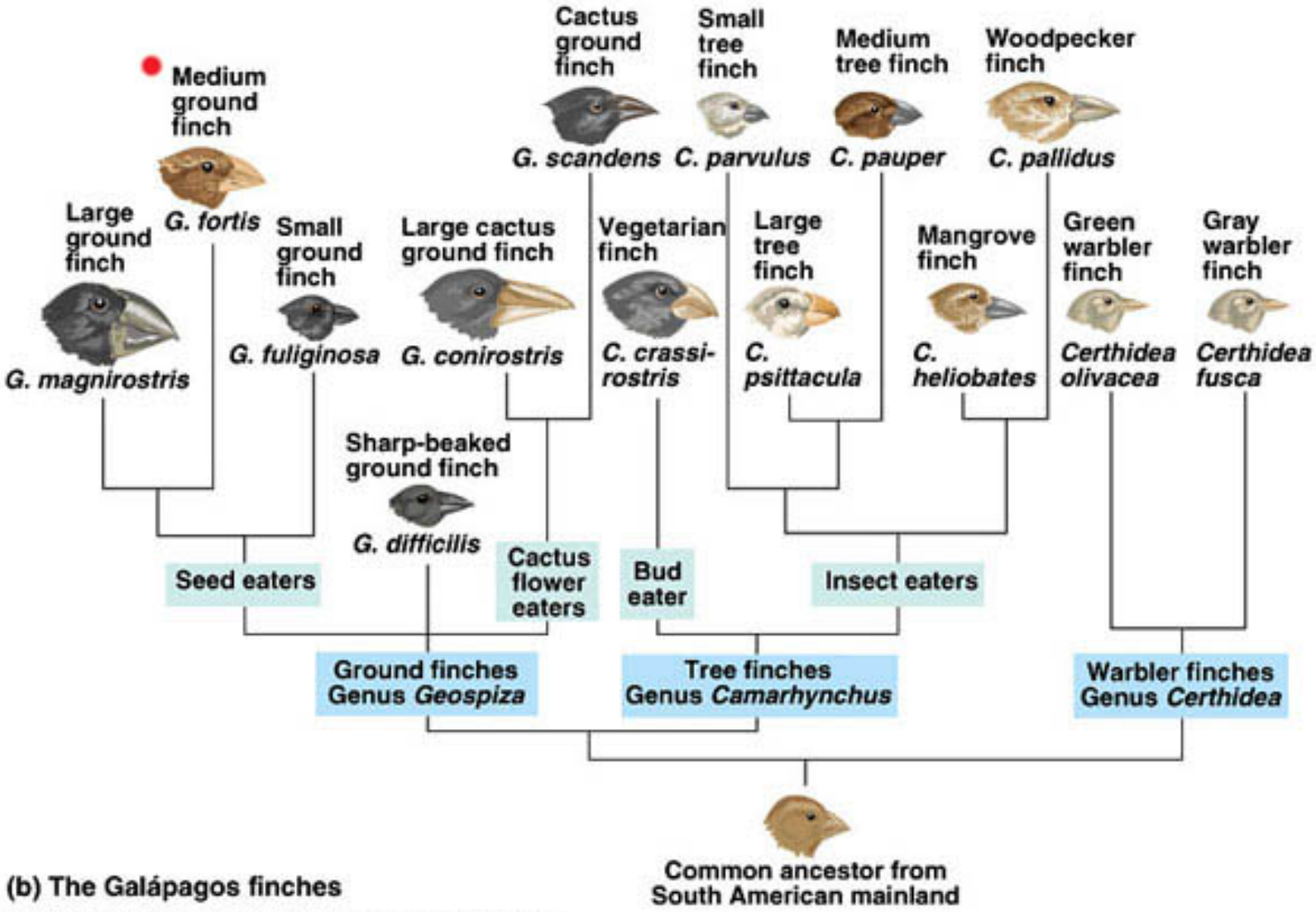
- Allopatric - geographic separation
  - A population becomes separated
  - No more gene flow to other populations - poof, new biospecies on an operational level
  - Over time, the new population evolves in its own direction
  - When is it different enough to consider a separate morphospecies?

Allopatric speciation

- How does the new species become morphologically different from the parent species?
  - Natural selection
  - Founder effect – NOT natural selection
  - Genetic drift – NOT natural selection

Allopatric speciation

- Natural selection - the new species may adapt differently to new environment or with a different set of mutations
  - E.g. Darwin's finches -
  - Different food plants on different islands meant finches adapted differently



(b) The Galápagos finches

Allopatric Speciation

- Founder effect : The separated population will have only a piece of the total genetic variation of the species
  - The mutation for polydactyl cats apparently arose in Southeast England. They were carried to Maine as ship's cats (for good luck) and were the beginning of the Maine Coon Cat.

While the Maine Coon Cat illustrates founder effect, there was also strong selection for polydactyl cats (that's what the sea captains preferred.

http://sdmvc.blogspot.com/2012_08_01_archive.html

http://www.tiritirimatangi.org.nz/oystercatcher

Here's the Variable oystercatcher of New Zealand. Babies have all-white bellies. Adults are usually solid black, or have a bit of white feathers mixed in on their belly.

Here's the Chatham Island Oystercatcher. Only about 250 of these birds live on an island off the coast of New Zealand. All adults have white bellies. Using founder effect, can you explain why these birds look different from the Variable, who they evolved from?

http://blog.doc.govt.nz/2012/02/27/chatham-island-oystercatcher/

Allopatric speciation

- Genetic drift - over time the new species accumulates neutral changes in genes
  - E.g. accumulated changes in isolated populations of cypress trees in the Southwest
  - Once solid forest, broken into patches as the region's climate became drier in the post-glacial time.
  - Cypresses were isolated from those in other patches. Each patch accumulated its own mutations.

C-F are all considered the same species

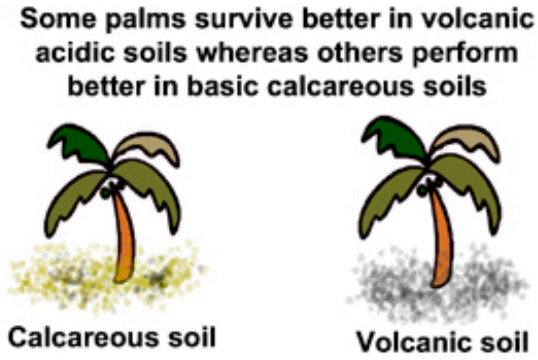
Sympatric speciation

- Occurs within a population, requires NO geographic separation
- Can occur from changes in any of the reproductive isolation mechanisms we already talked about:
  - Chromosomal, structural, ecological, chemical, behavioral

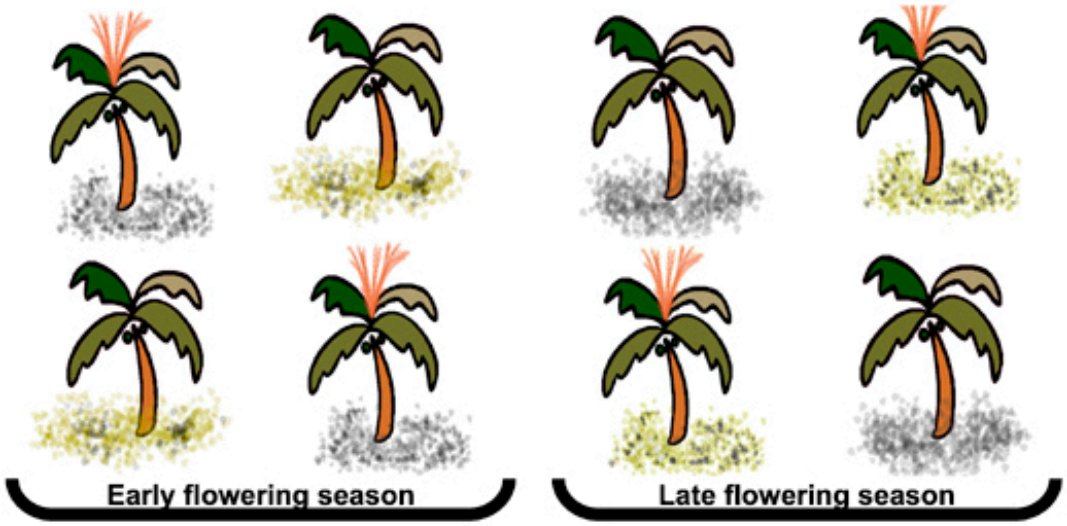
Examples of sympatric speciation

- Chromosomal: wheat
  - Two diploid (paired chromosomes) wild grasses hybridized to form a tetraploid wheat (2 sets of paired chromosomes)
- Structural: Chinese Houses flower
- Chemical: anise swallowtail
- Ecological: palms on Lord Howe Island

Disruptive selection



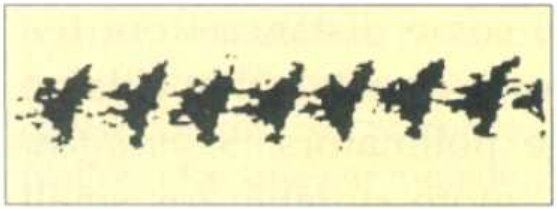
Assortative mating



Barrientos & Rieseberg, 2006, Splitting when together, *Heredity* 97:2-3
http://www.readcube.com/articles/10.1038/sj.hdy.6800840

Examples of sympatric speciation

- Chromosomal: wheat
  - Formed by accidental duplication of chromosomes
- Structural: Chinese Houses flower
- Chemical: anise swallowtail
- Ecological: palms on Lord Howe Island
- Behavioral: frog songs



a *Hyla versicolor*

b *H. chrysoscelis*

Tempo and Pattern of Speciation

- Phyletic gradualism: gradual change form one species to another
- Punctuated equilibrium: species arise quickly, then stay the same over time

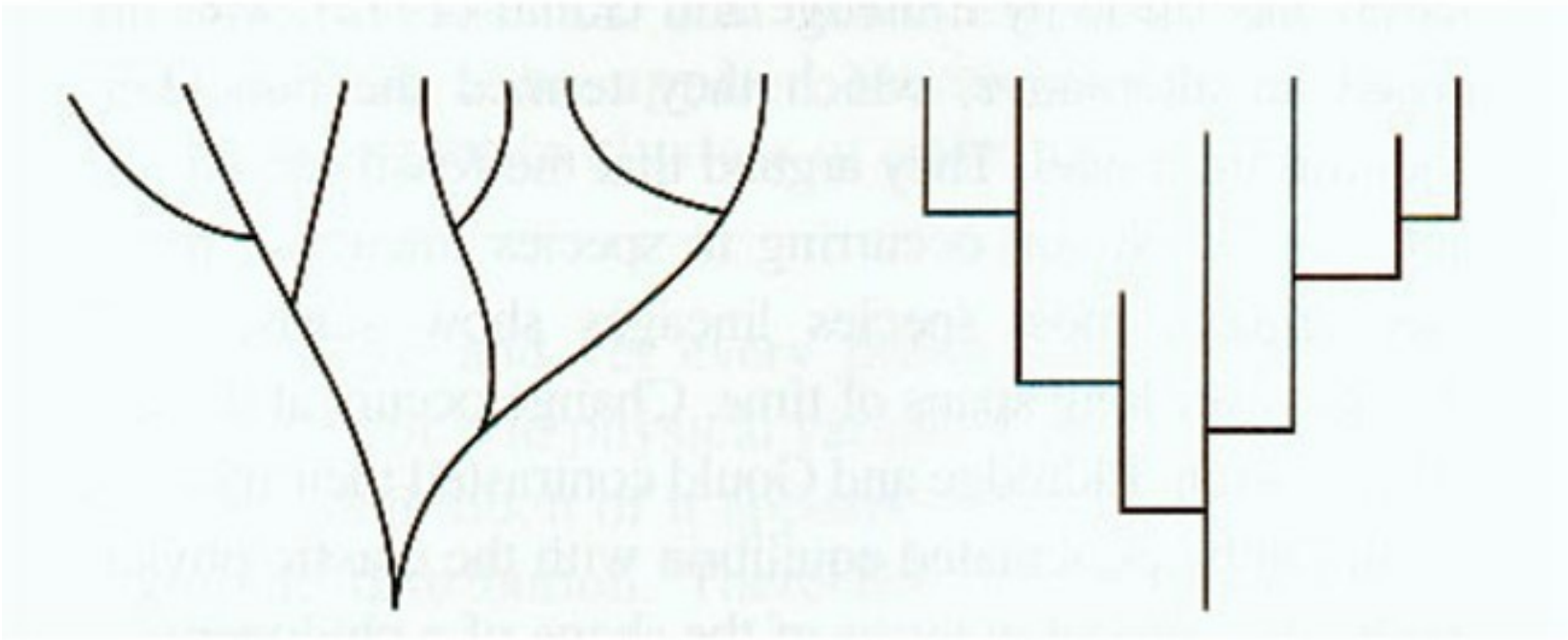


Fig. 3. Contrasting expectations of species-level evolution, the classic phyletic gradualism model (A), and the punctuated equilibrium model (B). Modified from various sources.

What does each imply about evolution?

- Phyletic -
  - Environments change gradually on a geologic time scale, driving change in populations
  - OR genetic drift is responsible for much of the morphologic change in new species
- Punctuated:
  - Environments change quickly, then remain stable
  - OR geographic isolation occurs quickly
  - OR reproductive isolation occurs quickly and is accompanied by rapid morphologic change

So which pattern is “right”?

- Different kinds of organisms show different kinds of patterns
- Some even show a hybrid - punctuated gradualism
  - Rapid speciation, followed by gradual change over time
  - Typical of single-celled organisms that rely less on sexual reproduction