

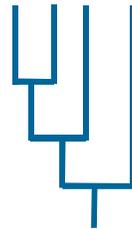
Speciation

most important problem in evolutionary biology

- change over time
- diversification

Outline

- Species concepts
- Mechanisms of speciation
- Genetics of speciation
- Haldane's rule



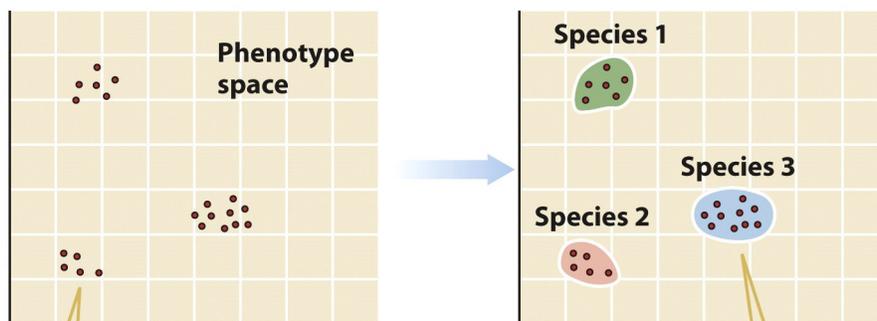
Species Concepts

species as categories -- taxa
 species as evolutionary groups -- "smallest
 independent evolutionary unit"

"...lineage of ...populations which maintains its identity
 from other such lineages and which has its own
 evolutionary tendencies and historical fate"
 (Wiley 1978)

importance -- conservation of biological diversity
 understanding the process of diversification

phenetic species concept



- many characters
- problems of character weighting

phenetic species concept

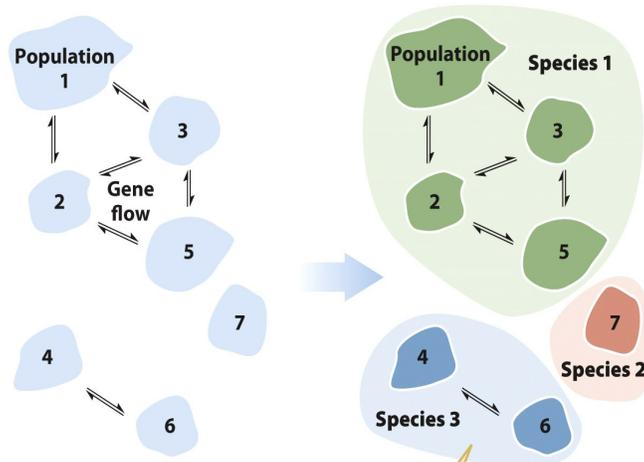
fossil species

problems of cryptic species - limited characters



Biological Species Concept -- Ernst Mayr (1947)

"Species are actual or potentially interbreeding natural populations which are reproductively isolated from other populations"



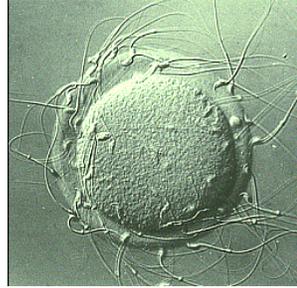
Biological Species Concept -- Ernst Mayr (1947)

emphasizes: genetic exchange within species
reproductive isolation between species

pre-mating (prezygotic)



post-mating (postzygotic)



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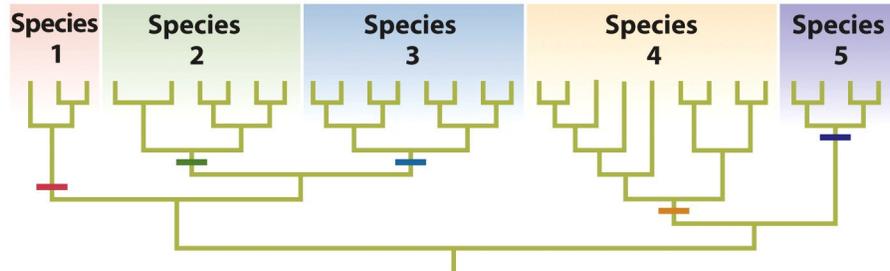
can be difficult to apply

and, doesn't apply to many species:

- asexual species
- hybridizing species
- fossil species

Phylogenetic Species Concept -- Joel Cracraft (1989)

"An irreducible (basal) cluster of organisms diagnosably different from other such clusters, and within which there is a parental pattern of ancestry and descent"



"..smallest monophyletic group distinguished by a shared derived character"

Outline

Species concepts

Mechanisms of speciation

- geographical speciation
- ecological speciation

Genetics of speciation

Haldane's rule

mechanisms of speciation

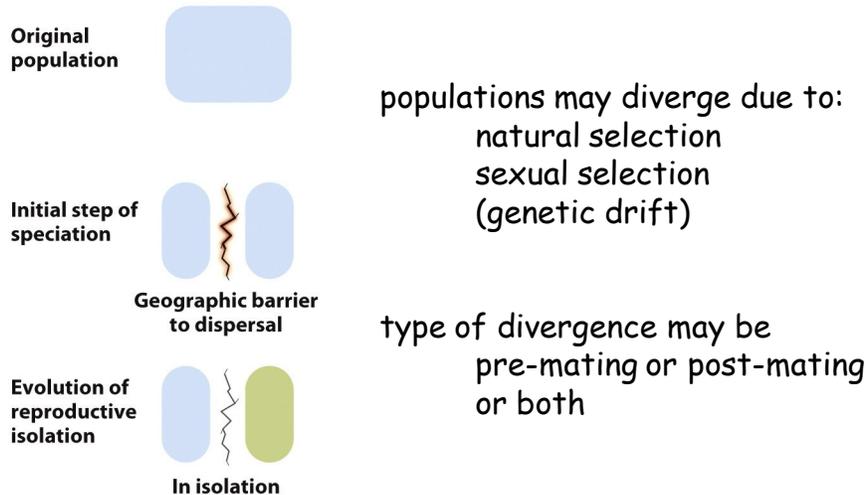
geographic isolation (allopatric speciation)
 vicariance
 founder event

geographic isolation models

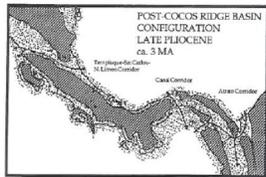
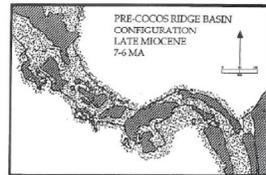
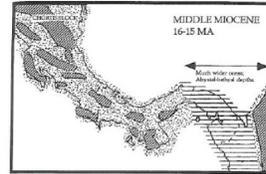
isolation of populations
 genetic divergence of populations
 development of reproductive isolation

vicariance models:

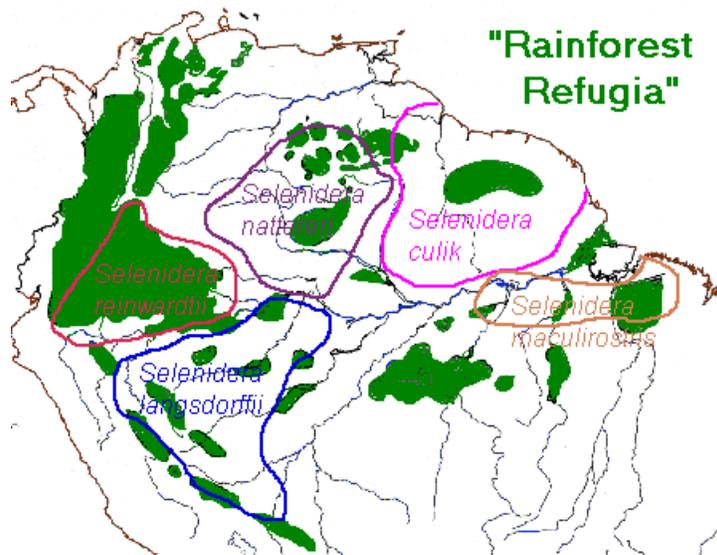
geographic speciation due to range splitting



closing of the Isthmus of Panama

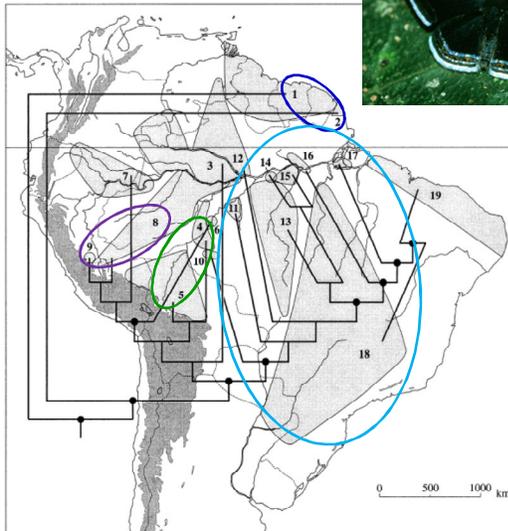


Pleistocene contraction of Amazonia

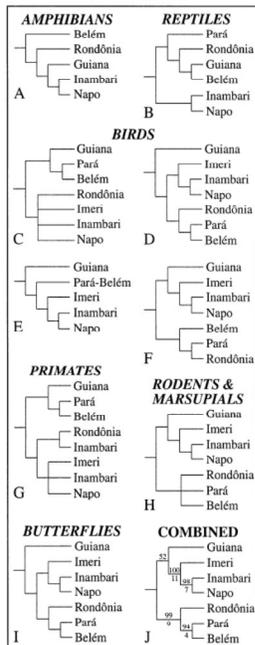


vicariant speciation in a butterfly clade

- * 1 *Charis cleonus*
- * 2 *Charis rocana*
- 3 *Charis negro*
- * 4 *Charis ariqueemes*
- * 5 *Charis manu*
- 6 *Charis humaita*
- 7 *Charis iquitos*
- * 8 *Charis tefe*
- * 9 *Charis palacazu*
- 10 *Charis cacaulandia*
- 11 *Charis manicore*
- 12 *Charis ipiranga*
- 13 *Charis cuiaba*
- 14 *Charis maues*
- 15 *Charis tapajos*
- 16 *Charis santarem*
- 17 *Charis breves*
- 18 *Charis brasilia*
- 19 *Charis caryatis*



Hall and Harvey 2002



A frogs 342 spp

B lizards 107 spp

C toucans 10 spp

D toucans, woodpeckers, manikins, cotingas 37 spp

E parrots, toucans 25 spp

F all Neotropical passerines 1717 spp

G primates 51 spp

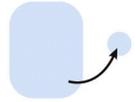
H sciurid, murid, echimyid rodents and marsupials 17 spp

Hall and Harvey 2002

geographic speciation due to a founder event



founder population is genetically different from source population; genetic drift is important at the *start* of the process



Dispersal to isolated region

divergence via:
natural selection in a novel environment
sexual selection



In isolation

type of divergence may be pre-mating or post-mating or both

patterns of speciation in Hawaii are consistent with founder events

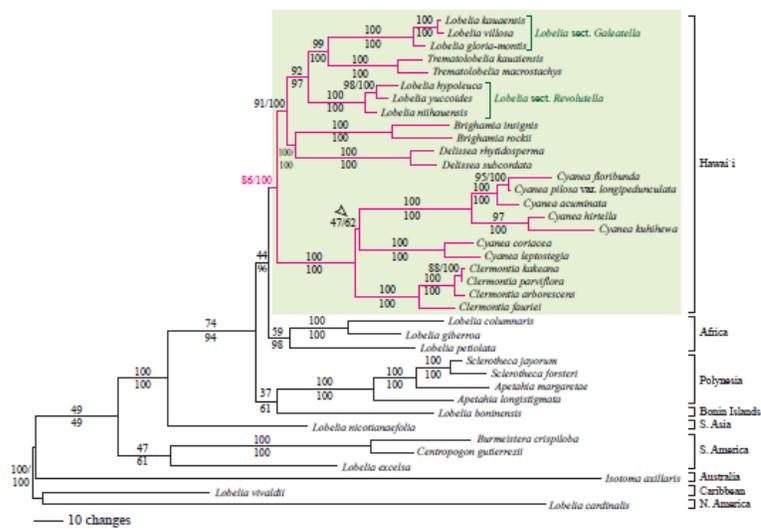


founder event speciation in the Hawaiian lobeliads



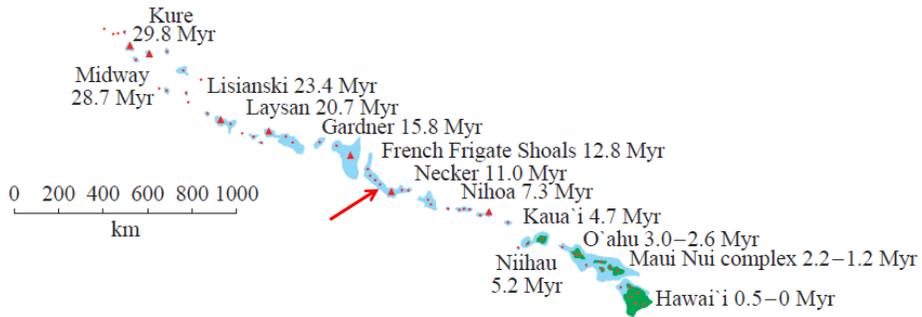
Givnish et al 2009

phylogenetic analysis based on DNA sequences from seven segments of chloroplast genome



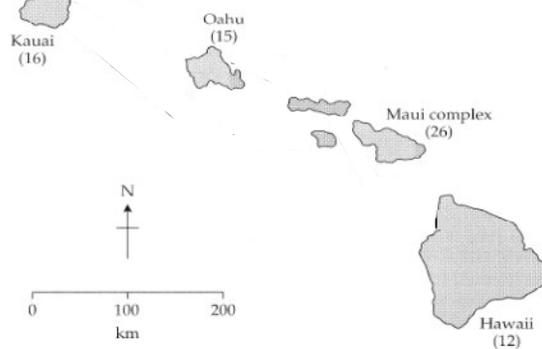
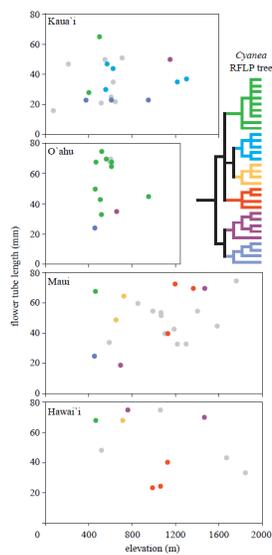
Givnish et al 2009

adaptive radiation from a single colonization event ~13 mya



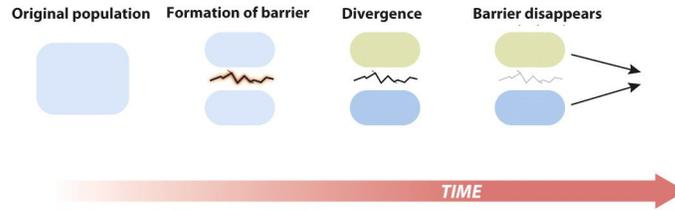
Givnish et al 2009

founder event speciation in *Cyanea*



Givnish et al 2009

outcomes of divergence in allopatry

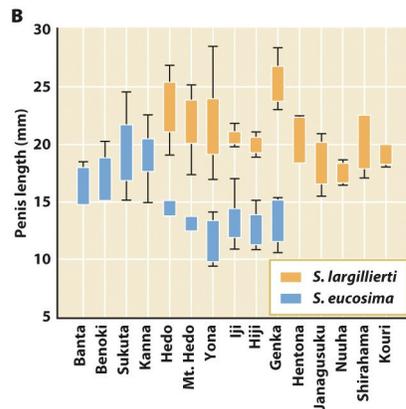
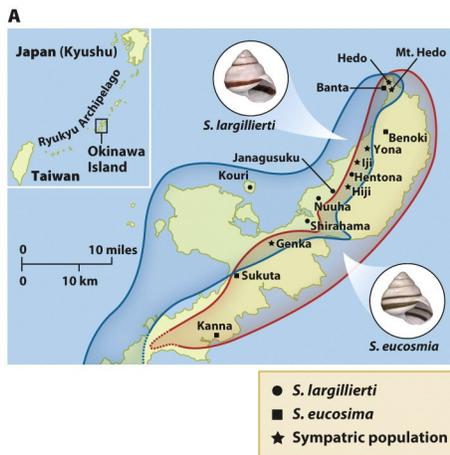


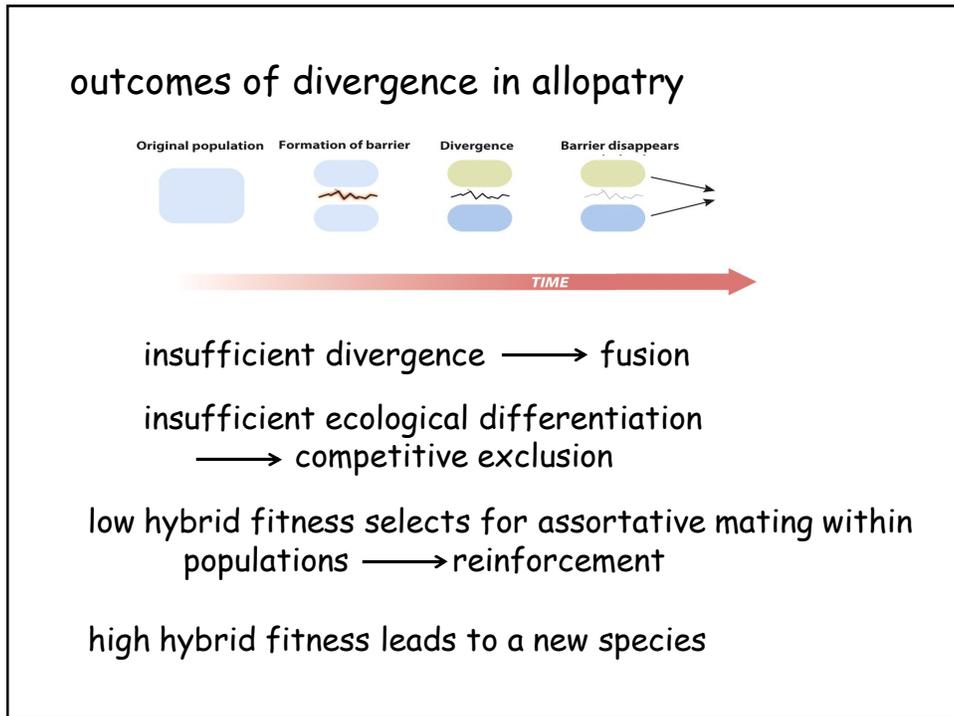
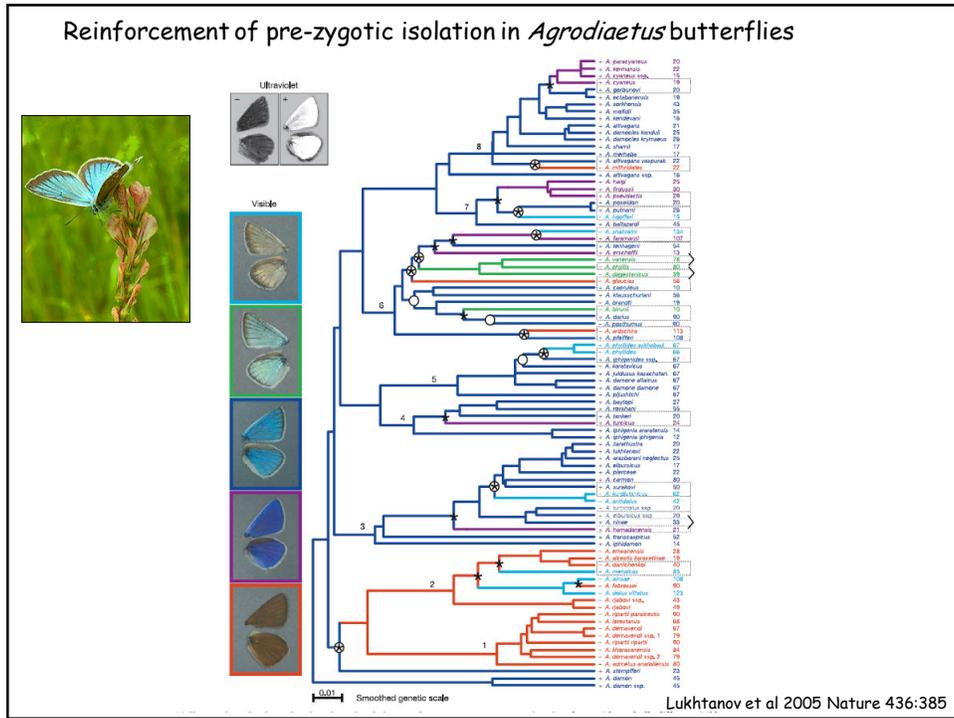
insufficient divergence → fusion

insufficient ecological differentiation
→ competitive exclusion

low hybrid fitness selects for assortative mating within populations → reinforcement

reproductive character displacement in snails





Species are evolutionarily independent groups. A species is often defined as a group of populations that are capable of interbreeding, but this definition applies best to diploid, sexually reproducing taxa. Populations which are phenotypically or ecologically distinct, yet regularly interbreed, or species that reproduce largely asexually may still be valid species.

Reproductive isolation between species may result from assortative mating (prezygotic) or from hybrid sterility/inviability (postzygotic).

The process of adaptive divergence that leads to speciation frequently occurs through geographic isolation. Genetic drift may accelerate the process of divergence in founder events.

Although reinforcement may occur during secondary contact, it is not a universal requirement for speciation.