Bio1B Evolution 9

Last lecture:
Evolution of sacrifice (altruism)
Species & speciation

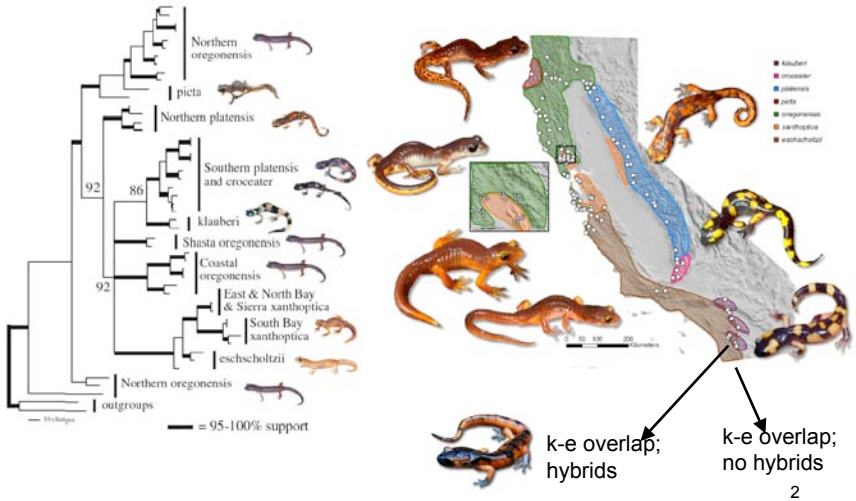
- What is a species anyway? (Pp. 487-492)
  - Concepts - typological, biological, phylogenetic
  - Reproductive isolation - mechanisms
  - Easy one? - Humans & living relatives

Today

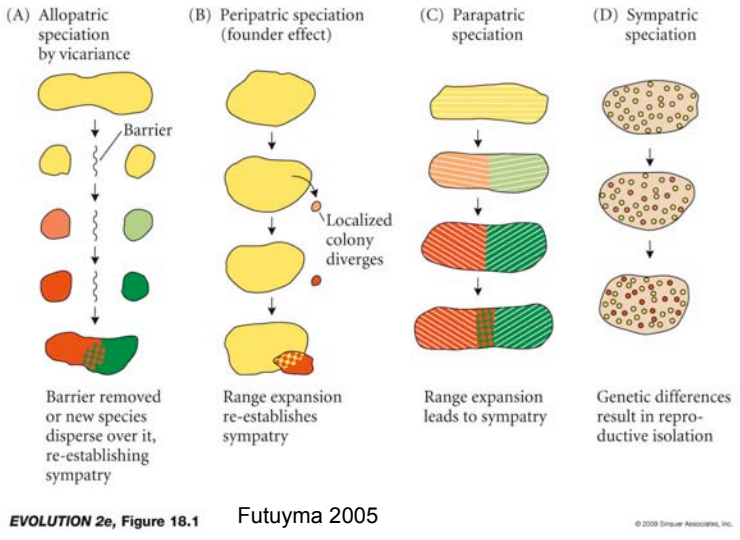
Species & speciation

- What is a species anyway? (Pp. 487-492)
  - Interesting one - Ensatina salamanders
- Speciation processes (Pp 492-504; Losos & Rickleffs (2009) paper -
- Introduction & geographic modes
- Adaptive radiations
- Hybridization - hybrid zones, reinforcement & hybrid-speciation

Ensatina eschscholtzii - One ring species? Or 2 biological species? Or >11 Phylogenetic species

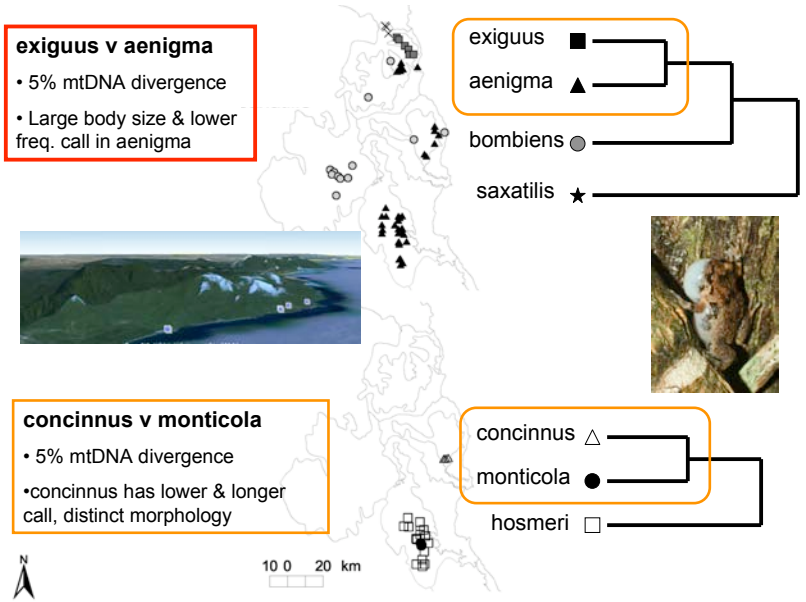


Geographic modes of speciation

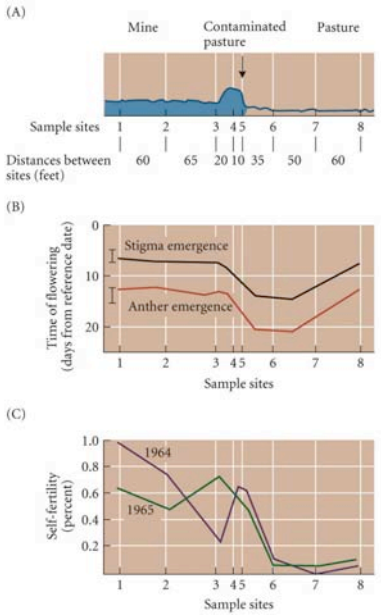


Futuyma 2005

Allopatric sister species among northern, montane *Cophixalus* (Hoskin 2004)



Parapatric evolution of reproductive isolation over a very short distance in the grass species *Anthoxanthum odoratum*

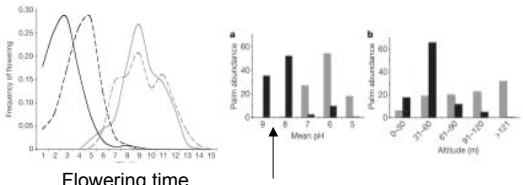


Futuyma 2005 ***EVOLUTION 2e*, Figure 18.20**

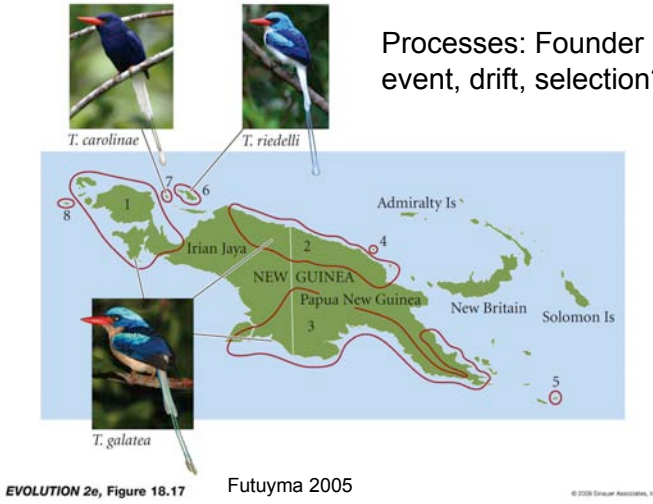
Sympatric speciation on remote islands:

eg. Lord Howe Island palms (*Howea*) Savolainen et al. 2006 Nature 441:210-214

Recently (<1Mya) formed sister species - ecologically distinct and with divergent flowering time - despite high gene flow across the range of each species on the island



Peripatric speciation: paradise-kingfishers in New Guinea (Mayr)

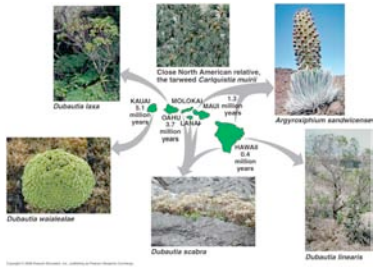


Processes: Founder event, drift, selection?

***EVOLUTION 2e*, Figure 18.17** Futuyma 2005

Adaptive radiations (pp. 524-5)

- Rapid speciation with ecologically-driven divergent selection
- Common on remote islands or other novel environments following colonization
- Promoted by isolation & ecological opportunity

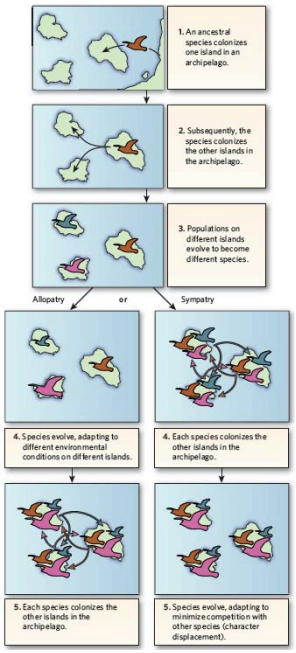


e.g. Hawaiian silverswords (Fig. 25.18)

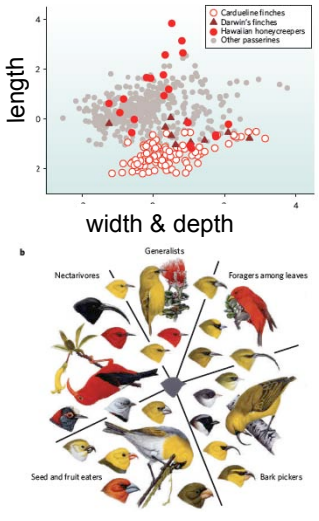
Other examples: African cichlids, Hawaiian arthropods, Andean lupines, Carribean anole lizards etc etc

Speciation on islands: Losos & Rickleffs 2009

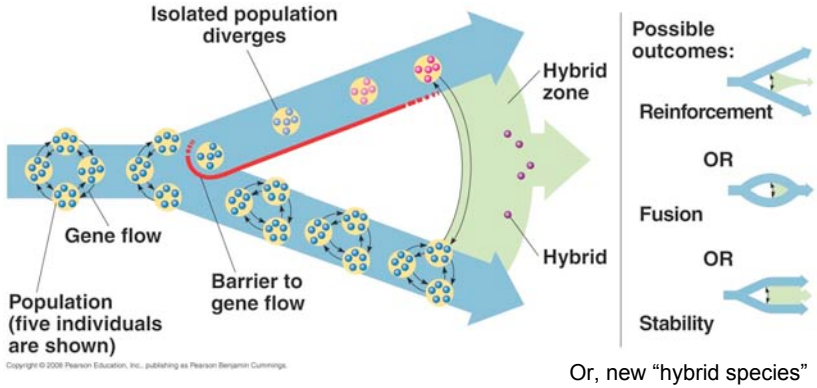
Adaptive divergence among or within islands



Adaptive divergence of bill dimensions



Hybrid zones - alternative outcomes



Or, new "hybrid species"

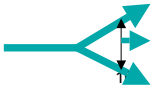
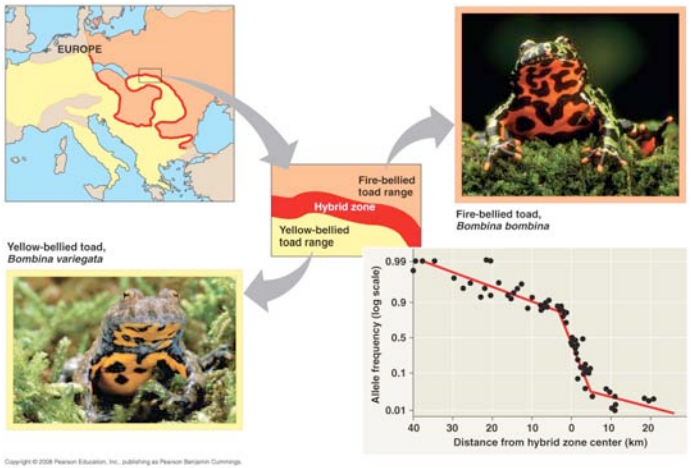
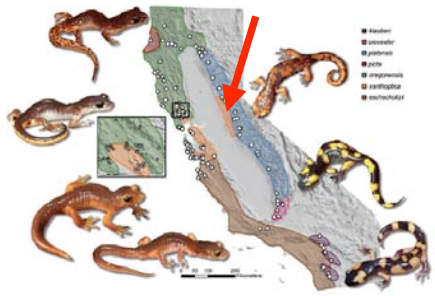


Fig. 24.14

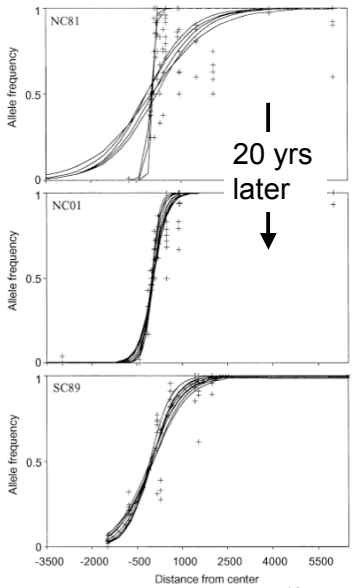
Hybrid zone - *Bombina variegata-bombina* (Fig. 24.13)



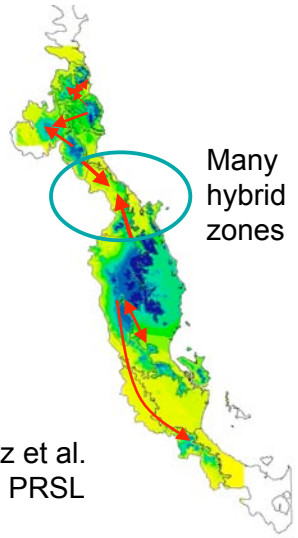
A stable hybrid zone in Ensatina



Alexandrino et al. 2005



Recent (<8kya) expansion from long-isolated (>2 Myr) refugia in the NE Australian rainforest



Many hybrid zones

Moritz et al. 2009 PRSL

Is there evidence for reproductive isolation?

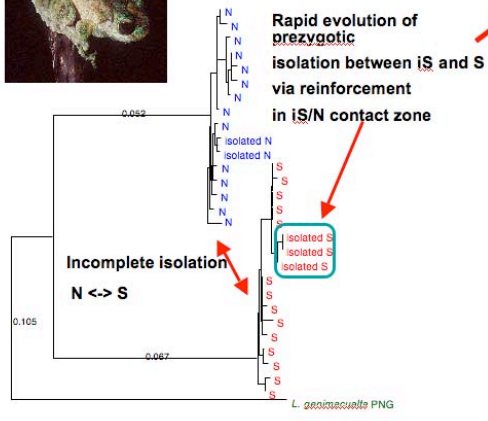
Is there evidence for reinforcement => prezygotic isolation?

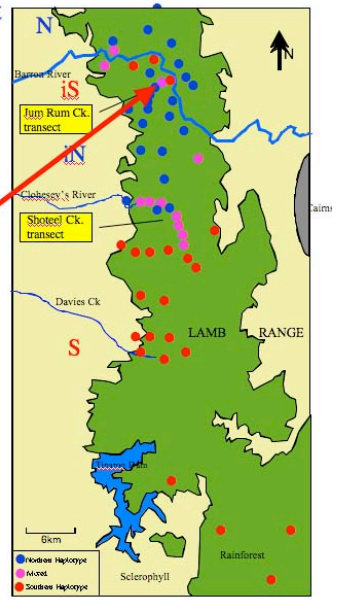
Skink = narrow (<1km) hybrid zone - random mating, but some selection against hybrids

Small marsupial - random mating, hybrid swarm

Frog - reinforcement => Reproductive isolation

Rapid allopatric speciation via reinforcement in the green-eyed tree frog
(Hoskin et al. 2005, Nature)



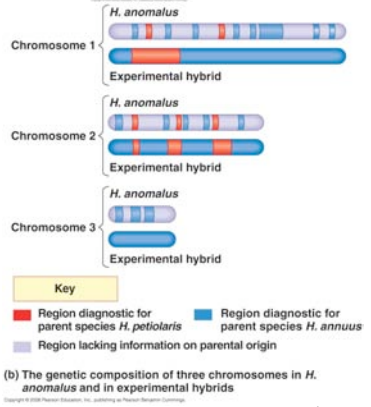


Hybrid speciation

=> Formation of unique and isolated lineages from inter-lineage hybrids

- Allopolyploidy (see p. 496)
- If same ploidy, requires eco-geographic isolation from parent lineages
- E.g. arid-adapted *Helianthus anomalus* = *H.annuus* X *H. petiolaris*

Fig 24.18, p. 503



Adaptive shifts via hybridization: diploid vs polyploid

Review: Mallet 2007, Nature 446:279-283