Speciation 1

Green Mumbles
https://www.youtube.com/watch?v=wTcfDCjBqV0

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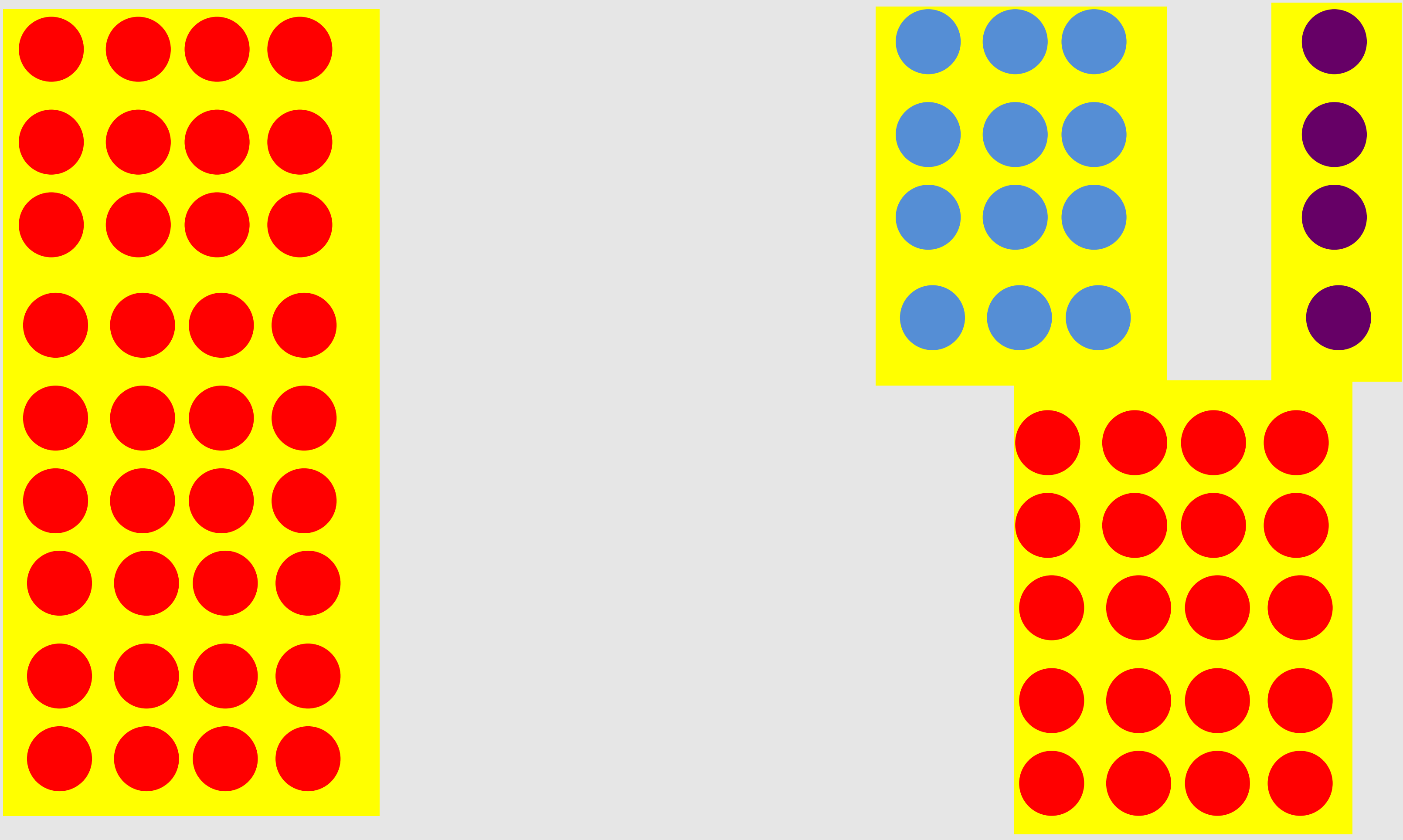
EEB464 Fall 2019

Learning objectives

- Understand factors that can lead to speciation
- Consider the geography of speciation
- Describe approaches to studying it



Initiation of speciation

Maintenance of current species

Prezygotic

Postzygotic

Prezygotic

- Physical or temporal isolation
- Lack of proper mating cues
- Mechanical problems
- Gametic problems

Postzygotic

- Hybrid inviability
- Hybrid sterility

Physical or temporal isolation

Wikimedia
commons

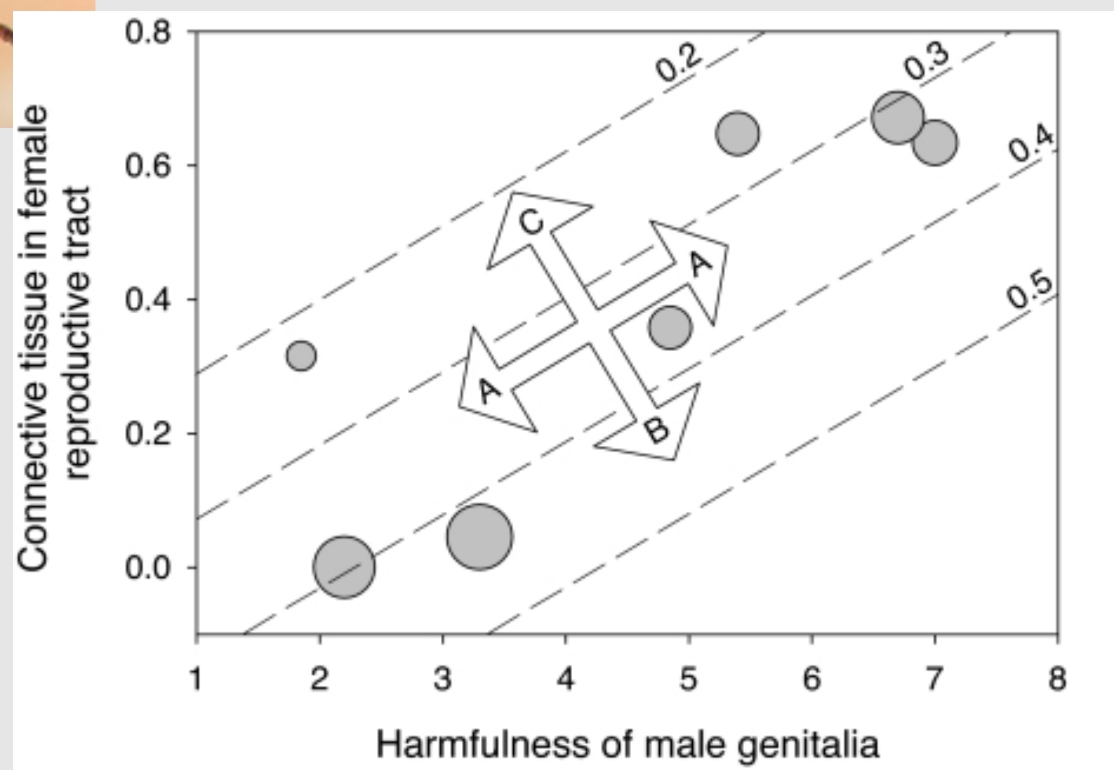
Lack of proper mating cues

Jurgen Otto & Dario Travato https://www.youtube.com/watch?v=xYIUFEQeh3g

Mechanical problems

Fleur Champion de Crespigny via *National Geographic*

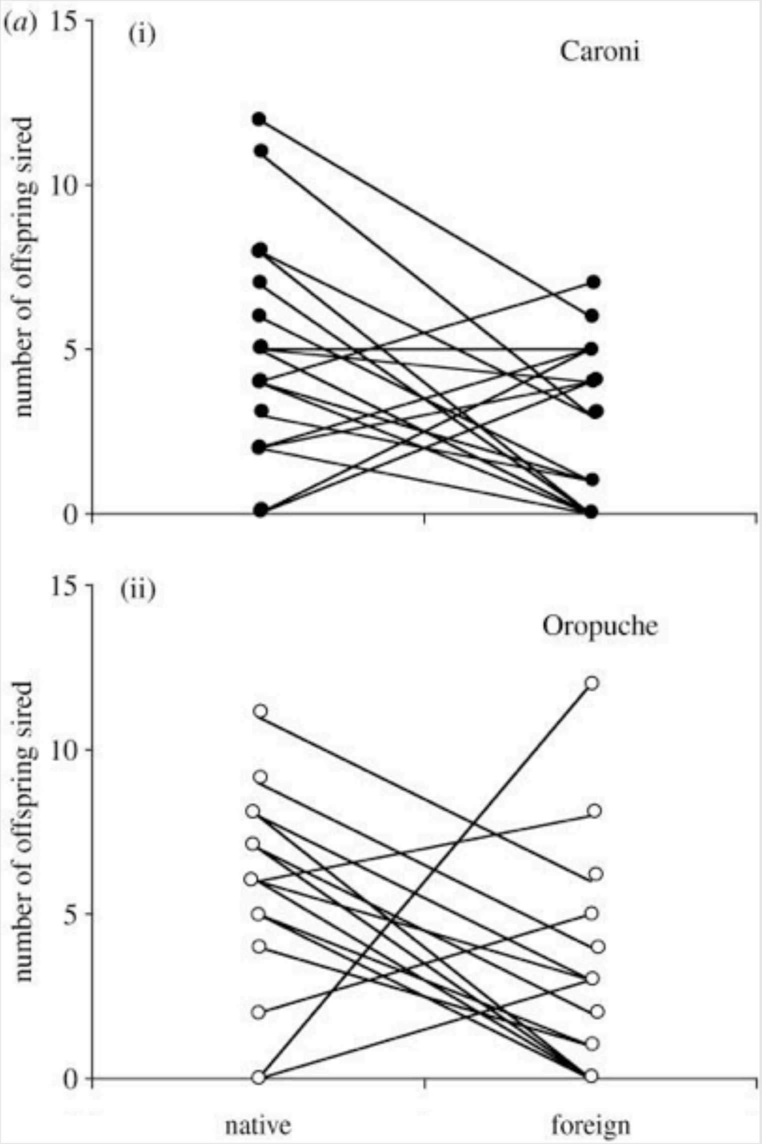
Johanna L. Rönn/Uppsala University via *National Geographic*



Rönn et al. 2007

Gametic problems

Wibowo Djatmiko

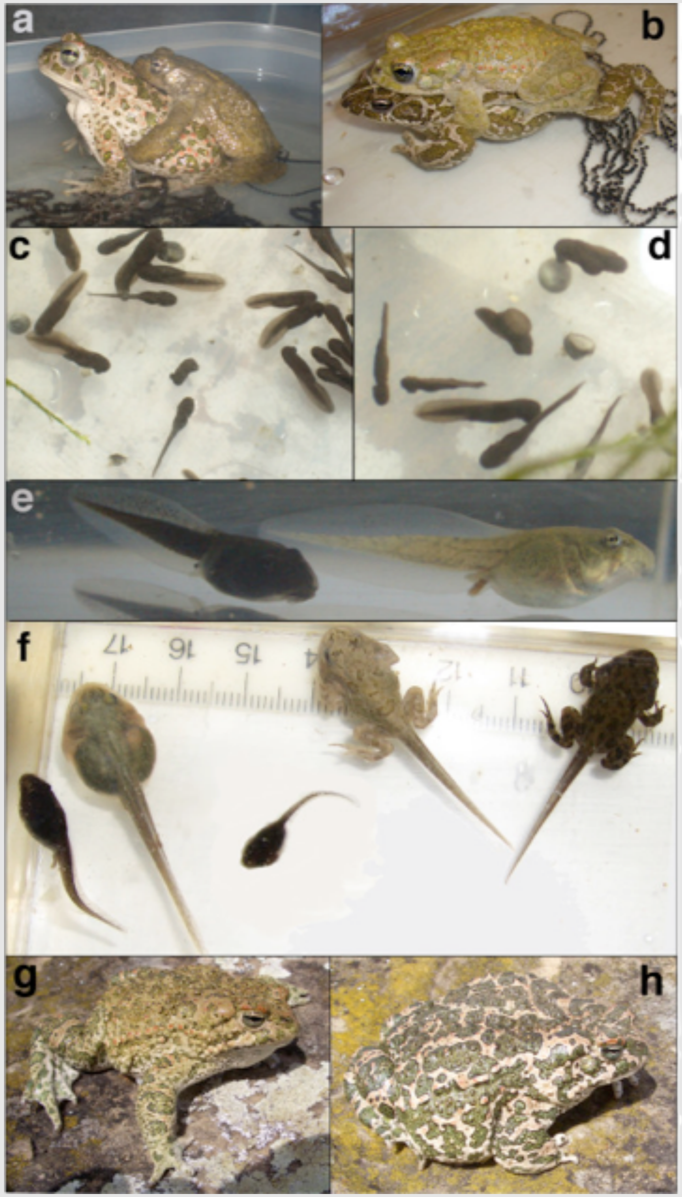


What do you see as trend here?

A. No trend
B. Foreign sires producing more offspring
C. Foreign sires producing fewer offspring

Ludlow, A.M. & A.E. Magurran. 2006. Gametic isolation in guppies (Poecilia reticulata). *Proc. Biol. Sci.* 273(1600):2477-2482

Hybrid inviability



Crosses of green toads from Sicily. a: Cross *B. balearicus* female × *B. siculus* male; b: reciprocal cross *B. siculus* × *B. balearicus*;

c-d: offspring in the age of seven days, showing dead and malformed embryos and tadpoles in comparison with apparently normally developing ones;

e: about one-months old normal tadpole (left) in comparison with leucistic "large" tadpole (right);

f: in the age of two months (from left to right): retarded tadpole, "giant" leucistic tadpole with developmental arrest, malformed dwarfed tadpole, leucistic tadpole that turned later out to be incapable of metamorphosis, apparently normally metamorphosing tadpole;

g: adult, two-year-old F_1-male;
h: adult, two-year-old F_1-female.

Photographs: M. Stöck.

Colliard et al. Strong reproductive barriers in a narrow hybrid zone of West-Mediterranean green toads (Bufo viridis subgroup) with Plio-Pleistocene divergence. BMC Evol Biol (2010) vol. 10 pp. 232

Hybrid sterility

http://ywwg.com/wordpress/?p=397

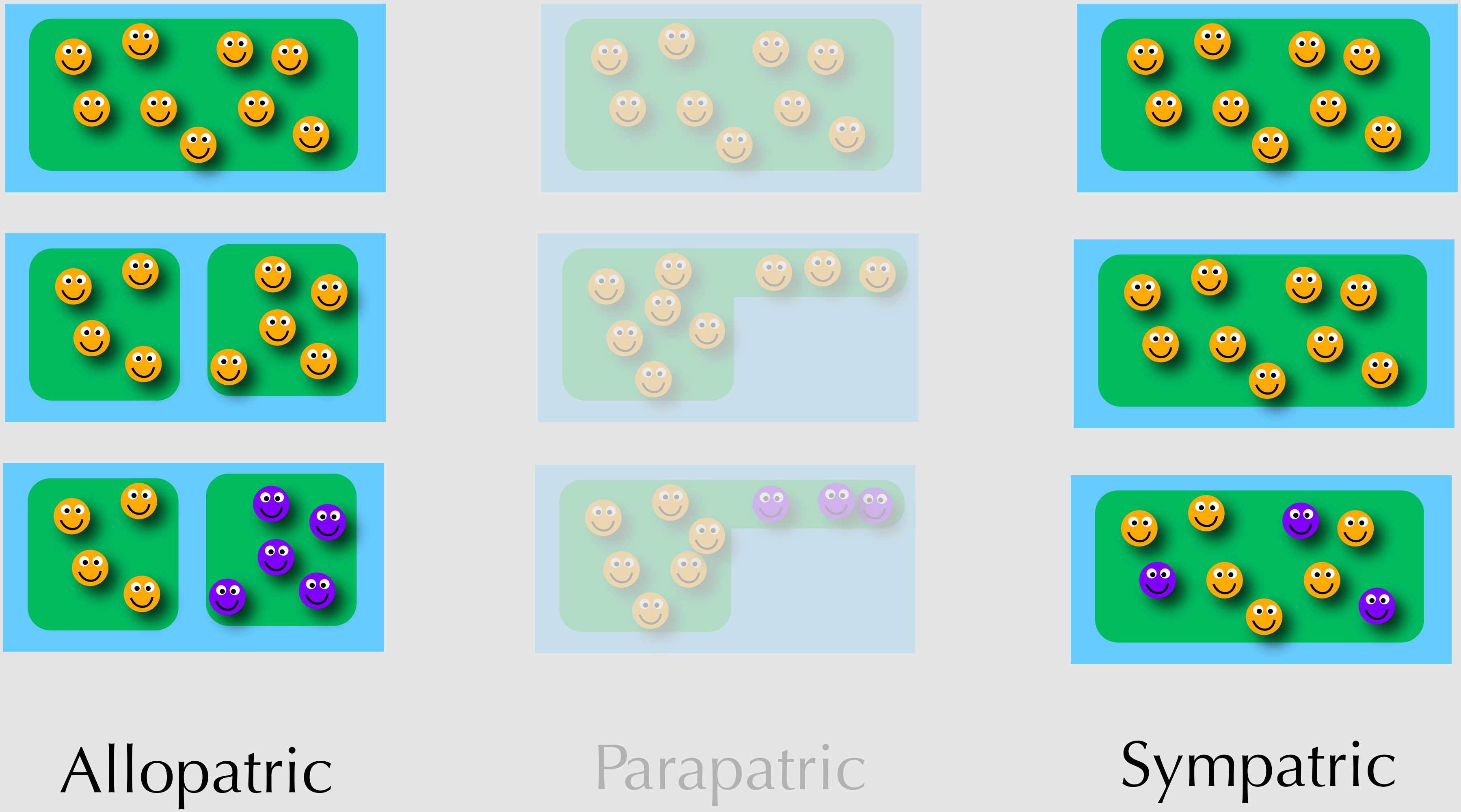
Dobzhansky-Muller Incompatibilities

How can genes evolve within a species neutrally but still lead to hybrid inviability/sterility?

Think of the ancestral species being genotype

AA BB

Speciation



		Allopatric	Sympatric
Prezygotic	Physical or temporal isolation		
	Lack of proper mating cues		
	Mechanical problems		
	Gametic problems		
Postzygotic	Hybrid inviability		
	Hybrid sterility		

Sticklebacks

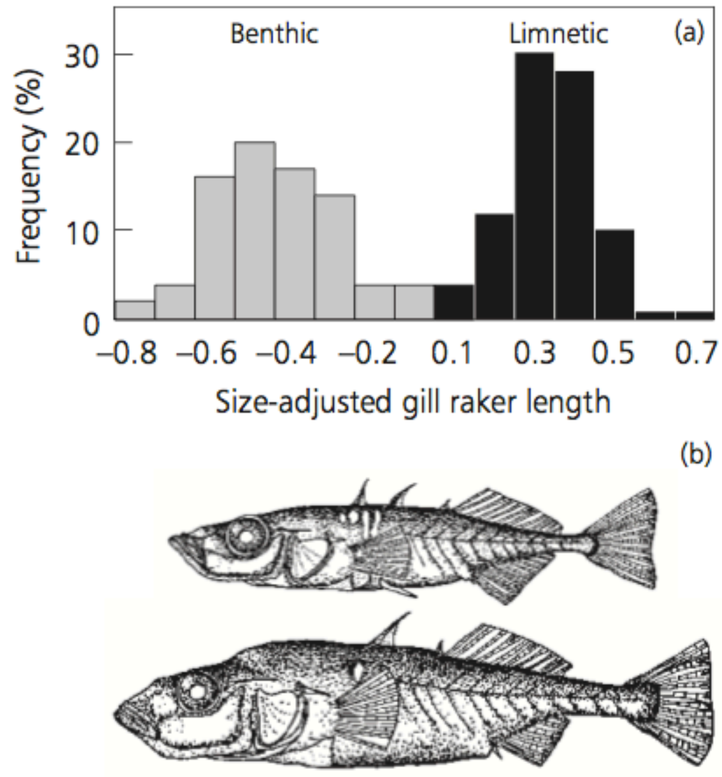
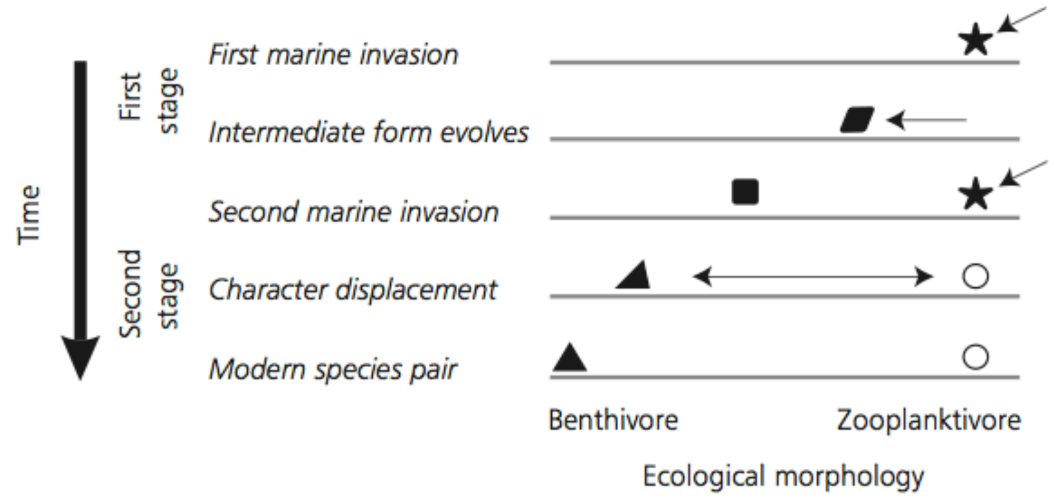


Figure 9.2 (a) Frequency distribution of size-adjusted gill raker lengths for Paxton Lake benthic (gray) and limnetic (black) sticklebacks. Gill rakers are protuberances from the gill arch that are thought to function during feeding to sieve particles of food or to direct the movement of water through the oral cavity. Plankton-feeding fish tend to have more numerous, longer gill rakers (see Schluter and McPhail 1993). *Source*: Schluter and McPhail (1992). (b) Limnetic (above) and benthic (below) sticklebacks from Paxton Lake, British Columbia. *Source*: Schluter (1993).

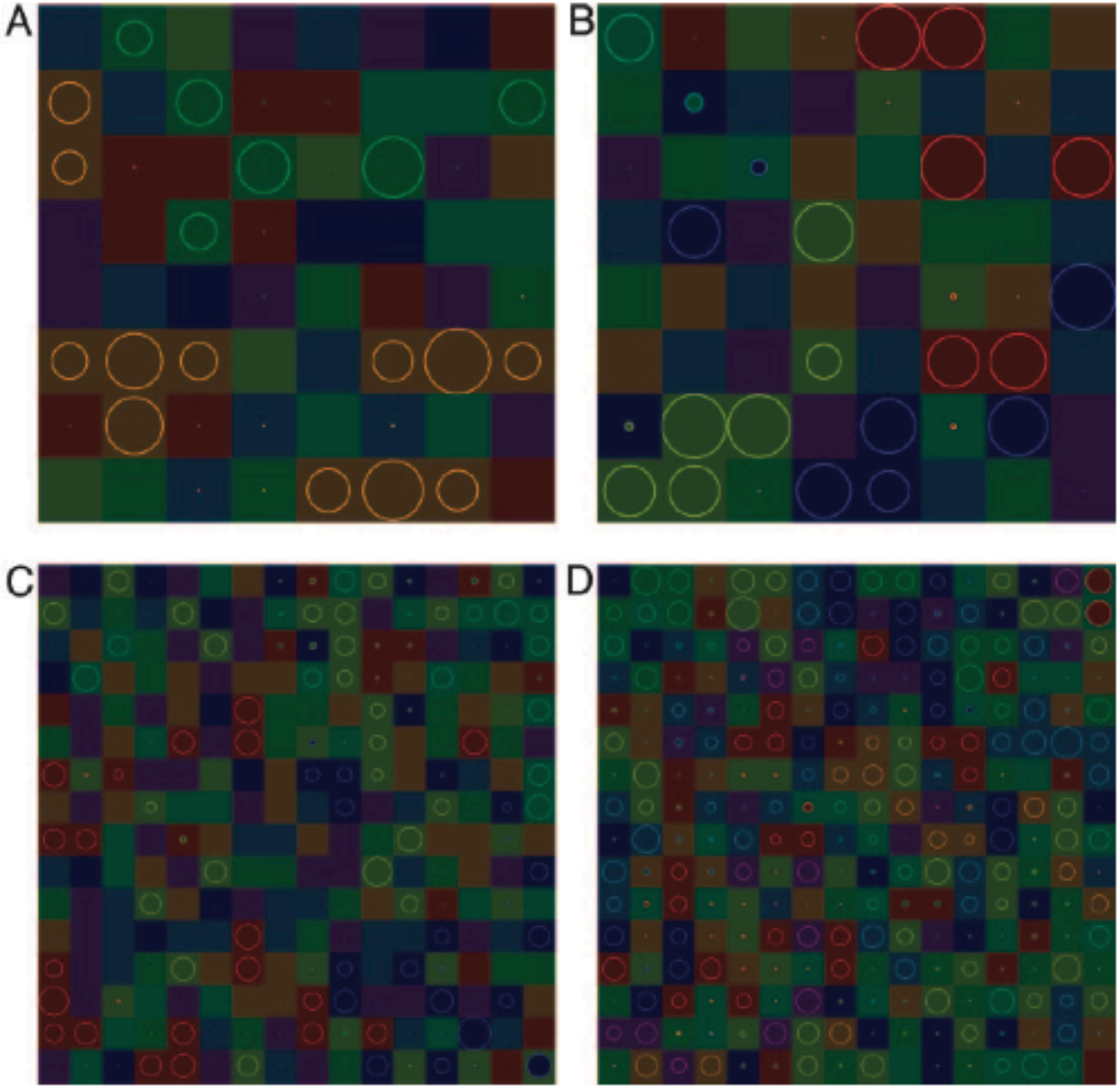
Rundle HD & Schluter D (2004). Natural Selection and Ecological Speciation in Sticklebacks. In: Adaptive Speciation, eds. Dieckmann U, Doebeli M, Metz JAJ & Tautz D, pp. 192–209. Cambridge University Press.

The geographic context of speciation of the limnetic–benthic pairs, whether they arose within each lake via sympatric speciation or instead had an allopatric phase, is unclear and not all the evidence points to one conclusion. The weight of evidence, however, favors the double-invasion scenario of McPhail (Schluter and McPhail 1992; McPhail 1993) as depicted below (figure modified from Taylor *et al.* 1997). In this scenario each coexisting benthic and limnetic pair results from two separate invasions by the marine threespine stickleback (*Gasterosteus aculeatus*) into freshwater after the retreat of the glaciers at the end of the Pleistocene period (< 13 000 years ago).



The sequence began with the first invasion of lakes by the marine species, which then evolved into an intermediate phenotype characteristic of most small, single-species lakes today (Schluter and McPhail 1992). The marine form invaded a second time after a secondary rise in sea level a few thousand years later. Ecological character displacement, driven by frequency-dependent resource competition, increased the ecological and phenotypic divergence in sympatry (Schluter 1994). The first invader gave rise to the present day benthic species, while the second invader remained a plankton specialist like its marine ancestor, and has evolved into the present-day limnetic species. The double-invasion scenario can be accommodated within the framework of adaptive dynamics, as outlined in Box 9.5.

Rundle HD & Schluter D (2004). Natural Selection and Ecological Speciation in Sticklebacks. In: Adaptive Speciation, eds. Dieckmann U, Doebeli M, Metz JAJ & Tautz D, pp. 192–209. Cambridge University Press.



Gavrilets and Vose. Dynamic patterns of adaptive radiation. P Natl Acad Sci Usa (2005) vol. 102 (50) pp. 18040-18045

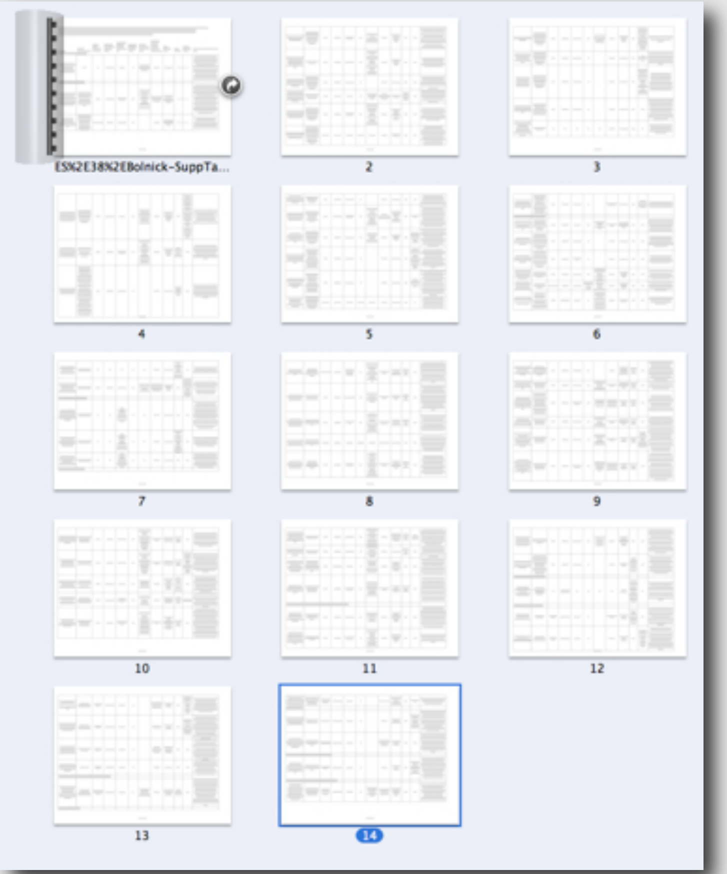
Sympatric speciation

Empirical

Empirical Summary: The Frequency of Sympatric Speciation

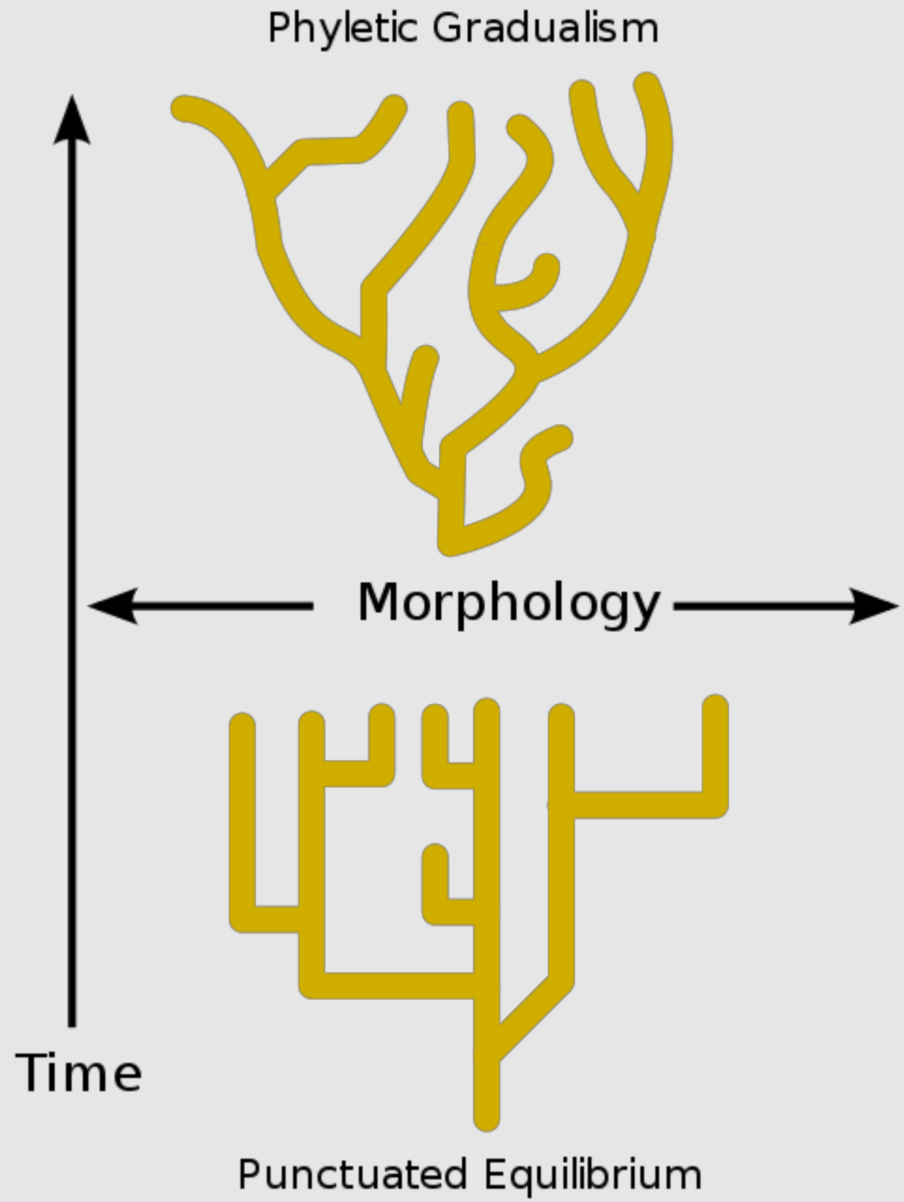
Available data continue to support the orthodox position that sympatric speciation is less common than parapatric or allopatric speciation. However, there are enough well-supported examples to confidently say that sympatric speciation can occur in nature, and other putative cases of sympatric speciation remain understudied (**Supplemental Table 1**). This raises an important question: Are we likely to ever obtain an unbiased estimate of the frequency of sympatric speciation? We suggest not, because (*a*) ascertainment biases may favor recognition of nonsympatric speciation events to an unknown extent, (*b*) relationships between current and past biogeography can be rapidly disrupted by global climate change or range expansion, and (*c*) potential incipient species such as sympatric host races may not be reliable indicators of the likelihood of speciation.

Theoretical



Bolnick and Fitzpatrick. Sympatric speciation: Models and empirical evidence. Annu Rev Ecol Syst (2007) vol. 38 pp. 459-487

Punctuated equilibrium



Various works by
Gould and Eldredge