Workshop on population and speciation genomics

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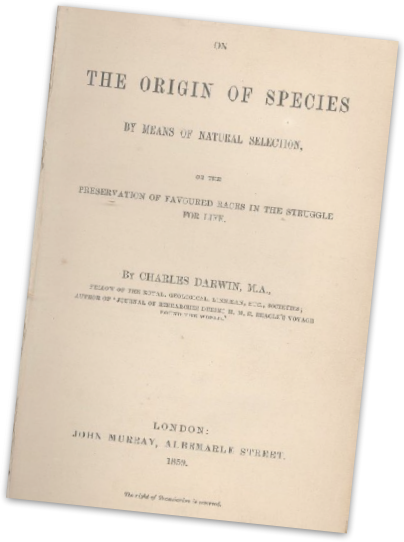
"The process by which different kinds of living organism are believed to have developed from earlier forms during the history of the earth."

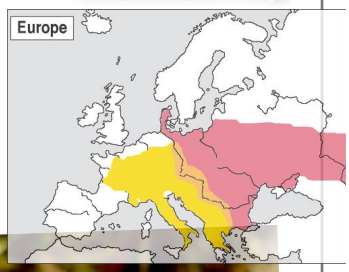
The Oxford Advanced Learner's Dictionary



ⓘ Charles R. Darwin (1809-1882)

What is a species?

distribution map



ⓘ Hybrid zone between yellow- and red-bellied toad

What is a species?

ring species

Stebbins (1994)

ⓘ Ensantia eschscholtzii inhabits the western part of the USA

What is a species?

Individuals within a species are variable and there is usually no “ideal” or “typical” individual.

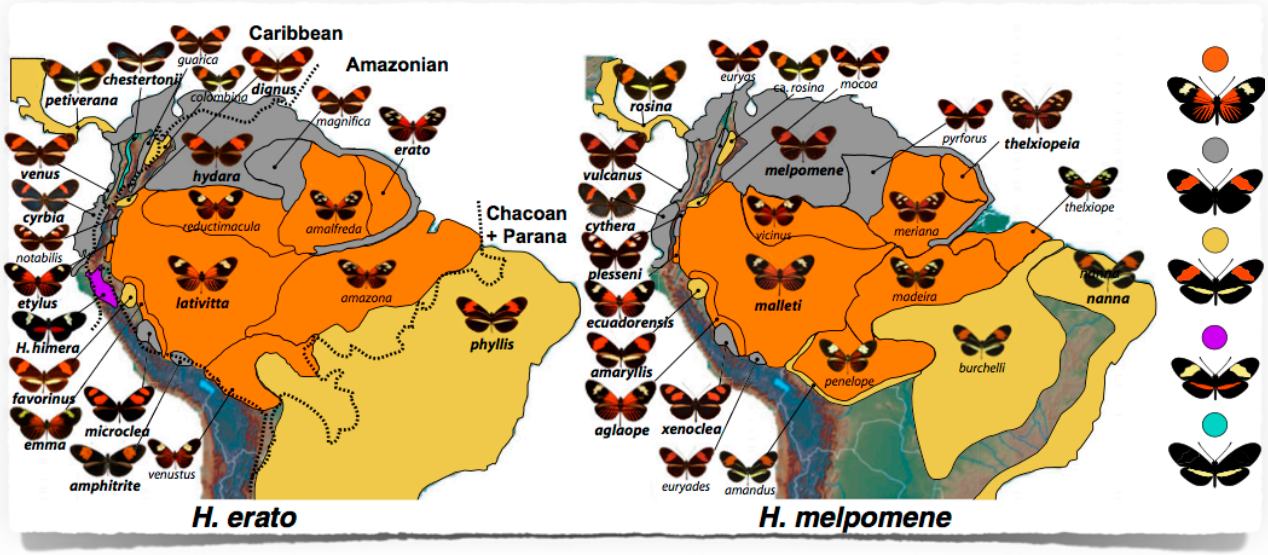


image: www.heliconius.org

ⓘ Heliconius erato and H. melpomene are morphologically similar because of mimicry

Species concepts

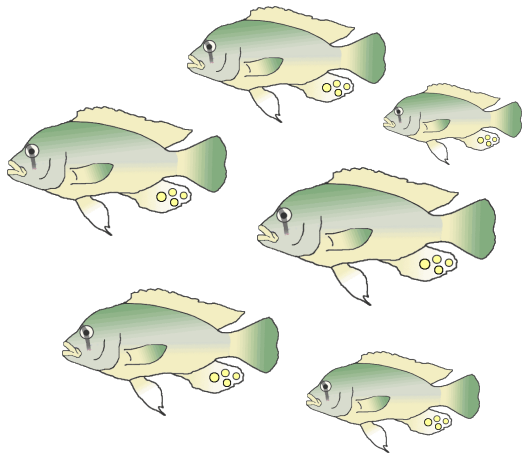
The category species is defined according to a species concept

biological species concept	A species is a group of interbreeding natural populations that is reproductively isolated from other such groups (Mayr 1963).
cohesion species concept	A species is the most inclusive populations of individuals having the potential for phenotypic cohesion through intrinsic cohesion mechanisms (Templeton 1989).
ecological species concept	A species is a lineages (or a closely related sets of lineages), which occupies an adaptive zone minimally different from that of any other lineage in range and which evolve separately from all lineages outside its range (Van Valen 1976).
evolutionary species concept	A species is a single lineage of ancestral-descendant lineages that evolve separately from other such lineages and have their own evolutionary tendencies and historical fate (Simpson 1961; Wiley 1978).
phylogenetic species concepts	A species is the smallest monophyletic group of common ancestry (de Querioz & Donoghue 1988). A phylogenetic species is a basal cluster of organisms that is diagnosably distinct from other such clusters (Cracraft 1989)

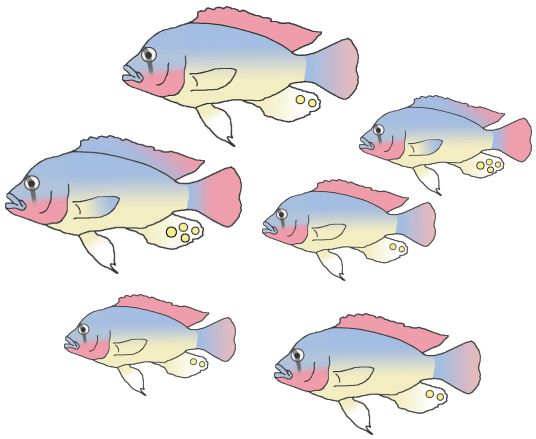
Coyne & Orr (2004); Zachos 2016

Biological species concept

Members of a species share a gene pool; selection and drift operate within species.



species X



species Y

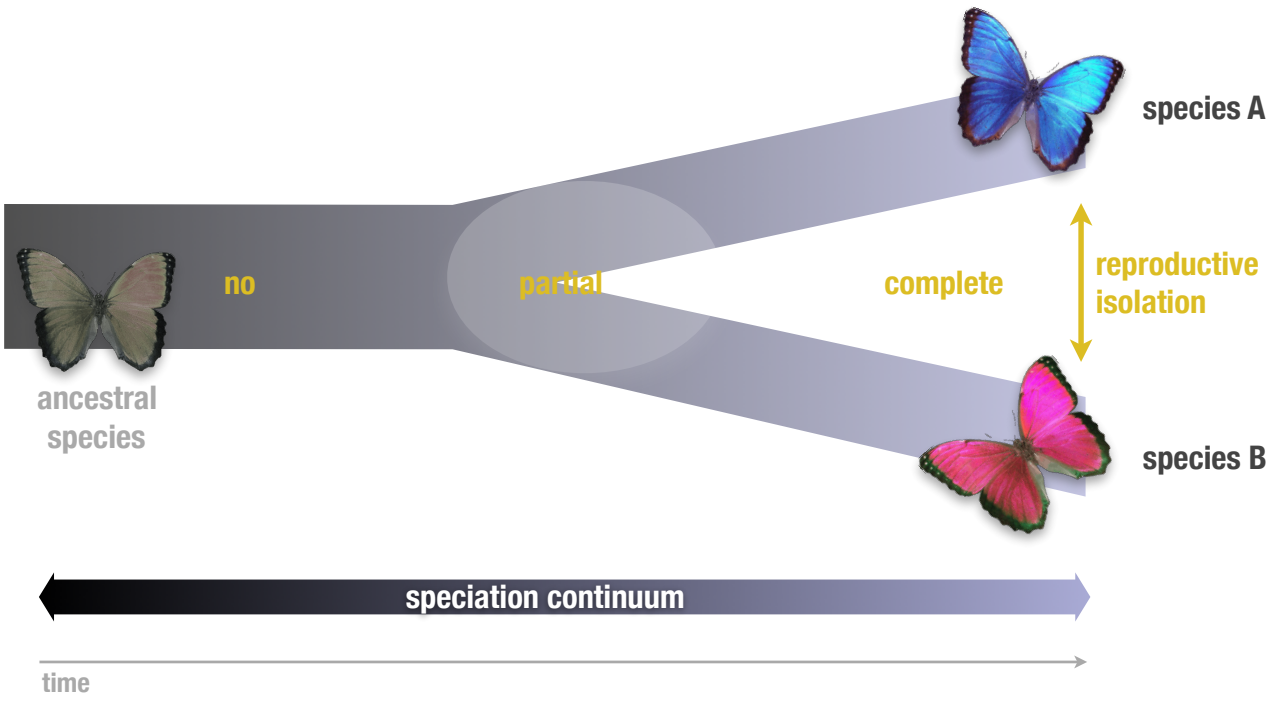
ⓘ Evolutionary biologists interpret species as independent evolutionary units

Biological species concept

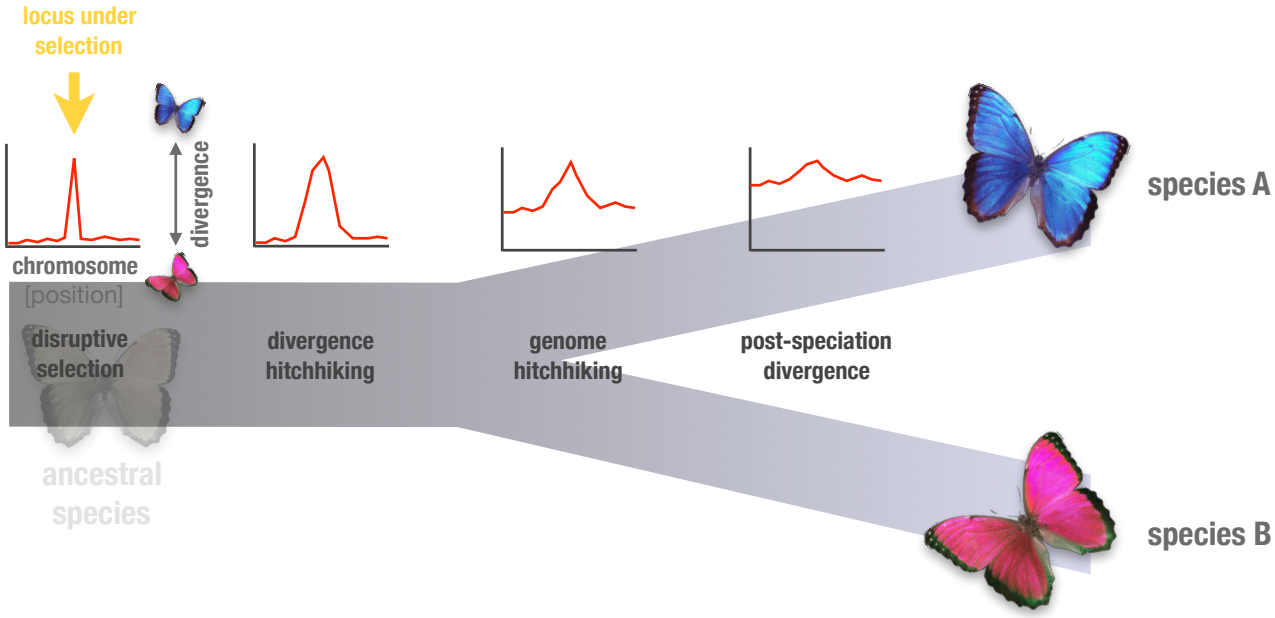
A species is a group of interbreeding natural populations that is reproductively isolated from other such groups (Mayr 1963).

ⓘ The biological species concept places the category species within the framework of population genetics

Reproductive isolation

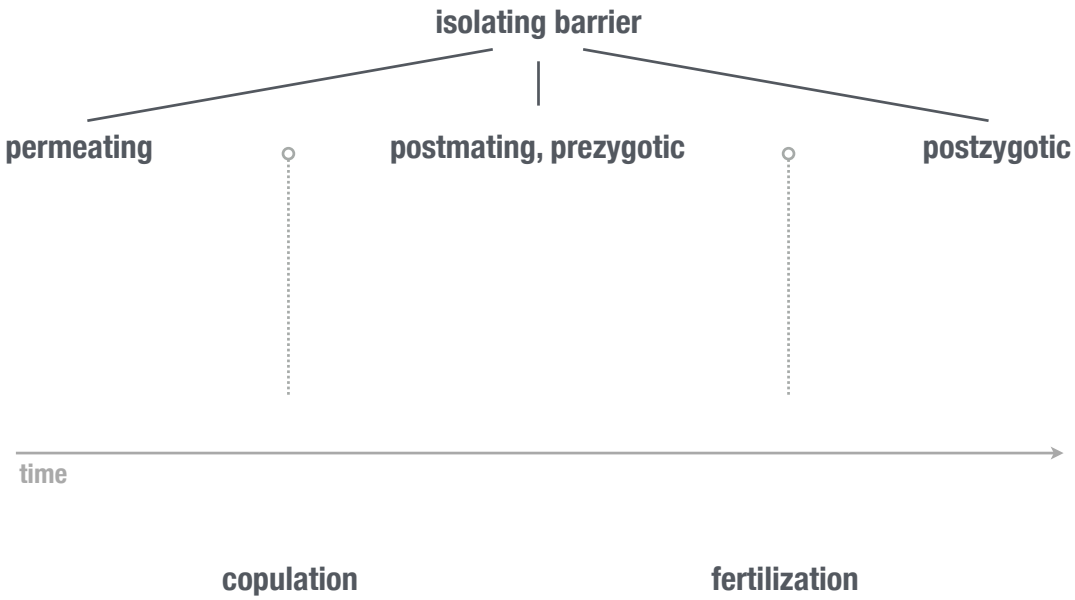


Reproductive isolation

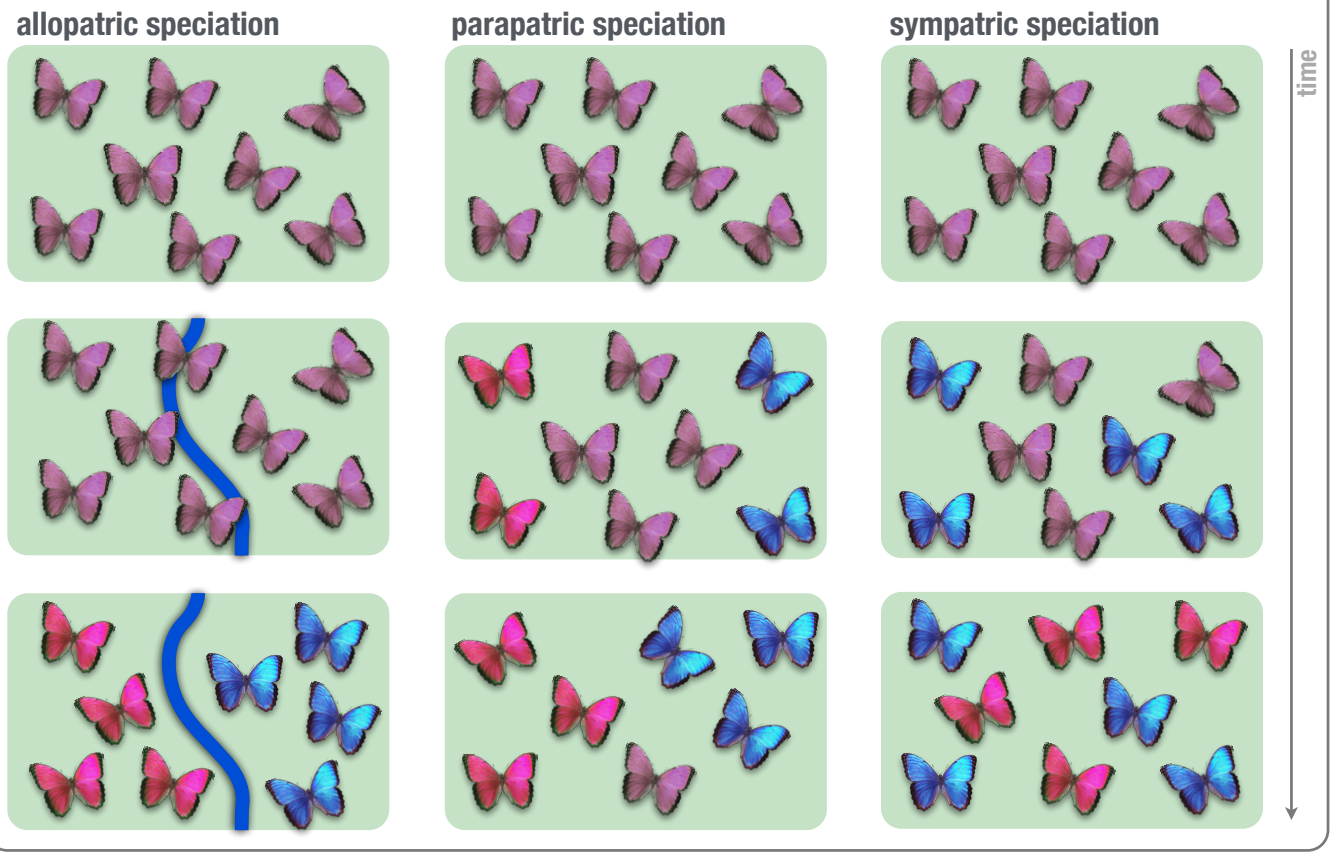


••• JL Feder, SP Egan & P Nosil (2012) TREE

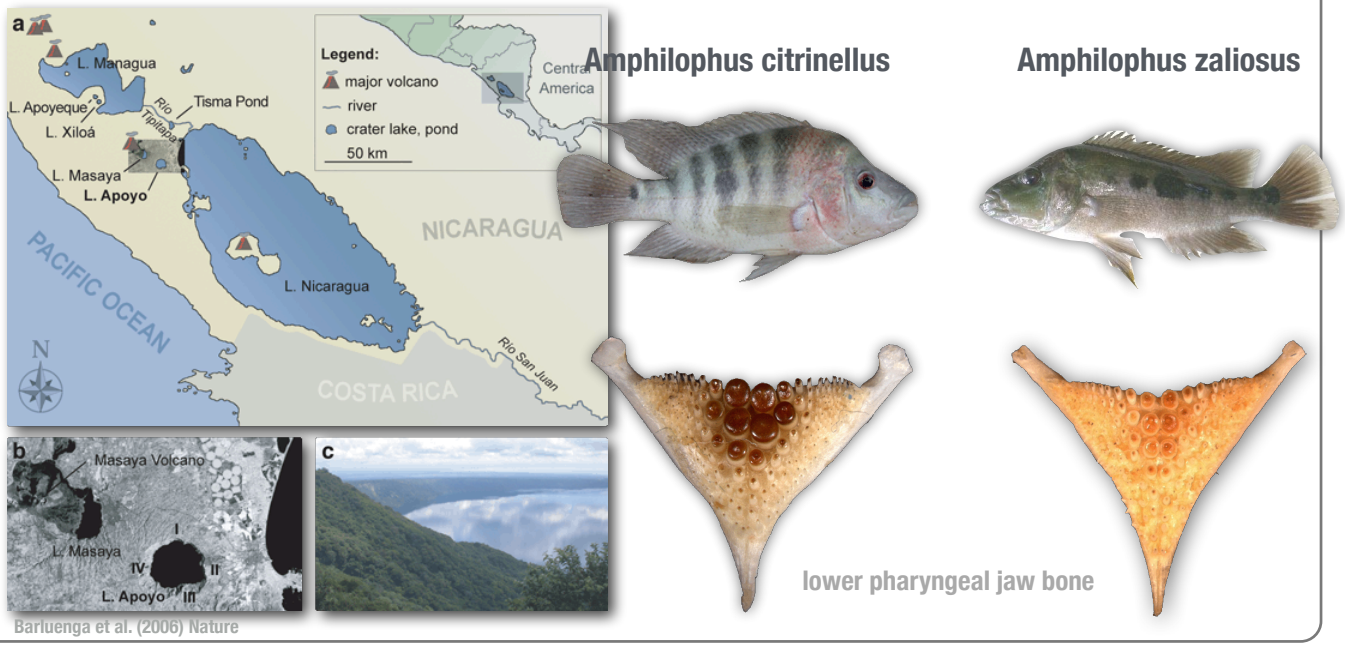
Reproductive isolation



Geographic conditions



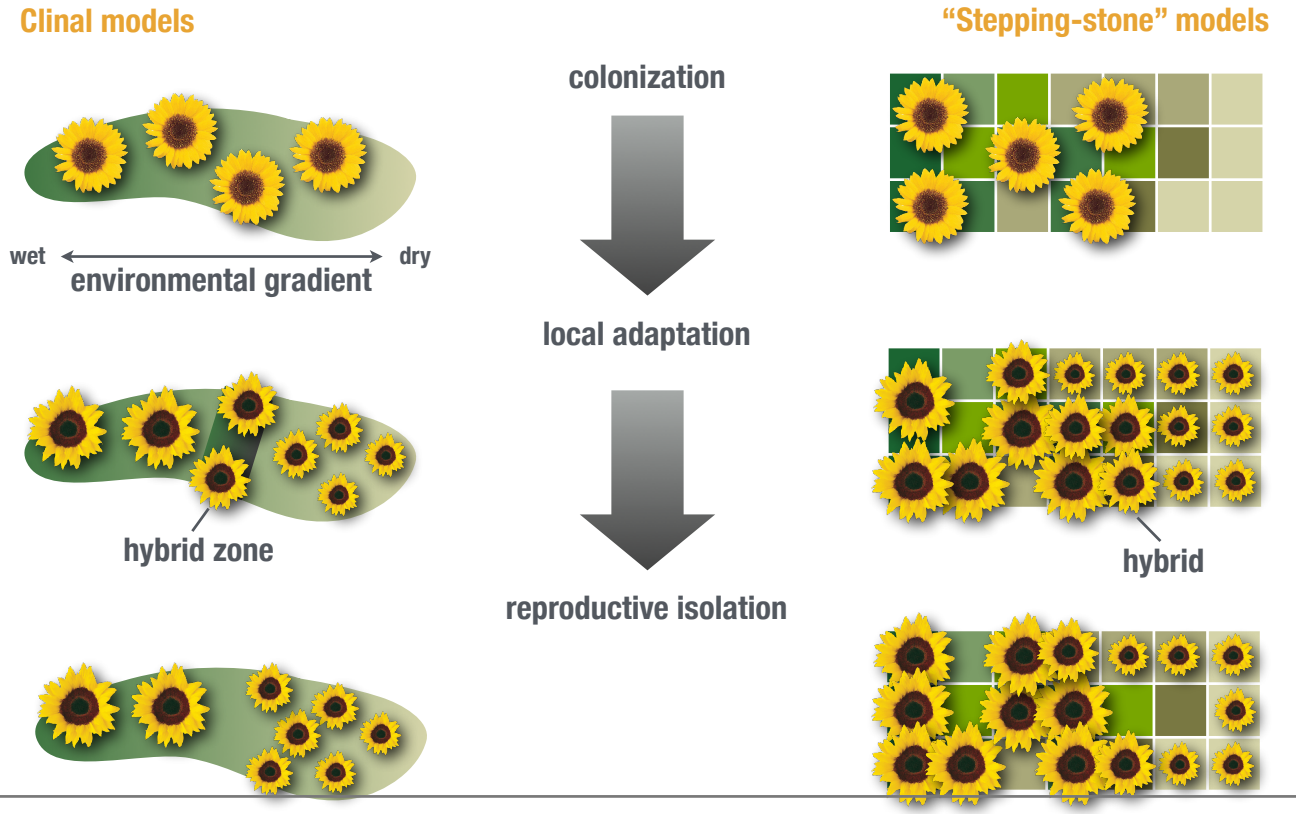
Sympatric speciation



Barluenga et al. (2006) Nature

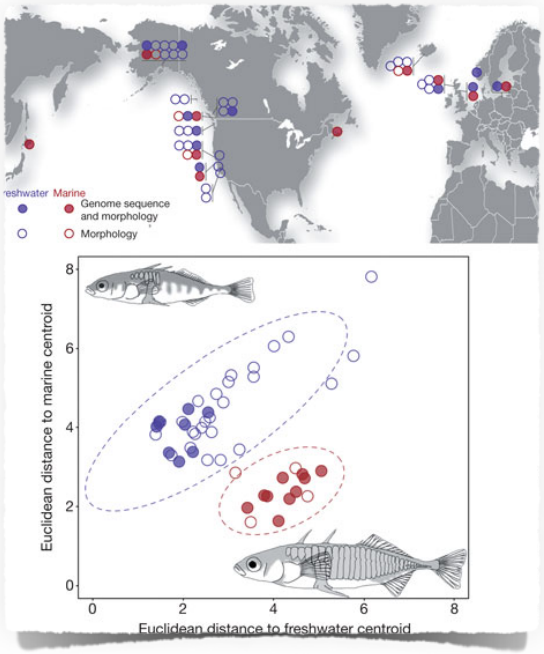
ⓘ The Laguna de Apoyo is a small volcanic crater lake in Nicaragua

Parapatric speciation



Ecological speciation

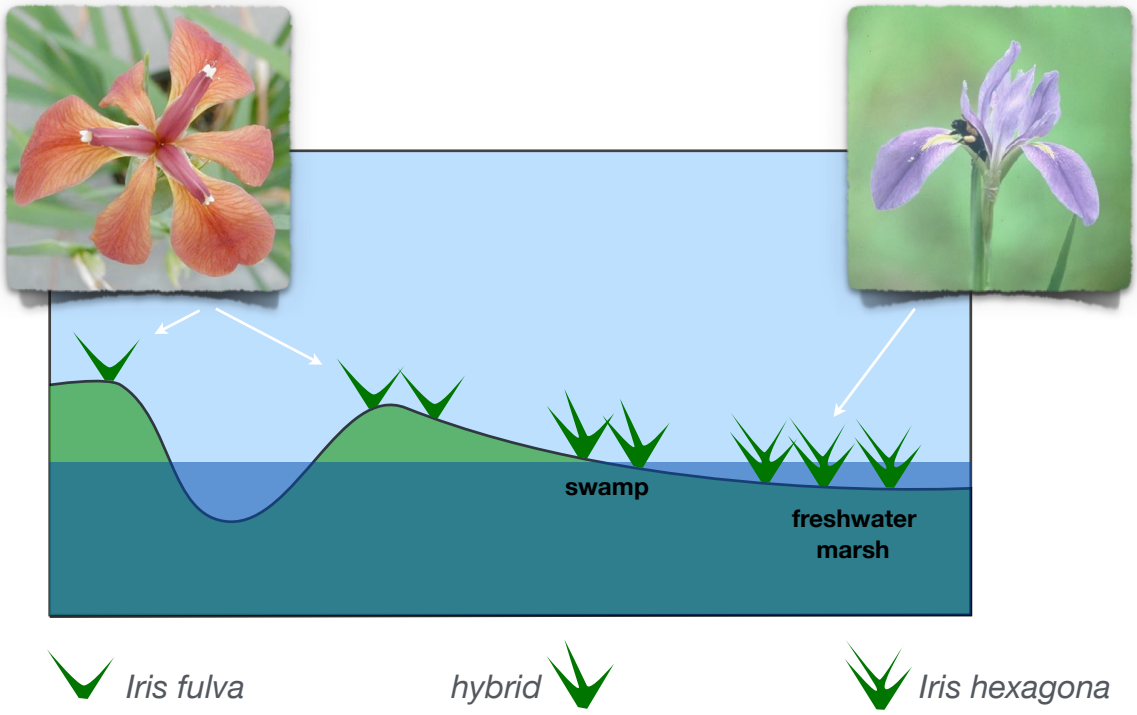
The evolution of reproductive isolation between populations by adaptation to different environments.



Jones et al. (2012) Nature

ⓘ Ecological speciation can happen in allopatry, parapatry and sympatry

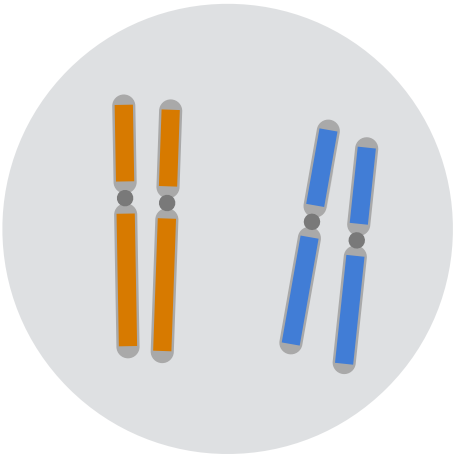
Hybrid speciation



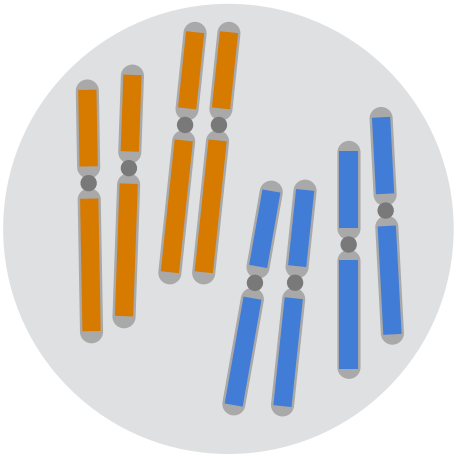
from: Arnold & Bennett (1993)

ⓘ Luisiana irises

Polyploid speciation



diploid
(2n=4)



tetraploid
(4n=8)

Natural selection

- **... is the process by which the forms of organisms in a population that are best adapted to the environment increase in frequency relative to less well-adapted forms over a number of generations** (Ridley 2004)

images: www.idscaro.net, www.wikipedia.com

Sexual selection

- … is the selection on mating behavior, either through:

  competition among members of one sex (usually males) for access to members of the other sex or through

  choice by members of one sex (usually females) for certain members of the other sex
  (Ridley 1996)

images: www.crbs.umd.edu, www.smh.com.au

Natural selection

Sexual selection

Both natural and sexual selection operate if the following conditions are met:

reproduction	organisms must reproduce to form new generations
heredity	offspring resemble parents (“like must produce like”)
trait variation	individuals in natural populations vary in (adaptive) traits
variation in fitness	individuals in natural populations vary in the number of their offspring that survive to reproduce (‘lifetime reproductive success’)

Natural selection

Sexual selection

There are fundamental difference between natural and sexual selection:

	fitness	competitors
sexual selection	individual fitness	other members of the same sex
natural selection	fitness of the genotype	other individuals in the same population