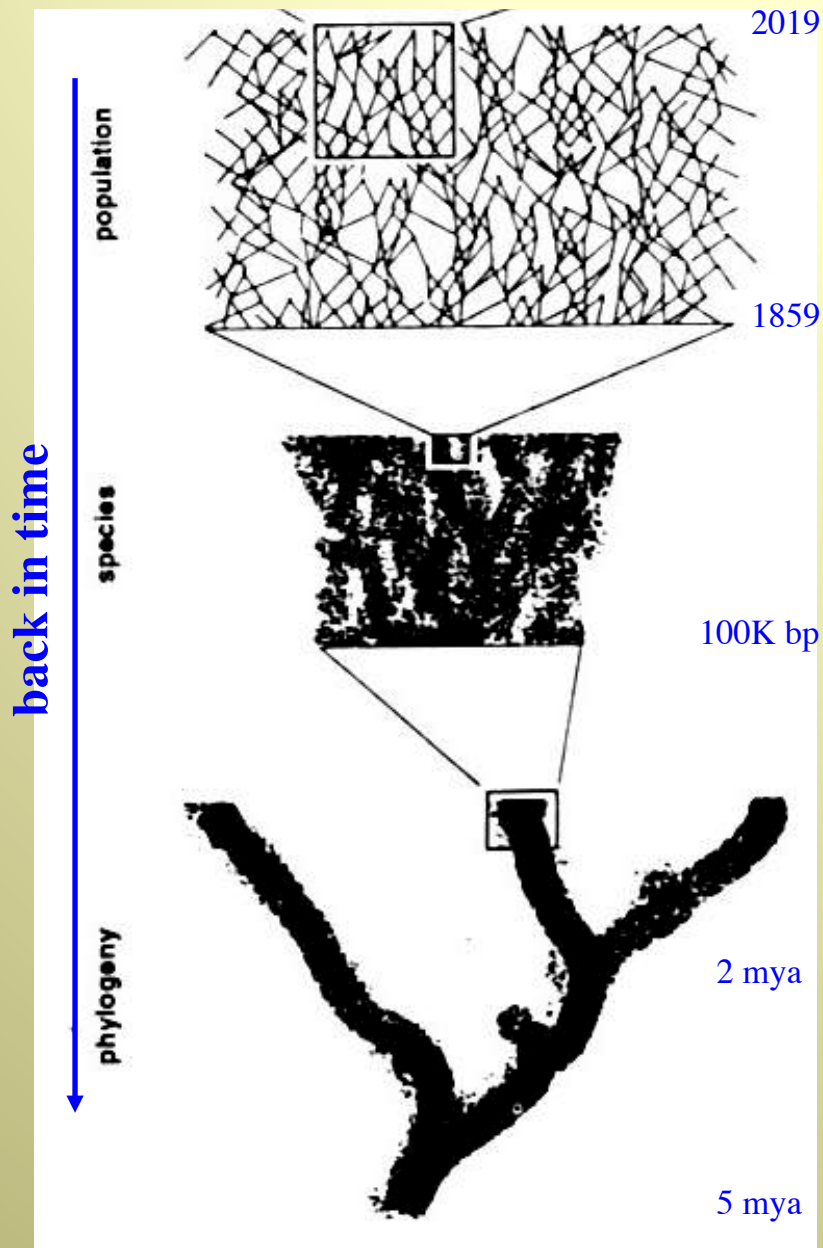
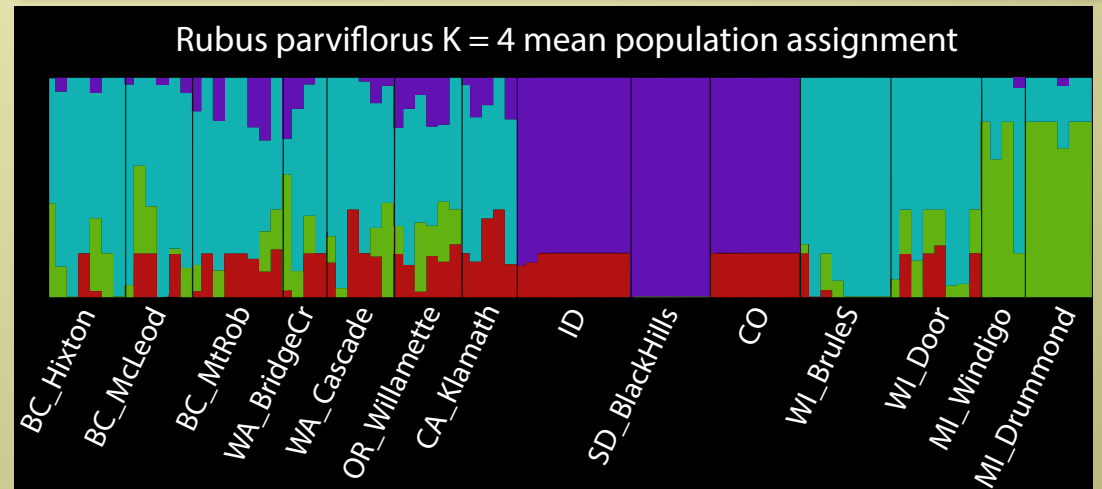
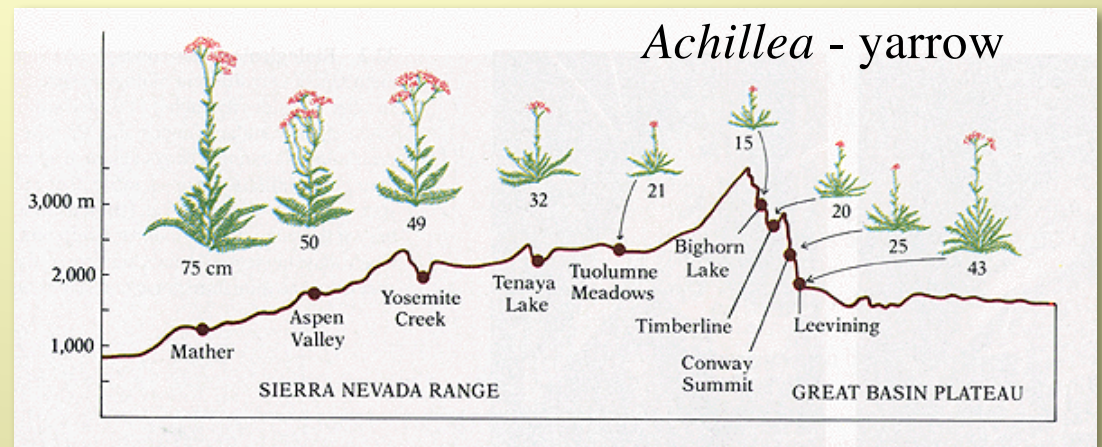


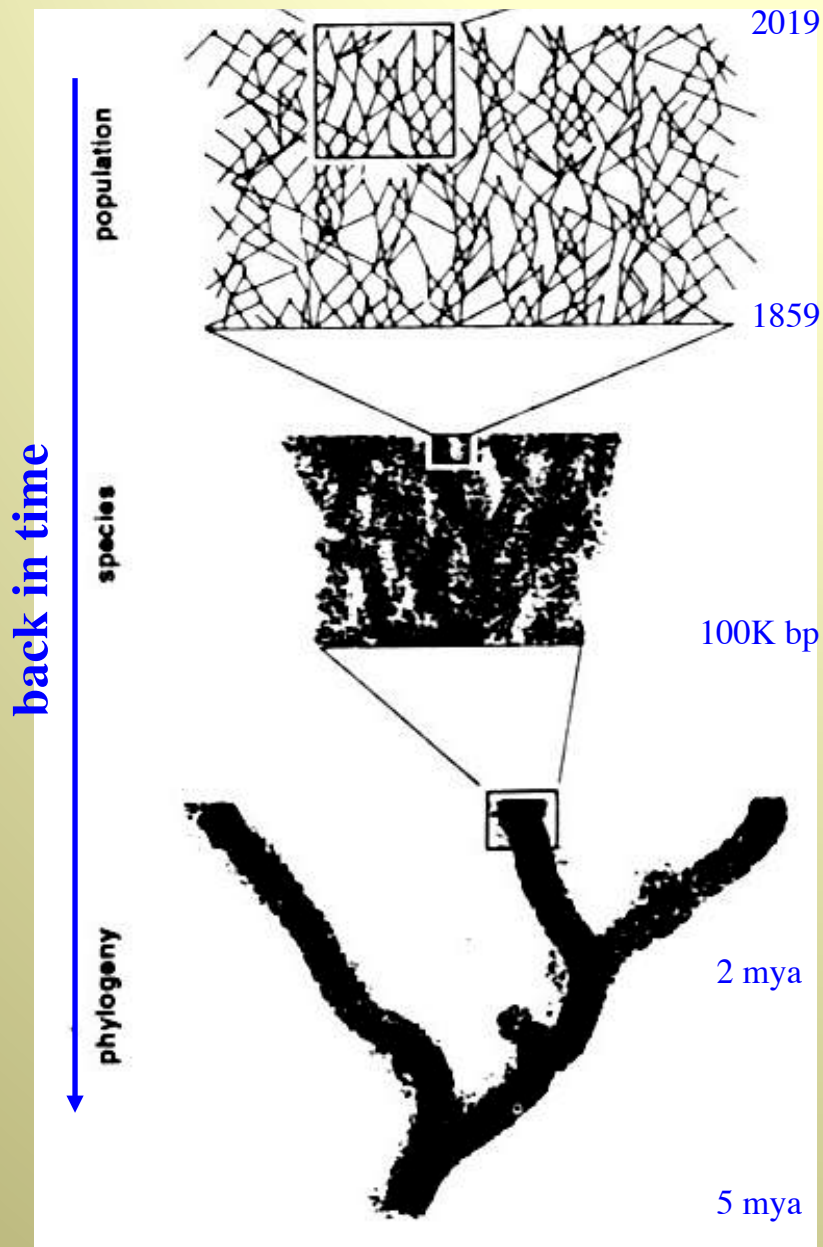
Speciation



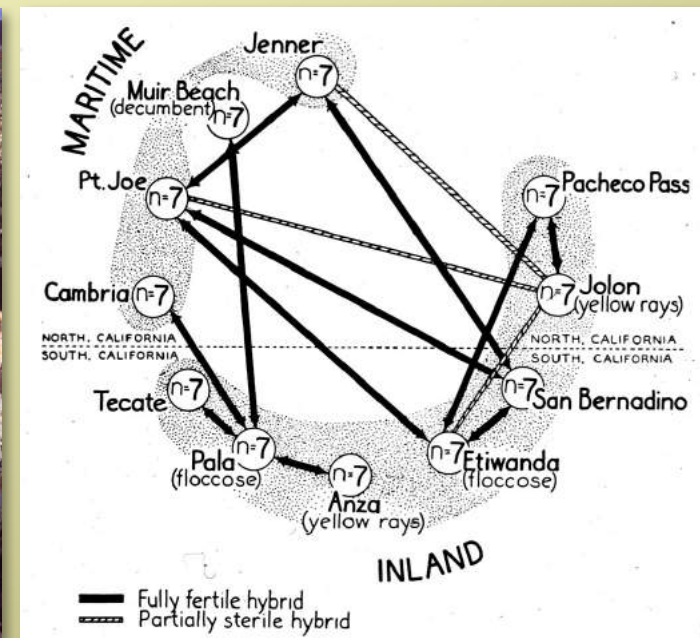
Substantial variation exists in species - *anagenesis*



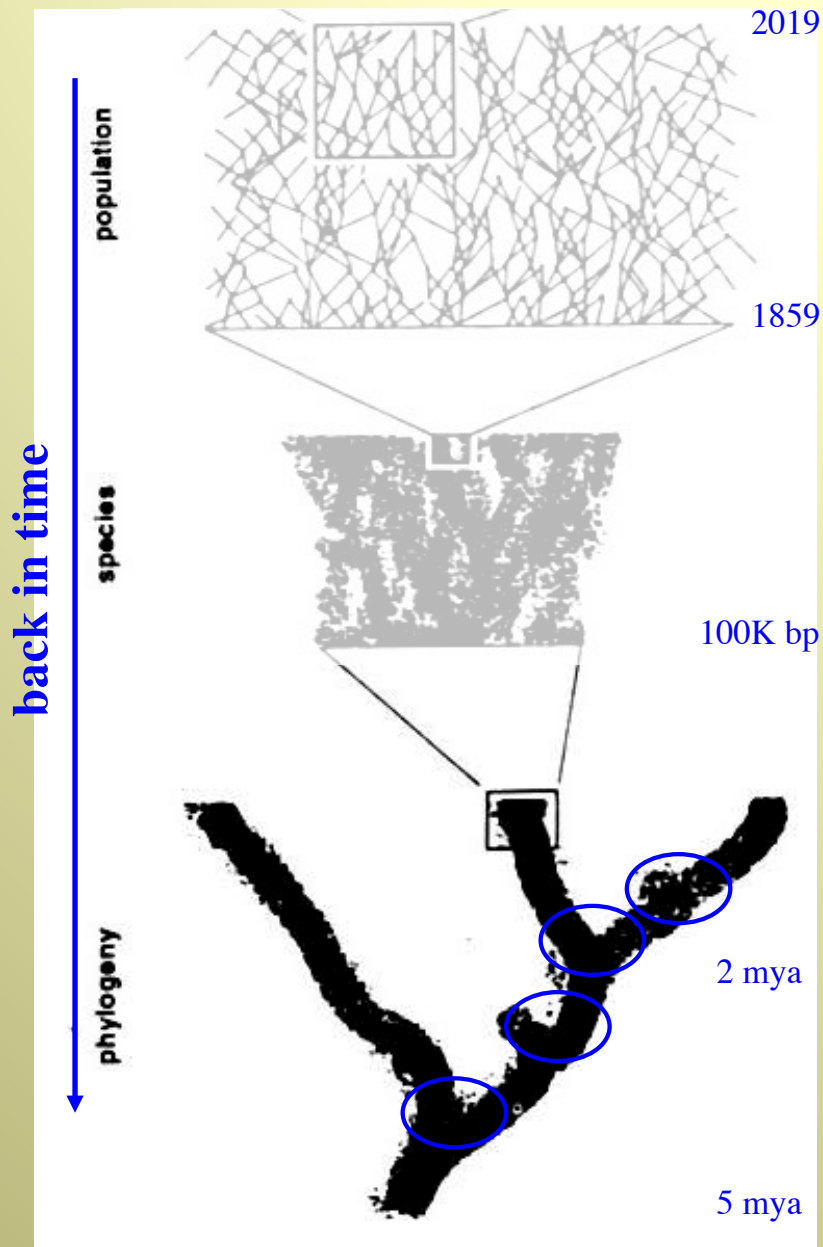
Speciation



The degree of reproductive isolation among geographical sets of populations within an actively evolving species complex is often tested by **crossing experiments** — as in the tidy tips of California

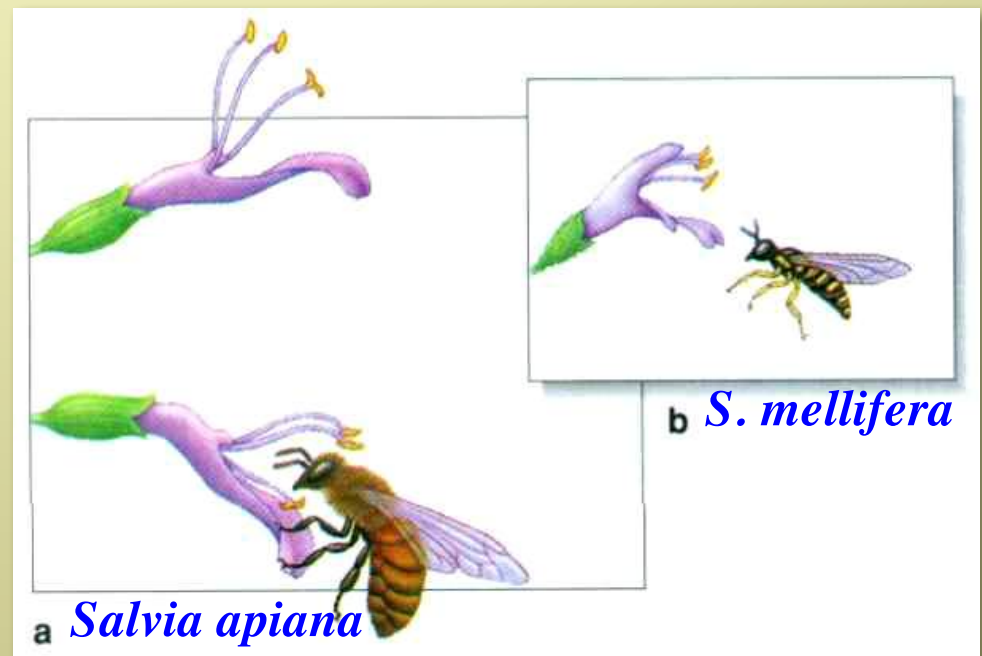


Speciation



Reproductive isolation will ultimately stop all genetic connections among sets of populations – cladogenesis or speciation

Example: mechanical isolation via floral shape changes and pollinators between two parapatric species of California *Salvia* (sage)



Speciation

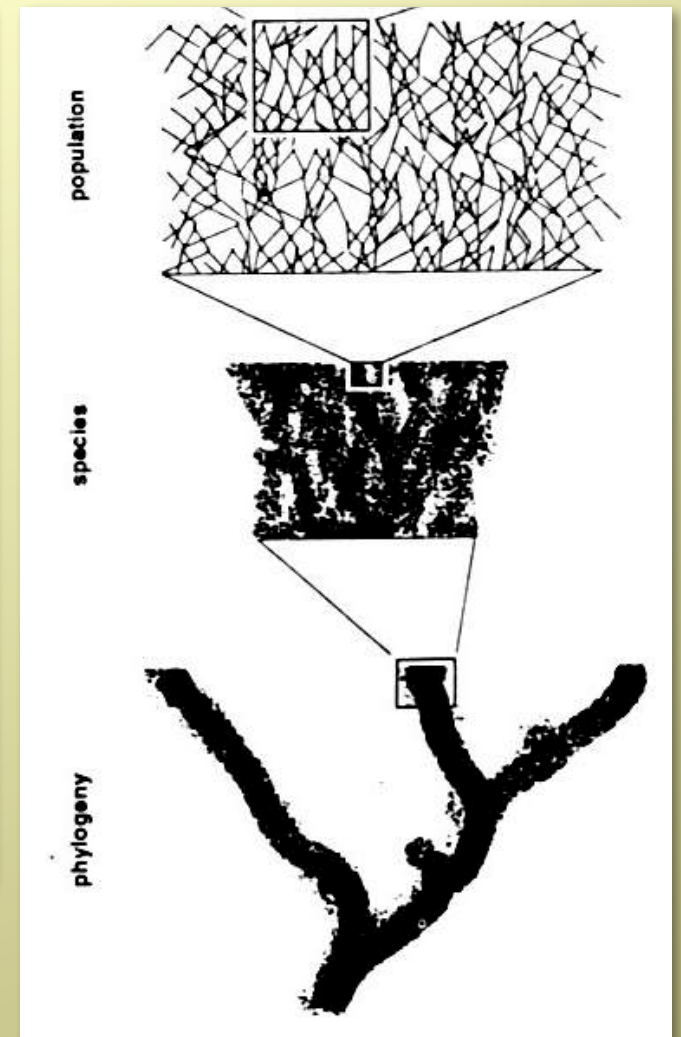
Although simple in concept, the **recognition** of species and thus the **definition** of what are species have been controversial — more than likely due to the continuum nature of the pattern resulting from the process of speciation

Biological Species Definitions

Species represent groups of populations reproductively & potentially reproductively isolated from other such groups

Phylogenetic Species Definitions

Species represent monophyletic clades of populations distinguished from other such clades by shared derived features



Speciation

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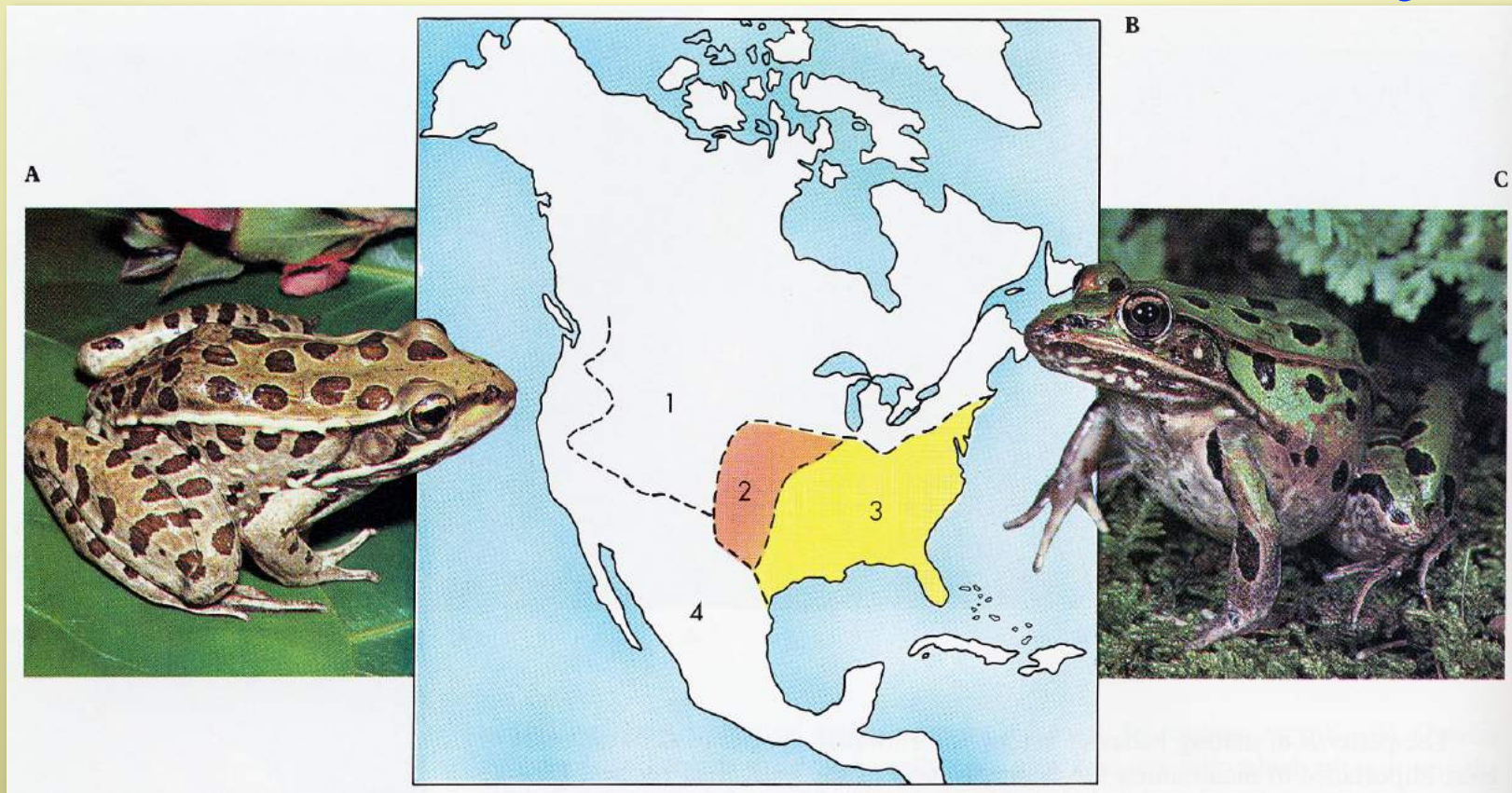
Species represent monophyletic clades of populations distinguished from other such clades by shared derived features

Of the numerous species definitions that have been suggested, the **Biological Species Concept** and the **Phylogenetic Species Concept** are the most used

Speciation

Animal examples of speciation often show clear reproductive barriers - hence zoologists preference (as opposed to botanists) for the **Biological Species Concept**

Reproductive isolating mechanism — **mating calls**

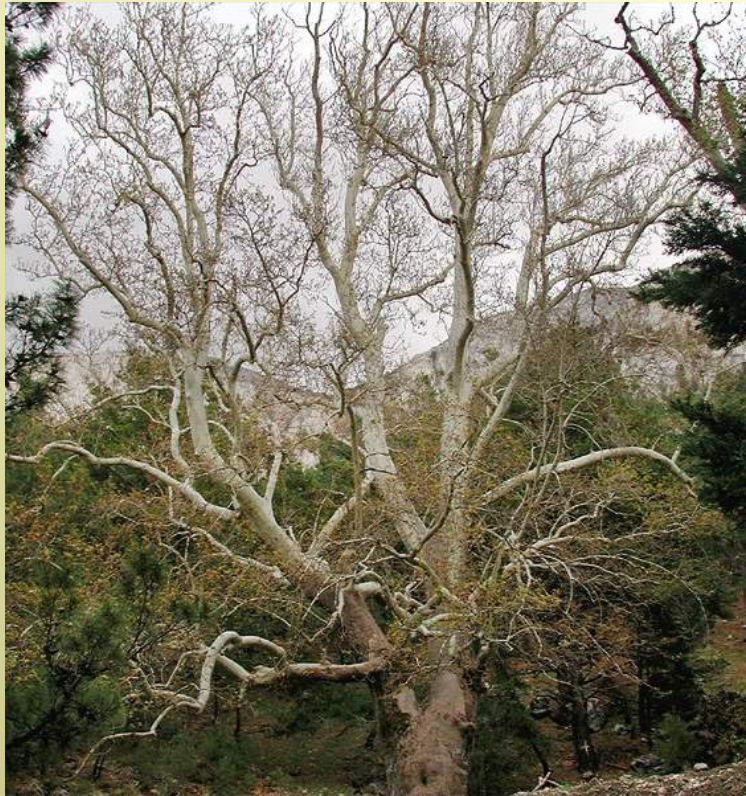


Rana pipiens - northern leopard frog in Wisconsin

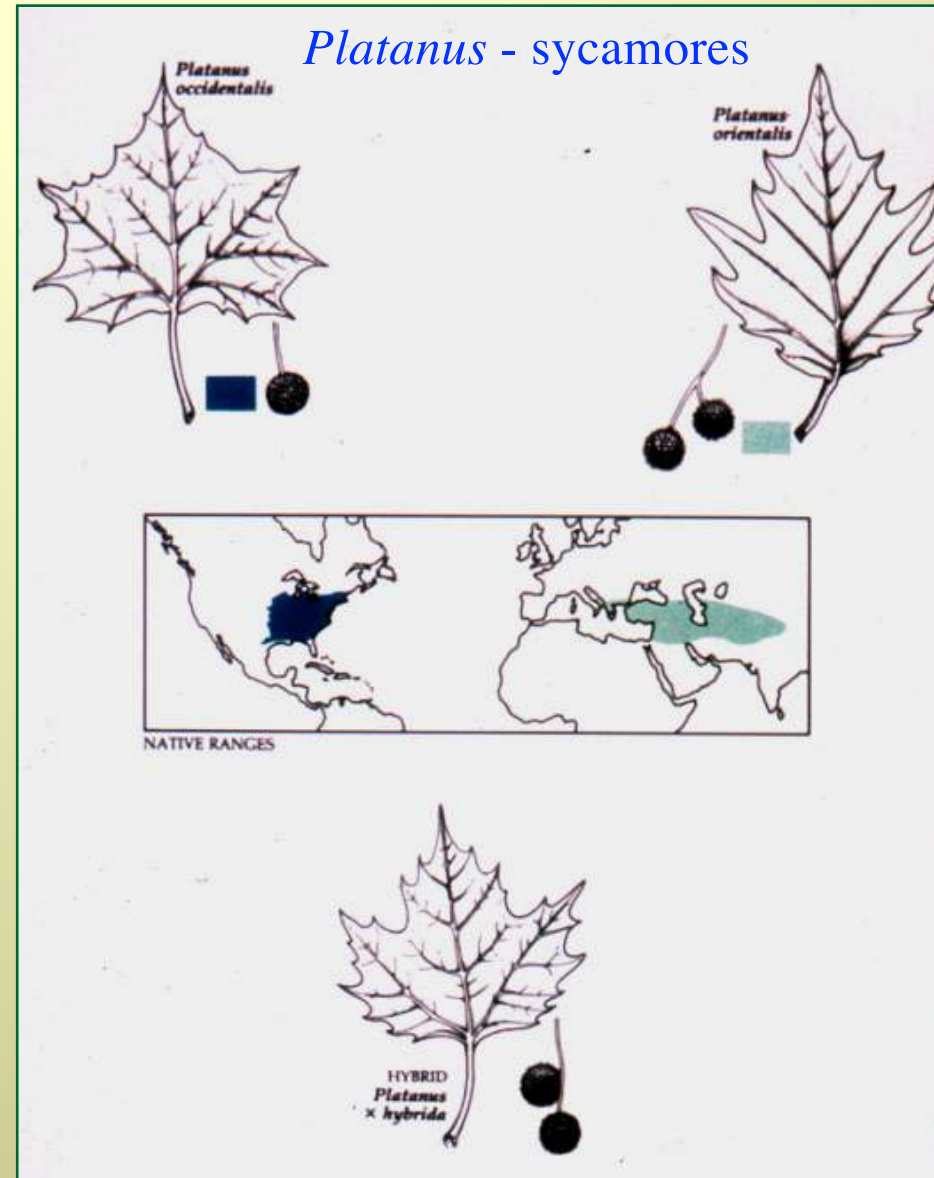
Rana berlandieri - southern leopard frog in California

Speciation

Plant examples of speciation often show **weak reproductive barriers** - hence botanists' skepticism for the Biological Species Concept

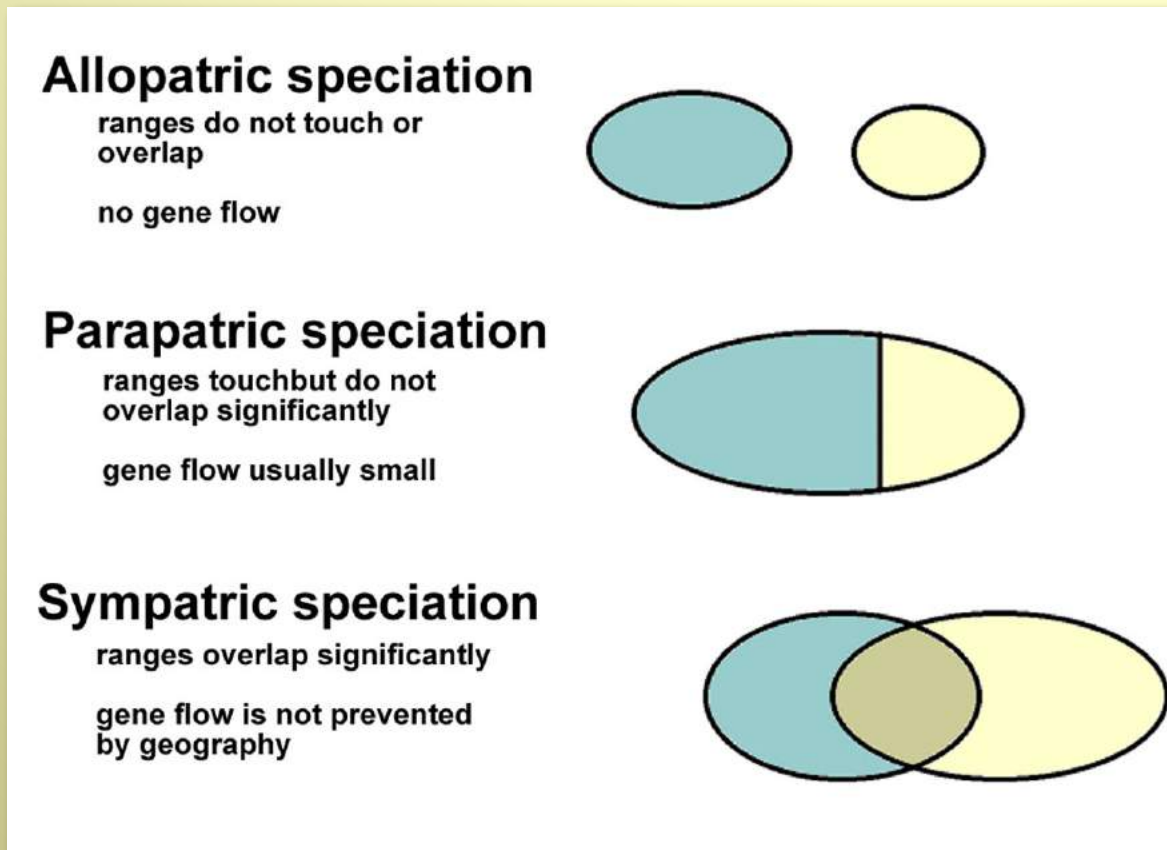


No reproductive isolation mechanism (except geography) — hybrid European plane tree



Speciation

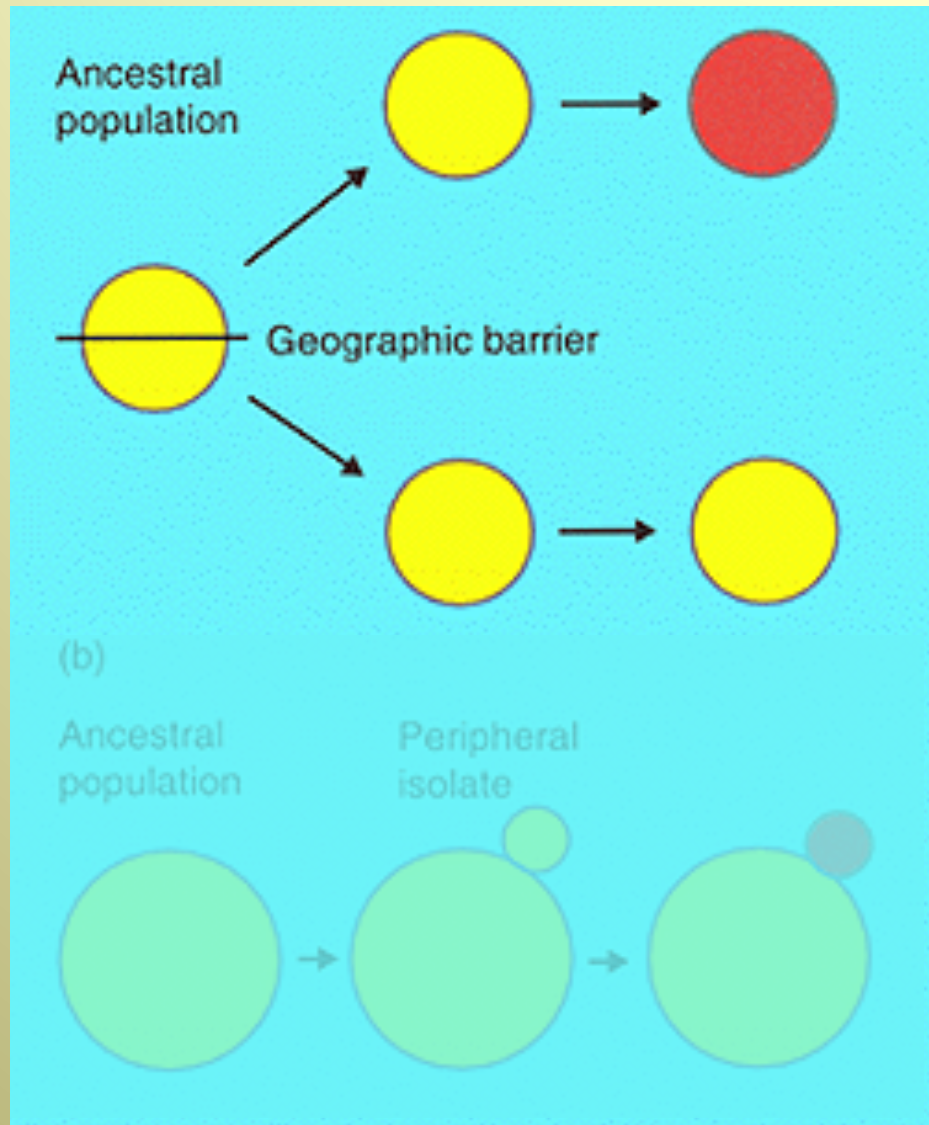
The different **models of speciation** are usually based on **biogeography**



- *-patry* refers to “fatherland” or “homeland”
- **parapatric** & **sympatric speciation** still debatable
- **allopatric speciation** refers to lineage splitting facilitated by complete geographical separation
- often called the **geographical model of speciation** — it is the best documented and most important

Speciation

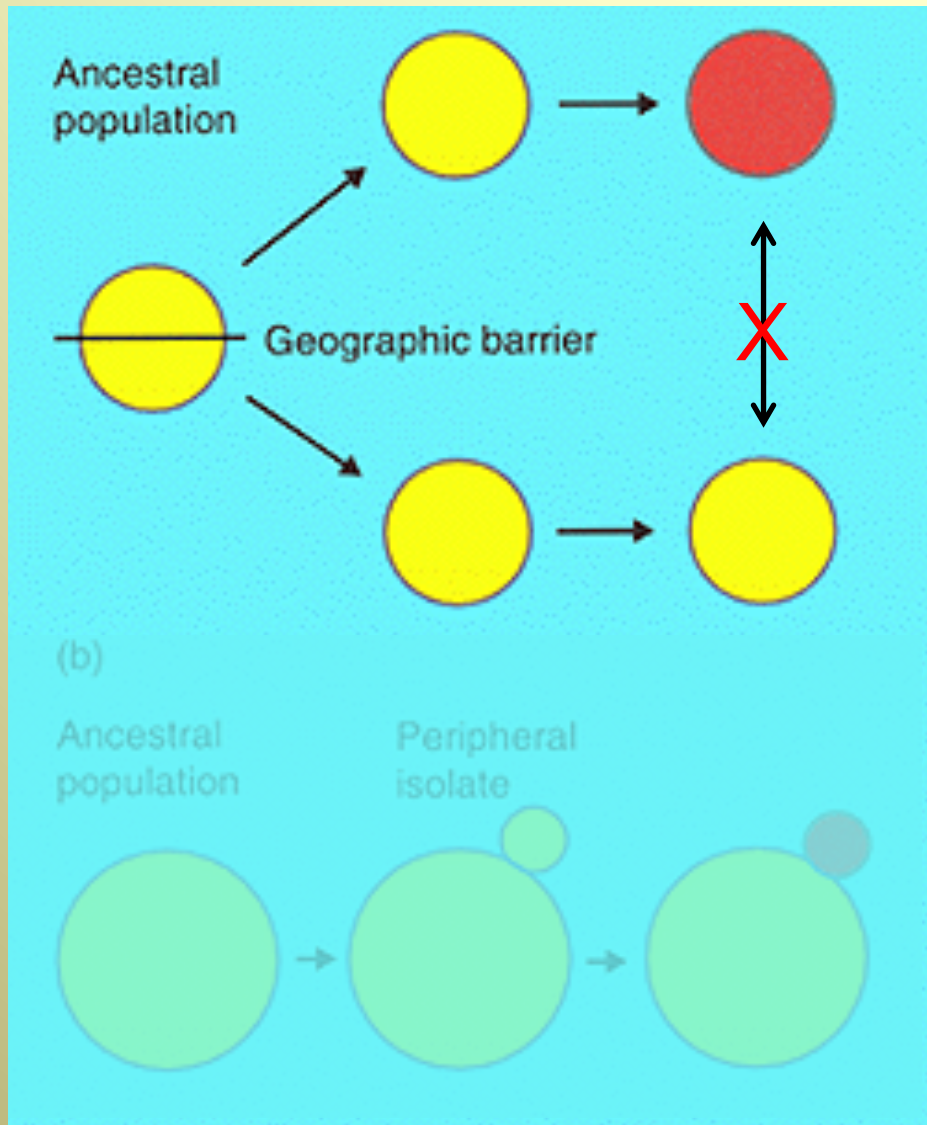
In the **conventional allopatric model** of speciation, some type of barrier (desert, mountain, ocean, forest incursion) breaks up the ancestral area of a species



In isolation, one or both of the **allopatric** sets of populations slowly evolve on their own

Speciation

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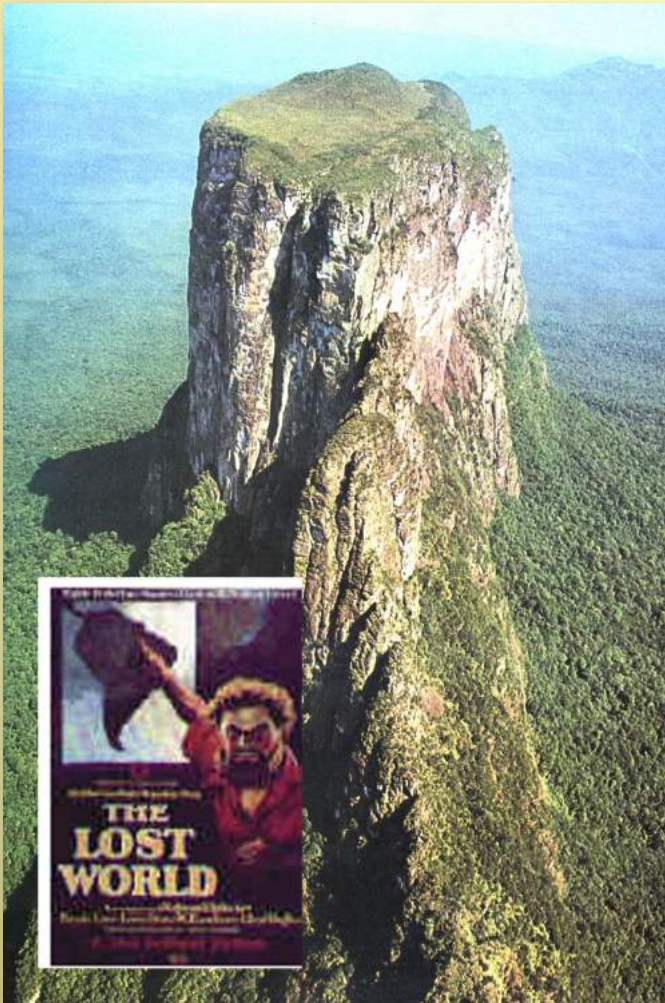
In isolation, one or both of the **allopatric** sets of populations slowly evolve on their own

Speciation is considered complete if the two resulting lineages maintain their differences even if they come back in contact (**sympatry**) . . .

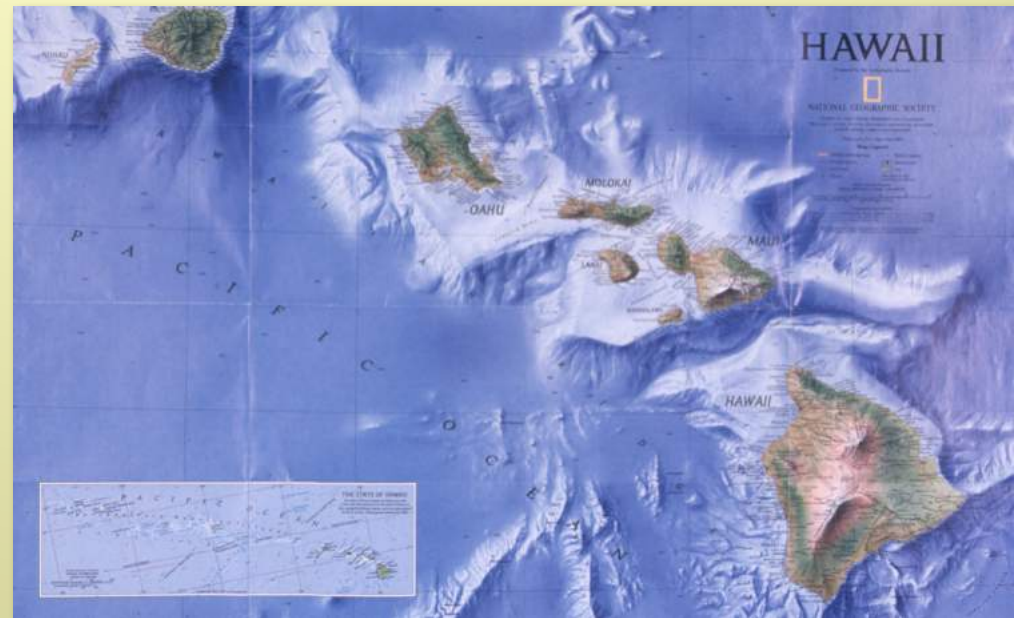
. . . indicating the **origin of a reproductive isolating feature** while in allopatry

Speciation

A more rapid type of **allopatric speciation** often occurs on “islands”



Hawaiian Islands — oceanic “islands”



Tepuis in Venezuela — continental “islands”

Speciation

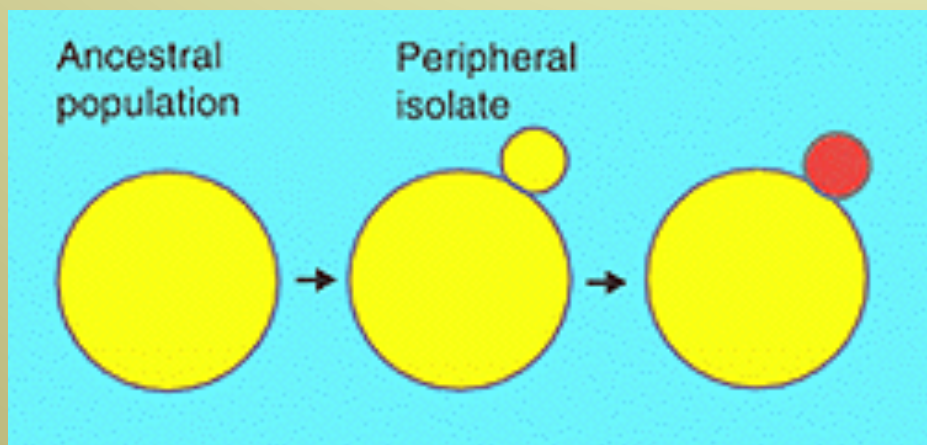
A more rapid type of allopatric speciation often occurs on “islands”



Often called the “**peripheral isolate**” or simply **island model** of allopatric speciation

A **dispersal event** ensures instant geographical/reproductive isolation

The **founder event** often involves a very small subset of the original genetic pool of the ancestral species — thus differences accumulate rapidly



Speciation

A very common and instantaneous form of speciation in plants (and a few animals) is **allopolyploidy**.

Allopatric speciation

ranges do not touch or overlap

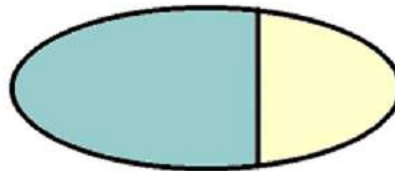
no gene flow



Parapatric speciation

ranges touch but do not overlap significantly

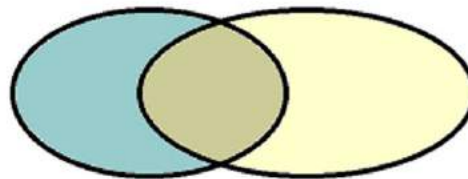
gene flow usually small



Sympatric speciation

ranges overlap significantly

gene flow is not prevented by geography

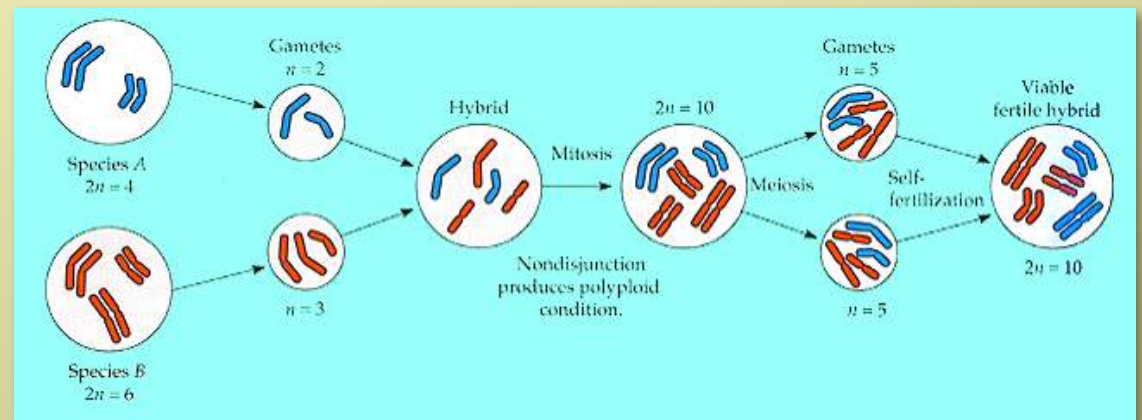
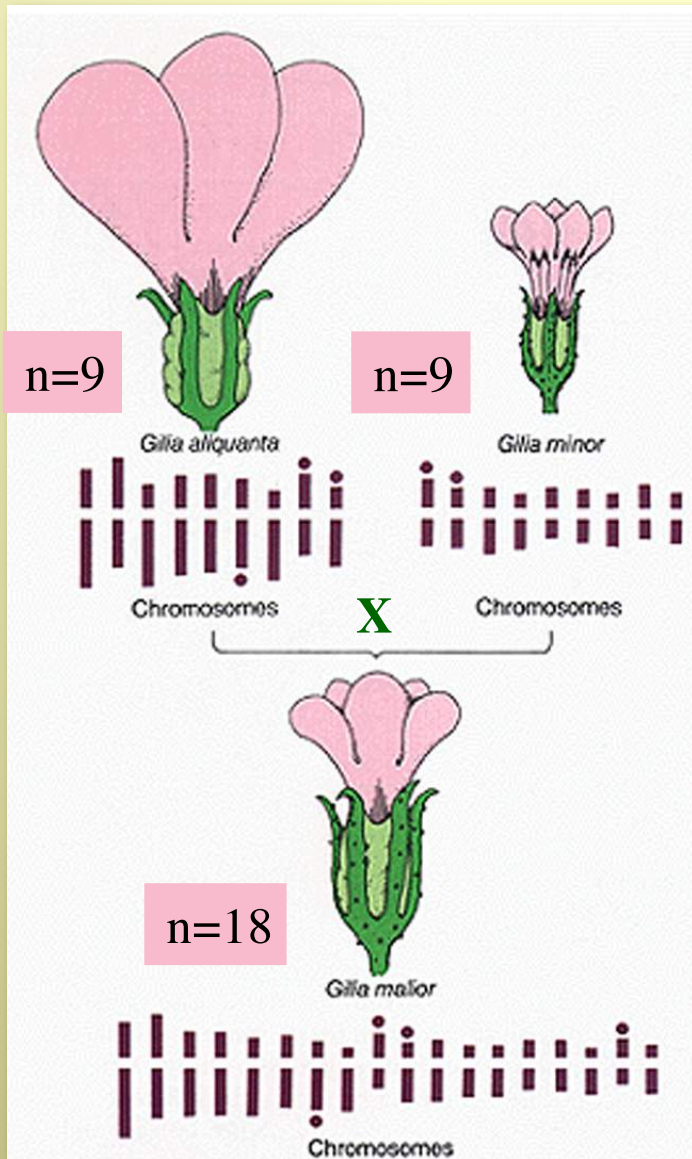


Allopolyploidy is a type of **sympatric** speciation as it occurs within the ranges of the original parental species.

Speciation

A very common and instantaneous form of speciation in plants (and a few animals) is **allopolyploidy**.

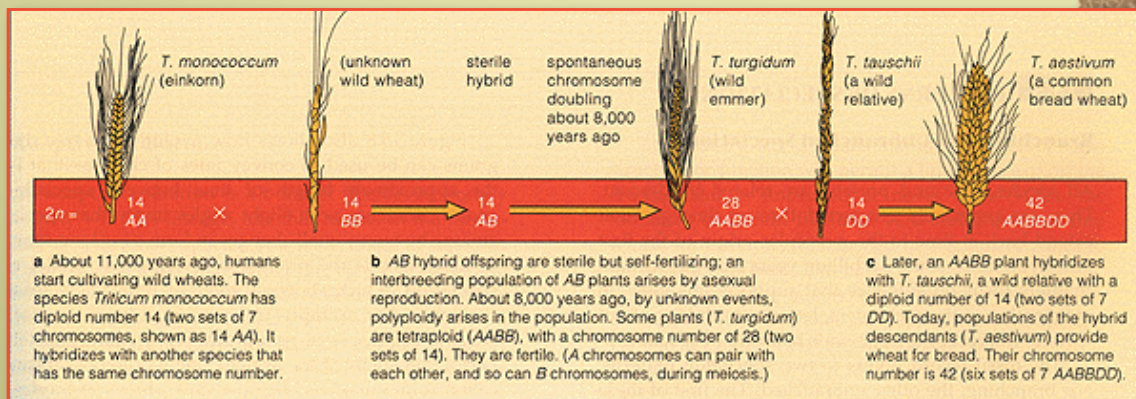
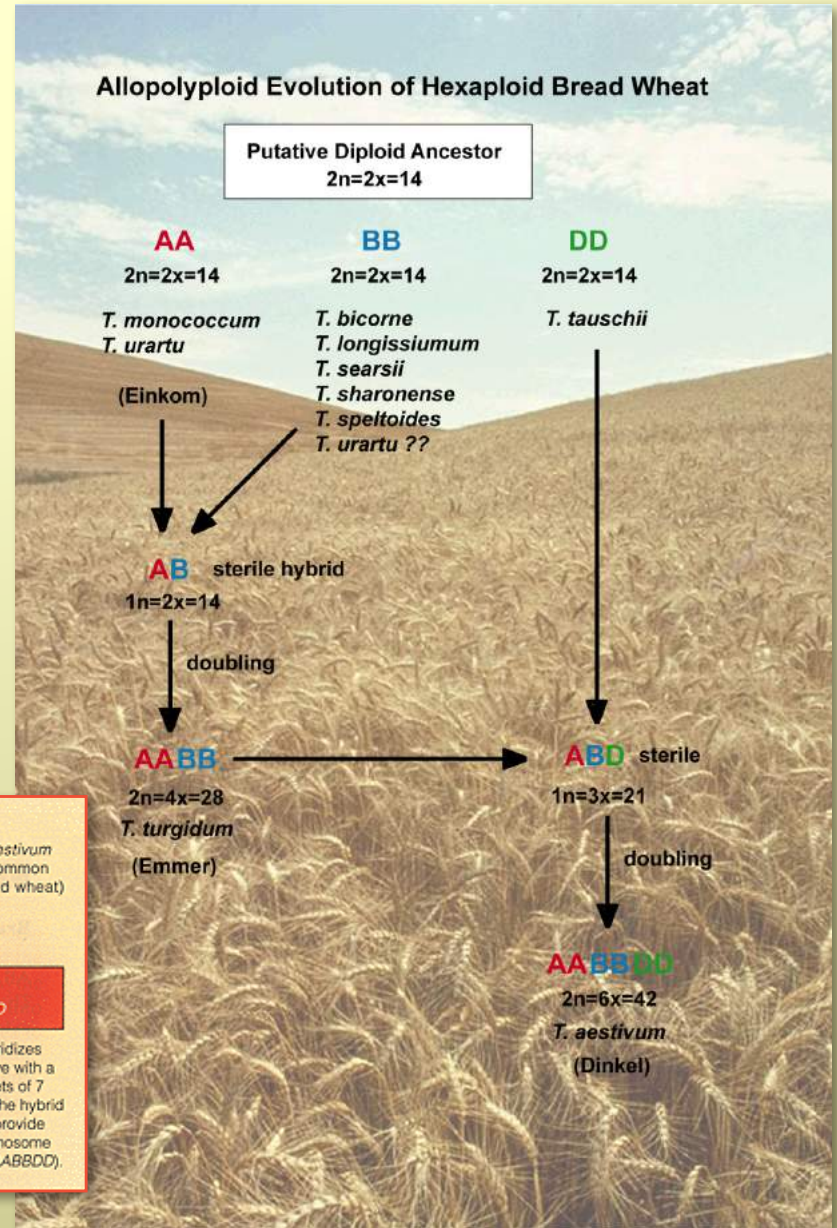
- **hybridization** occurs between two species
- meiotic incompatibilities makes **hybrid sterile**
- doubling of chromosomes occurs (**polyploidy**)
- **allopolyploid is fertile** and **reproductively isolated** from both parental species



Speciation

Under human selection in the Middle East, **bread wheat** (*Triticum aestivum*) has evolved in about 11,000 years.

Two successive rounds of hybridization followed by polyploidization have given bread wheat the genomes of three diploid species — it is a **hexaploid** (3 pairs of chromosomes, or 2 from each diploid parental species).



Speciation



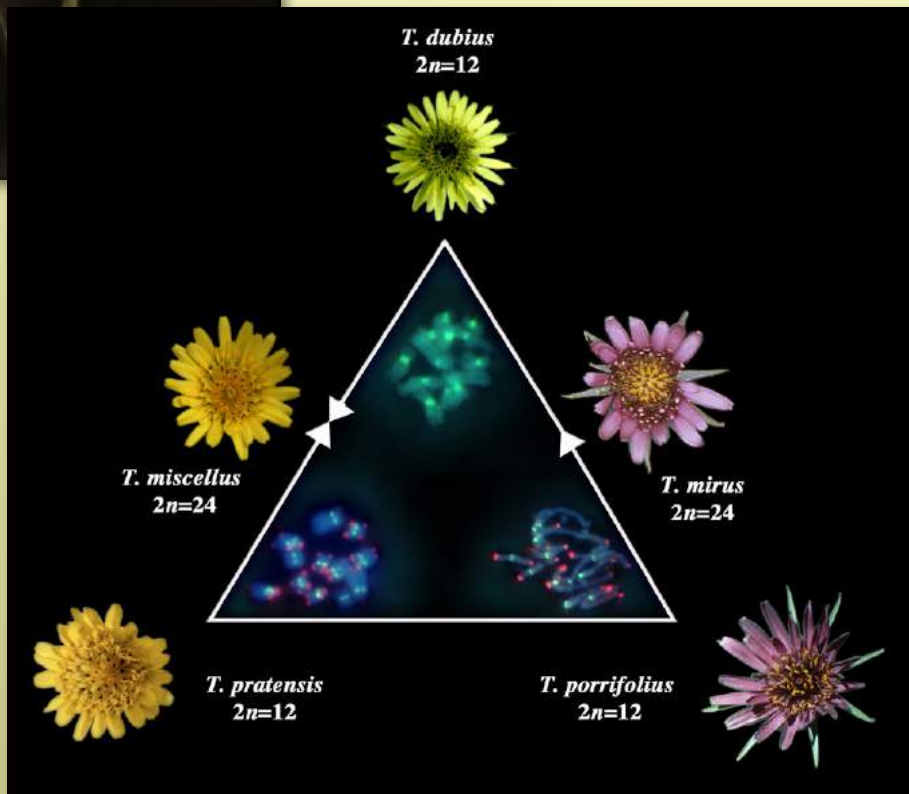
Tragopogon - goat's beard

Even more recent speciation has occurred in the goat's-beards in North America.

- Three diploid ($2n=12$) species were introduced into North America about 200 years ago.

- By early 1900s, these species had hybridized with each other and then formed two different allopolyploid (tetraploid) species.

- These two new allopolyploid species have **evolved numerous times** (!) in areas where the diploid species overlap in geographical range in North America



Speciation

PHILOSOPHICAL
TRANSACTIONS
OF
THE ROYAL
SOCIETY
2014

Tangled up in two: a burst of genome duplications at the end of the Cretaceous and the consequences for plant evolution

Kevin Vanneste^{1,2}, Steven Maere^{1,2} and Yves Van de Peer^{1,2,3}

K-Pg event

