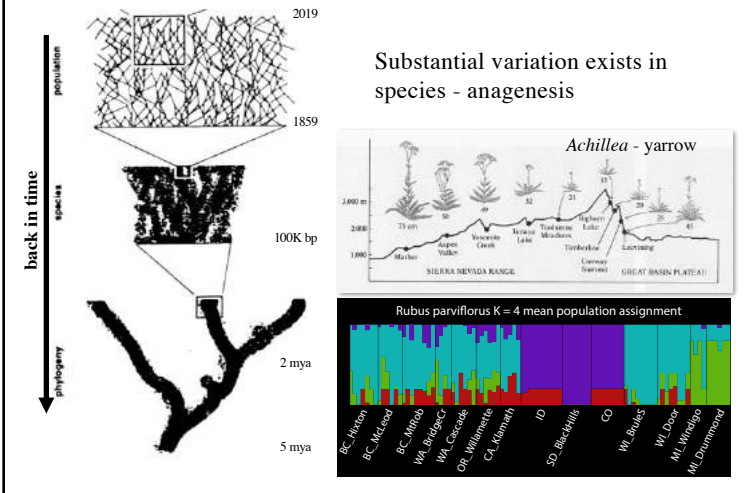
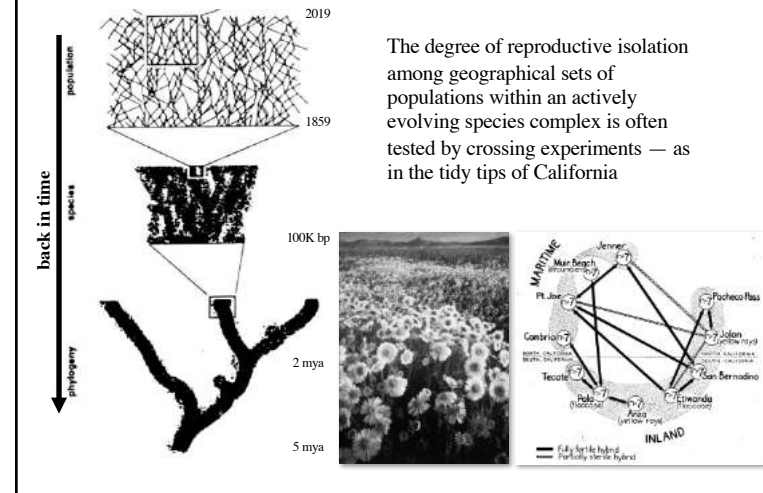


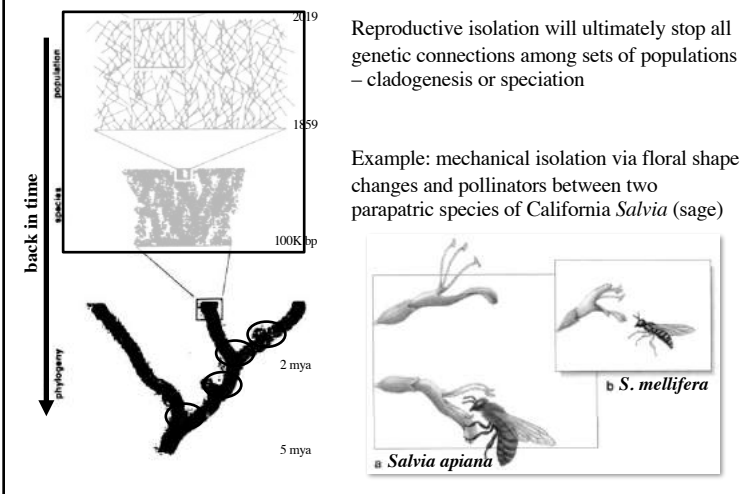
## Speciation



## Speciation



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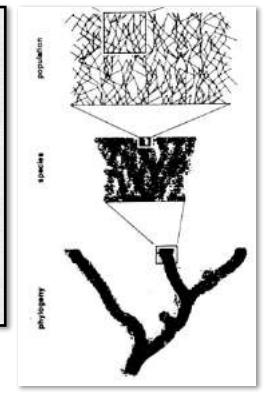
Although simple in concept, the recognition of species and thus the definition of what are species have been controversial — more than likely due to the continuum nature of the pattern resulting from the process of speciation

### 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



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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



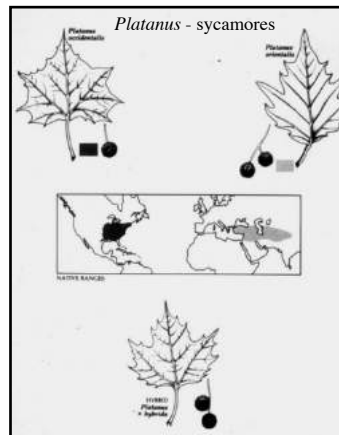
*Rana pipiens* - northern leopard frog in Wisconsin  
*Rana berlandieri* - southern leopard frog in California

## 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

### Allopatric speciation

ranges do not touch or overlap  
no gene flow



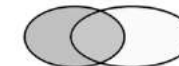
### Parapatric speciation

ranges touch but do not overlap significantly  
gene flow usually small



### Sympatric speciation

ranges overlap significantly  
gene flow is not prevented by geography



- -patry refers to "fatherland" or "homeland"

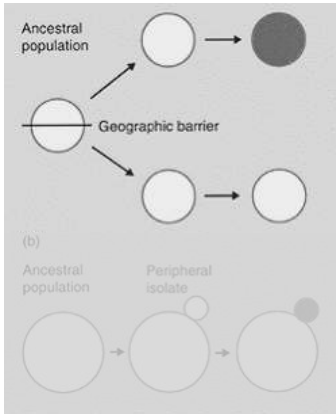
- parapatric & sympatric speciation still debatable

- 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

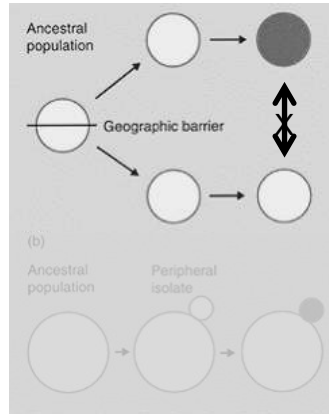
In the conventional allopatric model of speciation, some type of barrier (desert, mountain, ocean, forest incursion) breaks up the ancestral area of a species



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

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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) . . .

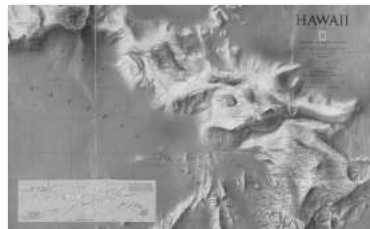
. . . indicating the origin of a reproductive isolating feature while in allopatry

## Speciation

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



Hawaiian Islands — oceanic “islands”



Tepuis in Venezuela — continental “islands”

## Speciation

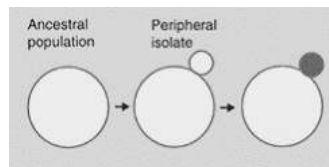
A more rapid type of allopatric speciation often occurs on “islands”



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



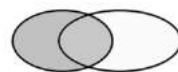
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### Sympatric speciation

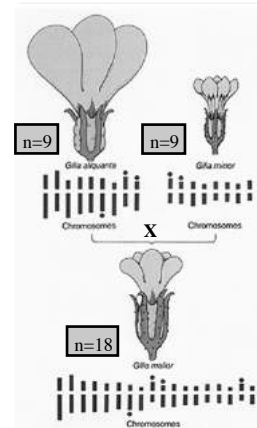
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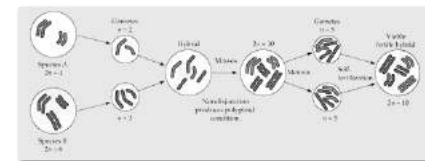
Allopolyploidy is a type of sympatric speciation as it occurs within the ranges of the original parental species.

## Speciation

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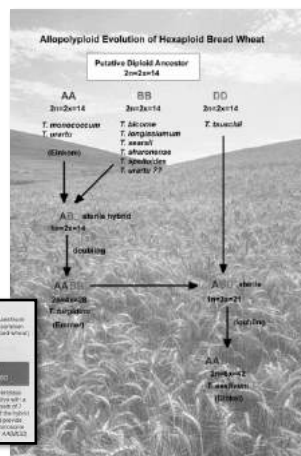
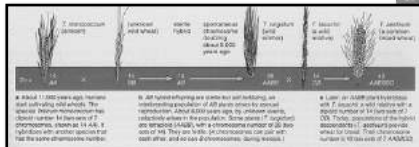
- hybridization occurs between two species
- meiotic incompatibilities makes hybrid sterile
- doubling of chromosomes occurs (polyploidy)
- allopolyploid is fertile and reproductively isolated from both parental species



## 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).

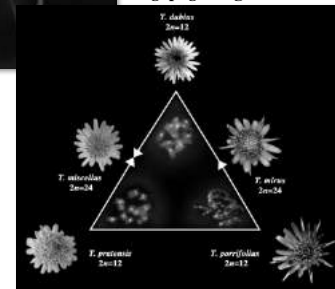


## Speciation

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



*Tragopogon* - goat's beard



- 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

Koua Vannote<sup>1,2</sup>, Steven Mazer<sup>2</sup> and Yves Van de Peer<sup>1,2</sup>

K-Pg event

