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## Lecture 10

### ***Species, speciation & hybridization***

- 1. What is a species?**
- 2. How do species arise?**

Required reading: Coyne – Chapter 7

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# ***Speciation***

## **Key questions**

1. What ecological and genetic conditions are required for speciation to occur?
2. How does reproductive isolation evolve?
3. Is the evolution of adaptation required for speciation?

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## ***Two main species concepts***

### **Taxonomic (or morphological)**

- Based primarily on distinct morphological differences

### **Biological**

- Based on inter-fertility (crossability) among individuals

Concepts vary among different groups of organisms - **no** universal species concept

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## ***The biological species concept\**** **(Ernst Mayr, 1942)**



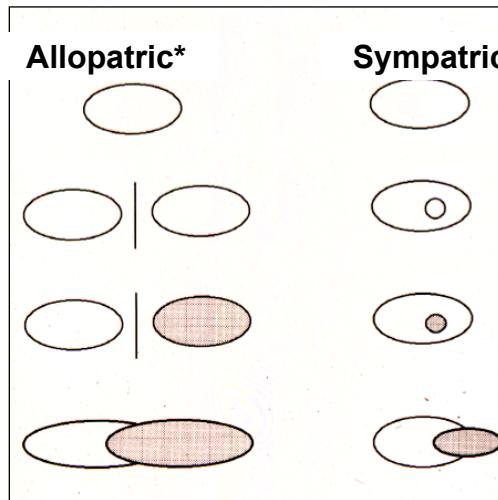
Ernst Mayr -  
Harvard(1904-2005 )

*“a group of interbreeding natural populations that are reproductively isolated from other such groups”*

\* Although Mayr first formally defined the BSC, Dobzhansky first suggested the idea

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## ***Two main modes of speciation***



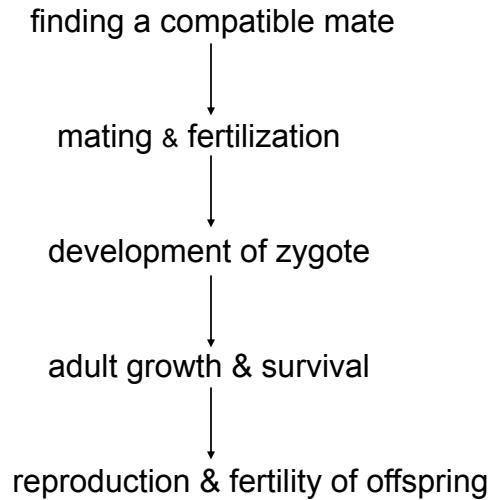
\* Often known as the theory of geographic speciation since geographical isolation is involved (see Coyne p. 178)

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## ***What causes reproductive isolation (RI)?***

Stages when RI can occur:



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## ***Reproductive isolating mechanisms***

Speciation involves the evolution of reproductive isolation between populations

- **Premating isolation**
- **Postmating isolation**

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## ***Reproductive isolating mechanisms***

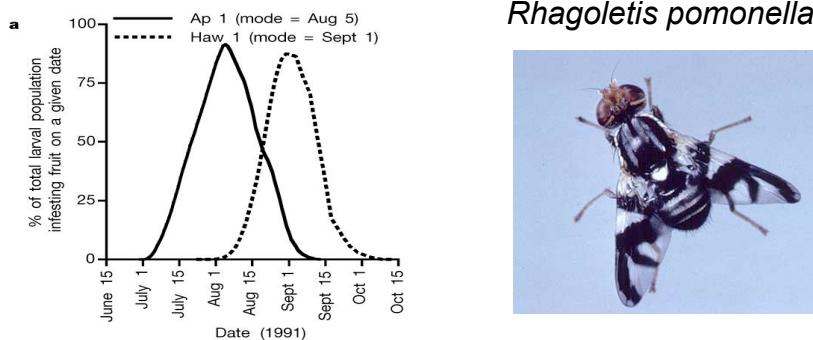
### **Premating:**

Preventing zygote formation

- Geographical, ecological
- Temporal, behavioural
- Mechanical, prevention of gamete fusion

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### ***Premating isolation in apple maggot flies: habitat and temporal isolation***

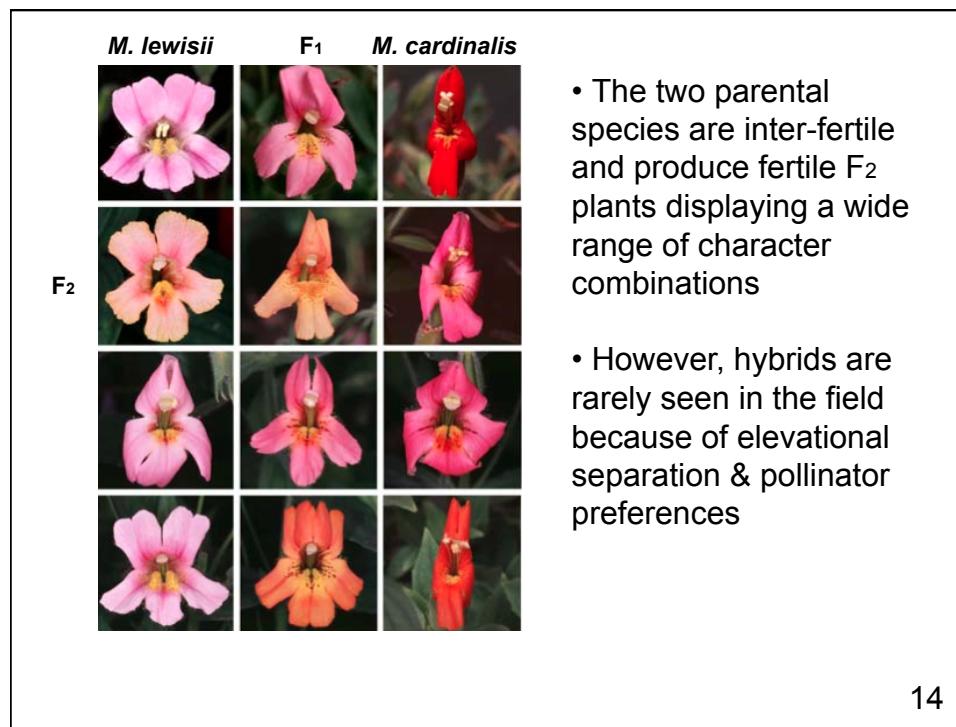
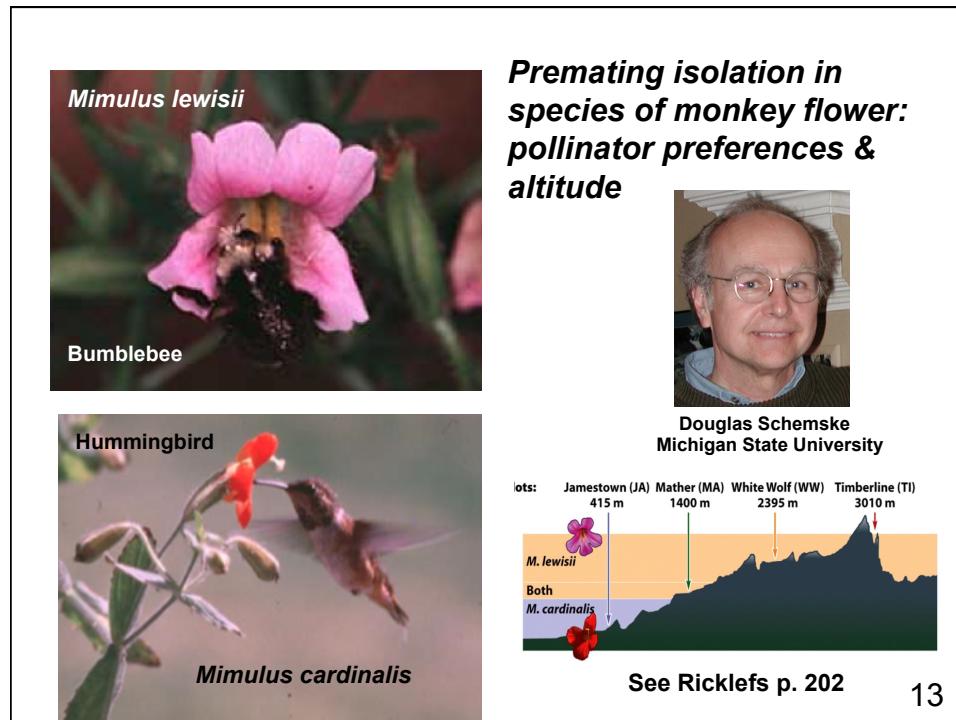


- arrival of domesticated apples in 19<sup>th</sup> century led to host shift
- differences in host plant emergence and mating on preferred host restricts hybridization
- this reduces gene flow in sympatry (same region) to ≈ 6%

Guy Bush & Jeff Feder

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## ***Reproductive isolating mechanisms***

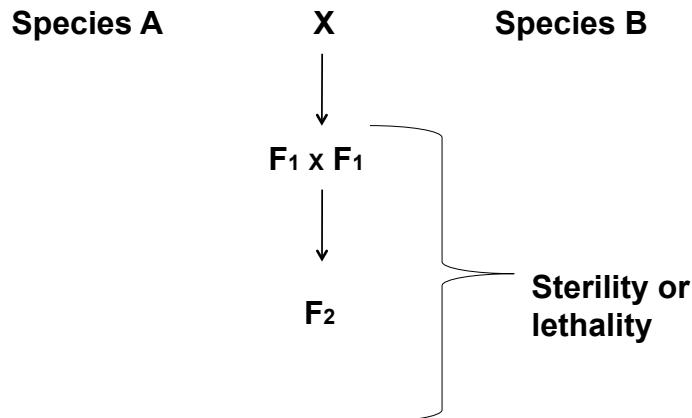
### **Postmating:**

Preventing the proper functioning of zygotes once they are formed

- Inviability, sterility, or abnormal development of hybrids
- $F_2$  breakdown

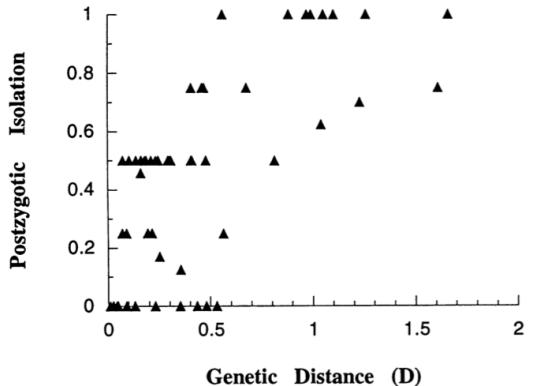
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### ***Intrinsic postmating isolation: inherent genetic problems with hybrids***



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## ***Relation between genetic distance\* and postmating (zygotic) isolation in fruit flies***



- the more genetically differentiated pairs of flies are the more likely they are to be reproductively isolated

- the plot can be viewed as a time course for the evolution of reproductive isolation

• Genetic distance is a measure of the degree of genetic differentiation between samples

Coyne & Orr *Evolution* 1997

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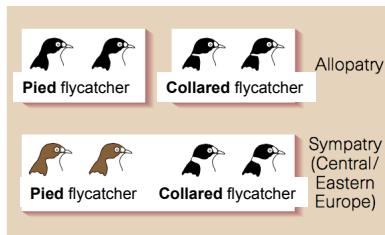
## ***The mule - an example of intrinsic postmating isolation***



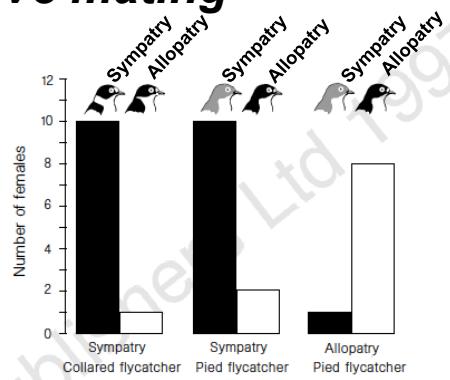
Mule is a sterile hybrid from a cross between a male donkey and a female horse

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## ***Postzygotic isolation due to assortative mating***



- matings in sympatry are mostly between same species
- hybrids have very low fertility
- females from sympatric populations choose to mate with males of their own species



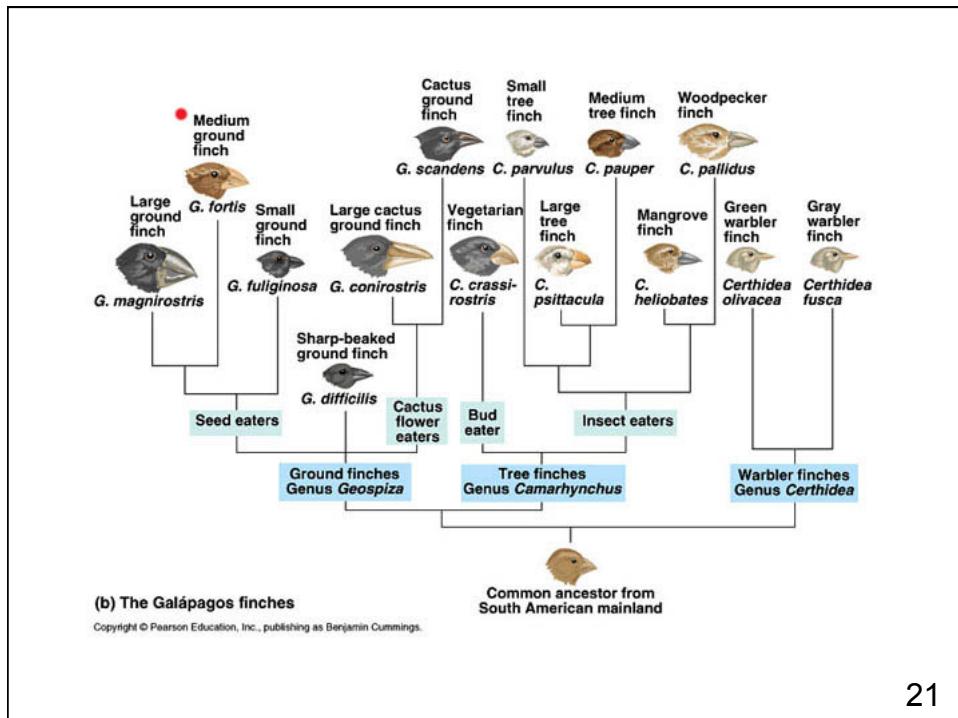
females from sympatric populations prefer conspecific males that have the sympatric colouring over those with the allopatric colouring

Sætre et al 1997 19

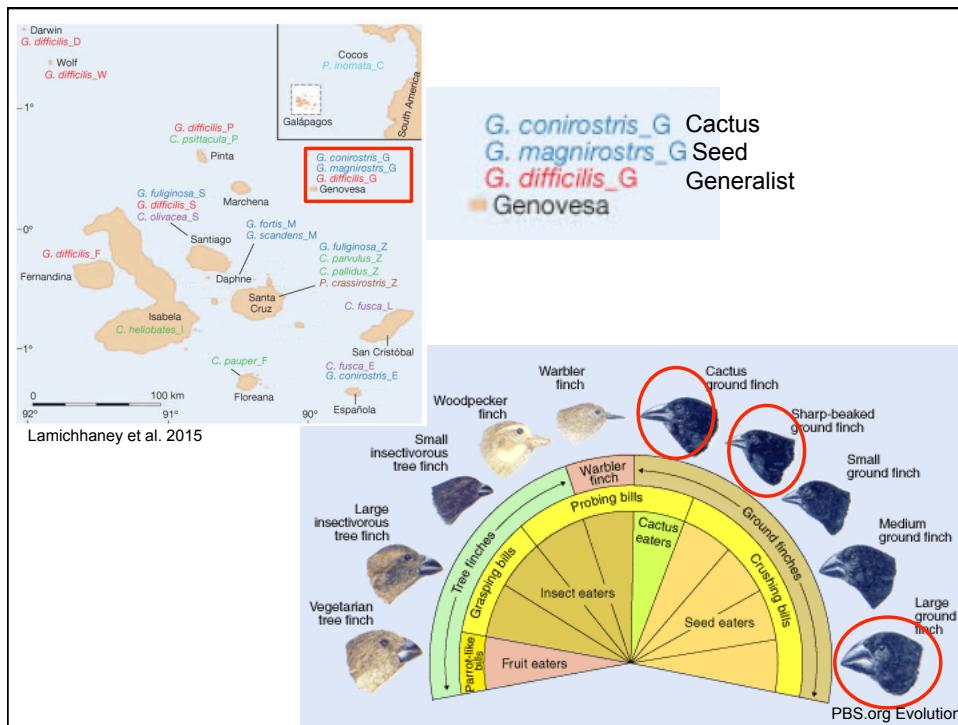
## ***Adaptive radiation***

- the evolution of ecological and phenotypic diversity within a rapidly multiplying lineage as a result of speciation
- From a single common ancestor the process results in an array of species that differ in traits allowing exploitation of a range of habitats and resources
- Four features commonly identify an adaptive radiation
  1. Recent common ancestry from a single species
  2. Phenotype-environment correlation
  3. Trait utility
  4. Rapid speciation

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## ***Hybridization***

- The exchange of genes between species as a result of occasional inter-specific mating
- Varies among different groups of organisms
  - common in plants and fish, rare in mammals
- Can result in complex patterns of variation
- Variation can be of evolutionary significance resulting in speciation, especially by polyploidy

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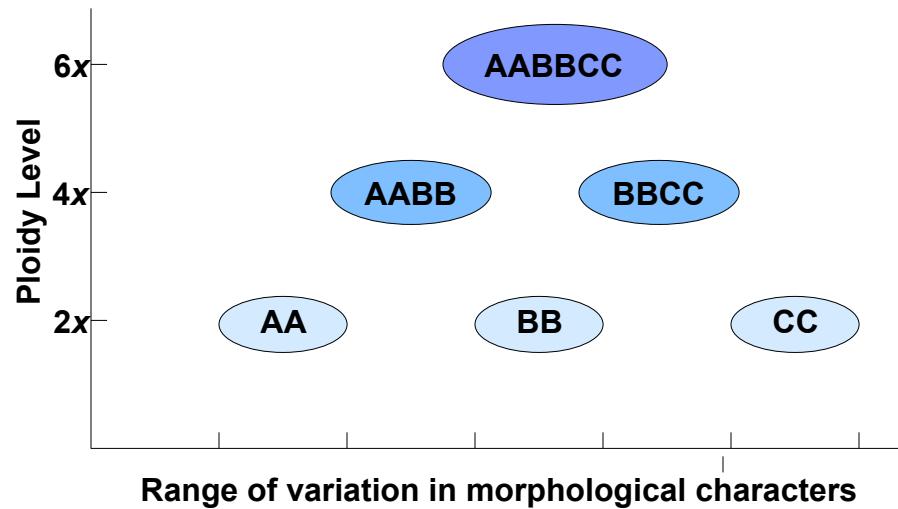
## ***Polyplody***

- An organism, tissue, or cell with more than two complete sets of homologous chromosomes
- Polyploid conditions range from autopolyploidy (e.g. AAAA) to allopolyploidy (e.g. AABB)
- Allopolyploidy arises from occasional hybridization between species and is the commonest type of polyploidy

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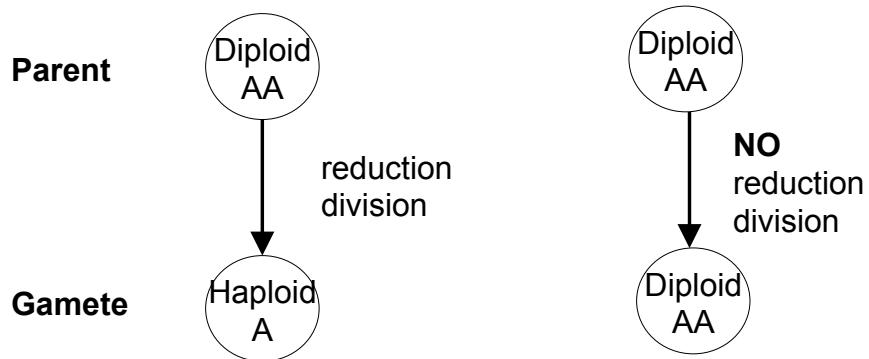
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## *An allopolyploid complex*



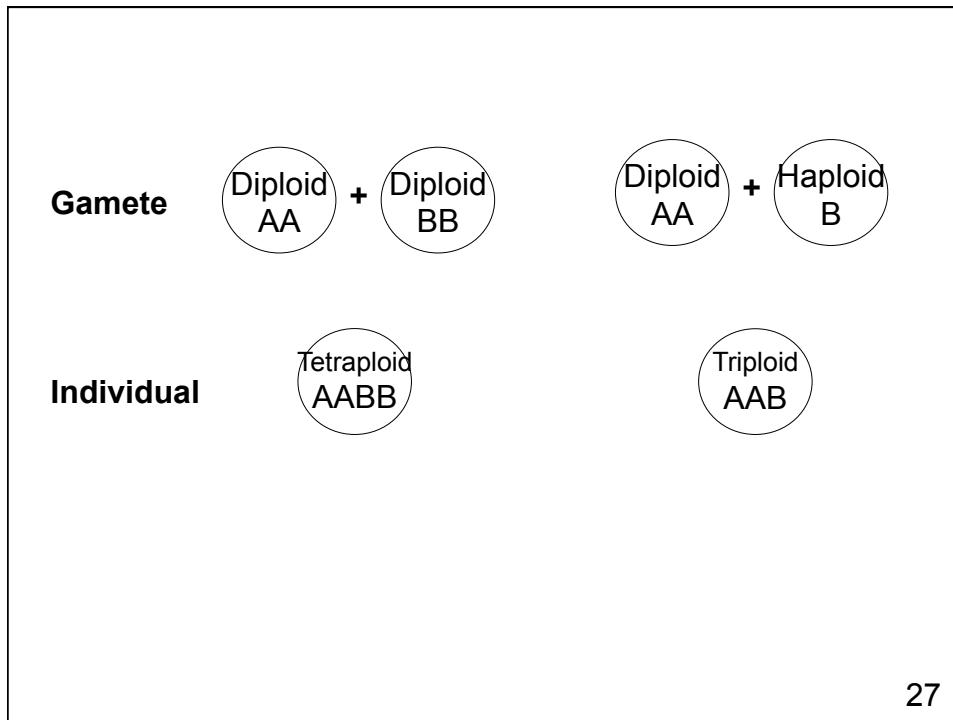
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### *Normal meiosis      Unreduced gametes*



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## ***Evolutionary significance of polyploidy***

- Polyploids reproductively isolated from their diploid parents hence a form of sympatric speciation
- Polyploids exhibit novel phenotypes allowing exploitation of new habitats
- Hybrid vigour evident due to heterozygosity, particularly in allopolyploids
- Approximately half of all flowering plants are of polyploid origin including many crops plants & invasive species

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*Next Lecture - 11*

## ***Phylogenetics & macroevolution***



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