

Speciation: Keeping species separated

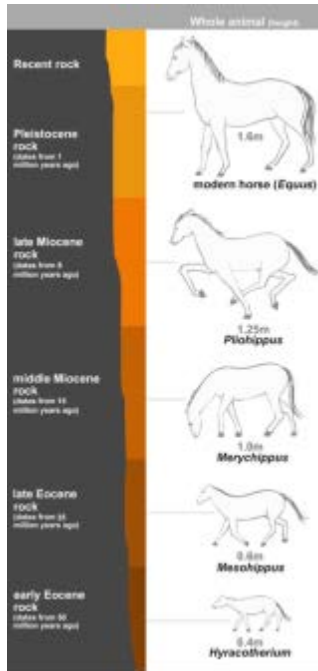


EVOLUTION has two fundamental processes

- Change within a lineage
- Formation of new lineages (associated with split of existing lineage)

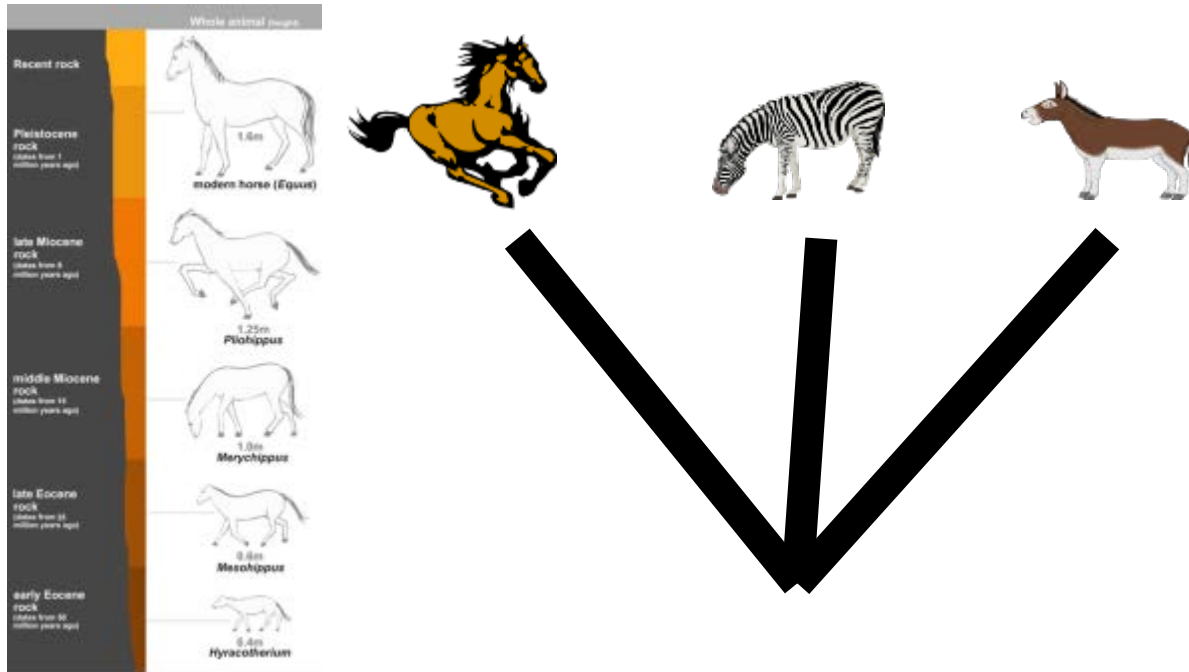
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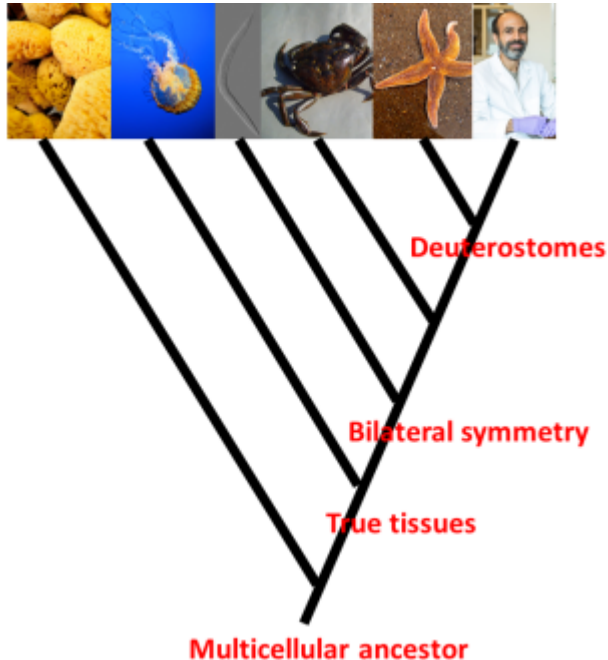
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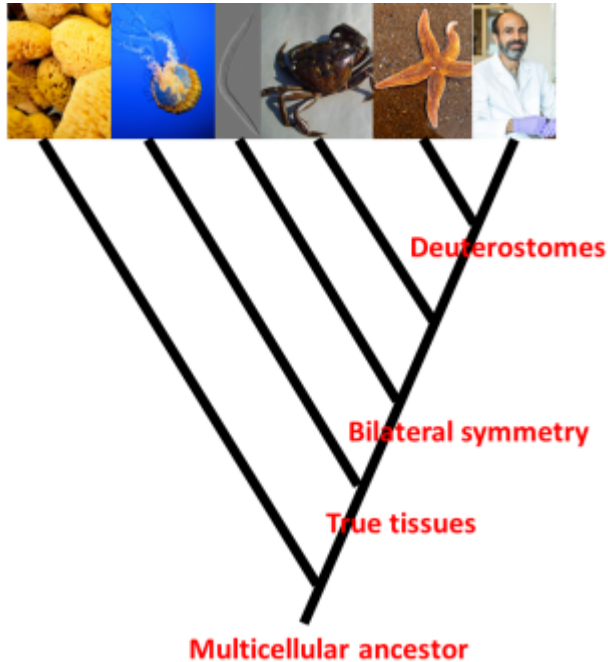
New lineage formation leads to the diversity of life on Earth

Partial “tree” of animal life

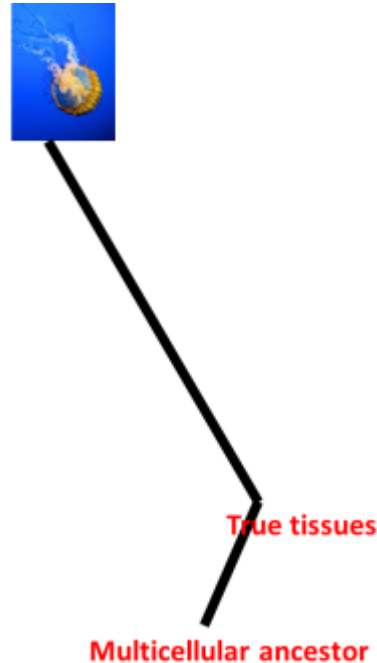


New lineage formation leads to the diversity of life on Earth

Partial “tree” of animal life



Twig of animal life



Species form & make new lineages- no intermediates?

- Organisms exist in discrete clusters- don't observe in nature all intermediate forms...
- Darwin addressed this only indirectly- considered species and genera to be extension of “varieties”



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Some big questions on origin of species



- **Why do these clusters not “fuse” - why don’t we see all the intermediates?**
 - How does geography affect species formation?
 - What is the genetic basis of species formation?



What is a “species” anyway???

On a practical level, decide based on appearance... but how different do you have to be?



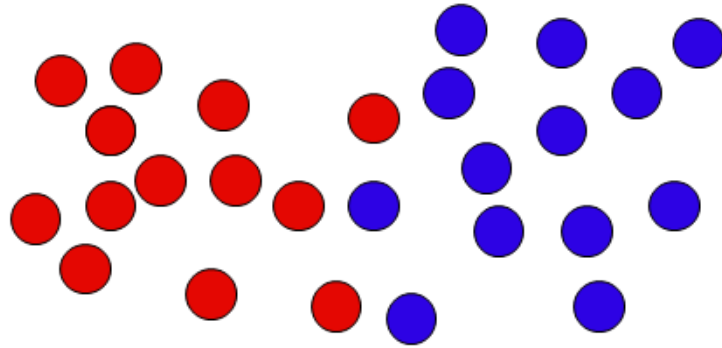
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Most widely used concept: “gene pools”

- Groups of interbreeding natural populations that do not exchange genes with other such groups
 - Termed the “Biological Species Concept”



What prevents exchange?

“Barrier traits” separate gene pools in two ways

1) Interbreeding doesn't happen at all

- Live in different parts of common environment
- Breed at different times of day or different seasons
- Just not attracted to each other

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2) Whoops! Well, interbreeding does not result in gene exchange for other reasons

- Sperm don't fertilize eggs of other species
- Hybrids die early in life
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Example: habitat differences

- ***Rhagoletis* fruit flies**
 - Two races in North America: breed exclusively on apple or hawthorn berries
 - Survival & reproduction better on “own” host
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 - Apple race JUST formed in last few hundred years-- before 1600s, no apple trees in USA



Example: timing differences

- **Cicadas- some species emerge every 13 years, and some every 17 years**
 - Until that time, burrow underground and eat off tree roots
 - Then emerge, drop exoskeleton, and call
 - Only overlap once every 221 years!



Example: preference differences

- North American fruit flies *Drosophila pseudoobscura* and *D. persimilis* co-occur & look identical, but “sing” different songs
 - Females reject males singing wrong song

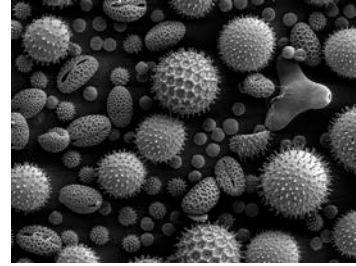


Example: fertilization specificity

- Red and pink abalone spawn at similar times, but sperm only fertilize females of same species
 - Molecular genetic studies have identified several of the proteins (on sperm and egg) mediating this species-specific interaction



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Example: hybrid sickly/ dead

- Intertidal copepods from northern and southern California produce sickly hybrids
 - This inviability is associated with defects in their mitochondrial electron transport system- their means of getting energy
 - Specific genes known



Example: hybrid sterile

- Liger - a hybrid of lion father and tiger mother. Probably doesn't happen in nature since they don't overlap ranges. Males are usually sterile.
- Zonkey - usually a hybrid of a zebra father and a donkey mother. Found in South Africa. Usually sterile (especially males).



Barrier traits act together

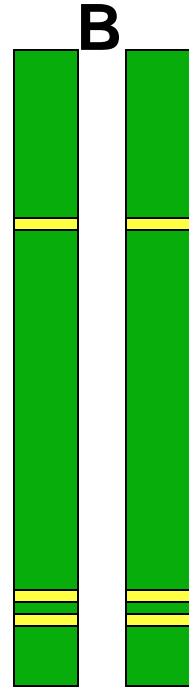
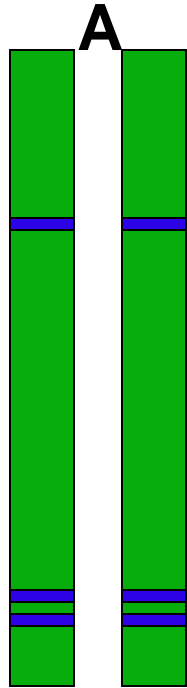
- *Very few cases where one looks at two species and only sees a single barrier trait separating them.*
- Still debated among some evolutionary biologists whether some barrier traits are more common “earlier” in divergence process.
- BUT, since 1930's, genetic studies of species formation have focused on studying these traits.



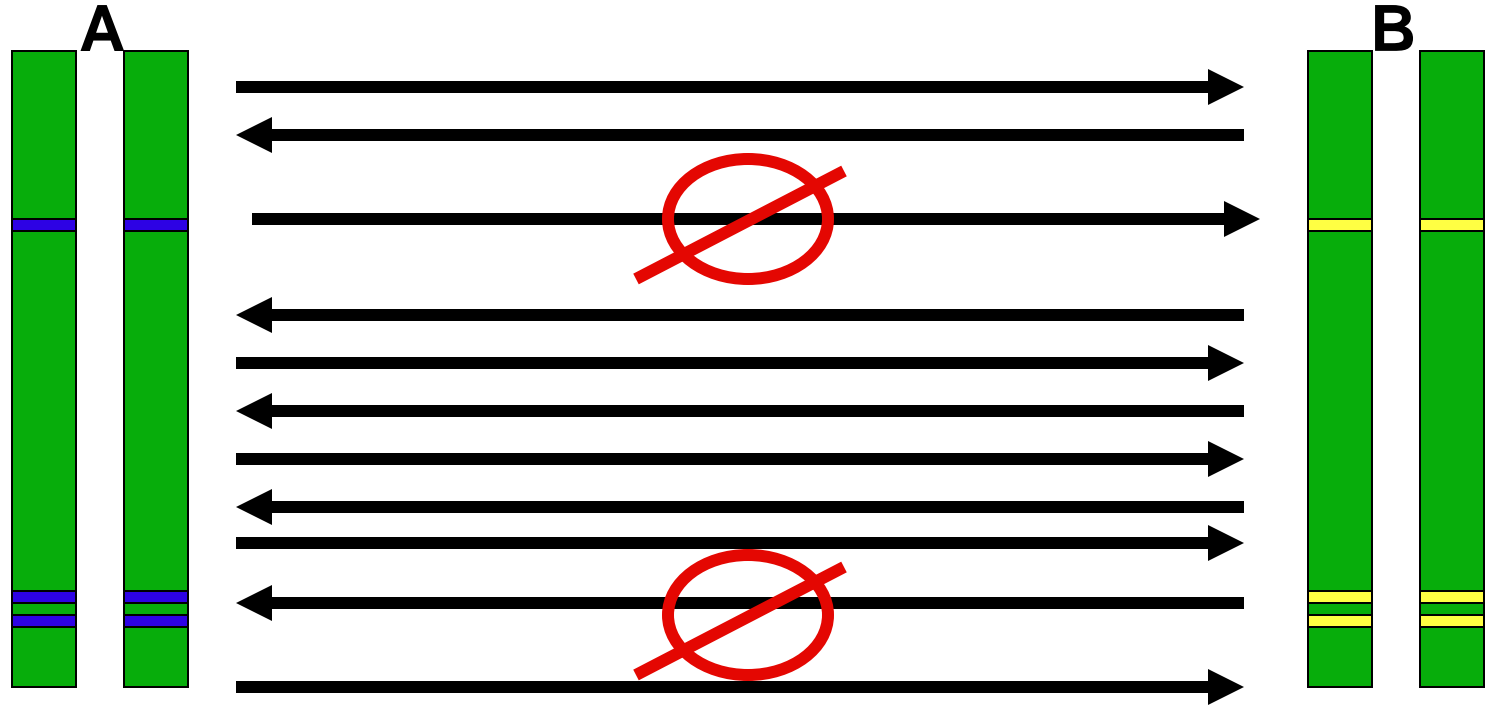
... and these barriers are not always perfect...

- Estimates suggest 10-25% of species hybridize with other species, and many of these exchange some genes
- This does **NOT** undermine their usefulness or their effect
 - still keep parts of genome into “distinct” clusters
- *Speciation is a process, not a point*

Hybridizing species can exchange some genes, but not others



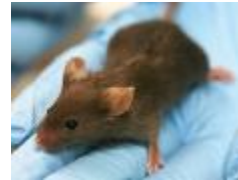
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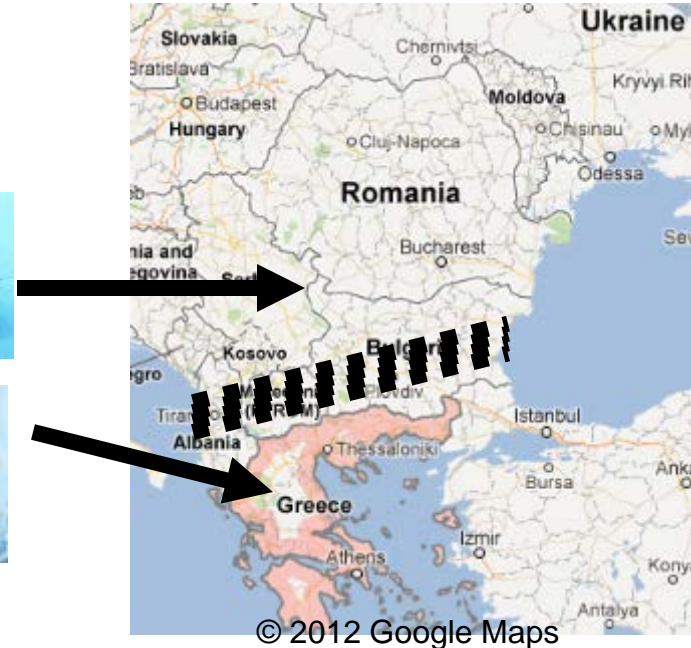
Some “hybrid zones” have persisted for thousands of years

- Diagnosable clusters persist despite many generations of gene exchange
- **Example:** house mouse hybrid zone in SE Europe estimated ~6000 years old
- Some genes more freely across zone, others don't

Mus musculus



Mus domesticus



-- Tricky areas --

- What if geographically separated?
- What if the groups are asexual?
- “How much” gene exchange is too much?



Quick recap:

- Species defined as diagnosable groups that don't exchange genes
- Gene exchange prevented by (one or) multiple “barrier traits”
- Gene exchange need not be reduced to zero for groups to be “species”, but need to be diagnosable



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