



Speciation in an Ecological Context

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Species Diversity



THINK

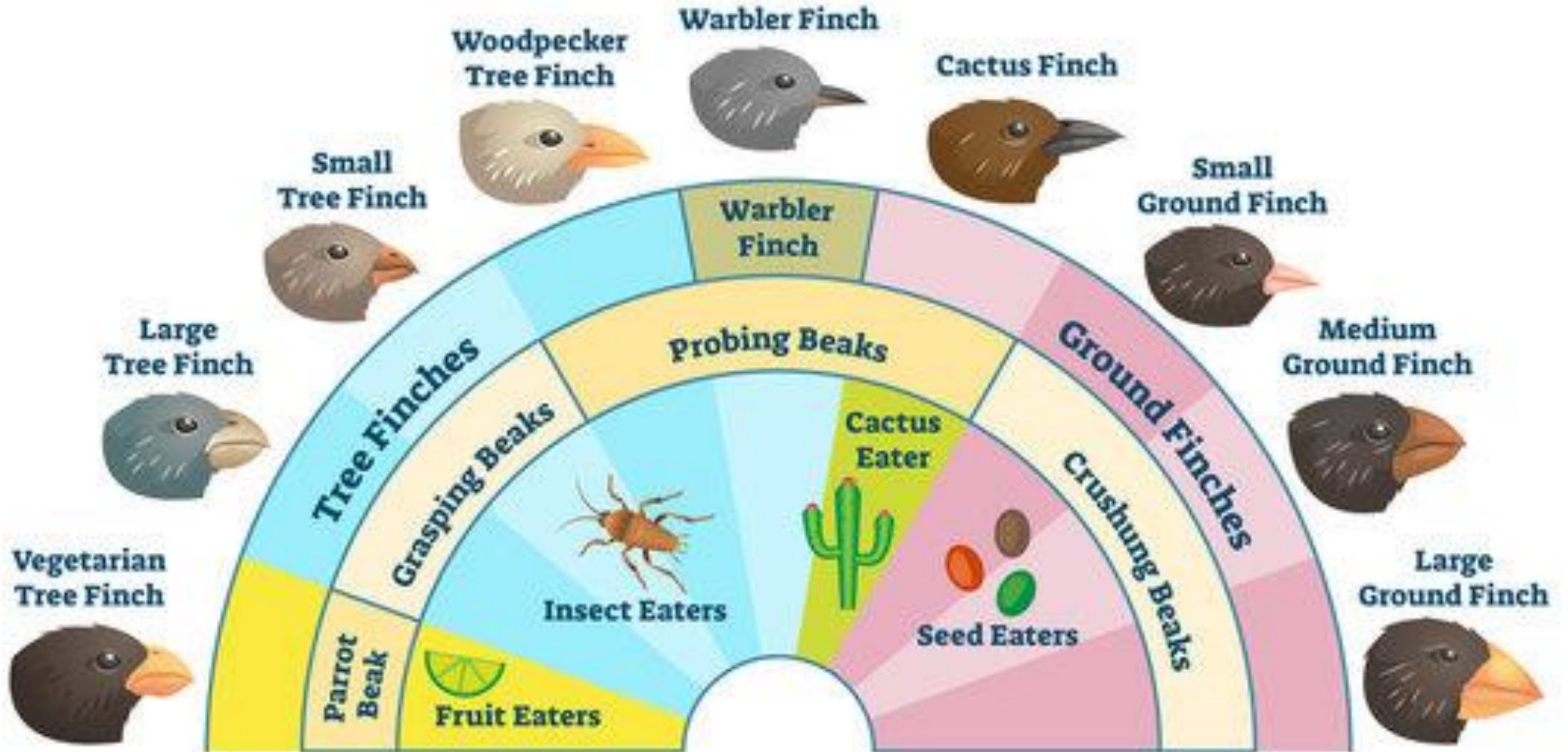
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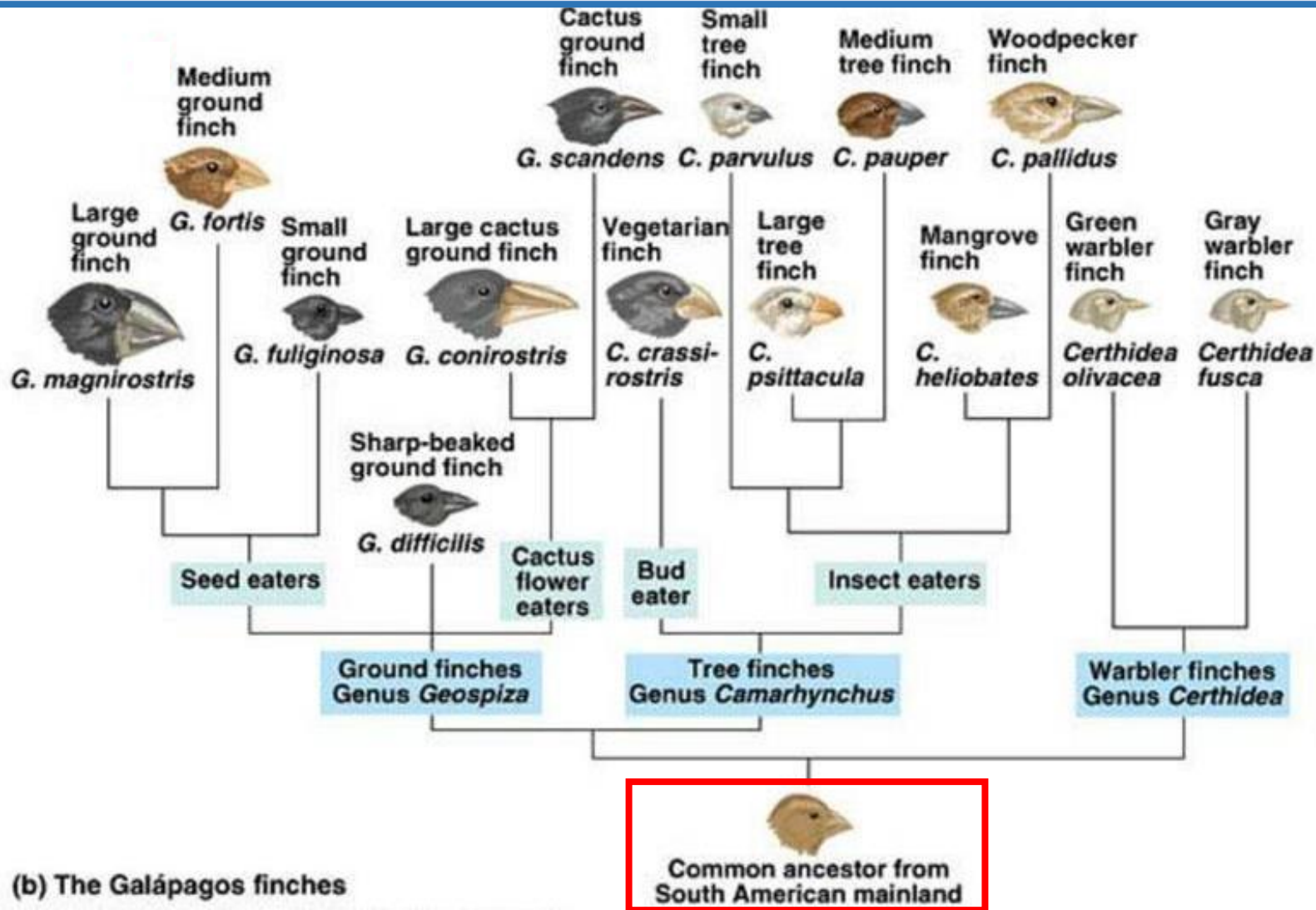
Find a partner or two (If you see someone without a partner, invite them to join you!)

Where did these species come from?

All species come from pre-existing species



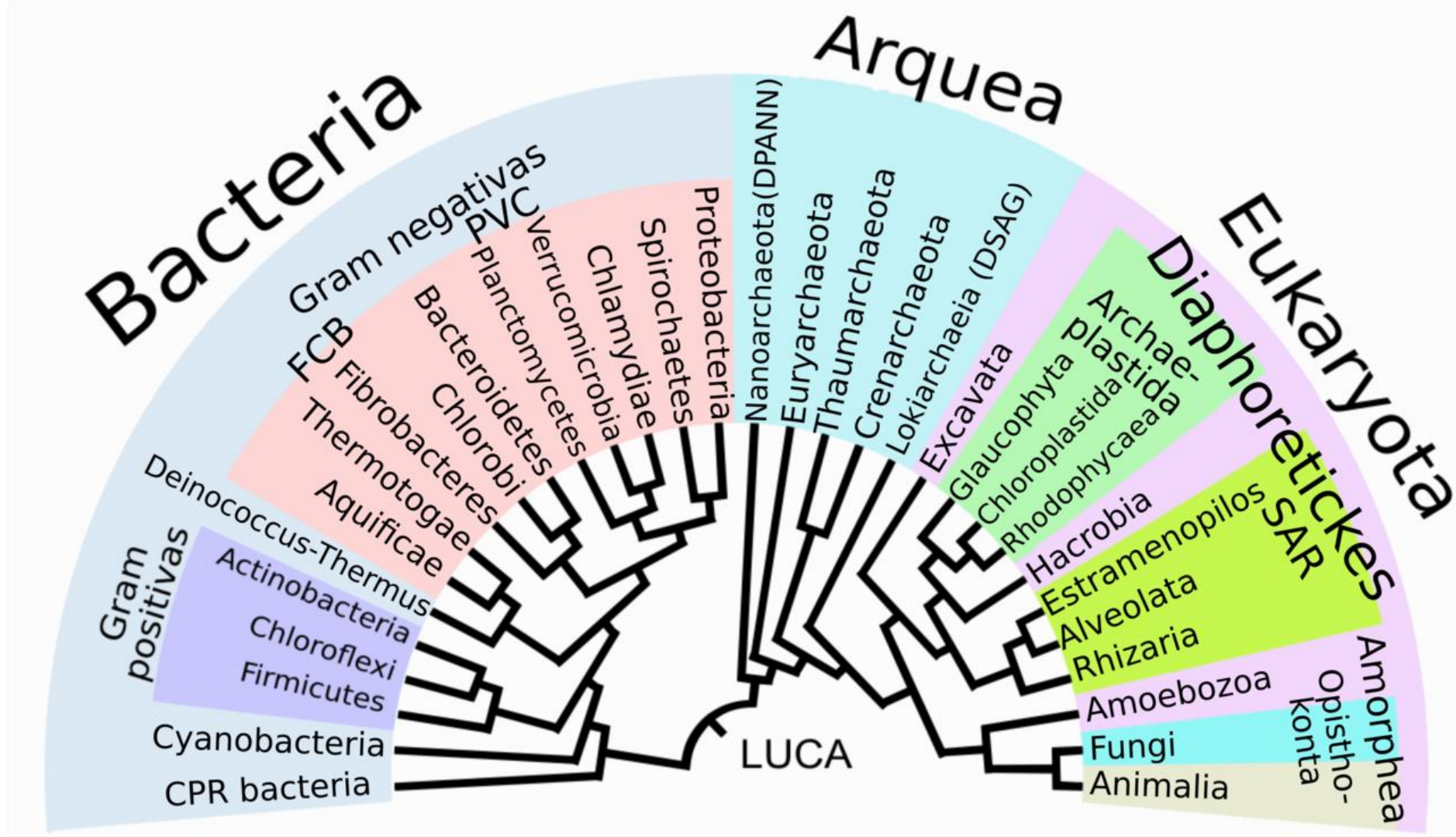
All species come from pre-existing species



All species are descendant from a common ancestor!

(b) The Galápagos finches

All species come from pre-existing species



All species come from pre-existing species

Speciation

is the process by which new species originate

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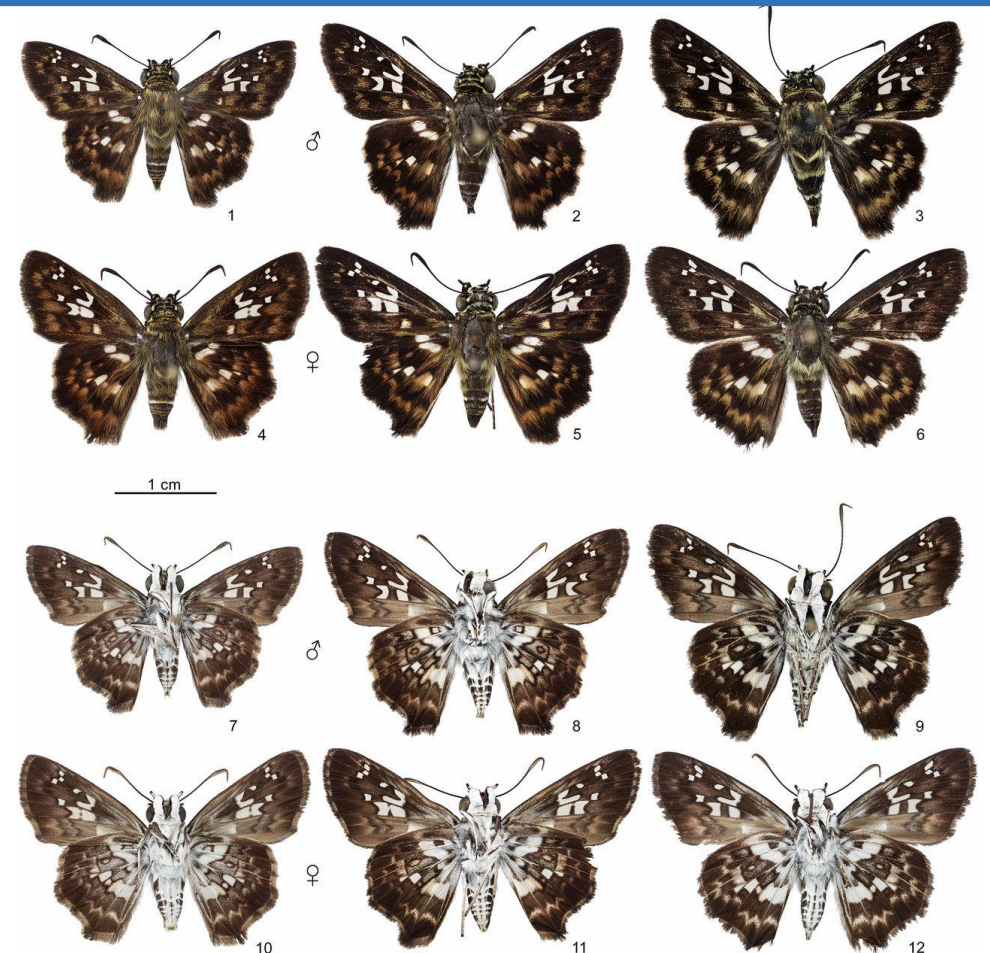
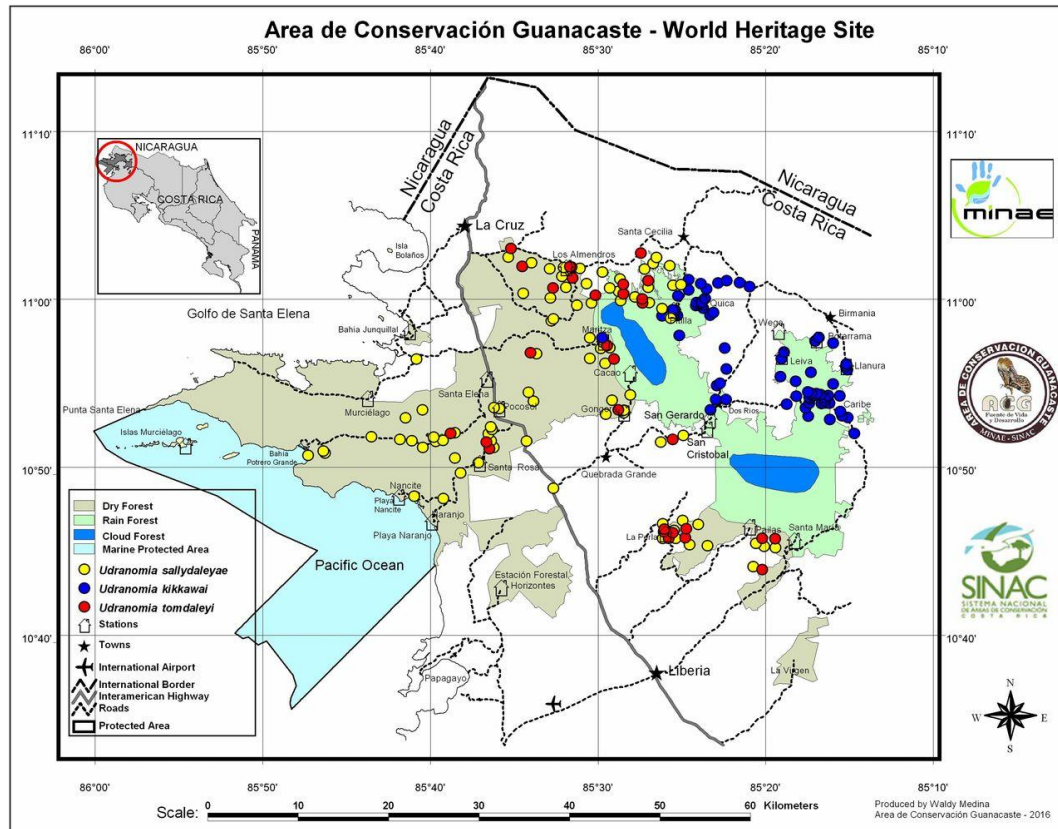
What is a species?

Species concepts

- **Morphological Species Concept:** species are group differentiated in appearance.
- **Biological Species Concept:** Groups of actually or potentially interbreeding natural populations which are reproductively isolated from other such groups (Ernst Mayr, 1963).
- **Phylogenetic Species Concept:** A species is the smallest group of populations that can be recognized by a unique combination of shared characters (e.g., Cracraft, 1981; Nixon & Wheeler, 1990).

Limitations: Cryptic species

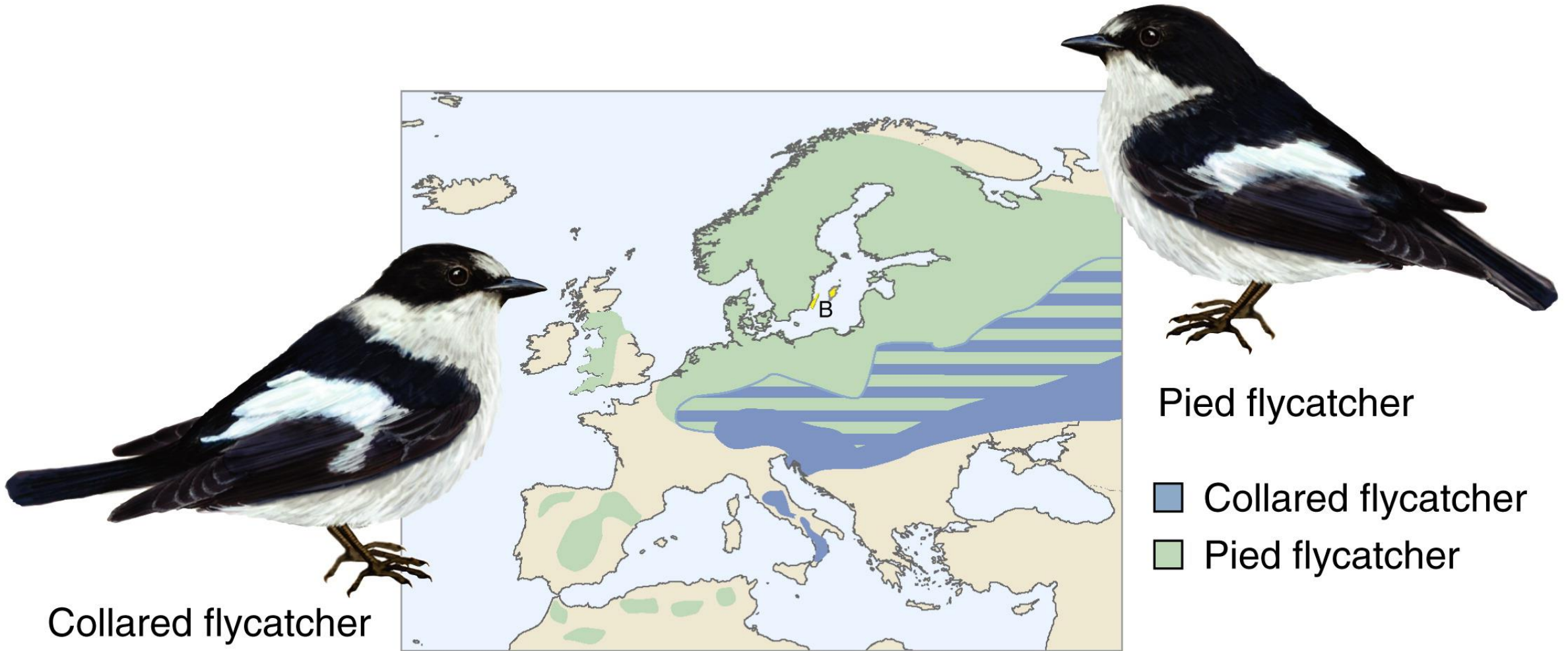
Cryptic species: Morphologically similar, but distinct species



“...10–20% of the traditional (~15,000), morphologically based “single” species will turn out to be two or more.”

Janzen et al. 2017 PNAS

Limitations: Hybridizing species



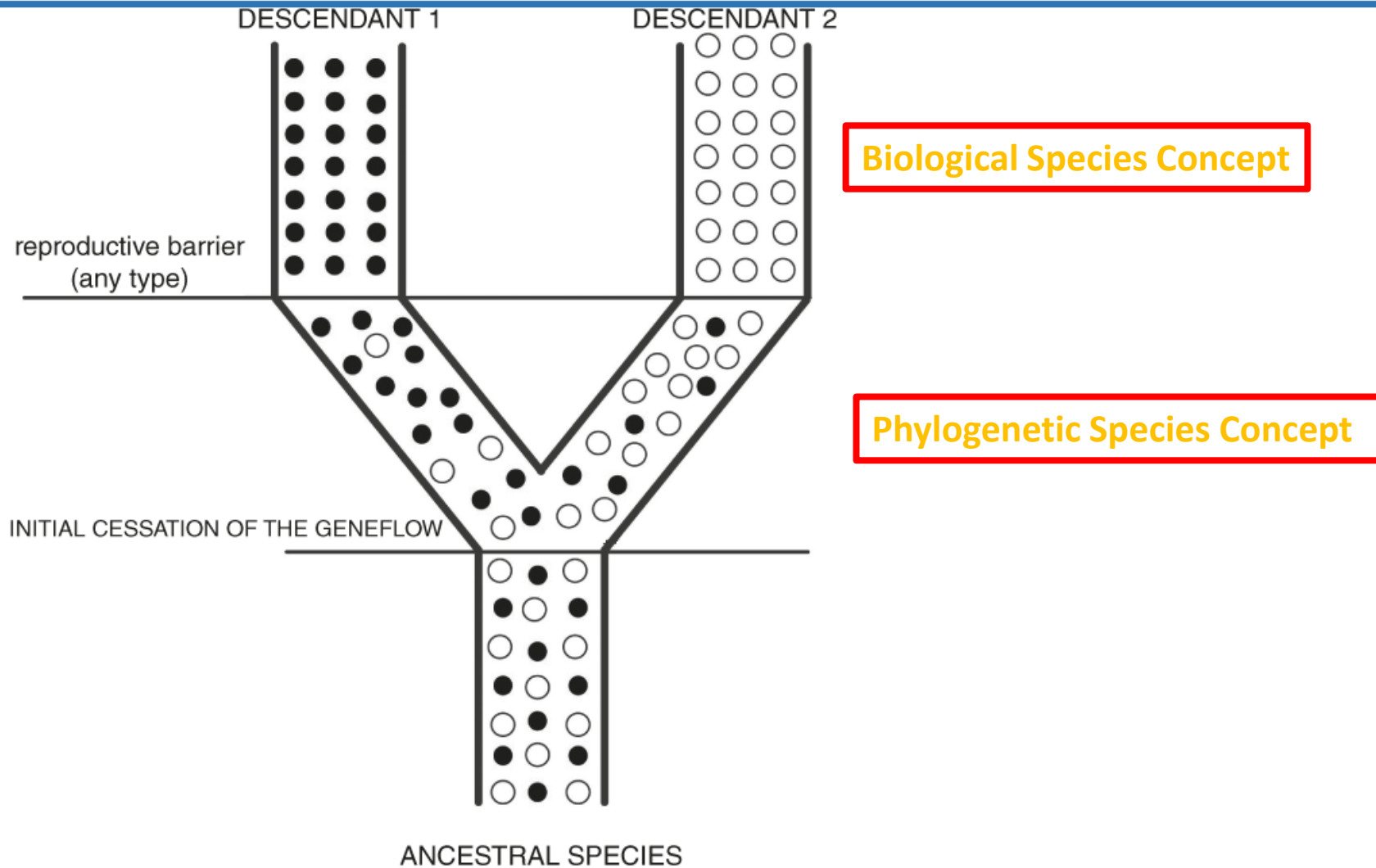
Limitations: Asexual species



Species concepts - conclusions

- Species concepts are not mutually-exclusive.
- Speciation is part of an evolutionary process... at any time expect to find (parts of) lineages at all stages of divergence.
- Species concepts mark stages in the existence of a species and do not determine species status.

Species concepts - conclusions



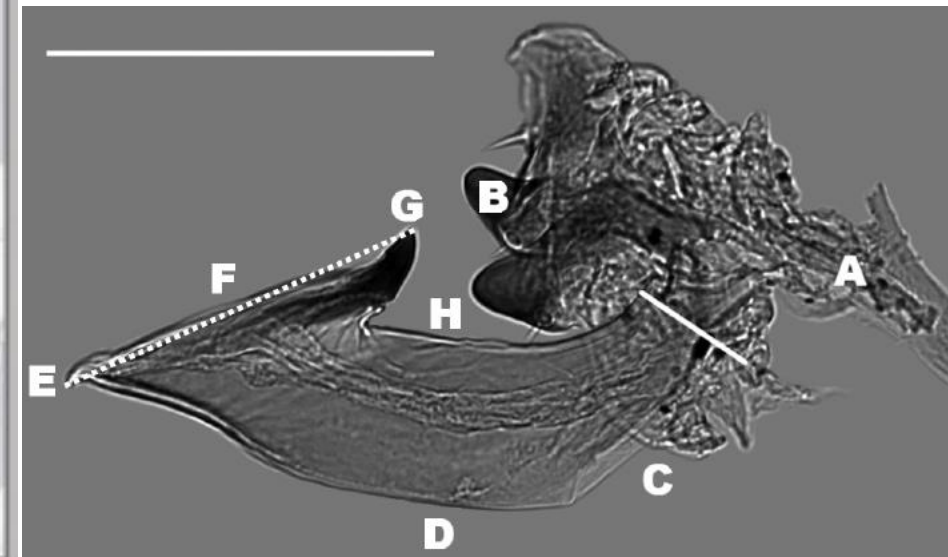
Case study – *Drosophila arizonae*



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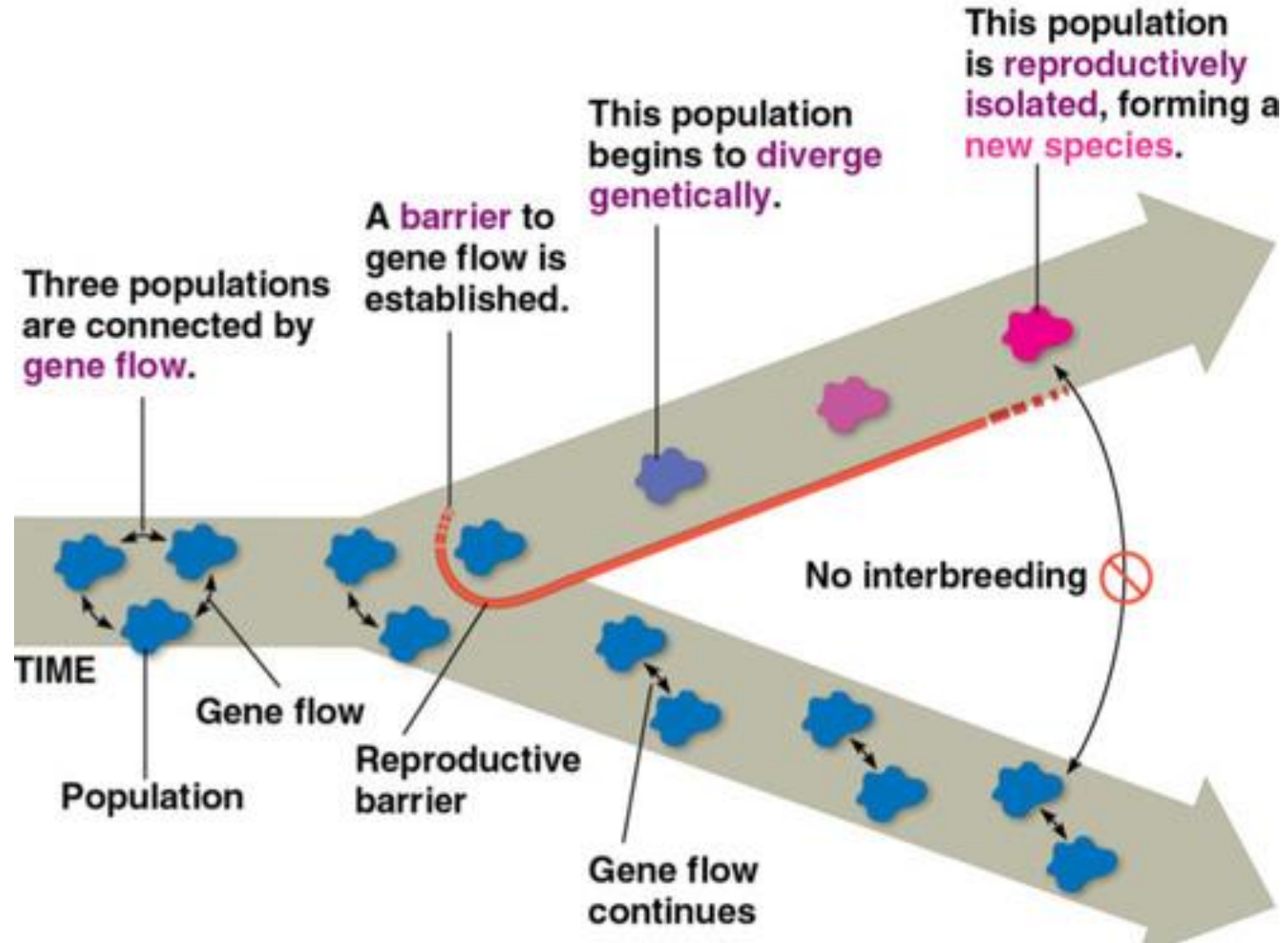
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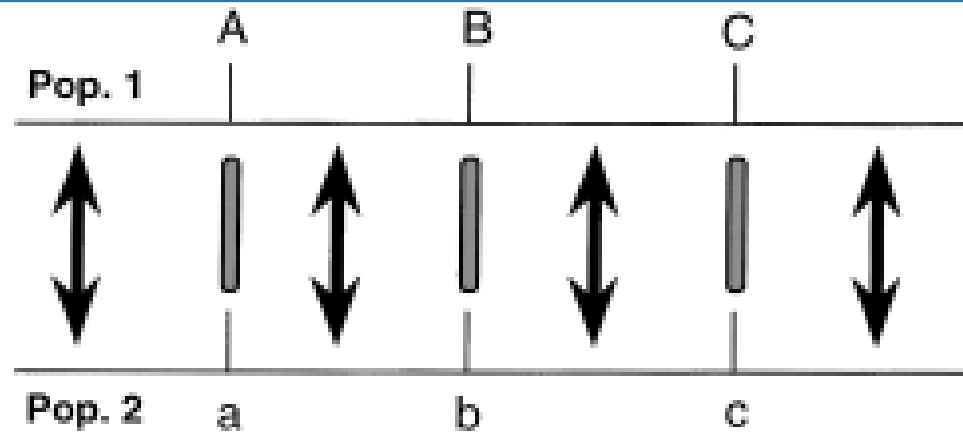
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Can divergent populations of
Drosophila arizonae be considered
different species?

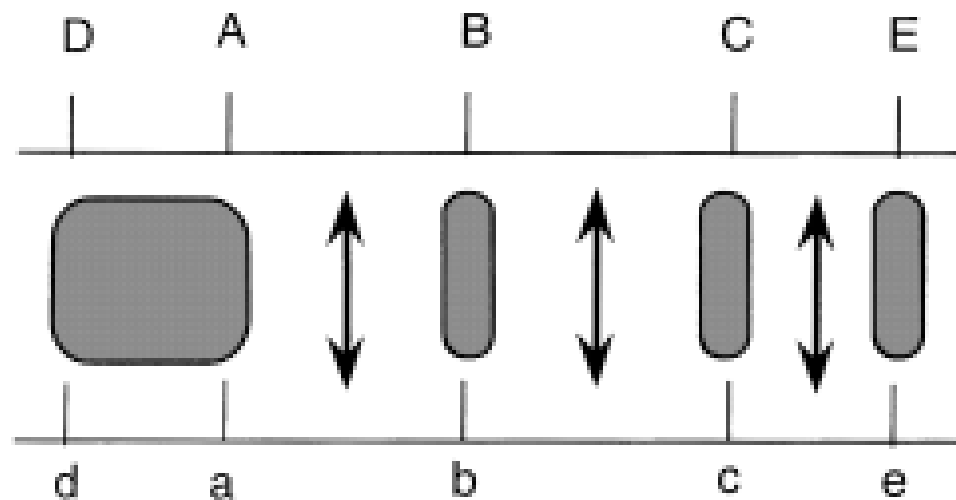
Interruption of gene flow



Genetic changes associated with speciation

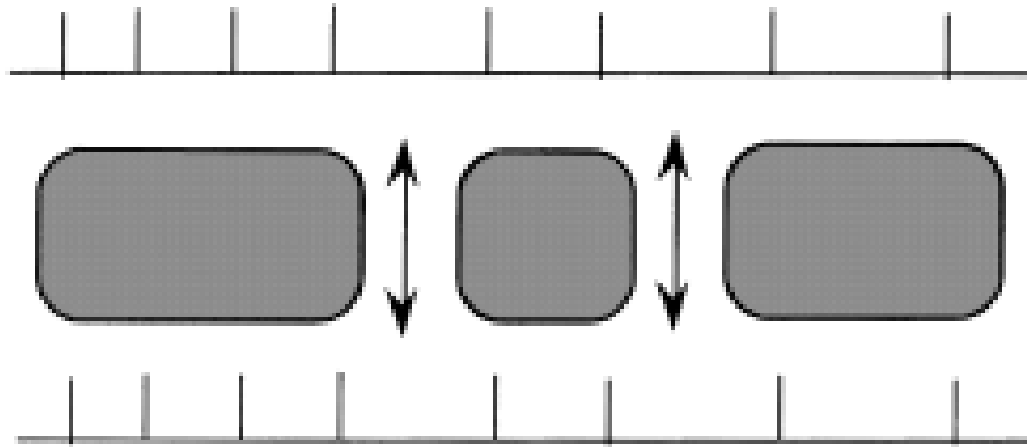


Stage I –
Populations/races with
differential adaptation;
RI not apparent.
3 divergent loci shown
here.

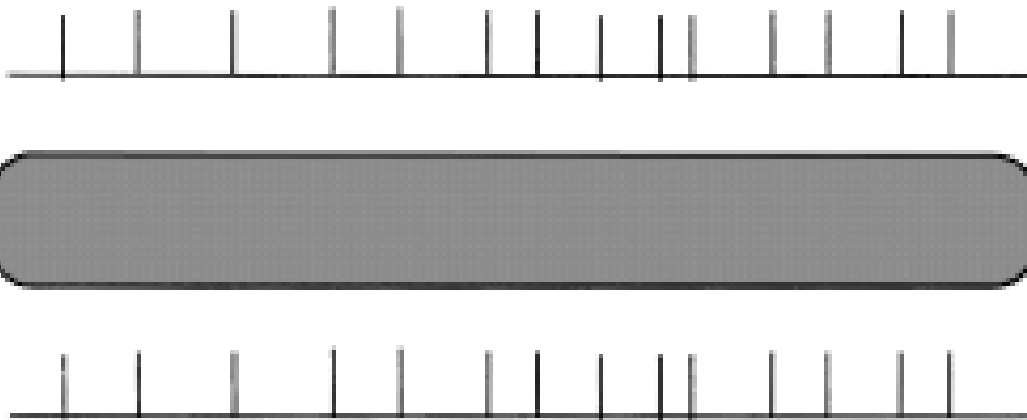


Stage II –
Transition between race and
species with some degree of RI;
populations may fuse or diverge.

Genetic changes associated with speciation

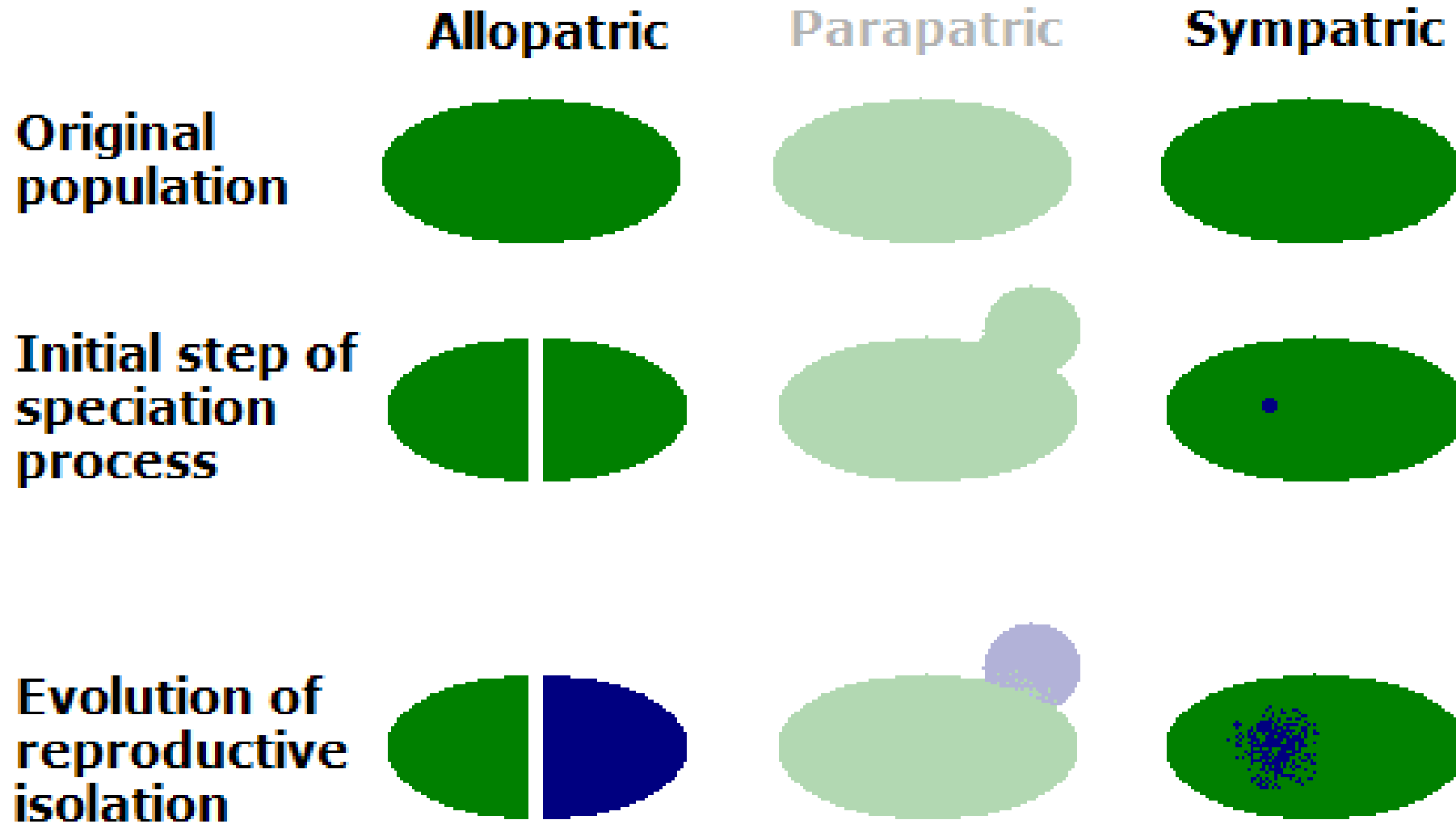


Stage III –
Divergent populations beyond
the point of fusion but still share
a portion of their genomes via
gene flow; good species.

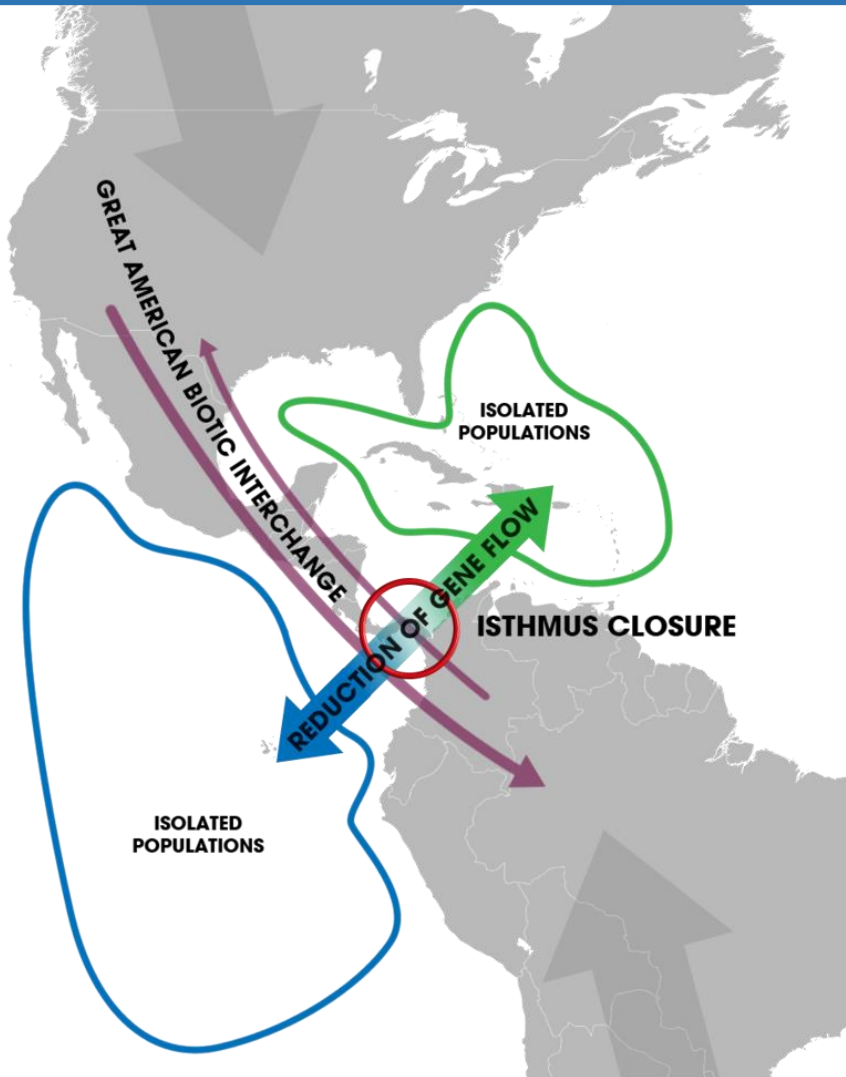


Stage IV –
Species with complete RI.

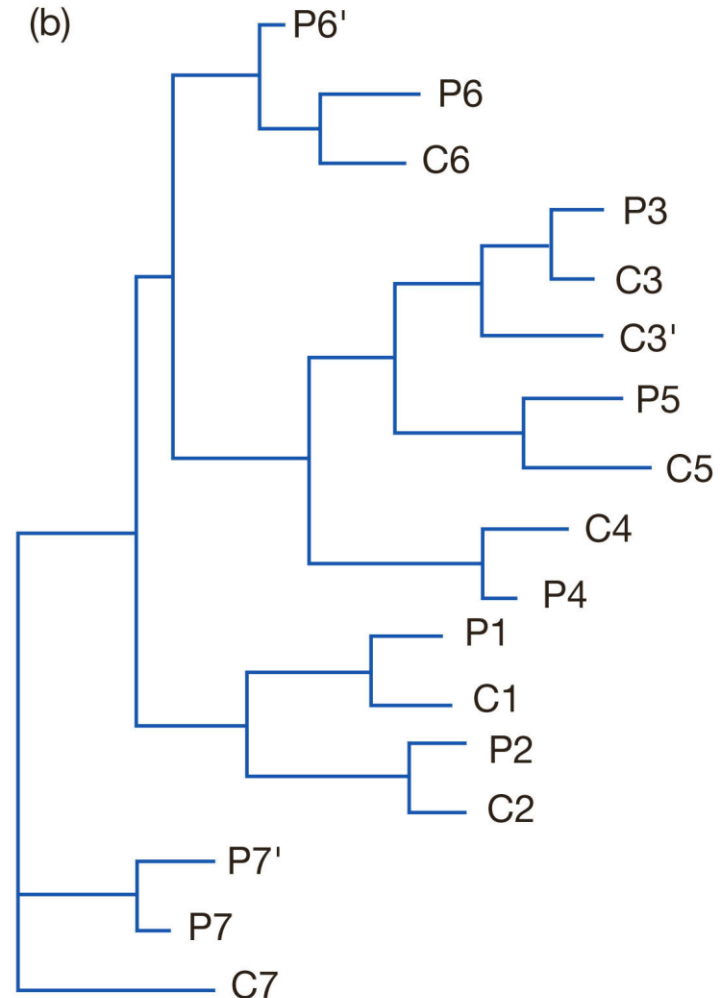
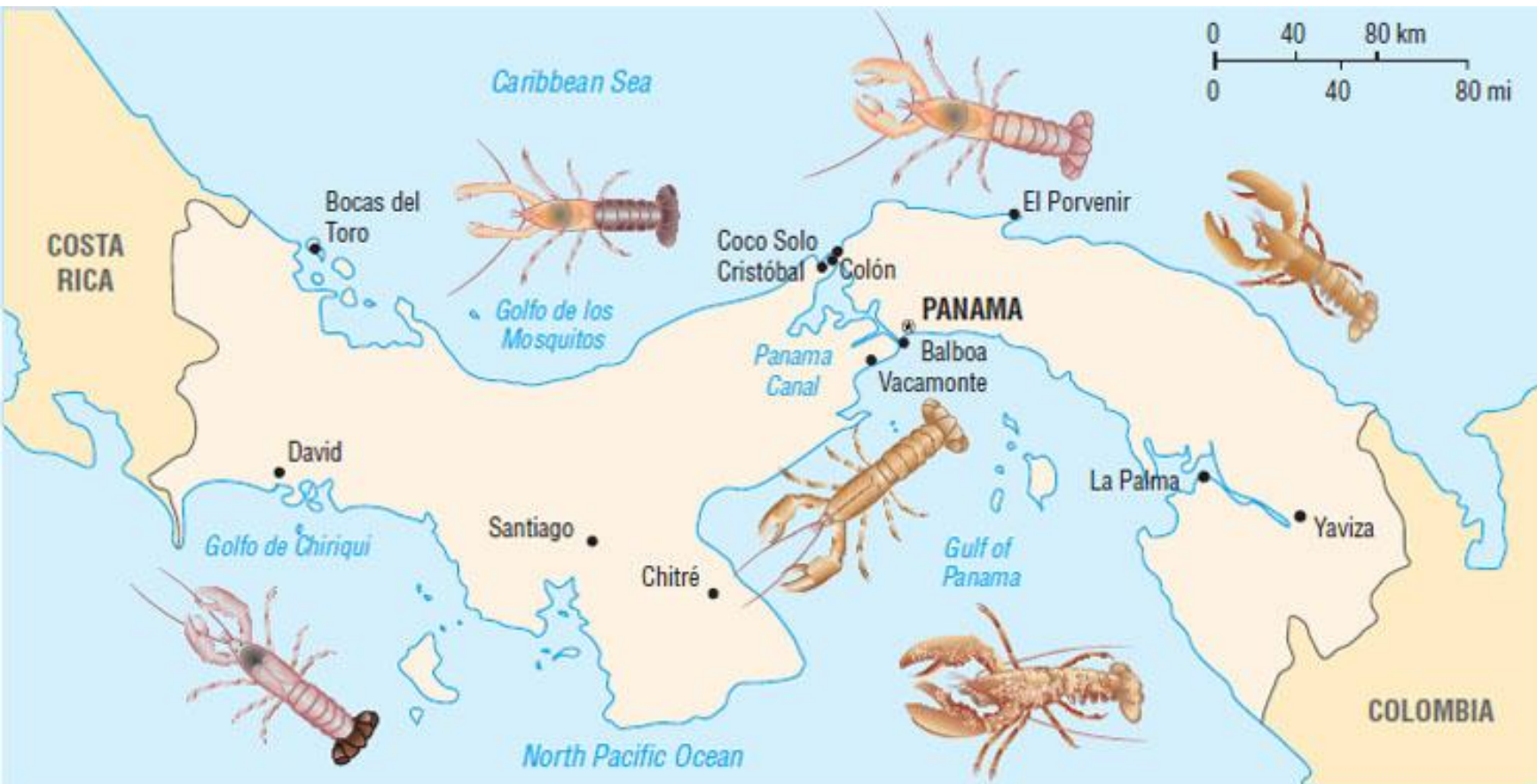
Modes of speciation



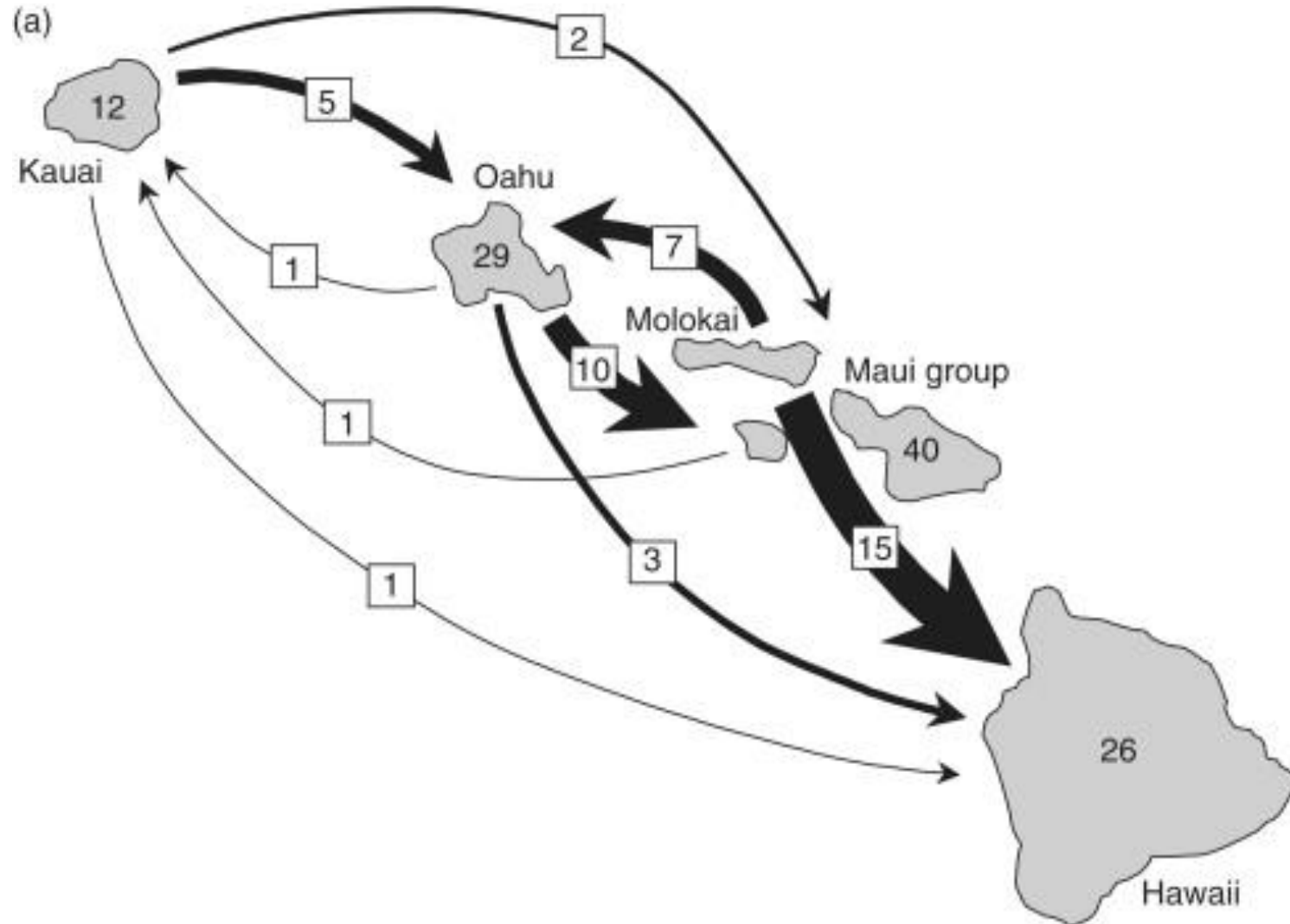
Geographical barriers - Vicariance



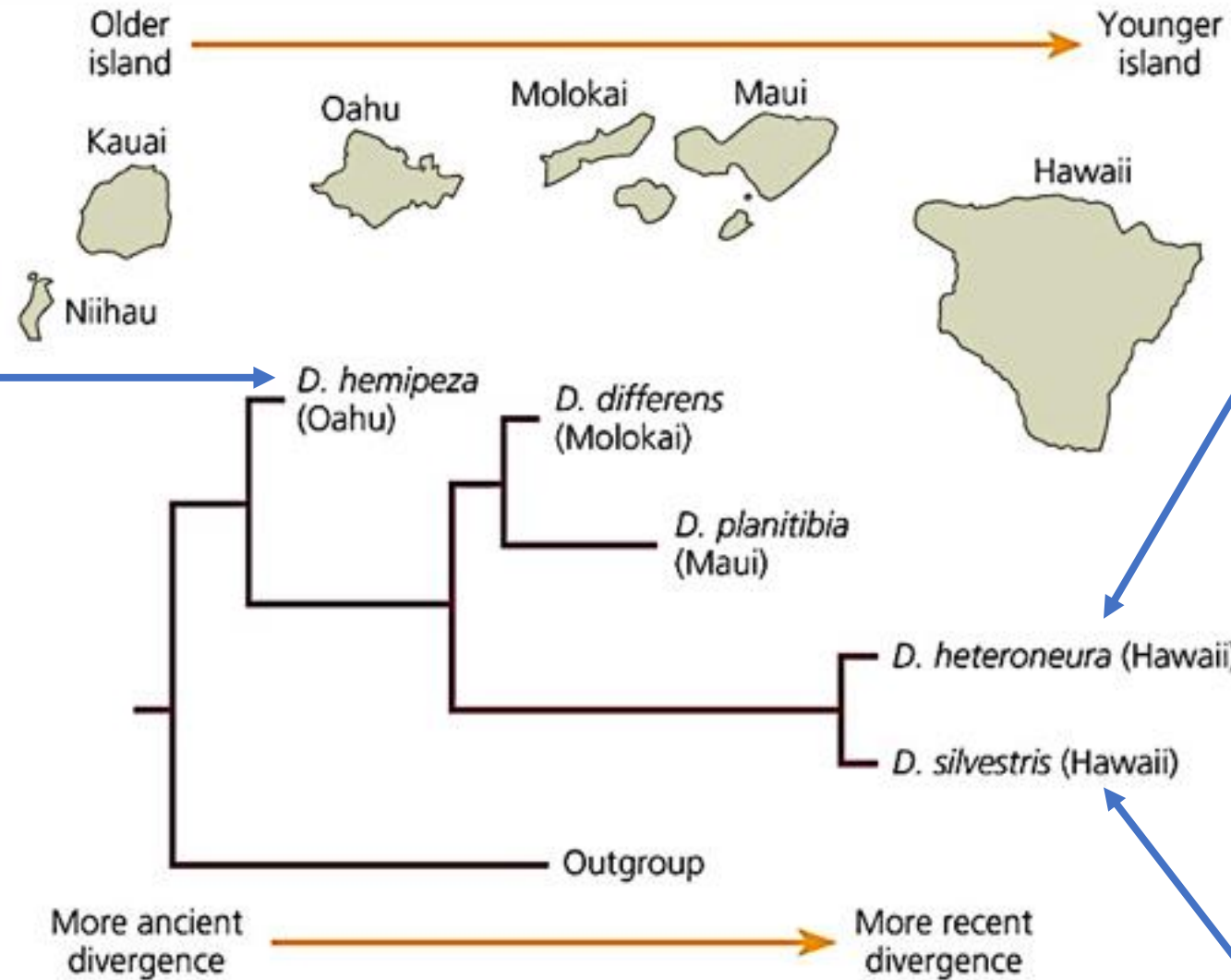
Geographical barriers - Vicariance



Geographical barriers - Dispersal



Geographical barriers - Dispersal



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Can gene flow be interrupted by non-geographical barriers?

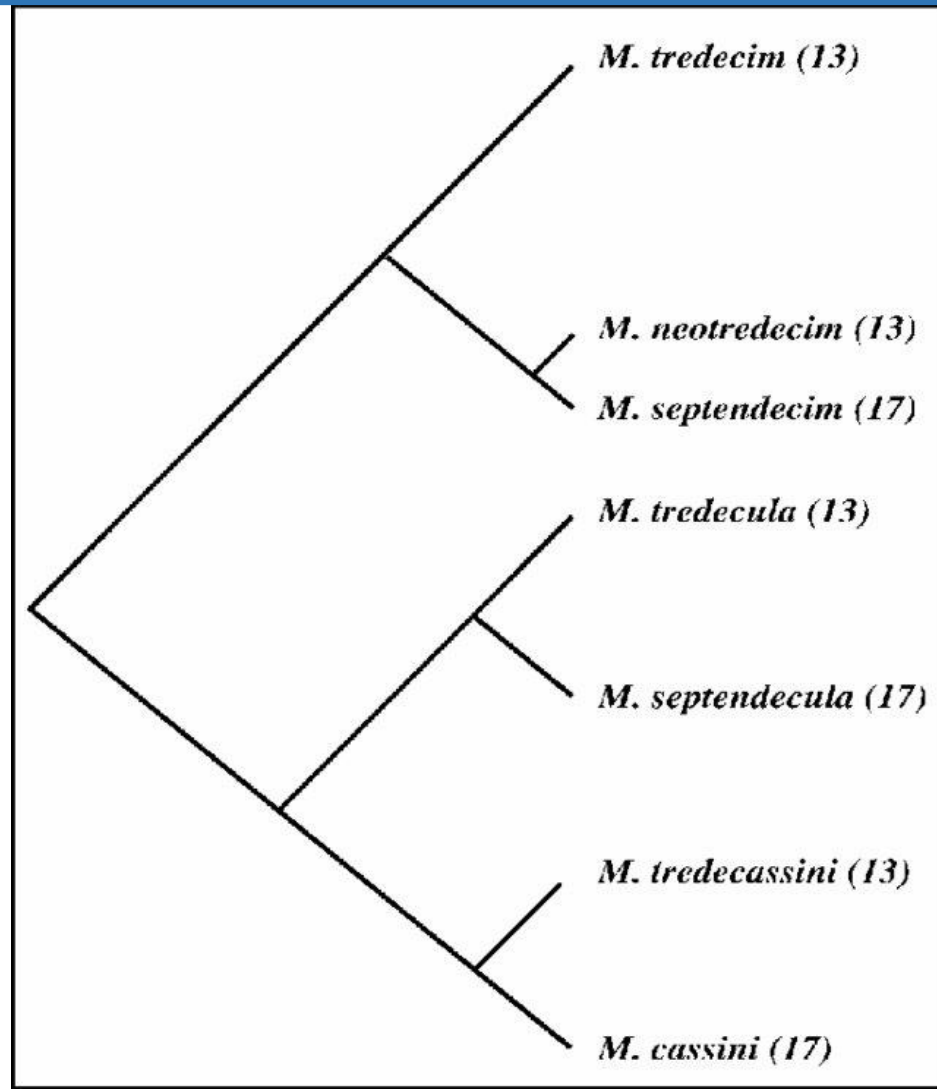
Temporal barriers



Periodical cicadas (genus *Magicicada*) live only in the eastern United States.



There are seven species, three with 17-year life cycles and four with 13-year cycles.

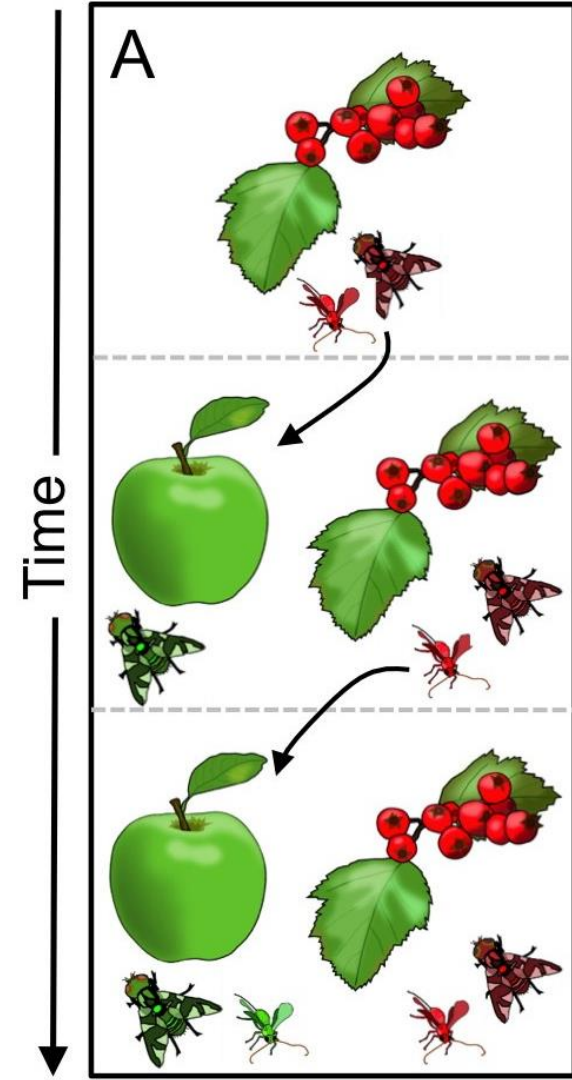


Ecological barriers



Host shift of the apple maggot, *Rhagoletis pomonella*, from its native hawthorn host to apples introduced in New York State in the 1860s.

Mating and eclosion are synchronized with hawthorne (later) or apple (earlier) development.



Behavioral barriers



Blue footed boobies mate after their ritual to attract other members of species



Bird of Paradise is having courtship ritual which includes unique dance in front of their mates



Frogs only respond to mating calls of the same member of species



Western Meadowlark and Eastern Meadowlark are similar birds, but they will not interbreed because they use different mating songs to attract mates



Species of fireflies can find mates because of light difference



Also crickets notice their mates after song difference

Summary – 3 main stages of speciation

1 – Isolation of populations

- Gene flow is interrupted
- Ecological or geographical changes

2 – Character divergence

- Separated populations undergo “normal” evolutionary processes independently
- Genetic divergence → morphological divergence

3 – Evolution of reproductive isolation

- Reproductive isolation accumulates as a byproduct of character divergence
- It can be observed in nature upon secondary contact

Conclusions

- **Speciation** is the process by which **new species** originate from **pre-existing species**.
- The balance between **speciation** and **extinction** rates is responsible for **maintaining the biodiversity** of our planet.