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# *Speciation*

# *Population Change*

- Populations can change and diverge when they are isolated from one another.
  - Speciation is a splitting event that creates two or more distinct species from a single ancestral group.



**Large ground finch**



**Small ground finch**



# *Population Change*

- Speciation is the outcome of isolation and divergence.
  - Isolation is created by reductions in gene flow.
  - Divergence is created when mutation, genetic drift, and selection act on populations separately.

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## *Defining and Identifying Species*

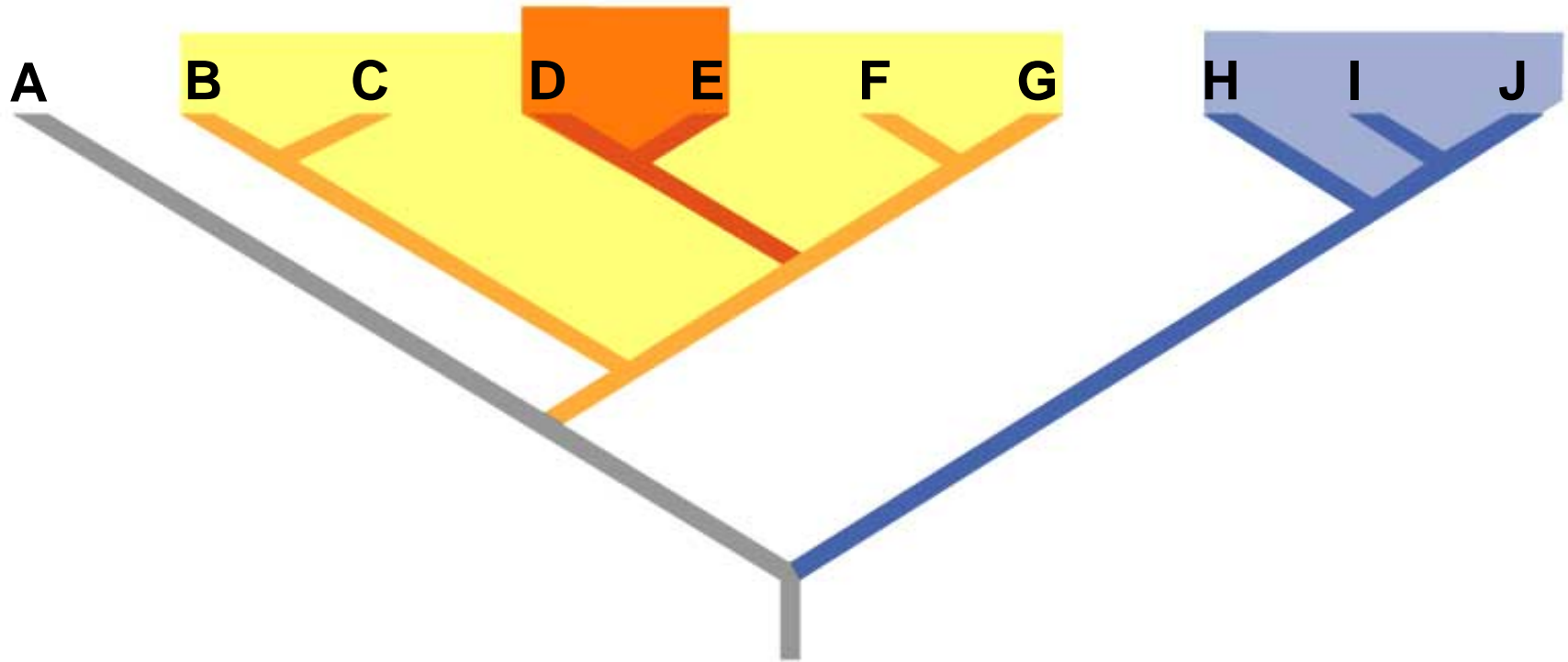
- Species are distinct types of organisms because they represent evolutionarily independent groups.
- Lack of gene flow makes a species independent.

# *Defining and Identifying Species*

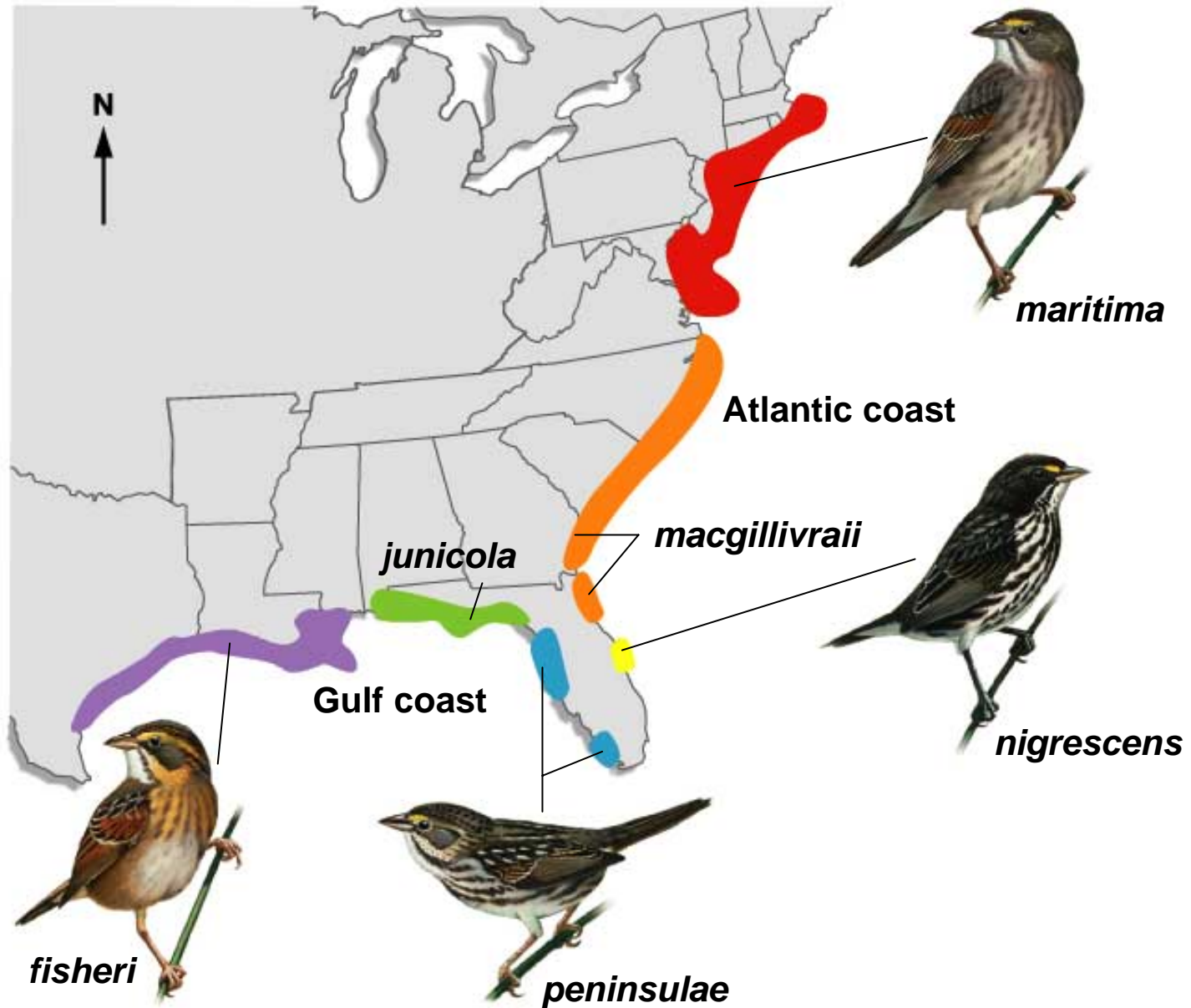
- Species are defined based on several different concepts:
  - The biological species concept is based on reproductive isolation.
  - The morphospecies concept is based on identifying evolutionarily independent lineages.
  - The phylogenetic species concept is based on reconstructing the evolutionary history of populations.

**TABLE 23.1 A Summary of Species Concepts**

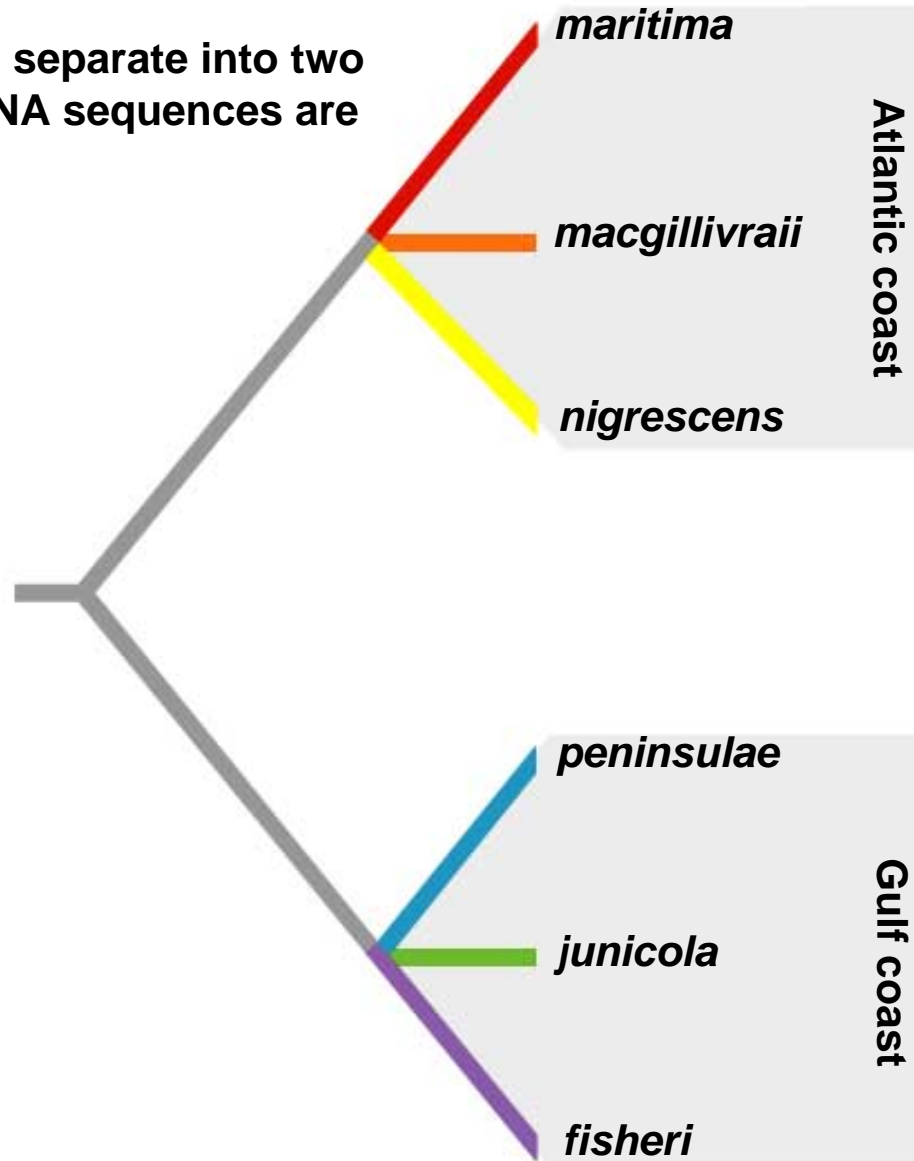
Species Concept	Criterion for Recognizing Species	Advantages	Disadvantages
Biological	Reproductive isolation between populations (they don't breed and produce viable offspring)	Reproductive isolation = evolutionary independence	Not applicable to asexual or fossil species; difficult to assess if populations do not overlap geographically
Morphospecies	Populations are morphologically distinct	Widely applicable	Subjective (researchers often disagree about how much morphological distinction = speciation)
Phylogenetic	Smallest monophyletic group on evolutionary tree	Widely applicable; based on testable criteria	Few well-estimated phylogenies are currently available



Each subspecies of seaside sparrow has a restricted range.



The subspecies separate into two groups when DNA sequences are compared.



## *Isolation and Divergence in Sympatry*

- Sympatric speciation occurs in populations that occupy the same geographic area.
  - Natural selection can cause this to occur in spite of gene flow.
  - Polyploidy, a type of mutation, can also cause sympatric speciation.
- Sympatric speciation is relatively common and quick to occur.

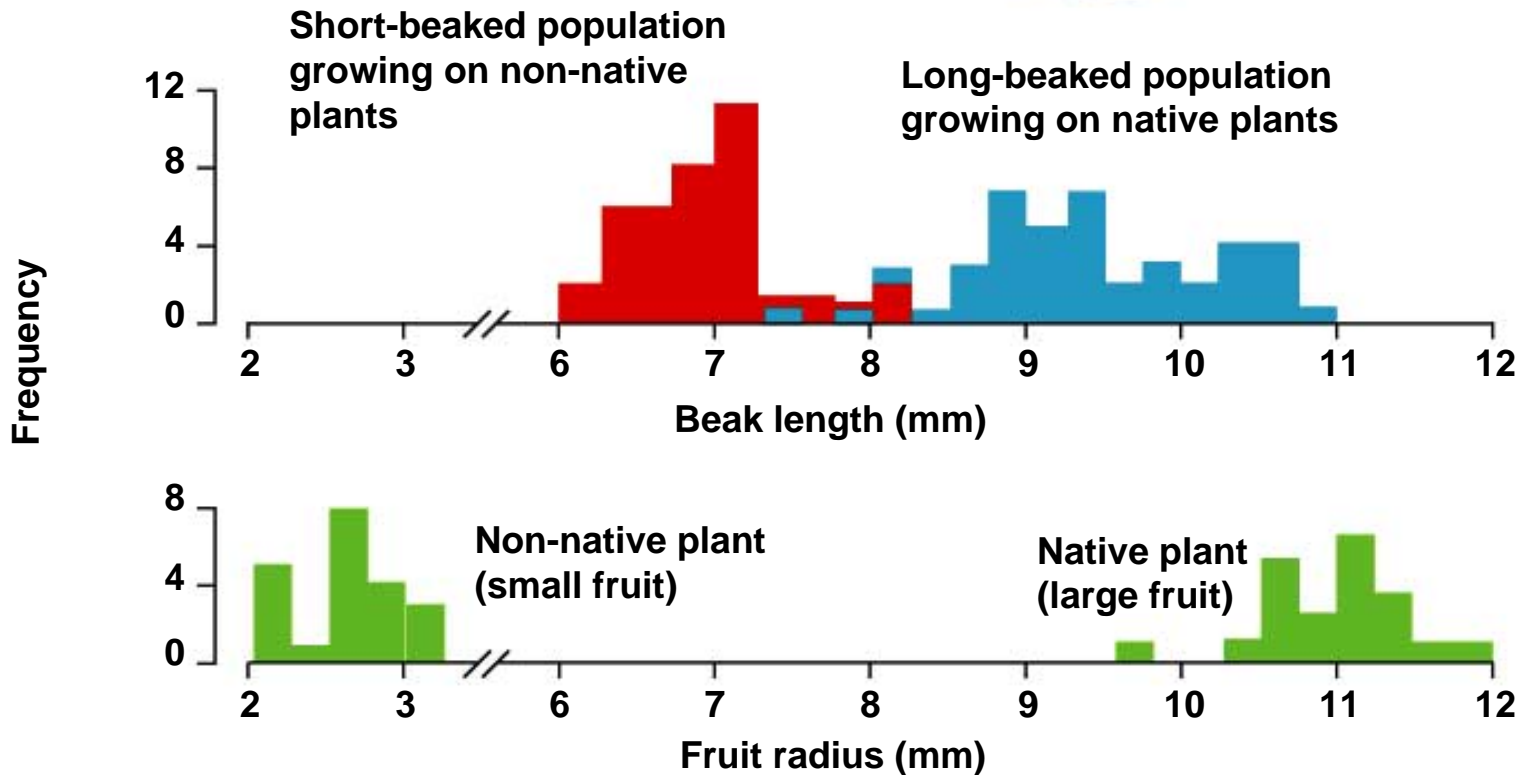


### Beak length correlates with fruit size.

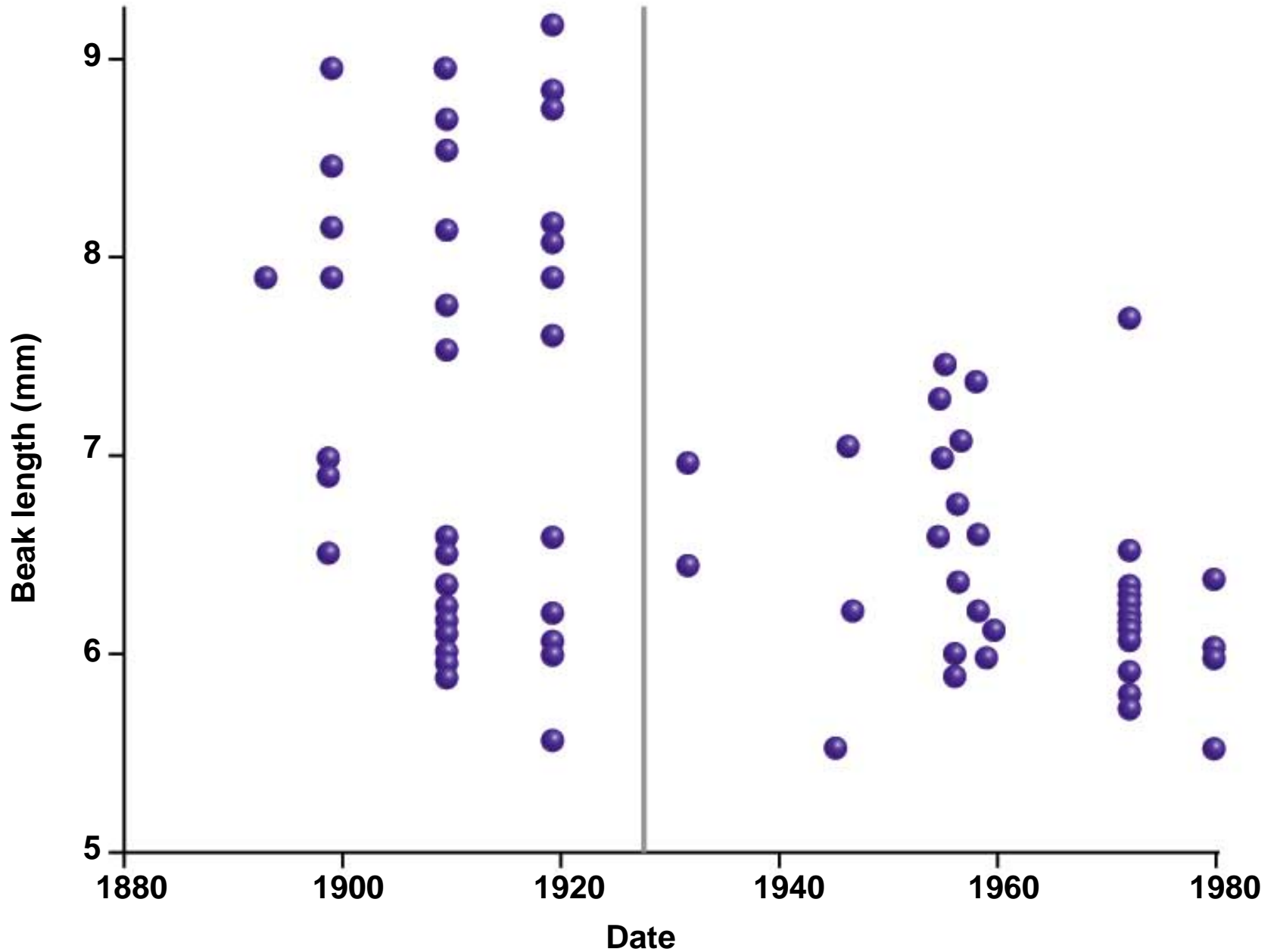
Flat-podded golden rain tree (non-native species)

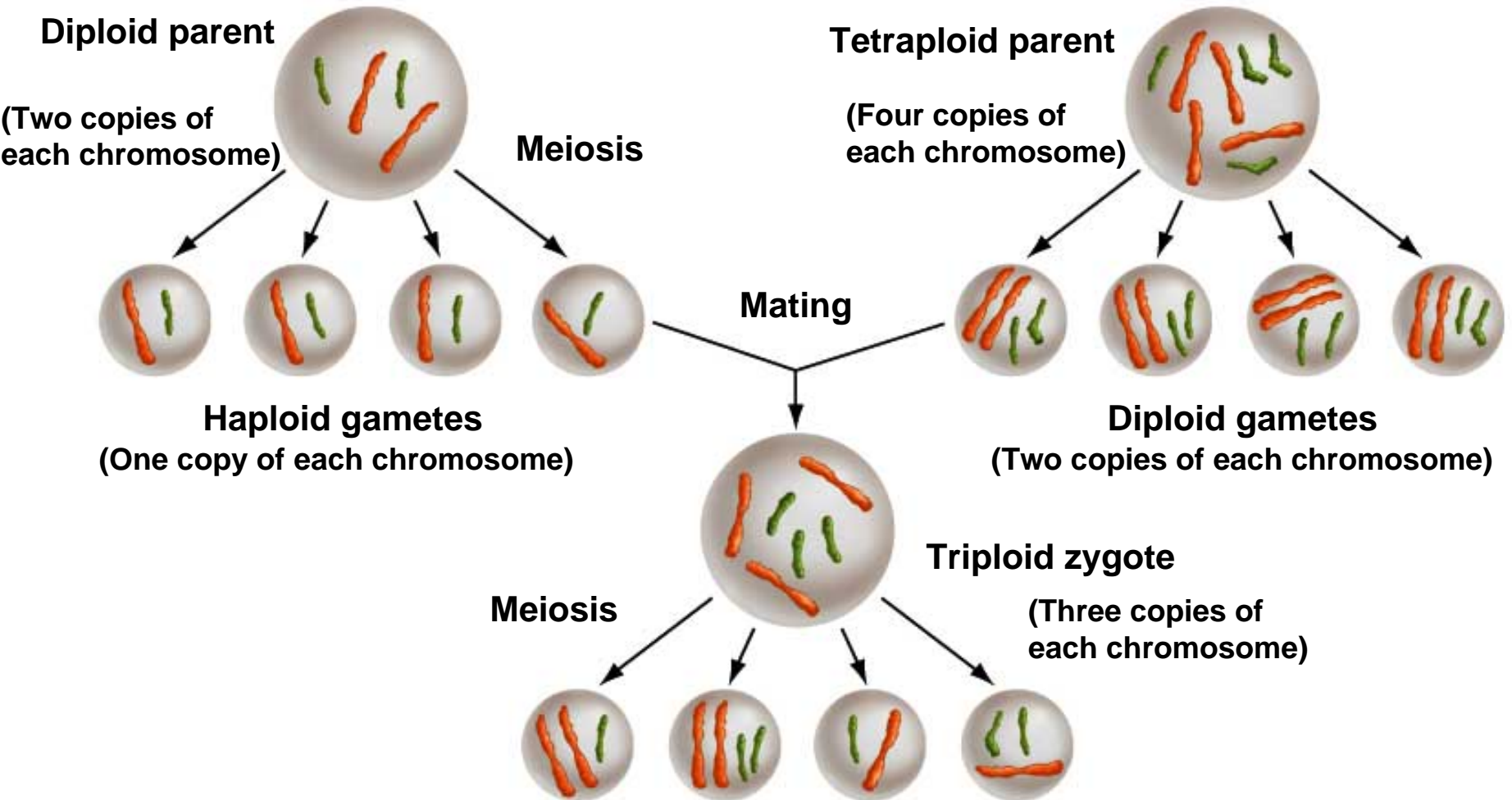


Balloon vine (native species)



This correlation appears to be a product of natural selection.





**When these gametes combine, most offspring have incorrect number of chromosomes.**

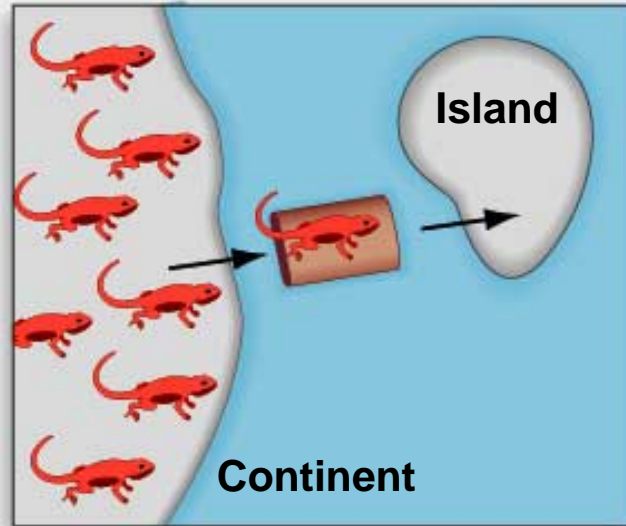
## *Isolation and Diversion in Allopatry*

- Allopatric speciation occurs when populations become physically separated from each other.
  - A population can colonize a new habitat.
  - A new physical barrier can split a widespread population into two or more isolated groups.

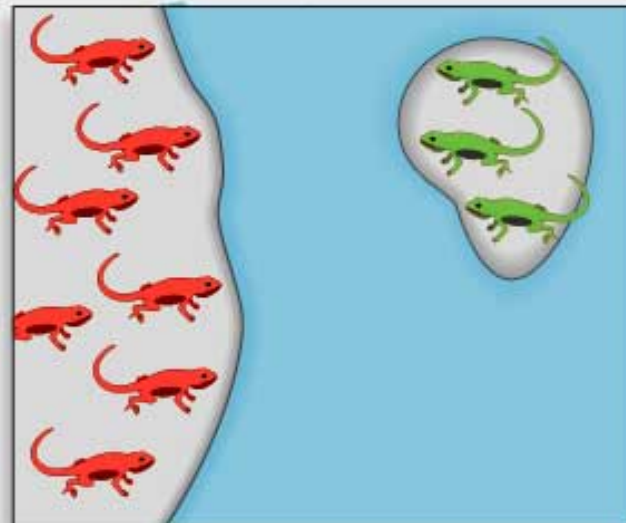
## *Isolation and Diversion in Allopatry*

- Colonization events are more common on islands.
- When a physical barrier separates a population, a vicariance event is said to occur.

## DISPERSAL AND COLONIZATION

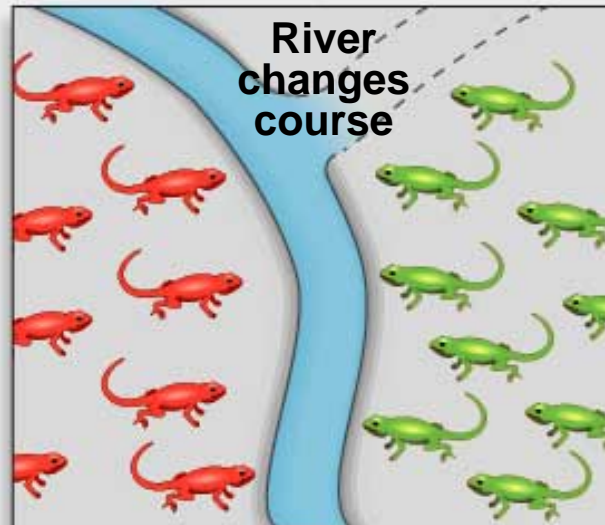
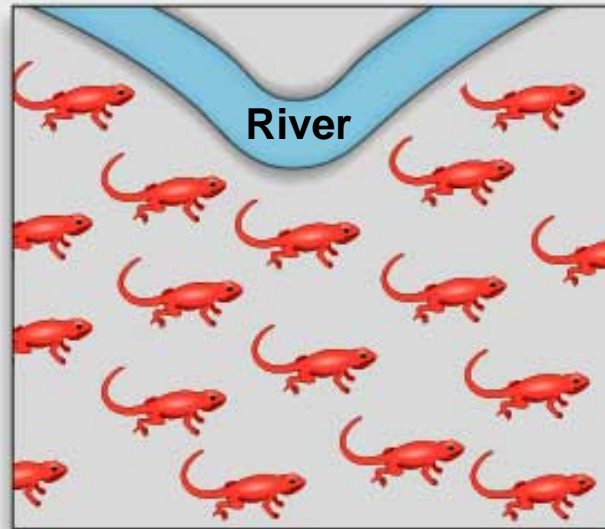


**1. Start with one continuous population. Then, a colonist floats to an island on a raft.**



**2. Finish with two populations isolated from one another.**

## VICARIANCE



**1. Start with one continuous population. Then a chance event occurs that changes the landscape (river changes course).**

**2. Finish with two populations isolated from one another.**

## REFUGIUM HYPOTHESIS

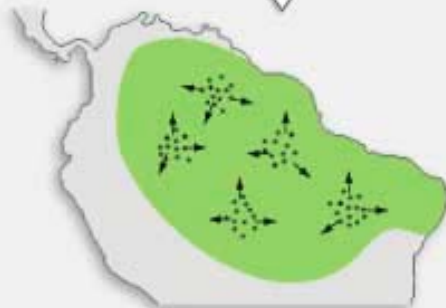


1. Before glaciation: Many rainforest birds have large, continuous ranges.

- Extent of forest
- ▣ Range of forest birds



2. During glaciation: Climate becomes cooler and drier. Forests shrink to isolated islands. Speciation occurs as populations diverge in isolated habitat refuges.



3. After glaciation: Climate becomes hotter and wetter. Forests expand. New species begin expanding their ranges out from refuges.

Current data support the refugium hypothesis.



 Area where ranges of many forest plant species overlap

 Area where ranges of many forest bird species overlap

## *Secondary Contact*

- These are mechanisms that keep two or more species reproductively isolated after they come back in contact with each other following isolation and divergence.
  - Prezygotic mechanisms make it very unlikely that interbreeding will even take place.
  - Postzygotic mechanisms cause hybrids to become sterile or to fail to develop properly.

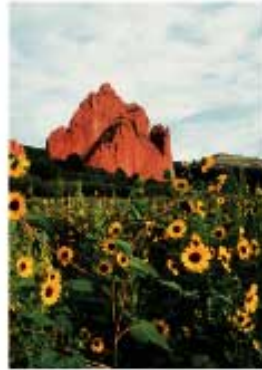
## TYPES OF PREZYGOTIC ISOLATION

Type	Description	Example
Temporal	Populations are isolated because they breed at different times	Bishop pines and Monterey pines release their pollen at different times of year
Habitat	Populations are isolated because they breed in different habitats	Parasites that begin to exploit new host species are isolated from the original population
Behavioral	Populations do not interbreed because their courtship displays differ	To attract males, female fireflies give a species-specific sequence of flashes
Gametic barrier	Matings fail because eggs and sperm are incompatible	In sea urchins, a protein called bindin allows sperm to penetrate eggs. Differences in amino acid sequence of bindin cause matings to fail between closely related populations
Mechanical	Matings fail because male and female genitalia are incompatible	In many insects the male copulatory organ and female reproductive canal fit like a “lock-key”. Changes in either organ initiate reproductive isolation

## *Secondary Contact*

- Hybrid zones are areas where interbreeding occurs and hybrid offspring are common.
- New species may also arise through the hybridization process.

*Helianthus annuus*



*H. anomalus*



*H. petiolaris*



DNA comparison of S region of genome:

