Big Idea 1: The process of evolution drives the diversity and unity of life.

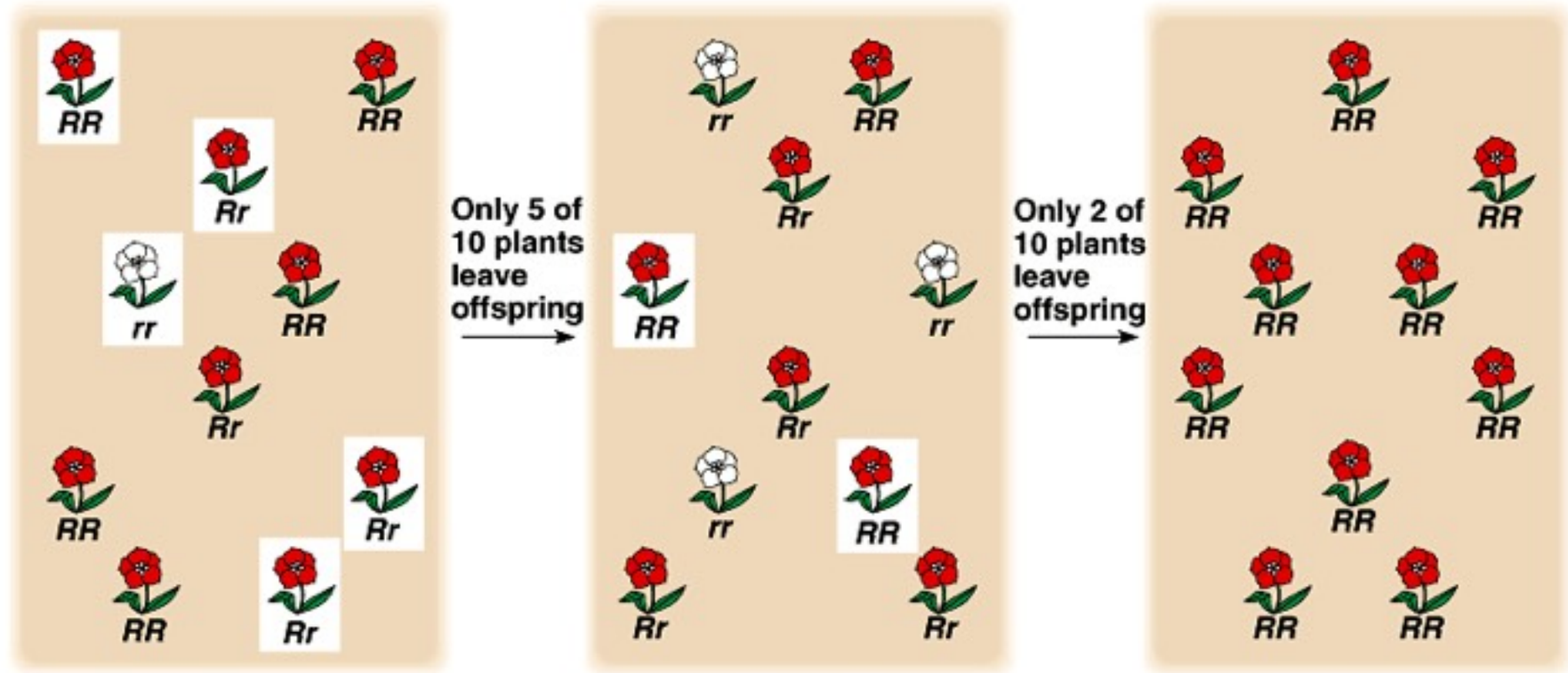
Enduring understanding 1.A: Change in the genetic makeup of a population over time is evolution.

Essential knowledge 1.A.3: Evolutionary change is also driven by random processes.

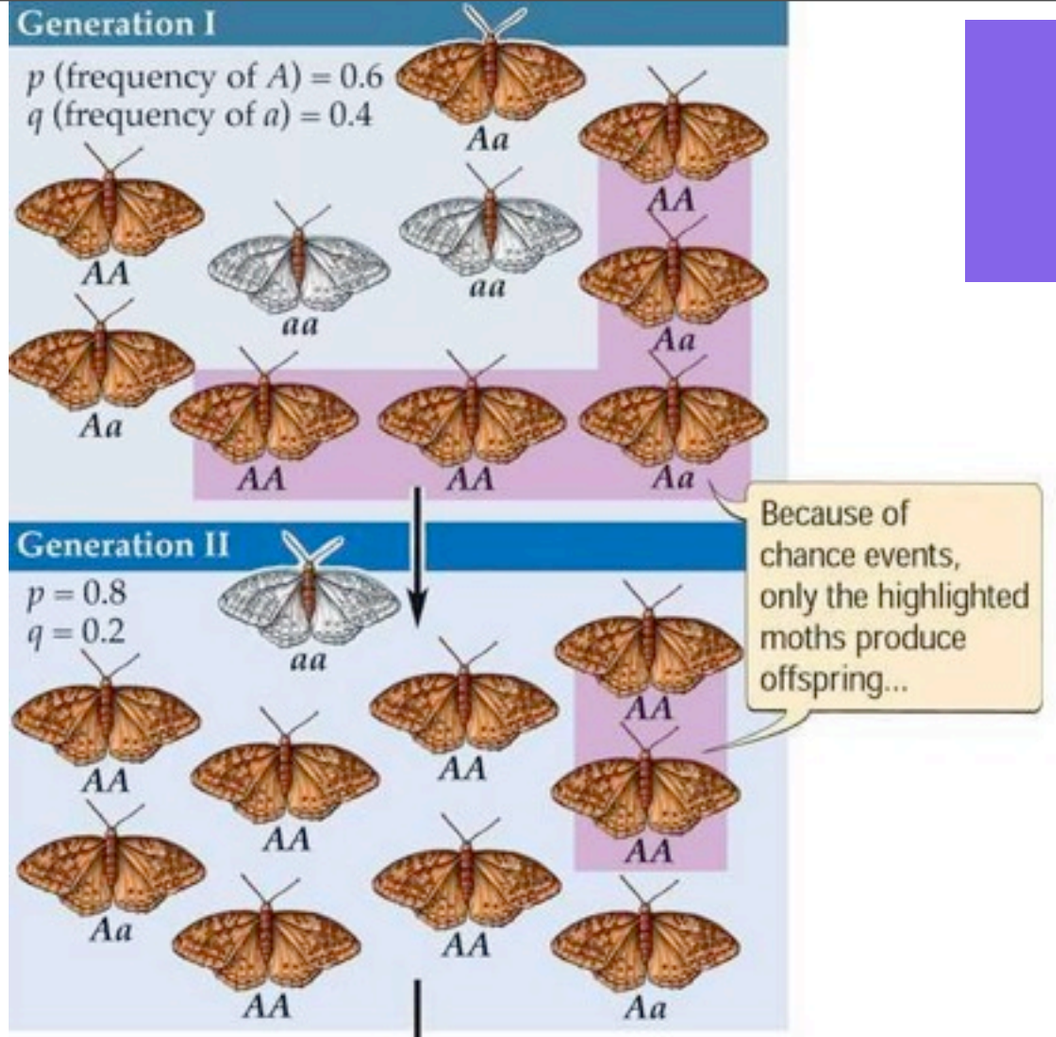
a.Genetic drift is a nonselective process occurring in small populations.

Genetic Drift

- **Genetic Drift- random and unpredictable fluctuations in allele/gene frequencies.**
  - **Genetic Drift will have a greater effect on smaller populations**
  - **Genetic Drift tends to reduce variation**
  - **Genetic Drift can "fix" (100% frequency) harmful alleles**



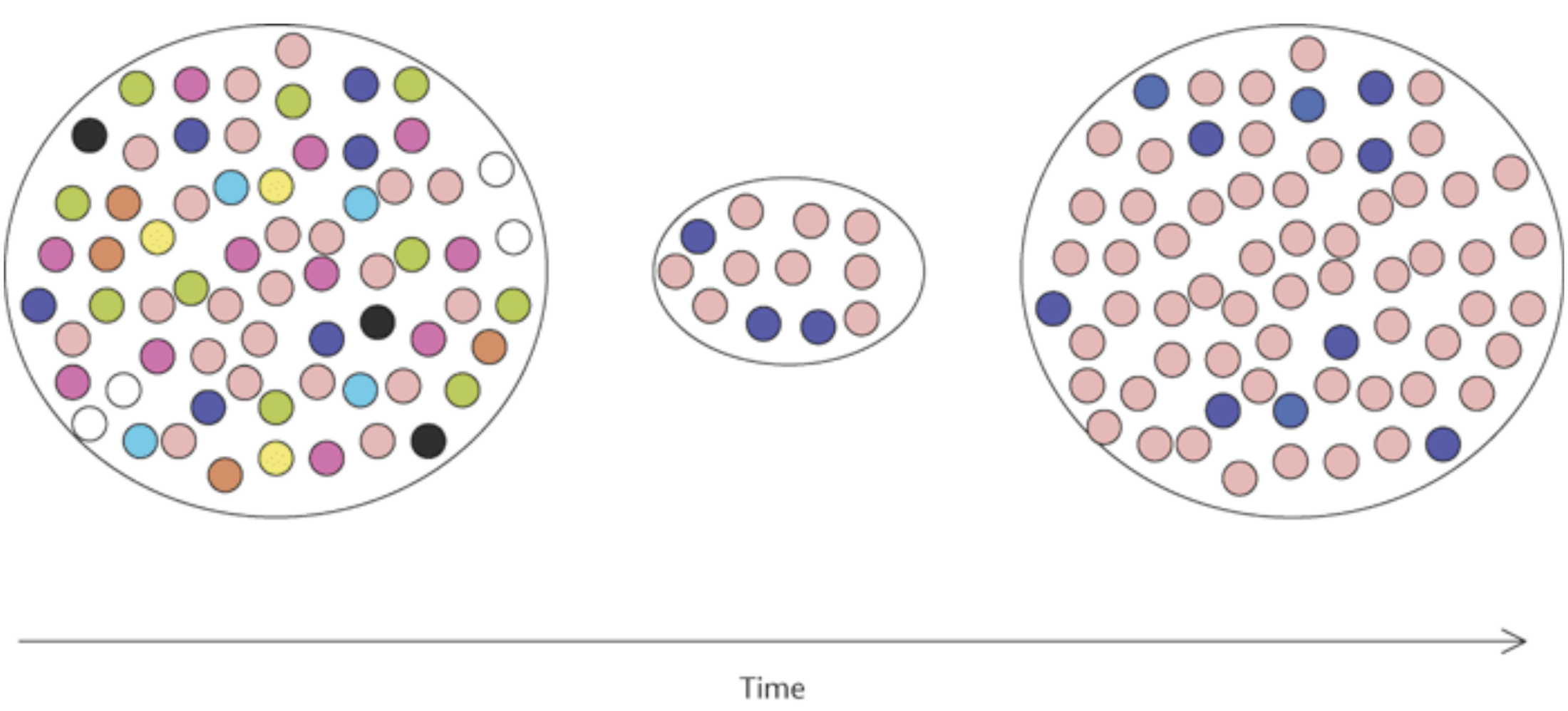
Genetic Drift



- **There are two events that increase the effect of genetic drift.**
  - **A bottleneck effect**
  - **A founder effect**

The Bottleneck Effect

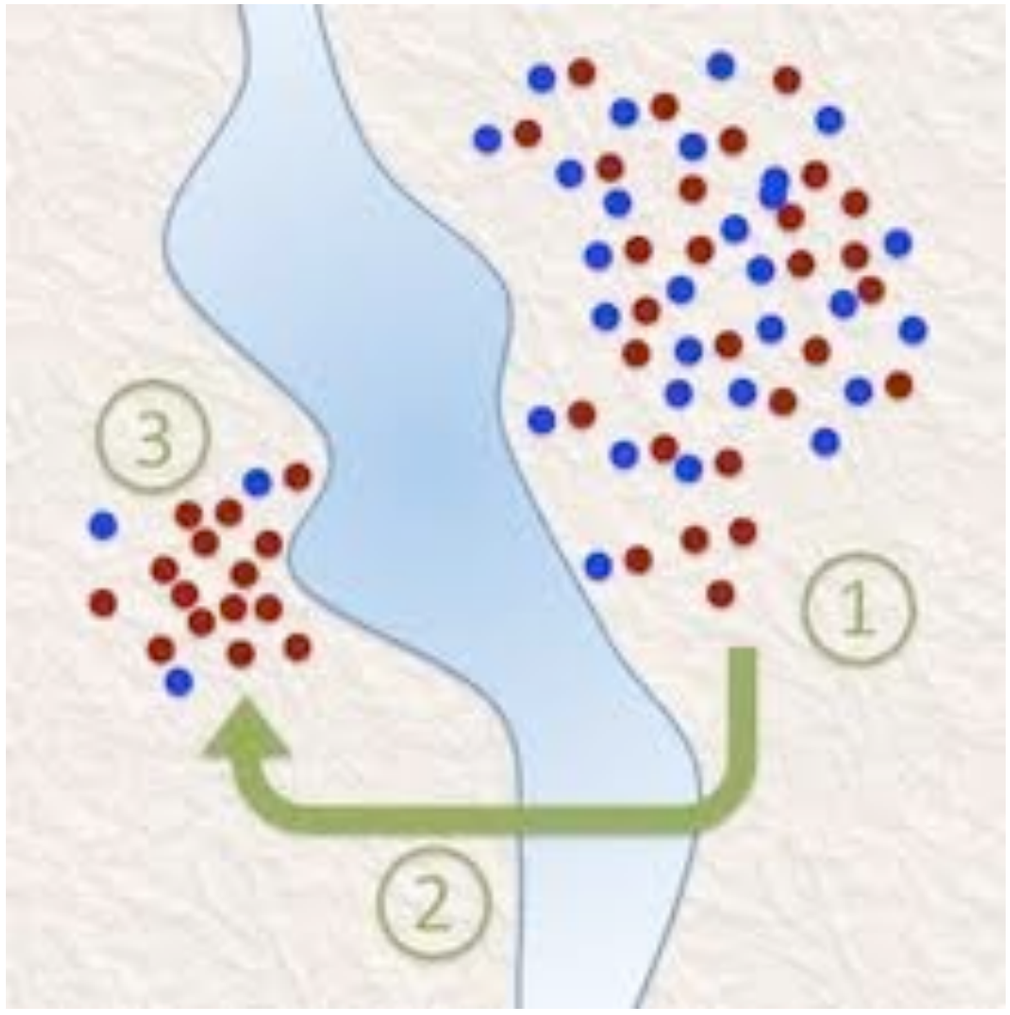
- **Bottleneck Effect- can occur when there is large reduction in population size, the survivors may not reflect the composition of the original population.**
  - **can have a lasting effect on populations**



The Founder Effect

- **Founder Effect- when a small group leaves a larger population, establishes a new population that is not representative of the original .**

new population



original population

"The Perfect Organism"

- **No, Never, Not going to happen!**
- **Natural selection has never and will never fashion the perfect organism.**
  - **Selection can act on only existing variation.**
  - **Bad luck and changing environments**
  - **Can only work with what your given**
  - **Life is all about Trade-offs**

Essential knowledge 1.A.3: Evolutionary change is also driven by random processes.

b. Reduction of genetic variation within a given population can increase the differences between populations of the same species.

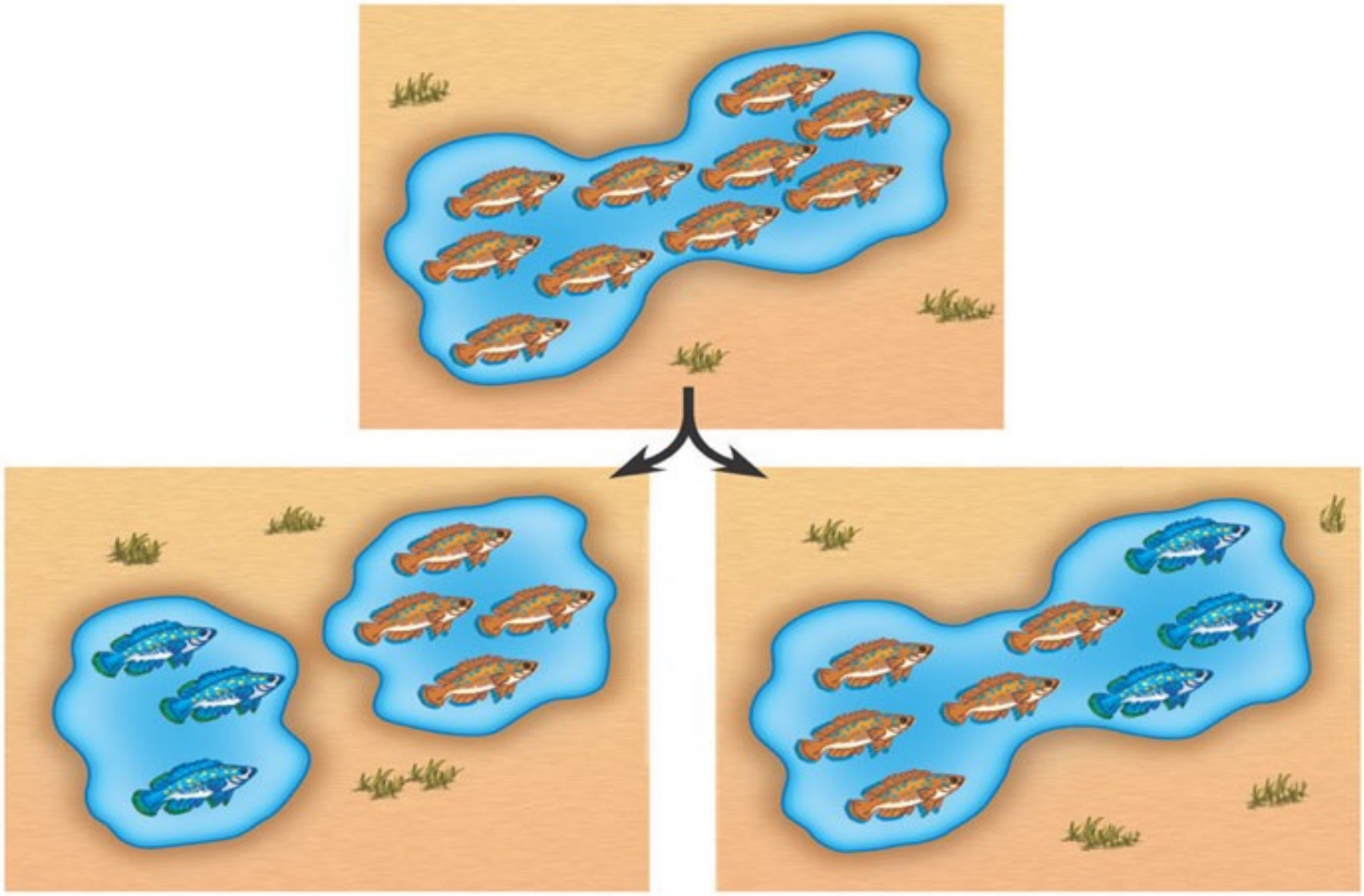
"Biological Species Concept"

- Before we begin to explore "how" species change we ought to first understand "what" a species is.
- The **biological species concept** defines a species as a group of populations whose members can interbreed in nature and produce viable, fertile offspring-but can not produce viable, fertile offspring with members of other such groups.
  - *gene flow (transfer of alleles) between populations tends to hold populations together genetically through the ongoing exchange of alleles.*
  - *in fact, removing gene flow plays a key role in the generation of new species as we will see shortly*

"Creating New Species"

- Speciation occurs in two main ways depending on how gene flow is interrupted.
- **Allopatric speciation-** gene flow is interrupted when a population is divided *geographically isolated* into two subpopulations
- **Sympatric speciation-** gene flow is interrupted not by geographical isolation but rather polyploidy, habitat differentiation or sexual selection. The population splits into subpopulations even though they remain geographically in contact.

"Creating New Species"



Allopatric speciation. A population forms a new species while geographically isolated from its parent population.

Sympatric speciation. A small population becomes a new species without geographic separation.

"Allopatric Speciation"

- "Physically" interrupted gene flow is the easiest and most common way to generate a new species.
- Obviously the degree of geographical isolation needed to create a new species will vary depending on the populations motility.

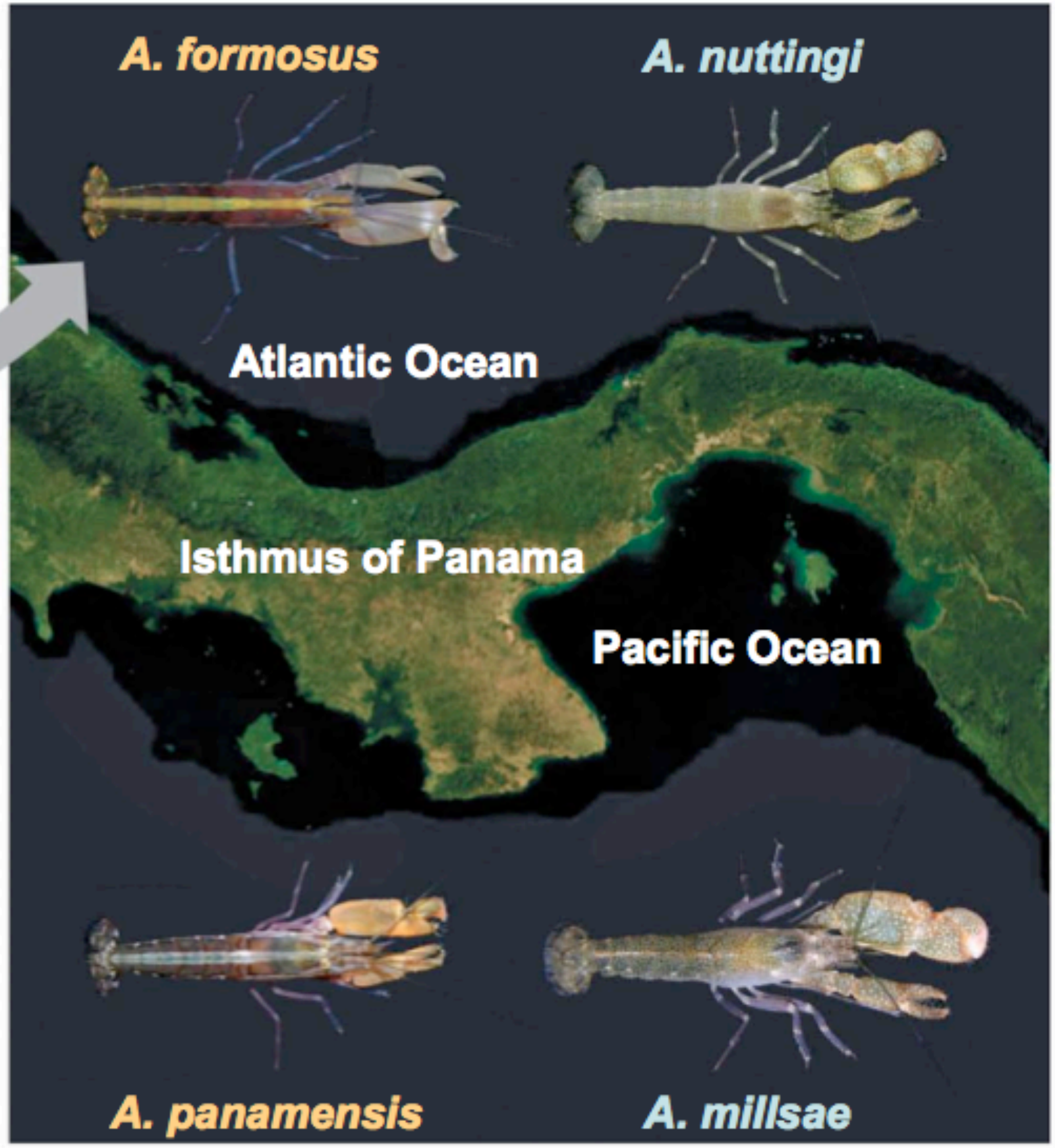
The grand canyon is enough to stop gene flow between chipmunks. Would it separate a population of birds? NO

"Allopatric Speciation"

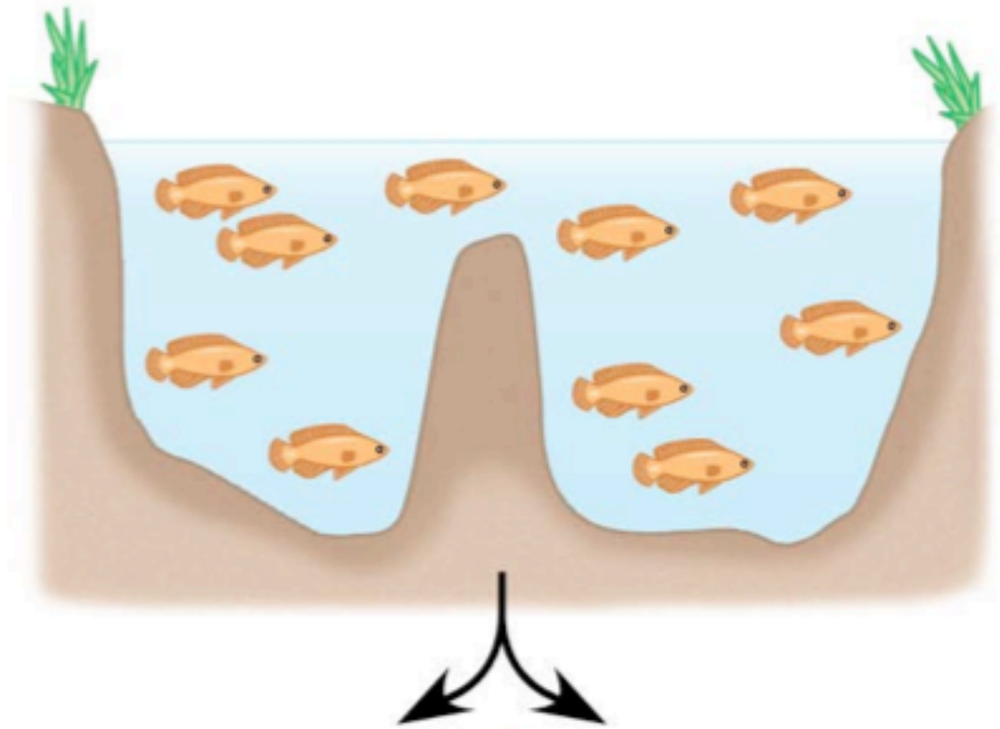
- Once gene flow is interrupted, the two separate populations may diverge.
  - different mutations
  - natural and sexual selection
  - genetic drift
- With enough time any of one or combination of these factors can dramatically change the gene pools enough that if gene flow is reestablished the members of each subpopulation are longer able to produce viable, fertile offspring.

15 pairs of sibling species of snapping shrimp (*Alpheus*) are separated by the Isthmus of Panama

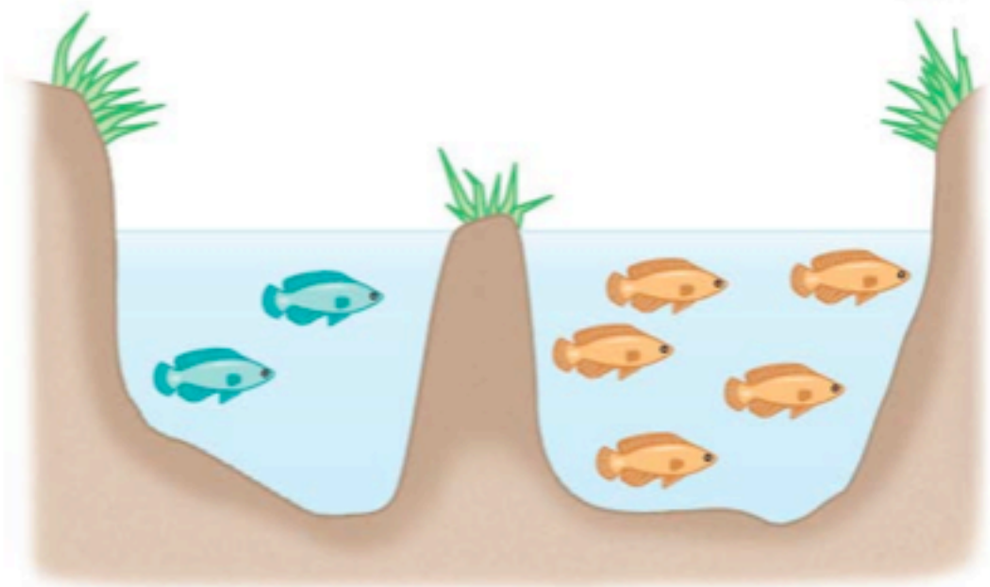
These species originated 9 to 13 million years ago, when the Isthmus of Panama formed and separated the Atlantic and Pacific waters

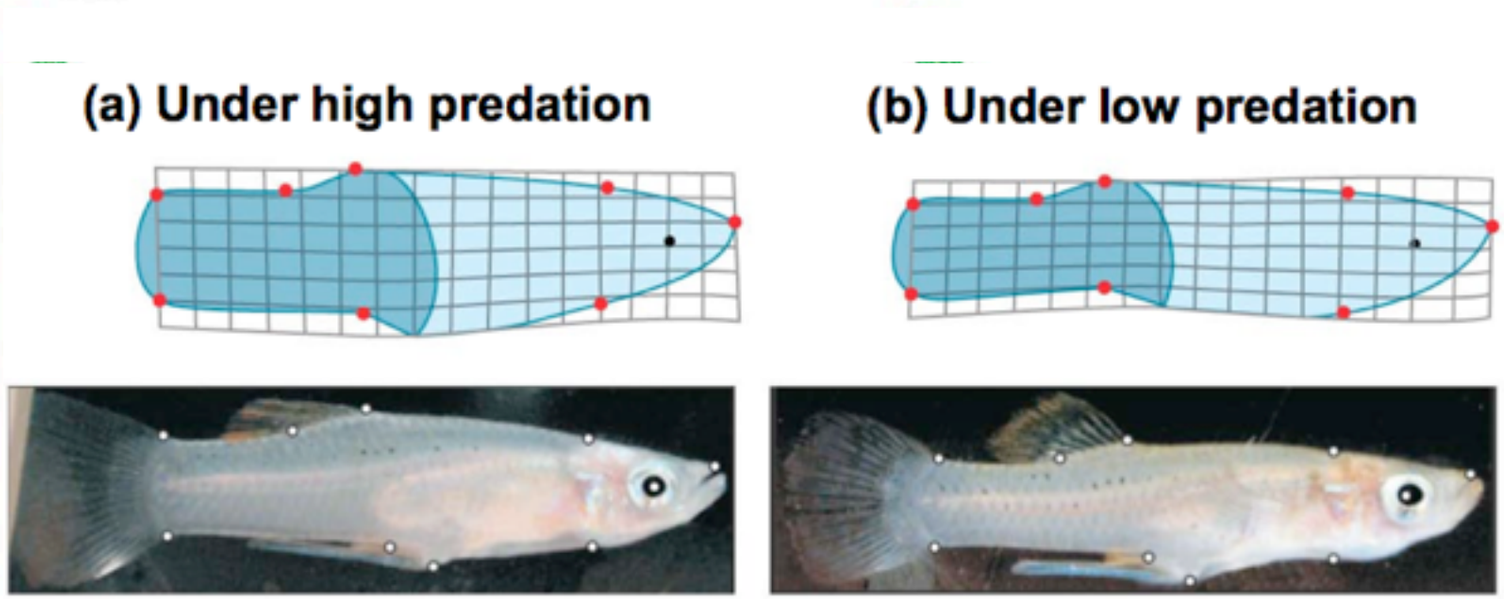


Evidence of Allopatric Speciation



Andros Island, Bahamas Mosquitofish (Gambusia hubbsi) colonized a series of ponds that later become isolated from each other. New ponds are all very similar except some ponds contain predatory fish while others do not.

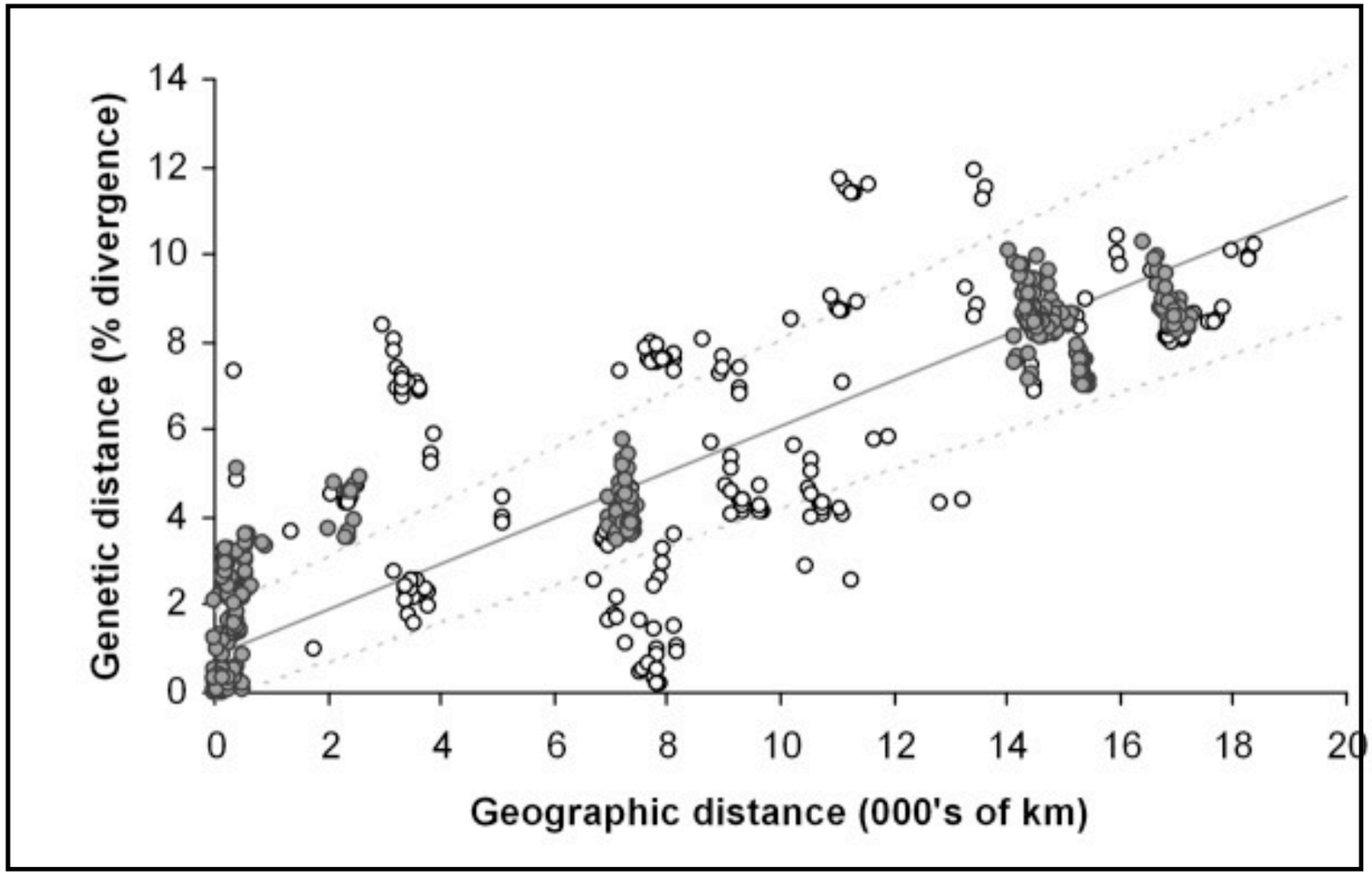




After bringing fish back together researchers found that the fish from different ponds no longer mated with one another apparently due to morphological differences or other unseen changes.

FIELD EVIDENCE: Allopatric Speciation

- Many studies, in the **FIELD** provide evidence for allopatric speciation.

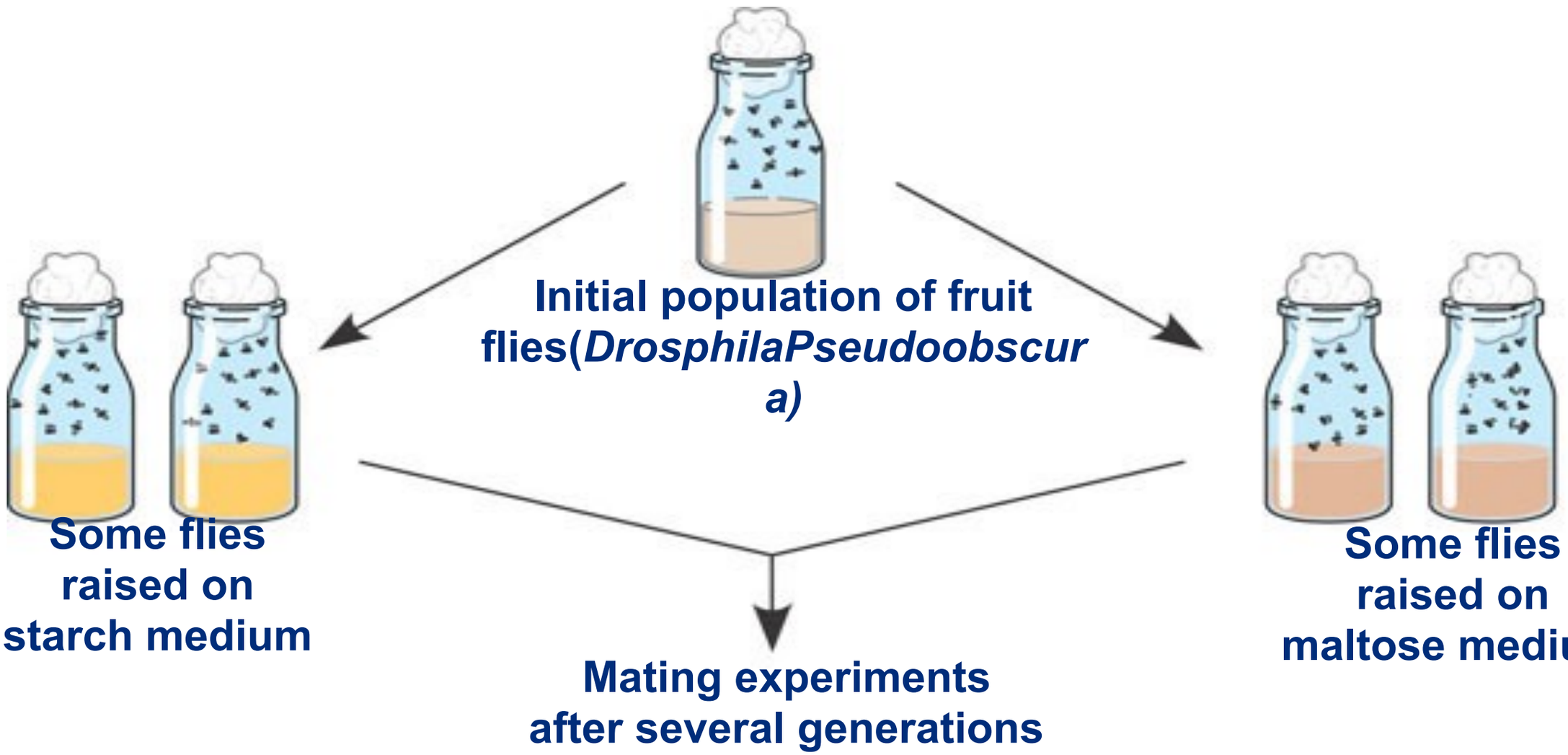


In almost all cases the *longer and farther* two populations are apart the greater the likelihood intrinsic isolation will occur.

LAB EVIDENCE: Allopatric Speciation

EXPERIMENT

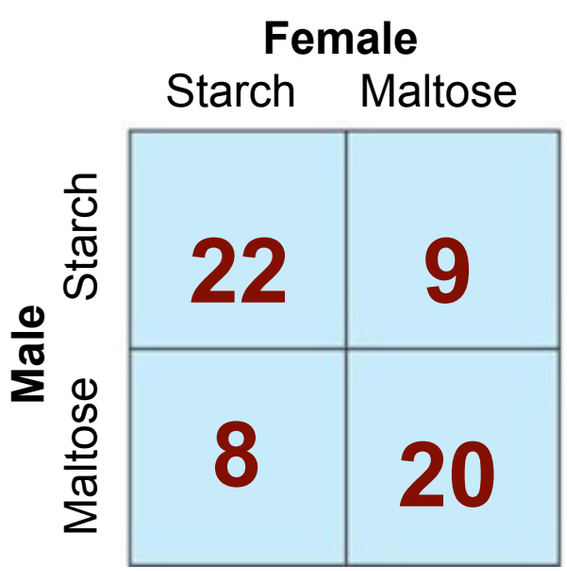
Diane Dodd, of Yale University, divided a fruit-fly population, raising some populations on a starch medium and others on a maltose medium. After many generations, natural selection resulted in divergent evolution: Populations raised on starch digested starch more efficiently, while those raised on maltose digested maltose more efficiently. Dodd then put flies from the same or different populations in mating cages and measured mating frequencies.

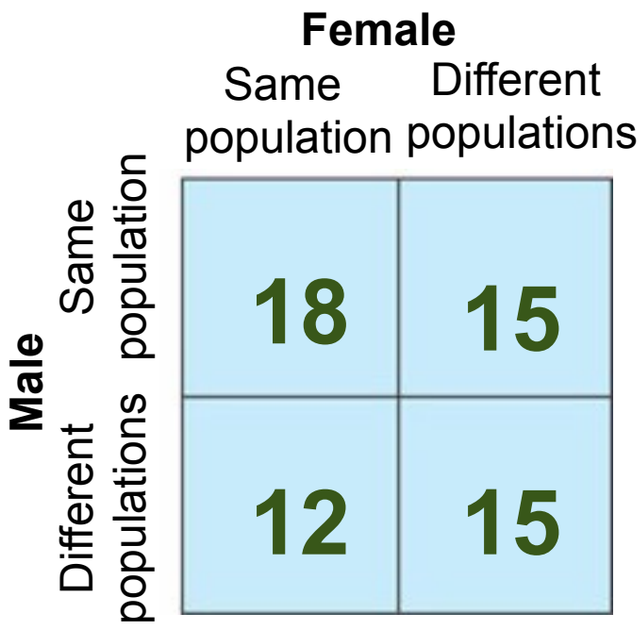


RESULTS

When flies from “starch populations” were mixed with flies from “maltose populations,”the flies tended to mate with like partners. In the control group, flies taken from different populations that were adapted to the same medium were about as likely to mate with each other as with flies from their own populations.

Mating frequencies in experimental group





Mating frequencies in control group

CONCLUSION

The strong preference of “starch flies” and “maltose flies” to mate with like-adapted flies, even if they were from different populations, indicates that a reproductive barrier is forming between the divergent populations of flies. The barrier is not absolute (some mating between starch flies and maltose flies did occur) but appears to be under way after several generations of divergence resulting from the separation of these allopatric populations into different environments.

"Allopatric Speciation"

- A point of emphasis... geographical isolation by itself does not lead to reproductive isolation, reproductive isolation has to become *intrinsic* for speciation to take place.
  - females choose certain male traits
  - receptors on gametes no longer "fit"
  - organisms mate at different times of the year

think of the reproductive isolating barriers we just looked a few slides back, geographic isolation has to lead to one or more of those in order for speciation to occur

Learning Objectives

LO 1.6 The student is able to use data from mathematical models based on the Hardy-Weinberg equilibrium to analyze genetic drift and effects of selection in the evolution of specific populations. [See **SP 1.4, 2.1**]

LO 1.7 The student is able to justify the selection of data from mathematical models based on the Hardy-Weinberg equilibrium to analyze genetic drift and the effects of selection in the evolution of specific populations. [See **SP 2.1, 4.1**]

LO 1.8 The student is able to make predictions about the effects of genetic drift, migration and artificial selection on the genetic makeup of a population. [See **SP 6.4**]