MODULE 3
EVOLUTION: CHANGES THROUGH TIME

7TH AND 10TH GRADE

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LEARNING OBJECTIVE

Through this module, the participants will:

- *explain what is speciation.*
- *distinguish between geographical isolation, reproductive isolation, and behavioral isolation.*
- *describe and represent examples of speciation mechanisms: geographical isolation, reproductive isolation, and behavioral isolation.*
- *on a dramatization, explain an example of how the evolution process occurs.*

Beginning

How do adaptations help animals and plants survive in their environment?

Image #1

Geological Timeline

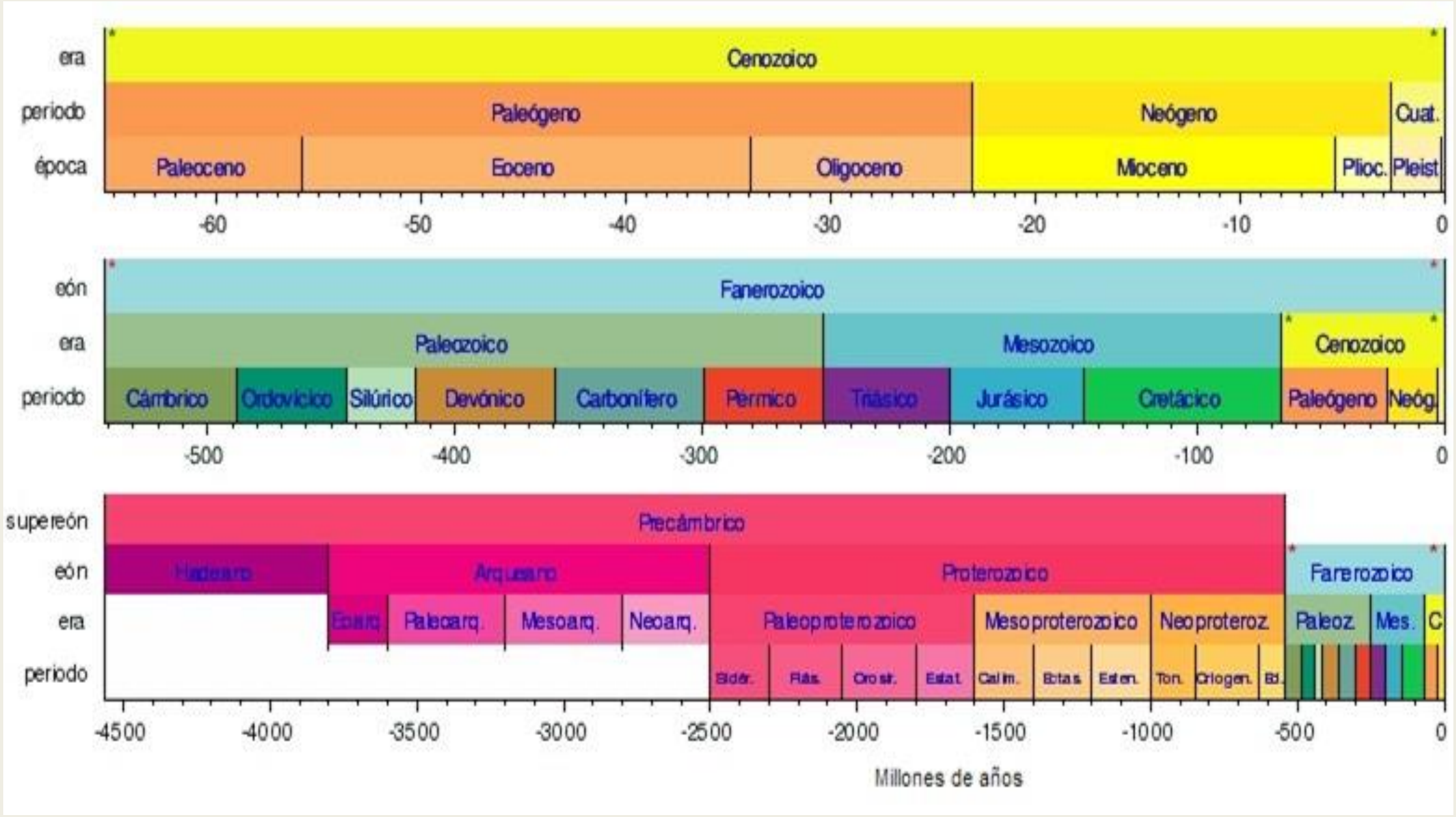


Table #1
Possible explanations of each illustration to exemplify speciation

Illustration	Explanation
Illustration #1: ***The Scene***	The story begins with this image. Some fruit flies can be seen in a rotting plantain cluster.
Illustration #2: ***A disaster occurs*** **GROUP #1**	A hurricane dragged the plantains to the sea. This makes flies abandon the plantains. Then, some flies remain in a part of the continent and their offspring, that some out of the eggs, remain in the island (where the plantains arrive).
Illustration #3: ***Populations diverge*** **GROUP #2**	Through time, the flies from the island develop differently versus the continent's flies. The shape, dietary preferences and courtship exhibitions change during the course of many generations of natural selection.
Illustration #4: ***We meet again*** **GROUP #3**	Another storm occurs and introduces the island's flies into the continent. These will not mate easily with the continental flies. Now that genes can't flow between both populations, the lineage has separated.

Activity # 1: Our speciation drama…

Illustration #1: The Scene

A population of fruit flies is in various rotting plantain clusters, laying their eggs in the fruit.

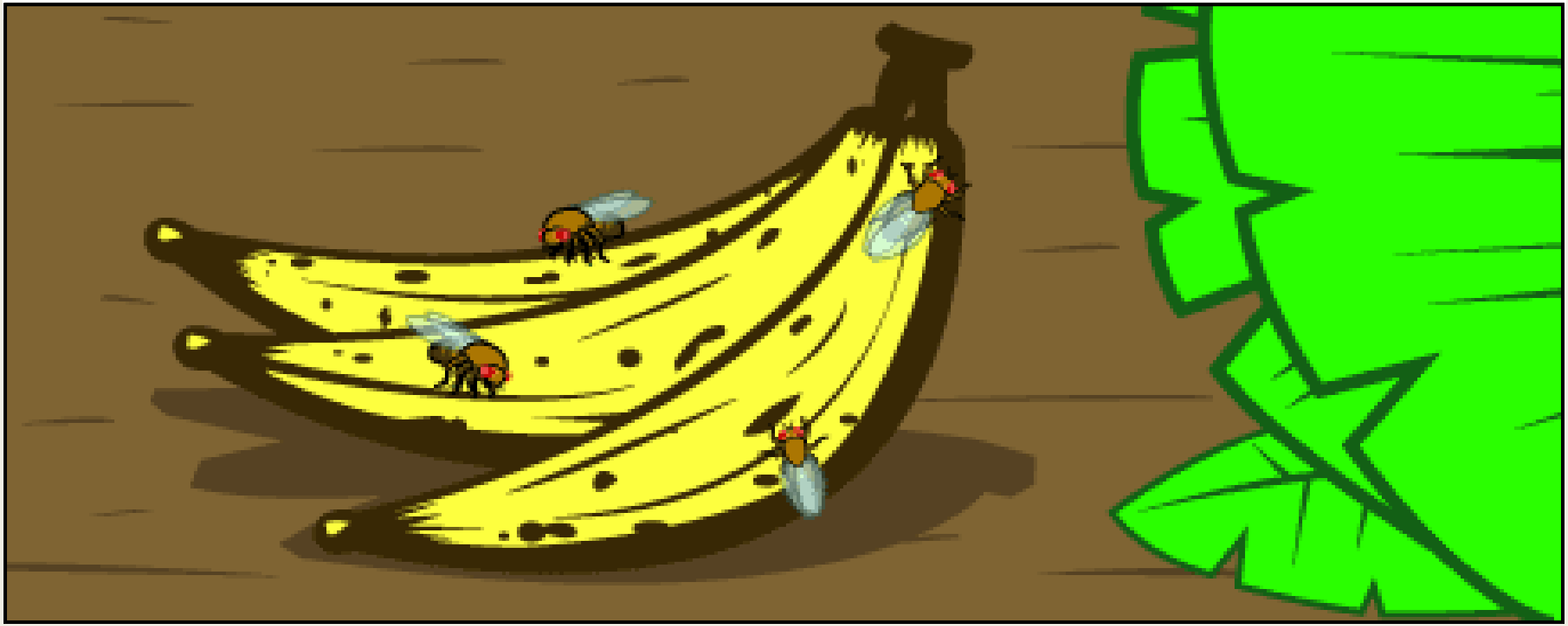
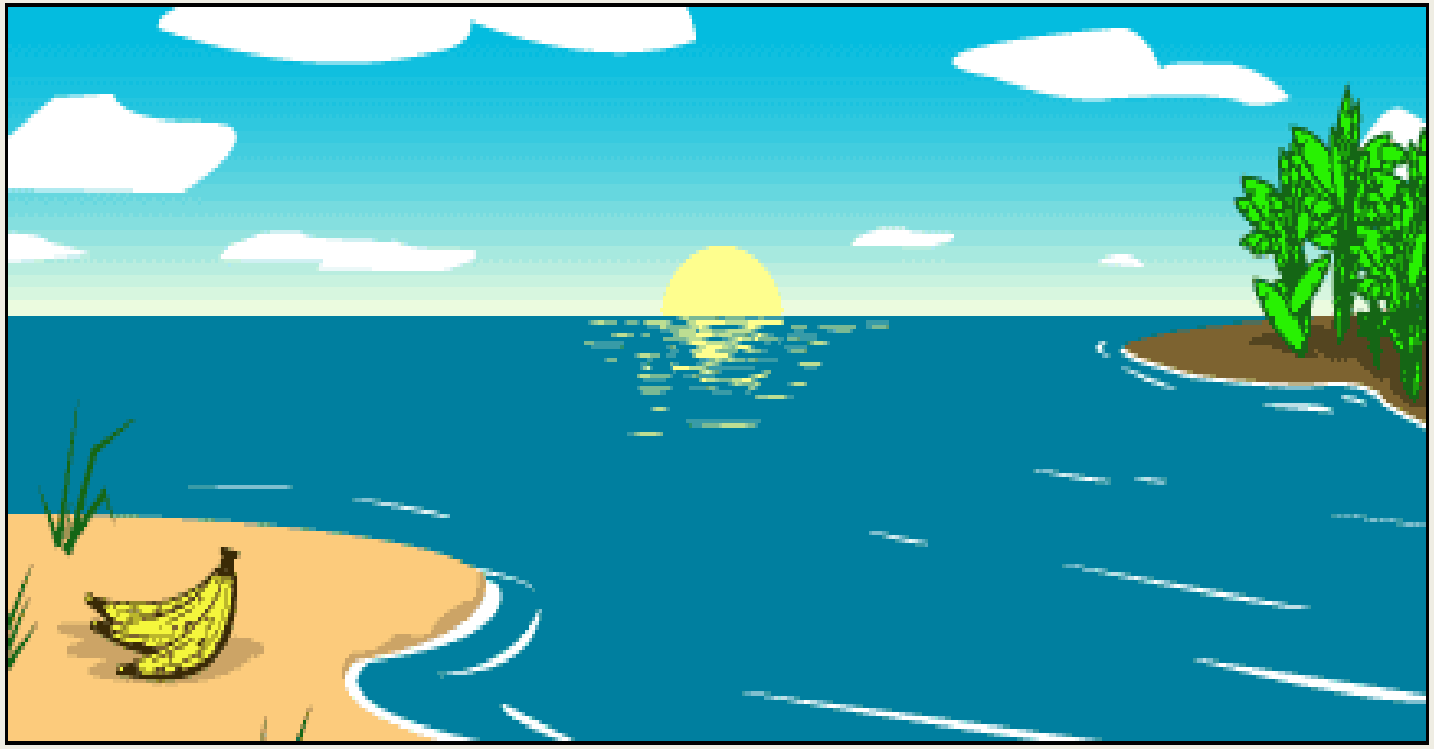


Illustration #2: *A disaster occurs*



A hurricane drags the plantains to the ocean alongside some flies that they had. The plantain cluster ends up being dragged to an island far off the continent's coast. The fruit flies emerge from their nest and arrive to the island. Both parts of the population, the continental one and the insular one, are too far to be joined by gene flow.

Illustration #3: Populations diverge

The ecological conditions are slightly different in the island, so the island's population evolves under different selective pressures and experiments random events that are different from those of the continental population. The shape, dietary preferences and courtship exhibitions change during the course of many generations of natural selection.

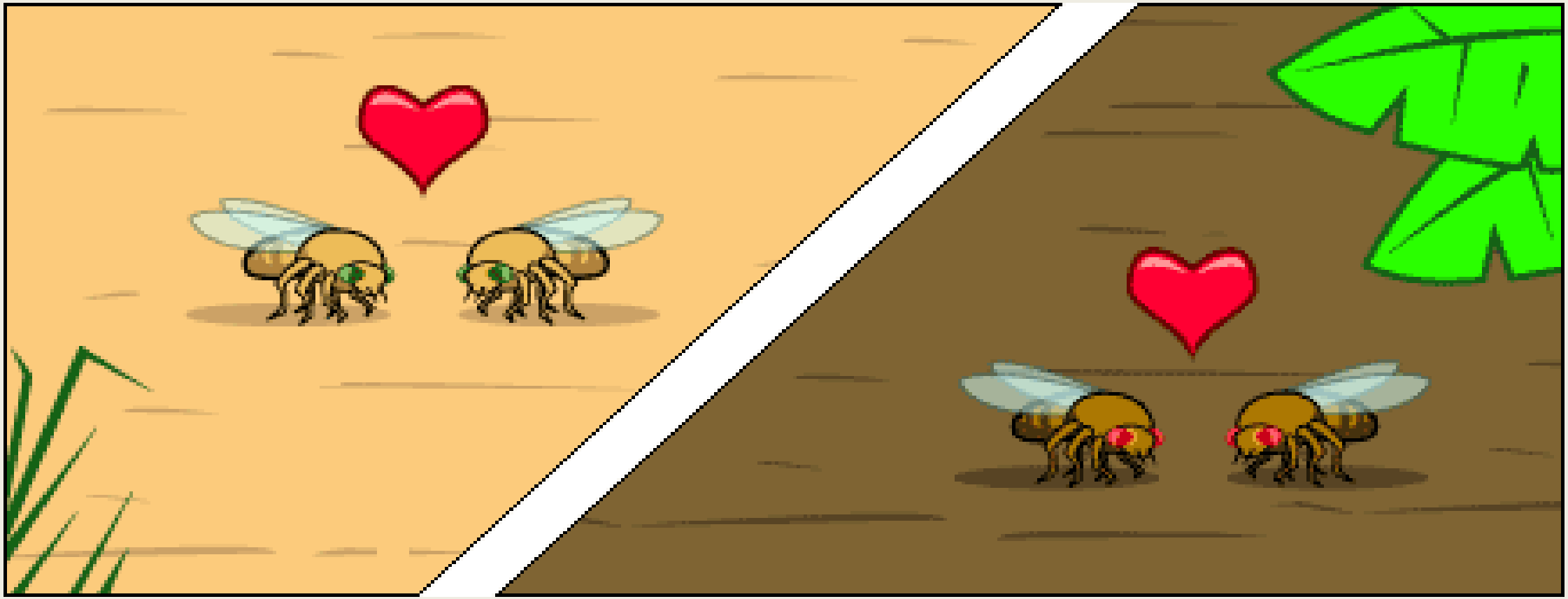
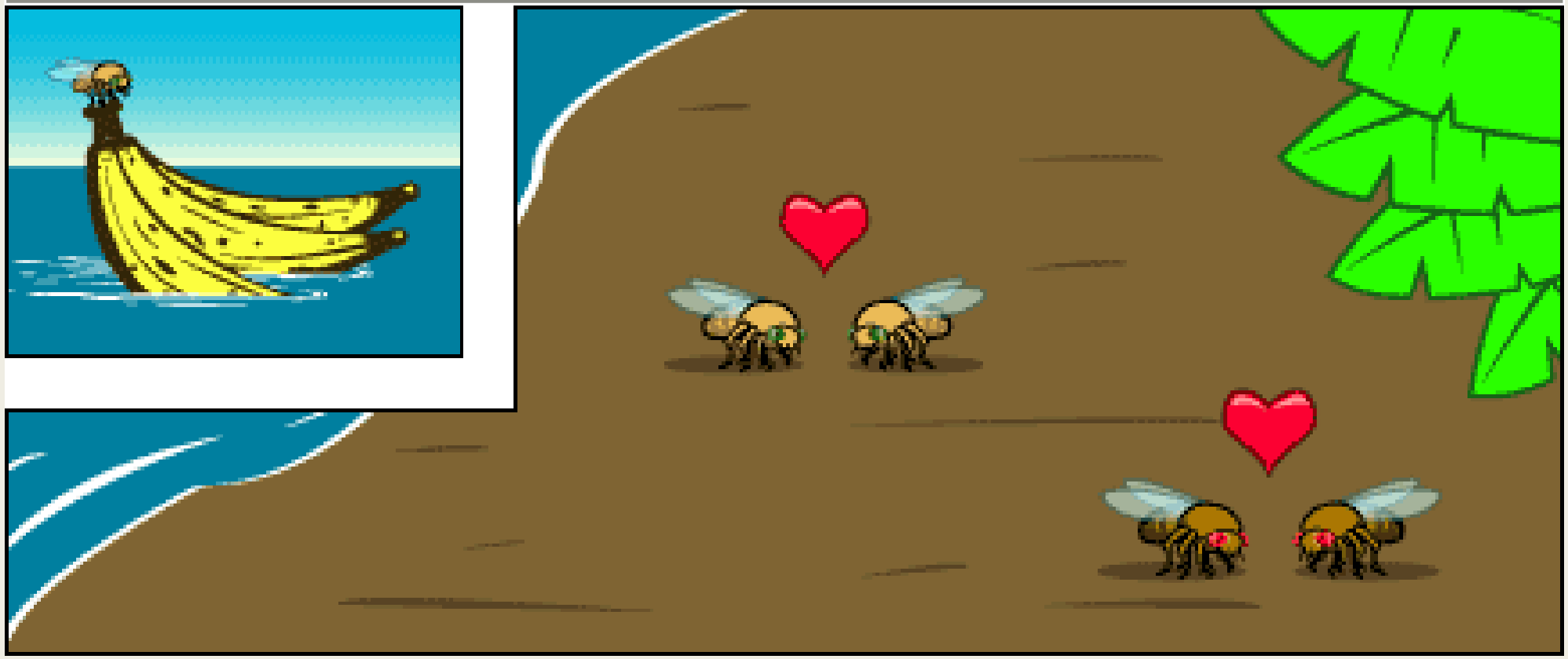


Illustration #4: We meet again

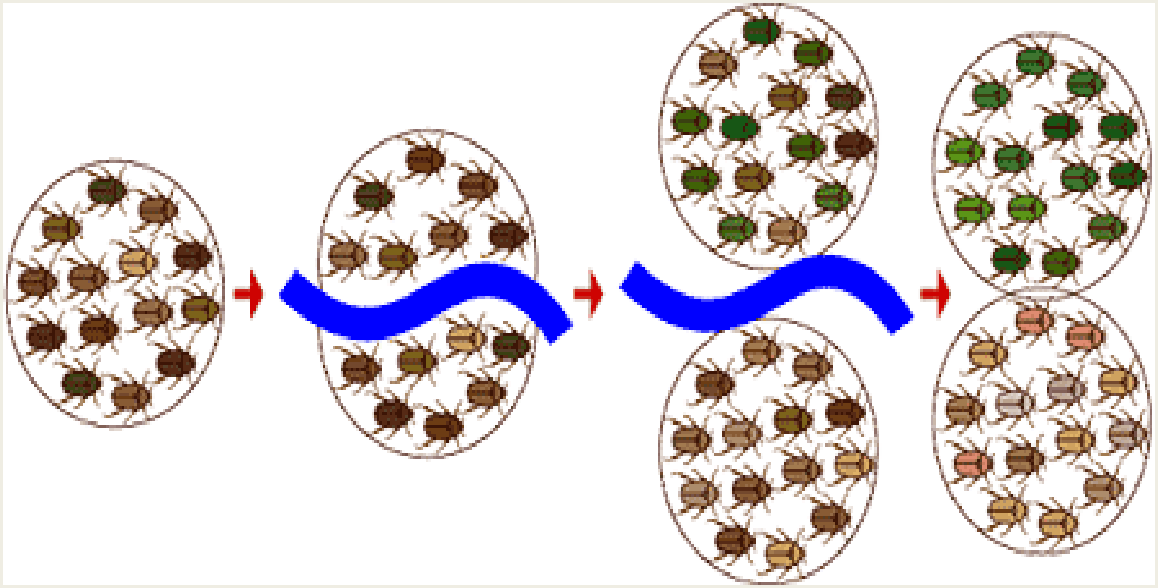
When another storm introduces the island's flies into the continent again, they don't mate easily with the continental flies, because they have developed different mating behaviors. The few that do mate with the continental flies will produce non-viable eggs due to other genetic differences between both populations. The lineage has separated now that genes can't flow between populations.



Geographical isolation

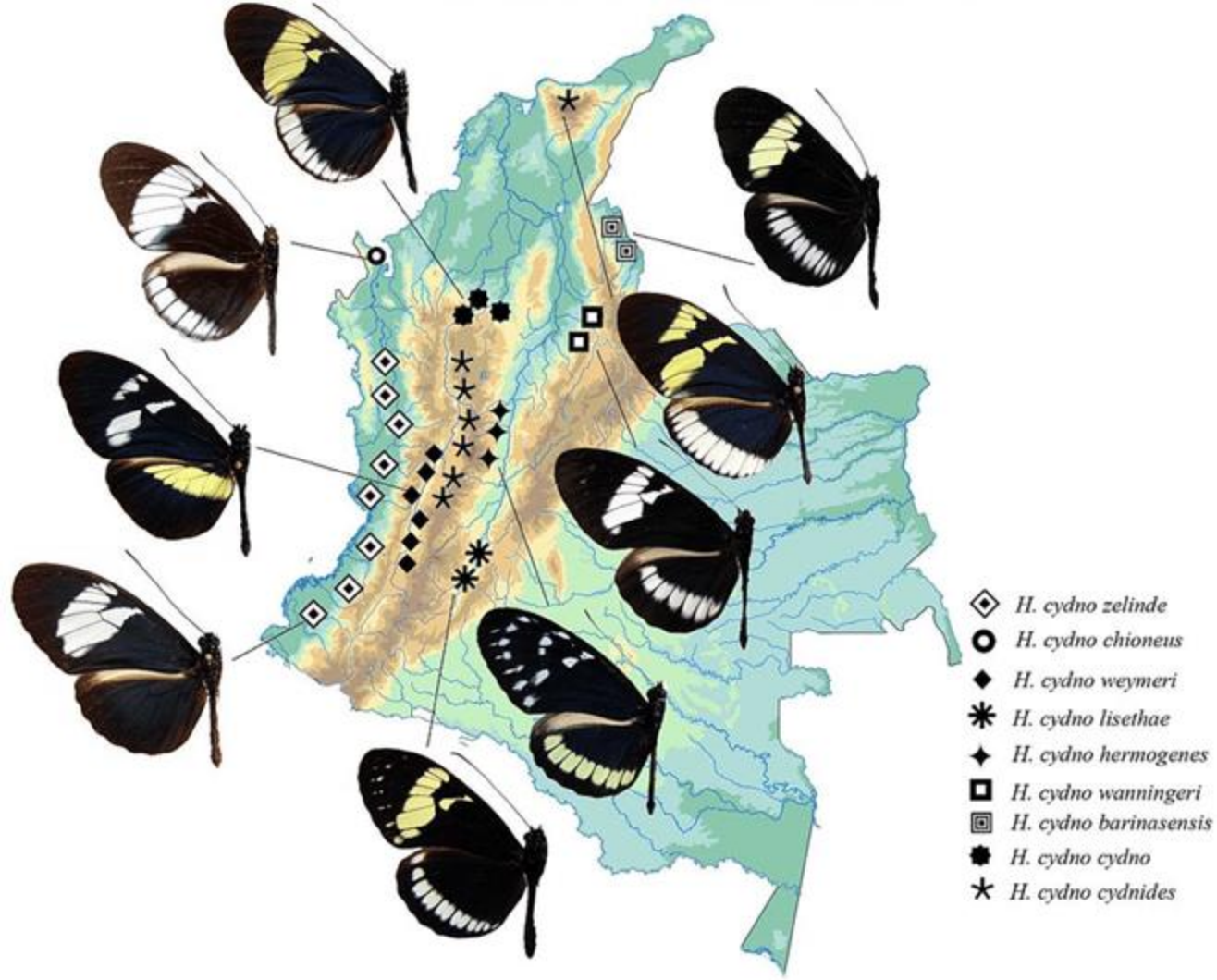
- Occurs when the populations are isolated due to a factor, for example, deforestation, which gives as a result that individuals from the secluded groups can’t interbreed. It can lead to the formation of new species.
- It can lead to the formation of new species.
- Scientists think that it is frequent that the speciation process starts with geographical isolation: rivers change their course, mountains elevate, continents drift, organisms migrate; and what once was a continuous population, divides into two or more small populations.

Geographical isolation



It is not necessary to have a physical barrier, like a river, to separate two or more organism groups; it could simply be an unfavorable habitat between both populations what prevents them from mating.

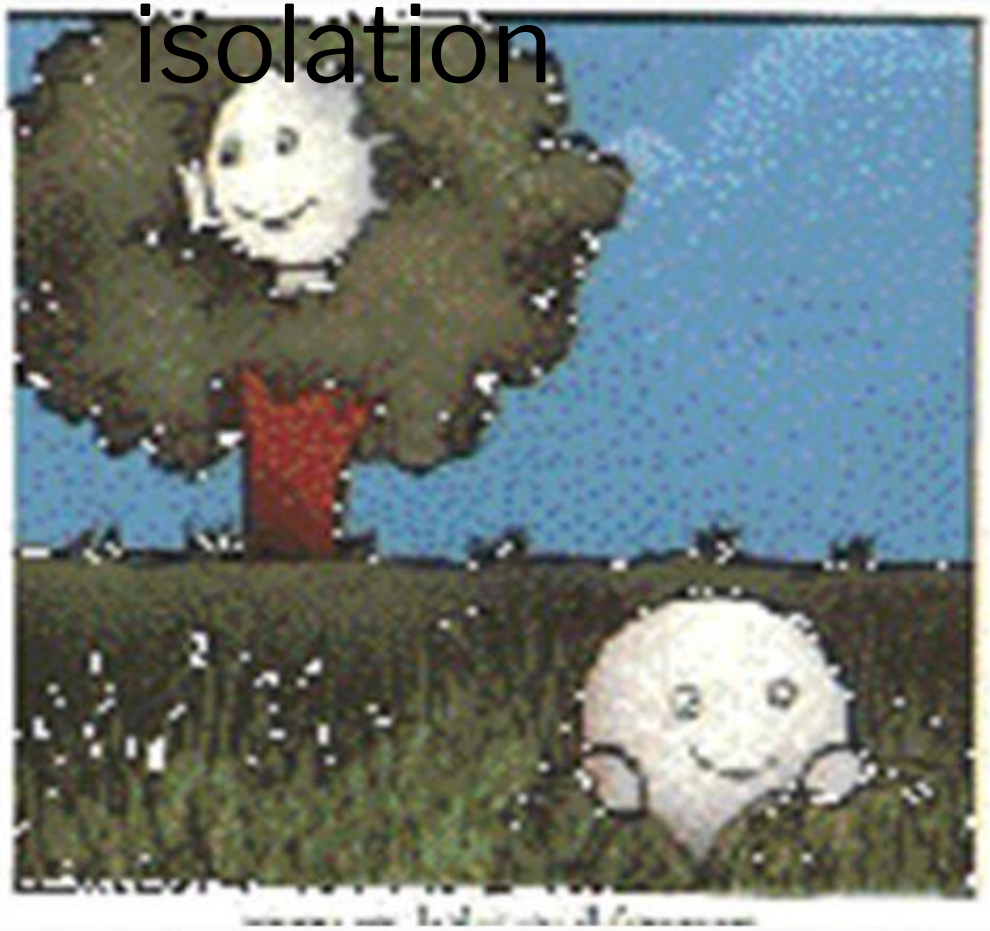
Geographical isolation



- Geographical races (subspecies) of *Heliconius cydno* in Colombia showing their distribution among inter-Andean valleys.

  (Constantino & Salazar, 1998).

Geographical / ecological isolation



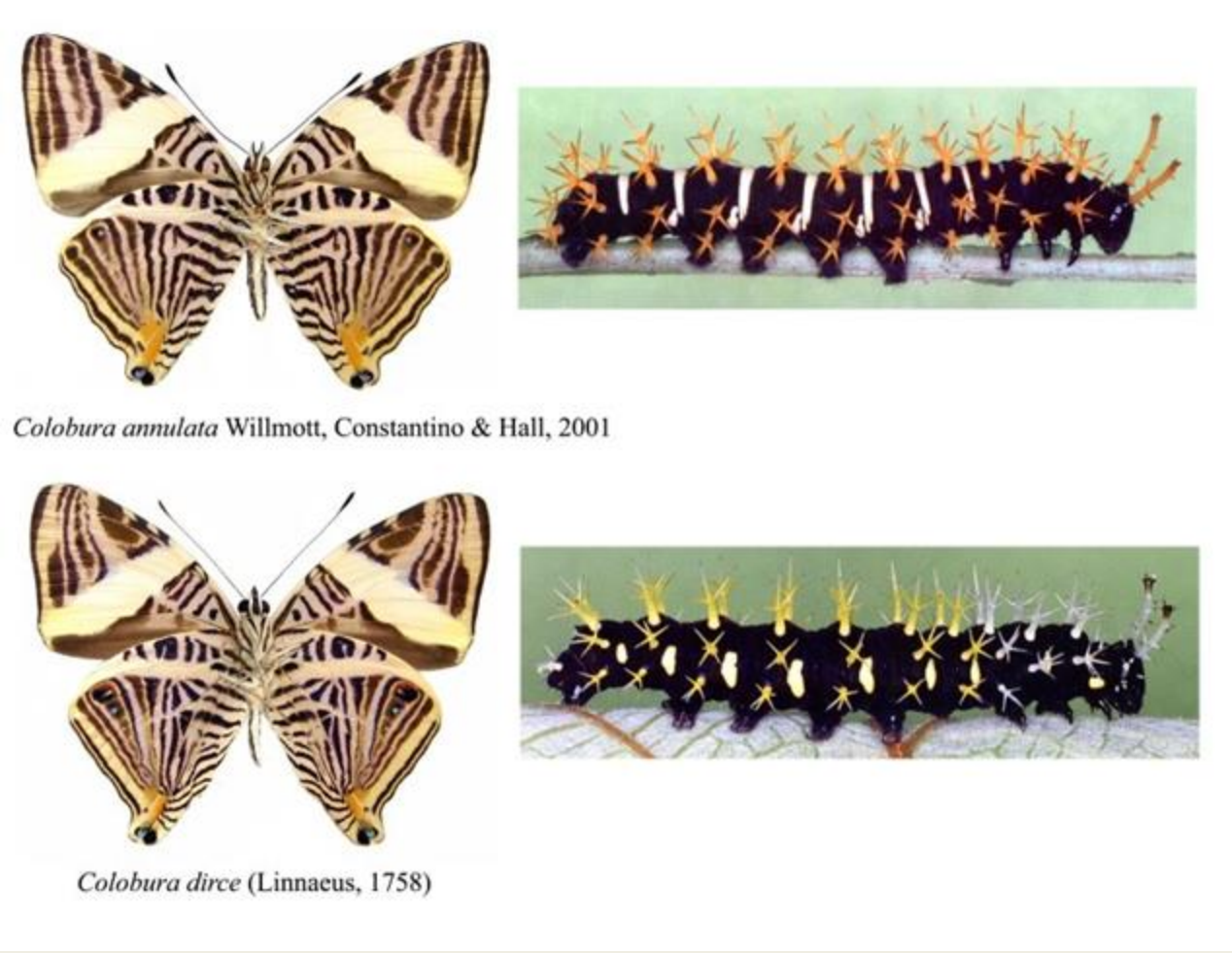
Individuals that occupy the same territory but live in different habitats.

Places like mountains, rivers, lakes, interrupt gene flow between populations.

Reproductive isolation

- Occurs when organisms that once interbreed cannot produce offspring.
  - *For example, by developing different mating seasons.*

Reproductive isolation



Reproductive isolation in two sibling species and sympatric of the genus *Colobura* morphologically identical in their adult state, but with different immature states.

A.-B. Colobura annulata Willmott, Constantino & Hall, 2001.
C-D. Colobura dirce (Linnaeus, 1758).

Reproductive isolation

Darwin's finches are fourteen bird species discovered by Charles Darwin in the Galápagos Islands during his trip boarding the *Beagle*.

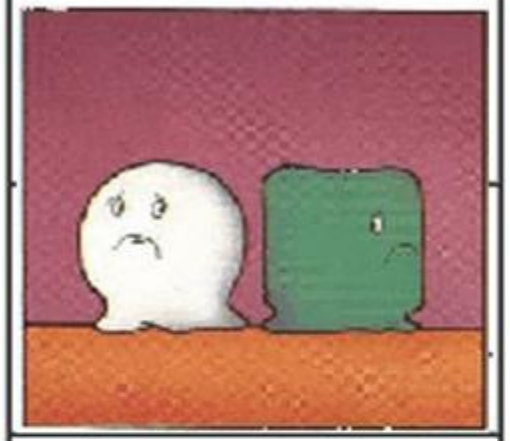
These finch species have evolved from a common ancestor, adapting to diverse food sources (insects, fruits, seeds), so the size and shape of beaks have been notoriously differentiating.

These differences maintain through time thanks to the existence of **reproductive isolation mechanisms**: geographical, ecological and sexual barriers that prevent that members of these fourteen species mate between them and form hybrids.

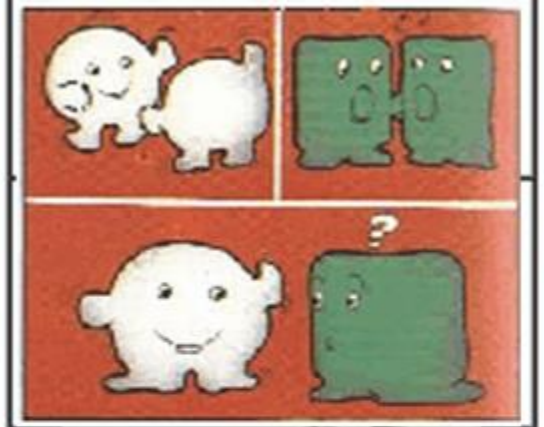
What are the factors that prevent that two populations interbreed?

Two populations are incapable of interbreeding if…

…they live in different habitats

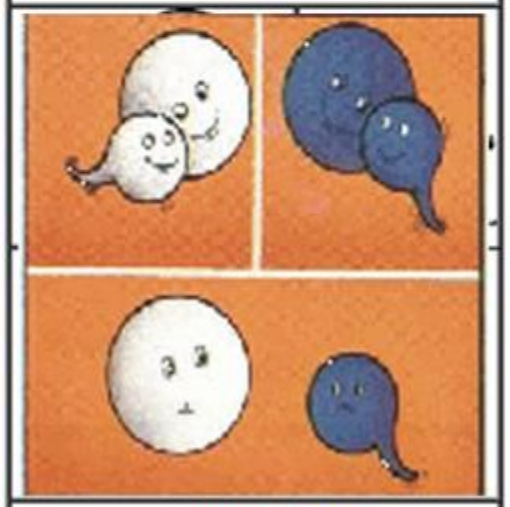


…they have different traits



…they have different behaviors

…they reproduce on different seasons



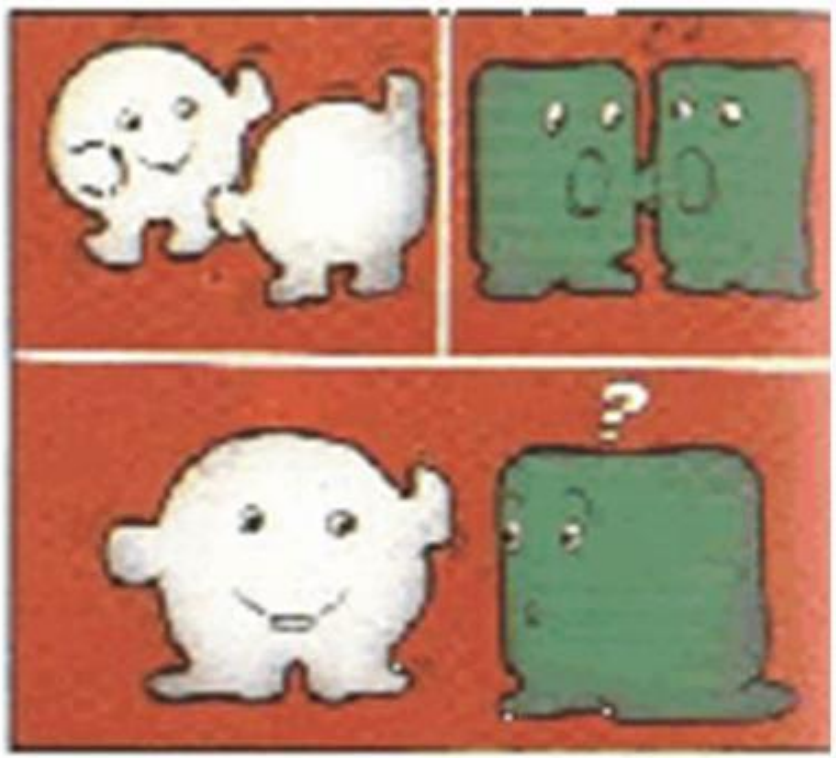
…their gametes are incompatible

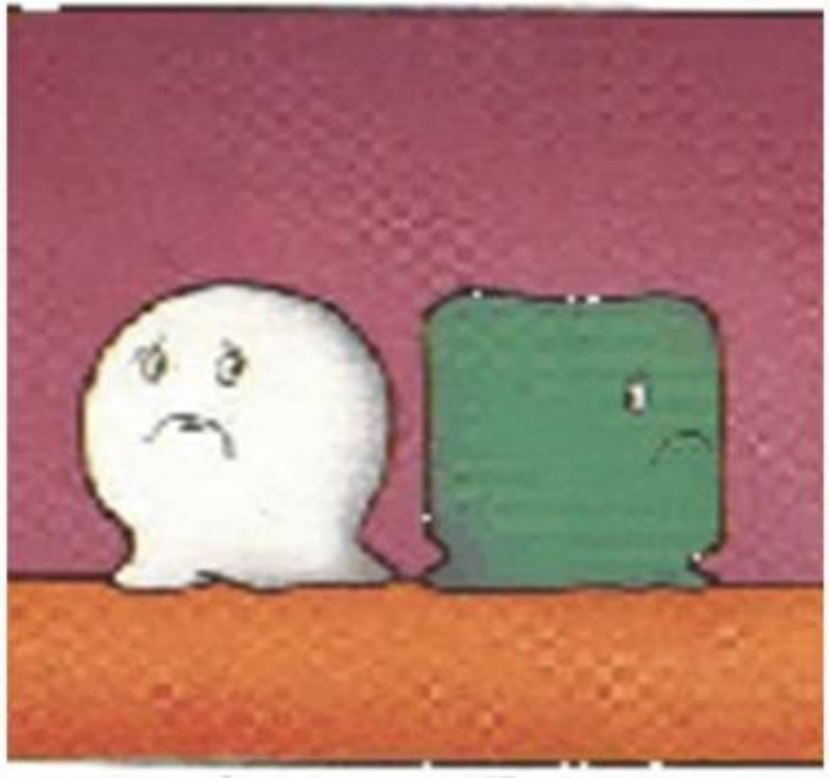
…their offspring does not survive or if it's infertile

Behavioral isolation

- Sexual attraction between males and females of a species is weak or absent.
- In the majority of animal species, members of both sexes first have to seek and unite.
- Then, they perform complex courting rituals, where the male often takes initiative and the female responds.
- This generates additional actions from the male and responses from the female and, finally, there is copulation or sexual intercourse (or, in the case of some aquatic organisms, liberation of sexual cells for fertilization in the water.
- These elaborate rituals are species-specific and play an important role in species recognition.
- If the sequence of events in the courtship process turns inharmonious on either of the sexes, then the process will be interrupted.
- Courtship and mating rituals have been thoroughly analyzed on some

Behavioral isolation





There is no attraction between males and females, or between male and female gametes.
Courtship rituals that different species do not recognize, do not trigger copulation.

Closure

Example of an acrostic for the concept **evolution**

- **E**vidence of change through time in species
- **V**ariations in species lets them adapt to their environment
- **O**rganisms need to change in order to survive
- **L**ineages in recent species are very different from their primitive
- **U**nique environmental conditions make species change
- **T**he idea of changing species was proposed by Charles Darwin
- **I**mportant: adaptations guarantee species availability
- **O**rigin and maintenance of species
- **N**o species will survive unless they adapt to their environment