

SPECIATION

Modes of Speciation
Causes of Speciation
Evidence of Speciation

DEFINITION

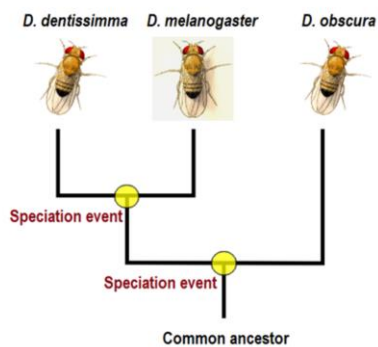
Speciation is the evolutionary process by which reproductively isolated biological populations evolve to become distinct species.

- Speciation is a lineage-splitting event that produces two or more separate species.

For example

- The different species of fruit fly such as *D.*

DEFINITION



➤ Considering a tip of the tree of life that constitutes a species of fruit fly.

➤ Move down the phylogeny to where the fruit fly twig is connected to the rest of the tree.

➤ Branching point, and every other branching point on the tree, is a speciation event.

➤ At that point genetic changes resulted in two separate fruit fly lineages, where previously there had just been one lineage.

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HOW SPECIATION CAN HAPPEN?



Step I- The initial scene

Step II- Disaster strike

Step III- The population diverges

Step IV- Meet again

MODES OF SPECIATION

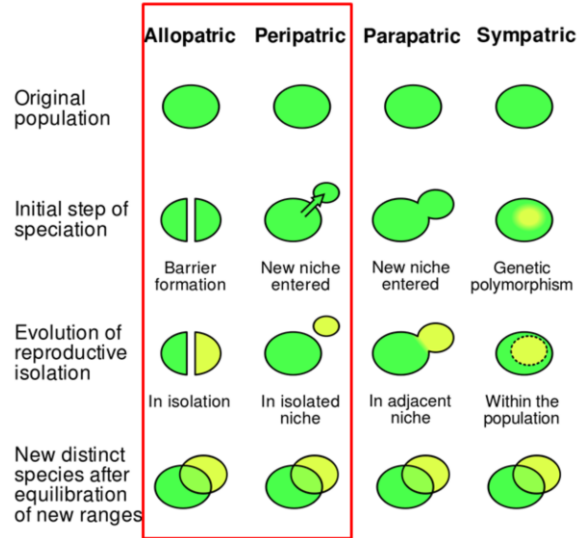
Allopatric speciation

- A population splits into two geographically isolated populations (for example, by habitat fragmentation due to geographical change such as mountain formation). The isolated populations then undergo genotypic and/or phenotypic divergence.
 - Animals of Galapagos Island such as finches, tortoises etc.

Peripatric speciation

- A subform of allopatric speciation, new species are formed in isolated, smaller peripheral populations that are prevented from exchanging genes with the main population.
 - 1) Mayr bird fauna, 2) The Australian bird *Petroica multicolor*, 3) Reproductive isolation occurs in populations of *Drosophila*

MODES OF SPECIATION



MODES OF SPECIATION

Parapatric speciation

- Only partial separation of the zones of two diverging populations afforded by geography; individuals of each species may come in contact or cross habitats from time to time, but reduced fitness of the heterozygote leads to selection for behaviours or mechanisms that prevent their interbreeding.
- Ring species

Sympatric speciation

- Refers to the formation of two or more descendant species from a single ancestral species all occupying the same geographic location.
- Often-cited examples of sympatric speciation are found in insects that become dependent on different host plants in the same area.
- The existence of sympatric speciation as a mechanism of speciation remains highly debated.

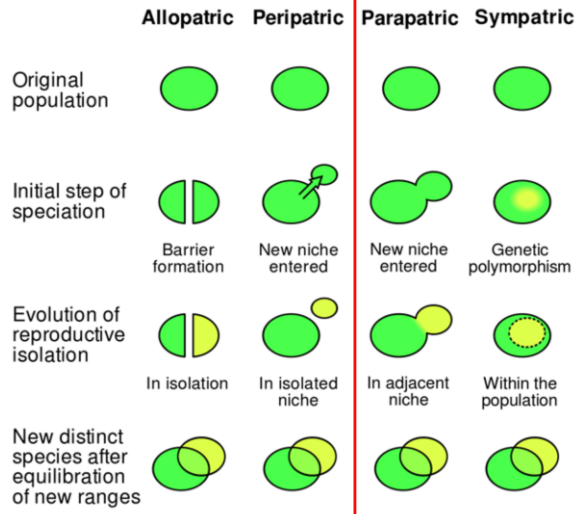
Ring species

The *Larus gulls* form a ring species around the North Pole.

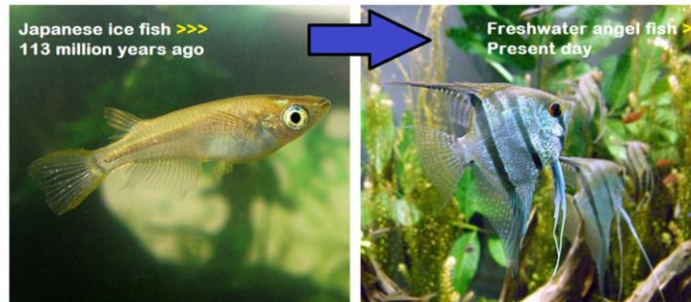
The *Ensatina salamanders*, which form a ring round the Central Valley in California.

The greenish warbler (*Phylloscopus trochiloides*), around the Himalayas.

MODES OF SPECIATION



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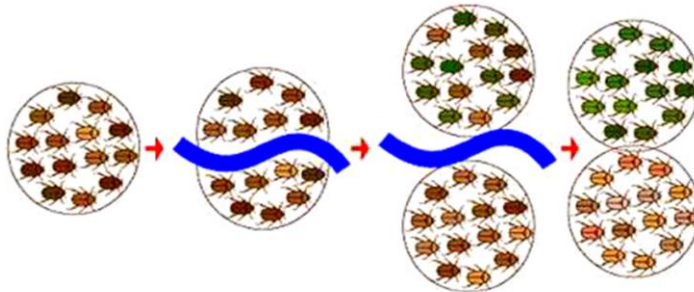
The best illustrated example of sympatric speciation is that of the cichlids of East Africa inhabiting the Rift Valley lakes, particularly Lake Victoria, Lake Malawi and Lake Tanganyika. There are over 800 described species, and according to estimate, there could be well over 1,600 species in the region. All the species have diversified from a common ancestral fish, the Japanese rice fish (*Oryzias latipes*) about 113 million years ago. Their evolution is cited as an example of both natural and sexual selection.



CAUSES OF SPECIATION

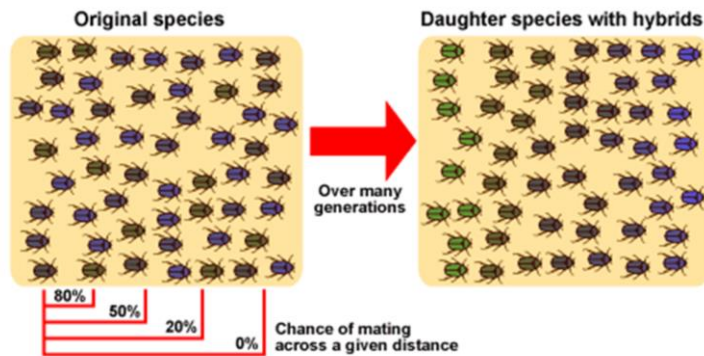


GEOGRAPHIC ISOLATION



Populations were prevented from interbreeding by geographic isolation. Geographic isolation is a common way for the process of speciation to begin: rivers change course, mountains rise, continents drift, organisms migrate, and what was once a continuous population is divided into two or more smaller populations.

REDUCTION OF GENE FLOW



Speciation might also happen in a population with no specific extrinsic barrier to gene flow. Imagine a situation in which a population extends over a broad geographic range, and mating throughout the population is not random. Individuals in the far west would have zero chance of mating with individuals in the far eastern end of the range. So we have reduced gene flow, but not total isolation.

REPRODUCTIVE ISOLATION

The environment may impose an external barrier to reproduction

- River or mountain range, between two incipient species

Facts about reproductive isolation

- External barrier alone will not make them separate, full-fledged species.
- The evolution of internal (i.e., genetically-based) barriers to gene flow is necessary for speciation to be complete.

If internal barriers to gene flow do not evolve, individuals from the two parts of the population will freely interbreed if they come back into contact.

- Whatever genetic differences may have evolved will disappear as their genes mix back together.

Speciation requirements

- The two incipient species be unable to produce viable offspring together
- They avoid mating with members of the other group.

The environment may impose an external barrier to reproduction, such as a river or mountain range, between two incipient species but that external barrier alone will not make them separate, full-fledged species. Allopatry may start the process off, but the evolution of internal (i.e., genetically-based) barriers to gene flow is necessary for speciation to be complete. If internal barriers to gene flow do not evolve, individuals from the two parts of the population will freely interbreed if they come back into contact. Whatever genetic differences may have evolved will disappear as their genes mix back together. Speciation requires that the two incipient species be unable to produce viable offspring together or that they avoid mating with members of the other group.

EVOLUTION OF DIFFERENT MATING LOCATION, MATING TIME, OR MATING RITUALS

Genetically-based changes to these aspects of mating could complete the process of reproductive isolation and speciation.

For example

- Bowerbirds construct elaborate bowers and decorate them with different colors in order to attract females. If two incipient species evolved differences in this mating ritual, it might permanently isolate them and complete the process of speciation.

EVOLUTION OF DIFFERENT MATING LOCATION, MATING TIME, OR MATING RITUALS



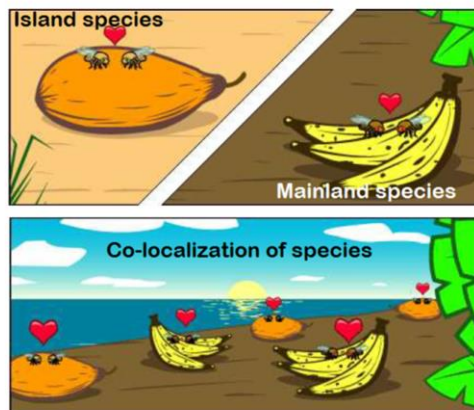
Different species of bowerbird construct elaborate bowers and decorate them with different colors in order to woo females. The Satin bowerbird (left) builds a channel between upright sticks, and decorates with bright blue objects, while the MacGregor's Bowerbird (right) builds a tall tower of sticks and decorates with bits of charcoal. Evolutionary changes in mating rituals, such as bower construction, can contribute to speciation.

LACK OF "FIT" BETWEEN SEXUAL ORGANS



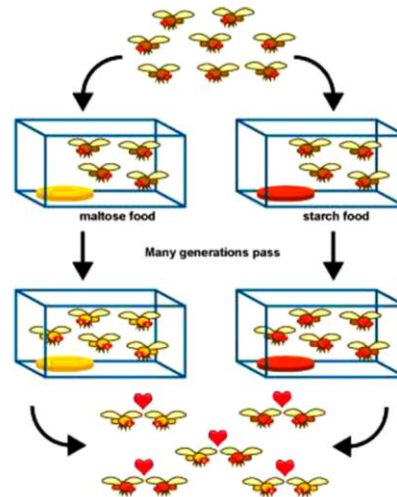
Variably-shaped damsel fly genitalia
causes reproductive isolation

OFFSPRING IN VIABILITY OR STERILITY



EVIDENCE OF SPECIATION

Diane Dodd Experiment
of Speciation



The first steps of speciation have been produced in several laboratory experiments involving "geographic" isolation. For example, Diane Dodd examined the effects of geographic isolation and selection on fruit flies. She took fruit flies from a single population and divided them into separate populations living in different cages to simulate geographic isolation. Half of the populations lived on maltose-based food, and the other populations lived on starch-based foods.

