SPECIATION: SYMPATRIC AND ALLOPATRIC SPECIATION

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Speciation is the process of formation of a new genetically independent group of organisms, called species, through the course of evolution.

- The process of splitting of genetically homogenous population into two or more populations that undergo genetic differentiation and eventual reproductive isolation is called speciation.
- The entire course of evolution depends upon the origin of new populations (species) that have greater adaptive efficiency than their ancestors.

Speciation occurs in two ways.

1. Transformation of old species into new species over time.
2. Splitting of a single species into several, that is the multiplication of species.

A single species may change over time into a new form that is different enough to be considered a new species. This process is known as anagenesis. More commonly, a species may become split into two groups that no longer share the same gene pool. This process is known as cladogenesis. There are several ways in which anagenesis and cladogenesis may take place. In all cases, reproductive isolation occurs.

Speciation Causes

Speciation occurs as a result of several factors which are:

1. **Natural selection**

- As explained by Charles Darwin, different individuals in a species might develop specific distinct characteristics which are advantageous and affect the genetic makeup of the individual.
- Under such conditions, these characteristics will be conserved, and over time, new species might be formed.

- However, in this case, the essential aspect of this factor is that speciation occurs only when a single species splits into several species resulting in the multiplication of species.

2. **Genetic drift**

- Genetic drift is the change in the allele frequencies in a population as a result of "sampling error" while selecting the alleles for the next generation from the gene pool of the current population.
- It has been, however, argued that genetic drift doesn't result in speciation and just results in evolution, that is, change from one species to another, which cannot be considered speciation.

3. **Migration**

- When a certain number of species from a population migrate from one geographical region to another, the species might accumulate characteristics which are different from that of the original population.
- Migration usually results in geographical isolation and ultimately leads to speciation.

4. **Chromosomal Mutations**

- Chromosomal mutations have the potential to serve as (or contribute to) isolating mechanisms, and the locking up and protection of a particularly favorable gene complement through a chromosomal mutation.
- These mutations, when preserved from one generation to another, might result in the formation of new species.

5. **Natural causes**

- Sometimes, natural events imposed by the environment like a river or a mountain range might cause the separation of what once a continuous population is divided into two or smaller populations.
- These events result in geographical isolation of the incipient species followed by reproductive isolation leading to speciation.

6. **Reduction of gene flow**

- Speciation might also occur in the absence of some extrinsic physical barriers.

- There might be a reduced gene flow over a broad geographical range where individuals in the far east would have zero chance of mating with individuals in the far western end of the range.
- In addition, if there are some selective mechanisms like genetic drift at the opposite ends of the range, the gene frequencies would be altered, and speciation would be ensured.

Speciation process

Classically, speciation has been observed as a three-stage process:

1. Isolation of populations.
2. Divergence in traits of separated populations (e.g. mating system or habitat use).
3. Reproductive isolation of populations that maintains isolation when populations come into contact again (secondary contact).

- Recent research shows that steps one and two may take place simultaneously in the same place, and often the third step does not occur.
- The process of speciation begins with the isolation of subpopulation of a species which could either occur through physical isolation (allotropic speciation) or genetic isolation (sympatric speciation).
- Once the population is separated, a gradual accumulation of small genetic changes results in a subpopulation of a species that eventually accumulate so many changes that the subpopulations become different species.
- Over time, the subpopulation now becomes genetically independent and will continue to diverge by mutation, selection, and genetic drift.
- The genetic differentiation might cause a slight change in the mating dance or even a small change in the shape of the male genitalia or some changes in the habitat or feeding habits of the subpopulation, which results in reproductive isolation.
- Eventually, the genetic differentiation between the subpopulation becomes so high that the formation of hybrids between them would be physiologically, developmentally, or behaviorally impossible even if the modes of the separation were abolished.

Sympatric Speciation

Sympatric speciation occurs when populations of a species that share the same habitat become reproductively isolated from each other. This speciation

phenomenon most commonly occurs through polyploidy, in which an offspring or group of offspring will be produced with twice the normal number of chromosomes. Where a normal individual has two copies of each chromosome (diploidy), these offspring may have four copies (tetraploidy). A tetraploid individual cannot mate with a diploid individual, creating reproductive isolation.

Sympatric speciation is rare. It occurs more often among plants than animals, since it is so much easier for plants to self-fertilize than it is for animals. A tetraploidy plant can fertilize itself and create offspring. For a tetraploidy animal to reproduce, it must find another animal of the same species but of opposite sex that has also randomly undergone polyploidy.

Examples of Sympatric speciation

- Sympatric speciation is observed in apple maggot flies which 200 years ago laid eggs and bred only on hawthorns but now lays eggs on both hawthorns and domestic apples.
- As a result, gene flow between parts of the population that mate on different types of fruit is reduced, and in fewer than 200 years, some genetic differences between these two groups of flies have evolved.

Allopatric Speciation

Allopatric speciation, the most common form of speciation, occurs when populations of a species become geographically isolated. When populations become separated, gene flow between them ceases. Over time, the populations may become genetically different in response to the natural selection imposed by their different environments. If the populations are relatively small, they may experience a founder effect: the populations may have contained different allelic frequencies when they were separated. Selection and genetic drift will act differently on these two different genetic backgrounds, creating genetic differences between the two new species.

Examples of Allopatric speciation

- The classic example of allopatric speciation is that of Darwin’s finches. The divergent populations of finches inhabiting the Galapagos Islands were observed to have differences in features such as body size, color, and beak length or shape. The differences resulted because of the different types of food available in various Islands.

- Another example is of Grand Canyon Squirrels which were separated during the formation of the Grand Canyon and resulted in two different species of squirrels.