Quadrant II – Transcript and Related Materials

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Name of the Presenter: Ms. Vinita Q. D'Sa

Notes

Speciation refers to formation of new species. The Study of speciation helps to understand the process of evolution. Speciation is influenced and controlled by a variety of factors.

According to Biological species concept, the species is actually a group of actually or potentially interbreeding natural populations which share in a common gene pool, but are reproductively isolated from other such groups. There is a free gene flow between the members of the same species but free gene flow between two species does not occur on account of marked differences in their genotype.

It indicates new species arise by the establishment of reproductive barrier or reproductive isolation.

Reproductive isolation is basic to the origin of species and actually appears by the accumulation of genetic differences which are caused by mutations, recombination, hybridization, genetic drifts and natural selection. All these factors can increase the genetic divergence only if the populations of species are geographically isolated.

Mechanism of origin of species/ formation of new species

There are two distinct ways in which new species arise from the pre-existing ones.

1) **Phyletic speciation –** When one species is transformed into another. Transformation of the old species into new one in due course of time -Transformation in time.
   At any one time only one species exists. For example, species A is transformed into species B; Species B is transformed into species C and so on
   Time Time
   Species A ……. Species B …… Species C
   Two types: Autogenous transformation and Allogenous transformation
   Autogenous transformation – It is Phyletic speciation where one species is transformed into another by itself by the operation of evolutionary agents like mutation,
   Natural selection, genetic drift and migration.
   Allogenous transformation –one species is transformed into a new species by mating with another species- hybridization.

2) Splitting of the species into two or more species – true Speciation.

True Speciation- when one species gives rise to two or more species by process of splitting or fragmentation.
SPECIES A divides into Species B and Species C

a) INSTANTANEOUS SPECIATION Sudden speciation. New species develop at a single stoke by chromosomal aberrations and mutations. De Vries believed in instantaneous speciation.
b) GRADUAL SPECIATION A new species develops gradually by accumulation of genetic divergence and reproductive isolation. It is brought about by the operation of elementary forces of evolution such as mutation, recombination, natural selection and genetic drift. Gradual speciation is subdivided into two main types: ALLOPATRIC AND SYMPATRIC.

The evolution of two spatially or geographically separated populations into two separate species is called allopatric speciation. Species originating in or occupying different geographical areas are termed allopatric species, allopatric species do not overlap in their distribution. The operating forces in allopatric are genetic divergence and geographical isolation.

When two populations occupying the same area (side by side) evolve into separate species, speciation is termed sympatric. It is brought about by influence of genetic divergence and isolating mechanisms other than geographical isolation. Species occupying the same geographical area are termed sympatric species.

Mechanism of speciation: The origin of new species requires a sequence of events over a very long span of time. It takes place only when both ecological conditions and the genetic makeup of a population are favourable. The mechanism of speciation cannot be understood without a clear understanding of the biological species concept. According to Mayr, **a species is a group of actually or potentially interbreeding natural population that is reproductively isolated from other such groups.** According to this species concept a species is formed of

many populations. The individuals of a species interbreed among themselves, but there will be no interbreeding between two different species.

When there is interbreeding, the gene- carrying gametes are transmitted from one individual to another. Hence interbreeding brings about transfer of genes from one individual to another. This is called gene flow. The gene flow readily occurs between members of the same species but there is no gene flow between two different species. Hence each species has a common gene pool. The quality of gene pool differs from one species to another. Thus, each species maintains its integrity as long as the gene pool does not mix with other species.

When a population is isolated from its parental species, it is prevented from interbreeding with its parental species this leads to failure of gene flow between the isolated population and the parental species. The genetic constitution of the isolated population gradually changes from the parental population. This leads to development of genetic variation and genetic divergence in the isolated population. After the development of genetic divergence, the isolated population fails to mate with the parental species even if it comes in contact with the parental species. Now the isolated population can be called new species.

Speciation may be studied under the following heads:

There are the following patterns of speciation

Allopatric Speciation: When two related populations occupy geographically or spatially separated areas, they are called allopatric populations. The evolution of allopatric populations into separate species is called ALLOPATRIC SPECIATION/ geographical speciation. A physical barrier like a river, desert, mountain range, thick forests, Land bridges, water connections etc, can separate populations of a single species and prevent gene flow between them so that new mutations, genetic drifts and action of natural selection occur independently in isolated populations. In course of time, each segregated population forms a unit. If these populations remain separated for a long time, and if the interacting forces of evolution operate to produce divergence, allopatric species are formed from allopatric populations due to establishment of reproductive isolation. At this stage, even if these allopatric species are brought together or come into contact (become sympatric), they will remain distinct units with no interbreeding because of the establishment of reproductive isolation. The initial step or basic step for allopatric speciation is geographic isolation (hence also called geographic speciation) followed by reproductive isolation. Allopatric species originate by the interplay of both geographical isolation as well as reproductive isolation.

Allopatric speciation involves following steps:

1. Geographic isolation of demes of a widely spread out population of a species over a period of a number of generations.
2. Accumulation of genic differences independently in each deme.
3. Genetic divergence leading to the establishment of reproductive isolation.

Evidence for ALLOPATRIC SPECIATION.

The bird ***Acanthiza pusilla*** is widely distributed on the Australian continent. It slightly differs from Tasmanian species, ***A. ewingi***. It is presumed that during Pleistocene glaciation, when sea level was lower, ***Acanthiza*** entered Tasmania. With the rise of sea level, it became isolated and got differentiated into a new species, ***A. ewingi.***

A major example occurred in the Galapagos finches that Darwin studied. There are about 15 different finches on the Galapagos Islands and they each look different and have specialised beaks for eating different types of foods such as insects, seeds and flowers. All these finches came from a common ancestor species that must have emigrated to the different islands. Once populations were established on the islands, they became isolated from each other and different mutations arose. The mutations that caused the birds to be most successful in their respective environments became more and more prevalent, and many species were formed over time.

Sympatric Speciation

When two populations occupying the same area (side by side) evolve into separate species, speciation is termed sympatric.

It is brought about by influence of genetic divergence and isolating mechanisms other than geographical isolation. Species occupying the same geographical area are termed sympatric species.

Sympatric species originate by the instantaneous development of reproductive isolation between segments of a species population due to a sudden change in their genotype.

As a result, the species population is split into two or more reproductively isolated populations.

Once reproductive isolation is established, each population follows its own evolutionary course and forms sympatric species.

These populations whether continue to occupy the same region or move out of the original habitat will remain distinct.

Sympatric speciation is found in two species of Midas cichlid fish (***Amphilophus* species**), which live in Lake Apoyo, a volcanic crater lake in Nicaragua. Researchers analysed the DNA, appearance, and ecology of these two closely related species. The two species, though overall very similar, do have slight differences in appearance, and they cannot interbreed.

Parapatric Speciation

Parapatric speciation is a mode of speciation in which there is no extrinsic barrier between the population. The large geographic range of the population causes the individuals to mate with the neighbouring individuals than with the individuals in a different part of the geographical range.

In this case, the population is continuous, but the population doesn't mate randomly. Here, the genetic variation occurs as a result of reduced gene flow within the population and varying selection pressures across the population's range. This occurs in population which is distributed over a large geographical range.

Thus, the individuals in the far west region cannot mate with the individuals in the far east region. Through a few generations, new species might be formed within the existing population.

Example

The grass species ***Anthoxanthum odoratum*** where some species living near the mine have become tolerant to heavy metals; however, other plants that don't live around the mines are not tolerant. But because the plants are close together, they could fertilize each other and result in a new species.