Premating Or Prezygotic Isolating Mechanisms

Premating or prezygotic isolating mechanisms are those that prevent contact between the species when they are reproductively active, or which prevent or restrict the union of gametes after mating or cross-pollination has occurred. It may be caused by the following reasons :

1. **Habitat Isolation (Ecological Isolation)**

- Often two closely related species will thrive in different ecological conditions (habitats) within the same territory, but no hybrid between them will be found. However, when the members of the representative species are taken into the laboratory, hybrids between them can be obtained.
- Thus, their respective gene pools are isolated physically, but not physiologically. Again, because of the ecological separation that inhibits the sharing of traits, the incorporation of new adaptations may lead to functional separation of their gene pools, and speciation.
- Habitat or ecological isolation is most common in plants because of their sedentary nature. In them it operates in two ways. The species may live in the same general area but have such different habitat preferences that their populations are rarely close enough together to cross fertilize each other frequently.
- In addition, if hybrids are occasionally formed, they may be either unable to grow maturity or leave few progeny under natural conditions, because no site to which they are adapted is available. This is well illustrated by several species of oaks.
- Many oaks are interfertile and hybrids are occasionally found. Such is the case with four Texas species: Quercus mohriana, Q. havardi, Q. grisea and Q. stellate, studied by **C.H. Muller** (1952). These four species are kept distinct because they grow in very distinct soil types—namely, limestone, sand, igneous outcrops and clay respectively—and the few hybrids between them are confined to the zones where the soil types come into contact.
- Furthermore, two plant species of scarlet oak (Quercus coccinea) and black oak (Q. velutina) are sympatric throughout most of the Eastern United States and both are distinguishable by shapes of their leaves and acorns.
- **Sympatry** is the phenomenon of occurrence of two or more populations in the same area; more precisely, the existence of a population in breeding condition within the cruising range of individuals of another population.
- Such populations which are related and share a portion of their ecologic ranges but remain isolated from the another not by space but through the physiologic expression of genetic difference, are called **sympatric populations** or **species**.

- Habitat isolation is not a very effective isolating mechanism in mobile animals and has been observed most frequently in mouse, river fishes and certain water snakes. For example, two subspecies of American mouse (Peromyscus maniculatis) inhabit regions that share a common boundary.
- While laboratory hybrids between these subspecies exist, none has been found in nature. The explanation for this isolation is that one subspecies lives in the forests and the other on sandy beaches. Apparently, members of the two groups rarely encounter each other.
- The same situation has been found for another subspecies of mouse in Oregon as well as for the water snake Natrix sipedon. One subspecies of snake is a freshwater race, and the other is a saltwater race.

2. **Seasonal Isolation (Temporal Isolation)**

- Two groups may exist in exactly the same ecological area, but do not interbreed because they become sexually mature at different times of the year or under different conditions. Further, seasonal barriers are particularly frequent among aquatic animals, because water temperatures are most stable than air temperatures and embryonic development is more closely harmonised to definite temperatures.
- These two factors combined and permit a close regulation of the breeding seasons. Seasonal isolation is common in plants and occurs frequently among insects and other inverbrates and some vertebrates. For example, over ten subspecies of Cypress trees (Cupressus) are found in California. They do not interbreed because each race produces pollen at a different time of the year.
- In animals it may be the time or condition for mating which may vary. In the northeastern United States, three species of frog, Rana pipiens, R. sylvatica and R. clamitans all mate in the same ponds at different times.
- R. sylvatica begins breeding when the water is 440 F and completes its mating season before the temperature reaches 550 F, the breeding temperature necessary for R. pipiens. R. clamitans must have temperatures of at least 600 F.
- By this time the temperature is reached, both R. sylvatica and R. pipiens are past their breeding stages. Further, most closely related species of anurans (frogs and toads) have overlapping breeding seasons, but in them, the isolation is provided by acoustic stimuli.

3. **Ethological or Behavioral Isolation (Sexual Selection)**

- Ethological (Gr, ethos=habit, custom) refers to behaviour pattern. Ethological isolating mechanisms are barriers to mating due to incompatibilities in behaviour. It is based on the production and reception of stimuli by the sex partners.
- The males of every species have specific courtship behaviour and females of the same species are receptive. Courtship involves an

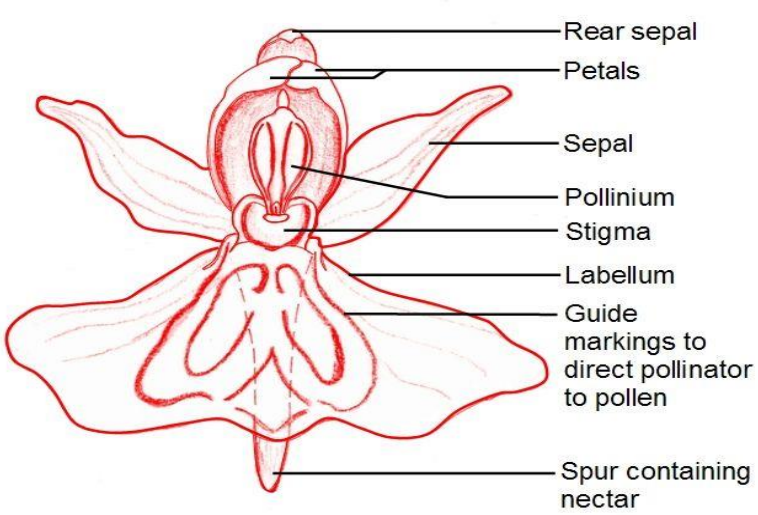
exchange of stimuli (visual, auditory, tactile, olfactory or chemical) between male and female continuing until both have reached a state of physiological readiness in which successful copulation can occur.

- The species specific stimuli which help two sexes for the simultaneous recognition of each other for courtship forms the **ethological isolation**.
- For example, birds and insects embark on mating after highly standardized ritual dances. In some species of birds, plumage of the male stimulates the female sexual interest.
- Thus, the different colour patterns of insects; different colour patterns of plumages of birds; light signals sent out by male fire flies (beetles of family Lampyridae); melodious songs produced by the males of insects, frogs, birds, etc., sex attractants (ectohormones or pheromones) produced by most insects, mammals including human female; are some of the examples of stimuli which have a significant role in ethological isolation.
- In most animals it is the male that actively searches for a mate. He is usually rather easily stimulated to display to objects. Sometimes quite inappropriately, when he does not receive adequate response from his display partner, or is actively repulsed, his display derive eventually becomes exhausted.
- Consequently, if such a displaying male encounters an individual of a different species, or a male of his own species, he will break off his courtship sooner or later. If the male is displaying to a non-receptive female, the same will happen, perhaps, after longer intervals. In Drosophila, for example, it is shown that males act quite specifically to remove inhibitions, so that females will copulate with males of her own species.
- These actions of courtship include orientation of the body, display of wings and licking with tongue. Further, when the antennae, the most sensitive tactile organs of females, are etherised, the males can easily bring about copulation with females of different species.

4. **Mechanical Isolation**

- Mechanical isolation is provided due to differences in the structure of flower of flowering plants or in the genital organs of different species in animals, so that cross-pollination or copulation may not be easily brought about.
- In case of higher plants mechanical isolation provides the most effective and a major isolating mechanism. It is more effective in those plants where flower structures remain well specialized for insect pollination.
- For example, different species of Asclepias of Asclepiadaceae differ in the shape of pollinia (sacs carrying pollen) and that of the stigmatic slits, so that with the help of particular insect bringing about pollination, pollinia of one species cannot bring about pollination on the stigma of another species. Such kind of mechanical isolation is also common in the other members of family Asclepiadaceae and Orchidaceae.

- The orchid family has evolved flowers having an architecture that is particularly susceptible to large numbers of variations on a single adaptive theme.
- They are bilaterally symmetrical or **zygomorphic**, because one of the six perianth members or tepals is modified into an elaborate structure known as the **lip**; the stamens and stigma are united to form a single structure, the **column**, which in each species produces a very specific relationship between the pollen-releasing anthers and the pollen-receiving stigma; and their sticky pollen mass cannot be transported by any means other than a particular vector.
- Unless the flower is visited by an insect or other visitor particularly adopted to one or a few related species, no seed is formed. Flowers of some orchids even mimic in shape the females of certain species of wasps and bees.



Orchid Flower Structure

- Male wasps or bees are attracted to these flowers and engage in "**pseudocopulation**" with them, thus, receiving and transferring the pollen sacs. The occurrence of mechanical isolation among animals was recognized quite early.
- As, soon after the discovery of the manifold structural differences in the genital armatures of different species of insects, it was asserted by **Dufour** (1844) that these genital armatures act like lock and key, preventing hybridization between individuals of different species.
- For example, interspecific crosses in Drosophila may cause injury or even death to the participants, and the same is true in Glossina (tsetse fly) and in pulmonate snails of subfamily Polygyrinae.
- However, **Karl Jordan** (1905) contradicted Dufour's hypothesis by showing that out of 698 species of Sphingidae family of Insecta, 48 were not different in their genitalia from other species of the family, while in about 50% of the species with geographic variation in colour, there was geographic variation in the structure of the genitalic armatures. Since that time much additional information has accumulated

indicated the slight importance of the genitalic armatures as isolating mechanisms in animals.

- According to **Mayr** (1970), the genitalic apparatus of animals is a highly complicated structure and is the pleiotropic by-product of very many genes of the species. Any change in the genetic constitution of the species may result in an incidental change in the structure of genitalia. As long as this does not interfere with the efficiency of fertilization, it will not be selected against.

References

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