Postmating Or Postzygotic Isolating Mechanisms

Postmating Or Postzygotic Isolating Mechanisms are those which prevent the growth of hybrid individuals after fertilization has occurred or which reduce the fertility of the F1 hybrids or the viability of their descendants. They are caused by the following methods :

1. **Gametic Mortality**

It has been postulated that sperm can tolerate only narrow ranges of physiological conditions (pH, temperature, etc.) and that these conditions are favourably met in female members of the same species. Deviation from the physiological compatibility would prove lethal to sperm, and, few, if any, would survive to fertilize the egg. Therefore, even though members of these two groups could copulate, the mating process would not lead to viable offspring. Further, the sperms may encounter an antigenic reaction in the genital tract of the female, so that they become immobilized and killed before they have a chance to reach the eggs. **Patterson** reported such "insemination reaction" to occur in many Drosophila which leads to an enormous swelling of the walls of the vagina and the subsequent killing of the spermatozoa.

In certain sterile human females sperm mortality due to excessive acidic conditions of vagina has been reported by many medical journals. Sperm mortality may also occur due to physiological inability (i.e., fertilizin-antifertilizin reaction) of sperms to penetrate the egg membrane of the alien species. Such **gametion isolation** is not unique to animals; in plants such as the Jimson weed (Datura), the sperm-bearing pollen tube of one species encounters a hostile environment in the flower tissue of the other species and is unable to reach the egg.

2. **Zygotic Mortality**

The development of the fertilized hybrid egg is often irregular and development may cease at any stage between fertilization and adulthood, zygotic mortality can be caused due to several cytological, genetical, embryological, molecular, biological, biochemical and physiological reasons in most animals. For example, certain hybrid zygotes of Ambystoma mexicanum lack nucleolus and in the absence of nucleolus, such zygotes die without undergoing cleavage. Certain authors have included the isolations due to sperm mortality and zygotic mortality under **physiological isolation**. Such physiological isolation also can occur as an incompatibility between the embryo and the female parent. Interspecific hybrids between two species of Jimson weed (Datura) result in the death of the embryo at the eight-cell stage. By removing the embryos and culturing them artificially, viable seeds can be produced that germinate and grow into healthy offspring.

3. **Hybrid Inviability**

Many naturally occurring animal hybrids though have somatic hybrid vigour and fertility, but leave no offspring. The reason for the reproductive failure of fully fertile species hybrids is perhaps that they are less well adjusted to available ecological niches than individuals of the parental species. Also, species hybrids are usually less successful than individuals of pure species in courtship, when definite behaviour patterns and species-specific stimuli play an important role. Ecological and ethological inferiority, thus, reduces their chances of leaving offspring. For example, two species of the chicory plant, Crepis tectorum and Crepis capillaris, can be crossed, but the hybrid seedlings die in early development. Crosses between the bullfrog, Rana catesbeiana and the green frog, Rana clamitans, results in inviable embryos.

Rana clamitans

4. **Developmental Hybrid Sterility**

Sometimes postzygotic isolation involves in the production of vigorous but sterile species hybrids. This type of hybrid sterility involves the abnormal development of gonads, or abnormal meiosis or abnormality in gamete formation. It is usually most common in male animals and plants. For instance, inviable F1 hybrids between different species of Drosophila and flies, also between various species of mammals such as cattle x yalk, cattle x buffalo, horse x zebra, and between some species of birds such as mallard and muscory ducks. Thus, in certain hybrid crosses, such as between females of the toad species Bufo fowleri and males of Bufo valliceps, the hybrids may survive but are completely sterile.

The abnormality occurs due to poor growth and a low rate of mitosis in the cells of seminiferous tubules. Further, developmental abnormality also occurs at the time of meiosis of spermatocytes due to which either no sperm is produced or if any sperm is produced that remains undifferentiated, to be unable for fertilization. **A. Muntzing** (1930) has used the terms, **haplontic sterility**, where the sterility is set in haploid parts (gametes) and **diplontic sterility**, where the sterility is brought about due to events before meiosis or after fertilization in diploid tissues.

5. **Segregational Hybrid Sterility**

In both plants and animals hybrid sterility may result from abnormal segregation at meiosis of either whole chromosomes or blocks of genes contained in chromosomal segments. If the chromosomes of the parental species are not homologous (i.e., chromosomes of both parents of a hybrid contain individual gene dissimilarities), they cannot pair at all. Further, segregational hybrid sterility or **genetic isolation** may also be caused due to genetically controlled spindle abnormalities, asynapsis or desynapsis and similar other abnormalities. For instance, in the hybrid (Raphanobrassica) between the radish and cabbage, the nine chromosomes derived from the radish may not pair at all with the nine chromosomes derived from the cabbage, so that at meiosis one observes 18 single chromosomes instead of nine pairs found in the parental species. Since these unpaired chromosomes are unable to line up on the meiotic metaphase spindle, they are distributed irregularly to the poles caused daughter cells with unbalanced complements of chromosomes, the genes of which are unable to direct the development of the pollen grains or embryo sacs.

Further, sometimes chromosomal sterility may result when the chromosomes from two parents do not lack homology but differ due to structural changes like translocation or inversions (chromosomal aberrations). In such a case the pairing of chromosomes will be imperfect and results in the segregation to the gametes of abnormal disharmonious combinations of genes (i.e., sterile gametes). For instance, in hybrids in between Primula verticillata and P. floribunda, the sterility in hybrid is known due to small structural difference between parental chromosomes.

Likewise, the functional offsprings, mules of horse and donkey, are sterile. The horse and donkey each contributes 33 chromosomes to the offspring or (species hybrid) mule. During meiosis of gametogenic cells of the mule, however, the chromosomes fail to pair. This failure is thought to be the result of the degree of genic dissimilarity between the horse and donkey chromosomes, so that they do not “recognize” one another at homologues. Since the orderly separation of chromosomes into gametes is necessary for fertilization to take place, the mule is sterile.

There is evidence that genetic isolating mechanisms are occasionally modified or reinforced by conditioning. Young birds can sometimes be imprinted on a foster species, when raised by foster parents. In parasitic birds, cuckoos and cowbirds, such conditioning is absent, and species recognition is rigid. Young cowbirds, for instance, leave the company of their foster parents and flock together as soon as they are independent. In the human species, however, conditioning is an important isolating mechanism. The free interbreeding of individuals coexisting in a geographical region is strongly influenced by religious, economic and cultural barriers.

Primula floribunda

6. **F2 Break Down**

In both animals and plants, there are examples of hybrids which are highly or at least partly fertile, but which give rise to weak, abnormal, or sterile progeny in the second (F2) generation. This phenomenon is called **hybrid breakdown**. Classical examples of hybrid breakdown are provided by the F1 hybrids, Gossypium arboreum x G.herbaceum and Gossipium barbadense x G. hersutum. In both of these cases, F1 progeny is either missing or is very weak. From the developmental point of view, F2 breakdown is similar to segregational sterility, except that the effects of the segregation of disharmonious gene combinations are delayed until after fertilization.

References

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3859346/