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Topic: Heterospory and evolution of seed habit in Pteridophytes

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HETEROSPORY AND EVOLUTION OF SEED HABIT IN PTERIDOPHYTES:

Heterospory is an act of the production of two different kinds of spores – i.e., **microspores** and **megaspores.**

These heteromorphic spores are dissimilar in shape, size and number. For example, the total output of smaller microspores per **microsporangium** is several times higher as compared to large-sized megaspores whose number per **megasporangium** has eventually been reduced from several or four to one. In living **Pteridophytes**, the heterospory is prevailing in *Sellaginella, Marsilea, Salvinia,* etc. According to Rashid (1976) only 9 genera of Pteridophytes are heterosporous. These are Selaginella, Isoetes, Stylites, Marsilea, Pilularia, Regnellidium, Salvinia, Azoll and Platyzoma.

Biological Significance of Heterospory:

The heterosporous condition is directly related to the distinction of sex in the gametophyte – i.e., the microspore germinates to produce microsporophyte bearing 1-2 antheridia, and the megaspore to megagametophyte producing from several to

one archegonium. In heterospory, the prothallial gametophyte, therefore, is strictly dioecious.

Origin of Heterospory:

As per experimental evidence, the heterosporous habit arose as a result of the disintegration of a certain number of spores and consequently better nutrition to the surviving one. Hence the nutritional factor is involved in the manifestation of heterospory.

The origin of heterospory can be better discussed on the basis of evidences from paleobotany, developmental and experimental studies.

1. Palaeobotanical evidences:

It has been suggested that heterospory arose due to degeneration of some spores in a few sporangia. As more nutrition becomes available to less number of spores, the surviving spore grow better, hence increase in their size.

Palaeobotanical evidences show that the earlier vascular plants wert all homosporous and the heterosporous condition appeared subsequently in the lowermost upper Devonian. Anumber of heterosporous genera belonging to the Lycopsida, Sphenopsida and Pteropsia were known in the late Devonian and early Carboniferous periods.

During this period important heterosporous genera were Lepidocarpon, Lepidostrobus, Mazocarpon, Plaeuromeia, Sigillariostrobiis (members of Lycopsid) Calamocarpon, Calamostachys, Palaeostachys (members of Sphenosida). Some of these forms even arrived at the seed stage.

According to Williamson and Scot (1894) two species of Calamostachys form the initial stage that might lead to the heterospory. These species were C. binneyana and C. casheana. In C. binneyana most of the sporangia were with large number of small spores in tetrads but in some sporangia spores were large.

However, in C. casheana two different types of spores-microspores and megaspores were present in different sporangia. Similar type of abortion of spores was also observed in Stauropteris (Chaloner, 1958Lepidocarpon and Calamocarpon).

2. Evidences from Developmental Studies:

In heterosporous Pteridophytes the development of micro and megasporangia follow the same pattern. They have identical organization but for their size. While in megasporangia most of the spore mother cells degenerate but in microsporangia only a few mother cells are disorganize.

The phenomenon of heterospory becomes distinct either before or after meiosis. In Selaginella Isoetes it is distinct before meiosis. In the microsporangium all the sporocytes undergo meiosis and form a large number of microspores. However, in megasporangium, a part of the sporogenous tissue degenerates they provide nutrition to growing sporocytes (megaspores).

In Isoetes there are only 50-300 megaspores in megasporangium. In Selaginella erythropus megasporangium contains only one megaspore which is functional.

In Marsilea, Salvinia and Azolla the phenomenon of heterospory becomes distinct after meiosis. In Marsilea 64 microspores and 64 megaspores are formed after meiosis in microsporangium and megasporangium respectively. In

microsporangium all the microspores are functional while in magasporangium one megaspore is functional and rest degenerate.

3. Evidences from Experimental Studies:

Experimental studies on Selaginella (Goebel, 1905) and Marsilea (Shattuck, 1910) suggest that nutritional factors mainly govern the heterospory. Under conditions of low light intensity, the photosynthetic activity of Selaginella was retarted and it produced microsporangia. By sudden lowering of the temperature, the size of the microspores in the sporocarp of Marsilea increases by six times.

Heterospory and Seed-habit:

Heterospory is the most important evolutionary development for seed-habit in vascular plants including all **spermatophytes.**

The adoption of heterospory and the retention and germination of a single megaspore within megasporangium to form a female gametophyte, led to the phenomenon of "seed habit", a characteristic feature of the spermatophytes. A seed is that ovule which contains an embryo developed as a result of fertilization.

The origin of seed habit is associated with the following:

(i) Production of two types of spores (heterospory).

(ii) Reduction in the number of megaspores finally to one per megasporangium.

(iii) Retention and germination of the megaspores and fertilization of the egg.

(iv) Continued development of the fertilized egg into the embryo while still in situ.

Biological Significance of Heterospory:

The phenomenon of heterospory is of great biological significance on account of the following facts:

(i) The development of the female gametophyte starts while the megaspore is still inside the megasporangium.

(ii) Same is true of microspores i.e., they also start germinating into male gametophytes while they are still inside microsporangium.

(iii) The female gametophyte derives its nourishment from the sporophyte i.e., female gametophyte is dependent on sporophyte for its nourishment.

(iv) The dependence of female gametophyte on sporophyte for its nourishment provides better starting point for the development of new embryo than an independent green prothallus which has to manufacture its own food.

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