For B.Sc. Part I (Hons.) Students (Paper- 2 group B (Pteridophyta)

HETEROSPORY AND EVOLUTION OF SEED HABIT

Presented by:
Dr. Ankit Kumar Singh
Assistant Professor
Department of Botany
Marwari College
Lalit Narayan Mithila University
Darbhanga
ankitbhu30@gmail.com

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Heterospory ????

- Most of the pteridophytes produce only one kind of spores i.e., they are **homosporous**. But some pteridophytes produce two kind of spores , differing in size. The smaller spores are called **microspore** and larger ones **megaspores**. They are formed in microsporangia and megasporangia respectively.
- The difference in size of spore is related to their function.
- The microspore on germination gives rise to male gametophyte and megaspore to female gametophyte.
- Thus the difference in size of spore is related to the sex of gametophyte.
- **The phenomenon of production of two types of spores differing in size, structure and function on the same plant is known as heterospory.**
- Heterospory is known in 9 genera of pteridophytes :

Selaginella, *Isoetes*, *Stylites*, *Marsilea*, *Pilularia*, *Regenellidium*, *Azolla*, *Salvinia* and *Platyzoma*.

- Some of these genera also nearly approaches to seed habit.

Origin of Heterospory

- A detailed study of heterosporous forms has revealed that heterospory originated due to reduction in the number of spores with in sporangia.
- When all the spores in a sporangium are functional there is greater competition for nutrition and as such a spores receives a limited food supply and its size remain smaller, i.e. microspores are formed.
- On the other hand if some spore mother cells in a sporangium disintigrate during development, the remaining one gets sufficient nutrition for their development and consequently their size is increased, i.e. megaspore are formed.
- The above interpretation of the origin of heterospory received support from palaeobotanical , developmental and experimental studies.

1. Palaeobotanical evidences of Heterospory

- 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 most of the earliest vascular plants were homosporous and many fossils of the late devonian and early carboniferous period (e.g. *Lepidocarpon*, *Lepidostrobous*, *Mazocarpon*, *Sigillariostrobous*, *Calamocarpon* and *Calamostachys*) were heterosporous.

➢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 certain species of *Lepidocarpon*, *Calamocarpon*, and *Stauropteris*.

➢For example a mature megasporangium of Lepidocarpon, and Calamocarpon had only a single functional megaspore as other spore aborted during development and in Stauropteris a megasporangium had two functional megaspores and two aborted spores.

➢The above examples indicate that

(i) Heterospory has not evolved in living forms but was also present in fossil plants.

(ii) It originated due to disintegration of some species in a sporangium

2. Evidences from Developmental Studies

➢Developmental studies in pteridophytes particularly the events that take place during the formation of sporocytes, meiosis and maturation of spores provides a real insight in the understanding of heterospory.

➢In *Selaginella*, development of micro and megasporangium is similar till the differentiation of sporocytes.

➢Subsequently in the microsporangium all the sporocytes undergoes meiosis, with a result large number of microspores are formed.

➢On the otherhand in the megasporangium all the sporocytes except one abort and the surviving sporocytes undergoes meiosis forming four large functional megaspores.

➢In *Isoetes* the microsporangia and megasporangia are identical till the differentition of sporogenous tissue .

➢In microsporangium almost entire sporogenous tissue forms sporocytes , which after meiosis forms a very large number(1,50,000 – 1,000,000) of microspores .

➢ In the megasporangium, however a part of the sporogenous tissue and so many sporocytes degenerates and they provide nutrition to the growing sporocytes (megaspores). There are only 50-300 megaspores in a megasporangium.

➢ In *Marsilea* , differences in the development of microsporangium and megasporangium do not become evident until after meiosis.

➢ In a microsporangium all the 64 microspores formed after reduction division are functional , but in megasporangium also 64 spores ar formed, only one is functional and rest degenerates .

➢ A similar condition also exists in *Salvinia* and *Azolla*.

➢ Developmental studies have thus shown that determining process of heterospory becomes operative either before (e.g., *Selaginella*, *Isoetes*) or after meiosis (e.g., *Marsilea, Salvinia*, *Azolla*).

3. Evidences from Experimental Studies

- Experimental studies on *Selaginella* and *Marsilea* 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.
- Due to low photosynthetic activity, nutrition became a limiting factor and spores could not grow in size.
- Thus under such condition only microspores were produced. By sudden lowering of the temperature, the size of the microspores in the sporocarp of *Marsilea* increases by six times.

Importance of Heterospory

1. Heterospory expresses sex determining capability of the plant. In homosporous species, differentiation of sex takes place at the gametophyte stages, whereas in heterosporous species the differences in the size of the spores is related to the sex of the gametophyte. The microspores always gives rise to male gametophyte and a megaspore to female gametophyte. Thus in heterosporous forms the sex of the gametophyte can be predicted at the spore stage.

2. The development of the female gametophyte starts while the megaspore is still inside the megasporangium. Same is true of microspores i.e., they also start germinating into male gametophytes while they are still inside microsporangium. Hence the development of gametophyte is not affected by ecological factors as in case of independently growing gametophytes.

3. An important Characteristics of seed habit is that the megaspore is retained by the parent even after fertilization. This ensures nutrition for the developing embryo.

Seed Habit

- In order to evaluate seed habit in vascular cryptogams, let us first recapitulate the situation in seed bearing plants (spermatophytes).
- The spermatophytes produce two types of spores – microspore(pollen grains) and megaspores.
- In angiosperms, there is only one functional megaspore which is not liberated from the megasporangium(ovule).

➢ The male and female gametes fuse to form zygote or oospore, which eventually developes into embryo inside ovule.

➢ The embryo and rest of the gametophytic tissue (Integuments and ovary wall) form the seed

➢ After shedding, the seed germinate and forms a new plant.

Thus the requirements for the seed formation are follows-

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

2. Reduction in the number of functional megaspores finally to one per megasporangium.

3. Retention of the megaspore in the megasporangium until embryo development.

4. Elaborations of the apical part of megasporangium to receive microspore or pollen grains.

5. Availability of sufficient nutrition for the development of embryo.

➢ The evolution of seed habit in heterosporous pteridophytes can be evaluated on the basis of above mention requirements.

➢ *Selaginella* , the most common genus of heterosporous pteridophytes, provides the best example.

❖ From the above observations it is concluded that the life history of *Selaginella* approaches towards seed habit because of the following features:

1. The occurrence of the phenomenon of heterospory.

2. Germination of megaspore inside megasporangium.

3. Retention of megaspore inside megasporangium either till the formation of female gametophyte or even after fertilization.

4. Development of only one megaspore per megasporangium for example, in *Selaginella monospora*, *S. rupestris*, *S. erythropus* etc.

❖ Though *Selaginella* as well as lower Spermatophytes shows homologies in their structure as follows:

Selaginella:.

1. Megasporangium.
2. Megaspore.
3. Female gamestophyte.
4. Archegonium.
5. Egg.

Lower Spermatophytes (Gymnosperms)

1. Nucellus of ovule.
2. Megaspore (Embryosac).
3. Endosperm.
4. Archegonium.
5. Egg

Even then the seeds are not formed in Selaginella because:

1. Megasporangium is not surrounded by integument.
2. The retention of megaspore permanently inside the megasporangium has not been well established.
3. The embryo immediately gives rise to the sporophyte without undergoing a resting period.

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Thank You!!!