Pteridophytes

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Heterospory

Formation of two types of spores , one spore is large and other I small is heterospory. The small spore is called micro spore and the large spore is called megaspore. The microspore is produced in large no inside the microsporangium while megaspore is produced in definite no (4,8,16).Inside mega sporangium the microspore on germination produce male gamete and megaspore on germination produce female gamete.

The phenomenon of heterospory is associated with all seeded plant .In pteridophytes heteropory is found in limited members –the majority of pteridophytes show homospory.

The most important aspect of heterospory is that it is an expression of sex determining process of plant.In homosporous forms sex differentiation take place only at the time of formation of gametophyte while in heterosporous individuals sex differentiation fully expressed during sporognesis.It is decided that former would give rise to male sex and later to the female sex.Thus in heterosporous forms sex is determine during the differentiation of spore.

All seeded plants are heterosporous it is evident thatheterospory has great role in the evolution of seed. Heterospory is usually regarded as prerequisite of seed formation .The greatest biological significance of heterospory is that of microspores which are produce in large nos and give rise to numerous male gametes while megaspore which is in most cases reduced to one becomes larger in size is attributed to a ability of more nutrients to developing embryo.

Origin of Heterospory

It is now believed that hterospory has been originated by the reduction of spore in no of certain sporangia ,followed by an increase in size of remaining spore.The cause of this is thought to be nutritional. Few large megaspore in megasporangium is receiving more nutrients than the many small spore.

From paleobotanical record it is evident that earliest land vascular plant were homosporous but heterosporous condition have been reported in fossil lycopods eg lepidodendrales,extinct calamites as many isolated ferns and progymnosperms (archaeopterys) of upper Devonian and carboniferous period.It is also evident from palaeo botanical record that heterospory has not been a phylogenetic feature because in the genus calamostachy one sps exhibit homospory eg *calamostachy biana*, *while the other sps calamostachy casiana* exhibited heterospory .Similar case was the condition in two fern of genus steuropteris.In the extinct lycopods heterospory have been reported in entire lepidodendrales.However in these case the no megaspore formation has never been consined. Thus from paleobotanical record it may be concluded that heterospory was achieved by different plant groups indifferent geological ages and not phylogenetical criteria. from the experiment evidences shown by Goebel and Shartuck (1910) it is evident that nutritional factors actually concerned manifestation of heterospory.

Seed habit

All the spermatophytes are exihibit seed habit. However seed habit has not been suddenly,it might have passed through different stages before reaching true seed condition. pteridophytists are usually considered as progenitor of seed habit because in these forms heterospory achieved for the first time a numerous genera exhibit various tendencies towards seed formation.

Before discussing how far pteridophytic genera have progress towards seed habit. Let us first discuss the characters and perquisites of seeds.The evolutionary stages leading the development of seed habit from a non seed bearing plant probably involved in the following-

i. The evolution of heterospory to the production of two kinds of spores.
ii. Reduction in no of angiospores to a single functional sporewithin megasporangium.
iii. Development of female or megagametophyte within the megaspore
iv. Permanent retention of female gametophyte within the megasporangia.
v. Elaboration of apex of megasporangium for pollen reception.
vi. formation of integument ie in development of nucellus and micropyle.
vii. Histological union between megaspore and megasporangium.

Keeping in the mind the above characteristics of seed habit let us now discuss how far pteridophytic genera approach towards seed habit.Among the living genera selaginella, isoletes and steletes of class lycopsida,Marsilea,regnilidium,pleurinaria of marsiliales,savinia and azolla of salviniales are heterosporous and exhibit some tendencies towards seed habit.However in non of the cases megasporangium has developed a protective structure called integument,secondary the retention of megaspore permanently within he megasporangium has not been established in all the sps. And lastly histological union between megasporophyll and megasporangium is absent.Among the fossil forms extinct lycopods like lepidocarpon and medasemia exhibited tendencies toward seed habit. In having integument like structure ,reduction in no of megaspore,formation of pollen receptive organ and retention of female gametophyte within megasporangium. However in both the cases the protective structure of megasporangium are not homologous in each integuments.

Conclusion

Thus from the above discussion It may be concluded –

i. Heterospory is originated as a result of nutritional factor.
ii. Heterospory is found among the members found ranging from upper Devonian to recent.

iii. **Heterospory is a perquisite of seed formation along with other features**

iv. **Heterospory originated from homospory and ultimately give rise to seed habit.**

v. **Numerous forms of pteridophytes both extinct and stant exhibt marked tendencies toward seed habit by achieving heterospory along with other features but none of them has reached to seed stage.**

vi. **There I large gap between any non heterosporous form and tissue seeded stage.**

Apospory-and Apogamy

In the normal life cycle of fern the plant body is represented by sporophyte which bears sporangia within the spore mother cells. The later on reduction division produce spore which on germination produce gametophyte or prothallus .Sex organs are produced on the prothallus and gametic union resulted in the formation of a zygote or **embryo and a adult sporophyte is developed from embryo.Thus in a normal cycle there is a reduction division prior to the formation of gametophyte and later give rise to sporophyte through syngamy or fertilization. However more than century ago there was a discovery that a gametophyte give rise to sporophyte without gametic union that sporophyte might give rise to gametophyte ithout production of spore. The first named phenomenon is called apogamy and second aposporyfig**

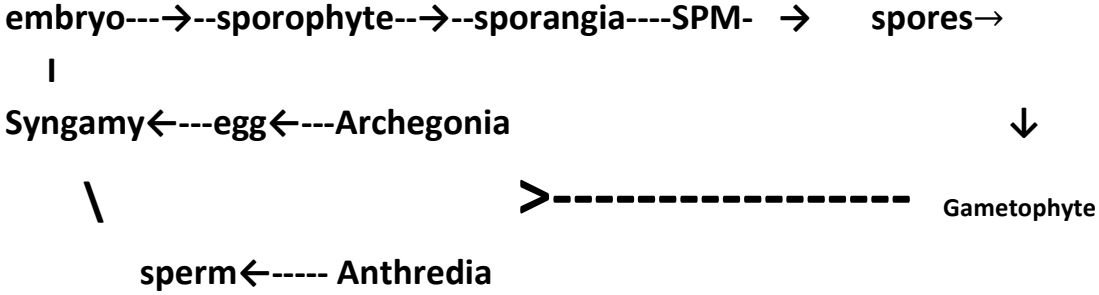

fig life cycle of fern

Apospory-It is the origin of non vascular gametophyte vegetatively from vascular sporophyte without the formation of spore. The phenomenon was described by DURREY(1884) as a natural phenomena in *Athrium phlix-phomena* since then it has been reported in a no of ferns and considered to be one of the pathway on natural of polyploidisation in pteridophytes.

Development-aposporously produced gametpphytes grow directly out of the leaf of the sporophyte.They usually develops along the margin or at the apex of the blade ,but it has also beenfound that they may grow out in sporangia in a sorus.

diagram

Induction-Apospory may be induced in a certain sps that are not normally aposporous. Munrog & Well (1970) followed the structural change during induction of apospory. In pteridium root cells has shown starvation is conductive to apospory. First of all root meristem get disorganized . In the degeneration of cells vacuole losses definition and organells begin to break up the ne viable cells.Some become green and form protuberous. It divide to form filaments on which gametophytes is differentiated .These transformed cells shows more lamellae in their plastids, more mitochondria , endoplasmic reticulum and ribosomes. The origin of apospory consists of three steps-

i. **Disorganisation of root meristem**
ii. **Degeneration of cells**
iii. **Transformation of viable cells**
iv. **differentiation of characteristics of gamtophytes**

apospory may also be induced by cutting a young leaf and maintaining a leaf under favorable for the formation of regenerating out growths. It is the young leaf only which can produce the gametophytes
fig

Cytology-many aposporous produced gametophyte bear anthredia and archegonia that are of normal structure and with functional gamete.In such gametophyte chromosome come to show that chromosome no is

2n and sporophyte resulting from union of their gametophyte 4n chromosomes. In this way a ploypoid series may be developed by apospory. Lawton (1932) obtained tetraploids gametophyte and sporophyte in *Aspidium* .Manton (1932) produced 2n ,3n,4n gametphyte in *Osmunda.*

Apogamy

The development of vascular sporophyte from a non vascular thalloid gametophyte without fertilization is called apogamy.It was first discovered in ferns by FARLOW(1874) .In some ferns apogamous sporophyte is the rule either because of absence or non functional nature one or both sex organs.This is called obligate apogamy.Apogamous sporophyte can also be induced o gametophyte which have functional sex organs and forms sporophyte by syngamy under condition.This is called induced or facultative apogamy.

Development-Earlier workers described the origin of apogamous sporophyte from a thickened part of prothallus.The porophyte arises in direct continuity with gametophyte.Whitter(1970) has described in detail the origin and development of apogamous sporophyte. It consist of following steps-

I. **Formation of meristematic centre in thee thickened part of prothallus . The meristem originate from a single cell or from a grouop of two or three cells.**

II. **The initial cell develop from a meristem are similar to prothallus.**

III. **By activity of meristematic region around of tissue is formed .The tissue undergoes –**

a.differentiation into shoot and apices.the first root in the form of adventitious root and first xylem element is usually appear after the stem and leaf apical cells have been delimited.

Diagrams

Induction-A variety of factor favoring apogamy.It can be induced in following ways

i. **Grow away from the soil surface.**
ii. **By growing the prothallus expose to direct elimination and supplied ith *capillary water.***
iii. **By growing prothallus on medium enriched with glucose and sucrose**

Cytology –In obligate apogamy sexual reproduction is entirely lacking and apogamous sporophyte is produced by mitotic division and not by fertilization.with the result that both generation have same level of ploidy. In many sps both are 2n chromosome no .However normal meiosis occur prior to spore formation.There fore it might be expected that there would be a reduction in chromosome no but to maintain balance chromosome no of two generation , a compensatory mechanism take place during sporogonial development.

If the chromosome no is not doubled ,the chromosome will not pair and this will result abortive spores.The viable spores are those which have same no in sporophyte.In obligate apogamous cycle there is alternation of 2n and 2n generation involving syndiploidy and reduction division .MANTON (1950), describe this phenomena in *Pteris critica.However sporangium contain 8 (eight) spore mother cell following redistribution of nucleus before meiosis.* *Thus in this sps* 32 spore are formed after normal meiosis and each have 2n chromosome. Brathywaty(1964)described the similar process Splinium. Here 16 spore mother cells are present in sporangium. During meiosis no chromosome pairing occur at the first meiotic division and second meiotic resulted in the formation of 32 diplospores which give rise diploid gametophyte ..

Evans (1964) has described another method of spore formation in obligate apogamous sps of polyploidy. Here meiosis is repressed by mitosis 16 spore

mother cell undergo mitosis forming 32 spores having same chromosomelike sporophyte.

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