COURSE: MSc Part -1

PAPER – 4

TOPIC- +Pteridophytes (Different topics)

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CONTENT

Topic-1

Stelar organisation

The term stele has been derived from a Greek word meaning pillar.Jeffrey (1898), for the first time pointed out the stelar theory from the point of view of the phylogeny. In a vascular plant, the stele is the central part of the root or stem containing the tissues derived from the procambium. These include vascular tissue, in some cases ground tissue (pith) and a pericycle, which, if present, defines the outermost boundary of the stele. Outside the stele lies the endodermis, which is the innermost cell layer of the cortex.

stele has following types:

There are two types of steles

1. Protostele -- In protostele phloem surrounds xylem. The type includes Haplostele, Actinostele, Plectostele, and Mixed protostele.

2. Siphonostele--- In siphonostele xylem is surrounded by phloem with pith at the centre. It includes Ectophloic siphonostele, Amphiphloic -siphonostele, Solenostele,

Haplostele- Xylem surrounded by phloem is known as haplostele. Example: *Selaginella.*

Actinostele- Star shaped xylem core is surrounded by phloem is known as actinostele. Example: *Lycopodium serratum*.

Plectostele- Xylem plates alternates with phloem plates. Example: *Lycopodium clavatum*.

Polystele- Xylem groups uniformly scattered in the phloem. Example*: Lycopodium cernuum*.

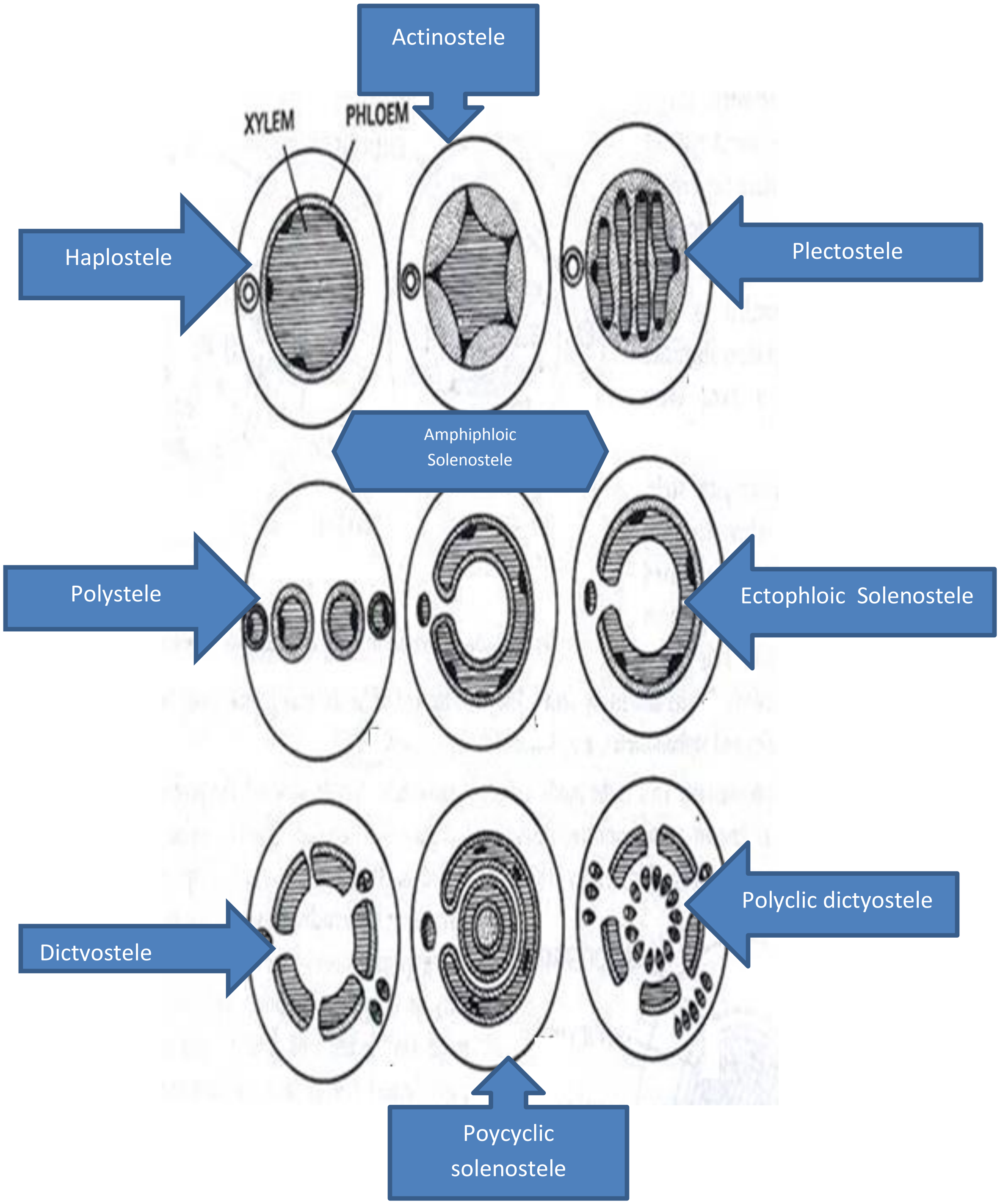
Amphiphloic solenostele-- The phloem is present on both the sides of xylem. The pith is in the centre. Example: *Marsilea.*

Ectophloic solenostele - Pith is in the centre and the xylem is surrounded by phloem Example *Osmunda*.

Dictyostele-- The stele is separated into several vascular strands and each one is called meristele. Example: -*Adiantum*.

Polycyclic solenostele-- In this type of stele if the outer cylinder is solenostelic it is called polycyclic solenostele

Polycyclic dictyostele-- if outer cylinder is dictyostelic it is known as polycyclic dictyostele.



Different Kinds of Stelar organization

Theories regarding origin of Siphonostele from Protostele

(a) Intraxylary or Intrastelar origin:

According to this theory the siphonostele is evolved by the conversion of the central mass of the xylem into parenchymatous pith. This theory is also known as expansion theory and it is supported by Boodle (1901), Bower (1911), Gwynne-Vaughan (1903, 1914). Petry (1914), Thompson and Gewirtz and Fahn (1960) etc.

(b) Extrastelar Origin: This theory is supported by Jaffery (1897, 1899, 1902, 1917). According to him the pith is originated as a result of invasion of the parenchymatous cells of the cortex into the stele. It takes place through the leaf gaps and branch gaps. This theory is also known as invasion theory.

Evolution of Dictyostele from Siphonostele:

Ultimately the siphonostele gives rise to dictyostele. In some of siphonostelic members due to the dwarf axis, the shoot and leaves become over-crowded resulting into the formation of several leaf gaps. The vascular supply given for a leaf from the main stele is called leaf trace.

The parenchymatous region left behind in the main stele after the departure of the leaf trace is called leaf gap. Similarly the vascular supply is also given to branch. Vascular supply given out for a branch from main stele is called branch trace.

The parenchymatous region left out in the main vascular cylinder due to departure of branch traces is called as branch gap forming the dictyostele (Brebner, 1902). This type of stele may further result into polycyclic condition by the formation of several rings.

Topic-2

Heterospory and seed habit

The production of two types of spores which differ in size by some species is known as heterospory. In modern pteridophytes heterospory is found in eight genera(*Selaginella, Marsilea, Salvinia, Isoetes,Stylites, Regnellidium, Pilularia and Azolla)*.The microspores are produced in Microsporangia but megaspores are produced in Megasporangia.

Origin of heterospory:

There are three evidences to prove the origin of heterospory, These are;

1) Palaeobotanical evidences

2) Developmental studies

3) Experimental evidences.

1) Palaeobotanical evidences:

The fossil record of ancient Pteridophytes found in two species of Calamostachys such as *C.binneyana* and *C.casheana*, indicate the initial step that have led to heterospory(Williams and Scott,1894).Whereas, *C.binneyana* is homosporous but some of the sporangia contain spores of unequal size. C.casheana however shows distinct heterospory. The megasporangia contains aborted spores alongwith large spores. This suggests that abortion of some spore leads to differences in size and number..

2) Developmental studies

The developmental pattern of microsporangia and megasporangia is similar and so is the developmental pattern of microspore and megaspore. It appears that disintegration of spore mother cell probably leads to first incipient heterospory and then to heterospory in heterosporous species.Such development(along with disintegration of spore mother cell) however does not occur in homosporous species.

3) Experimental evidences

Goebel conducted experiment on *Selaginella* and showed that plants growing under less sunlight produced only Microsporangia but growing in under illuminated light produce only megaspore.

Shattuck(1910) was successful in altering spore size in *Marsilea* under variable conditions of light,temperature and nutrition.He stated that spore enlargement is proportional to spore abortion. On the basis of Palaeobotanical evidences, developmental studies and experimental results it has been suggested that heterosporous habit arose as a result of

a) Disintregation of certain number of spores and consequent better nutrition of surviving ones.

b) The time of which the sex determinants exert their influence to segregate sexes.

.*Selaginella* exhibits a remarkable approach to seed habit on account of the following features.

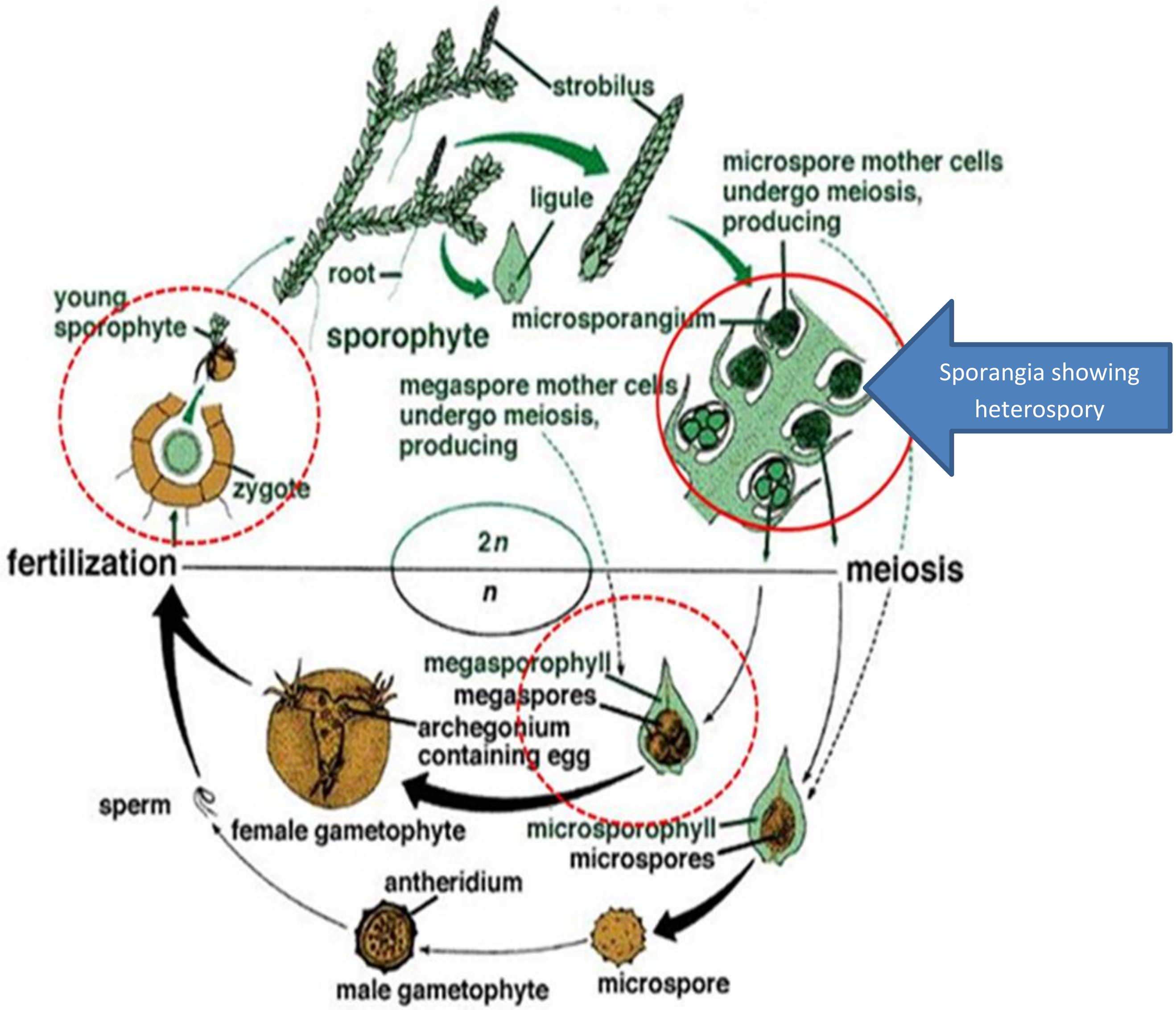
1. It is heterosporous

2. The number of megaspore is reduced to on in *S.rupestris* and *S.monospora*.

3 In *S.rupestris* the megaspore is never shed –a feature similar to a seeded plant.

4. The megaspore germinate inside the megasporangia and produces female gametophyte. Free nuclear division and wall formation during development of female gametophyte is similar to seed plant.

5. Megagametophyte dehisces out of megasporangium wall and hence creates an opening.Microgametophyte enters into the vicinity of the Megagametophyte to bring about incipient pollination. This character appears to be identical to a seeded plant



Diagrammatic representation of life cycle of *Selaginella* showing heterospory

Topic-3

Psilophytales

Classification of the psilophytopsida

In 1920 by the work of the great palaeobatanist the class was named as the psilophytopsida and one of the order that has been placed in is the psilophytales . In this order overall three genera's have been placed, these genera's have been summarised as the.

Rhynia, Hornea, psilophyton.

However, sporne in 1965 divided the class psilophytopsida in to the four families. these are enlisted as.

1) Rhyniaceae

2) Zosterophyllaceae

3) Psilophytaceae

4) Asteroxylaceae

RHYNIA

Systematic Position

Division - Pteridophyta

Class- Psilophytopsida

Order - Psilophytales

Family - Rhyniaceae

Genus - Rhynia

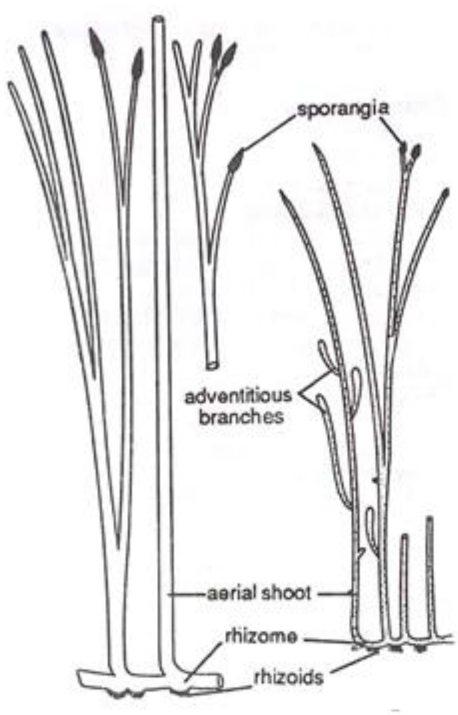
Distribution and habitat: The genus Rhynia, was named after village Rhynie in Aberdeenshire district of northern Scotland, where the first fossils of the plants were discovered. Two species are described from the red sand stone beds of middle Devonian age by Kidston and Lang in 1917. Some 380 million years ago, Rhynia, and other plant grew in this locality in marshy environment. There is evidence that these plants were growing in peaty habitats near volcanoes, where the atmosphere contained sulphurous vapours and the soil was saturated with acid water from hot springs. The two known species of Rhynia are *R.major* and *R. gwynne-vaughanii*.

The petrified remains of these plants are found and on the basis of reconstruction the form and structure of these plants have been described.

STRUCTURE OF RHYNIA

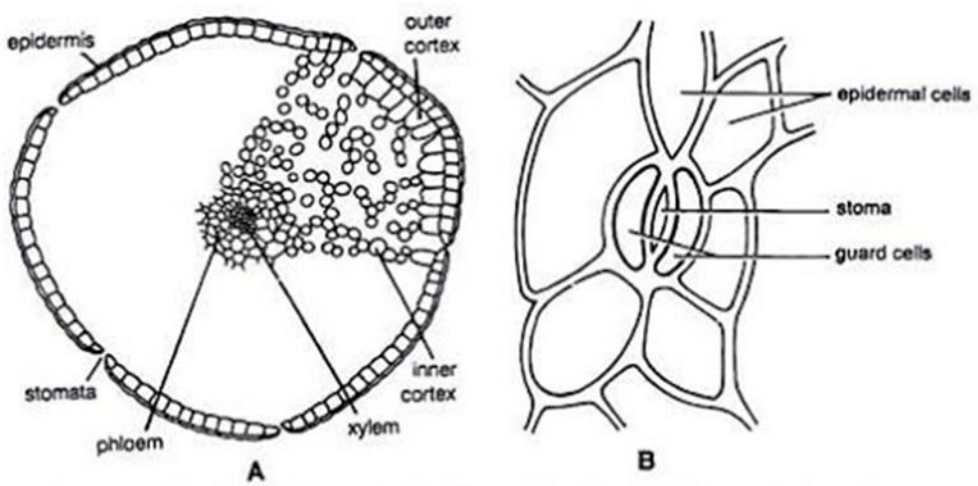
External features

The sporophyte plant body of Rhynia was simple and consisted of a slender, dichotomously branched rhizome, bearing erect, dichotomously branched aerial stems. The aerial branches of *R. major* were about 50 cm in height and 1.5 to 6 mm in diameter, whereas the stems of *R. gwynne-vaughanii* attained a height of 20 cm and were only 1 to 3 mm in diameter. There were no roots but from the rhizome grew numerous rhizoids. These stems were naked and had no leaves. The aerial branches seem to have terminated finally into sporangia. In *R. gwynne-vaughanii*, hemispherical protuberances were present which might have arisen from the lower part of the aerial stems or from the rhizome. The vascular bundles of these adventitious branches were not connected with those of the main stems. It suggests that they were capable of growing into new plants, if detached from the new axis and served as means of vegetative propagation.



Internal features

The internal structure of the rhizome as well as stem was similar. In the centre, a solid central core of vascular tissue was surrounded by cortex. The vascular cylinder was a protostele (haplostele), with a cylindrical mass of xylem, surrounded by a phloem layer .The xylem was composed of annual tracheids which were smaller towards the centre. The phloem was composed of elongated thin walled cells, with oblique end walls. Around the stele was a broad cortex with no intervening pericycle and endodermis. The cortex was differentiated into an inner and an outer region. The inner cortex was composed of spherical cells and had abundant intercellular spaces. It is presumed that the region of inner cortex was green, and as such has been the chief photosynthetic tissue of the plant. The outer cortex was formed of large angular cells without intercellular spaces, except below the stomata. The outermost layer was the epidermis, one cell in thickness and with a thick cuticle on its outer surface. In the epidermis of the aerial branches, stomata, with two guard cells were present

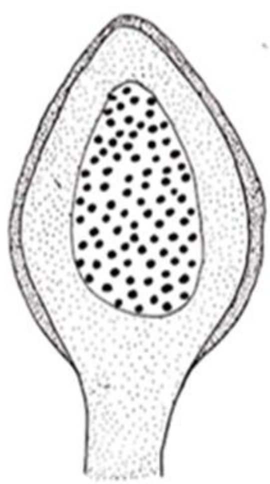


Rhynia. Internal Structure : A. T. S. of aerial shoot, B. a stoma

Reproduction in Rhynia

The sporangia are oval or cylindrical structures with pointed ends at the apices of the dichotomies. They may be slightly constricted at the bases though continuous with the stem and are always wider. Those of R. major were rather big (about 12 mm long and 4 mm in diameter). The sporangium wall is thick and multi- layered with the outer cells thick-walled and no method of dehiscence is observed.The sporangia were cylindrical and borne singly on the tips of some aerial branches. They were large, oval or cylindrical structures with pointed ends. The sporangia had walls several cell layers thick in which the cells of the outermost layer were thick walled and had a heavy cuticle. The middle layer was about three cells in thickness and composed of thin

walled cells. The inner layer of the jacket composed of small rounded cells and probably functioned as tapetum. The sporangial cavity contained numerous spores of same size (homosporous) with cutinized walls. The spores were apparently all alike and were arranged in tetrads. The presence of tetrads in some specimens suggests that they were formed byreduction division and that the plant bearing them represented sporophytic generation. The sporangium was without any specialized mechanism of dehiscence.



The Gametophyte

The spores: The spores were cutinized and were born in tetrads. The spores were 40µto 65µin diameter. Nothing is known about the gametophyte of Rhynia because gametophyte of thisfossil plant has never been discovered. Lyon (1957) reported some germinating spores from Rhynie Chert, which show multicellular structures, developing at the ends of germ tubes, that looked like that of R. major. These may represent the gemetophytic generation. Merker (1959) has suggested that the underground parts of Rhynia might possible be the gametophytes. According to Pant (1962), certain specimens described as R. gwynnevaughanii, may be the gametophytes of R. major. However, no conclusive evidence of archegonia or antheridia is known to identify these fossils as gametophytes.

Other Genera of Rhyniaceae:

Homeophylon (originally named Homea but name changed due to nomenclatural defect) was similar to Rhynia and was discovered from the same place but was smaller and the rhizomes were short and tuberous presenting a jointed appearance . The rhizome is devoid of any vascular supply.The vascular supply enters the rhizome tuber from the stem but fades out after expanding like a bell. There are some mycorrihazal fungi inside the rhizome parenchyma.

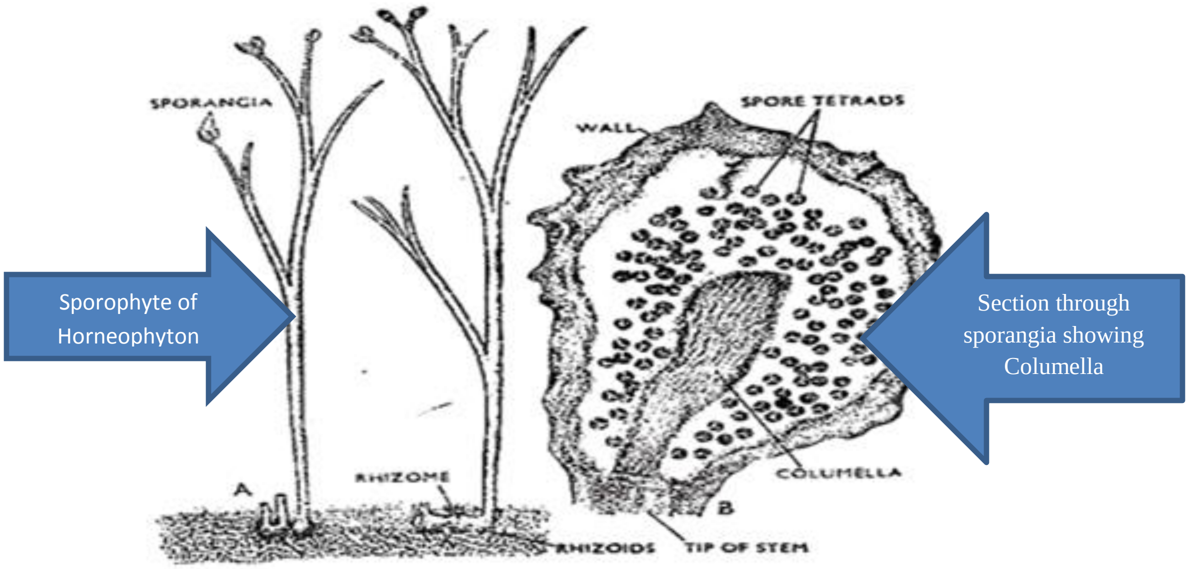
The sporangium is slightly wider than the stem apex and in all respects show that it is simply a modification of its apex. It has a sterile columella which is a projection of the stem phloem below with the spore sac overarching on it as in *Sphagnum or Andreaea*.

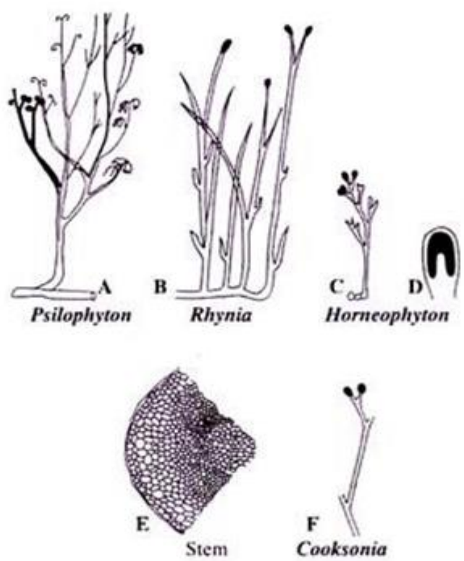
This columella sometimes shows a tendency to bifurcate like the stem. The tapetal cells form an extension of the columella lining the inside of the spore sac. The presence of this columella is of phylogenetic importance.

Horneophyton Lignieri

Horneophyton is among the most abundant fossil organisms found in the Rhynie chert, a Devonian Lagerstätte in Scotland. A single species, Horneophyton lignieri, is known. Its probable female gametophyte is the form taxon Langiophyton mackiei..

Besides Rhynia, Horneophyton and the doubtful genus Sporogonites, a number of other genera assignable to this family have been discovered. Cooksonia from Upper Silurian and Lower Devonian of Wales show slender, naked, dichoto-mously branched stem fragments with apical sporangia similar to Rhynia.





Psilophytales, reconstructions and structure of form genera. A, *Psilophyton princeps*, reconstructed. B, *Rhynia gwynne-vaughnaii*, reconstruceted. C, D, *Horneophyton ligneri* reconstructed. E, *Rhynia* transection of stem. F, *Cooksonia*.

(Figs. after: A, Dawson; B, Delevoryas; C,D kidston & Lang; E, Andrews; F, Lang)

Topic-4

THE TELOME THEORY

The discovery of a group of earliest known land plants with simple organization of the sporophyte (rootless, dichotomously branched, single sporangium terminating a branch tip,protostele vascular cylinder) from the upper Silurian and lower and middle Devonian depositshas been of the greatest important to the understanding of the structure and phylogeny ofvascular plants.

A theory which is based primarily upon the studies of the lower vascular plants, living as well as fossil and at the same time is capable of general application to all vascular plants has beensuggested by Zimmermann, under the title of Telome theory (1930 and later elaborated on1952).

The term telome has been given to the simple ultimate terminal portions of a dichotomously

branched axis. These axes are undifferentiated and single nerved. Zimmermann defines the telome as the single-nerved extreme portion (at base or apex) of the plant body from the tip to the next point of branching. The following two types of telomes have been recognized on the basis of their function:

(a) Vegetative or sterile telomes: These telomes are without sporangia and they are called

phylloids.

(b) Fertile telomes: Those telomes which bore terminal sporangia are called fertile telomes.

Following evolutionary development telomes may be grouped together in various ways to

form more complex bodies or Syntelome. Syntelome composed of either sterile (phylloid

trusses) or of fertile (fertile telome trusses) or mixture of the two (mixed telome).The telome

grow and divides dichotomously, the new segments becomes new telomes and older segment

below are mesomes.

The Origin of Telomes and the Ancestors of Primitive Land Plants

According to the Telome theory the early land plants originated from the green algae which

lived in tidal zone of the Cambrian and Silurian sea coasts. The plant body of those algal

ancestors was undifferentiated branched thallus (primitive telome). According to

Zimmermann these primitive telomes were formed from the unicellular stage by the following five elementary processes:

(i) Interconnection of cells

(ii) Differentiation of meristem

(iii) Rotation of cell axis

(iv) Shifting of chief phases in alternation of generation

(v) Differentiation of different permanent tissues

The dichotomously branched thallus had a central strand of mechanical tissue. These algal ancestors showed alteration of generation.

The Primitive Land Plant

The telome theory visualizes the Psilophytales of the upper Silurian and lower and middle Devonian deposits (*Zosterophyllum, Rhynia, Horneophyton, Psilophyton* etc) as representing the sporophyte of the ancient vascular plants. The sporophyte was relatively undifferentiated (no distinction between leaf and stem) and consisted of single-veined (protostele) telomes which may be sterile and fertile. The aerial portion developed stomata and the basal portion, hairs or rhizoids. The fertile telome produced terminal sporangia.

From the primitive syntelome of the early land plants the sporophytes of higher land plant evolved by certain organogenetic processes called ―elementary processes‖ each following its own trends.Zimmerman suggested that the following elementary processes were responsible for the development of higher vascular plants from the early vascular cryptogams.

1. Overtopping: Of the two usually equal dichotomies from the telome one become stronger and erect becoming the axis which grew further while the other remained overtopped as a short lateral branch . Thus from an equal dichotomy to a sympodial and finally to a monopodial system the contrast in shoots between axis and its lateral members became evident and finally it led to the formation of an axis with lateral appendages, the leaves, e.g. open-veined pinnately compound type of fern leaf and between rachis and leaflet. Overtopping mesomes formed the rachis and the overtopped mesomes constituted the leaflets.

2. Planation: Branching in more than one plane (cruciate dichotomy) is replaced by a dichotomy in a single plane (fan shaped dichotomy). Thus plantation caused telomes and mesomes to arrange them in a plane. By this process an organ of radial symmetry gives rise to one of bilateral symmetry. Plantation concerns mainly the evolution of the leaf.

3. Syngenesis (fusion or webbing): Fusion of the telome of telome trusses by the development of connecting tissue (as in the foot of swan) is called syngenesis or webbing. Telomes and mesomes connect by the formation of parenchymatous tissue between them (parenchymatous webbing) or by parenchymtous webbing accompanied by the fusion of their stele .Syngenesis is a very important elementary process because it explains the origin and evolution of both the leaf and stele of the stem. It leads to the formation of:

(i) Foliar appendages with open dichotomous venation. In this case the sterile telomes (Phylloids) become united only by the development of (parenchymatous webbing)

(ii) Pinnately veined leaf: Parenchymatous webbing was accompanied by over-topping.

(iii) Leaf with reticulate venation: if fusion of steles or vascular bundles also occurred.

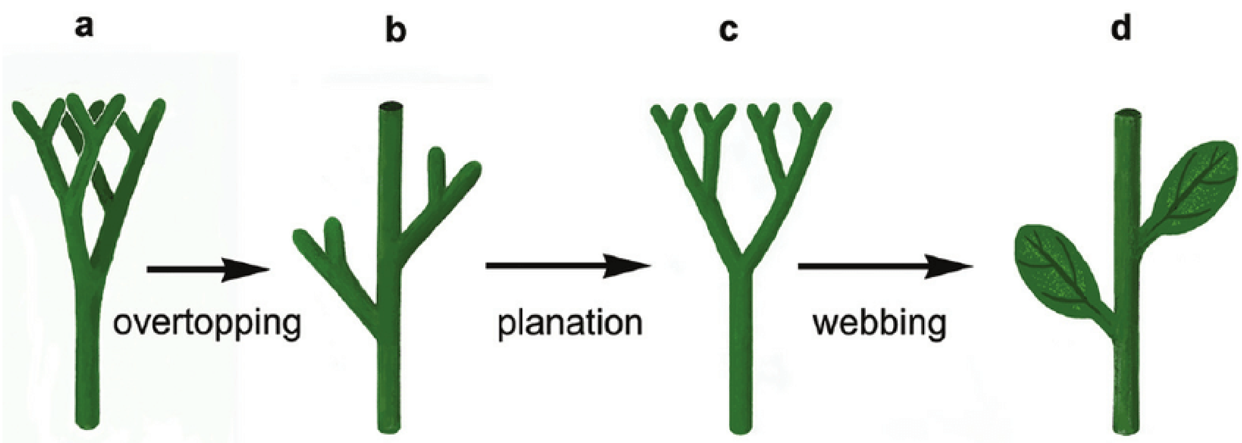
(iv) Parenchymatous webbing led to the polystelic condition (in an open form) as in many species of Selaginella.

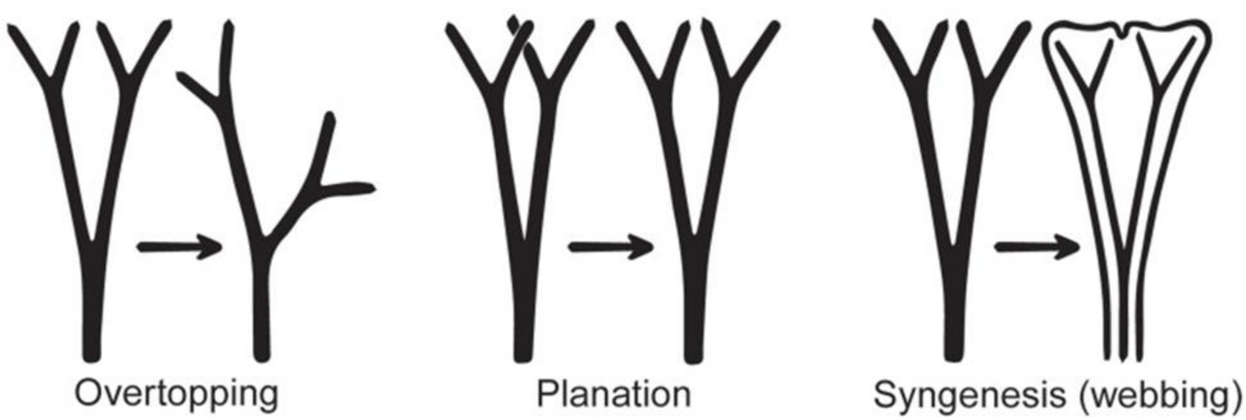
(4) Reduction: It implies a simplification of the telome trusses. It involved transformation of a syntelome into a single needle-like leaf. According to Zimmermann the microphyllous leaves of Lycopods were evolved by the reduction of telome trusses

(5) Curvation- This process resulted in unequal growth of the tissue on two opposite flanks of the organ. Wilson (1953) recognized two separate sub-processes

Recurvation: When telomes bent down inwards, it is called Recurvation. During this process, the fertile telomes (sporangiophores) were reflexed and sporangia became inverted

Incurvation: This process accounts for the shifting of sporangia from terminal position to the ventral surface of the leaf in ferns.





Merits of telome theory

1. It provides an excellent interpretation of origin and evolution ofsporophyte of land plants.

2. The elementary process proposed by Zimmermann provides a basis of interpretation which removes outstanding morphological difficulties in the lower vascular plant such as the nature of the aerial portion of the plant body of the family Ophioglossaceae and coenopterid ferns.

3. This theory emphasise on the fact that the plant body is an axis with a descending portion, the root, and an aerial portion, the shoot whose appendages are modified parts of the stem.

4. According to Eames, though the theory is built upon structure in the lowest known vascular plants, higher plant can also be safety interpreted in this way. It also tries to connect the fossil and living plants by their phylogenetical relations

5. Bierhorst is of the view that the theory is too simple and easily applicable but unfortunately its excessive use has greatly diminished its value.

Demerits of telome theory

1. According to Thomas (1950), the telome theory does not explain the whorled or spiral arrangement of sporangia, which is observed in some ancient and primitive plants.

2. Application of the telome theory to the origin of Lycopsida has been greatly criticised. Andrews (1960) supports this theory to some extent so far as Sphenopsida and Pteropsida are concerned, but for Lycopsida, he may well be quoted that _Zimmermann‘ concept for the Lycopsida is, so far as I am aware, purely hypothetical‘.

3. According to Bower (1946), this theory does not explain how a telome-like characterized body has been developed. It has been taken for granted by Zimmermann (1930) that a telome type body is _ready-made‘; whereas an fundamental problem is to know how such a unit has acquired its characteristic development so as to take place in Hofmeisterian

cycle.

4. This theory does not provide a satisfactory derivation of all leafy structures from branches.

5. Stewart (1964) also criticised the telome theory because it does not explain the derivation of the dictyostelic condition.

TOPIC-5

Sporocarp of Marsilea

Sporocarps: Sporocarp is a bean-shaped to ovoid, nutlike structure, attached to the basal part of the petiolewith the help of a stalk. It is green and soft when young,but turns dark-brown at maturity. Usually one sporocarpis present at the base of each petiole, but in some species, the number varies from 2 – 20. Sometimes, the attachment of sporocarps with the petiole shows so much variation that different species can be distinguished on this particular character ; for example in M.polycarpa many sporocarps are attached on one side of the petiole in a single vertical row. In M. quadrifolia, pedicels (stalks) are united with one another, and then jointly inserted on the petiole. In M. minuta, the stalks of all the sporocarps though free, are attached to the petiole at a single point.

Structure of sporocarp:

The sporocarp is differentiated into a stalk (pedicel) and a body. The stalk is fused laterally to the back of the body of the sporocarp, generally forming a distinct ridge called ‘raphe’. In some

species, the distal (upper) end of the raphe is marked by one or two teeth-like projections, known as tubercles.

Internal structure of the sporocarp:

The internalstructure of the sporocarp can be studied under the following headings:

a)Sporocarp wall:

The wall of the sporocarp is very hard,thick and highly resistant to mechanical injury. It is

differentiated into an outer epidermis, a middle hypodermis, and an inner paranchymatous zone. The epidermis is made up of cuboidal cells, covered with a thick layer of cuticle. A large number of sunken stomata are present in the epidermis. The hypodermis consists of two layers of radially-elongated palisade-like cells, which are compactly arranged without any intercellular spaces between them. The inner paranchymatous cells of this zone form a gelatinous ring inside the sporocarp wall.

Sori: When we cut the horizontal section of sporocarp, a ring appears in the form of a dorsal and a ventral mass.In this plane, both micro- and megasporangia are visible as sori. The sori are the reproductive structures arrangedin the two alternating rows in the cavity of the sporocarp

Each sorus has a receptacle which contains one terminal megasporangium and two microsporangia on the lateral sides. It is surrounded by an indusium. The sori overlap each other and the indusia of adjacent sori are partially fused.

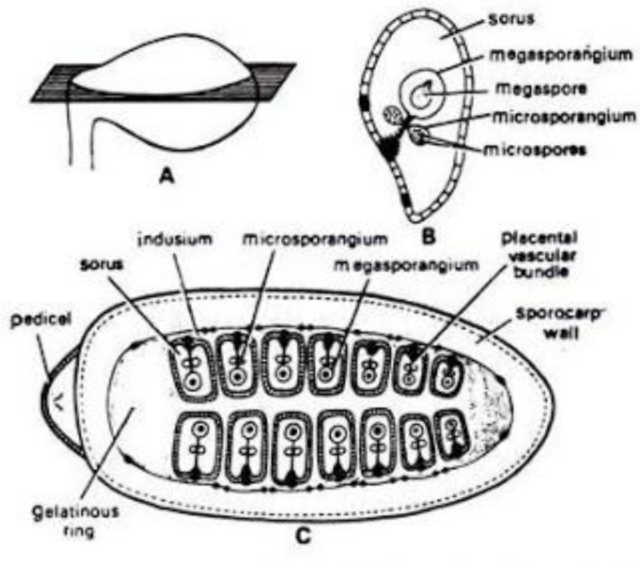
The number of sori in a sporocarp varies from two in M.aegyptica to twenty in M. quadrifolia and M. vestita. There are 11 – 12 sori in M. minuta. Each sorus bears both mega and microsporangia. The former are shortstalked and are arranged in a row at the tip of the receptacle, whereas the latter are long-stalked and arise on the sides. The number of micro- and megasporangia varies with species. In M. minuta, a sorus has 4-8 megasporangia and 8-13 microsporangia.

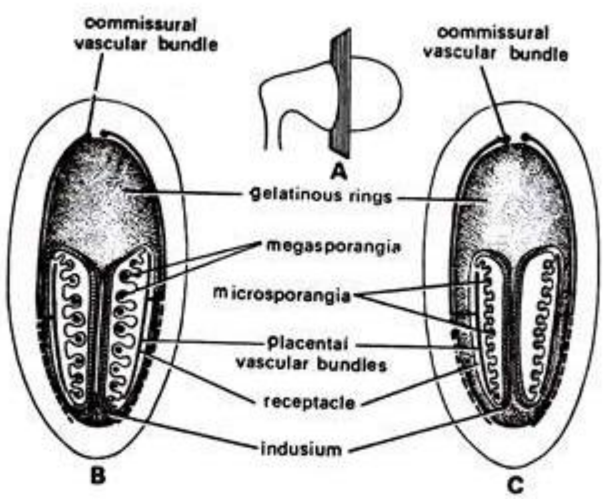
Morphological nature of Sporocarp of Marsilea:

Two theories have been put forward to explain the morphological nature of Marsilea

(a) Laminar concept was proposed by Bower according to which Sporocarp is formed by the fusion of one or more leaflets of pinnae.

(b0 The second concept was proposed by Johnson known as whole leaf concept according to which Sporocarp is a modified leaf.





Section through different regions of Marsilea sporocarp

Topic-6

Morphological Nature of the Sporocarp

Various interpretations have been given by different workers with regard to the morphological nature of the sporocarp. There ae two main hypotheses

1. Leaf-segment or laminar hypothesis and

2. Petiolar hypothesis

The sporocarp of Marsilea has been interpreted as a lateral modified segment of the leaf. According to Bower (1926), Busgen (1890), Campbell (1905), leaf segment or laminar hypothesis the sporocarp has been interpreted homologous with a modified fertile segment from the lower part of a leaf. Petiolar or whole leaf hypotheseis Johnson (1898, 1933) has interpreted the sporocarp to be homologous with an entire leaf. The argument for the latter interpretation by Johnson is that the apical growth of a sporocarp resembles to that of an entire leaf rather than to of a leaflet or leaf segment. The leaf segment or laminar hypothesis is supported by several workers and seems to be more correct.

Leaf segment or laminar hypothesis

The vascular supply to the peduncle of the sporocarp and the vascular supply to the interior of the sporocarp prove that the sporocarp is a modification of leaf segment (pinna) rather than that of an entire leaf. The advocates of the leaf segment theory interpret it in various ways. Bugen (1890) interpreted that the sporocarp has been resulted from the opposition of two leaflets (pinnae), whereas Bower (1926) and Campbell (1905) interpreted that the sporocarp has been resulted from a single pinna by its enfolding. Puri and Garg (1953) interpreted that the sporocarp has been resulted from the enfolding of a pinna with several pinnules each with a marginal sorus. The presence of single dorsal main vein in the sporocarp and the single bundle in the peduncle indicate clearly that the sporocarp has been derived from a single pinna. It has been argued by Bower (1908, 1926) the ancestors of Marsileales were probably ferns with a gradate sorus surrounded by an involucroid indusium and not Schizaeaceae. In Schizaeaceae the sporangia are borne singly and develop simultaneously whereas in Marsileales the sporangia are borne in sori of a gradate type in which the sporangia at the apex of a receptacle develop earlier than those at the base of the receptacle.

This way the relationships of the Marsileales appear to be more with the homosporous leptosporangiate ferns. There is no evidence that the heterospory of Marsileales arose earlier of the evolution of sporocarp. In all other ferns there is homospory and this point indicates that the origin of heterospory is somehow or other connected with evolution of the sporocarp.

Liberation of sori from the sporocarp: The outer wall of the sporocarp is extremely hard and strongly resistant to mechanical injury and drying out. In natural conditions the sporocarp may burst even two or three years later its formation. The spores within the sporocarp may remain viable 20 to 30 years and sometimes upto 50 years. The sporocarp may easily be germinated by injuring it on the ventral median line and keeping it in the water. The water enters to the interior of the sporocarp. Within half an hour the gelatinous ring imbibes water and becomes swollen with the result the sporocarp bursts into two valves from its ventral margin. As more water is imbibed the gelatinous ring protrudes out of the sporocarp. This gelatinous ring bears sori and is known as sorophore. The sori are attached to the gelatinous sorophore by their ends. As the sorophore expands and pushes out, it pulls out the sori, which are attached to it by their ends. Usually the attachment of the gelatinious ring breaks down from the ventral side of the sporocarp and the dorsal part of the side of the sporocarp and the dorsal part of the ·gelatinous ring remains attached by one end to the sporocarp. The gelatinous sorophore bears two alternating rows of soral sacs one on either side of it. A fully elongated sorophore is a long gelatinous cylinder 15 to 20 times longer than the length of the sporocarp. At the tip of the sorophore there are certain small gelatinous projections, also alternate with one another. They are the rudimentary sori which could not develop. The gelatinous ring elongates and straightens and becomes a worm-like structure. At the time of their separation from the gelatinous ring the ventral ends of the sori are turned off and sporangia with spores escape from the ventral ends of the sori. The indusia and the jackets of sporangia become gelatinized and the spores are liberated. The germinating spores and the developing gametophytes remain embedded in the gelatinous matrix up to their maturity.

Topic- 7

Structure and reproduction of Psilotum

1 The plant body of Psilotum is diploid. This is a sporophyte.

2. The spore producing structure is called as Synangium.

3. The spore mother cell of the Synangium undergoes meiotic division to produce haploid spore.

4.. After being shed from the synangium the spore falls on the soil to germinate and give rise to a prothallus . Prothallus is a minute green structure which can lead an independent life. This is because it can carry out its photosynthesis and also have rhizoids which can fix it to the soil.

5. The Prothallus marks the beginning of gametophytic generation. The Prothallus is monoecious ,means antheridia and archegonia are situated on the same thallus.

6.The antheridia produces large number of anthrozoids which is multiflagellate and hence requires water for dispersal.The archegonium produces egg while it is retained in the Prothallus.

7. The fertilization is oogamous. This gives rise to a diploid zygote .

8. The diploid zygote gives rise to a diploid plant.

Phylogeny of Psilotum:

Psilotum exhibits unique assemblage of complex characters which has great phylogenetic significance. This plant shows resemblance to:

Fern in the following respect

1. Axial nature of gametophytes having rhizoids..

2. Superficial position of antheridia on the Pro-thallus.

3. Exoscopic type of embryogeny.

4. Mutiflagellated spermatozoids.

Rhynia in the following respect

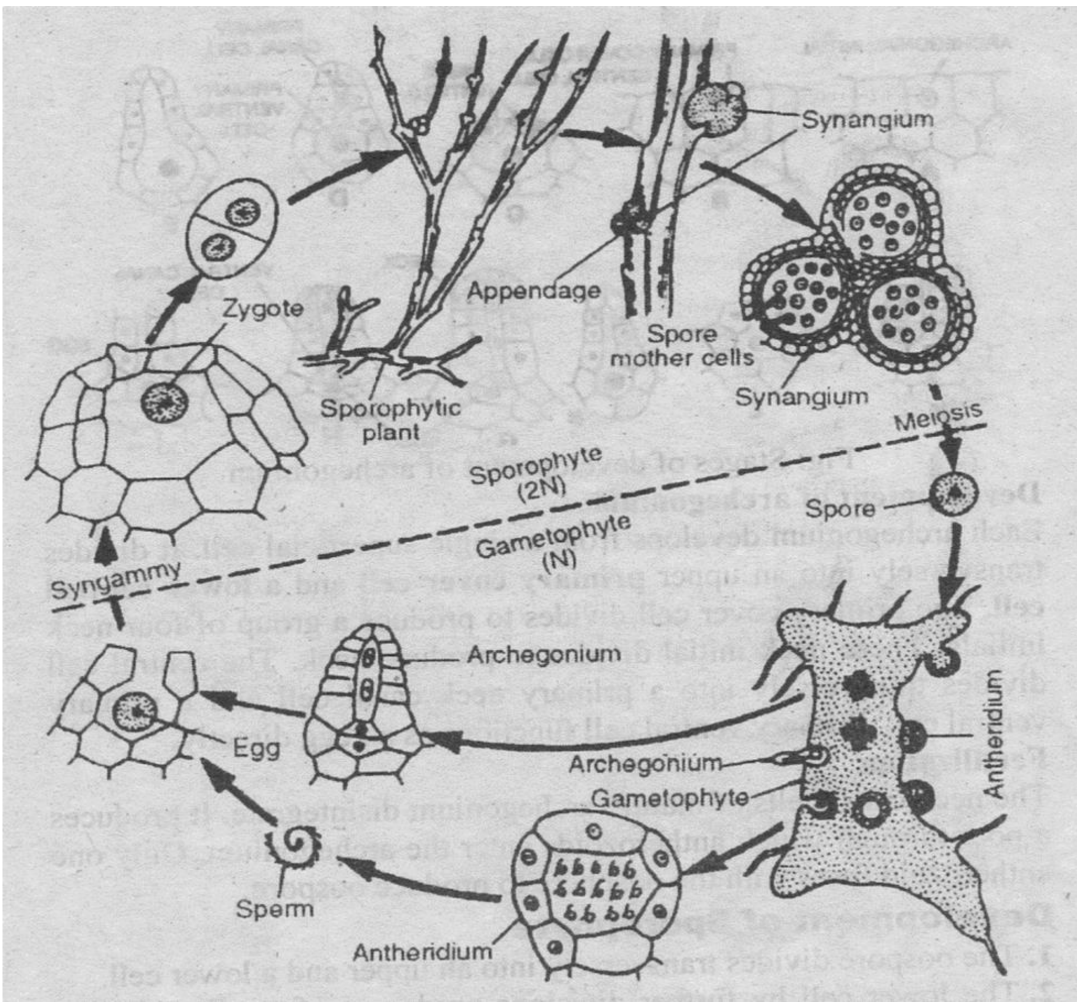
1. The sporophytes are dichotomously bran-ched with subterranean rhizome and upright branches.

2. Absence of roots and sporophytic generation bears rhizoids.

3. The branches are leafless e.g. Psilotum.

4. Sporangia multilayered, in rare instance are terminal.

The above similarities suggest that Psilotales (Psilotum and Tmesipteris) is the most primitive extant group among the vascular plants.



Topic -8

Types of Prothallus of *Lycopodium*

Prothallus in the members of Pteridophytes marks the beginning of gametophytic generation. Lycopodium is homosporous, therefore, spore germinates exosporically to produce gametophytic prothallus, which bears both male and female sex organs (i.e., monoecious and homothalic). The germination of the spores may be immediate in some species (e.g., Lycopodium cernuum, L. inundatum) or after a delay of several years (L. clavatum, L. complanatum).

The spores absorb water before germination. The first division of the spore is asymmetric to produce one small biconvex rhizoidal cell and a large cell. Soon after this division, the exine ruptures along the triradiate ridge. The rhizoidal cell dis-integrates, while the large cell again divides by a vertical wall to form two cells.

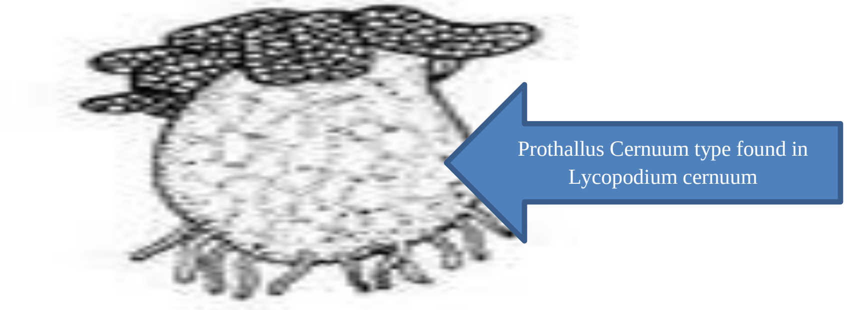
Of these two cells, the one nearer to rhizoidal cell is called basal cell which does not divide further. The other cell, by further divisions, forms apical cell with two cutting faces. The further development of gametophyte does not proceed if there is no infection into the basal cell by the mycorrhizal fungus.

The Prothallus of Lycopodium can be of three different types such as :

1. Cernuum Type

These types of gametophytes are found in most of the tropi-cal species (e.g. L. cernuum, L. innunda- tum). Here spore germinates immediately and the gametophyte completes its growth in one season. The prothalli are small, green and aerial with a lower conical basal region buried in the soil. Rhizoids occur in the colourless subterranean (basal) region.

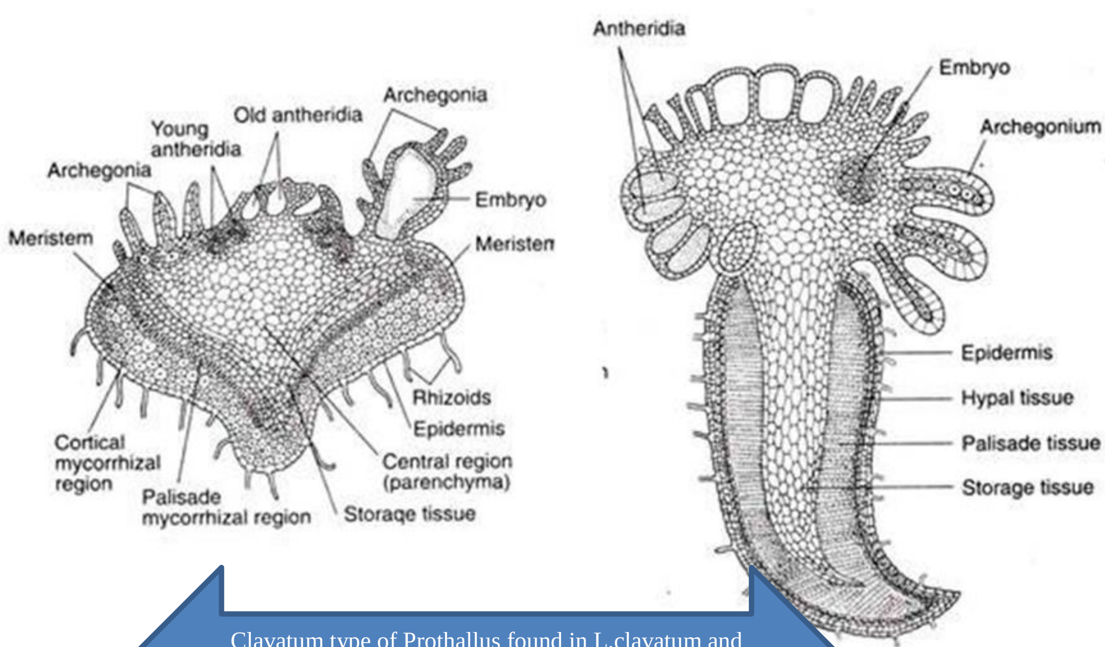
The subterranean region always contains an endophytic fungus. The entire plant body may not be over 3 mm long and are annual in nature. The upper green part is exposed and has a number of irregular leaf-like lobes (photosynthetic) forming a crown. Nutri-tionally, the prothallus is both autotrophic and saprophytic. The sex organs (antheri-dium and archegonium) generally occur near the bases of the aerial lobes.



2. Clavatum Type :

In this type, the spore germination is delayed for a long time (one to many years), thus the prothallus has a longer lifespan. Here the prothalli are fleshy, non-green, totally saprophytic and completely subterranean and perennial in nature. Development takes place beneath the surface of the ground or within a layer of humus.

The prothalli are large and may be up to 2 centimeters in length. They may be top-shaped with a convolute margin (*L. clavatum*) , or carrot- shaped (*L. complanatum and L. annotinum*)



Clavatum type of Prothallus found in L.clavatum and L.companalutum

The top of the prothallus are lobed and the sex organs and the growing embryos are located on these lobes. Although all the gametophytic cells are parenchymatous, the tissue differentiation is noted in the lower portion.

The central region constitutes storage tissue made up of vertically elongated cells. The radially elon-gated, closely packed chlorenchymatous cells constitute the palisade mycorrhizal layer. External to the palisade tissue is the cortical mycorrhizal region. The epidermis is present outside the cortical mycorrhizal region, some of the epidermal cells produce rhizoids..

3. Phlegmaria Type :

Here the pro-thalli are aerial but saprophytic in nature, grow on tree trunks below a coating of humus. This type is found in epiphytic species of Lycopodium (e.g., *L. phlegmaria*). Here the spore germination is immediate and the gametophyte grows for only one season.

The prothallus consists of a short, tuberous cen-tral part from which a number of colourless, slender and cylindrical branches develop in an irregular fashion. These branches bear sex organs and they are usually surrounded by glandular hairs called paraphysis.

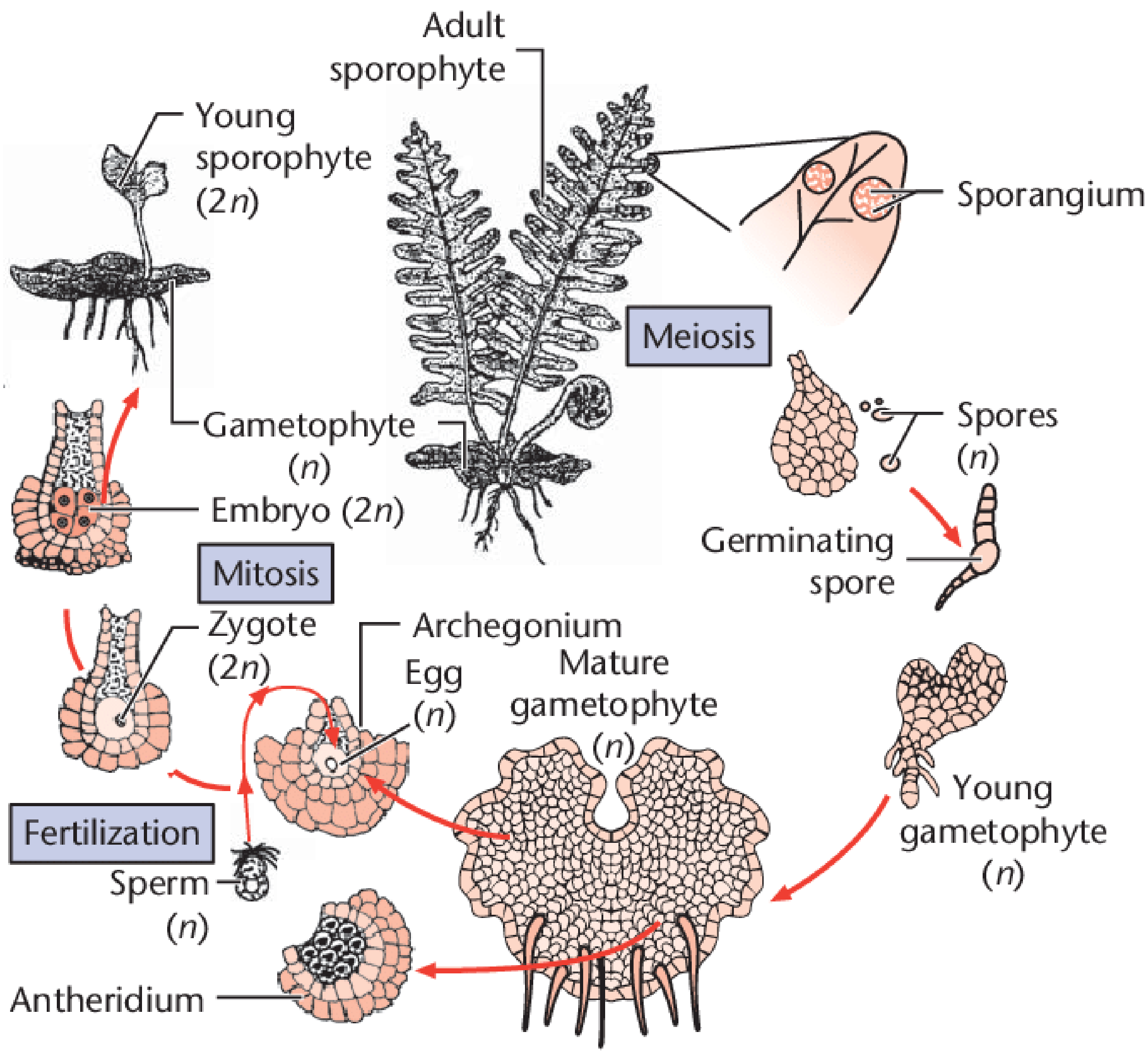
There are also some intermediate types in between these forms. For example, the gameto-phyte of *L.selago* is in-between the Cernuum and Clavatum types. Here spore germination and gametophyte development take place immediately like Cernuum type.

However, the spores germinate after a long resting period if the spores are deeply buried in the soil. As a result a subterranean saprophytic Clavatum type of gametophyte is formed. Hence more than one type of prothalli may occur in the same species.

Prothallus of *Lycopodium selago* showing Phlegmeria type of Prothallus

Topic-9

Life cycle of member of Filicales



SLM provided to the student can be consulted to obtain a detail account