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Guest Lecture in Dept of Botany

Classification of Pteridophyte

According to Gifford and Foster (1989) Pteridophyte is classified in to 7 divisions -

Divisions

1. Rhyniophyta (extinct plants, e.g. *Rhynia*, *Cooksonia*)
2. Zosterophyllophyta (extinct plants, e.g. *Zosterophyllum*)
3. Trimerophytrophyta (extinct plants, e.g. *Psilophyton*, *Trimerophyton*)
4. Psilophyta (Psilotophyta) (two living genera *Psilotum* and *Tmesipteris*)
5. Lycophyta (Microphylllophyta) (extinct forms such as *Protolepidodendron* and *Lepidodendron* and living genera *Selaginella*, *Phylloglossum*, *Isotes* and *Stylites*)
6. Sphenophyta (Arthrophyta) (Mostly extinct plant, e.g. *Calamites*, *Sphenophyllum*, the one living genus is *Equisetum*)
7. Filicophyta (Pteridophyta) (living and extinct ferns)

Characters of Rhyniophyta-

1. Plantbody consists of a rhizomatous stem and aerial leafless axes. Aerial shoots emerging out from rhizomatous stem. Root is absent. Rhizoids functions as root which is originated from lower part of rhizome.
2. Aerial shoot is three dimensional dichotomously branched naked with out any leafs. Instead of leaf some spine like appendages appear on stem. Apical tip of shoot is terminated in to sporangia.
3. Stem is protostelic
4. Sporangia are globose or reniform developed at the tip of dichotomizing shoots. Sporangia produced trilet isospores.
5. It may be Homosporous.
6. Eusporangiate type of sporangial development is found.
7. Exoscopic development of embryo is takes place

Example- *Rhynia major*(*Aglaphyton major* recent name), *Cooksonia*(fossil)

Characters of Zosterophyllophyta-

1. The stems of zosterophylls were either smooth or covered with small spines known as enations.
2. branched dichotomously, and grew at the ends by unrolling, a process known as circinate vernation.

3. The stems had a central vascular column in which the protoxylem was exarch, and the metaxylem developed centripetally.
4. The sporangia were kidney-shaped (reniform), with conspicuous lateral dehiscence and were borne laterally in a fertile zone towards the tips of the branches.

Examples- *Zosterophyllum*, *Sawdonia*

Characters of trimerophytophyta-

1. The largest fragment of the main stem is long, wide and consists of numerous spirally arranged trifurcate lateral branches
2. The primary and secondary branching patterns of the laterals are trichomatous.
3. The trichomatous secondary branches are unequal in size, of which the two upper ascending branches are smaller.
4. The smaller branches dichotomize twice and the third and largest branch dichotomize three times.
5. All the ultimate branches are terminated by clusters of fusiform sporangia.
6. All the axes are smooth.
7. Homosporous containing trilete, smooth wall isospores

Examples- *Trimerophyton*

Character of Psilophyta-

1. Plantbody is a rootless sporophyte that differentiated into a subterranean rhizome and an aerial erect shoot.
2. Branching is dichotomous in both subterranean rhizome and aerial shoot.
3. On the aerial shoots, spirally arranged scale-like (*Psilotum*) or leaf like appendages (*Tmesipteris*) are borne.
4. Stele is protostelic or siphonostelic with sclerenchymatous pith.
5. Bi- or trilocular sporangia are borne in the axils of leaf like appendages.
6. Mode of sporangial development is eusporangiate type.
7. Spores are of equal sizes and shapes i.e., homosporous.

Examples-*Psilotum* sp

Characters of Lycophyta:-

1. The sporophyte plant body is differentiated into definite root, stem and leaves
2. Sporophytes are dichotomously branched
3. The leaves are usually small and microphyllous
4. The xylem in the stem is exarch

5. Sporangia are borne singly on the adaxial(upper) surface of the sporophylls
6. The spores may be of either one type i.e., homosporous (*Lycopodium*) or two types i.e., heterosporous (*Selaginella*)

Example:- *Lycopodium*, *Selaginella*

Characters of Spenophyta:-

1. The stems and branches are jointed with nodes and internodes. The internodes are with longitudinal oriented ridges and furrows.
2. The leaves are extremely reduced and borne in whorls at the node of aerial branches and stems.
3. Branches arise in whorls.
4. The sporangia develop on a peltate appendage called sporangiophore. Sporangial walls are thick.
5. Most of the members are homosporous including *Equisetum*. However some extinct forms were heterosporous (*Calamites*).
6. The gametophytes are exosporic and green.
7. Antherozoids are multiflagellated.
8. Development of embryo is exoscopic type.

Examples- *Equisetum*, *Calamites*(fossil member)

Characters of Filicophyta:-

1. Sporophytes are usually perennial in nature and differentiated into roots, stem and spirally arranged leaves.
2. Mostly, the rhizomes are short and stout.
3. The leaves are large (megaphylls), pinnately compound and described as frond, except *Ophioglossum* (simple leaf).
4. The rachis is covered with brown hairs (ramenta). Leaf trace is usually C shaped with adaxial curvature.
5. Young fronds show circinate vernation(coiling of leaves), except *Ophioglossum*
6. Stele in Filicophyta is mainly solenostele and dictyostele. Protostele and siphonostele are present in many members.
7. Most ferns are homosporous, but a few aquatic members are heterosporous.
8. Sporangia are borne at the tips or at the margin of the pinnule or to the abaxial surface of the fronds.
9. Sporangial development is eusporangiate or leptosporangiate type.

Examples- *Pteris*, *Dryopteris*, *Adiantum*, *Pteridium* e,t,c.

Life History

Psilotum

Psilotum is known as Whisk fern.

Synangia-

Synangia is a spore producing structure in *Psilotum* sp.

When three sporangia are fused together to form a trilocular compact structure is known as synangia..

Structure- At maturity, many of the dichotomously branched aerial shoots become fertile and produce trilocular sporangia known as synangia. The mature sporangia is generally a three lobed structure and each lobe of the synangium corresponds to a sporangium. The synangia located at the tip of very short axis and closely associated with a forked, foliar appendages. At maturity synangium exhibits loculicidal dehiscence. Each sporangium produces equal size bilaterally symmetrical, kidney shaped monoaperturate spore. \

Fern character of *Psilotum*-

Bierhorst (1971) Placed *Psilotum* along with *Tmesipteris* with in Filicopsida primarily on the basis of similarities with some ferns like *Gleichenia* by the following characteristics:

1. Axial nature of gametophytes.
2. Superficial position of antheridia on the prothallus.
3. Exoscopic type of embryogeny.
4. Multiflagellated spermatozoids/
5. Development of sporangial structure.

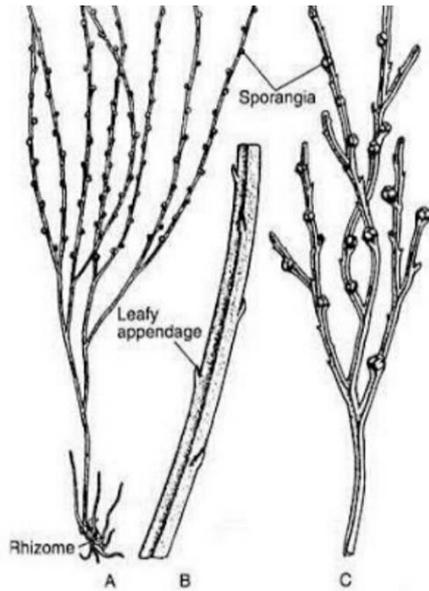
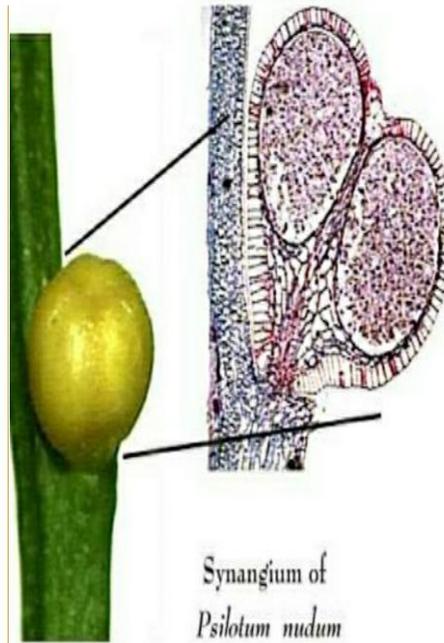


Fig. 7.11 : *Psilotum nudum* : A. A sporophyte plant, B. An enlarged part of stem showing scaly appendage, C. A fertile twig



Synangium of *Psilotum nudum*

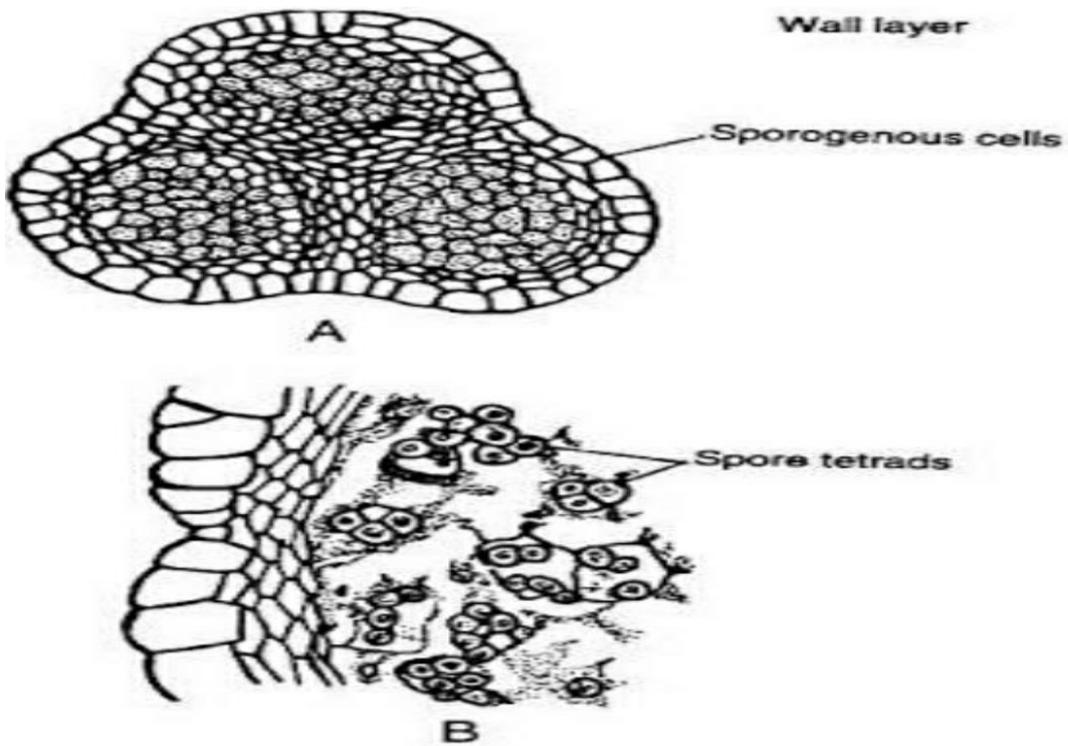


Fig. 23. *Psilotum*
A. T.S. of Young Synangium, B. Sectional View (a portion) of Synangium with Spore Tetrads

Selaginella

Rhizophores-

In many species of *Selaginella* peculiar leafless, proplike cylindrical, structures originate from the stem at the point of branching. These grow downwards in to the surface and form many adventitious roots at their free ends. They are known as rhizophores.

Morphological nature of rhizophore-

The morphological nature of rhizophore is controversial because of its unusual position and structure. It has been interpreted by various plant scientists as root, stem or an organ sui generis.

Root character of rhizophore-

1. Rhizophores are positively geotropic in nature.
2. It does not bear leaves
3. Presence of root cap in some species (*Selaginella densa*)

Stem character-

1. Exogenous in origin like stem.
2. Absence of root cap root hairs.
3. Production of roots endogenously from the tip.

Trabeculae-

In stem anatomy of *Selaginella* there is a air space between cortex and pericycle. Some endodermal

cells bridges the air compartment and connected cortex with pericycle known as trabeculae.

Ligule-

In *Selaginella* small, membranous, tongue-like structure originates from the axils of leaf or sporophyll known as ligule.

Structure of strobilus-

Selaginella is a heterosporous pteridophyte. In all species of *Selaginella* strobili or cone is developed terminally on side branches. In most species strobilus consists of a cylindrical axis bearing micro and megasporophyll at 90 degree angle. Microsporangia and megasporangia are

developed from the base of micro and megasporophyll respectively. In most of the species Microsporangia are developed at the top and megasporangia at the base of the strobilus. Microsporangia produced huge amount of tetrahedral microspores. Megaspores in megasporangia are reduced it varies from 3-4.

Justification of Selaginella approaching seed habit-

Selaginella exhibits a significant approach towards seed habit because of the following notable features:

1. It is a heterosporous pteridophyte.
2. In some species number of megaspore is reduced to one.
3. In some species megaspore is retained with in the megasporangium and the development of female gametophyte and subsequent fertilization takes place in situ.

It becomes evident that the heterosporous vascular cryptogam, Selaginella has considerably advanced towards seed habit in some species but its approach to thr true seed is not complete due to the following reasons:

1. The megasporangium wall is dehiscent and is not covered with the protective integuments.
2. The retention of the megaspore permanently with in the megasporangium has not become established.
3. The absence of complete histological fusion between the megasporangium wall and the megaspore.

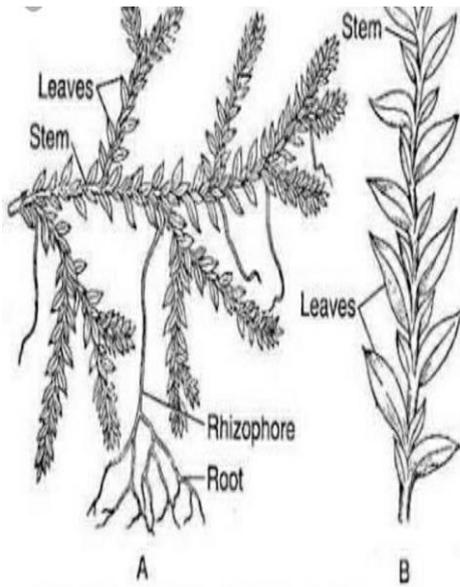


Fig. 7.46 : *Selaginella kraussiana* : A portion of sporophyte, B. An enlarged part of the stem showing leaf arrangement

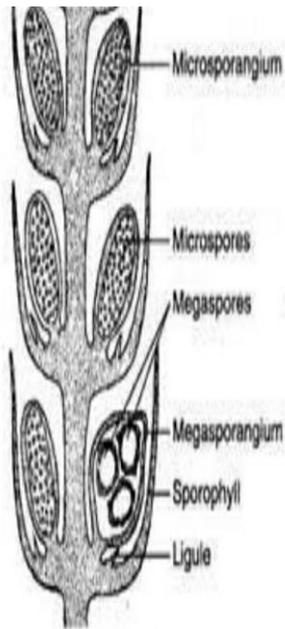
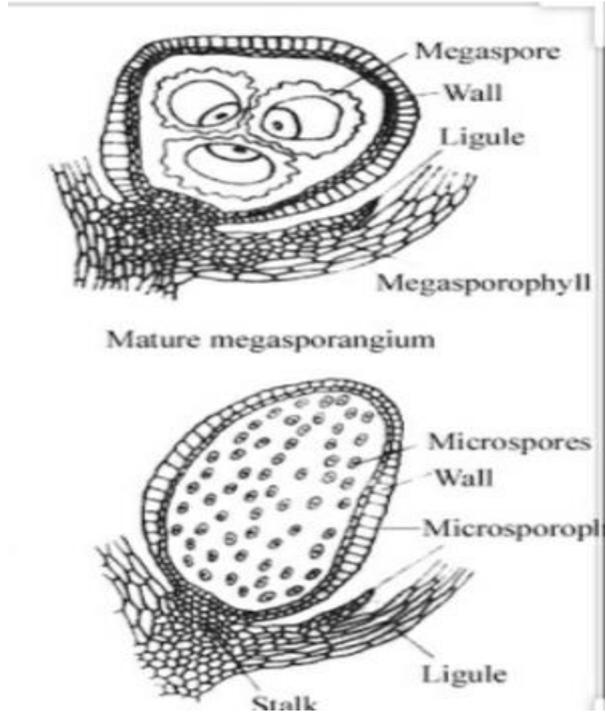
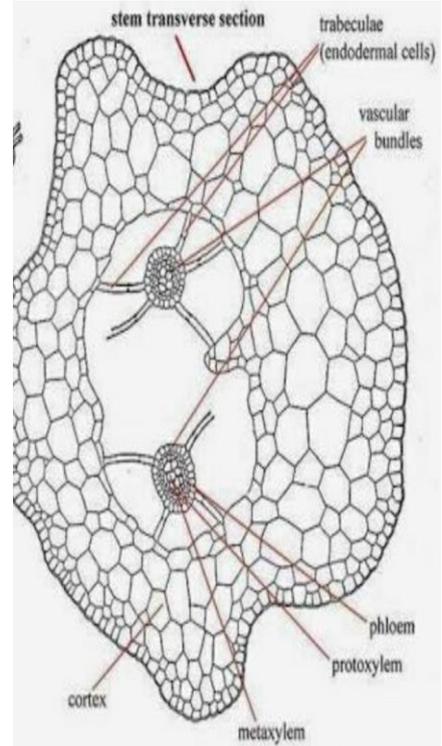


Fig. 7.51 : *Selaginella kraussiana* : L.S. of strobilus



Equisetum

Character-

1. Plantbody consists of a underground rhizome and a aerial shoot. Roots develop from nodes of rhizome. Aerial branches are developed from the nodes of main shoot which is present in whorls.
2. Presence of nodes and internodes in both stem and rhizome. Scaly leaves developed from the nodes of main shoot present in whorls.
3. Fertile shoot is terminated with strobilus or **sporangiiferous spike**. At the base of strobilus a ring like outgrowth is present known as **annulus**.
4. Presence of **carinal canal** and **vallecular canal** in cross section of stem which are a hydrophytic features
5. Presence of **peltate sporangiophores** which has a short stalk and two arms outside bearing two sporangia on abaxial surface.
6. Presence of **elaters** in the sporangium which helps in spore dispersal

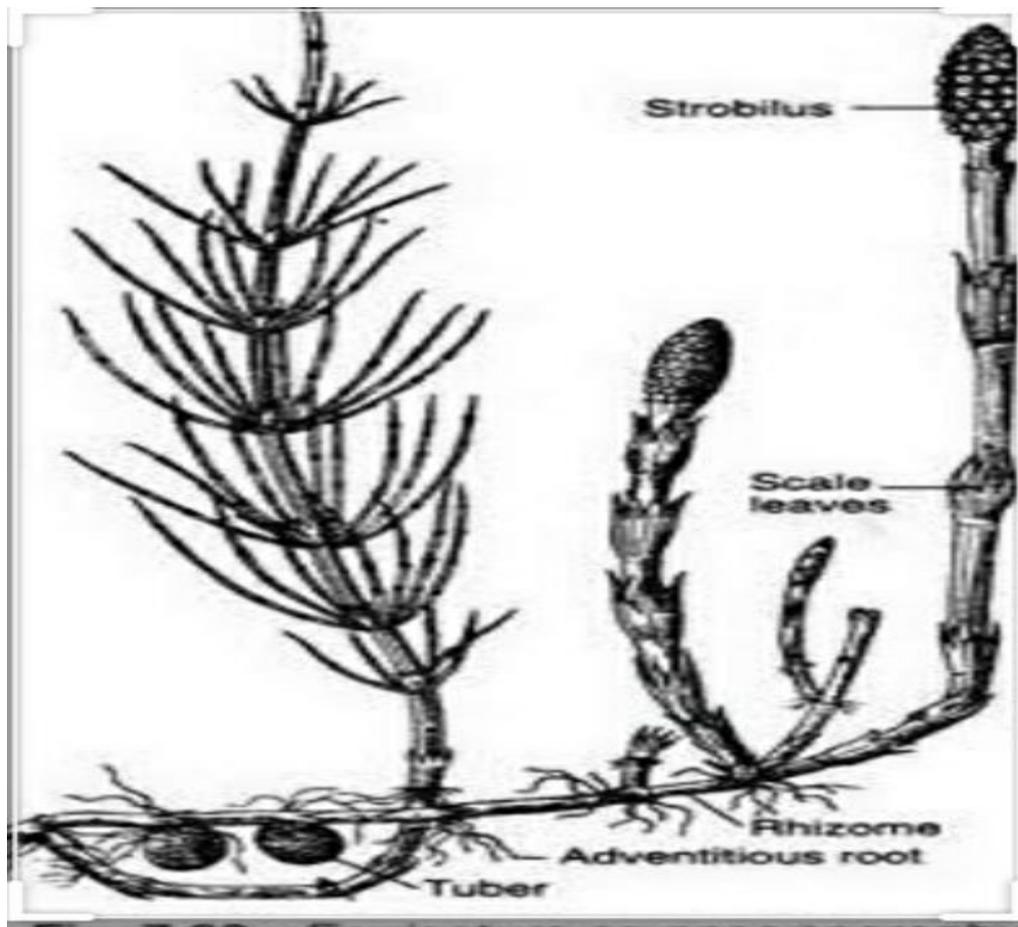


Fig- Sporophytic Plantbody of *Equisetum*

Internal features of stem-

In T.S of stem of *Equisetum* appears wavy in outline with ridges and furrows. It shows the following features internally-

1. The epidermal cell walls are thick, cuticularized and have a deposition of siliceous material.
2. Stomata are distributed only in the furrows between the ridges.
3. Presence of sclerenchymatous hypodermis .Outer cortex is chlorenchymatous and inner cortex is parenchymatous. Presence of vallecular canal in the inner cortex.
4. Presence of ectophloic siphon stele which is surrounded by pericycle and ednodermis.
5. Vascular bundles are conjoint, collateral and closed.
6. Presence of **carinal canals** in vascular bundles which are formed by the disintegration of protoxylem elements.

Xerophytic features of *Equisetum*-

1. Ridges and furrows in the stem.
2. Deposition of silica in the epidermal cells.
3. Presence of sunken stomata.
4. Presence of Sclerenchymatous hypodermis.
5. Reduced and scaly leaves.
6. Photosynthetic tissue in the stem.

Hydrophytic features of *Equisetum*-

1. Well developed aerating system like- carinal canal, vallecular canal and central pith cavity.
2. Reduced vascular elements.

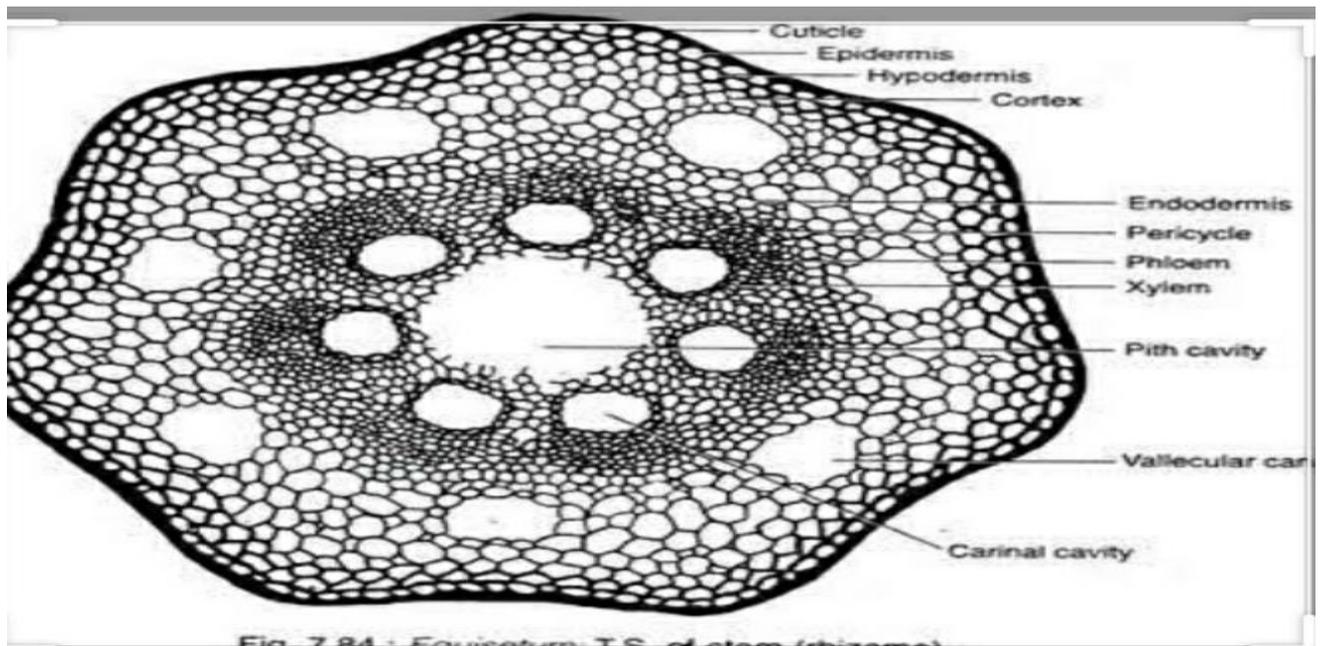


Fig- T.S of *Equisetum* stem

Structure of strobilus-

Strobilus in *Equisetum* are terminal in position and are generally borne terminally on the chlorophyllous vegetative shoot. A ring like outgrowth called annulus is present below the strobilus in the stem. Strobilus is composed of an axis with whorls of sporangiophores. Each sporangiophore is a stalked structure bearing a hexagonal peltate disc at its distal end. On the under surface of the sporangiophore disc elongated, cylindrical hanging sporangia are borne near the periphery in a ring. Spores are spherical and filled with densely packed chloroplasts. The spore wall is laminated and shows four concentric layers: exine, intine, middle cuticular layer and the most outermost perispore.

Incipient heterospory-

On spore germination of *Equisetum* 50% spore give rise to male gametophyte and 50% spore give rise to female gametophyte. This is a main feature of heterospory and seed habit. According to Schratz (1928) it is termed as incipient heterospory.

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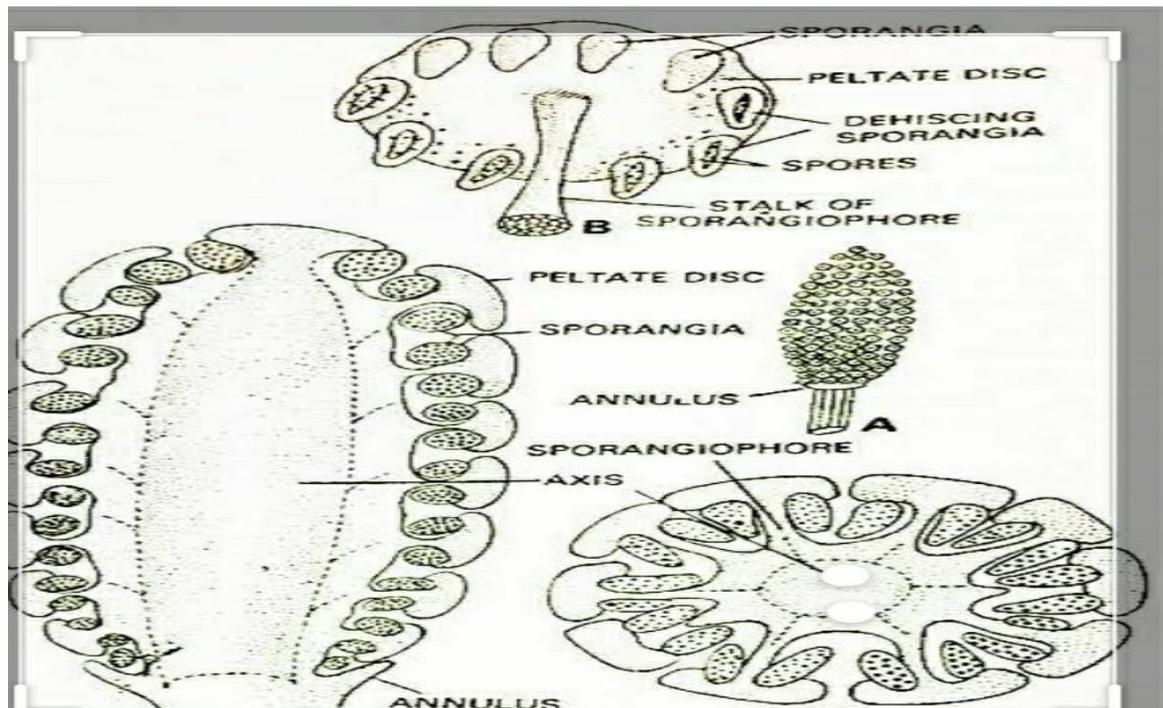


Fig – Structure o strobilus in *Equisetum*

Pteris

|Character-

1. Plantbody consists of rhizome and leaves. Rhizome are short and stout. Leaves are large(megaphylls) pinnately compound described as frond.
2. Rachis is covered with brown hairs known as ramenta.
3. Stem is mainly dictyostelic or solenostelic.
4. Young leaf shows circinate vernation.
5. Presence of coeno sori at the leaf margin except tip of the leaf.
6. Presence of annulus and stromium in the sporangium

Coenosorus-

Sorus in *Pteris* is called coenosorus. Coenosori are marginal , borne continuously on a vascular commissure connected with vein ends. Thus the sporangia of *Pteris* form a continuous linear sorus along the margin, hence the individuality of sori is lost. The coenosori are protected by the reflexed margin (**false indusium**) of the pinnae.

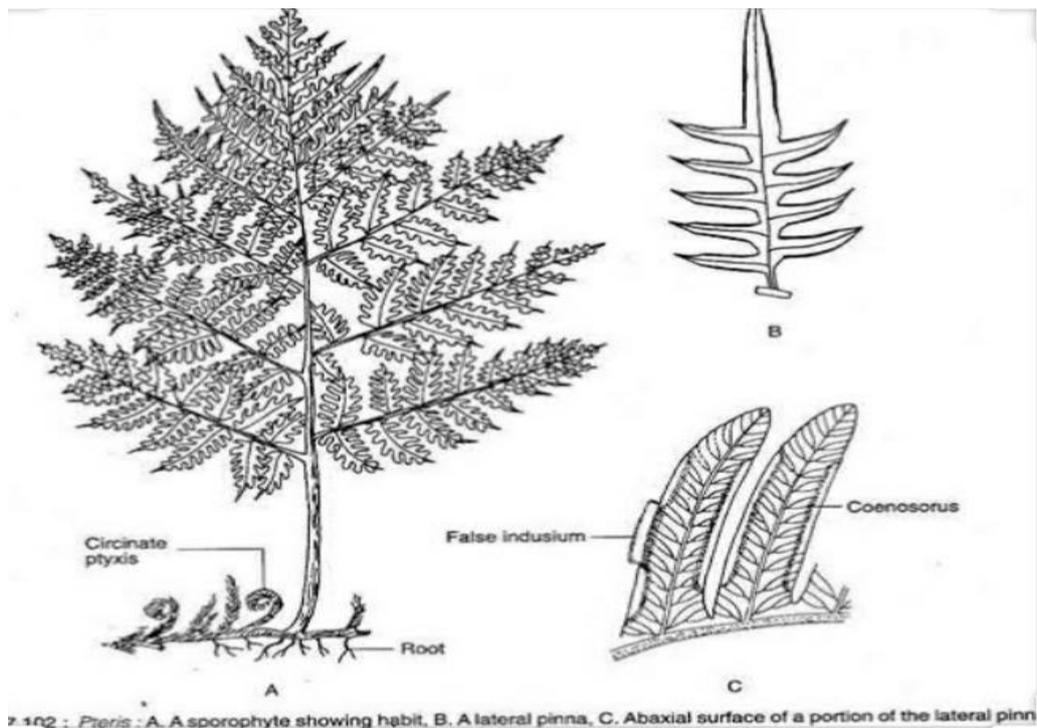


Fig- Sporophytic plantbody and coenosorus of *Pteris*

Structure of sporangium-

A mature sporangium has a long stalk that terminates in a capsule. The jacket of the capsule is single layered, but with three different types of cells: (1) a thick walled vertical annulus incompletely overarches the sporangium, (2) a thin walled radially arranged stomium, and (3) Large parenchymatous cells with undulated walls. Capsule contain many spores. Spores are triangular in shape with trilet aperture, bounded by two walls. The outer wall exine is variously ornamented.

