Classification of Vascular plants

Dr. Sushovan Bera

Associate Professor

Department of Botany

Jogamaya Devi College

Classification of Pteridophyta

By Gifford and Foster (1989)

Gifford, E.M. and Foster, A. S. (1989):

- Classified Vascular plants into **15 Divisions**
- Each of the Division formerly represented a Class or even an Order
- Division **1 to 7** represent the **Pteridophytic taxa**
- Division **8 to 14** represent **Gymnospermic taxa**
- Division **15** represents the **Angiospermic plants**
- Plants of each Division have characters which are recognizable and can be used to differentiate them from others
- Characteristics provides bases for making comparisons and also for establishment of tentative phylogenetic relationships

VASCULAR PLANTS

Pteridophytic Taxa

Div. 1. **Rhyniophyta**
(Extinct: *Rhynia, Cooksonia*)

Div. 2. **Zosterophyllophyta**
(Extinct: *Zosterophyllum*)

Div. 3. **Trimerophytophyta**
(Extinct: *Psilophyton, Trimerophyton*)

Div. 4. **Psilophyta**
(Living: *Psilotum* & *Tmesipteris*)

Div. 5. **Lycophyta**
(Living: *Selaginella* & Extinct: *Lepidodendron*)

Div. 6. **Sphenophyta**
(Living: *Equisetum* & Extinct: *Calamites*)

Div. 7. **Filicophyta**
(Living & Extinct Ferns)

Gymnospermic Taxa

Div. 8. Progymnospermophyta
(Extinct: *Archaeopteris*)

Div. 9. Pteridospermophyta
(Extinct seed ferns: *Lyginopteris, Medullosa*)

Div. 10. Cycadophyta
(Extinct & Living cycads: *Zamia, Cycas*)

Div. 11. Cycadeoidophyta
(Extinct: *Cycadeoidea*)

Div. 12. Ginkgophyta
(Living: *Ginkgo biloba*)

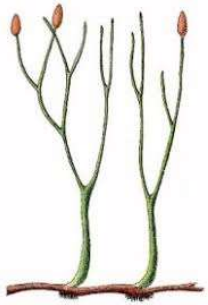
Div. 13. Coniferophyta
(Extinct & Living conifers like pine, fir)

Div. 14. Gnetophyta
(Living *Ephedra, Gnetum* and *Welwitschia*)

Div. 15. MAGNOLIOPHYTA
(Angiosperms / Flowering plants)

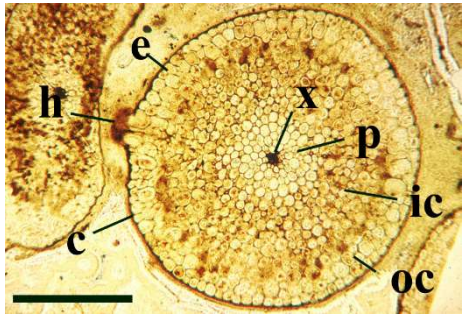
Div. 1. Rhyniophyta

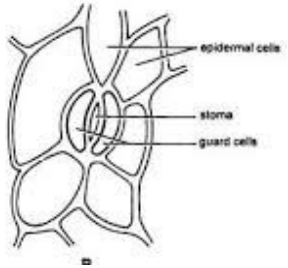
- Extinct plants with rootless sporophytic plant body
- Plant body differentiated into a prostrate rhizome and an erect aerial part
- Erect part with more or less dichotomous branching
- Tufts of rhizoids on rhizome part
- Stem with cylindrical protostele
- Sporangia terminal and devoid of sporophylls
- Homosporous, spores in tetrads

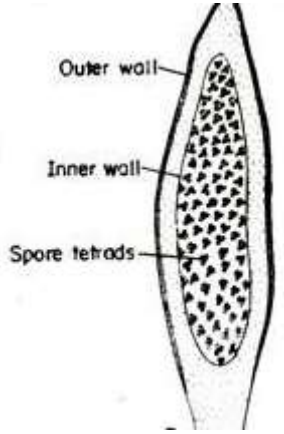


Rhynia

Cooksonia

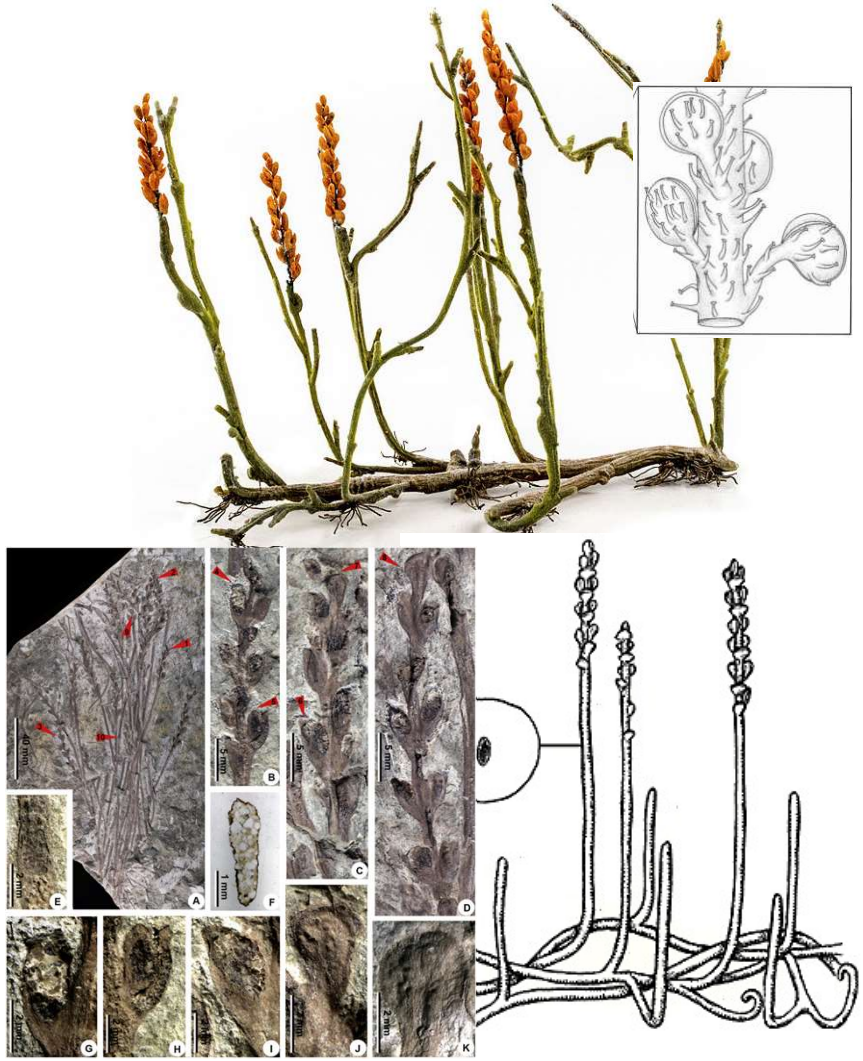






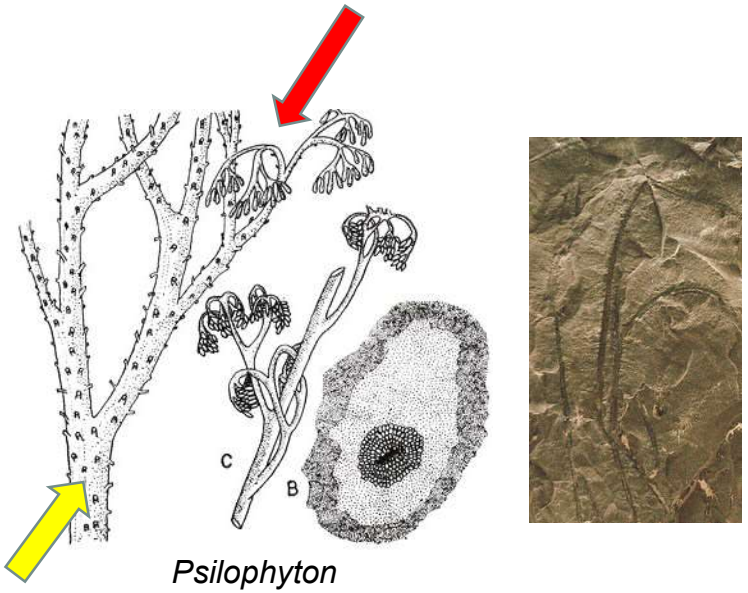
Div. 2. Zosterophyllophyta

- Plant body consisted of **dichotomously branched vegetative system** bearing many fertile branches and a **downward directed rhizome** system
- Stem either smooth or with multicellular spines (enations)
- Xylem strand ellipsoidal to terete, xylem exarch
- Fertile branches terminated into sporangia, bearing spike like structures
- Dehiscence of sporangia by slit along distal edges

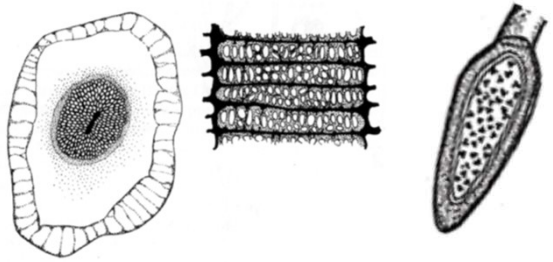


Div. 3. Trimerophytophyta

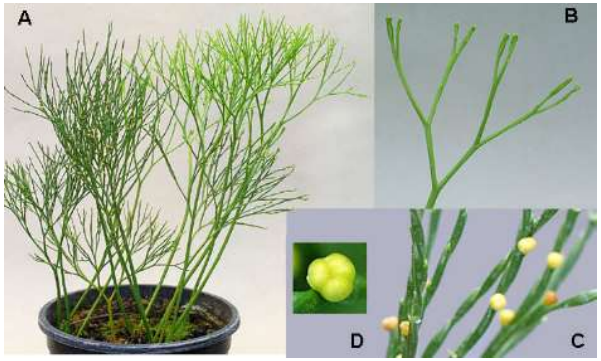
- Sporophytic plant body with stout main axes with dichotomous lateral branches
- Ultimate branches ended in paired pendulous sporangia
- Axes with blunt spines and interrupted longitudinal ridges
- Xylem terete, centrarch protostele, with -
  - **protoxylem** tracheids with helical + scalariform thickenings
  - **metaxylem** had scalariform tracheids but some with border pits
- Sporangia elongated to elliptical, homosporous, dehiscence longitudinal



Psilophyton



Div. 4. Psilophyta



- Rootless sporophytic body with numerous rhizoidal hairs
- Underground rhizome and aerial shoots are dichotomously branched, aerial portion with scaly leaf-like appendages
- Stele either solid / modulated protostele
- Bi- or Trilocular fructifications develop in axils of leaf like appendages, homosporous
- Gametophytes are colorless, cylindric, branched, subterranean, saprophytic
- Antheridia are partially embedded on gametophyte, antherozoids are multiflagellate.

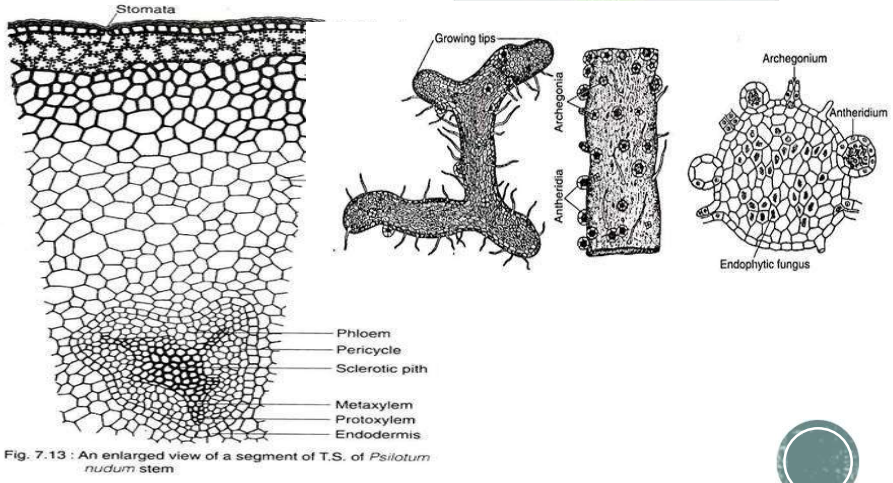
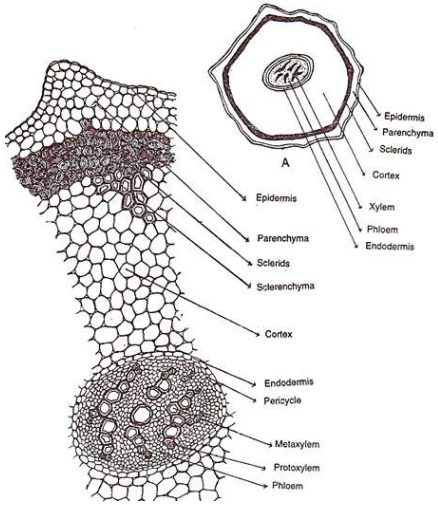
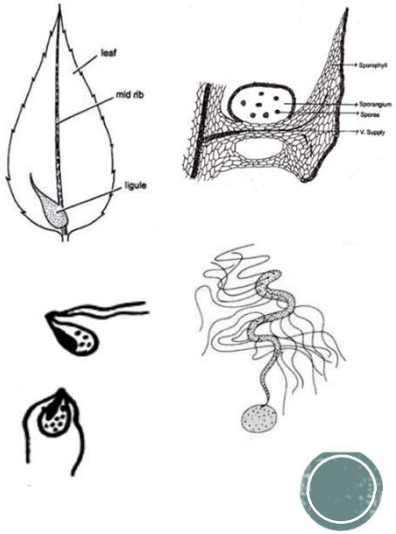


Fig. 7.13 : An enlarged view of a segment of T.S. of *Psilotum nudum* stem

Div. 5. Lycophyta

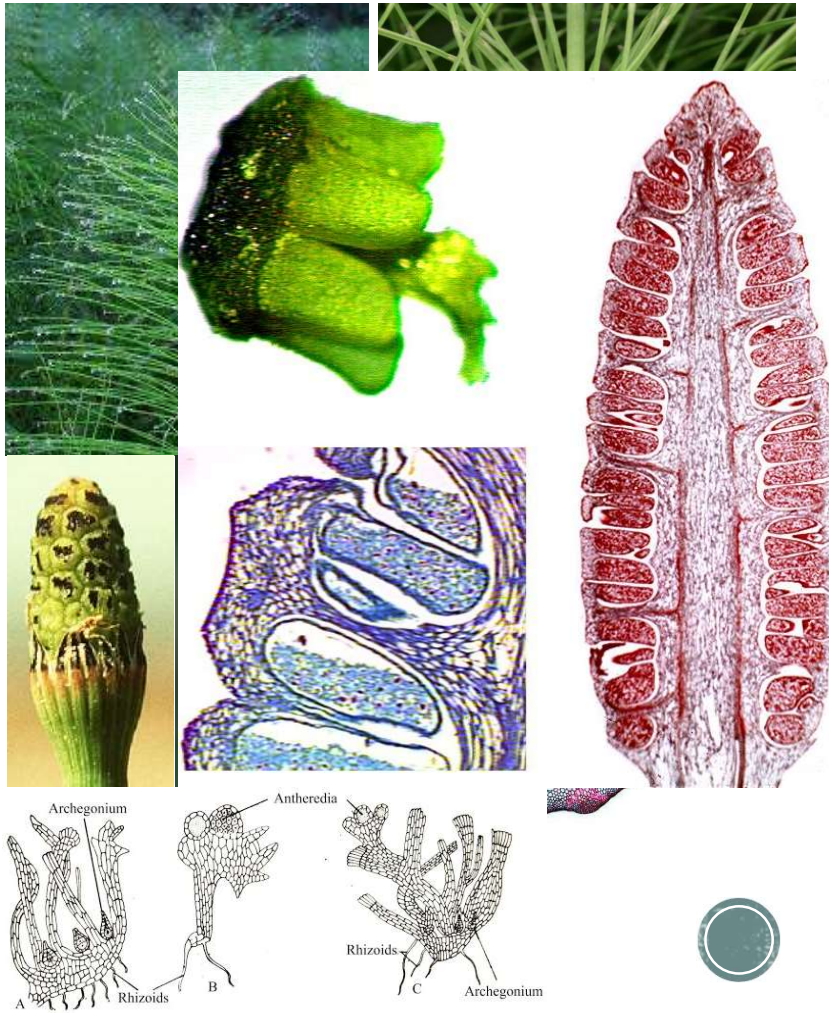
- Sporophytic plant body differentiated into root, stem leaf and eusporangium
- Leaves microphyllous, small, univeined, may be ligulate / eligulate, arranged spirally
- Without any leaf gaps
- Stem protostelic / siphonostelic, xylem exarch, some with secondary growth
- Sporangia attached with sporophylls on adaxial surface, sporophylls organised to form strobilus
- May be homosporous or heterosporous
- Antherozoids may be bi- (*Lycopodium*) or multiflagellate (*Isoetes*)





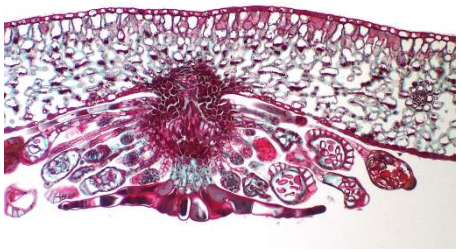
Div. 6. Sphenophyta

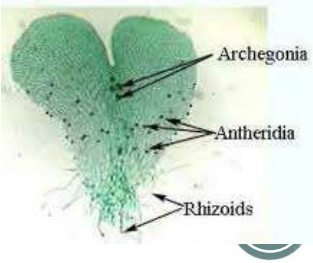
- Sporophytic plant body differentiated into stem, leaf, root and eusporangium
- Stem articulated, monopodially branched, longitudinally furrowed, contains nodes and internodes
- Leaves small, scaly, arranged on nodes forming whorl
- Stem protostelic or siphonostelic, xylem exarch mostly
- Presence of **carinal canals**, **vallecular canals**
- Sporangia develop on sporangiophores, and organised together to form strobilus
- Gemetophytes may be monoecious / dioeciuos, antherozoids multiflagellate
- Embryo lacks suspensor



Div. 7. Filicophyta

- Elaborate sporophytic plant body; differentiated into root, stem and **megaphyllous leaves**
- **Leaf gaps present** in primary vascular cylinder of stem
- Stem protostelic / siphonostelic, with complex vascular cylinder
- Sporangia terminal on ultimate axes, terminal on veins, marginal, on abaxial surface of fronds, forming **sori**
- Development of sporangia either eusporangiate or leptosporangiate type
- Homosporic mostly, may be heterosporic
- Gametophytes are green exosporic in majority but may be exosporic, non-green in some while endosporic in heterosporic type
- Antherozoids are multiflagellate
- Embryo exoscopic / endoscopic / intermediate type





Classification of Gymnosperms

Div. 8. Progymnospermophyta

- Sporophytic plant had profusely branched arborescent habit
- Ultimate branch systems were either naked or bore small lateral appendages
- Lateral appendages shows various degrees of flattening
- Presence of dense secondary wood
- Plants were free sporing, and without any seeds
- Either homo- or heterosporous

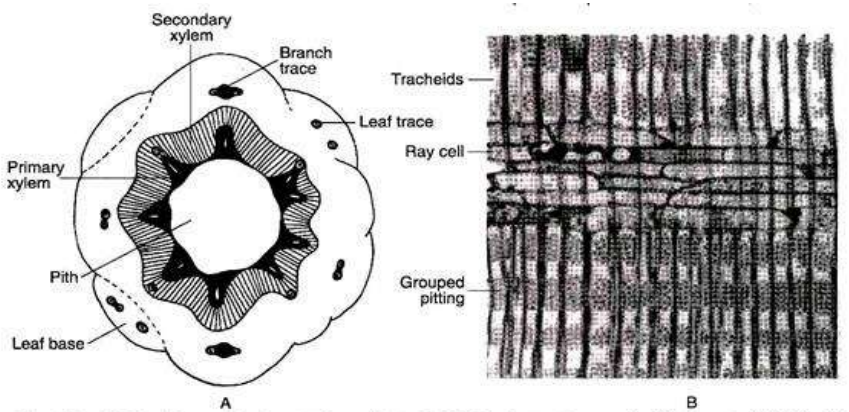
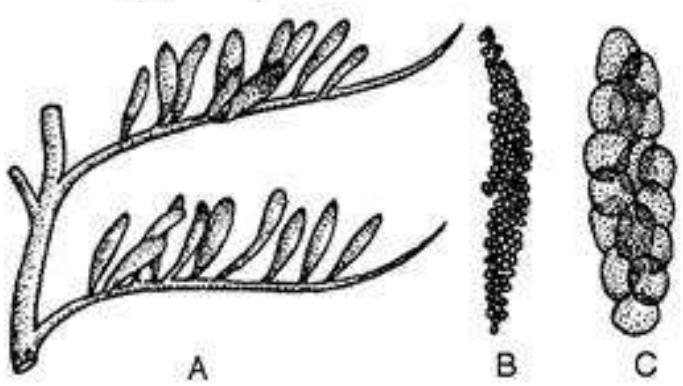


Fig. 1.94 : A. T.S. of shoot of *Archaeopteris macilenta*, B. R.L.S. of secondary wood of *Archoeopteris* (*Callixylon*)



Div. 9. Pteridospermophyta

- Plants have erect, columnar or sparingly branched trunks with large, pinnately compound, frond-like leaves with cuticle
- Pr. Xylem in form of a solid or modulated protostele and usually mesearch
- Sec. wood and phloem produced in smaller amount, cortex is massive, wood manoxylic (soft & porous)
- Leaf traces large with either single or several strands
- Tracheids of sec. xylem with multiseriate border pits
- Seed not produced in cone or inflorescence, but on modified or unmodified leaves
- Seeds with radial symmetry
- Megaspore surrounded by a thick wall

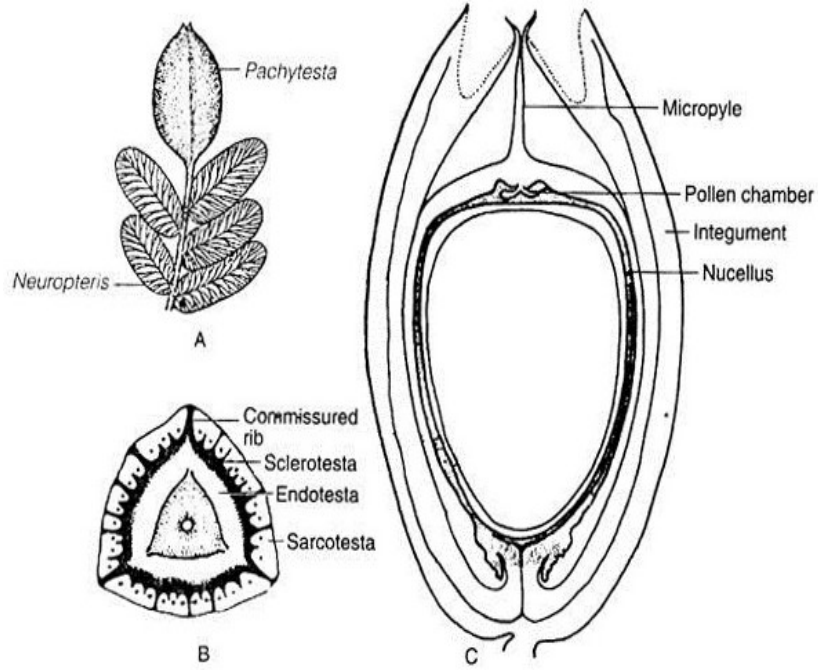


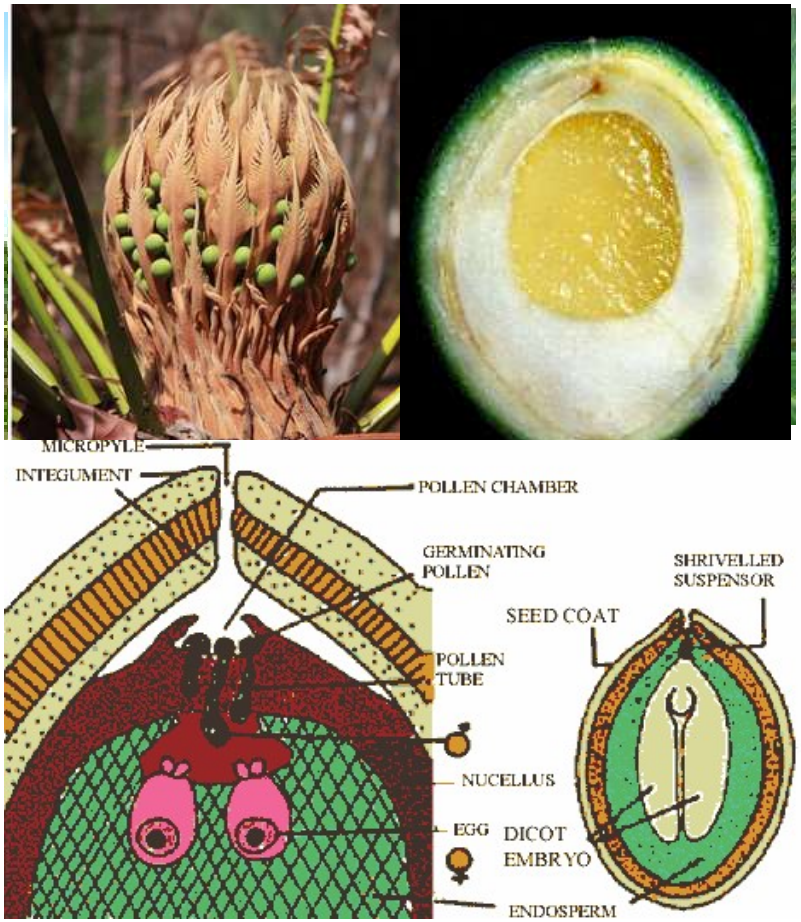
Fig. 1.6 : A. *Pachytesta* seed on *Neuropteris* frond, B. T.S. of *Pachytesta*, C. L.S. of Pachytesta

B

Neuropteris leaf with *Whittleseya* synangium

Div. 10. Cycadophyta

- Stout arborescent plant with palm like unbranched trunk beset with persistent leaf bases
- Leaves forming crown on top giving a palm-like look
- Vernation of young leaflets are distinctly **circinate** type
- Stomata **haplochaelic** type i.e. subsidiary cells do not formed from guard cell initials
- Except in *Cycas*, both male and female strobili are compact cone like structure
- Megasporophylls may be peltate, scale like with 2, or pinatified with 6-8 laterally placed ovules
- Microsporophylls are thick, scale like, bear microsporangia on lower / abaxial surface forming soral clusters
- Ovule consists of integument laterally joined with massive nucellus except near micropylar end
- Seeds with radial symmetry



Div. 11. Cycadeoidophyta

- Plants with columnar, upright, slender, branched / unbranched globose stem
- Leaves simple linear (*Williamsoniella*), large pinnate (*Williamsonia*) with unicostate parallel venation
- Stomata **syndetochaelic** type i.e. subsidiary & guard cells developed from same initial
- Presence of ramentum
- Stem with large pith, surrounded by a ring of collateral, conjoint, endarch, open primary vascular bundles; cortex parenchymatous with mucilage canals
- Pr. Xylem endarch, surrounded by cylinder of sec. xylem but stem without girdling leaf traces

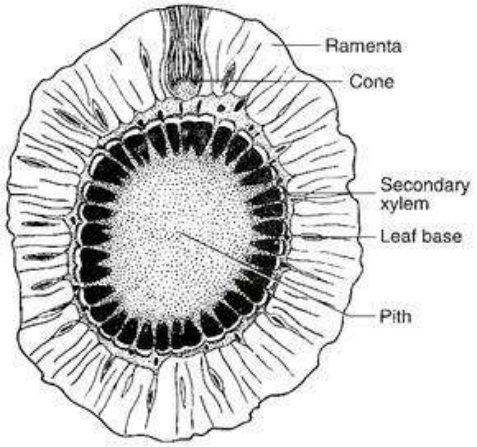


Fig. 1.32 : T.S. of trunk of *Cycadeoidea*

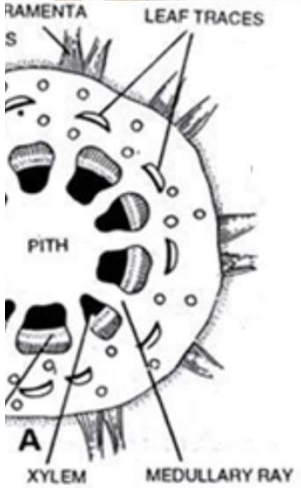


Fig. 2.13. ***Cycadeoidea.*** A, T.S. of stem showing primary

- Strobili either monosporangiate (*Wielandiella*), or bisporangiate (*Cycadeoidea*)
- Stalked ovules interspersed with sterile scales on terminal cone shaped receptacles, which in turn surrounded by a whorl of microsporophylls
- Microsporophylls either pinnate (*Cycadeoidea*), or entire (*Williamsoniella*), free or fused (*Williamsonia*) bearing rows of synangia
- Ovules not enclosed in cupule and seeds with two cotyledons

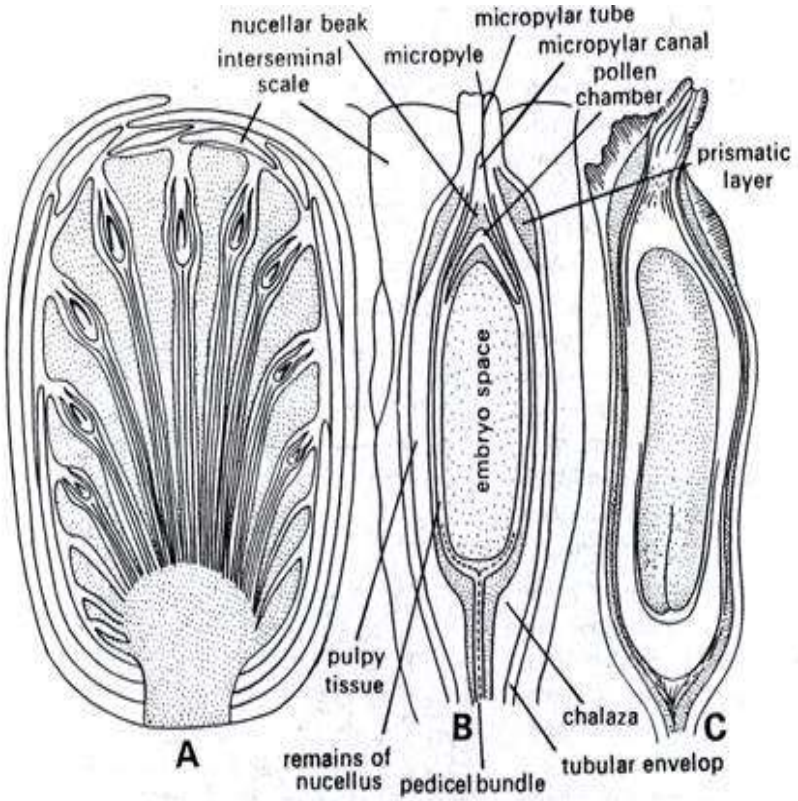


Fig. 2.20. *Cycadeoidea.* A, V.S. of gynoecium showing convex thalamus; B, V.S. of ovule; C, L.S

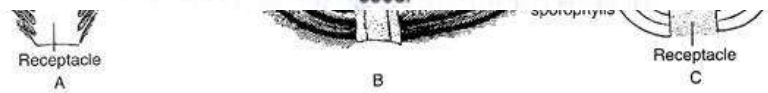


Fig. 1.33 : *Cycadeoidea* : A. An unexpanded flower, B. The same with a microsporophyll expanded, C. A mature flower

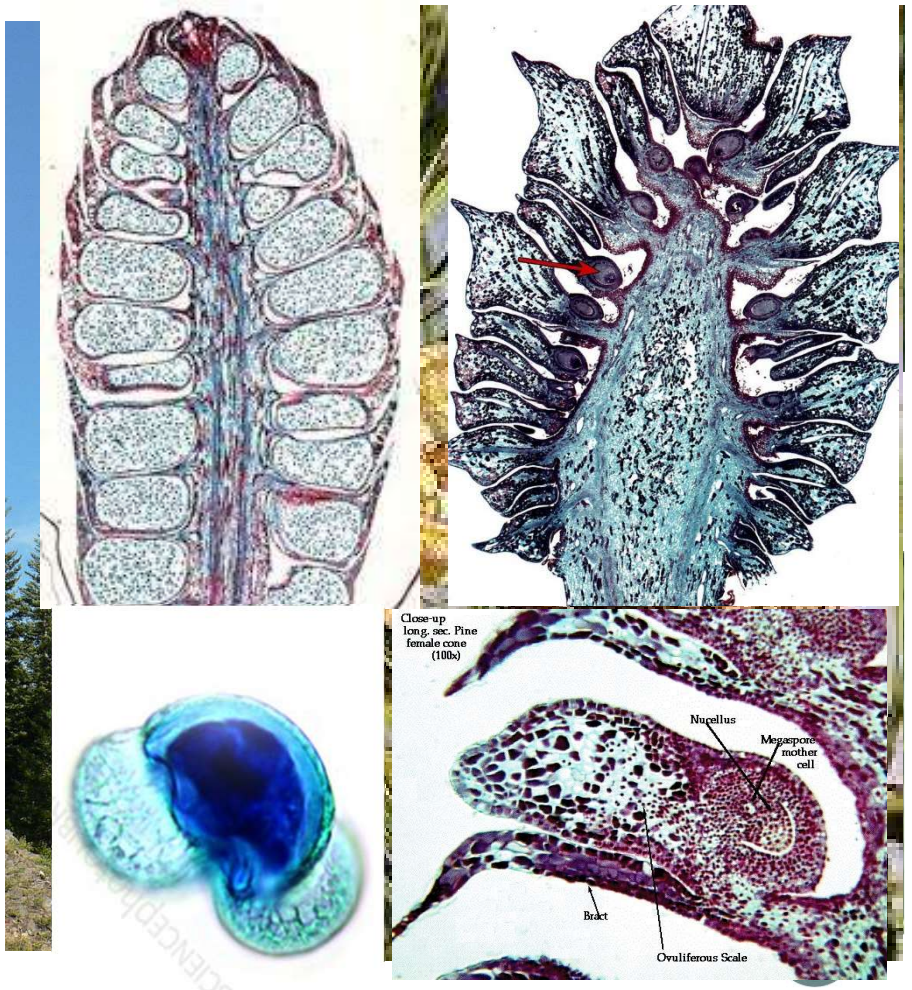
Div. 12. Ginkgophyta

- Trees with excurrent habit like conifers
- Exhibit shoot dimorphism, with long and dwarf shoots
- Foliage fan shaped, with a petiole bearing fan shaped dichotomously veined lamina
- Leaf blade may be entire or divided by a distal notch into two blades
- Stem with vigorous cambial activity, produce pycnoxylic sec. wood with well defined growth rings
- *Ginkgo* is dioecious

- Male cone arises in axils of bud scales or foliage leaf on spur shoot, is loose, pendulous, catkin like
- Female cone arises in axils of a leaf of spur shoot, consists of a stalk / peduncle bearing at its tip 2 erect ovules
- Each ovule is subtended by a rim like out growth called **collar**
- A peculiar column of female gametophytic tissue "**Tent Pole**" present between archegonia
- Mature seeds are large, fleshy with 2 layered integuments; outer fleshy layer when crushed emits unpleasant odour
- Spermatozoids are with spiral bands of cilia

Div. 13. Coniferophyta

- Large, profusely and excurrently branched stems with spirally arranged needle like / linear to lanceolate / univeined / scale like (Cupressaceae) / broad multiveined (*Agathis*) leaves
- Stem with small pith and abundant pycnoxylic wood in a thin cortex
- Leaves amphistomatic (*Pinus*) or hypostomatic (*Pseudotsuga*)
- Strobili unisexual, compact, consisted of a central axis bearing bracts that in turn bore fertile shoots i.e. complex sporophylls
- Presence of winged pollen
- Nucellus and integuments are free from each other at its micropylar end
- Male **gametes non ciliated**
- Seeds and ovules bilaterally symmetrical



Div. 14. Gnetophyta

- Sporophytic plants may be tree, shrubs or woody climbers or stumpy turnip-like plants (*Welwitschia*) with stem partly below the ground
- Leaves simple, broadly elliptical or strap shaped or reduced scale like, arranged spirally / oppositely / whorled manner
- Sec. wood with vessels but unlike those of angiosperms
- Flowers are unisexual but plants are dioecious (except *Gnetum*); flowers are organised into compact strobili

- Female flower with a single orthotropous ovule, nucellus surrounded by 2-3 envelops, micropyle projecting as a along bristle like tube
- Male flowers with perianth and antherophore, each with 1-8 synangia
- Female gametophyte tetrasporic (except *Ephedra*)
- Fertilization by means of a pollen tube with two male nuclei
- Embryo with two cotyledons and unicellular primary suspensor

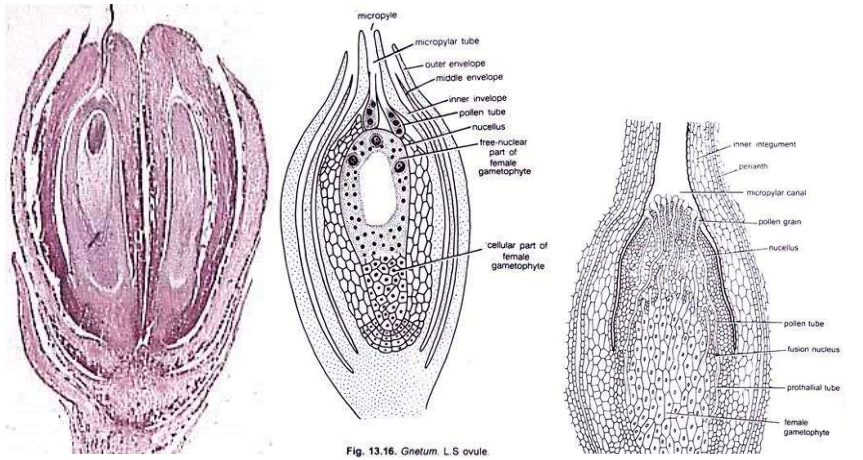


Fig. 13.16. *Gnetum*. L.S ovule.

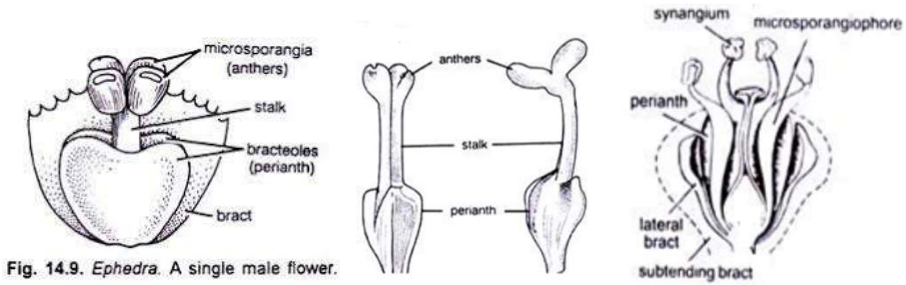


Fig. 14.9. *Ephedra*. A single male flower.


Thank you