

# GLIMPSES OF THE BOTANICAL PAST



INFORMATION ON SELECTED FOSSILS  
DISPLAYED IN THE  
T.S.MAHABALE HALL MUSEUM

DEPARTMENT OF BOTANY



SAVITRIBAI PHULE PUNE UNIVERSITY  
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*The earth speaks not of a succession of distinct creations but of a continuous ascent, in which, as the millions of years roll by, increasing perfection of structure and beauty of form are found.*

*Henry Fairfield Osborn (1925)*

## Introduction

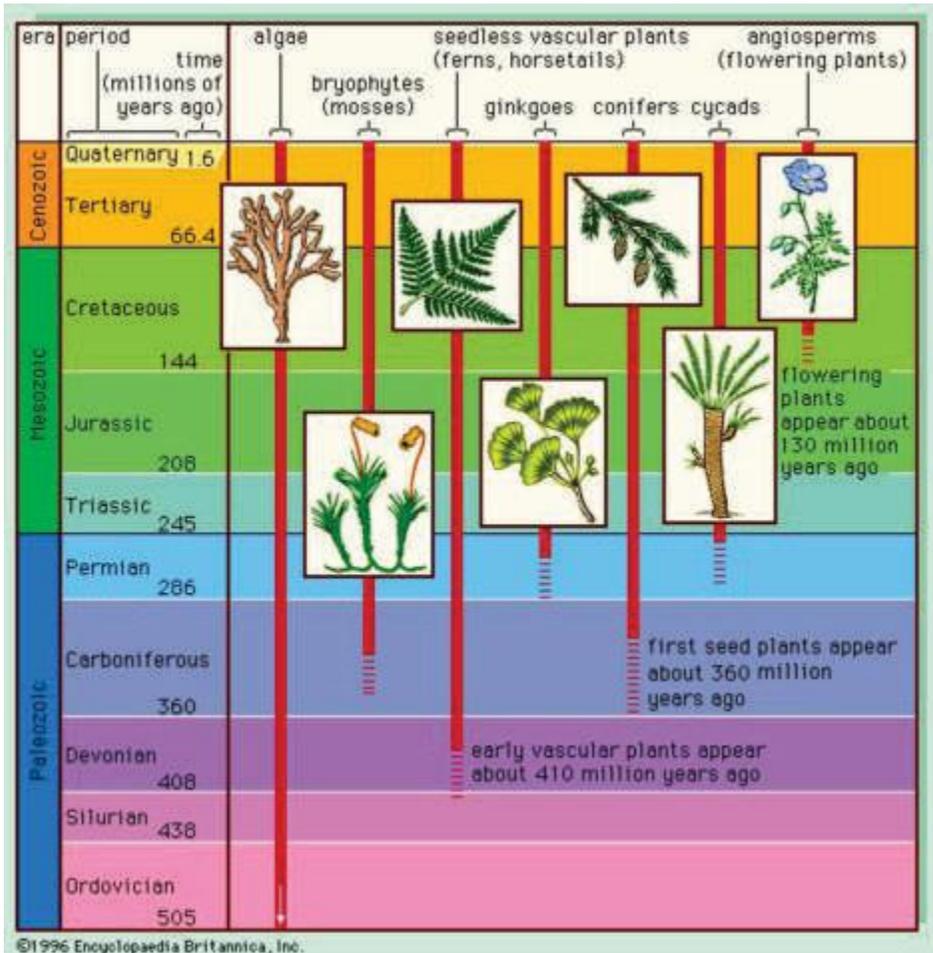
Palaeobotany deals with the recovery and identification of plant remains from geological context. It provides clues about the evolutionary history of plants.

**Fossils represent plants buried in sediments of sand, clay or ash. Due to exclusion of air and the acidic nature of sediments, decay of the organic matter is reduced. The sediments harden to form sedimentary rocks. The various fossil types include:**

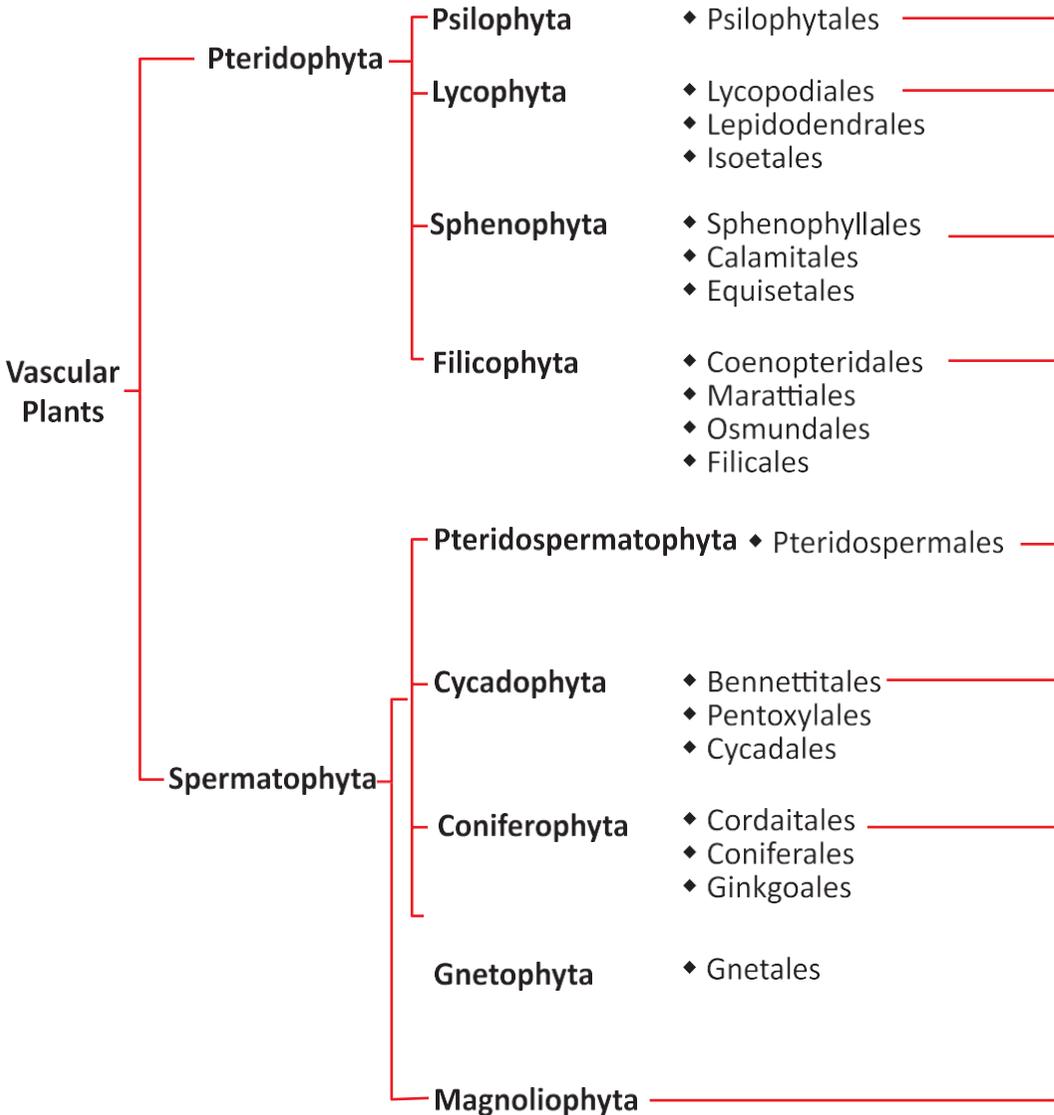
- **Compressions:** Compaction of sediments leading to flattening of plant parts, with some preserved organic matter.
- **Impressions:** The negative imprint of a compaction, showing no carbonaceous material.
- **Casts and molds:** Hardening of sediment around plant part before it gets flattened. The plant material disintegrates leaving a hollow (mold). If the hollow is filled up by sediment, it creates a cast inside the mold. These three dimensional fossils show surface features of plant parts.
- **Petrifactions/ Permineralizations:** Plant parts are infiltrated and impregnated by soluble minerals like carbonates or silicates, that suddenly precipitate and harden. Sections of the mineralized plant part reveal internal details that can be observed under a microscope.
- **Coal Balls:** Nodules containing permineralized plant parts in magnesium or calcium carbonates often found in coal seams. Reveal internal as well as external morphology.

Most of the specimens represented in the T.S. Mahabale hall of Botany Department are from collections made by renowned palaeobotanists like Dr. K. R. Surange and Dr. T. S. Mahabale, their colleagues and students. Dr. H.N. Andrews, who worked as a Fullbright lecturer in this Department during 1960-61, also contributed to this collection.

## Plant Evolution Time Scale



## Classification of Vascular Plants



## Fossils displayed

*Rhynia, Psilophyton*

*Lycopodites*

*Lepidodendron, Sigillaria, Stigmaria, Lepidostrobus*

*Calamites, Paracalamites, Annularia, Calamostachys, Phyllothea, Schizoneura*

*Pecopteris, Psaronius, Marattiopsis, Hausmannia, Gleichenites, Cladophlebis, Onichiopsis*

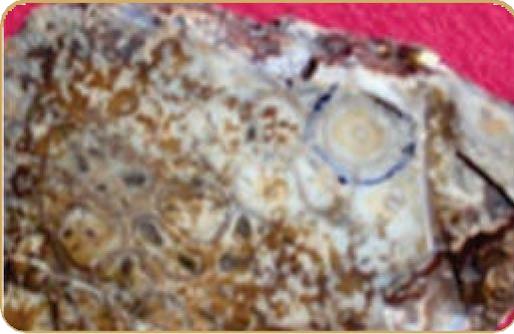
*Neuropteris, Cyclopteris, Sphenopteris, Pachypteris, Glossopteris, Vertebraria, Scutum, Alethopteris, Trigonocarpus*

*Williamsonia, Elatocladus, Nilssonia, Pterophyllum, Ptilophyllum, Otozamites, Dictyozamites, Pentoxylon, Nipaniophyllum*

*Cordaites, Noeggerathiopsis, Pseudoaraucaria, Brachyphyllum, Ginkgo, Czekanowskia*

*Palmoxylon, Tricocites, Enigmocarpon, Salix, Acer, carbonized Rice, Peas*

## PSILOPHYTA

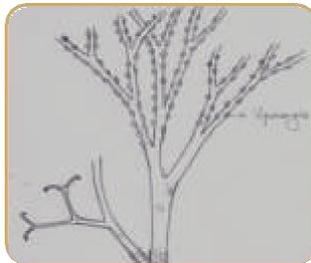


### ***Rhynia* sp. - Chert**

**Era – Palaeozoic, Period – Devonian**

**Age – 435 m.y. , Locality – Scotland, England**

The 'Rhynie chert' from Scotland has been formed by chemical precipitation of dissolved silica in hot springs. The organic matter in the plants coated with silica was mineralized. The fossil shows TS of *Rhynia* stem, showing some thick walled conducting cells in the centre surrounded by thin walled cortical cells. This was described as one of the first land plants with an erect habit and belongs to the Pteridophytes.



### ***Psilophyton princeps* - Petrification**

**Era – Palaeozoic , Period – Devonian**

Age – 435 m.y. , Locality – U.S.A. *Psilophyton princeps* is another permineralized early vascular land plant belonging to Pteridophytes. The stem shows dichotomous branching and is covered by short pointed spines.

## LYCOPHYTA

### ***Lycopodites* - Impression**

**Era – Palaeozoic, Period : Lower Carboniferous**

**Age : 350 m.y. , Locality- Not Known**

*Lycopodites* represents a leafy stem of the fossil Lycophyta. It shows a slender dichotomously branched stem with small thin leaves covering the stem in helical or pseudowhorled fashion.



### ***Sigillaria* - Impression**

**Era – Palaeozoic , Period : Lower Carboniferous**

**Age : 350 m.y. , Locality- Not Known**

*Sigillaria* represents the stem of a tree like Lycophyte similar to *Lepidodendron*. The impression shows stem surface of this plant, with distinct hexagonal leaf bases arranged helically on the stem. Each leaf scar shows a central scar representing the vascular trace to the leaf.

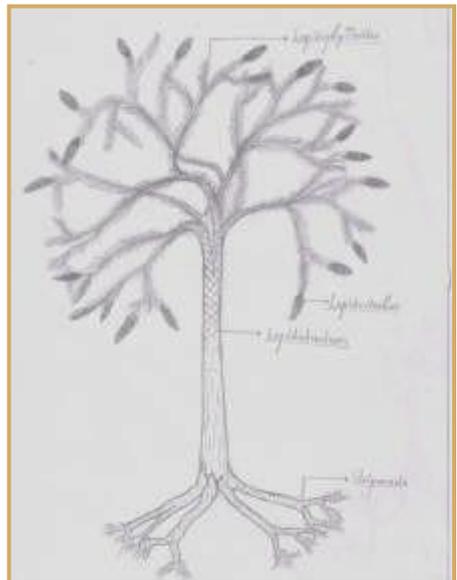
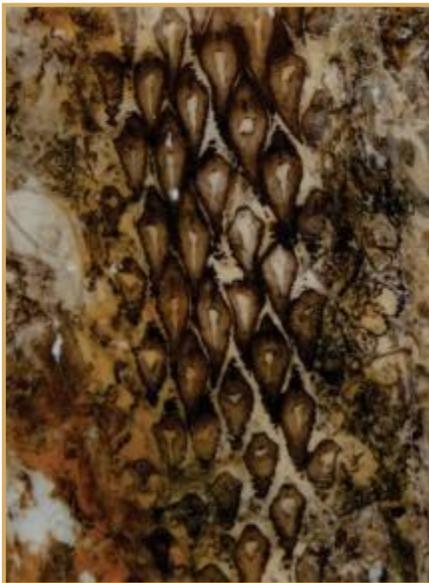


***Lepidodendron* - Impression, Peel of permineralized stem**

**Era – Palaeozoic , Period : Lower Carboniferous**

**Age : 350 m.y. , Locality- Not Known**

*Lepidodendron* is a genus of tree ferns (Lycophyta). The impression shows closely packed diamond-shaped leaf cushions left on the trunk of this tall tree. A leaf scar is seen on the cushions, with one vascular trace in the centre.



*Lepidodendron* reconstruction

***Stigmara ficoides*- Cast, Peel of TS of permineralized root**

**Era - Palaeozoic , Period – Lower Carboniferous**

**Age – 350 m.y. , Locality – Mazon Creek, U.S.A**

The Stigmarian system represents roots arising from the base of the trunk of *Lepidodendron*. The round nodes on the surface of *Stigmara* are scars where rootlets were once attached and arranged radially. The TS of the root shows a large number of rootlets enclosed in a sheath. The rootlets show a protosteles.



***Lepidostrobus*- Peel, LS of permineralized cone**

**Era – Palaeozoic , Period : Lower Carboniferous**

**Age : 350 m.y. , Locality- Not Known**

*Lepidostrobus* is a the form genus for the reproductive part of *Lepidodendron*. The LS of the cone shows an axis bearing a sporophyll. Spores are seen within the sporangium present in the basal region of sporophyll.

## SPHENOPHYTA

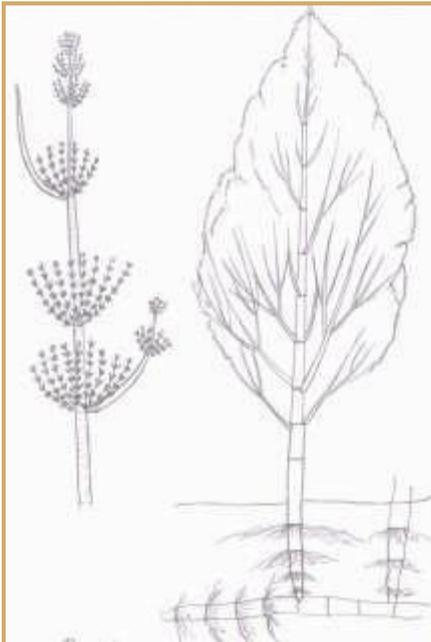


### *Calamites* sp.- Pith Cast

Era- Palaeozoic , Period- Lower Carboniferous

Age -350 m.y. , Locality – Pennsylvania, (U.S.A.)

*Calamites* was a form genus of stem casts of extinct tree like relatives of extant Equisetales (Horsetail ferns). It represents the central cavity of the trunk that had been filled with sediment. It shows furrows representing xylem, which extended into the cavity and ribs representing medullary rays.



*Calamites* reconstruction



### *Paracalamites* - (Stem) Pith cast

Era – Palaeozoic , Period – Upper Carboniferous

Age –310 m.y. , Locality – Nagpur, India

**It is a form genus of a Calamites like stem.** Stems of *Paracalamites* are generally narrow. The internodes are fairly long, marked by conspicuous ridges and furrows. Ridges and furrows are continuous from one internode to other.



***Annularia* sp. – Stem with leaves, impression**

**Era – Palaeozoic, Period – Carboniferous**

**Age – 350 m.y. , Locality U.S.S.R.**

*Annularia* is a representative of a *Calamites* leaf. A whorl of leaves is seen to arise from nodes on the stem. The leaves are lanceolate in shape.



***Calamostachys* – Peel of LS of permineralized cone**

**Era – Palaeozoic, Period – Carboniferous**

**Age – 350 m.y. , Locality U.S.S.R.**

*Calamostachys* represents the cone of *Calamites*. A central axis is seen with bracts and sporangia. The sporangia have a number of spores.



***Phyllothea* sp. Impression**

**Era – Palaeozoic , Period – Permian**

**Age – 225 m.y. , Locality – Asansol, India**

*Phyllothea* is an extinct genus related to extant horesetail ferns or Equisetales. It shows an unbranched axis, bearing whorls of up to 40 single veined leaves that are fused basally to form a narrow sheath.



***Schizoneura gondwanensis* Impression**

**Era – Palaeozoic, Period – Permian**

**Age -225 m.y. Locality – Bazargaon, India.**

*Schizoneura gondwanensis* is another Equisetalean genus showing jointed longitudinally furrowed stems bearing a whorl of leaves at each node that are split into two large segments on opposite side of the stem.

## FILICOPHYTA



### ***Pecopteris*- Leaf Impression and Compression**

**Era- Palaeozoic , Period- Lower Carboniferous**

**Age - 350 m.y. , Locality- Not Known**

*Pecopteris* is a leaf compression of a tree fern *Psaronius* . The pinnules are small and are attached along the entire width to the main axis. A single vein is seen to extend to the tip of the pinnule.



### ***Psaronius* Petrified stem TS, Peel**

**Era- Palaeozoic , Period- Lower Carboniferous**

**Age - 350 m.y. , Locality- Not Known**

*Psaronius* was a tree fern. The section of the stem shows overlapping dictyosteles, with leaf gaps. The outer region consists of a mantle of adventitious roots towards the basal part of the stem.





***Marattiopsis macrocarpa* – Leaf Compression, Impression**

**Era – Palaeozoic, Period – Lower Carboniferous**

**Age – 350 m.y., Locality – Not known**

*Marattiopsis* represents the leaves belonging to early ferns of the order Marattiales. The fossil shows elongated, linear and narrow leaves, with pinnules that are oblong and rounded at top. They are attached by the whole base to the prominent rachis. Midrib is slender and extends to the apex of pinnule. The fertile pinnules show two rows of synangia, that bear spores.



***Cladophlebis* sp. Impression, Compression**

**Era – Mesozoic, Period – Triassic**

**Age – 225 m.y., Locality – U.S.S.R.**

*Cladophlebis* foliage was produced by ferns belonging to the family Osmundaceae. The fronds are bipinnate, with pinnae attached alternately to rachis. Pinnules are with entire margins and are slightly flared at the point of attachment.



***Hausmannia* sp. Impression**  
**Era – Palaeozoic , Period – Permian**  
**Age – 225 m.y. , Locality – U.S.S.R.**

*Hausmannia* represents the fronds of an extinct fern belonging to the family Dipteridaceae. The leaves are palmate, large and fused to some extent. The pinnae show reticulate venation, thus resembling angiosperm leaves.



***Gleichenites gleichenoides*,**  
**Impression**  
**Era – Mesozoic , Period – Lower**  
**Cretaceous**  
**Age - 140 m.y. , Locality - Rajmahal**  
**Hills, India**

*Gleichenites gleichenoides*. is a form genus describing foliage of extinct ferns belonging to family Gleicheniaceae. Living members of this family are called Gleichenias. The fossil shows a frond with pinnae bearing rounded pinnules.



***Onchiopsis elongata* Impression**  
**Era - Mesozoic , Period – Lower**  
**Cretaceous**  
**Age – 110 m.y. , Locality – U.S.S.R**

*Onchiopsis elongata* belongs to the fern family Polypodiaceae. It shows bipinnate fronds, with narrow acuminate pinnae attached at an acute angle to the rachis. The pinnae show a single vein.

## PTERIDOSPERMATOPHYTA



***Glossopteris* sp. Impression**  
Era – Palaeozoic, Period – Permian  
Age – 225 m.y.,  
Locality – Adhari, India.

*Glossopteris* is a form genus representing leaves of seed ferns belonging to Glossopteridales. The leaves are simple, entire, sessile or shortly petiolate and spatulate or ovate in shape. The midrib is distinct and the arched veins arising from it form a network.



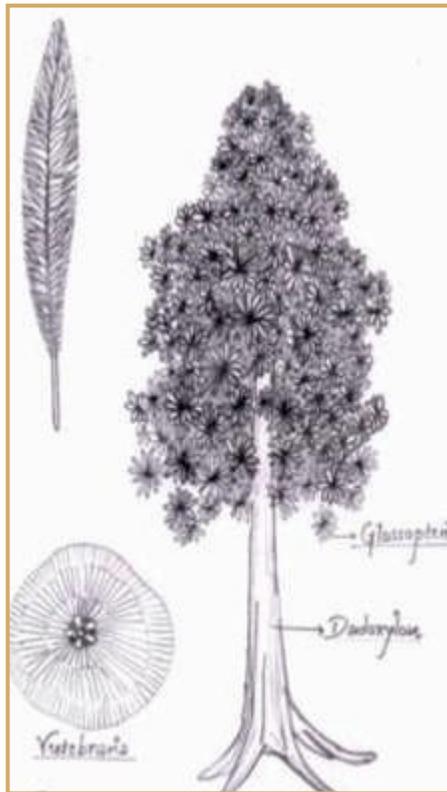
***Dadoxylon* – Petrified wood,**  
Era – Palaeozoic, Period – Permian  
Age – 225 m.y.,  
Locality – Adhari, India.

*Dadoxylon* represents the wood of seed ferns belonging to Glossopteridales. The TS shows growth rings and narrow medullary rays.



***Vertebraria indica* Compression**  
Era – Palaeozoic, Period – Permian  
Age – 280 m.y., Locality – Raniganj  
Coalfield, India

The roots of *Glossopteris* plant are called as *Vertebraria*. It shows characteristic rectangular blocks formed by cross partitions, thus resembling a vertebral column.



*Glossopteris* reconstruction



***Scutum* sp. Impression**

**Era – Palaeozoic, Period – Permian**

**Age – 225 m.y. ,**

**Locality- Umred, India**

*Scutum* represents an ovulate structure of the Glossopterids (seed ferns) located on a shield shaped megasporophyll. The megasporophyll was borne on a pedicel attached to the midrib of a leaf and bore many ovules / seeds.



***Cyclopteris richmondensis* Leaf Impression**

**Era – Palaeozoic ,  
Period - Lower Carboniferous  
Age – 350 m.y. ,  
Locality – Illinois, U.S.A.**

*Cyclopteris* is a form genus for foliar elements of some Pteridosperm fronds, especially of *Neuropteris* or related genera. This impression shows a rounded entire margined leaflet with densely spaced veins radiating outward in an open dichotomous pattern.



***Alethopteris* sp.- Leaf Compression**  
**Era – Palaeozoic , Period - Lower Carboniferous**

**Age - 350 m.y. , Locality - Not known**

*Alethopteris* represents a compression of foliage of seed ferns . The pinnules are tongue shaped with entire margins. They are borne at an acute or right angle on the axis and show confluent bases.



***Pachypteris* sp. – Leaf compression**

**Era – Palaeozoic , Period – Lower Carboniferous**

**Age – 325 m.y. , Locality – Yorkshire, England**

*Pachypteris* represents the foliage of a family of seed ferns belonging to order Corystospermales. Leaves are pinnate, with pinnules are directly attached to the rachis. A prominent midrib is seen on the pinnules.



***Neuropteris flexuosa* Stern - Permineralized  
Era – Palaeozoic , Period - Lower Carboniferous  
Age – 350 m.y. , Locality - Oklahoma, U.S.A**

Permineralized *Neuropteris flexuosa* represent leaves of extinct seed ferns. The leaflets show a prominent midvein from which secondary veins emerge at sharp angles. The leaflets are attached to the axis by a short stalk, thus distinguishing this genus from *Alethopteris*.



***Sphenopteris hoeninghausii* – Impression  
Era – Palaeozoic , Period – Lower Carboniferous  
Age– 300 m.y. , Locality – Pennsylvania, U.S.A.**

*Sphenopteris hoeninghausii* represents a frond of the extinct seed fern *Lyginopteris oldhamia*. Leaves show pinnules constricted at the base. Sporangia can be seen on the pinnules of fertile fronds.



***Trigonocarpus parkinsonii* Brongn. –  
Permineralised seeds  
Era – Palaeozoic ,  
Period – Lower Carboniferous  
Age – 350 m.y. ,  
Locality – Mazon Creak, U.S.A**

*Trigonocarpus* represents the ovules of seed ferns belonging to family Medullosaceae. The oval shaped seeds show trimerous symmetry and the outer surface shows three ridges.

## CYCADOPHYTA

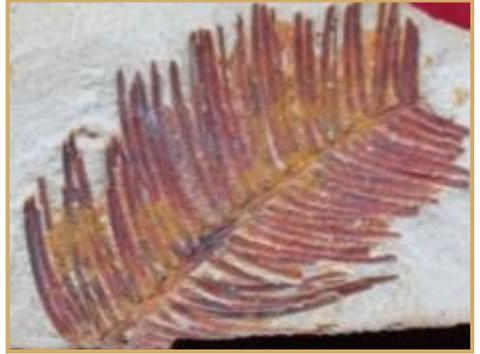


***Williamsonia seawardiana*  
Compression**

**Era – Mesozoic , Period -Lower Cretaceous**

**Age - 140 m.y. , Locality- – Rajmahal Hills, India**

The fossil represents the trunk of *Williamsonia* which shows similarities to the Cycads (Bennettitales). The compression shows leaf bases which form a thick layer around the trunk.



***Elatocladus conferta* -  
Leaf Impression**

**Era – Mesozoic , Period – Jurassic Age – 180 m.y. ,**

**Locality – Sriperambudur, India**

*Elatocladus* are leafy twigs of a gymnosperm belonging to order Bennettitales. The leaves are helically arranged around the stem and are dorsoventrally flattened. The leaves are long and linear with an acute, symmetrical apex with a single distinct midvein extending the length of each leaf.

***Nilssonia principii* – Leaf impression**

**Era – Lower Cretaceous**

**Age – 140 m.y. , Locality – Rajmahal Hills, India**

*Nilssonia* represents the leaf of a Cycadeoid plant. The lamina of *Nilssonia* is attached to the upper surface of the rachis. The lamina shows entire margin and a prominent midrib, with few lateral veins at right angles to the midrib.





***Pterophyllum morrisii* Oldham**  
**Era – Mesozoic , Period –Jurassic**  
**Age – 190-140 m.y. ,**  
**Locality –Chunakhal, India**

*Pterophyllum* represents the foliage of several mesozoic Cycadeoids. The pinnae are linear with almost parallel margins. They are attached to the rachis by the full width of the base.



***Ptilophyllum* spp. Leaf impression, compression**  
**Era – Mesozoic , Period -Lower Cretaceous**  
**Age - 140 m.y., Locality – Rajmahal Hills, India**

*Ptilophyllum* is another type of Cycadean frond showing variable leaf type. Pinnae are linear, and narrow straight or slightly falcate, with parallel or sub parallel veins. The pinnae are characterized by their attachment to the upper surface of the rachis which they almost cover.



***Otozamites* sp. Compression**

**Era – Mesozoic , Period – Jurassic**

**Age - 190 m.y. , Locality – India.**

*Otozamites* is another type of Cycadean frond. The leaves are pinnate, arranged alternately on the thick rachis and show auriculate bases. The veins radiate from the base to the margin.

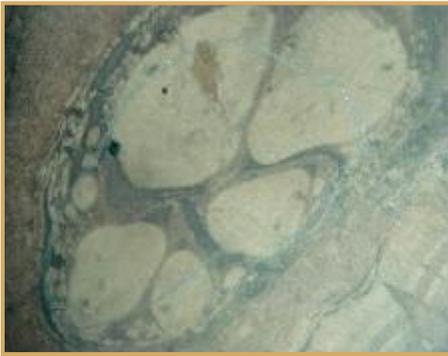


***Dictyozamites longifolia* Compression**

**Era – Mesozoic , Period – Lower Cretaceous**

**Age - 110 m.y. , Locality- U.S.S.R.**

*Dictyozamites* is a cycadeoid leaf fossil. The fronds are linear or lanceolate in shape, and pinnately compound, with pinnae with parallel veins and smooth margins. The pinnae are constricted at the base where they are attached obliquely to the upper surface of the rachis.

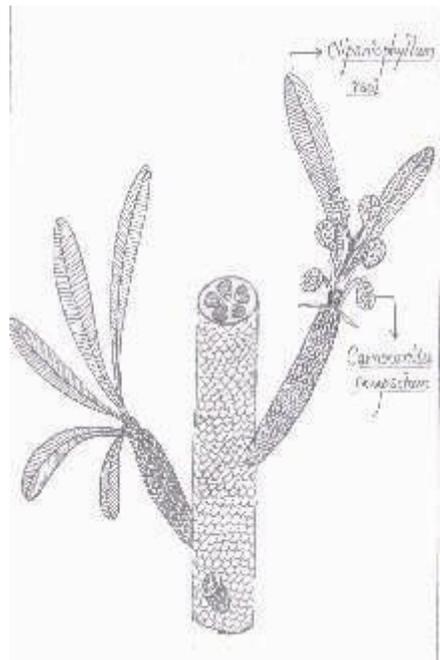


***Pentoxylon sahnii* – Petrification Stem TS**

**Period–Lower Cretaceous**

**Age – 140 m.y. , Locality – Nipani, India**

*Pentoxylon* is a fossil stem of gymnosperm wood of Cycads. It shows five steles embedded in a thin walled ground tissue. The xylem wedge consists of a mesarch primary xylem that is completely surrounded by dense secondary xylem. The wood is pycnoxylic and resembles that of *Araucaria*.



*Pentoxylon sahnii* reconstruction

***Nipaniophyllum raoi*–Leaf Impression**

**Era – Mesozoic,**

**Period - Lower Cretaceous**

**Age – 140 m.y. ,**

**Locality – Nipani, India**

*Nipaniophyllum* is the leaf organ of genus of *Pentoxylon*, a gymnosperm showing affinities to Cycadophyta as well as Coniferophyta. Leaves are simple, petiolate, strap-shaped, and possessed a well-developed mid rib with many parallel lateral veins borne at right angles to it.



## CONIFEROPHYTA



***Cordaites* sp. – Leaf compression**  
Era – Palaeozoic , Period – Lower Carboniferous

**Age - 350 m.y., Locality – unknown**

*Cordaites* is a genus of extinct gymnosperms which grew in wet marshy areas. *Cordaites* leaves are typically strap shaped. The leaf lacks a midrib and shows parallel veins that are occasionally dichotomously branched.



***Noeggerathiopsis* sp.-Leaf Compression**

**Era – Palaeozoic, Period – Permian**

**Age – 225 m.y., Locality – U.S.S.R.**

*Noeggerathiopsis* another foliage form genus like *Cordaites* and belongs to Gymnosperms. The leaves are elongated and strap shaped with sub parallel venation. The characters used to distinguish it from *Cordaites* are its smaller size, spatulated shape and the absence of interstitial veins or fiber between the veins.



***Proaraucaria mirabilis* Petrification**

**Era – Mesozoic, Period – Jurassic/Lower Cretaceous**

**Age – 150-140 m.y. , Locality – Patagonia, U.S.A.**

*Proaraucaria mirabilis* belongs to extinct conifers. The fossil shows a seed bearing cone that resembles the cone of a living *Araucaria*. A single seed is embedded within the cone scale on its adaxial surface. The seeds are oval and slightly flattened.



***Brachyphyllum* sp. Compression, Impression**

**Era - Mesozoic , Period – Jurassic,**

**Age- 190 m.y. , Locality – Shriperambudur, India**

*Brachyphyllum* are sterile leafy branches of fossil gymnosperms belonging to the extant family Araucariaceae. They show spirally arranged imbricate and scale like leaves. Leaf cushions on the branch are seen on the impression.



***Ginkgo huttoni* Leaf Impression**

**Era – Mesozoic , Period – Jurassic**

**Age – 210 m.y. , Locality – U.S.S.R.**

The fossil species *Ginkgo huttoni* belongs to a distinct order Ginkgoales in the gymnosperms. It shows wedge shaped, partially lobed leaves with many veins per segment. Its extant relative is *Ginkgo biloba*.



***Czekanowskia* sp.- Impression**

**Era – Mesozoic , Period – Jurassic**

**Age – 190 m.y. , Locality – U.S.S.R.**

*Czekanowskia* foliage resembles that of *Ginkgo*. The leaves show a large number of veins radiating from base to the margin of a slightly lobed fan shaped lamina. The veins dichotomize several times before reaching the leaf margin.

## MAGNOLIOPHYTA



*Palmoxyton* sp. Petrification Stem TS  
Era – Coenozoic , Period – Paleocene  
(Lower)

Age – 65 m.y. ,

Locality- Mohgaonkalan, India

*Palmoxyton* is a fossilized Palm (Arecales) wood belonging to monocotyledons. The fossil shows silicified ground tissue with many vascular bundles that decrease in number from periphery to centre.



*Tricocites trigonum* Fruit petrification, TS, LS

Era – Coenozoic , Period – Paleocene (Lower)

Age – 65 m.y. ,

Locality – Mohogaonkalan, India

*Tricocites* is a fossilized fruit of a monocot genus, probably an Arecaceae member. It has three locules each occupied by large seed. The fruit wall is thick and fibrous, divided into a number of longitudinal chambers separated by partitions of hard tissue. The “chambers” may have acted as a float during dispersal. The surface was covered by a smooth, watertight rind.



***Enigmocarpon parijae* Sahni Fruit petrification**

**Era – Coenozoic**

**Period – Palaeocene (Lower)**

**Age – 65 m.y.**

**Locality - Mohgaonkalan, India**

*Enigmocarpon* represents a petrification of a fruit. The fossil shows an eight-locular capsule, that is seen in many extant dicotyledonous taxa. The fruit shows axile placentation with several seeds separated by septae.



***Salix* sp.– Leaf Impression**

**Era – Coenozoic**

**Period – Miocene**

**Age – 22 m.y.**

**Locality – Cerdana, Spain**

The fossil shows similarity to the extant *Salix* leaves. The leaves are broadly ovate with a long acuminate tip. Prominent midrib with a pair of opposite secondary veins in lower part of the leaf.



***Acer pyrenaicum* – Leaf Impression, compression**

**Era – Coenozoic**

**Period – Miocene**

**Age – 22 m.y.**

**Locality - Cerdana, Spain**

The leaf of *Acer* is similar in shape and morphology to the extant *Acer* leaves. It is palmately lobed and shows veins originating at base and running to the margin.



Rice grains - *Oryza sativa* L.



Pea Seeds – *Pisum arvense* L.

Carbonization is a process by which most constituents of plants decay, but the carbon remains as it is.

Such carbonized grains have been obtained from excavation sites at Newasa, Dist. Ahmednagar, Maharashtra, India

They date to about 1500 to 1000 B.C. (Quaternary period).

**DEPARTMENT OF BOTANY**



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