



# **GYMNOSPERMS**

**(Classification, distribution, Geological time scale and contributions of Prof. Birbal Sahni)**

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- Vascular plants ( plants which have vascular tissues- xylem and phloem) have been divided into three groups: **Pteridophyte, Gymnosperms and Angiosperms.**
- Among these three groups Pteridophytes produce spores for reproduction where as Gymnosperms and Angiosperms produce seeds for reproduction.
- Gymnosperms along with angiosperms are together known as **Phanerogams (phanero= exposed; gams = sex organs or spermatophytes (sperma= seed).**
- Gymnosperms are called **naked seeded plants.** In gymnosperms, the ovules are exposed freely before and after fertilization. They are not enclosed within an ovary wall. In angiosperms, on the other hand the ovule or ovules are completely enclosed within a structure called the ovary. Due to this reason in gymnosperms fruits are not formed and only naked seeds are produced whereas in angiosperms the seeds are produced inside fruit.

- **Coulter and Chamberlain (1910)** divided gymnosperms into 7 orders.  
Some of the orders are extinct today.

The seven orders are as follows:

1. **Cycadofilicales** (extinct)
2. **Bennettitales** (extinct)
3. **Cycadales** (Mesozoic to present day)
4. **Cordaitales** (extinct)
5. **Ginkgoales** (Palaeozoic to present day)
6. **Coniferales** (Palaeozoic to present day)
7. **Gnetales** (recent)

- **Chamberlain (1934)** divided Gymnosperms into two large groups:
  - A. Cycadophyta** – sporophylls are in cones. They include three orders:
    1. **Cycadofilicales (Pteridospermae)**
    2. **Bennittiales (Cycadeoideales)**
    3. **Cycadales**
  - B. Coniferophyta**- are divided into four orders:
    1. **Ginkgoales**
    2. **Cordaitales**
    3. **Coniferales**
    4. **Gnetales**

# Distribution

- The **Cycadales** and **Ginkgoales** include living members which have a long Fossil history and can be regarded as “**living fossils**” .
- **Ginkgoales** in the past (early Mesozoic) were represented by widely distributed group of plants but now the order is represented by a single species **Ginkgo biloba**.
- In similar ways **Cycadales** flourished well during the Mesozoic and are now represented by nine well defined genera that are confined to Limited areas in the tropical and subtropical countries of the world.



- The **Coniferales** form the most conspicuous order of the living gymnosperms and include the plants like ***Pinus*, *Abies*, *Juniperus*, *Cupressus*, *Biota*** etc.
- Some conifers are the world tallest and long-lived plants for example ***Sequoia gigantea*** lives for 4,000 years and grows 300-400 feet in height. The conifers are Cosmopolitan and widely distributed throughout the northern and Southern hemisphere of the globe and form extensive forest. The **Gnetales** are represented by three living genera ***Gnetum*, *Ephedra*** and ***Welwitschia***. ***Welwitschia*** is monotypic and represented ***Welwitschia mirabilis*** and is found in deserts of Southwest Africa. ***Ephedra*** (30 to 40 species) has many species that are distributed in tropical and temperate regions of Asia, Africa and South America.



*Pinus sp.*

# Distribution of Gymnosperms in India

- Gymnosperms show poor distribution in India.
- In peninsular India only few species are found eg. *Cycas*, *Podocarpus* and *Gnetum*.
- In other parts such as Kashmir, Assam and Arunachal Pradesh Conifers form predominant flora.
- A total of **16 genera** and **53 species** are found in India.
- Among **Cycads** only *Cycas* is found in India.
- It is represented by four species- *C. circinalis*, *C. beddomei*, *C. Pectinata* and *C. rumphii*.

## Cycadales

- *C. circinalis* (Mysore, T.N., Orissa)
- *C. beddomei* (Cudappah district of Andhra Pradesh and Calicut)
- *C. pectinata* (eastern hills of Assam and plains)
- *C. rumphii* (Andaman and Nicobar islands)
- *C. revoluta* (cultivated as ornamental in gardens)

## Ginkgoales

Only few plants of ***Ginkgo biloba*** occur in India.



# Coniferales

(are found predominantly in Himalayas and have rich vegetation in north-west Himalayas)

- **Abies**- *A.pindrow*, *A.spectabilis* etc.(2300 to 4300 above sea level)
- **Cedrus**-*C.deodara* (is found from NW Himalayas to Central Himalayas)
- **Larix**-*L.griffithiana* (is confined to Eastern Himalayas)
- **Picea**-*P.smithiana* (Western and Central Himalayas )and *P.spinulosa* (Eastern Himalayas)
- **Pinus**- *P. wallichiana* and *P.roxburghii* (throughout Himalayas)
- *P.gerardiana* (Kashmir and Kinnaur of H.P.)
- *P.merkusii* (hillock in East Bengal)
- *P. insularis* (Khasya region of Assam)

- ***Tsuga***- *T.dumosa* (Central and Eastern Himalayas)
- ***Cupressus***- *C.torulosa* and *C.kashmiriana* (wide distribution in Himalayas)
- ***Juniperus***- (alpine ranges of Himalayas)
- ***Podocarpus***- *P.neriifolius* (Assam, East Himalayas and Andaman) and *P.wallichianus* (Western Ghats, Nilgiri hills, Assam and Nicobar)
- ***Cephalotaxus***-*C.griffithii* and *C.mannii* (Eastern Himalayas, Arunachal Pradesh, Naga and Khasi hills)
- ***Taxus***- *T.baccata* (all along Himalayas)

**Gnetales** is represented in India by a number of species of *Gnetum* and *Ephedra*

- ***Gnetum***-*G.gnemon* (Assam, Nilgiri hills and Simla hills); *G. Montana* (Assam, Sikkim and parts of Orissa); *G. ula* (Kerela, Visakhapatnam, Orissa and Nilgiri hills)
- ***Ephedra***- eight species of *Ephedra* are known in India. *E.foliata* in occurs plains of Rajasthan and Punjab). Rest of the seven species are found in north-west Himalayan region.

## GEOLOGICAL TIME SCALE

- Earth's history is approximately 350 million years old.
- Geologists have used two major units for subdividing the geological history of the earth these are- **time** and **strata**.
- On the basis of time the geological history of earth has been divided into five **Eras** namely **Archaeozoic, Proterozoic, Palaeozoic, Mesozoic and Coenozoic**.
- Eras have been divided into **periods** and periods into **epochs**.
- Similarly on the basis of strata, the geological history of the Earth is divided into system, series, stage and zone.
- The various eras and their age along with plant groups evolved during that period have been described in the given figure.

ERA	YEARS IN MILLION	PERIOD	EPOCH	FAUNA	FLORA
Cenozoic	1	Quaternary	Recent (Holocene)	Age of Mammals	Angiosperms Monocotyledons
	6		Pleistocene	Age of Human beings	Age of Angiosperms - Dicotyledons
	15	Tertiary	Pliocene	Human evolution	
	10		Miocene	Mammals and birds	
	20		Oligocene		
	100		Eocene Paleocene		
Mesozoic	125	Cretaceous		(Golden age of Reptiles) Rise of Dinosaurs	Sphenopsides, Ginkgos, Gnetales, (Dicotyledons)
	150	Jurassic			Herbaceous lycopods, Ferns, Conifers, Cycads
	180	Triassic			
Paleozoic	205	Permian		Mammal like reptiles	Arborescent lycopods
	230	Carboniferous	Pennsylvanian	Earliest Amphibians and abundant Echinoderms	Seed ferns and Bryophytes
	255		Mississippian	Earliest reptiles	
	315	Devonian		Age of fishes	Progymnosperms
	350	Silurian		Earliest fishes and land invertebrates	Zosterophyllum
	430	Ordovician		Dominance of invertebrates	Appearance of first land plants
510	Cambrian		Fossil invertebrates	Origin of algae	
Precambrian	3000	Upper		Multicellular organisms	
		Middle		Appearance of eukaryotes	
		Lower			Planktons prokaryotes

**1. Precambrian Era** Aarchaeozoic and Proterozoic eras are together known as Precambrian. It is said that life originated on the earth in Precambrian. The Rocks of this era have only a few fossils because either the environment was not suitable for fossilization or the organisms present during that time had so soft tissues that it was not fit for fossilization. Therefore, the absence of any fossil records makes it very difficult to tell something about the environment of Precambrian era.

**2. Palaeozoic Era** This era had vegetation including both aquatic and land plants. The aquatic plants included species such as *Nematothallus* and *Prototaxites*. These two species show similarities with thallophytes. The first fossils of land plants were found in the Silurian and Devonian periods of this era (225-350 million years ago). *Manograptus*, *Sporogonites*, *Zosterophyllum*, *Cooksonia*, *Rhynia*, *Horneophyton* and *Psilophyton* were important fossil genera discovered.

In the Carboniferous and Permian periods, Lycopsids, Sphenopsids and Pteropsids formed dense forests. Seed ferns (Pteridospermatophytes) were also abundant in this period (age of seed ferns). Presence of annual rings in certain fossil plants of this period indicates seasonal changes.

Significant changes in environment occurred in late carboniferous resulting in the development of swampy regions. This type of habitat was unstable for woody vegetation and in the late Devonian period the vegetation present on the earth was converted into coal due to geological events. The coal beds of Pennsylvania and West Virginia we are formed due to coalification of Lycopsids, Sphenopsids, seed ferns and gymnosperms of that period. Fortunately few Psilopsids, Lycopsids and Sphenopsids escaped destruction and eventually gave rise to the present forms.

**3. Mesozoic Era** The environment for the Triassic period of this era was very arid (dry) and thus unsuitable for the growth of plants requiring in humid climate. Fossil records however indicate the presence of many ferns, Cycadophytes and conifers in the Triassic period. This period is also known as the **age of Cycads**. Although flowering plants also originated in the period, their number was negligible.

Significant changes occurred in the vegetation of the Cretaceous. Of the 300 cretaceous species collected from North America 200 species belong to angiosperms. It shows that angiosperm formed a significant part of the cretaceous vegetation.



4. **Coenozoic Era** This era is known as the “**age of angiosperms**”. High mountain ranges such as Himalayas in Asia and Alps in Europe were formed during this era. As a result, the effect of hot winds got reduced and ICE AGE started. Gradually the ice shifted towards the poles. Simultaneously the development of tropical and temperate regions occurred. These changes had major effect on vegetation. The seed plants gradually migrated towards tropical regions and those which could not migrate became extinct. As most plants of the late coenozoic era were deciduous, it shows that there was seasonal variations too. The vegetation of the temperate and the Polar Regions mostly consisted of annual and biennial herbs which could withstand low temperature.

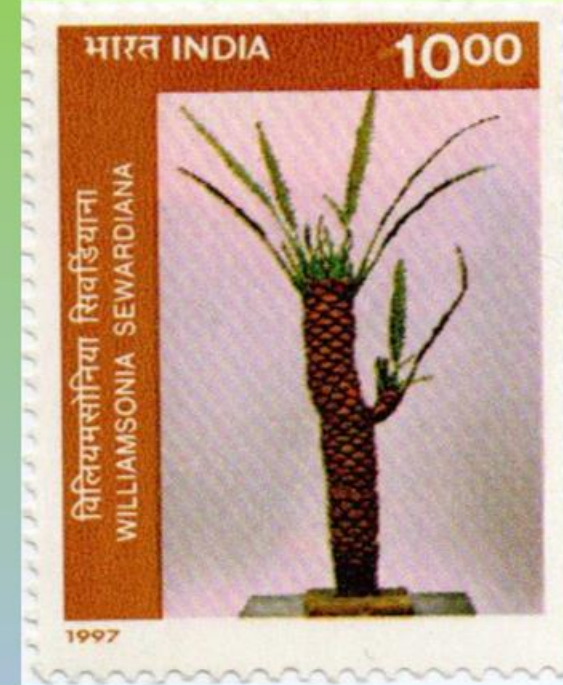
## Prof. Birbal Sahni (1891-1949)

The study of fossil plants in India in the 19<sup>th</sup> century owes its progress entirely to Prof. Birbal Sahni. In 1918, he published the first of the series of notable researches on the Zygopteridae. About this time he had also begun in collaboration with Prof. Seward, the important task of revising the Indian Gondwana plants and made exhaustive work on the Indian Fossil conifers. Between 1918 and 1949 Prof. Sahni had published a large number of papers dealing with nearly every aspect of fossil botany. Besides describing a large quantity of fossil material from India and other countries, he contributed important observations on the related palaeographical and geological problems such as Permo-carboniferous life provinces, Wagner's theory of continental drift, Himalayan uplift and the eastward opening of the Himalayan geocyncline. In 1939 with a view to coordinate research in fossil botany by workers spread in different parts of the country, he started the research Bulletin "Palaeobotany in India" with himself as its editor.



Prof. Birbal Sahni

- Areas in India to which Prof. Sahni devoted special attention were the Rajmahal Hills of Bihar, the Deccan intertrappean series and the salt range of Punjab, which now forms a part of Pakistan.
- He worked on morphology and evolutionary trends of Pteridophyta and Gymnosperms eg. *Nephrolepis*, *Ginkgo*, and *Cephalotaxus*.
- The three species *Homoxylon rajmahelense*, *Rajmahalia paradoxa* and *Williamsonia sewardiana* have been reported from Rajmahal hills by Prof. Birbal Sahni.
- During his last 6 or 7 years Prof. Sahni energies were focussed on the creation of the Institute of Palaeobotany at Lucknow. The institute was later given the name Birbal Sahni Institute of Palaeobotany in his honour.



Postage stamp issued by Gov. of India for *Williamsonia sewardiana*

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**THANKS**