



Pinus

Systematic Position

Division: Coniferophyta

Class: Coniferopsida

Order: Coniferales

Family: Pinaceae

Genus: *Pinus*

Species of *Pinus*

There are six species of *Pinus* commonly found in India

- (i) *Pinus gerardiana* – (Chilgoza Pine)
- (ii) *Pinus wallichiana* Syn. *Pinus excelsa* – (Blue Pine/Kail)
- (iii) *Pinus roxburghii* Syn. *Pinus longifolia* – (Chir Pine)
- (iv) *Pinus merkusii* (Teenasserim Pine): Height-3 mt
- (v) *Pinus insularis* Syn. *Pinus khasya* – (Khashi Pine)
- (vi) *Pinus armandi* (Armandi's Pine)

Pinus is an evergreen and perennial tree with xerophytic adaptation which is growing on the slopes of hills in temperate climate. It is conical in shape due to excurrent growth of the plant

Salient Features of *Pinus*

- They are evergreen, perennial lofty trees with spirally growing branches which give pyramidal or conical appearance.
- The body is divided into stem, roots and needle-like leaves.
- The stem is erect and cylindrical and is covered with bark.
- There are two types of branches: the long shoot of unlimited growth and dwarf shoot of limited growth.
- The long shoot bears apical bud and grows indefinitely with many scaly leaves.



- Dwarf shoot does not contain any apical bud and they arise on the long shoot in the axil of scaly leaves.
- Leaves are dimorphic: the long green needle shaped foliage leaves and small, brown, membranous scale leaves.
- Scale leaves are thin and brownish in color which is developed only on long as well as dwarf shoots while the foliage leaves are large, needle-like and found only at the apex of the dwarf shoots.
- The pine bears tap root system with insufficient hairs, but it disappears soon. Many lateral roots also develop which play an important role to absorb the mineral containing water.
- The branch roots are infested with mycorrhizal fungus and hence it is called the mycorrhizal root.
- They have endarch vascular bundles. Individual vascular bundles are separated by means of medullary rays.
- The anatomy of leaves shows xerophytic structure: thick cuticularised epidermis with sunken stomata and sclerenchymatous hypodermis.
- Resin ducts are present in the mesophyll tissue and the cells of the mesophyll have ridges on the walls which project inside the cell cavities.
- Microsporophylls are arranged spirally on the central axis and forms male cone.
- Megasporophyll of the female cone is composed of large ovuliferous scale and lower smaller bract scale, which are the free from each other.
- Each ovuliferous scale bears two anatropous ovules or megasporangia.
- The pollen grains are winged.
- During the development of male gametophyte, two prothallial cells are formed which later on degenerates. Besides these, 2-3 archaegonia are formed with a neck of eight cells.

External Morphology of *Pinus*:

1. *Pinus* is a large, perennial, evergreen plant.
2. Branches grow spirally and thus the plant gives the appearance of a conical or pyramidal structure.

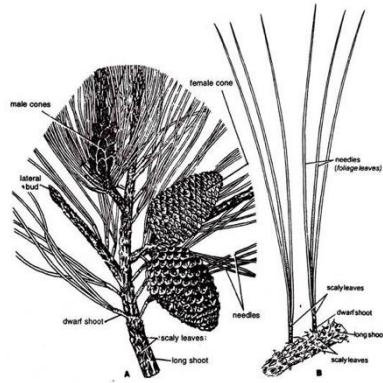


Fig. 26. *Pinus gerardiana*. A, Branch of a mature plant bearing male and female cones; B, A part of stem showing two types of shoots.

3. Sporophytic plant body is differentiated into roots, stem and acicular (needle-like) leaves
4. A tap root with few root hairs is present but it disappears soon. Later on, many lateral roots develop, which help in absorption and fixation.
5. The ultimate branches of these roots are covered by a covering of fungal hyphae called ectotrophic mycorrhiza.
6. The stem is cylindrical and erect and remains covered with bark. Branching is monopodial.
7. Two types of branches are present: long shoots and dwarf shoots. These are also known as branches of unlimited and limited growth, respectively.
8. Long shoots contain apical bud and grow indefinitely. Many scaly leaves are present on the long shoot.
9. Dwarf shoots are devoid of any apical bud and thus are limited in their growth. They arise on the long shoot in the axil of scaly leaves.
10. A dwarf shoot has two scaly leaves called prophylls, followed by 5-13 cataphylls arranged in 2/5 phyllotaxy, and 1-5 needles.
11. The leaves are of two types, i.e., foliage and scaly.
12. Leaf: *Pinus* has two types of leaves: scale leaves and foliage leaves.
 - (a) Scale leaves: The scale leaves are small, membranous and brownish in colour. These are protective in function. They are present on the main and dwarf shoots.
 - (b) Foliage leaves: The foliage leaves are green and needle-like. They are found only on the dwarf shoots forming the spur.

T.S. Needle (Foliage Leaf)

1. It is circular in outline in *Pinus monophylla*, semicircular in *P. sylvestris* and triangular in *P. longifolia*, *P. roxburghii*, etc.

2. Outermost layer is epidermis, which consists of thick-walled cells. It is covered by a very strong cuticle.

3. Many sunken stomata are present on the epidermis.

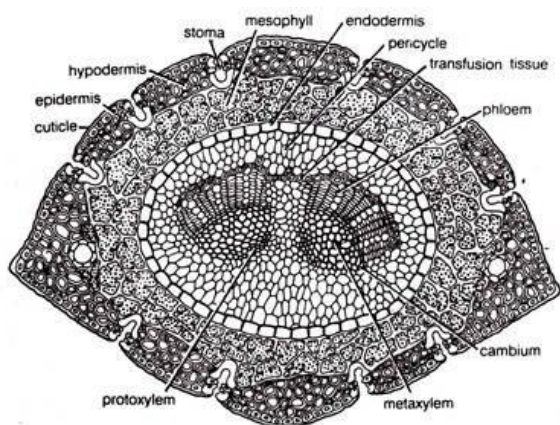


Fig. 38. *Pinus*. T.S. needle.

4. Each stoma opens internally into a substomatal cavity and externally into a respiratory cavity or vestibule.

5. Below the epidermis are present a few layers of thick-walled sclerenchymatous hypodermis. It is well-developed at ridges.

6. In between the hypodermis and endodermis is present the mesophyll tissue.

7. Cells of the mesophyll are polygonal and filled with chloroplasts. Many peg-like infoldings of cellulose also arise from the inner side of the wall of mesophyll cells.

8. Few resin canals are present in the mesophyll, adjoining the hypodermis. Their number is variable but generally they are two in number.

9. Endodermis is single-layered with barrel-shaped cells and clear casparian strips.

10. Pericycle is multilayered and consists of mainly parenchymatous cells and some sclerenchymatous cells forming T-shaped girder, which separates two vascular bundles. Transfusion tissue consists of tracheidial cells.

11. Two conjoint and collateral vascular bundles are present in the center. These are closed but cambium may also present in the sections passing through the base of the needle.

12. Xylem lies towards the angular side and the phloem towards the convex side of the needle.

Reproductive Structures of *Pinus*

- *Pinus* is monoecious, and male and female flowers are present in the form of cones or strobili on the separate branches of the same plant.
- Many male cones are present together in the form of clusters, each of which consists of many microsporophylls. The female cones consist of megasporophylls.
- The male cones on the plant develop much earlier than the female cones.

Male Cone

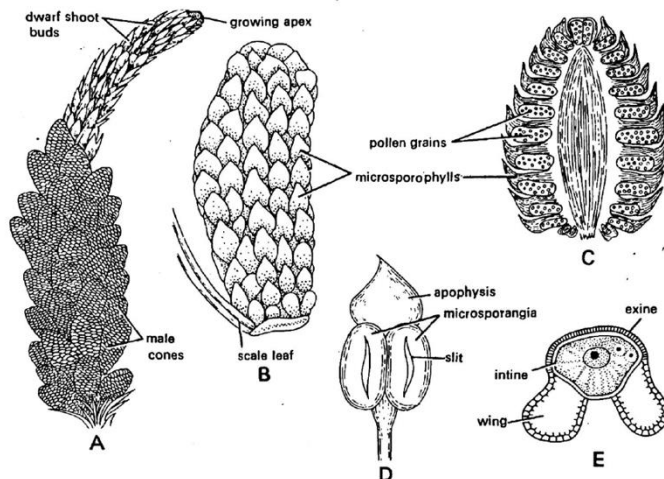


Fig. 16 A-E. *Pinus* : Male cone; A. A group of male cones, B. A single male cone, C. Longitudinal section of male cone, D. Microsporophyll, E. Pollen grain.

Each male cone is ovoid in shape and ranges from 1.5 to 2.5 cm. in length.

A male cone consists of a large number of microsporophylls arranged spirally on the cone axis.

Each microsporophyll is small, membranous, brown coloured structure.

A microsporophyll is comparable with the stamen of the flower of angiosperms because it consists of a stalk (=filament) with a terminal leafy expansion (= anther), the tip of which is projected upwards and called apophysis.

Two pouch-like microsporangia (= pollen sacs) are present on the abaxial or undersurface of each microsporophyll. In each microsporangium are present many microspores (= pollen grains).

Each microspore or pollen grain is a rounded and yellow-coloured, light, uninucleate structure with two outer coverings, i.e., thick outer exine and thin inner intine.

The exine protrudes out on two sides in the form of two balloon-shaped wings. Wings help in floating and dispersal of pollen grains.

A few microsporophylls of lower side of cone are sterile.

Female cone

- Female cone develops either solitary or in groups of 2 to 4.
- They also develop in the axil of scaly leaves on long shoots like male cones.
- Each female cone is an ovoid, structure when young but becomes elongated or cylindrical at maturity.

L.S. Female Cone:

In the centre is present a cone axis

Many megasporophylls are arranged spirally on the cone axis.

A few megasporophylls, present at the base and at the apex of strobilus, are sterile.

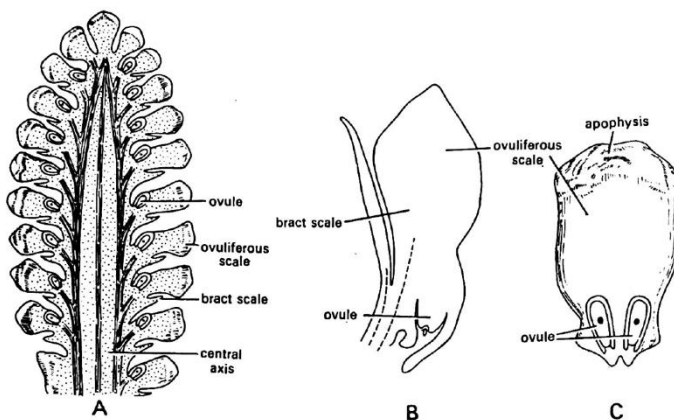


Fig. 19 A-C. *Pinus* : Female cone; A. Longitudinal section, B. Megasporophyll, C. Ovuliferous scale.

Megasporophylls present in the middle of the strobilus are very large and they decrease in size towards the base and apex.

Each megasporophyll consists of two types of scales, known as **bract scales** and **ovuliferous scales**.

Bract scales are thin, dry, membranous, brown- coloured structures having fringed upper part. These are also called carpellary scales.

An ovuliferous scale is present on the upper surface of each bract scale.

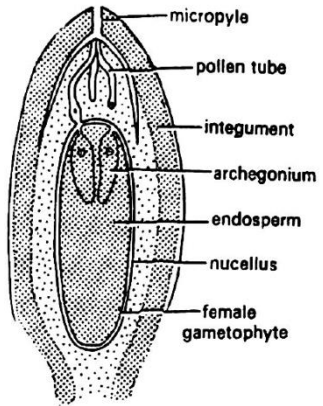


Fig. 20. *Pinus* : Longitudinal section of ovule.

Each ovuliferous scale is woody, bigger and stouter than bract scale and it is triangular in shape. A broad sterile structure, with pointed tip, is present at the apex of these scales. This is called apophysis.

At the base of upper surface of each ovuliferous scale are present two sessile and naked ovules.

Micropyle of each ovule faces towards the cone axis.

Each ovule is orthotropous, and it remains surrounded by a single integument, consisting of an outer fleshy, a middle stony and an inner fleshy layer. It opens with a mouth opening called micropyle.

Integument surrounds the megasporangium or nucellus. Just opposite the micropyle is present a pollen chamber. In the endosperm or female gametophyte are present 2 to 5 archegonia.



Morphological nature of Ovuliferous Scale

known as **apophysis** (Fig. 19 C). In surface view, the apophysis is known as **umbo**. Two ovules are present at the base of the ovuliferous scale on its dorsal surface. The micropyle of each ovule is directed towards the cone axis.

1. Morphological nature of ovuliferous scale. There is a great deal of controversy regarding the morphological nature of the ovuliferous scale as it is present in the axil of a bract scale. Several theories have been advanced to explain its morphological nature. Some important ones are briefly discussed below.

- (1) According to **excrecence or ligular theory** of Sachs (1882) and Eichler (1889), the female cone is equivalent to a simple flower. The central cone axis is equivalent to **receptacle or thalamus** and the bract scales to **open carpels**. They considered the ovuliferous scale as an outgrowth of the bract scale, similar to the ligule of *Selaginella* or the placenta of angiosperms.
- (2) Robert Brown (1827) considered the ovuliferous scale as an **open foliar carpel** which is present in the axil of bract scale and bearing naked ovules.
- (3) Schleiden (1839) considered ovuliferous scale as an **axillary placenta**, present in the axil of an axillary leaf (bract scale).
- (4) According to Alexander Brown (1842), the ovuliferous scale represents the first two leaves of an axillary shoot which had fused. Growth of the axillary shoot is, however, stopped after the formation of first two leaves.
- (5) Van Tieghem (1869) considered the bract as a leaf and the ovuliferous scale as a **single leaf branch** in the axil of the bract.
- (6) Bessey (1902) regarded the ovuliferous scale as a chalazal development of two ovules.
- (7) According to the **foliar theory** of Delpino, (1889) the ovuliferous scale was formed by inward turning and fusion of two lateral lobes of the bract scale. He considered the bract as a tripartite structure with a median sterile and two lateral fertile lobes which were fused together.
- (8) Hirmer derived the ovuliferous scale and bract scale from a single structure which forked vertically like the sporangiophore of Sphenophyllales.
- (9) **Brachyblast theory** of Braun suggests that the female cone is equivalent to an inflorescence rather than a flower. The ovuliferous scale was considered as a determinate axillary shoot bearing 2-3 fertile leaves. Each fertile leaf bears an ovule on the dorsal side.



- (10) On the basis of his extensive studies of fossil conifers, Florin (1951) arrived to the conclusion that the female cone of *Pinus* is comparable to the inflorescence of angiosperms. The cone axis represents peduncle, the bract scale is a true bract and the ovuliferous scale developed in its axil represents a rudimentary female flower (modified reproductive shoot). The female cone of *Pinus* is thus a **compound strobilus**. He introduced a combined term '**seed-scale-complex**' for the bract scale and ovuliferous scale. According to Florin, the flattened seed-scale-complex usually has a rudimentary axis, two basal megasporophylls and two or three sterile distal scales, the latter fused to form the so-called ovuliferous scale.

Describing the morphology of the seed-scale-complex in *Pinus pinaster*, Guedes and Dupuy (1971, 1974) established that only two prophylls make up the scale. On the basis of epidermal features and the developmental order of the various zones of the scale, Lemoine-Sebastian (1973, 1975) visualised that the complex seed scale is composed of an axial portion (which represents the body) possessing the ovules and a foliar part (which corresponds to the apophysis).

From the foregoing discussion it appears that **morphologically the ovuliferous scale is a reduced shoot and the female cone is an inflorescence.**

References

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