3. Reproductive structures—

Vegetative reproduction with the aid of vegetative reproductive structures has not been reported.

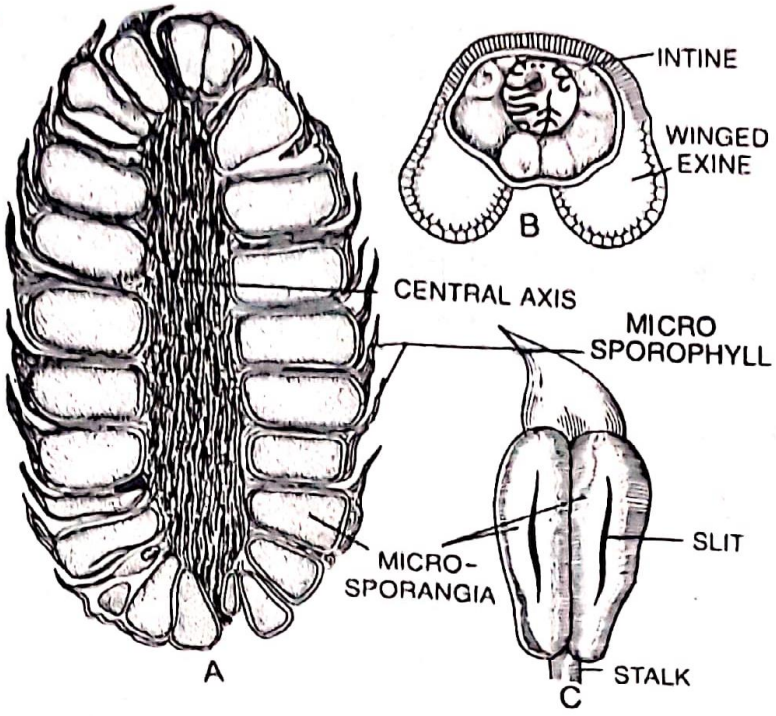

Fig. 3.15 –*Pinus* sp. A–A male cone in median longitudinal section. B–Single microspore (pollen). C–Single microsporophyll i.e. stamen (ventral surface).

The *Pinus* plant represents the sporophytic generation. The plant is monoecious i.e. male and female sporophylls are borne on the same plant but in separate cones i.e. strobili. Flowers are unisexual, they are represented by sporophylls i.e. male flowers by microsporophylls (stamens) and female flowers by megasporophylls (carpels).

(a) ***Male cone i.e. Staminate strobilus*** :—Male cones are simple; they form compact and oval structures, measuring about 2 to 3 cm in length. They occur singly in the axils of scale leaves of long shoots replacing thereby dwarf shoots (Fig. 3.14,A). Male cones thus appear to be morphologically equivalent to dwarf shoots.

Each cone is provided with a short and elongated central axis (thalamus) upon which numerous microsporophylls are arranged spirally (Fig. 3.15,A). The microsporophylls are borne directly on the central axis; therefore, the male cone is homologous to the male flower of an angiosperm and not to an inflorescence. Microsporophylls are scaly and they vary from 60 to 135 in number in each cone. Each microsporophyll consists of a short stalk (i.e. filament) and a leaf-like expanded structure, the apex of which is slightly bent upwards. Two microsporangia are borne on the lower i.e. abaxial surface of such leaf-like expanded portion of each microsporophyll (Fig. 3.15,C).

A microsporangium is sessile and oblong in shape (Fig. 3.15,C); it consists of a wall of several layers of cells. The development of the microsporangium is of eusporangiate type. A nearly mature microsporangium contains inside microspore mother cells surrounded externally by a sporangium wall and tapetum. Each microspore mother cell by reduction division forms four haploid uninucleate microspores *i.e.* pollen grains. Each mature microsporangium, therefore, contains numerous *microspores*. The pollen grains are *winged* (Fig. 3.15B) and yellow in colour. When mature, each microsporangium dehisces by a longitudinal slit along the long axis. As a result large number of pollen grains get released forming a cloud which is often called 'shower of sulphur'.

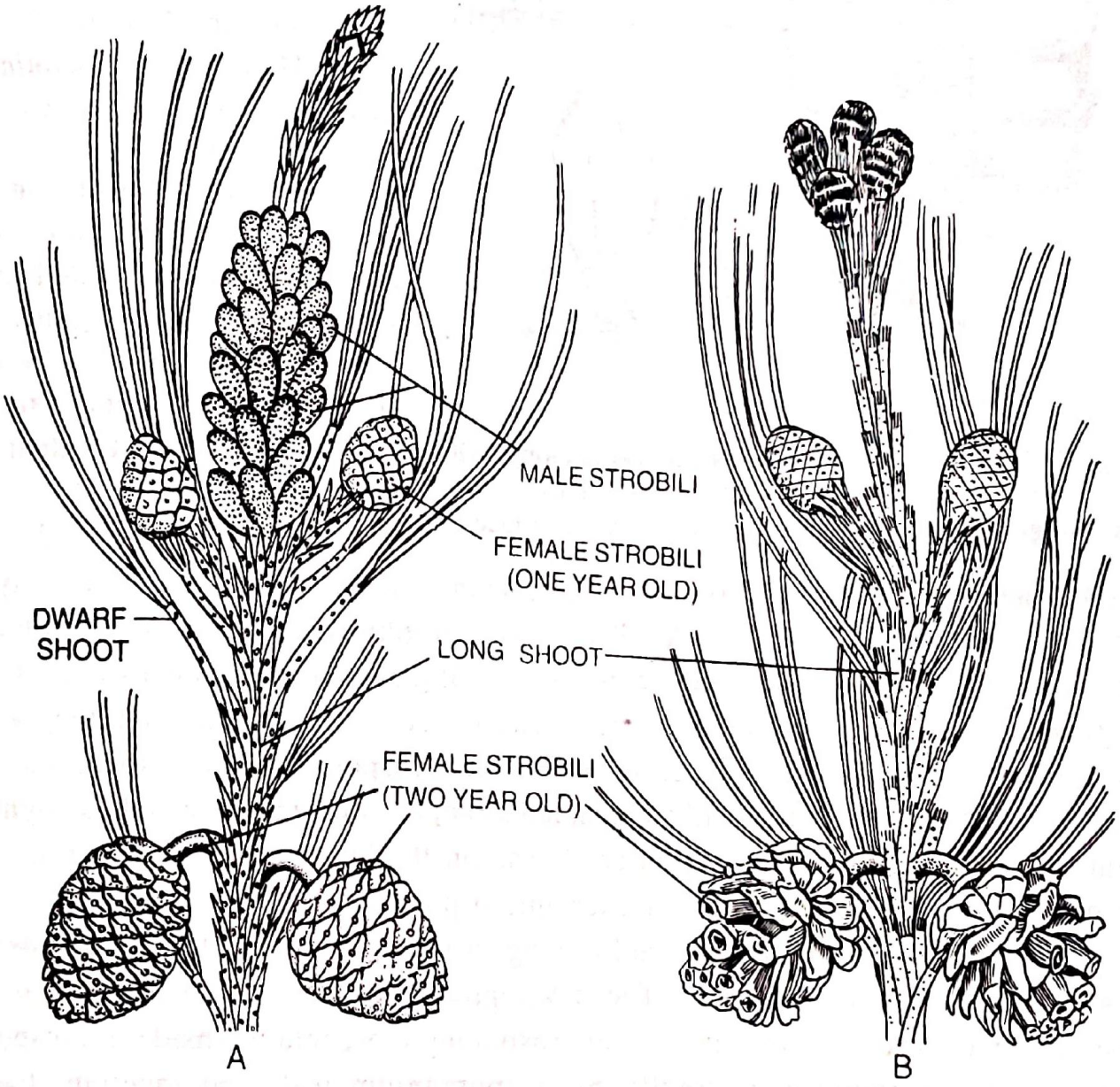

Fig. 3.14 —*Pinus* sp. A-B –Long shoots bearing male and female strobili.
A–At early spring. B–At early monsoon.

(*b*) ***Female cone i.e. Ovulate strobilus*** :— Female cones form true cone-like structures and they are compound in nature. They arise in clusters of 1 to 4 in the axils of scale leaves of the long shoots (Fig. 3.15, A-B) taking the position of

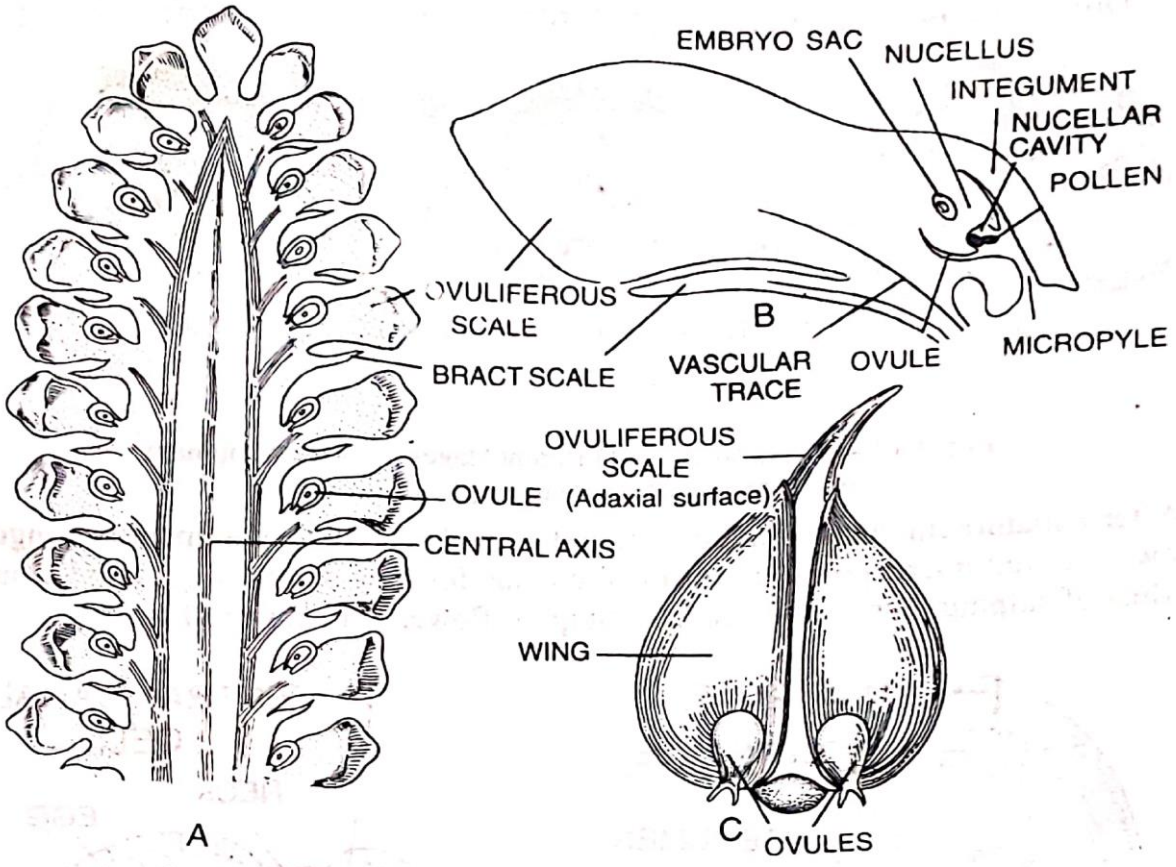

Fig. 3.16 —*Pinus* sp. A–Median longitudinal section of a female strobilus. B–Vertical longitudinal section of an ovule and its associated structures. C–An ovuliferous scale with its two ovules.

dwarf shoots. At first they are green in colour and gradually become brown-red.

The female cone is a hard, woody and dry structure; it consists of a central axis (Fig. 3.16, A) upon which numerous megasporophylls are spirally arranged.

The megasporophyll is shortly stalked and consists of a large ovuliferous scale and a bract scale attached on the lower side of the ovuliferous scale. Each ovuliferous scale bears two inverted or anatropous megasporangia (ovules) on the surface near the base (Fig. 3.16, C). Bract scale and ovuliferous scale are supplied with separate vascular traces.

An ovule (Fig. 3.16, A) consists of a massive nucellus surrounded by an integument. The integument is fused with the nucellus at the basal region and open at the top to form a micropyle. Nucellar beak and pollen chamber are not formed here. The integument consists of three layers e.g., an outer fleshy, a middle stony and an inner fleshy.

Only one megaspore mother cell is differentiated within the nucellar tissue (Fig. 3.18, A), which by meiosis gives rise to a linear-tetrad of four megaspores. Of these four megaspores, only the lowermost one is the functional megaspore while others degenerate (Fig. 3.20, B).

Structure of the Gametophytes

1. **Male gametophyte** —Microspore (pollen grain) is the first cell of the male gametophyte, which is provided with an outer exine and an inner intine. The exine becomes inflated into two wings (Fig. 3.17, A). Germination of the microspore starts inside the

microsporangium long before the shedding of microspores.

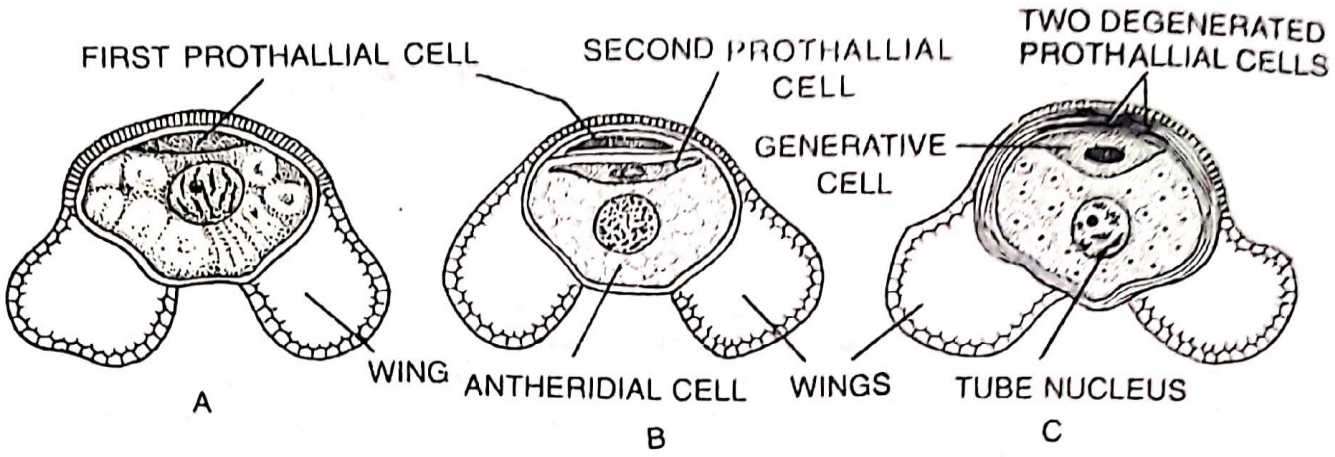

Fig. 3.17 —*Pinus* sp. A-C –Different stages in the development of the male gametophyte before pollination.

After a mature microsporangium longitudinally dehisces, then numerous winged and yellow coloured microspores are liberated outside forming a yellow coloured cloud just like dust of sulphur, hence often called "Sulphur flower" or shower of sulphur.

Microspore-nucleus cuts off two small prothallial cells one after another and a single larger antheridial cell (Fig. 3.17, B). Prothallial cells are not persistent, they degenerate very soon. Antheridial cell next cuts off against the second prothallial cell, a small generative cell and a larger tube cell (Fig. 3.17, C). At this 4-celled stage the

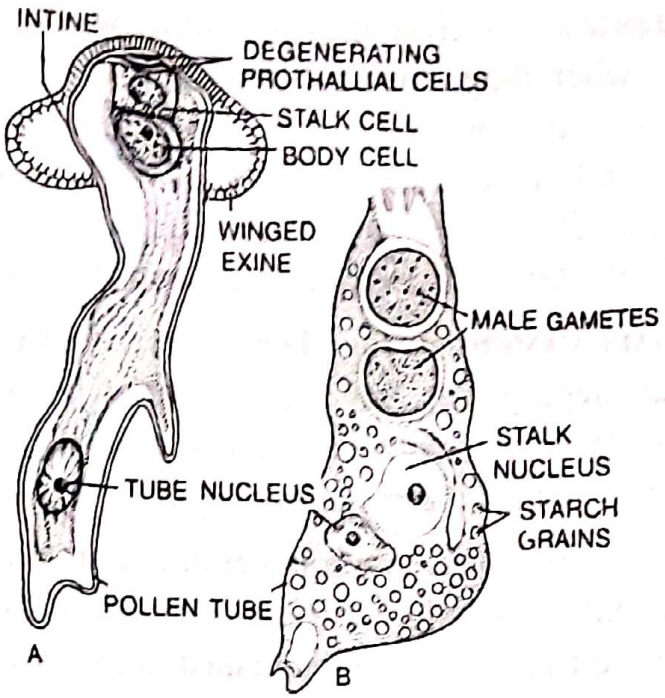

Fig. 3.19—*Pinus* sp. Further development of the male gametophyte after pollination. A–Formation of pollen tube, stalk cell and body cell. B–Tip of pollen tube containing two male gametes; a stalk nucleus and a tube nucleus.

microspores are shed from the microsporangium, further development of which takes place only when they reach the ovule (i.e. after pollination).

The tube cell elongates to form an unbranched pollen tube; within the pollen tube generative cell moves and later divides into a sterile stalk cell and a spermatogenous or body cell. The body cell further divides and forms two non-motile male gametes (Fig. 3.19, B). Of these two gametes, one may be slightly larger than the other.