Gnetum

Reproduction:

Gnetum is dioecious. The reproductive organs are organised into well-developed cones or strobili. These cones are organised into inflorescences, generally of panicle type. Sometimes the cones are terminal in position.

A cone consists of a cone axis, at the base of which are present two opposite and connate bracts. Nodes and internodes are present in the cone axis. Whorls of circular bracts are present on the nodes. These are arranged one above the other to form cupulas or collars (Fig. 13.10). Flowers are present in these collars. Upper few collars may be reduced and are sterile in nature in G. gnemon.

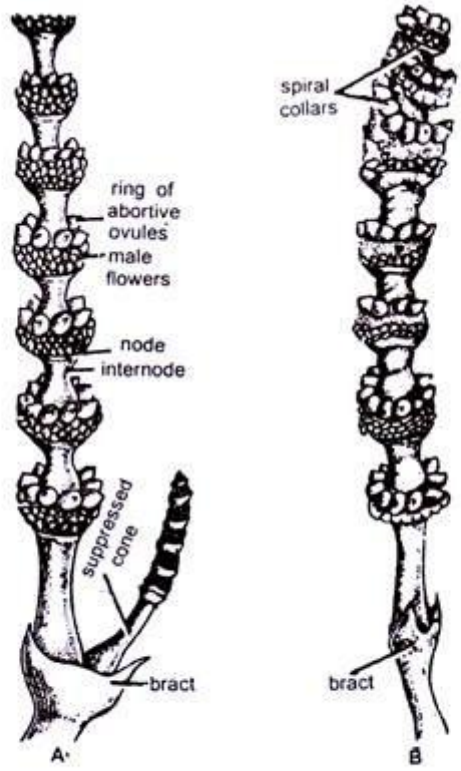

Fig. 13.10. *Gnetum*. A, A branch bearing a panicle of a well-developed male cone and a suppressed cone in *G. ula*; B, An old cone of *G. gnemon* showing spiral collars at the apical end. (Modified after Madhulata, 1960).

Male Cone and Male Flower:

The male flowers are arranged in definite rings above each collar on the nodes of the axis of male cone. The number of rings varies between 3-6. The male flowers in the rings are arranged alternately. There is a ring of abortive ovules or imperfect female flowers above the rings of male flowers.

Each male flower contains two coherent bracts which form the perianth (Fig. 13.11). Two unilocular anthers remain attached on a short stalk enclosed within

the perianth. At maturity, when the anthers are ready for dehiscence, the stalk elongates and the anthers come out of the perianth sheath. In Gnetum gnemon a few (2-3) flowers are sometimes seen fusing each other (Fig. 13.12).

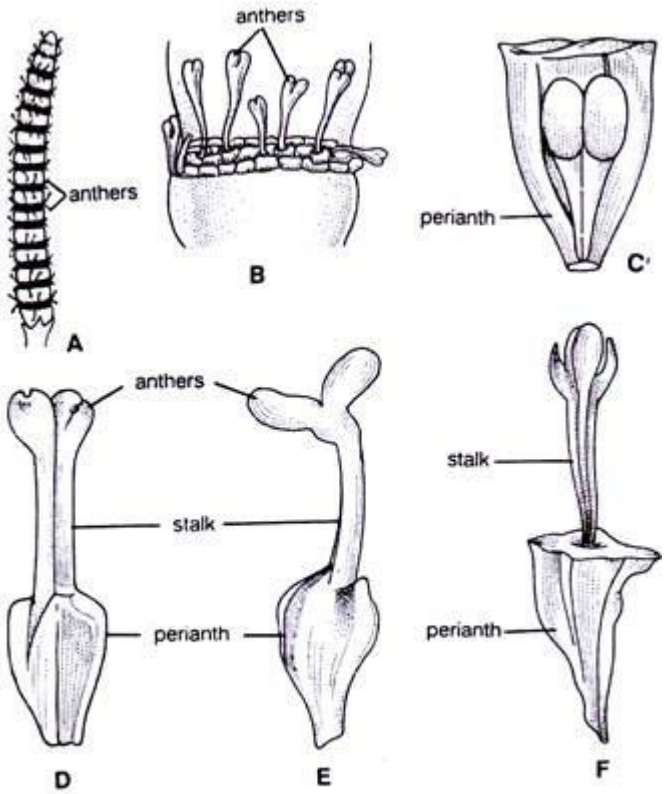

Fig. 13.11. *Gnetum ula*. A, A male cone; B, A part of 'A' showing male flowers; C, L.S. male flower; D-E, Male flowers with anthers emerged out of a perianth; F, A dehisced male flower.

Fig. 13.12. *Gnetum gnemon*. Showing fusion of male flowers. (modified after Madhulata, 1960).

Female Cone:

The female cones resemble with the male cones except in some definite aspects. A single ring of 4-10 female flowers or ovules is present just above each collar (Fig. 13.15). Only a few of the ovules develop into mature seeds (Fig. 13.15B).

In the young condition, there is hardly any external difference between female and male cones. All the ovules are of the same size when young but later on a few of them enlarge and develop into mature seeds. All the ovules never mature into seeds.

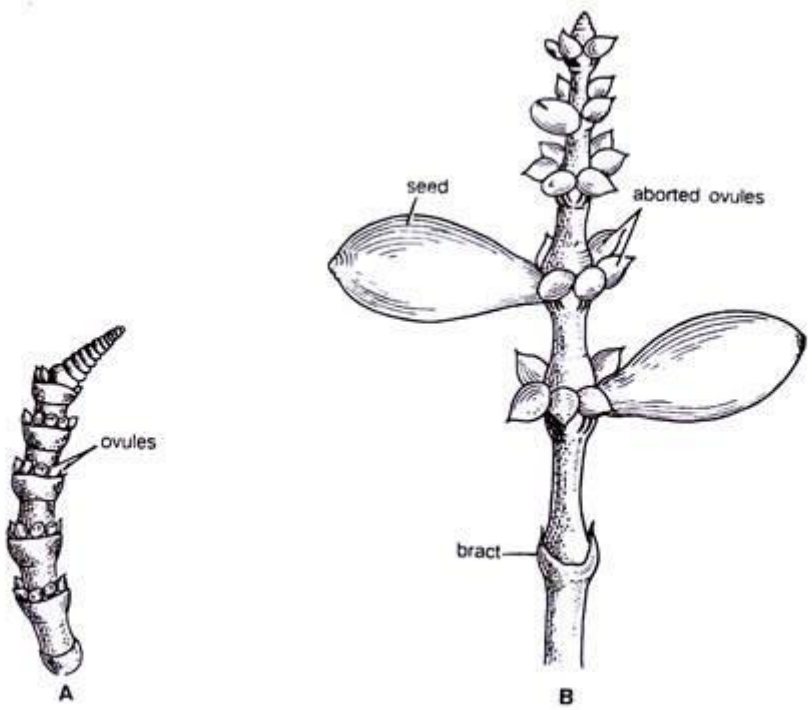

Fig. 13.15. *Gnetum*. A, An old female cone of *G. ula*; B, A female cone of *G. gnemon* bearing two seeds.

Ovule or Female Flower:

Each ovule (Fig. 13 16) consists of a nucellus surrounded of three envelopes. The nucellus consists of central mass of cells. The inner envelope elongates beyond the middle envelope to form the micropylar tube or style. The nucellus contains the female gametophyte. There is no nucellar beak in the ovule of *Gnetum*.

Stomata, sclereids and laticiferous cells are present in the two outer envelopes. Madhulata (1960) observed the formation of a circular rim from the outer epidermis of the inner integument in *G. gnemon*. Thoday (1921), however, observed the formation of a second such rim at a higher level. The ovules in G. ula are stalked.

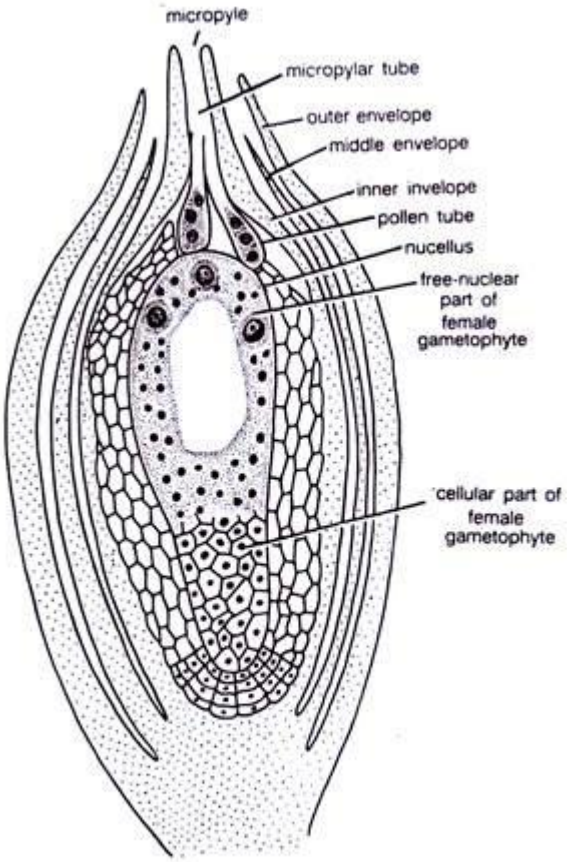

Fig. 13.16. *Gnetum*. L.S ovule.

Abnormal Cones:

More than one rings of ovules in the male cones in Gnetum gnemon have been reported by Thompson (1960) and Madhulata (1960). Collars, arranged spirally in the female cones of *G. gnemon* and *G. ula* have been observed by several workers including Maheshwari (1953).

Pearson (1912) reported some cones bearing only two collars in G. buchholzianum. Rarely, the lower collars in the male cones bear one or two fertile ovules whereas normal male flowers are present in the upper collars of the same cone.

Morphological Nature of Three Envelopes:

Several different views have been given by many different workers regarding the morphological nature of the three envelopes surrounding the nucellus.

A few of them are under mentioned:

(i) According to Strasburger (1872) three envelopes of nucellus are integuments developing from the differentiation of single integument.

(ii) Baccari (1877) opined that the outer envelope is a perianth while the inner two envelopes are integuments.

(iii) Van Tieghem (1869) considered the two inner envelopes as the integuments while the outer envelope as an ovary or analogous to it.

(iv) According to Lignier and Tison (1912), however, the outer two envelopes form a perianth while the inner envelope is equivalent to an angiospermic ovary. Vasil (1959) also supported the view of Lignier and Tison (1912) in case of Gnetum ula.

Fertilization:

The fertilization in *Gnetum* has been studied only by a few workers. Vasil (1959) studied this phenomenon in *G. ula*. At the time of fertilization, the pollen tube pierces through the membrane of the female gametophyte just near to a group of densely cytoplasmic cells. The tip of pollen tube bursts and the male cells are released. One of the male cells enters the egg cell.

The male and female nuclei, after lying side by side for some time, fuse with each other and form the zygote. According to Swamy (1973), the only identifying features of the zygote are its spherical shape and dense cytoplasm. Both the male cells of a pollen tube may remain functional if two eggs are present close to the pollen tube.

Endosperm:

In all gymnosperms, except Gnetum, a cellular endosperm (Fig. 13.21) develops before fertilization. In Gnetum, the cell formation, although starts before fertilization, a part of the gametophyte remains free-nuclear at the time of fertilization.

After fertilization the wall formation in the female gametophyte starts in such a way that the cytoplasm gets divided into many compartments. Each of these compartments contains many nuclei (Fig. 13.21C).

All the nuclei of one compartment fuse and form a single nucleus. The wall formation starts from the base and proceeds upwards. The wall formation varies greatly in *Gnetum*. Only the lower portion of the gametophyte may become cellular leaving the remaining upper portion free-nuclear. Sometimes the entire gametophyte may become cellular.

In some cases the upper portion may become cellular instead of the lower portion. Sometimes only the middle portion may become cellular and in still other cases there may not be any wall formation at all. The characteristic triple fusion of the angiosperms is, however, absent in *Gnetum*.

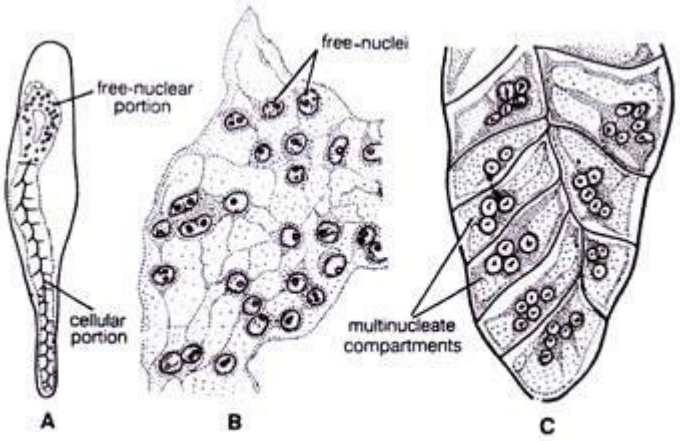

Fig. 13.21. *Gnetum ula*.. A, Female gametophyte showing the development of endosperm; B, A part of upper portion of 'A'; C, A part of lower portion of 'A'. (modified after Vasil, 1959).

The Embryo:

The embryo development in several species of *Gnetum* has been studied by many different workers including Lotsy (1899), Coulter (1908) and Thompson (1916), but the details put forward by these wokers are highly variable.

Maheshwari and Vasil (1961) have stated that in all the angiosperms the first division of the zygote is accompanied by a wall formation but in all gymnosperms, except *Sequoia sempervirens*, these are free-nuclear divisions in the zygote. *Gnetum* in this respect forms a link in between gymnosperms and angiosperms by showing both free-nuclear divisions as well as cell divisions.

Thompson (1916) opined that a two-celled pro-embryo is formed (Fig. 13.22 A). From each of these two cells develops a tube called suspensor (Fig. 13.22B). Now the nucleus divides and one of the two nuclei undergoes free-nuclear divisions forming four nuclei. The embryo gets organised by these four nuclei (Fig. 13.22C, D). There is no division in the other larger nucleus..

Madhulata (1960) has worked on the zygote development in *Gnetum gnemon*. According to her 2-4 or sometimes up to 12 zygotes may develop in a gametophyte, of which normally one remains functional. From the zygote develops generally one or sometimes 2-3 small tubular outgrowths.

Only one of these tubes receives the nucleus and survives while the remaining tubes disintegrate and soon die. The surviving outgrowth elongates, becomes branched and grows into different directions through the intercellular spaces of the endosperm. All the primary suspensor tubes usually remain coiled round each other.

A small cell is cut off at the tip of the primary suspensor tube in Gnetum gnemon. It soon divides first transversely and then longitudinally resulting into four cells. Now irregular divisions take place forming a group of cells. Some of these cells divide and elongate to form secondary suspensor (Fig. 13.23). The remaining cells at the tip form the embryonal mass.

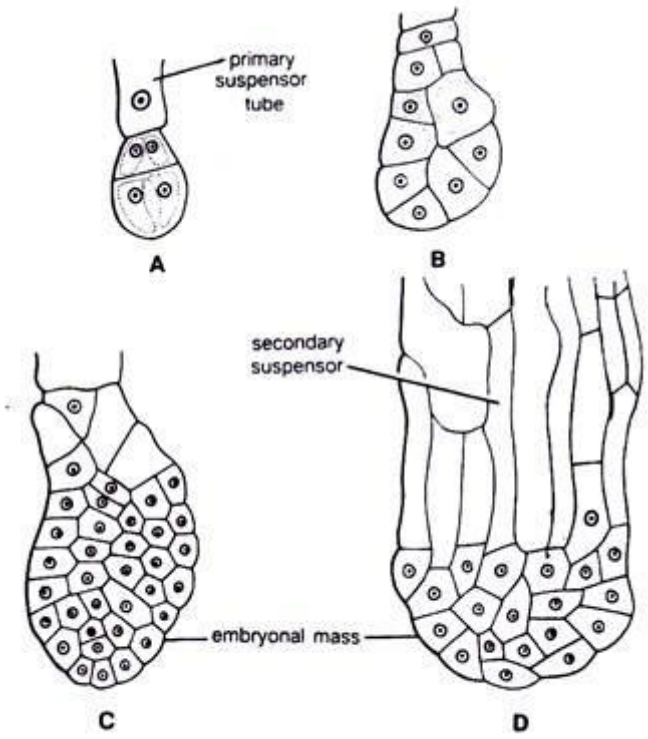

Fig. 13.23. *Gnetum gnemon.* Development of embryonal mass.

In *Gnetum ula* a small cell is cut off at the tip of the tube called peculiar cell. This peculiar cell soon divides and forms a group of cells. The secondary suspensor and embryonal mass are differentiated from this group of cells. By this time, the wall of the tube starts to become thick.

What so ever may be the pattern of formation of the embryonal mass and secondary suspensor, the cells of the former are small, compact, dense in cytoplasm and develop into embryo-proper while that of the latter (i. e. secondary suspensor) are thin-walled, uninucleate and highly vacuolated.

The primary and secondary suspensors help in pushing the embryo into the endosperm. Soon a stem tip with two lateral cotyledons form in the tip region of the embryonal mass. On the opposite side develop the root tip with a root cap.

A feeder develops after the formation of stem and root tips (Fig. 13.25). The feeder is a protuberance-like structure present in between root and stem tips. Thus, the stem tip, two cotyledons, feeder, root tip and root cap are the parts of a mature embryo.

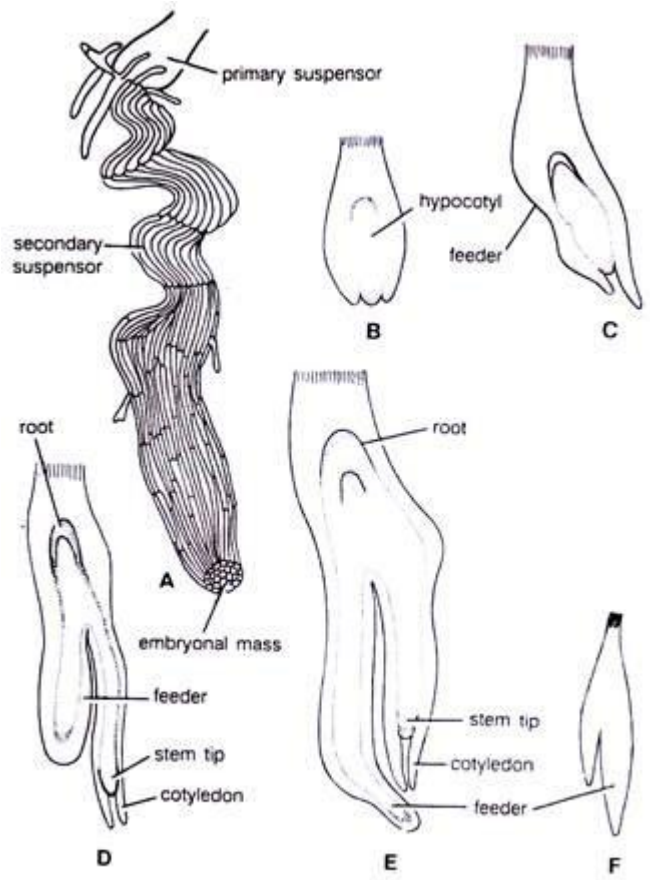

Fig. 13.25. *Gnetum ula*. Development of embryo.

Seed:

Gnetum seeds (Fig. 13.26) are oval to elongated in shape and green to red in colour. It remains surrounded by a three-layered envelope which encloses the embryo and the endosperm. Outer envelope is fleshy, and consists of parenchymatous cells. It imparts colour to the seed.

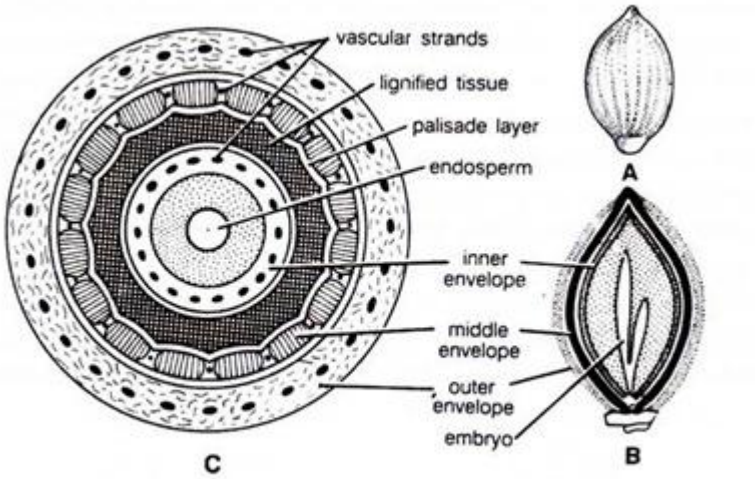

Fig. 13.26. *Gnetum*. A, An entire seed; B, L.S. seed; C, T.S. seed.

The middle envelope is hard, protective and made up to three layers, i.e., outer layer of parenchymatous cells, middle of palisade cells and innermost fibrous region. The inner envelope is parenchymatous. Branched vascular bundles traverse through all the three envelopes.

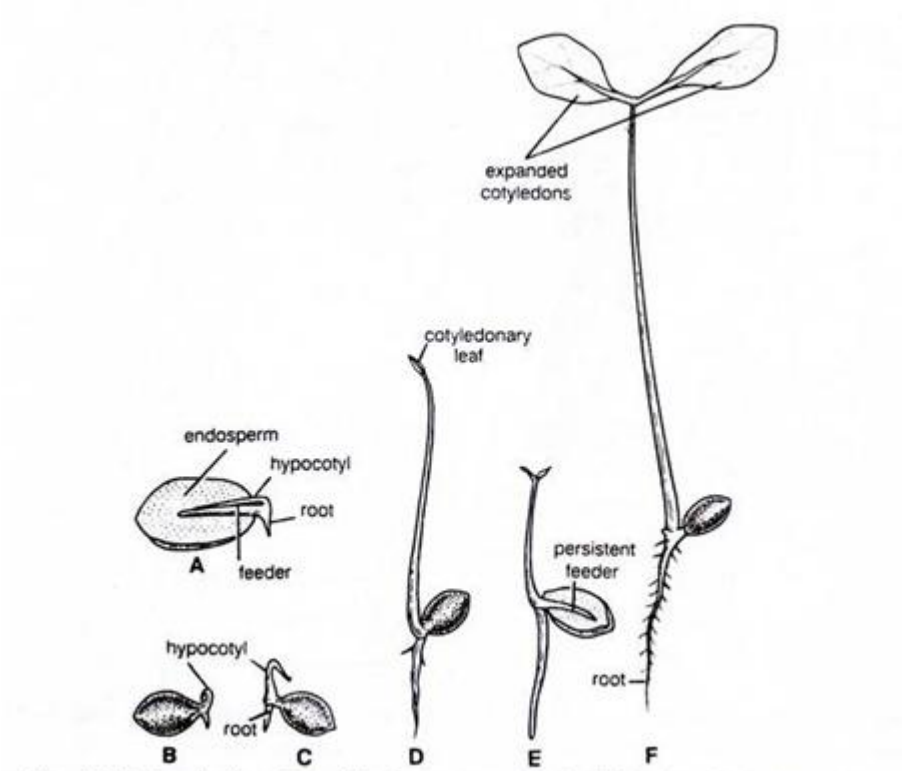

Fig. 13.27. Germination of seed in *Gnetum gnemon*. (modified after Madhulata, 1960).

Germination of Seed:

Germination is of epigeal type (Fig. 13.27). The cotyledons are pushed out of the seed. The hypocotyl elongates, and this brings the cotyledons out of the soil. The first green leaves of the plant are formed by the cotyledons. The first pair of

foliage leaves is produced by the development of plumule. A persistent feeder is present up to a very late stage in the seed.

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5. Relationships of *Gnetum*:

Gnetum and Other Gymnosperms:

Gnetum shows several resemblances with gymnosperms and has, therefore, been finally included under this group.

Some of the characteristics common in both *Gnetum* and other gymnosperms are under mentioned:

1. Wood having tracheids with bordered pits.

2. No sieve tubes and companion cells are present.

3. Presence of naked ovules.

4. Absence of fruit formation because of the absence of ovary.

5. Anemophilous type of pollination.

6. Development of prothallial cell.

7. Cleavage polyembryony.

8. Resemblance of the vascular supply of the peduncle of the cone of Cycadeoidea wielandii with that of a single flower of Gnetum.

9. Resemblance of the structure of basal part of the ovule in Gnetum and Bennettites.

Gnetum and Angiosperms:

A key position to Gnetum has been assigned by scientists while discussing the origin of angiosperms. Both Gnetales and angiosperms originated from a common stalk called “Hemi-angiosperm”.

Thompson (1916) opined that the ancestors of both Gnetum and angiosperms were close relatives. Some other workers have gone up to the extent in stating that Gnetum actually belongs to angiosperms. Hagerup (1934) has shown a close relationship between Gnetales and Piperaceae.

In a beautiful monograph on Gnetum, Maheshwari and Vasil (1961) have stated that **"*Gnetum* remains largely a phylogenetic puzzle. It is gymnospermous, but possesses some strong angiospermic features".**

Some of the resemblances between Gnetum and angiosperms are under mentioned:

1. The general habit of the sporophyte of many species of Gnetum resembles with angiosperms.

2. Reticulate venation in the leaves of Gnetum is an angiospermic character.

3. Presence of vessels in xylem is again an angiospermic character.

4. Clear tunica and corpus configuration of shoot apices is a character of both Gnetum and angiosperms.

5. Strobili of Gnetum resemble much more with angiosperms than any of the gymnosperms

6. Micropylar tube of Gnetales can be compared with the style of the angiosperms because both perform more or less similar functions.

7. Tetrasporic development of the female gametophyte is again a character which brings Gnetum close to angiosperms.

8. Absence of archegonia again brings Gnetum and angiosperms much closer.

9. Dicotyledonous nature of the embryo of Gnetum brings it quite close to the dicotyledons.

Resemblances Between Gnetum, Ephedra and Welwitschia:

All the three genera of Gnetales show following resemblances:

(1) Opposite leaves;

(2) Vessels in their secondary wood,

(3) Similar structure and development of perforation plates in their vessels;

(4) Similar Gnetalean mode of development of their vessels i.e. by the dissolution of torus and middle lamella of the bordered pits;

(5) Almost similar structure of their sieve cells and phloem parenchyma;

(6) Spiral or annular elements in their protoxylem;

(7) Arrangement of their flowers in compound strobili;

(8) Unisexual flowers;

(9) Dioecious plants;

(10) Stalked male flowers bearing synangia made of 1-6 or more sporangia;

(11) Almost consistent structure of the wall of their microsporangia;

(12) Wingless pollen grains;

(13) Orthotropous ovules;

(14) Ovules surrounded by several envelopes which are interpreted variously as integuments or perianth;

(15) Extremely elongated micropylar tube;

(16) Formation of unicellular primary suspensors;

(17) Dicotyledonous embryo;

(18) Simple type of polyembryony.