BOTANY

SEMESTER-II

Basics of Vascular plants and Phytogeography

SYLLABUS

UNDER GRADUATE COURSES (UNDER CBCS 2020 - 2021 ONWARDS)

Practical syllabus of Botany Core Course-2/Semester-II

Basics of Vascular Plants and Phytography

(Pteridophytes, Gymnosperms, Taxonomy of Angiosperms and Phytography)

(Total hours of laburatory exercises 30 Hrs. @ 02 Hrs/Week)

Course Outcomes : One successful completion of this practical course, Student shall be able to :

1. Demonstrate the techniques of section cutting, preparing slides, identifying of the material and drawing exact figures.
2. Compare and contrast the morphological, anatomical and reproductive ffeature of vascular plants.
3. Identify the local angiospersm of the families prescribed to their genus and species level and prepare herbarium.
4. Exhibit skills of preparing slides, identifying the given twigs in the lab and drawing figures of plant twigs, flowers and floral diagrams as they are :
5. Prepare and preserve speciments of local wild plants using herbarium techniques.

Practical Syllabus :

1. Study/microscopic observation of vegetative sectional/anatomical and reproductive structures of the following using temporary or permanent slides/specimens/mounts.
   (a) Pteridophyta : Lycopodium and Marselia.
   (b) Gymnosperms : Cycas and Gnetum
2. Study of fossil specimens of Cycadeoidea and Pentoxylon (Photographs/ diagrams can be shown if specimens are not available).
3. Demonstration of herbarium techniques.
4. Systematic/taxonomic study of locally avilable plants belonging to the families prescribed in theory syllabus. (Submission of 30 number of Herbarium sheets of wild plants with the standard system is mandatory).
5. Mapping of phytogeographical regions of the globe and India.

CONTENTS...

1

(A) PTERIDOPHYTA, (B) GYMNOSPERMS

(A) PTERIDOPHYTA

(i) Lycopodium

Systematic Position :

Division : *Pteridophyta*
Class : *Lycopsida*
Order : *Lycopodiales*
Family : ***Lycopodiaceae***

1. *Lycopodium* are commonly called as *club mosses* ,
2. The plant body is sporophytic and differentiated intoroots, stem and leaves.
3. The genus is divided into two sub genera. They are *Urostachya* and *Rhopalostachya*. In *Urostachya*, the plant body is either erect or pendent
4. In *Rhopalostachya*, the plants have creeping stems which produce adventitious roots below and errect branches above.
5. Roots are adventitious and dichotomously branched. They are produced along the entire length of the stem in the sub gems *Rhopalostachya*, while they arise only at the base of the stem in the sub genus *Urostachya*.
6. The stem is erect in *Urostachya* and prostrate in *Rhopalostachya*. It is thickly covered with many leaves .

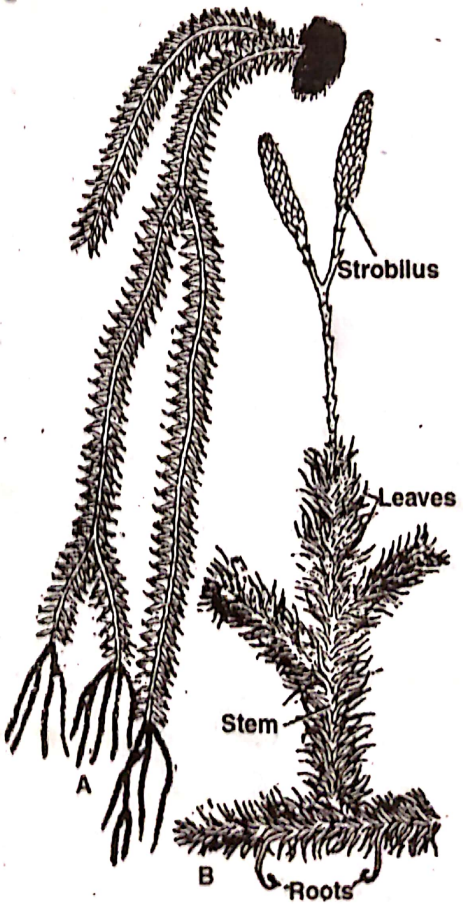


Fig. External features.
A. L. phlegmaria; B. L. clavatum

7. Leaves are simple, small, lanceolate with broad base and sessile . They are arranged spirally in *L. clavatum,* in pairs in *L. alpinum* and in whorls in *L. cernuum.*
8. Leaves are similar, In some species dimorphic leaves are produced which are arranged in definite vertical rows along the stem. eg. *L . volubile.*

I. Internal Structure :

A. Root T.S :

1. Internally root consists of outer epidermis, middle cortex and inner stelar region.
2. Several root hairs arise from epidermis in pairs.
3. The cortex is differentiated into outer cortex and inner cortex . Outer cortex is made up of thick walled cells and the inner cortex is made up of parenchymatous cells.
4. The xylem is monarch, diarch or triarch with one, two or three protoxylem groups.
5. The xylem is 'c' or ' u ' shaped with protoxylem at the tips of curved xylem.
6. Phloem is present in between two arms of the xylem.

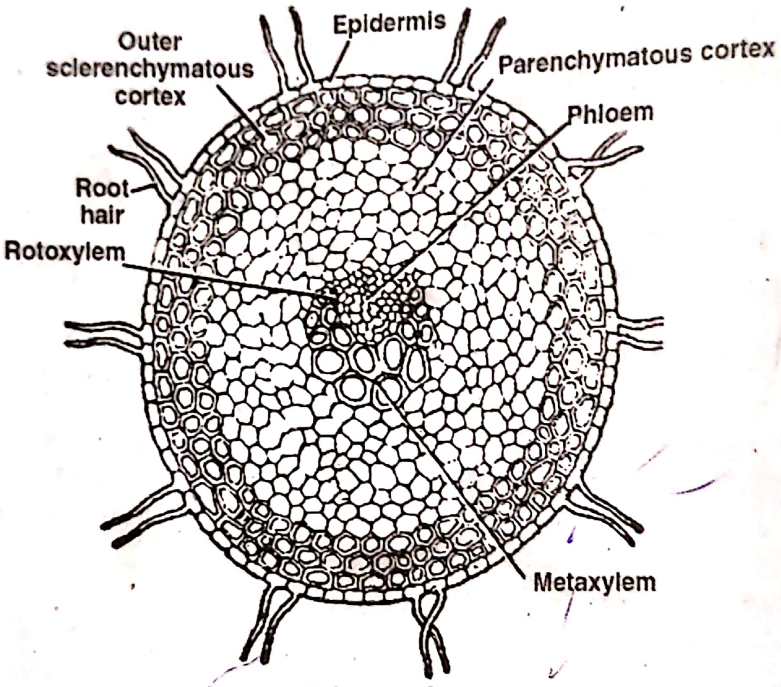


Fig. T.S. Aerial root

B. Stem T.S :

1. Internally stem is differentiated into epidermis, cortex and stele.
2. The outer most layer epdermis is having thick cuiticle and comprises of many stomata.
3. The cortex is divided into three concentric zones . The outer and inner cortex are made up of sclerenchymatous cells while the middle cortex is parenchymatous.
4. The central stelar region is separated from cortex by well developed endodermis.
5. Below the endodermis, pericycle is present which is 3 - 6 layered and is made up of thin walled cells.

6. The stele is a protostele without any pith region. It shows variation in different species. There are four different types of protosteles observed in *Lycopodium* , viz, actinostele, plectostele, mixed protostele and polyarch actinostele.
7. In actinostele the xylem is in the form of radial arms and has phloem in between. eg; *L. serratum*. In plectostele the xylem and phloem are present as alternating plates. eg : *L. volubile*. In mixed protostele, the xylem is present as irregular scattered patches embedded in the phloem. eg : *L.cerunum*. In polyarch actinostele, the radiating arms of xylem transformed into many irregular lobes with phloem patches in between. Eg : *L. lucidulum*.
8. Many leaf traces are present originated from the protoxylem points of the stele.

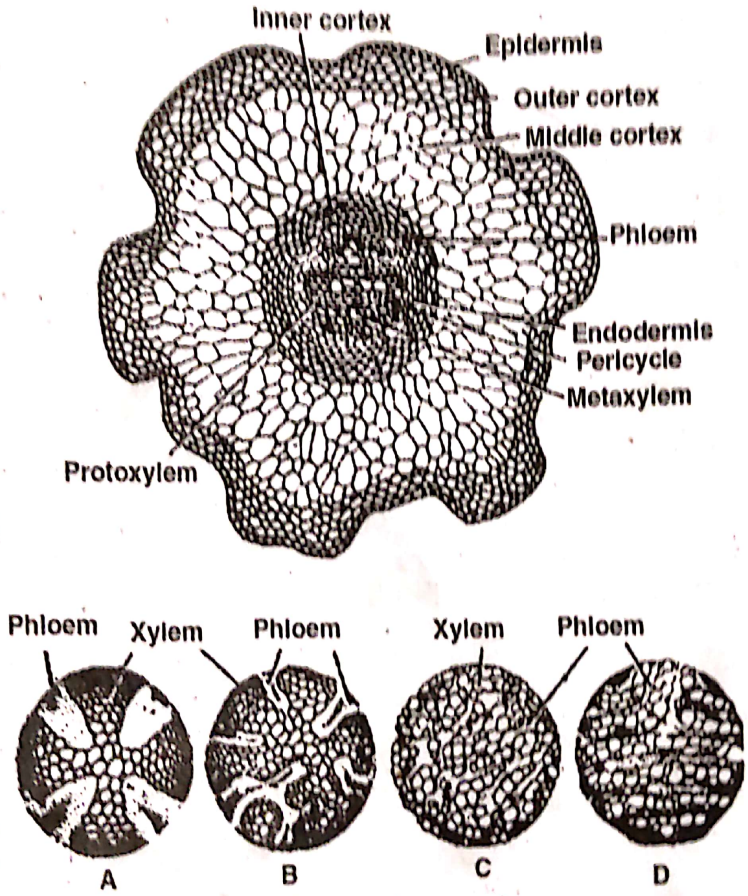


Fig. The stele of stem in different species : (A) L. serratum, (B) L. lucidulum, (C) L. cernuum; (D) L. volubile

C. T.S.of Leaf :

1. It shows the presence of epidermis on both upper and lower surfaces, central stelar region with mesophyll tissue in between.
2. The epidermis is cuticulate with many stomata.
3. The mesophyll is made up of loosely arranged cells with many large intercellular spaces which contain chloroplasts.
4. A median concentric vascular bundle is present at the centre in which the central xylem is surrounded by a zone of phloem.

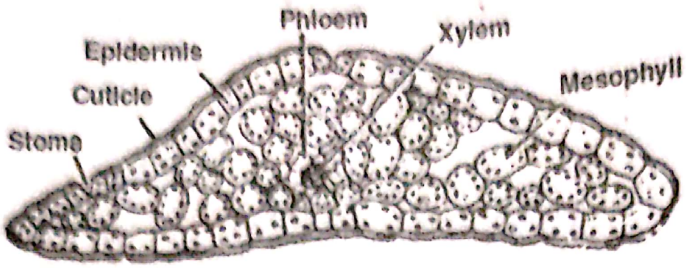


Fig. T.S. Leaf

5. Xylem consists of annular or spiral trachieds and phloem consists of sieve tubes and phloem parenchyma.

II. Reproductive structures :

1. *Lycopodium* is homosporous, producing only one kind of spores in sporangia . The sporangia are present at the base of fertile leaves called sporophylls. The sporophylls are arranged in the form of a cone like structure called as strobilus. The sporophylls are spirally arranged on the central axis of the strobilus.
2. Sporangia are developed on the adaxial side of each sporophyll. Each sporagium is reniform, kidney shaped measuring 1-2.5mm in diameter. The sporangium is developed on a small stout stalk.
3. Many spores are produced inside the sporangium. Spores are arranged in tetrahedral fashion.
4. Each spore is minute, measuring 0.03 to 0.05 mm in diameter with a triradiate ridge .
5. Spores on germination gives rise to prothallus.

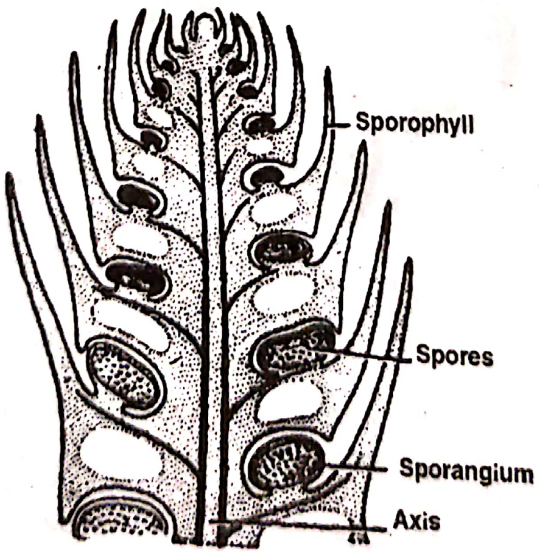


Fig. V.S. of the apical portion of the cone (strobilus)

POINTS FOR VIVA VOCE (ORAL EXAMINATION)

1. These are commonly called as 'Club mosses'.
2. In the sub genus-*Urostachya*, stem is errect and leaves are undifferentiated from sporophylls.
3. In the sub genus-*Rhoplaostachya*, stem is creeping and sporophyll differ from vegetative leaves by having dentate margins.
4. Root consists of characterestic 'C' or 'U' shaped xylem with protoxylem at the tips of curved Xylem.
5. Stem show four different types of protostele conditions.
6. Actinostele in *L. serratum*, Plectostele in *L. volubile.*
7. In actinostele, the xylem is in the form of radial arms and has phloem in between.
8. In Plectostele, xylem and phloem are present as alternating plates.
9. In mixed protostele, the xylem is present as irregular, scattered patches in the phloem.
10. In Polyarch actinostele, the radiating arms of xylem transformed into many irregular lobes with phloem patches in between.
11. Lycopodium is homosporous, producing only one type of spores.
12. Sporophylls are arranged in a strobilus. Each spore is minute with a triradiate ridge.

(ii) Marselia

Systematic Position :

Division	:	*Pteridophyta*
Class	:	*Pteropsida*
Order	:	*Marseliales*
Family	:	*Marseliaceae*
Genus	:	***Marselia***

I. External features :

1. Plant body is a sporophyte. It consists of slender rhizome from which several roots arise towards lowerside and leaves towards upper surface.
2. Rhizome is underground, in many species rarely above the soil and is much branched. It is divided into nodes and internodes.
3. Leaves and roots arise from nodal region. Leaves are alternate in two rows. Roots may also arise from internodal regions. Roots are adventitious roots.

4. Young leaves show ciminate vernation. Each leaf has long, slender petiole and four leaf lets at the apex. The leaflets are obovate in shape. The veins in each leaflet show dichotomous branching, the veinlets are connected with cross connections.
5. One to five bean shaped sporocarps are attached, at the base of the leaf, to the pedicle with their peduncles. These are reproductive structures.

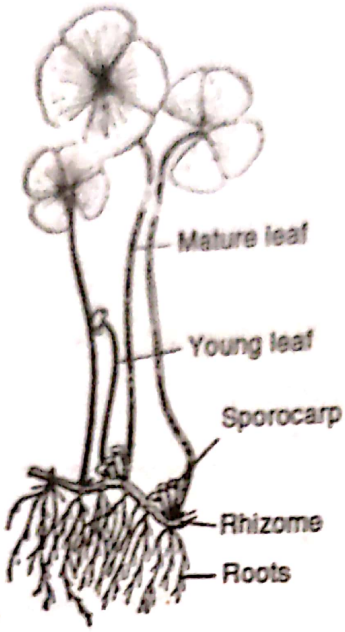


Fig : Marselia showing habit

II. Anatomical features :

(A) Root T.S :

1. In transverse section, root shows the epidermis, cortex and the central stelar region. Epidermis is single layered and is made up of thick walled cells.

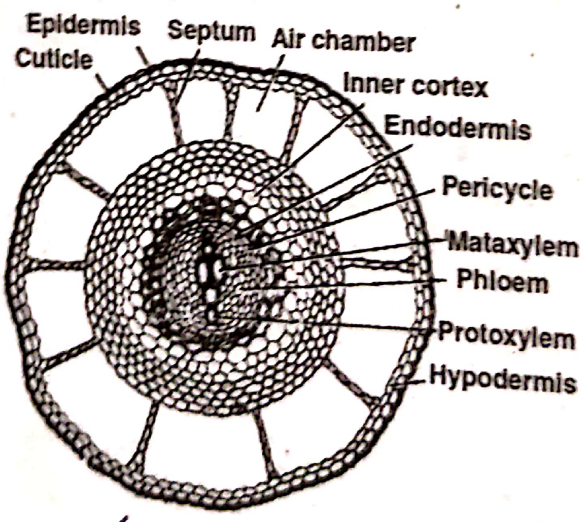


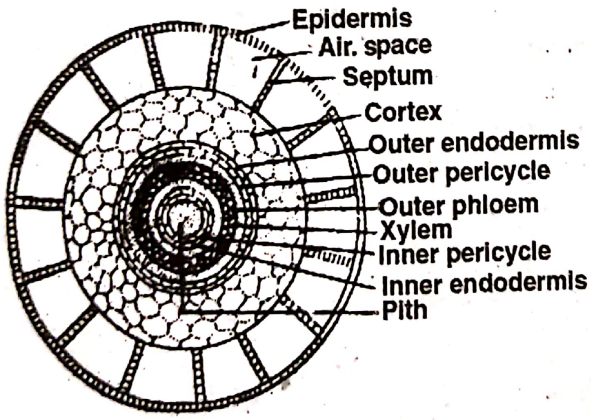
Fig : T.S. root

2. Cortex is divided into outer and inner cortex. The outer cortex is parenchymatous and it consists of large air chambers separated by septa or trabeculae.
3. Inner cortex is thick walled and sclerenchymatous.

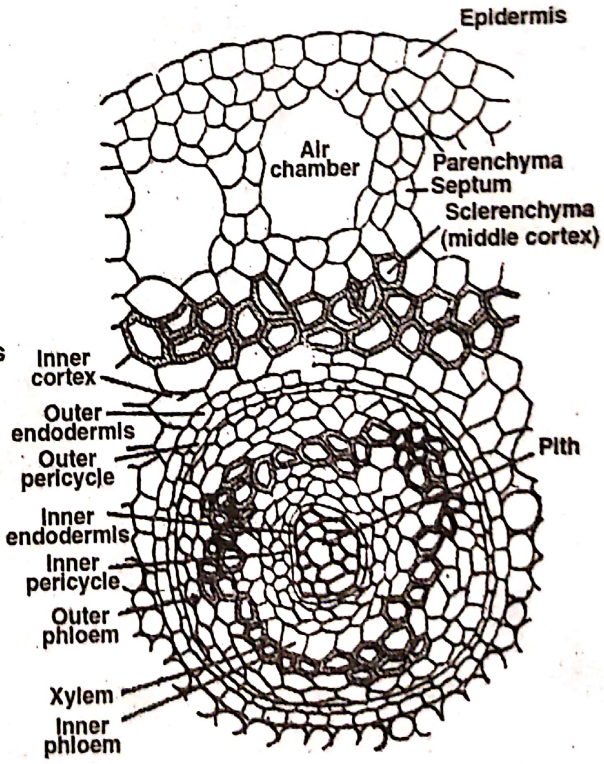
4. The central stelar region is covered by single layered pericycle and an outer endodermis.
5. The xylem is diarch and exarch. Two large strands of metaxylem are present in the centre with two groups of protoxylem on either side. Phloem is present surrouding the xylem .

(B) Rhizome T.S :

1. The outermost layer is epidermis, do not contain any stomata and is continuous.
2. The cortex is differentiated into three distinct regions. viz., outer, middle and inner cortex.
3. The outer cortex is paranchymatous and consists of a ring of air chambers separated by parenchymatous septa. This layer is called *aerenchyma*.
4. Middle cortex is made up of several layers of sclerechymatous cells.
5. Inner cortex is made up of many layered parechymatous tissue. Tannin cells are also present in this region .
6. The stele is a *amphiphloic siphonostele*. Single layered endodermis and pericycle are present outside the stele and inside the stele .
7. The stele consists of a ring of xylem tissue surrounded on both sides by phloem.
8. Thus in *Marselia*, the stele is covered both out side and inside by single layered pericycle and endodermis .
9. The centre of the rhizome is occupied by parenchymatous pith.



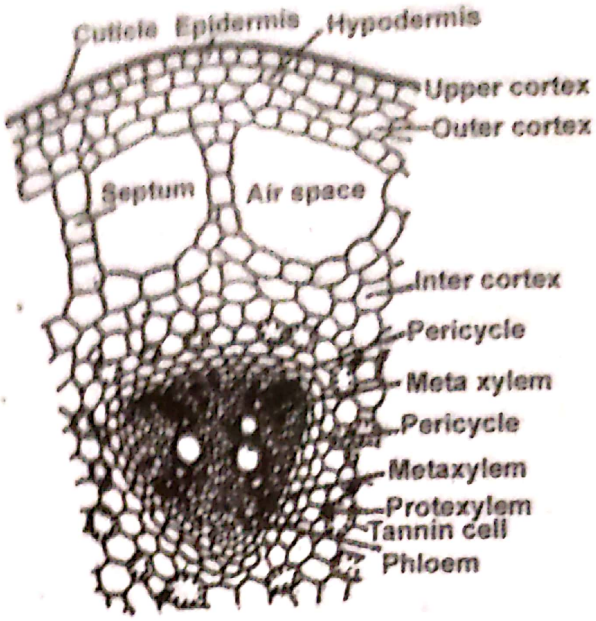
T.S. rhizome



T.S. rhizome (Sector enlarged)

(C) Petiole T.S :

1. Internally petiole consists of epidermis, cortex and stele.
2. Epidermis the outmost layer, made up of single layered rectangular cells.
3. Below the epidermis is the paranchymatous hypodermis.
4. Cortex is divided into outer cortex and inner cortex. Outer cortex is consists of air chambers which are separated with each other by trabeculae or septa.
5. Inner cortex made up of parenchymatous cells and some of the cells contain stach or tannins.
6. The stele is surrounded by pericycle and endodermis.

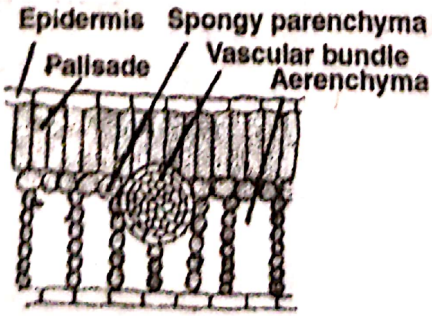


T.S. petiole

7. Xylem is ' V ' shaped and the arms of ' V ' are separated below. Each arm of ' V ' contain metaxylem at the centre and protoxylem towards the ends. The xylem is completely surrounded by phloem.

(D) Leaflet T.S. :

1. The transverse section of leaflet shows an upper epidermis and a lower epidermis. Stomata of sunken type are present on upper epidermis or some times on both surfaces.
2. Mesophyll is differentiated into paliside tissue and spongy parenchyma made up of many rounded cells.
3. The vascular bundle is called *concentric*. In this type the central xylem strand is surrounded by phloem .



T.S. leaflet (part)

III. Spore producing organ - Sporocarp :

1. *Marsella* is heterosporus producing two types of spores - micro and megaspores in a specialized structure called *sporocarp*.

2. Each sporocarp is a bean shaped structure , developed laterally on petioles. They are attached to the petiode with the help of a long stalk called *peduncle* .
3. Peduncle is usually unbranched and bear a single sporocarp. It is partly attached to the body of the sporocarp laterally forming a raphe. There are two projections above the raphe called *horns*.
4. The sporocarp is bilaterally symmetrical consisting of two equal halves.

(a) Internal Structure of the sporocarp :

1. Internally the sporocarp consists of a thick epidermis with many stomata followed by two layered hypodermis.
2. Inside this wall, a parenchymatous tissue is present. It transform into gelatinous tissue called sporophore.
3. Each valve of the sporocarp bears a row of elongate sori on the inner side.
4. Each sorus is surrounded by a thin indusium, contains microsporangia and megasporangia.
5. Microspores are developed in microsporangia and megospores are produced inside megasporangia.

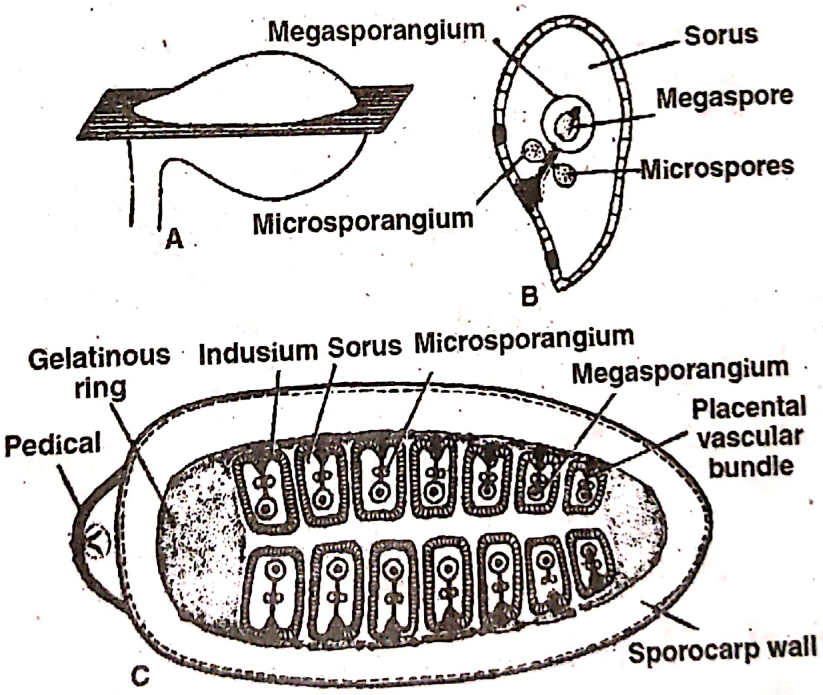


Fig. Horizontal longitudinal section of sporocap (A) Showing the plane of the section (B) Showing a single sorus (C) HLS of sporocarp of M. minuta

6. The position and arrangement of sporangia inside the wall is revealed by taking the sections in three different planes. They are vertical transverse, horizontal longitudinal and vertical longitudinal sections.

(b) V.T.S of sporocarp :

1. The gelatenous mass is more prominant on the dorsal side and less prominent on the ventral side of the sporocarp.
2. In the lower half of the sporocarp, two sori are present covered by individual indusium.
3. The two sori contain either mega or microspongia which have mega and microspores respectively.
4. Three bundles of vascular supply are observed in V.T.S .They are dorsal, lateral and placental bundles.

(c) H. L. S. of Sporocarp :

In this section,

1. The gelatinous ring is present on either side of the sporocarp in the form of patches.
2. The sori are in alternate rows. Each sorus has its own indusium .
3. The receptacle of each sorus shows one megasporangium at centre and two microsporangia on either side. This type of sorus is called a *gradate sorus.*
4. All the three vascular bundles as seen in V.T.S. are present here also.

(d) V. L. S. of sporocarp :

1. The vertical longitudinal section shows complete gelatinous ring surrounding the central micro and megasporangia with their indusia.
2. If the section is passing through the median line, only megasporangia are seen; but if it is slightly away from the median line only microsporangia are visible.
3. Many lateral and a single stalk bundles constitute the vascular supply.

(e) Structure of spores :

1. Each microspore is round small (45 to 75 m in dia) contain two wall layers viz., outer exospore and inner endospore.
2. The central nucleus is surrounded by cytoplasm having many starch grains.
3. Each megaspore is large (0.3 to 0.8mm) ellipsoidal in shape with a small projection at anterior end called *apical papilla.*

4. Nucellus is present in the apical papilla.
5. The large basal part consists of cytoplasm with may starch grains and oil granules. Microspore and megaspores on germination gives rise to male gametophyte and female gametophytes, respectively.
6. Antheridia are developed on male gametophytes while archegonia are developed on female gametophytes.

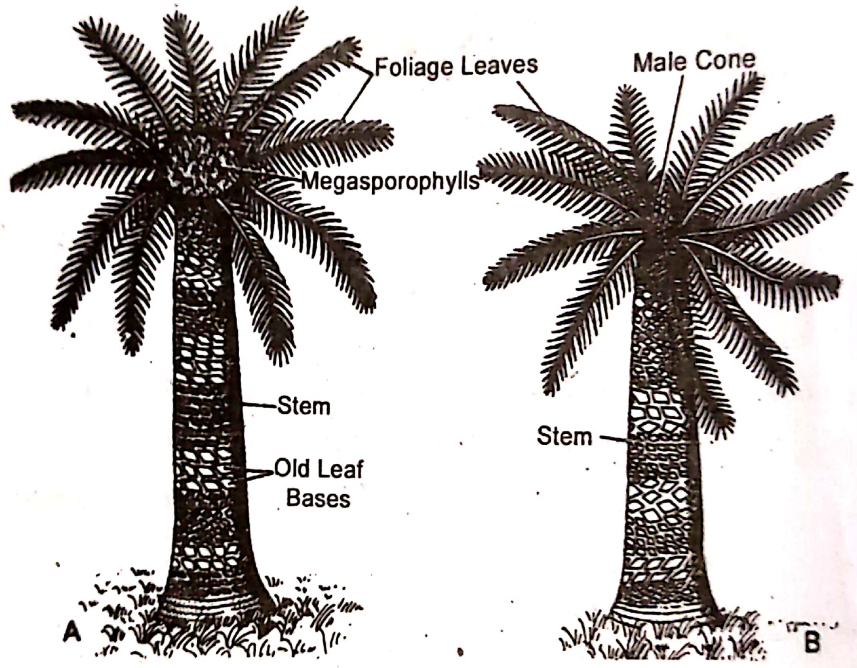
POINTS FOR VIVA VOCE (ORAL EXAMINATION)

1. It is commonly called as 'Water fern'.
2. Plant body comprises of rhizome, and leaves. Each leaf has four leaflets.
3. Bean shaped sporocarps developed at the base of the leaf.
4. Root has characterestic air chambers and diarch, exarch xylem.
5. Rhizome has amphiphloic siphonostele.
6. In *Marselia*, the stele is covered on both out and insides by single layered pericycle and endodermis.
7. Petiole consists of 'V' shaped xylem with metaxylem at the centre of each arm.
8. V. T.S. of sporocarp show two sori in the lower half covered by individual indusium.
9. H. L. S. of sporocarp show the sori in alternate rows. The receptacle of each sorus contain one megasporangium at centre and two microsporangia on eithersides.
10. V. L. S. of Sporocarp shows complete gelatenous ring surrounding the central micro and mega sporangia.
11. Microspore and megaspore germinates and give rise to male gametophyte and female gametophyte, respectively.

(B) GYMNOSPERM

(i) CYCAS

Division	:	*Spermatophyta*
Sub- Division	:	*Gymnosperms*
Class	:	*Cycadopsida*
Order	:	*Cycadales*
Family	:	***Cycadaceae***



A. Female plant **B. Male plant**

Fig : Cycas circinalis

MORPHOLOGY

1. Plant Body :

1. It is a diploid, dioecious (Male + Female) sporophyte.
2. It is long lived, evergreen, arborescent (tree - like) perennial plant.
3. It has unbranched columnar stem and a crown of pinnately compound leaves at the top.
4. Young stem is underground later it becomes aerial, erect. thick, unbranched trunk covered by woody peristant leaf bases.

5. Presence of heterophylly - two types of leaves.
   (a) Scale leaves - (Ramenta) brown hair like structures.
   (b) Foliage leaves - Unipinnasily compound leaves young leaves shows circinate vernation.
6. Early stages the root system is a taproot system and later replaced by adventitious roots.
7. Some lateral roots become aerial : dichotomously branched and are called coralloid roots.

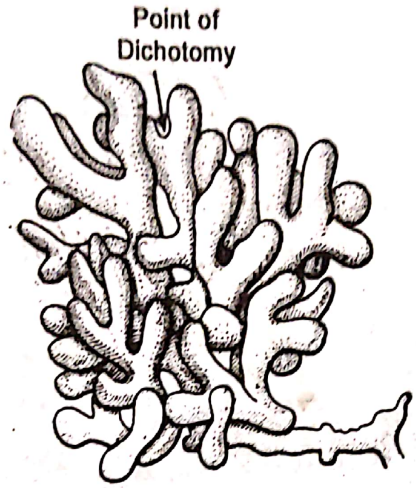


Fig : Collalloid root

2. Coralloid roots :

They are aerial (Apogeotropic) branches rapeatedly in a dichotomous manner to form dwarf branched coral like mass called "coralloid root.

They are contain blue green algae (Nostoc + Anabaena) and lead symbiotic life. They contain lenticels. They are useful for nitrogen fixation and respiration.

3. Male Cone (Male Strobilus = Male flower) :

1. This is present at the tip of the Male Plant having Sympodial growth.
2. It has a short stalk, long, compact and oval structure surounded young leaves.
3. Mature cones appear woody (20-to-60cm long) and consists many microsporophylls (stamens) arranged acropetally in close spirals on the central axis.
4. Some of the microsporophylls are is present at the extreme top and base may be sterile.

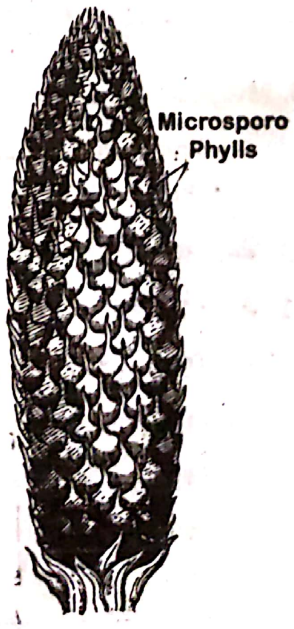


Fig : Male cone

(4) Microsporophylls :

1. It is flattened structure and more (or) less triangular in shape.
2. The basal part is narrow and sterile and the terminal sterile part is called apophysis (its tip is narrow and pointed).
3. The fertile part is present in between the basal part and apophysis.
4. Microsporangia (pollen sacs) present on the lower surface (abaxial) of the microsporosphyll in clusters is called sori.
5. Uni (or) bicelled indusial hairs occur entermixed with sporangia.

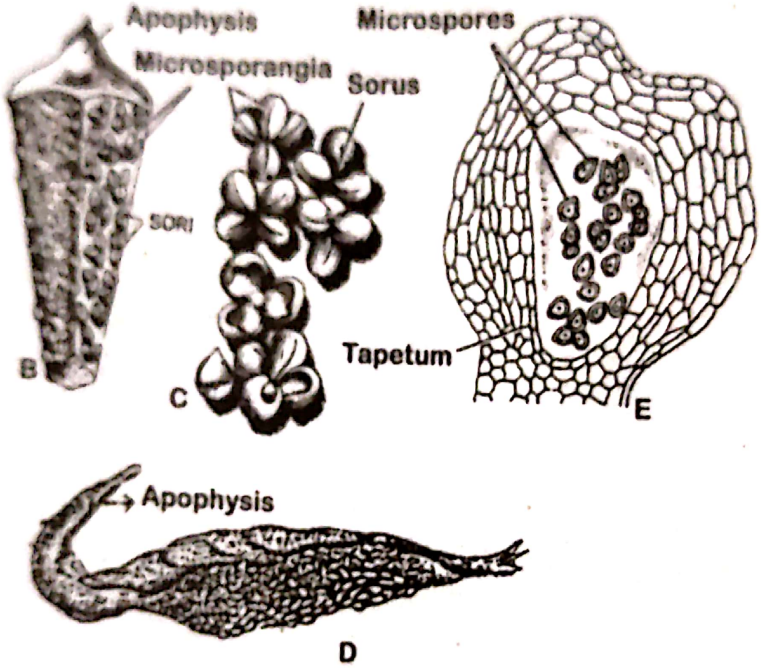


Fig : (B) Dorsal view of Microsporophyll (C) Sori enlarged (D) Lateral View of Microsporophyll, (E) Microsporangium (L.S)

5. Megasporophyll :

1. The female plant contain, loosely spirally arranged megasporophylls at the stem tip (like foliage leaves).
2. There is no formation of female cone.
3. The plant growth is monopodial.
4. They are pinnate (or) oval (or) rhomboidal structures with dorsiventral nature.
5. It has three Parts.
   (a) Lower stalk.
   (b) Middle fertile part bearing ovules.
   (c) Upper Sterile lobed (or) serrated (or) divided in to pinna like structure.

6. Megosporophylls are covered by browinsh hairs (Ramenta).
7. 1-to-6 pairs of ovudes are laterally arranged on the middle part.

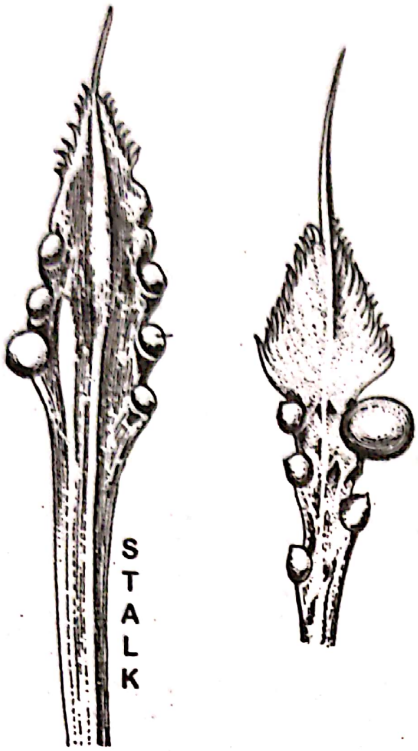
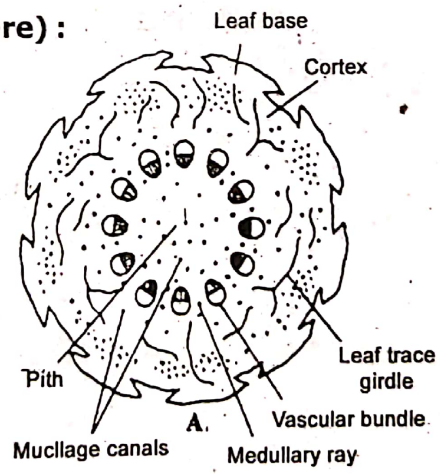


Fig :Megasporophylls of Cycas

Anatomy (Internal structure) :

STEM T.S. :



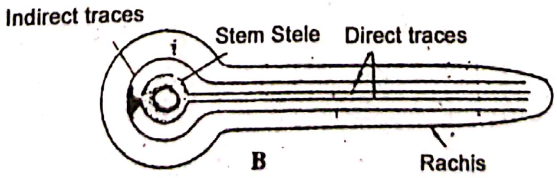


Fig : (A) Stem T.S (Primary structure) T.S. Of young stem

B. Diagrammatic representation of departure of leaf traces from main stele to rachis.

1. Stem T.S. (Primary structure) It has the follwing parts :

(a) Epidermis : It is a distinct and continuous layer with outer cuticle.

In the older stem it is not clear due to the presence of persistent leaf bass.

(b) Cortex : It is more with parenchymatous cells having rich starch grains.

Presence of "Girdle leaf traces " are the main character.

Mucilage Canals act as water reserviors.

Endodermis is not clear.

(c) Stele : Pericycle is not clear.

Primary stem V.B.- Conjoint, collateral, open with endarch xylem, (As in dicot stem - Eustele) vessels in xylem, companion cells in phloem are absent. The medulla (Pith) is large with parenchymatous cells rich with starch and mucilage canals.

Medullarys rays extended in between vascular bundles.

2. Leaf let (or) pinnule T.S. : It has the following part :

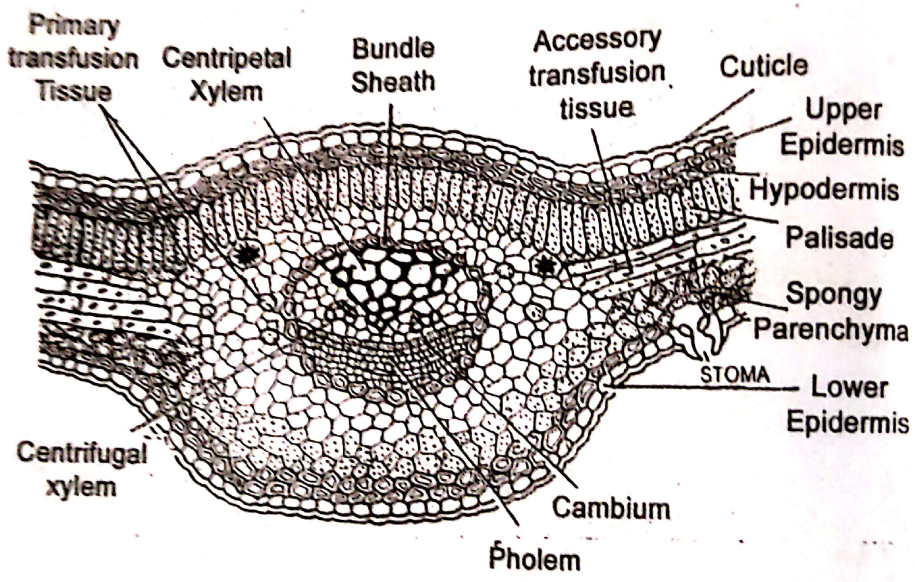


Fig : T.S. Of leaflet of Cycas

(a) Epidermis : It is present on the upper side (upper epidermis) and lower side (lower epidermis).

It contains single layer of barrel shaped cells with outer cuticle.

Presence of "Sunken stomata" on the lower epidermis.

(b) Mesophyll :

Present in between upper and lower epidermis. It contains.

(1) Hypodermis : It is present below the upper epidermis and above the lower epidermis with sclerenchyma in the lamina and more layers in the mid-rib region.

(2) Palisade tissue : It is present below hypodermis towards upper epidermis in the lamina region. It contains more chloroplasts and perform photosynthesis.

(3) Spongy tissue : It contains loosely arranged parencyma with chloroplasts (Chlorenchyma) above the lower epidermis in the lamina region. It is useful for photosynthesis and respiration.

(4) Transfusion tissue : It is present in between palisade tissue and spongy tissue.

They run parallel to the leaf let surface from the midrib to the margin.

They help in lateral conduction of water and salts and compensates the absense of lateral veins in the leaflets.

(c) Vascular bundle : Single, large vascular bundle present at the centre of the mid rib.

It is surrounded by a bundle sheath.

The V.B. is conjoint, collateral , open and diploxylic (presence of centripetal and centrifugal xylem).

The xylem is pseudomesarch.

A non-functional cambium is present in between centrifugal xylem.

Xerophytic Characters :

1. Epidermes has thick cells, Sunken stomata and outer thick cuticle.
2. Sclerenchymatous hypodermis.
3. Presence of transfusion tissue in the absence of lateral veins.

3. Coralloid root T.S. : It has the following parts :

(a) Epidermis : It has single layered thin walled cells in young condition, soon replaced by" periderm" due to secondary growth.

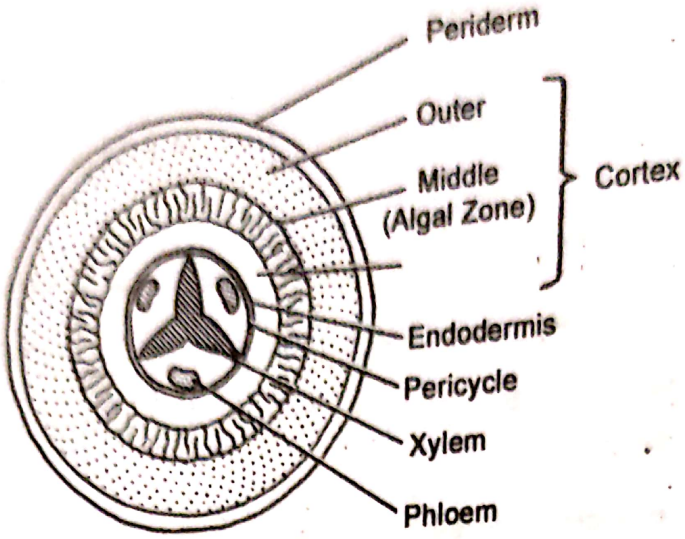
(b) Cortex : It is present below the epidermis with three regions. The outer and inner cortex contains thin walled parenchyma with mucilage ducts and tanin cells.

The middle cortex is called algal zone with symbiotic nitrogen fixing blue - green algae (Nostoc + Anabaena).

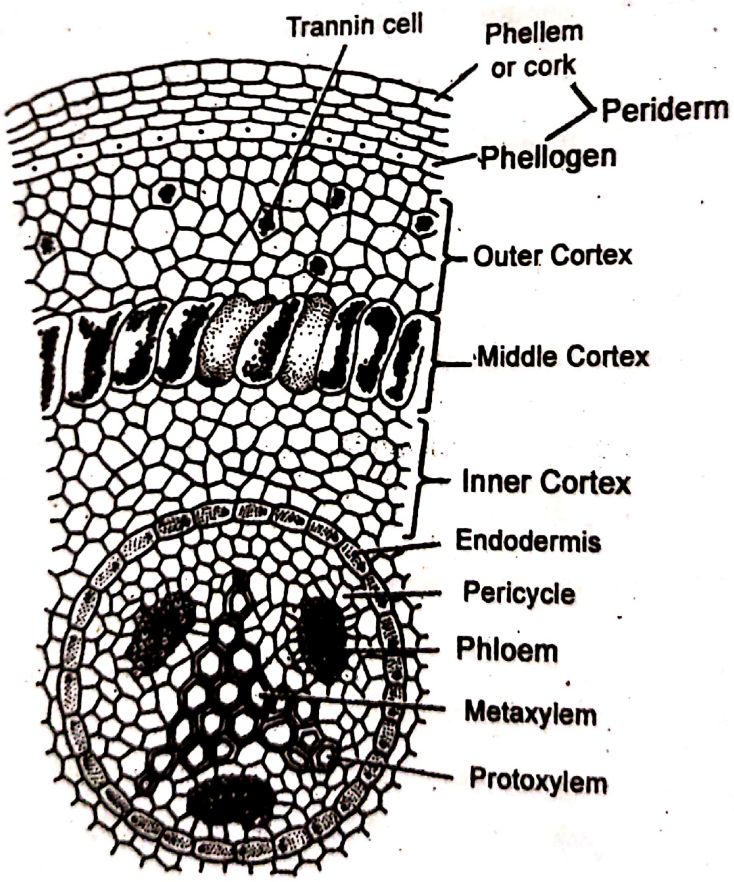
It has inner single layered Endodermis.

(c) Stele : It has 2 or 3 layers of pericycle.

Xylem + Phloem : Separate, Radial, Exarch, Alternate and Triarch (3 x + 3p).



Ground plan



Sector enlarged

4. Cycas ovule V.S/L.S :

1. It is orthotropous ovule.
2. It is unitegmic and protect inner nucellus.
3. The integument has three layer :

   Outer flesh layer - Sarcotesta.

   Middle stony layer - Sclerotesta.

   Inner flesh layer - Sarcotesta.

(4) Vascular tissuees is present in the outer and Inner integuments of Nucellus.

(5) The integument surrounds the nucellus except at the tip to form micropyle.

(6) Micropyle leads into nucellar beak and then into pollen chamber.

(7) The nucellus after meiosis develop into female gametophyte (or) Endosperm.

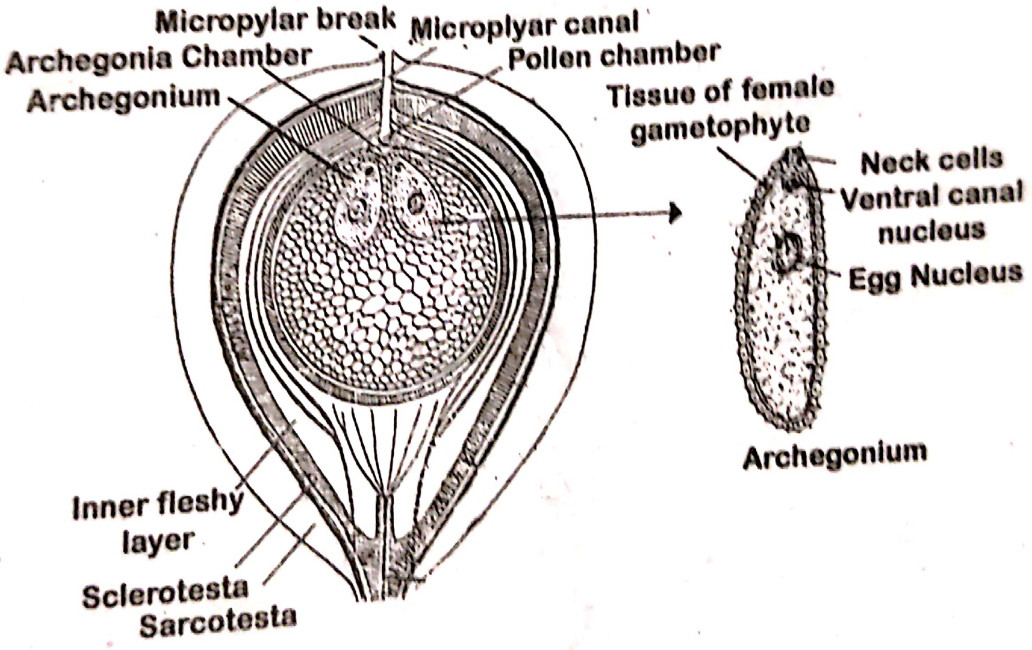


Fig : L.S. Of Cycas Ovule

(ii) Gentum

Division	:	*Gymnospermae*
Class	:	*Gnetopsida*
Order	:	*Gnetales*
Family	:	*Gnetaceae*
Genus	:	*Gnetum*

Vegetative structures : External Morphological Characters

1. The plant body is sporophyte which is differentiated in to root, stem and leaves resembling the angiosperm plant.
2. Species like *G. latifolia, G. ula, G. montanum* are woody climbers; while *G. contractum* is woody shrub.
3. Mostly the *Gnetum* root system is adventitious type.
4. Shoot system shows two types of branches; branches of limited growth and branches of unlimited growth.
5. The stem is usually articulate and differentiated in to nodes and internodes.
6. Leaves usually borne on branches of limited growth, they are completely absent at the lower portion of the climbing stem.
7. The foliage leaves are exstipulate, shortly petiolate and arranged in opposite decussate phyllotaxy.
8. The leaf lamina is simple, large, lanceolate to ovate, leathery texture, with reticulate venation and entire margin.

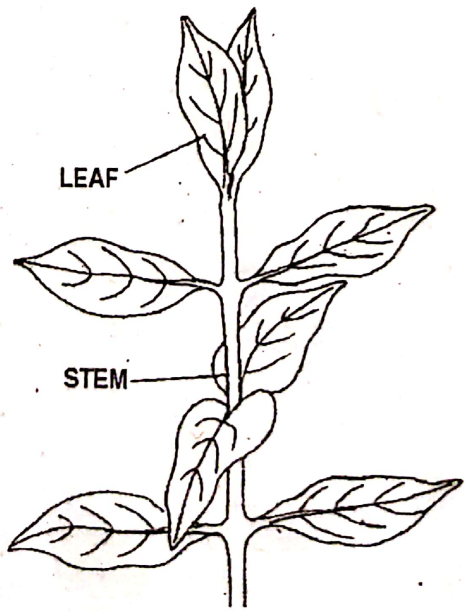


Fig : Vegetative Branch

Internal characters:

Root

T.S. of young root:

1. The transverse section of young root appears nearly round in outline.
2. Internally it is differentiated in to outermost single layered epiblema, middle multi layered paranchymatous cortex and central vascular tissue.
3. The vascular bundles are radial; the xylem and the phloem patches are arranged radially separated by the parenchymatous tissue.
4. Xylem is di-or triarch, exarch consisting of tracheids and vessels. Pith is parenchymatous.

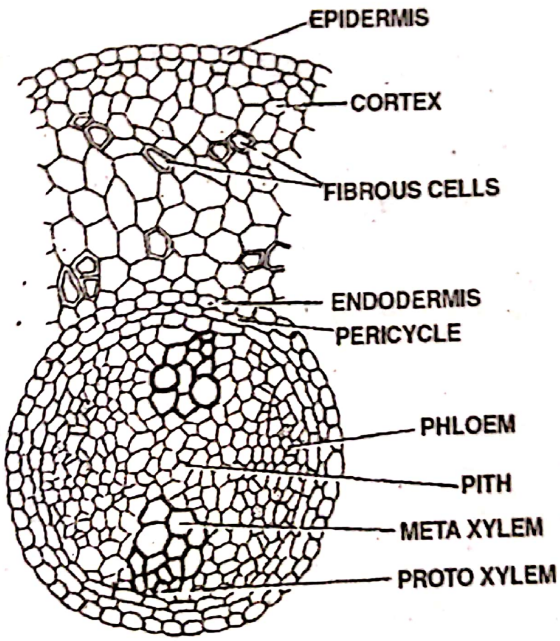


Fig : T.S. of root (Sector Enlarged)

T.S. of old root:

1. Outermost layer of the old stem is made up of multilayered cark cells.
2. Below the cork, multilayered cortex made up of parenchymatous cells is present. Thick-walled fibrous elements are scattered in the cortex region.
3. Single layered endodermis and multi layered pericycle are present below the cortex.
4. The secondary phloem appears like a ring of multi layered phloem tissue, formed by the activity of vascular cambium.
5. Secondary xylem is present below phloem separated by the cambium. The secondary xylem comprises of tracheids and vessels and is traversed by many thick multi layered medullary rays.

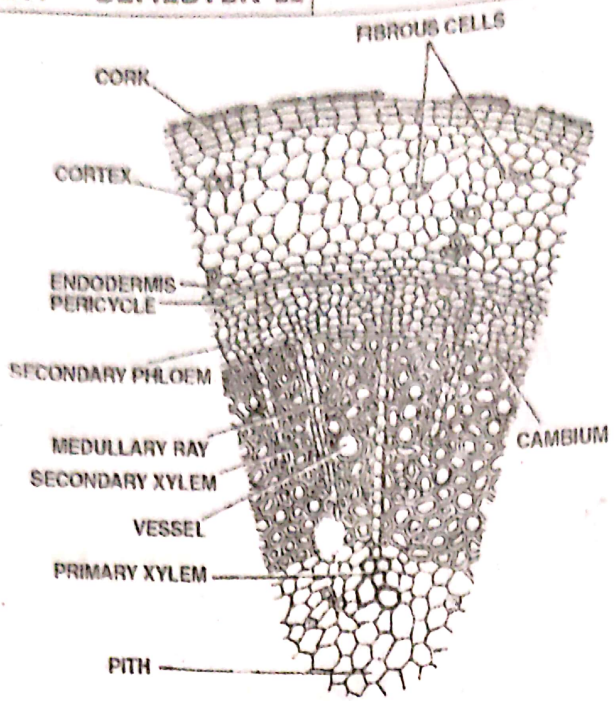


Fig : T.S. of old root (Sector Enlarged)

Stem

T.S. of young stem:

1. The transverse section of stem appears nearly circular in outline.
2. Epidermis is single layered made up of rectangular cells with thick walls. Thick cuticle is present on the epidermis. Many sunken stomata are present in the epidermis.
3. The cortex is multilayered with chloroplasts in the outer layers and thick walled fibrous cells in the lower layers.
4. No distinct pericycle and endodermis are present.
5. The vascular cylinder is represented by 20-24 conjoint, collateral, open and endarch vascular bundles. The xylem consists of tracheids and vessels.
6. Broad parenchymatous madullary rays are present in between the vascular bundles.
7. Pith is broad and parenchymatous.

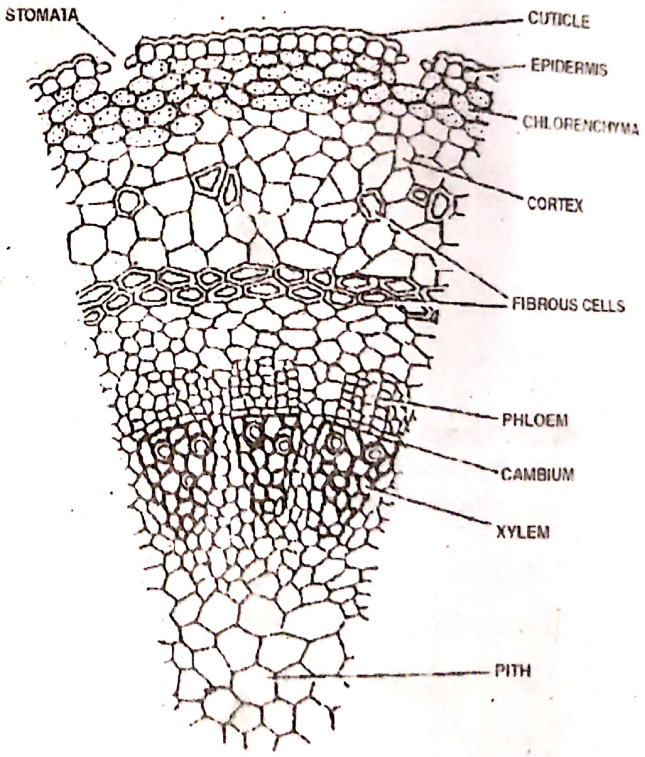
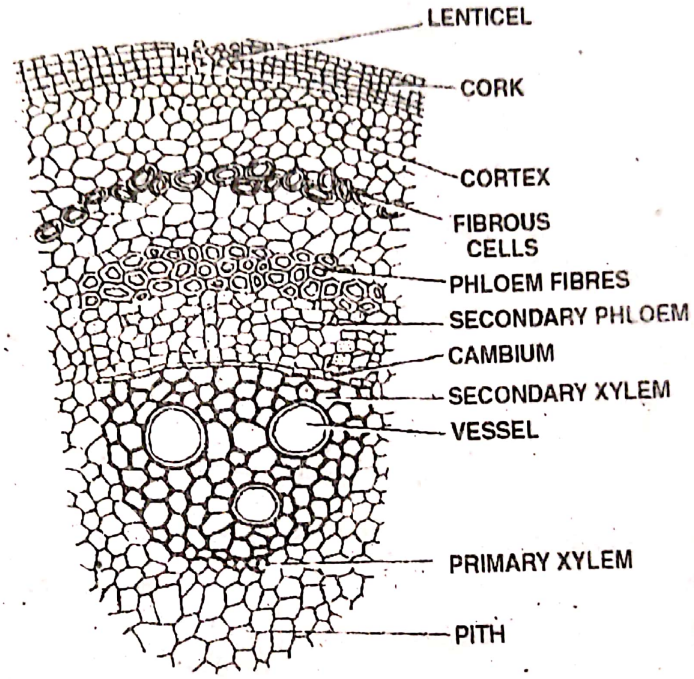


Fig : T.S. of young stem (Sector Enlarged)

T.S. of old stem:

1. The outer periderm consists of cork, cork cambium and secondary cortex.
2. Many lenticels are present interrupting the cork layer at many places.
3. As in the young stems the cortex is multi layered with parenchymatous cells.
4. A few thick walled fibrous cells are scattered irregularly in the cortex. In the lower cortex,an irregular ring of sclerenchymatous cells is present.
5. Normal type of secondary growth is observed in species like *G. gnemon* and abnormal secondary growth is observed in species like *G. ula*.



R. Sahithi

Fig : T.S. of old stem

Normal secondary growth :

1. Secondary growth occurs by the activity of interfascicular cambium developed between the vascular bundles.
2. Secondary xylem is produced to the outside and secondary phloem to the inside of cambium.
3. Broad and multisoriate medullary rays separate the secondary vascular bundles. Secondary xylem consists of tracheids and vessels.

Radial longitudinal section of wood :

1. As a common character of all gymnosperms, xylem consists of both tracheids and vessels.

2. Uniseriate bordered pits showing bars of sanio are seen on the tracheids while simple pits are present on the radial walls of vessels.
3. Medullary rays are parenchymatous, broad and thickness.

Tangential longitudinal section of wood:

1. This section shows the tracheids , vessels and medullary rays.
2. The exact shape, height and breadth of medullary rays are clearly understood in this section.
3. Medullary rays are mostly parenchymatous, multi cellular, boat shaped and many cells in height. Hence it is called heterogenous ray.
4. Bordered pits and simple pits are seen in cross section on the radial walls of tracheids andvessels.

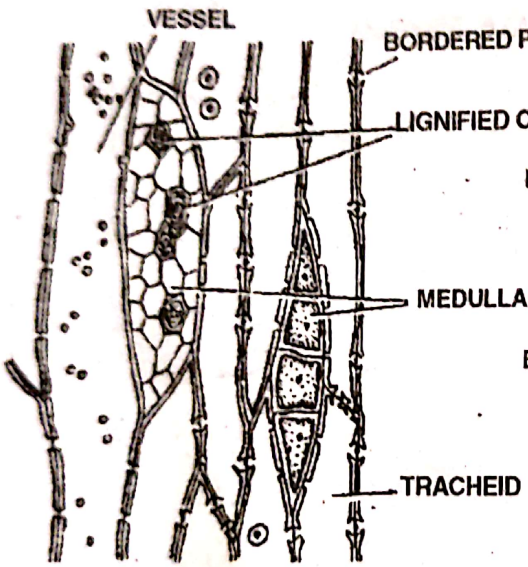


Fig : T.L.S. passing through wood

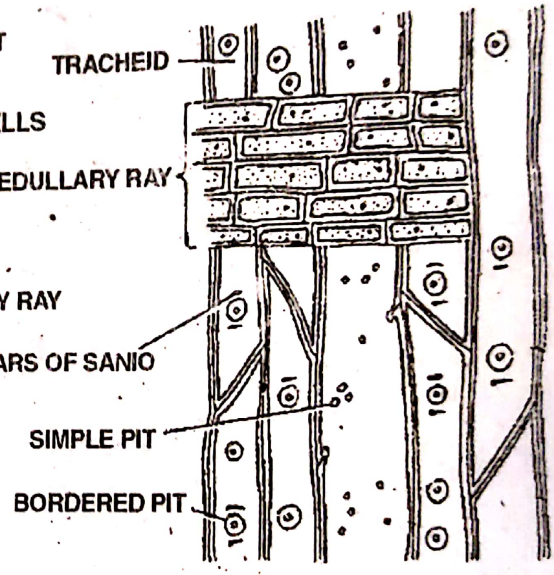


Fig : R.L.S. passing through wood

Leaf

T.S. of leaf :

1. Cross section of the leaf shows, upper epidermis, mesophyll with a layer of paliside and spongy parenchyma.
2. Epidermis is present on both side of the leaf covered by cuticle.
3. Many stomata are present on lower epidermis.
4. Spongy parenchyma consists of several irregularly distributed sclerotic cells, fibrous cells and lateciferous tubes.
5. The mid-rib region is very thick with many vascular bundles arranged in an arch shape. Stone cells are present in patches below the vascular bundles.

6. Each vascular bundle is conjoint, collateral and endarch with xylem facing towards upper surface.

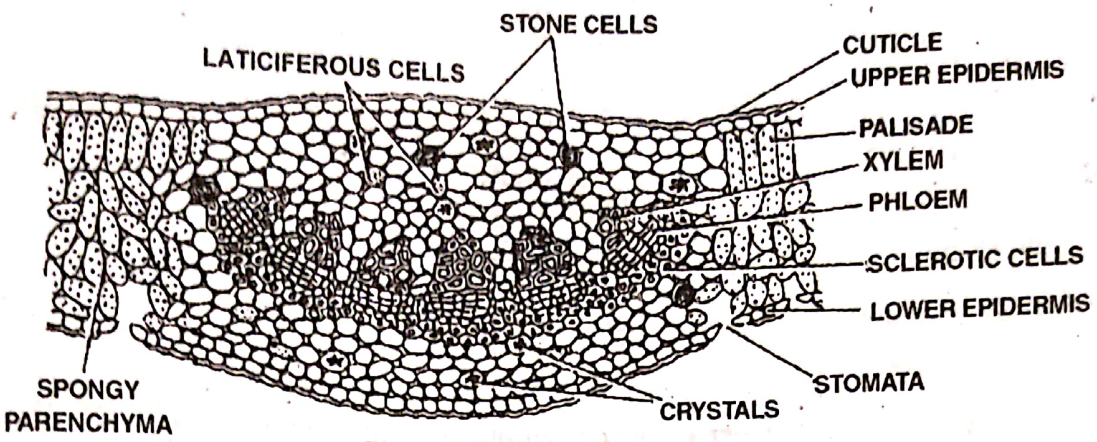


Fig : T.S. of Leaf

Reproductive structures:

Plants are dioeceous. Male and female reproductive organs, the strobili are produced on separate plants.

Male strobili (Staminate strobili):

1. The male strobili are borne in the axils of leaves. The strobili may be branched or unbranched.
2. The long stout axis of male strobili is divided in to nodes and internodes.
3. At each node cup like structure called collar is formed by the fusion of pair of sterile bracts.
4. The collars lie close to each other, due to suppressed growth rates of internodes.

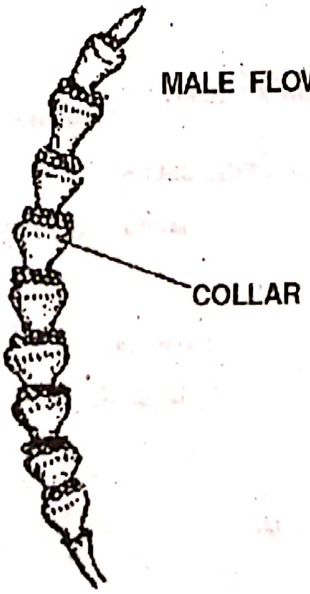


Fig : Male Strobilus

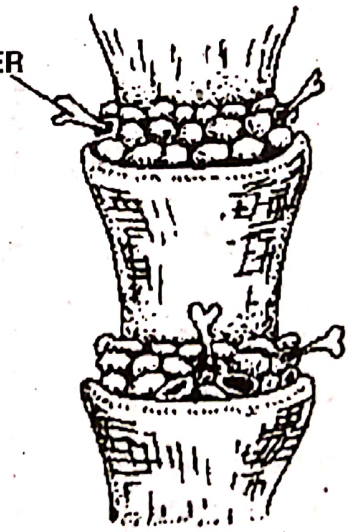
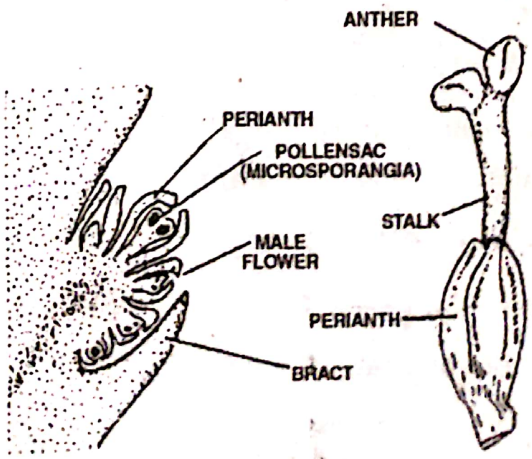


Fig : A portion of male strobilus enlarged

5. The male flowers are arise in whorls in the axils of collars. In each collar, 2-5 whorls of 25-30 male flowers each were present.

Male flower

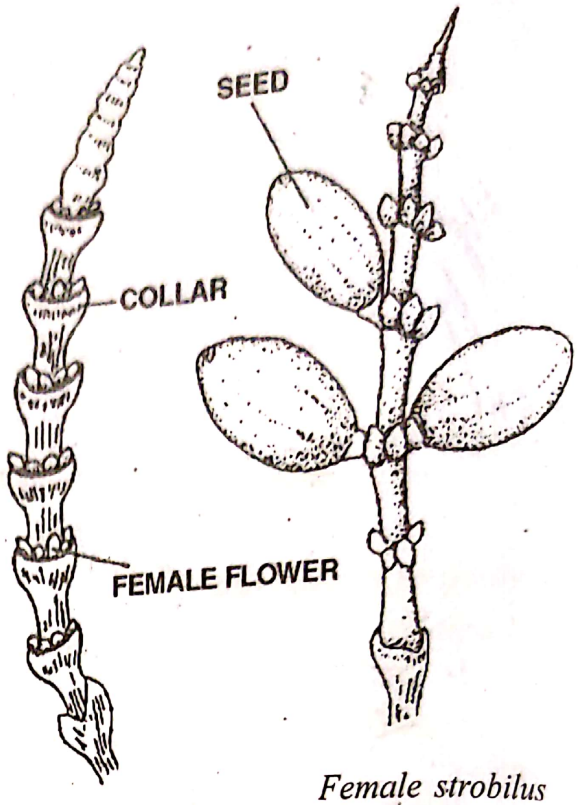
1. Each male flower consists of two unilocular microsporangia (anthers) on a small stalk (anthophore).
2. A perianth is present surrounding the flower, formed by the fusion of two bractioles.
3. The anthophore elongates at maturity and pushes the anthers beyond the collar.



Male Flower *L.S. of male strobilus*

Female strobili (Ovulate strobili):

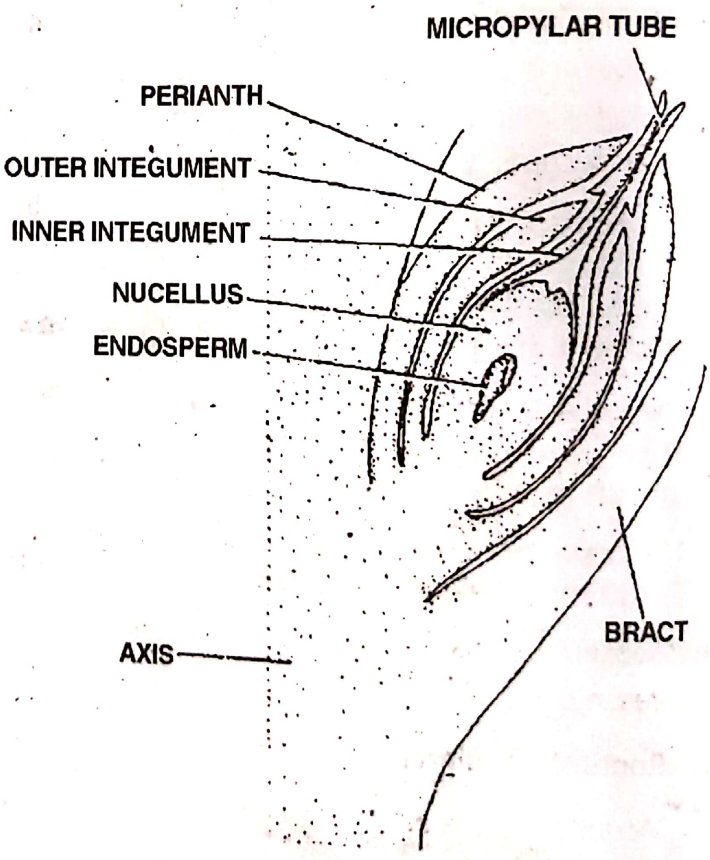
1. The structure and arrangement of strobilion cone axis is similar in both male and female strobili.
2. The female strobili are borne in axils of leaves as in case of male strobili.
3. At each collar, 4-10 female flowers are borne in single ring.
4. On the upper part of the strobili, collars do not bear any ovules. Each ovule (female flower) has a small stalk.
5. The ovules on maturity transformed in to seeds.



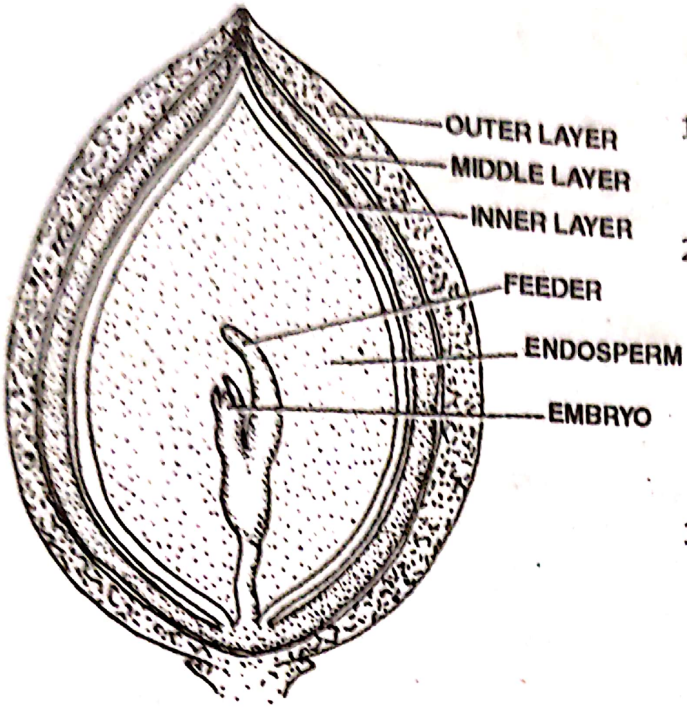
Female strobilus *Female strobilus bearing seeds*

L.S. of ovule :

1. Internally the ovule consists of a central mass of nucellus covered by three layered envelope.
2. Of the three envelops, the innermost integument elongates beyond the ovule and forms a long micropylar tube.
3. Archregonia are hot developed in any species of *Getum.*



L.S. of ovule (diagramatic)



L.S. of seed (Diagramatic)

Seed

L.S. of seed

1. The nucellus appears as a thin strip at the apex.
2. The seed has three-layered envelope. The outermostlayer is fleshy and parenchymatous. It is free from base to apex and contains sclereids and stomata.
3. The middle layer is hard and protective. It is differentiated in to paliside, sclerenchymatousand parenchymatous zones. The inner layer consists of thin-walled parenchymatous and lignified cells.
4. Massive endosperm is present at the center of seed, which encloses single dicotyledonous embryo.
5. Embryo is differenciate into radicle plumule, cotyledons and calyptra.

POINTS FOR VIVA VOCE (ORAL EXAMINATION)

1. Plant body resembles the angiospermic sporophyte with stem leaf and roots.
2. The foliage leaves are lagre, lanceolate with reticulate venation and opposite decussate phyllotaxy.
3. Xylem consists of both tracheids and vessels.
4. The end walls of vessels in *Gnetum* do not break completely as in angiospermic vessels.
5. Roots show diarch xylem.
6. Medullary rays are parenchymatous, broad and many cells in height.
7. Members of gnetales resemble angiosperms in that their reproductive organs resemble flower-like structure.
8. The integument of the ovule extends beyond the ovule to form micropylar tube.
9. Archregonia are not developed in any species of *Gnetum.*

2

FOSSILS

Cycadeoide

Class : *Cycadopsida*
Order : *Cycadeoideales*
Family : *Cycadeoideaceae*

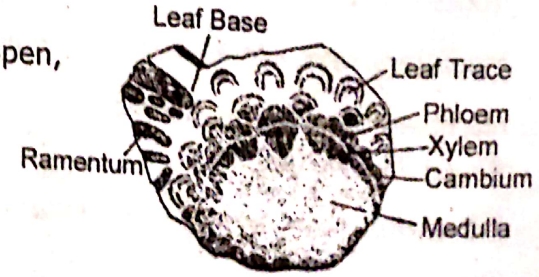
CYCADEOIDEA (BENNETTITES)

I. External Characters :

1. It is a fossil plant.
2. It has a short unbranched trunk with cluster of branches at the ground level.
3. The trunks were spherical, oval (or) columnar.
4. It was covered by an armour of persistant leaf bases with multicellular ramenta.
5. It contains large pinnate compound leaves with parallel veins and show xerophytic characters.
6. The flowers were hermaphrodite.

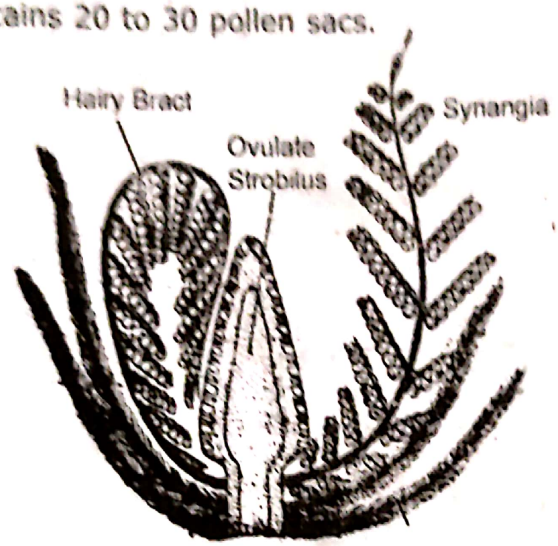
II. Stem T.S. :

1. Epidermis is not clear due to persistant leaf bases and ramenta.
2. Cortex and pith are large with parenchyma cells, mucilage canals and leaf traces are present (absence girdle leaf traces).
3. Vascular bundles are conjoint, collateral, open, endarch and present in a ring.
4. The secondary wood is manoxylic.



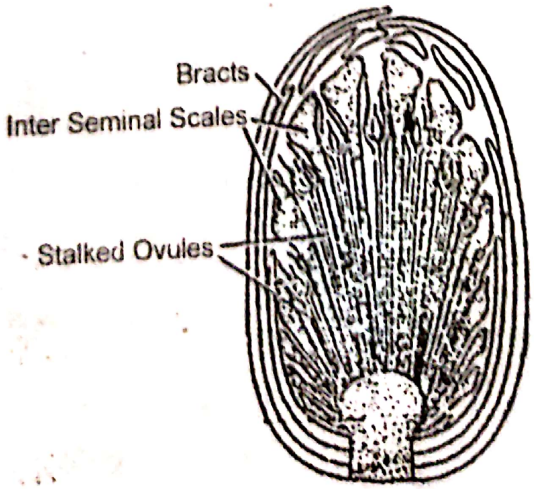
III. Microsporophylls :

1. Flowers were bisexual, occurred in the axils of leaf bases singly.
2. The bracts are arranged like perianth.
3. The Microsporophylls are similar to stamens and they are 08 to 20 in number (in a flower).
4. They were like foliage leaves having a central rachis bearing 10 (or) more pairs of pinnae.
5. They were present alternately on either side of the rachis.
6. The pinnae were sterile at the base and at the tip.
7. The pinnae had pollen capsules in two rows in sub-lateral position.
8. Each capsule contains 20 to 30 pollen sacs.



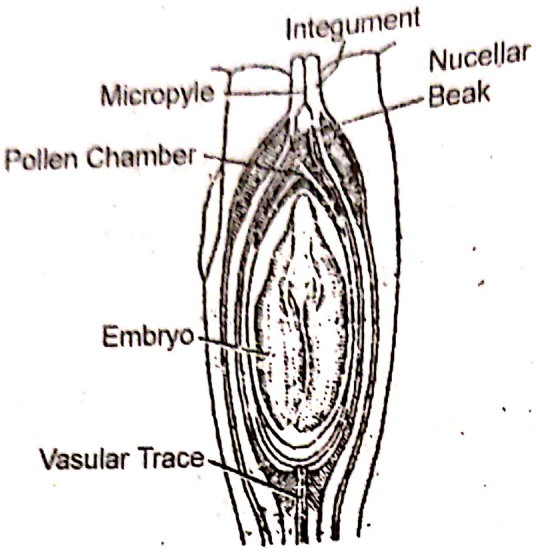
IV. L.S. female flower :

1. The axis of the flower expands in to ovuliferous receptacle.
2. It was conical (or) spherical in shape with many tiny stalked ovules and interseminal scales.
3. Ovules are orthotropous.
4. Each ovule has nucellus, integument, micropylar beak, nucellar beak and pollen chamber.



V. L.S. of Seed :

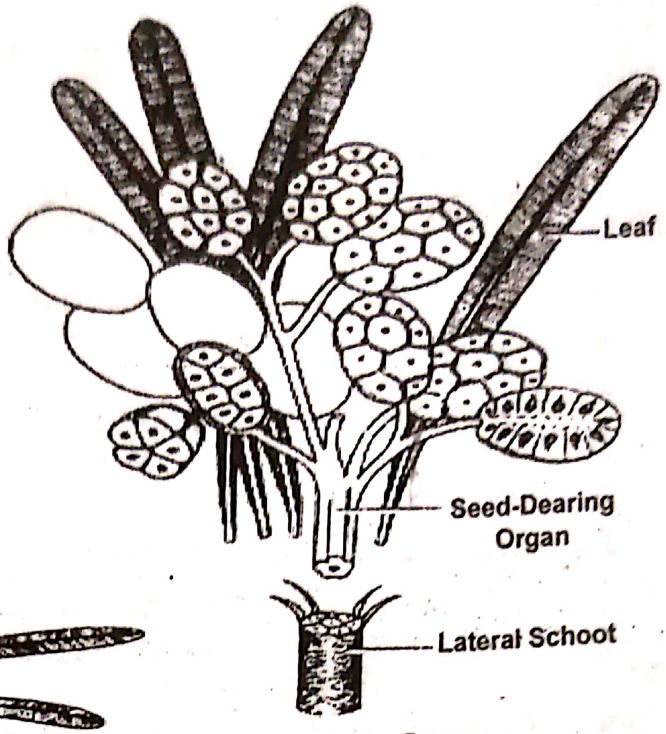
1. The ovuliferous receptacle with its seeds and interseminal scales matured in to a fruit.
2. The fused tips of interseminal scales forms a type of pericarp for the seed.
3. The seeds were small and contained an embryo with two cotyledons.



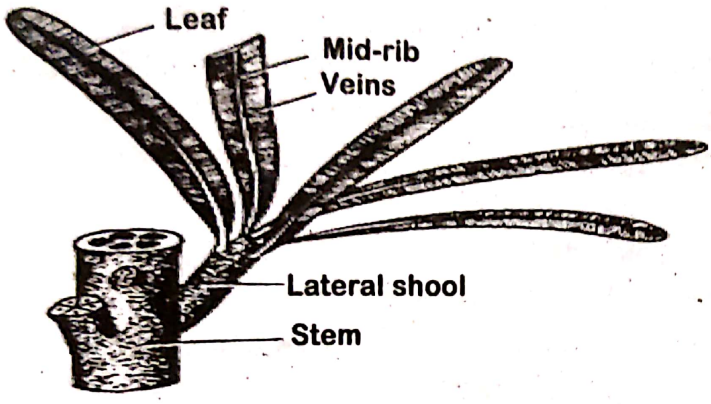
(2) Fossils : Pentoxylales (Srivastava + Vishnu - Mittre) Pentoxylon Characters:

P.character :.

1. Extinet mesozoic plants found in jurassic period.
2. They may be strubs (or) very small trees.
3. Long and short shoots were present on these plants.
4. Short shoots had spirally arranged leaves and terminally located reproductive organs.
5. Leaves are thick, simple, lanceolate. (Diploxylic leaf traces are present).
6. Stomata are haplocheilic (Previously syndetocheilic).
7. Leaves had open venation.
10. Ovules were sessile.
11. Female reproductive organs were like stalked mulbery.
12. Male reproductive organs (or) microsporophyll form whorl of branched microsporangiophores.
13. The micro -sporangiophores were fused basally in to a disc-like structure.



Female Cone



Pentoxylom ----- stem + leaves

Male flower

Microsporophyll

3 DEMONOSTRATION OF HERBARIUM

Botanical tour :

Botanical tour is essential for biology students, because it imparts field knowledge about flora and fauna. It enables the students to observe the plants in their natural habitats, collect the plant material and preserve them for further studies. Therefore, the tour is usually aimed to visit places of high bio-diversity. If such an area is locally available, students can visit them, other wise they have go on a tour to such places. For any tour, the students should carry the following things along with them. For collection of plant material - scalpel, knife, blade, polythene bags, plant press with many news papers or blotting papers; for packing the collected material, preferably plastic unbreakable containers; for preserving the plant material – FAA, (70% alcohol, 90% alcohol and 6% Formalin) for preparation of herbarium sheets – gum, gum tape, collection sheets, blotting sheets, news papers, labels, pen and pencil are required.

After collection, the plant material should be immediately preserved in FAA and a twig with inflorescence is pressed in newspapers in a plant press. After return to the laboratory, the preserved material was transferred to separate bottles with fresh preservative. This material is used for doing regular practical work. If the specimen is rare, a part of the plant is kept in specimen bottles for preservation in the museum. The pressed twigs, after return to the laboratory, were transferred to fresh papers repeatedly until they are completely dried. During this drying process to avoid rotting and to prevent fungal infection, chemicals like gemaxin are sprayed on the material. After completely dried up, the twig is pasted on a herbarium sheet at the center. Thus, a tour can help in collection of material for practical work, preservation of rare specimens, preparation of herbarium.

Herbarium :

Herbarium sheet is a lightweight card-board of standard size 16.5 x 11.5 inches. It contains a small paper bag pasted on one side of the lower side in the sheet to place any other important plant parts collected other than twigs. A label containing the details of the plant was pasted on the other side of the lower portion of the sheet. The details to be printed on the label are – name of the college, name of the herbarium, field book no., botanical name of the plant, family of the plant, local name, date of collection, place of collection, and collected by.

Preparation of herbarium sheet:

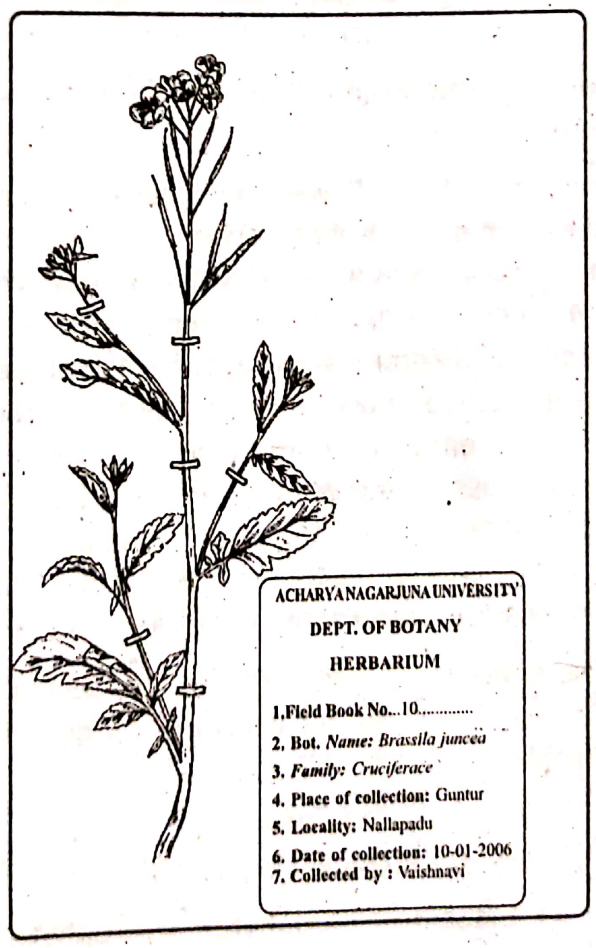
1. Take the fully dried twig with inflorescence and tag with a slip containing the herbarium number.

2. Place it at the center of the sheet and fix it firmly either by applying gum or by gum tape in such a way that the twig is properly spread.
3. Place, any plant parts, which are, detached from the twig during collection or preservation, or any important plant parts in the small paper bag pasted on the sheet.
4. Fill the label pasted on the sheet with all details of the specimen.

Storage of herbarium sheets:

Then the sheets are arranged in accordance with standard classification (Bentham & Hooker's). The sheets are arranged according to species, genera, families, classes, orders, series, etc., Each group is placed in a separate envelope, slightly larger than the size of the sheets (e.g.,17 x 12 inches). The details of the contents of the envelop are written on the top .

These envelopes are stored in specially designed storage racks.



4 TAXONOMY

Technical Description of the plant

The study of an angiospermic plant includes two parts. In the first part the characters of all parts of the plant are listed. In the second part it is essential to have neat diagrams of all parts of the plant including a twig with inflorescence, L.S of flower, T.S. of ovary, and floral diagram. It is also essential to give a floral formula for each plant species studied.

To describe each character of the plant, only the standard technical words were used. Another important aspect is that, the list of characters was written in chronological order starting form root, stem then leaves and next inflorescence, flower in particular and finally to fruit.

In regular practical work each student must be supplied with a twig with inflorescence.

The student should then write each character with the suitable alternative form for the given twig in a serial order.

The student should take the l.s. of flower and observe it under dissection microscope (if necessary). Similarly the t.s of ovary must be observed under microscope after placing it on a slide. The inner details of floral parts are clearly understood by these sections. In order to study the aestivation the floral parts are observed from the bud using needles. The ground plan of flower called floral diagram was drawn for each type of flower. Ideal characters of floral diagram are – it must be round in shape; all the floral part are represented in concentric circles, the symbol of either actinomorphic or zygomorphic must be written at the top of the diagram, bract must be represented at lower side while bractioles on either side of the circle. sepals in outermost circle, followed by petals, stamens and central t.s. of gynoecium. With characters like type of aestivation, types of anthers, position of anthers, length of filaments, Staminodes are represented either as cross (x) or astrick (*).

Then these characters are compared with the characteristics of each level in the classification. The family derivation of the plant given was obtained after preparing a indented key with the characters.

Habit	:	Herb / Shrub / Tree
Habitat	:	Annual / Biennial / Perennial.
		Mesophyte / Xerophyte / Hydrophyte.
Root Stem	:	Tap / Fibrous root system.

Stem :
Aerial / underground
Erect / Prostrate - Procumbent or Decum bent Cylindrical / Quadrangular.
Herbaceous / Slightly woody / Woody
Smooth / Hairy Branched / Unbranched

Leaf :
Simple / Compound - Pinnate or Palmate, sub-type.
Alternate / Opposite - Decussate or Superposed / Whorled phyllotaxy
Petiolate / Sessile
Stipulate / Exstipulate - Type and modification of stipules Lamina shape.
Margin
apex
Dorsiventral / Isobilateral
Smooth / Hairy
Venation - Pinnate or palmate, Sub-type
Special character

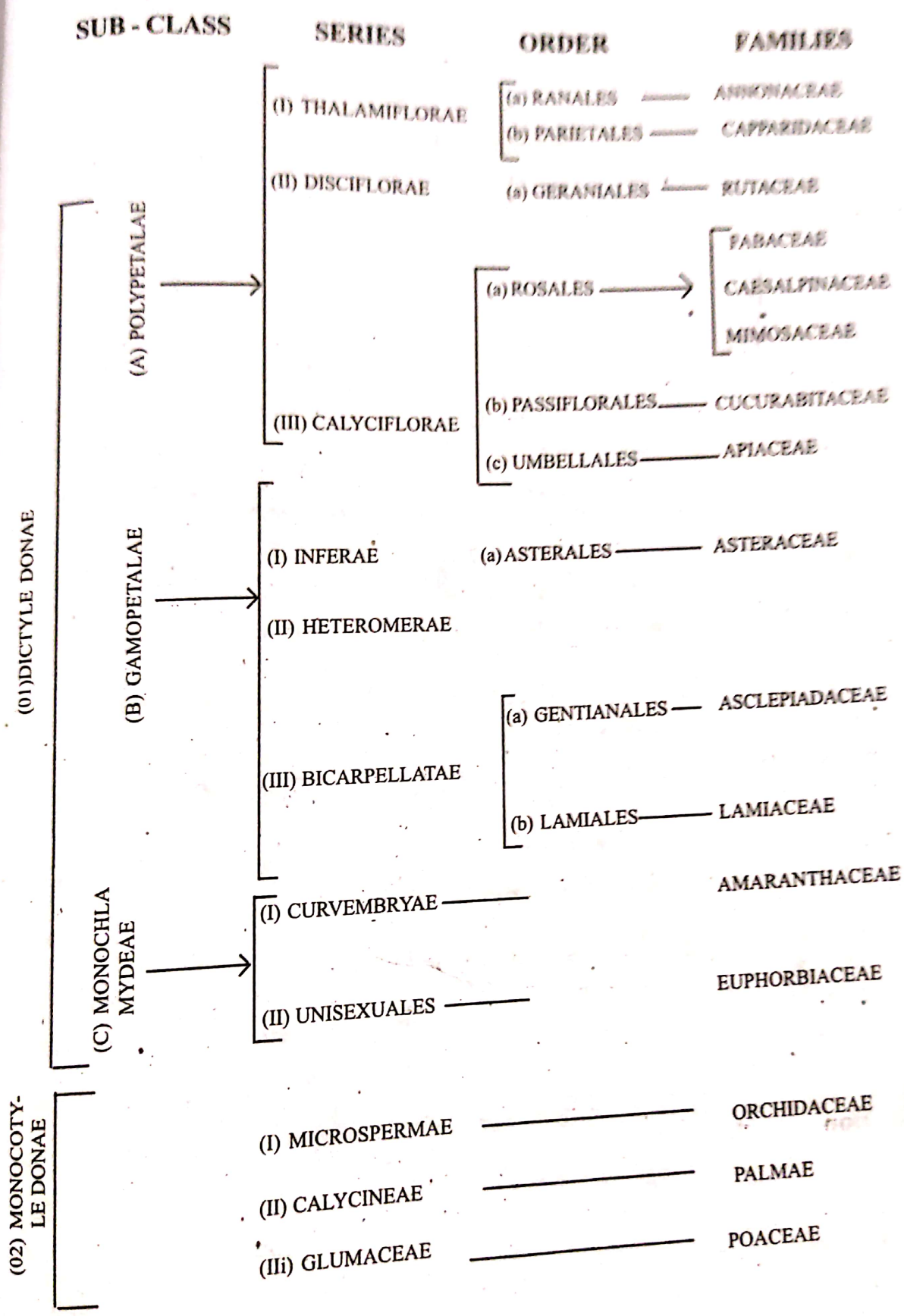
Inflorescence :
Axlliary / Terminal / Extra axillary
Racemose / Cymose / Mixed / Special
Sub type.

Flower in General:
Bracteate / Ebracteate
Bracteolate / Ebracteolate
Pedicellate / Sessile
Complete / Incomplete
Bisexual / Unisexual - female or Male
Monochlamydeous / Dichlamydeous
Homochlamydeous / Heterochlamydeous
Trimerous / Tetramerous / Pentamerous
Isomerous / Anisomerous Spiral / Spiro-cyclic / Cyclic Di, Tri, Tetra, Penta or polycyclic
Actinomorphic / Zygomorphic / Asymmetrical
Hypogynous / Perigynous / Epigynous

Flower in Detail :

Calyx (K) :
No. Of Sepals
No. Of Cycles
Polyspalous / Gamosepalous
Aestivation

		Colour
		Shape
		Deciduous / Persistent
		Odd sepal - posterior or Anterior / Absent
Corolla (C)	:	No. Of Petals
		No. Of Cycles
		Polyspalous / Gamopetalous
		Aestivation
		Colour
		Shape
		Odd petal - Posterior or Anterior / Absent
Androecioum (A) :		No. Of Stamens
		No. Of Cycles
		Polyandrous / Mono, Di Poly - adelphous / Syngenesious/ Synandrous.
		Epipetalous, gynandrous.
		Colour
		Filamentous / Sessile
		Basifixed / Dorsifixed / Versatile / Adnate
		Dithecous / Monothecous
		Longitudinal / Transverse - Dehiscence
		Introrse / Extrorse
		Inserted / Exserted
Gynoecioum (G) :		Mono / Bi / Tri / Tetra / Penta / Multi - carpellary
		Apocarpous / Sub - apocarpous / Syncarpous
		Uni / Bi / Tri / Penta / Multi - locular
		One/Many ovules in each locule
		Placentation-type
		Superior / Semi - inferior / Inferior ovary
		Style - Long / Short, Apical / Lateral / Gynobasic
		Stigma - Simple / Capitate / Bi, Tri., Tetra, Pentafid /Branched Special Character.
Pollination	:	Entomophily / Anemophily / Hydrophily
		Mechanism if any
Fruit	:	Simple / Aggre gate / Multiple sub type.



FAMILIES RELATED TO THE SYLLABUS

(1) ANNONACEAE

Class	:	Dicotyledonae
Sub Class	:	Polypetalae
Series	:	Thalamiflorae
Orders	:	Ranales
Family	:	Annonaceae

Annona squamosa Linn.

Habit : Shrubs or trees and some of them are scandent shrubs..

Habitat : Mesophytic.

Stem : Herbaceous woody stem, aerial, erect, cylindrical, branched, glabrous, green.

Leaves : Cauline and ramal, simple, alternate, exstipulate, entire, petiolate, ovate, acute, glabrous, venation unicostate reticulate.

Inflorescence : Axillary pairs or solitary flower.

Flower : Bracteate, pedicellate, complete, actinomorphic, bisexual, hypogynous, spirocyclic, thalamus elongated and cone like.

Calyx : Sepals 3, polysepalous, greenish, valvate, inferior.

Corolla : Petals 6, polypetalous, in two whorls of 3 each, inner minute, sepaloid, thick, fleshy with concavity at the base, valvate.

Androceium : Stamens numerous, polyandrous, spirally arranged on an elongated torus. Anthers are dithecous, adnate, connective thick and produced beyond anther into sterile appendage, extrorse, dehisce by longitudinal slits.

Gynoecium : Multicarpellary apocarpous superior ovary, unilocular with single ovule on basal placentation, style short and stigma minute.

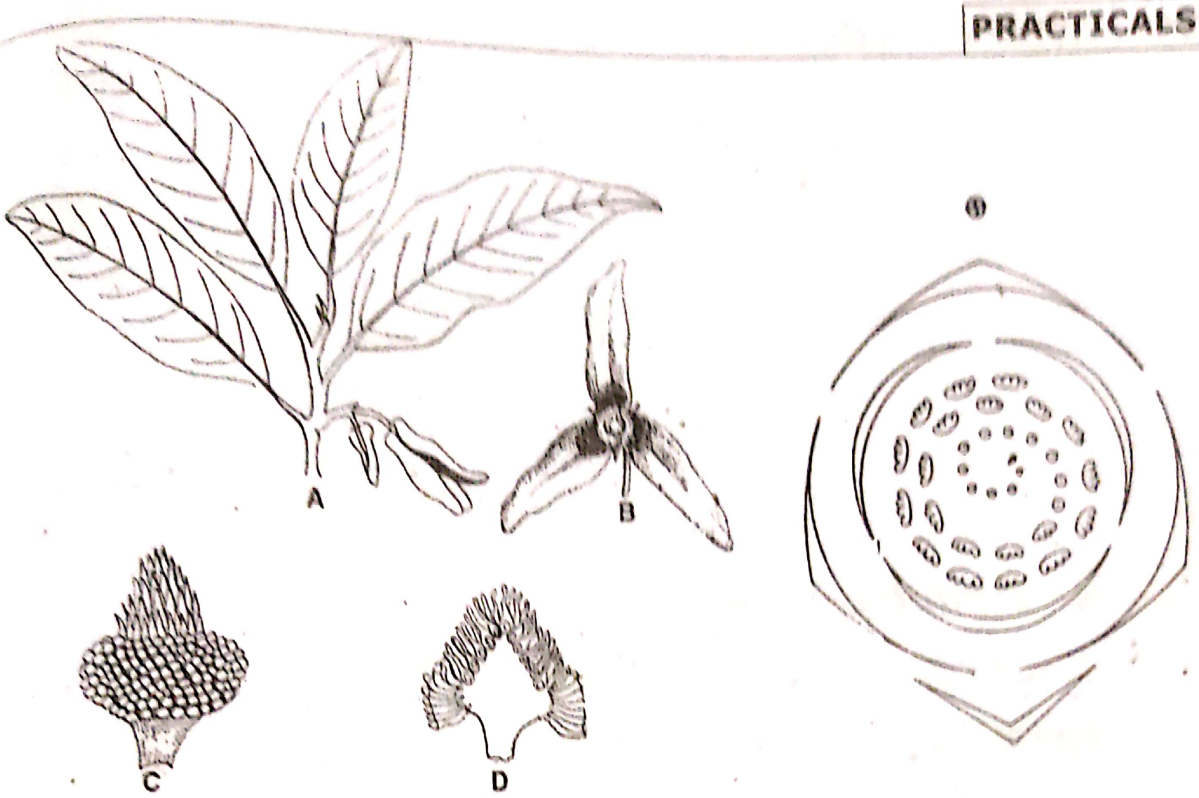


Fig : (A) Twig with infloresence (B) Flower
(C) Torus with stamen and carpels
(D) L.S. of Torus

Fruit : Etaerio of achenes. Seed endosperm ruminate and are embedded in the pulp.

Floral formula Br Ebrl ⊕ ♀ K_3 C_3 A_∞ G_∞

Identification of the family (based on Bentham & Hooker's classification) :

Venation reticulate, flowers pentamerous, cotyledons two

Class : Dicotyledonae

Flowers with distinct calyx and corolla, petals free.

Sub Class : Polypetalae

Flowers hypogynous, sepals free from ovary, stamens born on thalamus, disc absent.

Series : Thalamiflorae

Stamens usually many, carpels many and free, embryo small.

Orders : Ranales

Woody plants, stipules absent, trimerous perianth, numerous stamens and carpels, spirally arranged on the torus, fruit etaerio of achenes.

Family : Annonaceae

(2) CUCURBITACEAE

Class	:	Dicotyledonae
Sub Class	:	Polypetalae
Series	:	Calyciflorae
Orders	:	Passiflorales
Family	:	Cucurbitaceae

Coccinia cordifolia (Linn.)
Cogn. (=*Cocconiaindica* Wight & Ars.)

Habit : Wild climbing herbaceous plant with coiled tendrils.

Habitat : Mesophytic.

Stem : Herbaceous, aerial, weak, climbing, branched, angular, solid, glabrous, green.

Leaves : Cauline and ramal, alternate, simple, palmately lobed, cordate, denticulate, acute, glabrous, hairy (multicellular) tendril at the axil of leaf, exstipulate, long petiolated, venation multicostate reticulate diverging type.

Inflorescence : Solitary, axillary.

Male flower : Ebracteate, pedicillate, incomplete, actinomorphic, unisexual, perigynous, pentamerous, cyclic.

Calyx : Sepals 5, gamosepalous, valvate, green, superior.

Corolla : Petals 5, gamopetalous, imbricate, white, companulate.

Androceium : Stamens 5, appear as 3 (2+2+1), formed by fusion of two pairs of stamens and one stámen free, filaments slightly connate, two with dithecous anthers, one with monothecous anthers, dehiscence longitudinal.

Gynoecium : Absent.

Female flower : Ebracteate, pedicillate, incomplete, actinomorphic, unisexual, pistillate, epigynous, penetamerous, and cyclic.

Calyx : Sepals 5, gamosepalous, valvate, green, superior.

Corolla : Petals 5, gamopetalous, companulate, imbricate, white, superior.

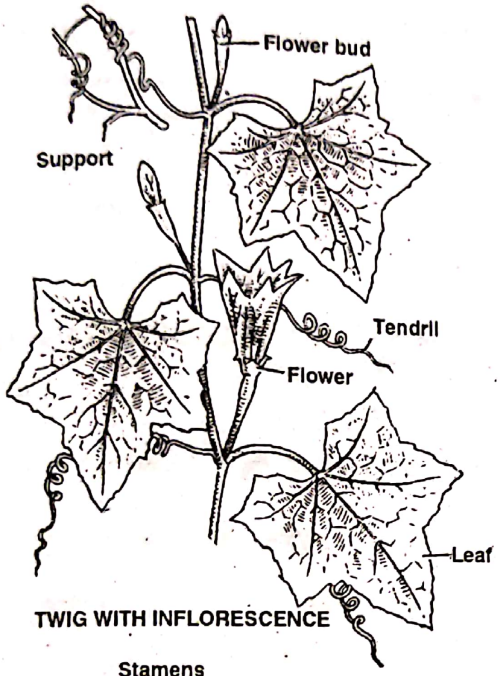
Androceium : Absent

Gynoecium : Tricarpellary syncarpous, inferior ovary, unilocular with many ovules on parietal placentation, placentae enlarged intruding and often meeting in center forming pseudoaxile placentation, style simple or 3-partite, stigma 3, forked and feathery.

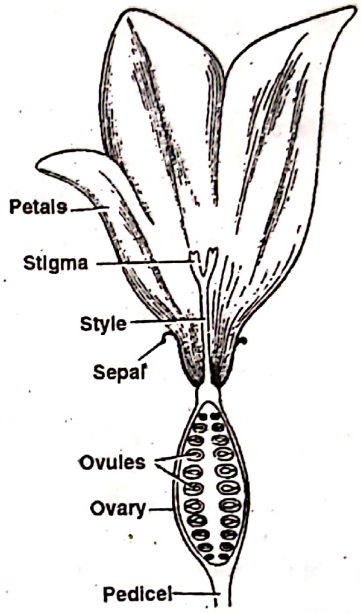
Fruit : Pepo

Male Floral formula : $\text{EBr Ebrl} \oplus \male K_{(5)} C_{(5)} A_{(2)+(2)+1} G_0$

Female Floral formula : $\text{EBr Ebrl} \oplus \female K_{(5)} C_{(5)} A_0 \overline{G}_{(3)}$

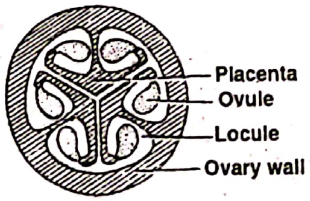


TWIG WITH INFLORESCENCE

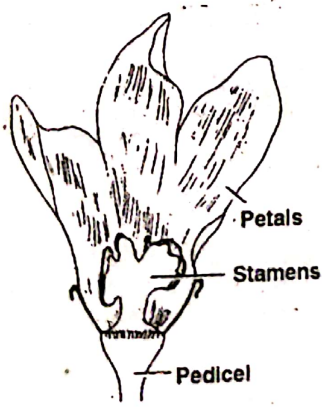


L.S.MALE FLOWER

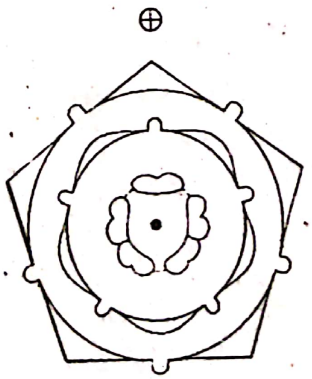
ANDROECIUM



T.S.OVARY



L.S.MALE FLOWER


FLORAL DIAGRAM (Male)

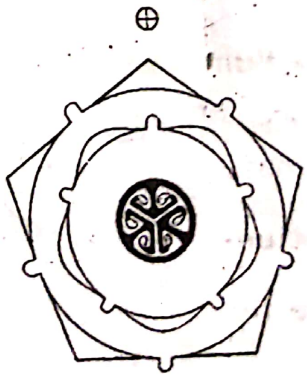

FLORAL DIAGRAM (Female)

Fig: Coccinia cordifolia

(a) *Luffa cylindrica* (Linn.) Roem. (=*L. aegyptica* Mill.)

Habit : Cultivated climbing herbaceous plant with coiled tendrils.

Habitat : Mesophytic.

Stem : Herbaceous, aerial, weak, climbing with tendrils, angular, solid, rough, green.

Leaves : Cauline and ramal, alternate, simple, palmately lobed, denticulate, acute, glabrous, hairy, tendril at the axils of leaf, exstipulate, long petiolated, venation multicostate reticulate, diverging type.

Inflorescence : Male flowers in cymose clusters borne on long peduncles, female flowers solitary.

Male flower: Bracteate, pedicillate, incomplete, actinomorphic, unisexual, staminate, perigynous, pentamerous, cyclic.

Calyx : Sepals 5, gamosepalous, basally connate, valvate, green, superior.

Corolla : Petals 5, polypetalous, imbricate or quincunceal, yellowish, superior.

Androceium : Stamens 5, polyandrous, alternate with petals, adnate to the petals at the base, filaments hairy, monothecous, sigmoid, dehescence longitudinal, a nectariferous disc present internal to stamens.

Gynoecium : Absent.

Floral formula : $Br\ Ebr\ \oplus\ \delta\ K_5\ C_5\ A_5\ G_0$

Female flower : Bracteate, pedicillate, incomplete, actinomorphic, unisexual, pistillate, epigynous, penetamerous, and cyclic.

Calyx: Sepals 5, gamosepalous, valvate, green, superior.

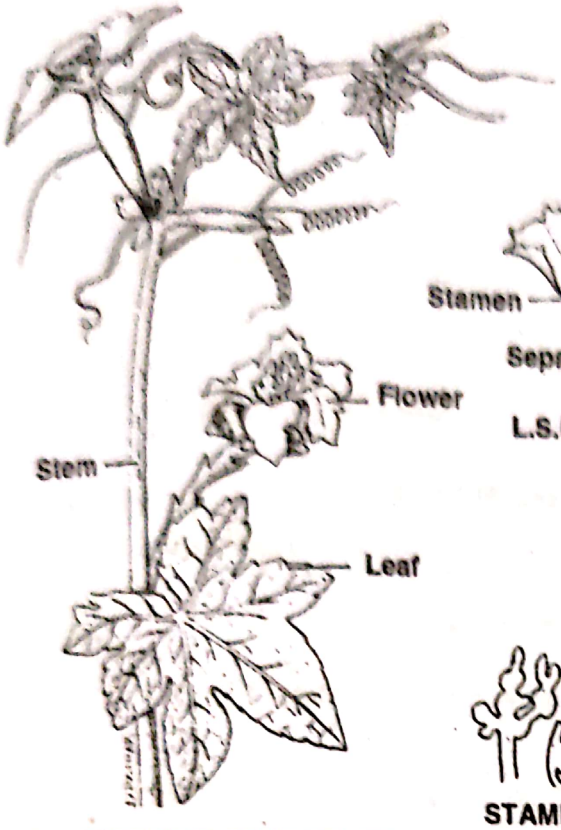
Corolla : Petals 5, polypetalous, imbricate, yellowish, superior.

Androceium : Absent

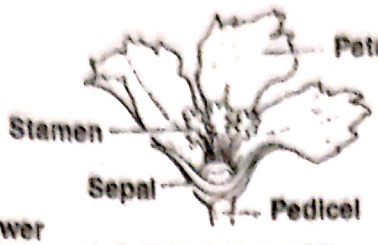
Gynoecium : Tricarpellary syncarpous, inferior ovary, unilocular with many ovules on parietal placentation, placentae enlarged intruding and often meeting in center forming pseudoaxile placentation, style simple or 3-partite.

Fruit : Cylindrical berry.

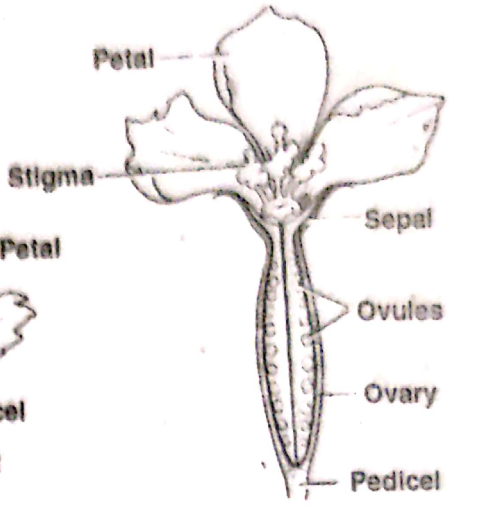
Floral formula : $Br\ Ebr\ \oplus\ \varphi\ K_5\ C_5\ A_0\ \underline{G}_{(3)}$



TWIG WITH INFLORESCENCE

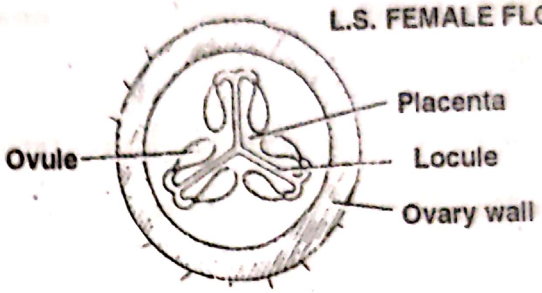


L.S.MALE FLOWER

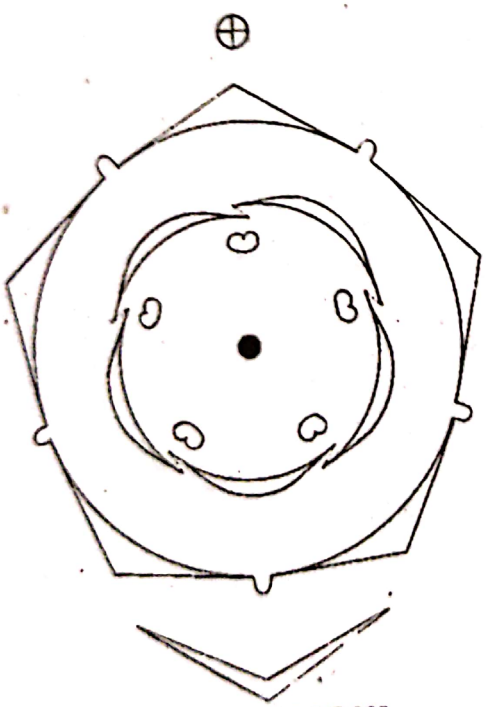


L.S. FEMALE FLOWER

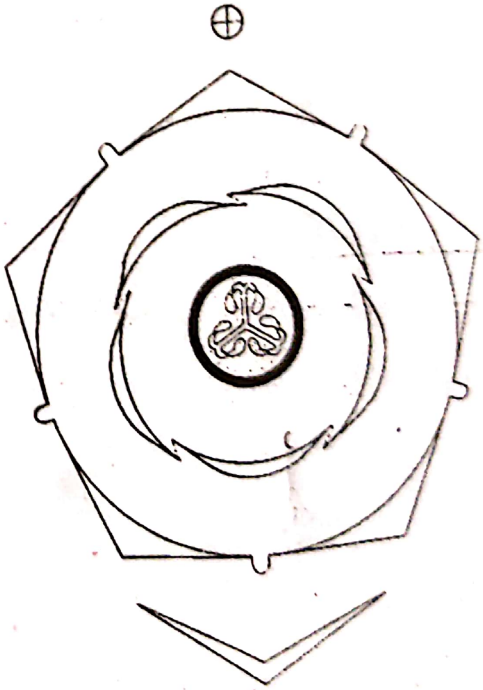
STAMENS



T.S.Ovary



FLORAL DIAGRAM
(MALE FLOWER)



FLORAL DIAGRAM
(FEMALE FLOWER)

Fig: Luffa cylindica

Identification of the family (based on Bentham & Hooker's classification) :

Venation reticulate, flowers pentamerous, cotyledons two.

Class : Dicotyledonae

Flowers with distinct calyx and corolla, petals free.

Sub Class : Polypetalae

(united in *coccinia*).

Flowers epigynous, sepals united,

Series : Calyciflorae

Flowers epigynous, carpels united, parietal placentation,
style divided.

Orders : Passiflorales

Herbs climbing with tendrils, leaves palmately lobed,

flowers unisexual, stamens 5 (appearing 3 in *Coccinia*), carpels 3,

pseudoaxile placentation due to intrusion of placentae, fruit berry (pepo).

Family : Cucurbitaceae

(3)ASTERACEAE

Class	:	*Dicotyledonae*
Sub Class	:	*Gamopetalae*
Series	:	*Inferae*
Orders	:	*Asterales*
Family	:	*Compositae (Asteraceae)*

Helianthus annuus Linn.

Habit : Annual cultivated herb.

Habitat : Mesophytic.

Stem : Herbaceous, aerial, erect, cylindrical, branched, solid, hairy, green.

Leaves : Cauline and ramal, opposite or alternate, exstipulate, simple, ovate, serrate, acute, hairy, venation unicostate reticulate.

Inflorescence : Heterogamous capitulum, ray florets are ligulate and peripheral, disc florets are tubular and central, involucre of bracts present.

(a) Ray Floret : Bracteate, sessile, incomplete, zygomorphic, unisexual, pistillate, epigynous, cyclic, pentamerous.

Calyx : Sepals 2, situated anterio-posteriorly, modified as pappus.

Corolla : Petals 5, gamopetalous, valvate, ligulate.

Androceium : Absent.

Gynoecium : Bicarpellary syncarpous, inferior ovary, unilocular with one ovule on basal placentation, style short, stigma bifid.

Fruit : Cypsela.

Floral formula : Br Ebrl % ♀ $K_{2\ Pappus}\ C_5\ A_0\ \underline{G}_{(2)}$

(b) Disc Floret : Bracteate, sessile, complete, actinomorphic, bisexual, epigynous, cyclic, pentamerous.

Calyx : Sepals 2, anterio-posteriorly situated, reduced to pappus.

Corolla : Petals 5, gamopetalous, valvate, tubular.

Androceium : Stamens 5, syngenesious, epipetalous, anthers fused to form a tube around the style, dithecous, basifixed, introrse.

Gynoecium : Bicarpellary syncarpous, inferior ovary, unilocular with one ovule on basal placentation, style short, stigma bifid.

Fruit : Cypsela.

Floral formula : $Br\,Ebrl\,\oplus\,\delta\,\varphi\,K_{(Pappus)}\,\widehat{C_{(5)}}\,\widehat{A_{(5)}}\,\underline{G}_{(2)}$

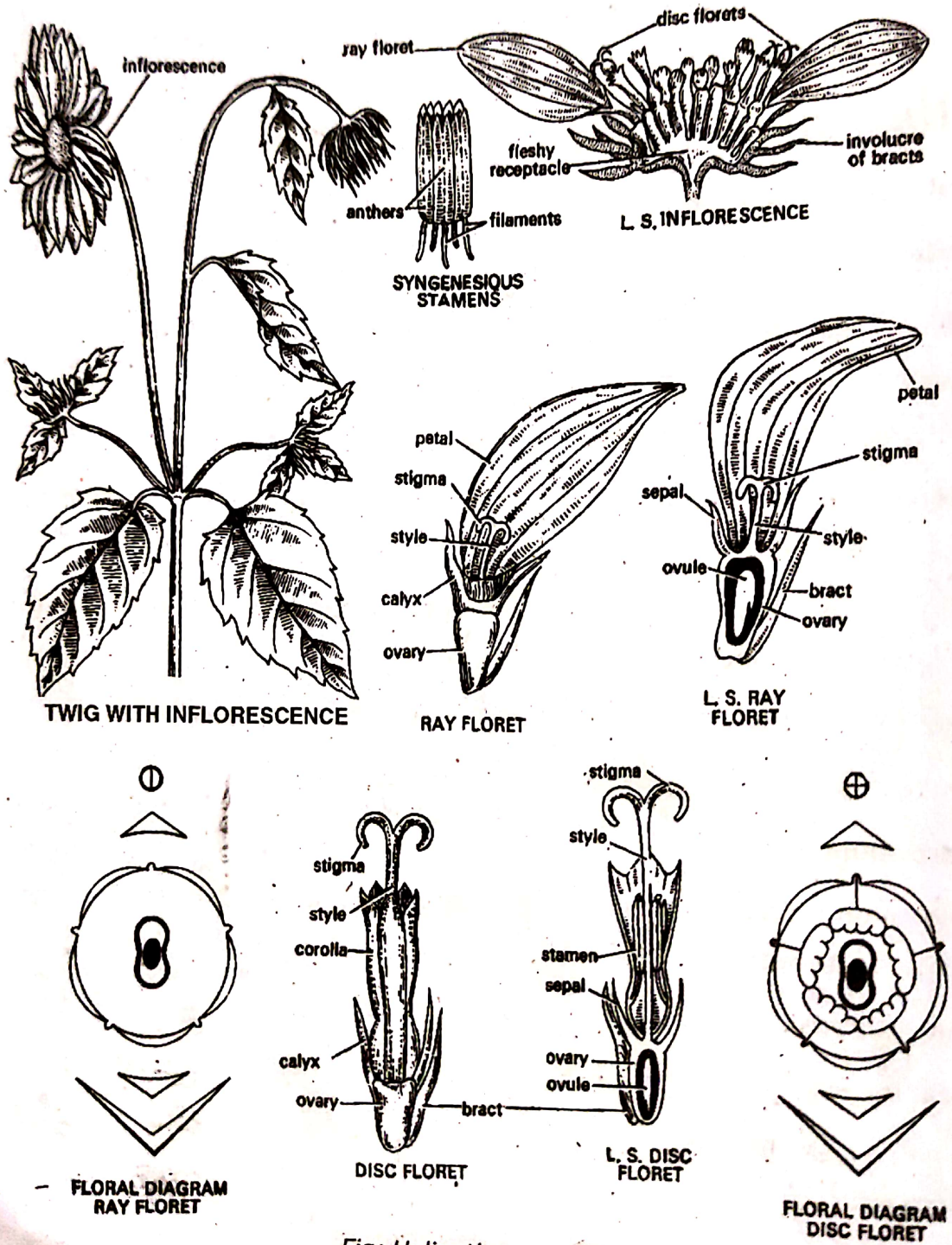


Fig: Helianthus annuus

(a) *Tridax procumbens* Linn.

Habit : Annual slender herb, common weed.

Habitat : Mesophytic.

Stem : Herbaceous, aerial, erect or prostrate, cylindrical, branched, slender, hairy, green.

Leaves : Cauline and ramal, opposite or alternate, exstipulate, simple, ovate, dentate, acute, hairy, venation unicostate reticulate.

Inflorescence : Heterogamous capitulum on long peduncles, Solitary, ray florets are ligulate and peripheral, disc florets are tubular and central, involucre of bracts present,.

(a) Ray Floret : Bracteate, sessile, incomplete, zygomorphic, unisexual, pistillate, epigynous, cyclic, pentamerous.

Calyx : Reduced as hair like pappus.

Corolla : Petals 5, gamopetalous, valvate, ligulate.

Androecium : Absent.

Gynoecium : Bicarpellary syncarpous, inferior ovary, unilocular with one ovule on basal placentation, style short, stigma bifid.

Fruit : Cypsela.

Floral formula: Br Ebrl % ♀ $K_{(Pappus)} C_{(5)} A_0 \underline{G}_{(2)}$

(b) Disc Floret : Bracteate, sessile, complete, actinomorphic, bisexual, epigynous, cyclic, pentamerous.

Calyx : Reduced as hair like pappus, persistent, appear as ring of hairs on the dried fruit.

Corolla : Petals 5, gamopetalous, valvate, tubular.

Androecium : Stamens 5, syngenesious, epipetalous, anthers fused to form a tube around the style, dithecous, basifixed, introrse.

Gynoecium : Bicarpellary syncarpous, inferior ovary, unilocular with one ovule on basal placentation, style short, stigma bifid.

Fruit :Cypsela.

Floral formula: Br Ebrl % ♀ $K_{(Pappus)} \overbrace{C_{(5)}} A_0 \underline{G}_{(2)}$

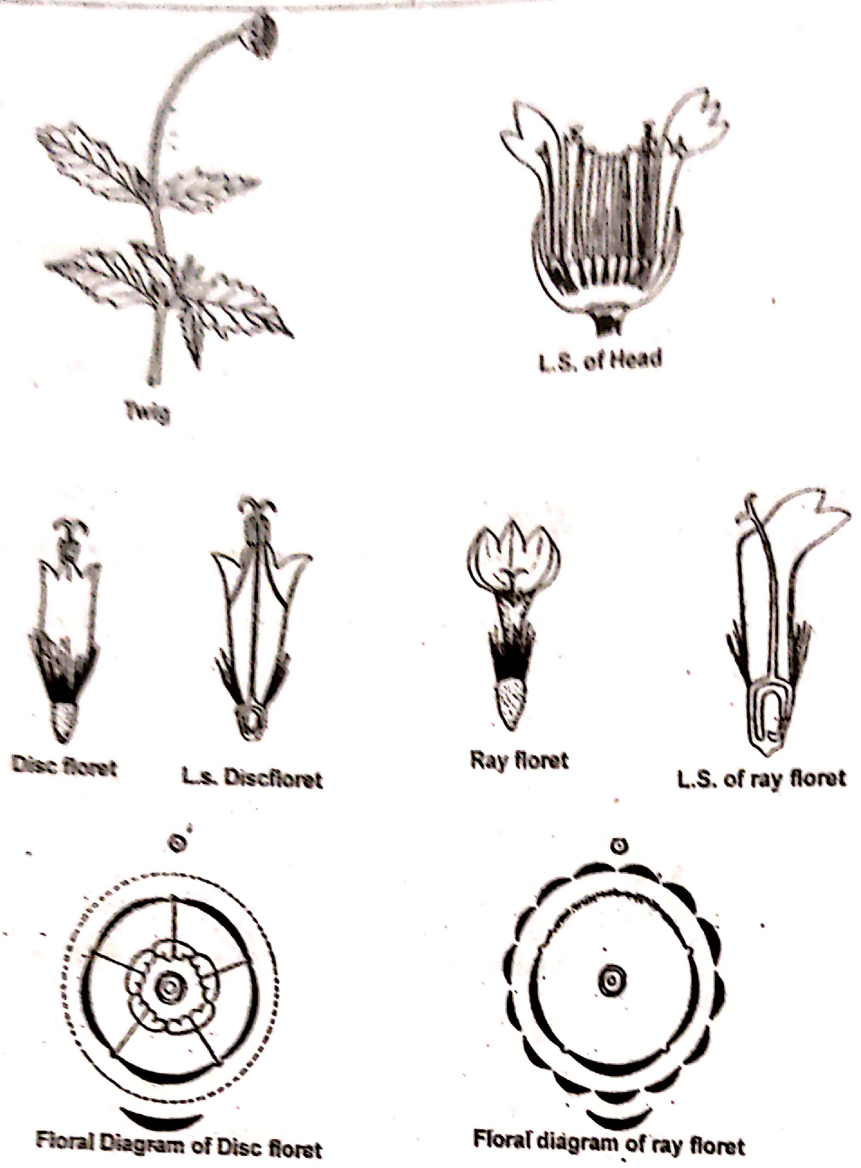


Fig: Tridax procumben's

Identification of the family (based on Bentham & Hooker's classification) :

Venation reticulate, flowers pentamerous, cotyledons two.

Class : Dicotyledonae

Flowers with distinct calyx and corolla, petals united.

Sub Class : Gamopetalae

Ovary inferior, Stamens usually equal to corolla lobes.

Series : Inferae

Leaves opposite, Stamens syngenecious, Ovary unilocular and with one ovule.

Order : Asterales

Leaves alternate, inflorescence capitulum, Calyx reduced to pappus, stamens epipetalous.

Family : Compositae (Asteraceae)

(4) ASCLEPIADACEAE

Class	:	Dicotyledonae
Sub Class	:	Gamopetalae
Series	:	Bicarpellatae
Orders	:	Gentianales
Family	:	Asclepiadaceae

Calotropis procera (Willd.) Dryand. ex W. Ait. (= *Asclepias procera* Willd.)

Habit : Annual shrub, commonly grown in barren lands.

Habitat : Mesophyte with xerophatic adoptations.

Stem : Herbaceous, lower portion woody, aerial, erect, cylindrical, branched, solid, smooth, upper portion covered by wooly hairs, pale green, milky latex present.

Leaves : Cauline and ramal, opposite decussate, stipulate, simple, elliptical, entire, hairy, wooly, acute, venation unicostate reticulate, milky latex present.

Inflorescence : Axillary or terminal polychasial cyme.

Flower :Bracteate, bractiolate, pedicillate, complete, actinomorphic, bisexual, hypogynous, cyclic, pentamerous.

Calyx : Sepals 5, polysepalous, quincuncial.

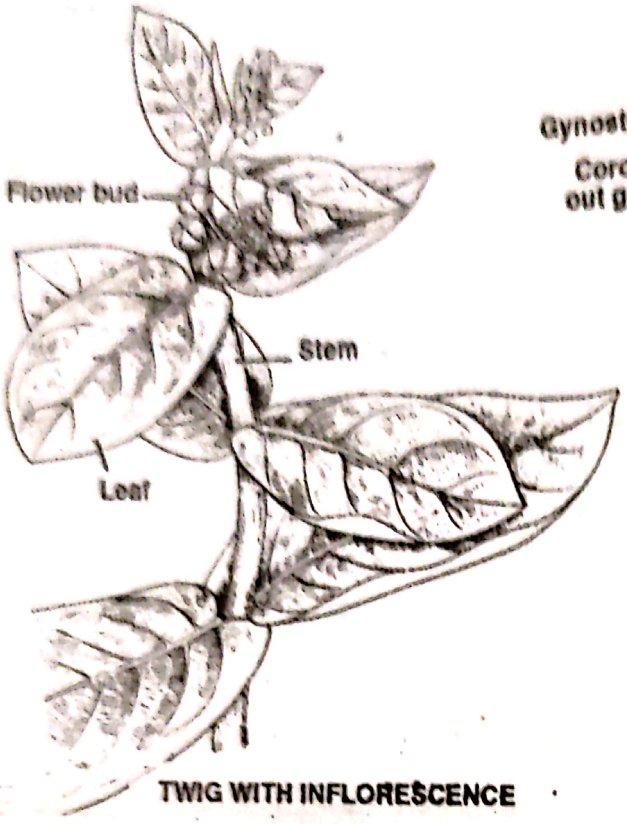
Corolla : Petals 5, gamopetalous, twisted, pink.

Androceium : Stamens 5, united with stigma to form gynostegium, stamen represented by two pollinia with their retinaculae. The pollenia of the adjacent anthers are joined by their retinaculae to corpusculum in a groove, to form a unit called as translator. A coronary outgrowth is present at the back of each stamen.

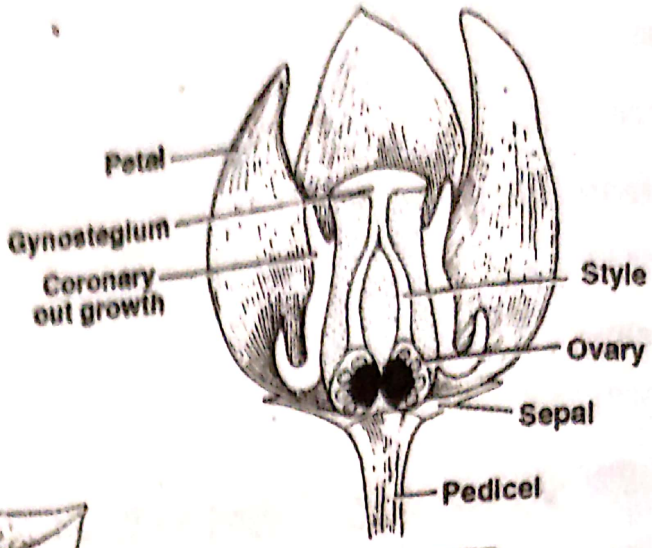
Gynoecium : Bicarpellary, ovaries are free but upper portion of style and stigma are fused, superior, with many ovules in each locule on marginal placentation, stigma modified as pentagonal head.

Fruit : Etaerio of follicle.

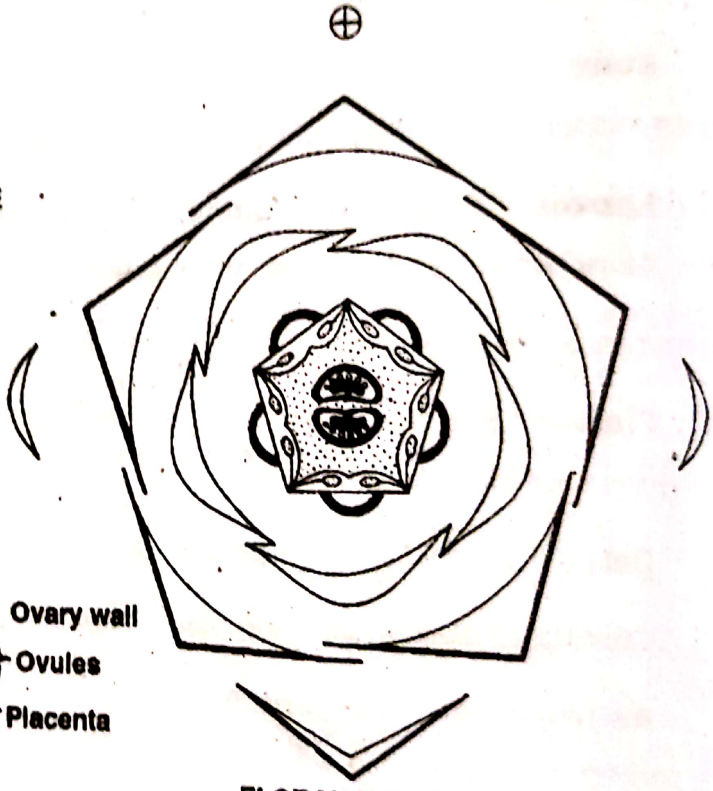
Floral formula: $Br, bri, \oplus, \delta, K_5, C_{(5)}, \widehat{A_{(5)}, \underline{G}_2}$.



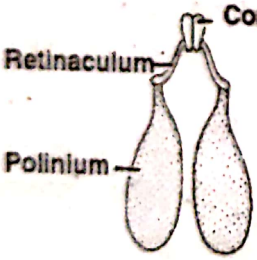
TWIG WITH INFLORESCENCE



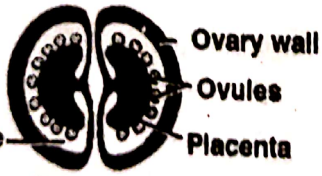
L.S. FLOWER



FLORAL DIAGRAM



TRANSLATOR



T.S. OVARY

Fig: Calotropis procera

(a) *Asclepias curassavia* Linn.

Habit : Annual shrub.

Habitat : Mesophytic.

Stem : Herbaceous, aerial, erect, cylindrical, branched, solid, glabrous, milky latex present.

Leaves : Cauline and ramal, opposite decussate, exstipulate, simple, petiolate, lanceolate, entire, acute, glabrous, venation unicostate reticulate.

Inflorescence : Extra axillary umbel.

Flower : Bracteate, bractiolate, pedicillate, complete, actinomorphic, bisexual, hypogynous, cyclic, pentamerous.

Calyx : Sepals 5, polysepalous, valvate.

Corolla : Petals 5, gamopetalous, petals are only basally connate, twisted and brightly coloured.

Androceium : Stamens 5, united with stigma to form gynostegium, stamen represented by two pollinia with their retinaculae. The pollenia of the adjacent anthers are joined by their retinaculae to corpusculum in a groove, to form a unit called as translator. A coronary outgrowth is present at the back of each stamen.

Gynoecium : Bicarpellary, ovaries are free but upper portion of style and stigma are fused, superior, with many ovules in each locule on marginal placentation, stigma modified as pentagonal head.

Fruit : Etaerio of follicle.

Floral formula : $Br\ Ebrl \oplus\ \delta\ K_5\ C_{(5)}\ \overbrace{A_{(5)}\ \underline{G}_2}$

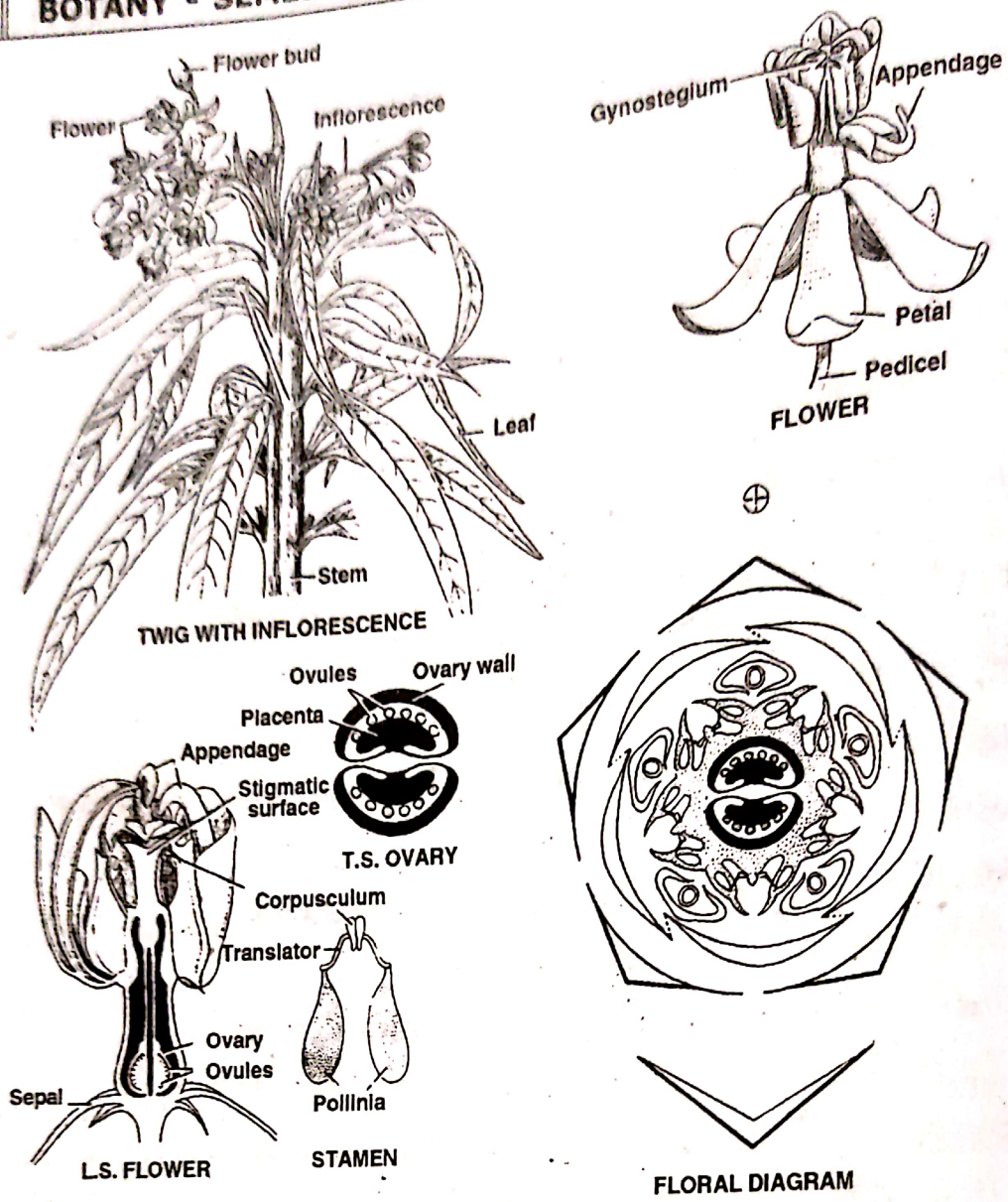


Fig: Asclepias curassavia

Identification of the family(based on Bentham & Hooker's classification) :

Venation reticulate, flowers pentamerous, cotyledons two.

Class : Dicotyledonae

Flowers with distinct calyx and corolla, petals united.

Sub Class : Gamopetalae

Ovary superior, carpels two.

Series : Bicarpellatae

Leaves opposite, flowers actinomorphic, stamens epipetalous.

Order : Gentianales

Flowers solitary or in cymose umbels, petals convolute, stamens gynandrous, pollen usually in pollinia with translators, ovaries free but style and stigma are united.

Family : Asclepiadaceae.

(5) AMARANTHACEAE

Class	:	*Dicotyledonae*
Sub Class	:	*Monochlamydae*
Series	:	*Curvembryae*
Family	:	*Amaranthaceae*

Achyranthus aspera Linn.

Habit : Herb.

Habitat : Mesophytic.

Stem : Herbaceous, aerial, erect, quadrangular, branched, solid, hairy, green.

Leaves : Cauline and ramal, opposite decussate, exstipulate, simple, sub-sessile, elliptic-ovate, entire, acute, pubescent, rough, coriacrous, venation unicostate reticulate.

Inflorescence : Spike in which flowers are sharply defluxed.

Flower : Bracteate , bracteolate, both bracts and bractioles have spinous tips - scarious, sessile, complete, actinomorphic, bisexual, pentamerous, hypogynous, cyclic.

Perianth : Tepals 5, polysepalous, quincuncial, hardened and ribbed.

Androceium : Stamens 10, 5 fertile stamens alternate with 5 petaloid fimbricate staminodes, dithecous, versatile, introrse

Gynoecium : Bicarpellary, syncarpous, superior ovary, unilocular with one ovule on basal placentation, style short and curved, stigma knob-like.

Fruit : Utricle.

Floral formula: Br Brl $\oplus$ ♀ P_5 A_{5+5} G_2

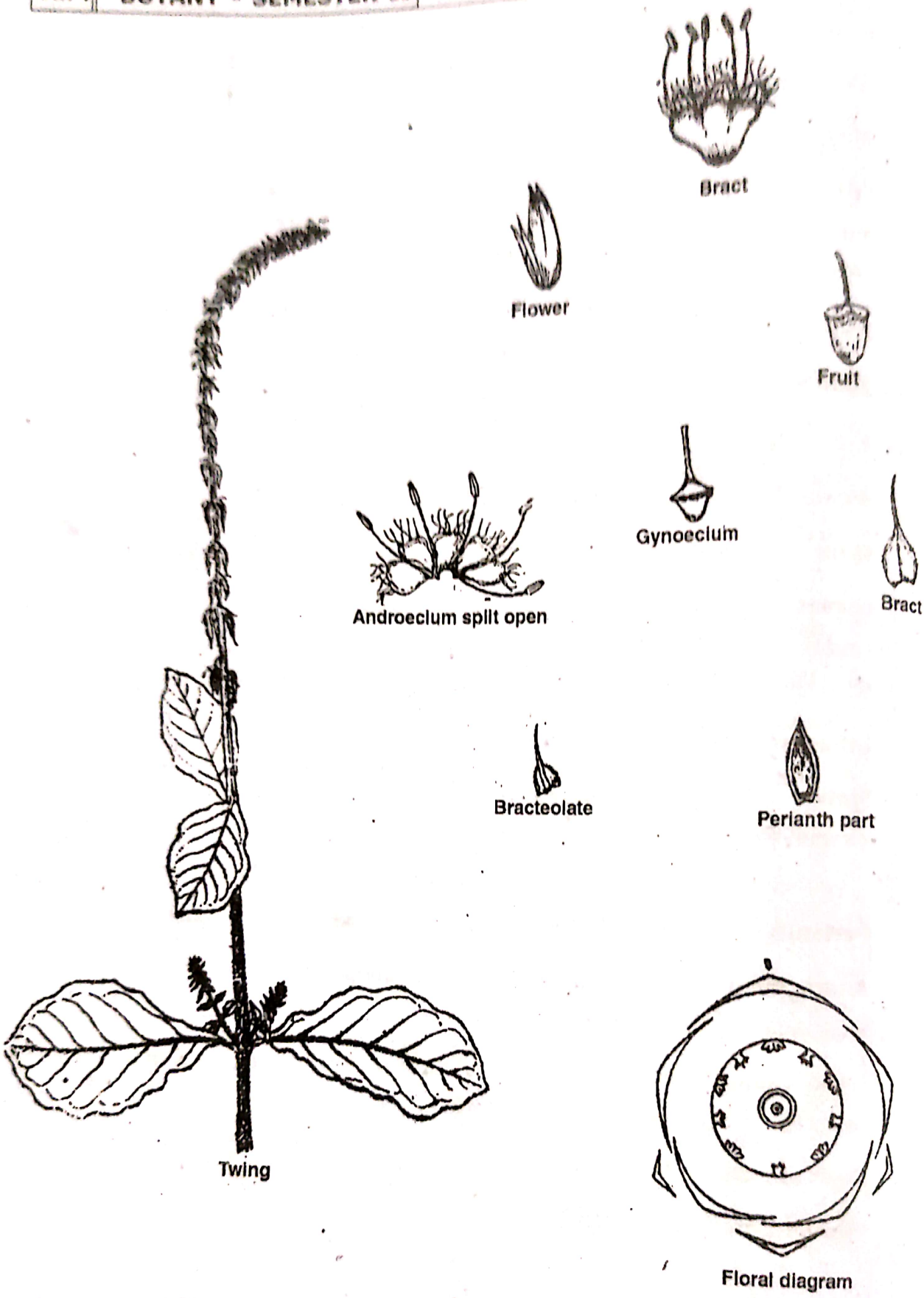


Fig: Achyranthus aspera

(a) *Amaranthus spinosus* Linn.

Habit : Herb.

Habitat : Mesophytic.

Stem : Herbaceous, aerial, errect, terete, branched, solid, spiny, green.

Leaves : Cauline and ramal, alternate, exstipulate, simple, petiolate, elliptic-ovate, entire, mucronate, acute, membranous, a pair of spines are present in the axil of each leaf which are modified axillary branches, unicostate reticulate.

Inflorescence : Terminal or axillary, condensed compound spike.

Male Flower : Bracteate , bracteolate, sessile, incomplete, actinomorphic, staminate, cyclic.

Perianth : Tepals 5, polyspetalous, quincuncial, membranous.

Androceium : Stamens 5, polyandrous, anteposed, filaments thin and lng, dithecous, versatile, introrse

Gynoecium : Absent

Female Flower : Bracteate , bracteolate, sessile, incomplete, actinomorphic, pistillate, cyclic.

Perianth : Tepals 5, polyspetalous, quincuncial, membranous.

Androceium : Absent

Gynoecium : Bicarpellary, syncarpous, superior ovary, unilocular with one ovule on basal placentation, styles 2 speading, stigma bifid and hairy.

Fruit : Utricle.

Floral formula:

Male flower :Br Ebrl $\oplus$ δ $P_5 A_5 G_0$

Female flower Br Ebrl $\oplus$ φ P_5 A_0 $\underline{G}_{(2)}$

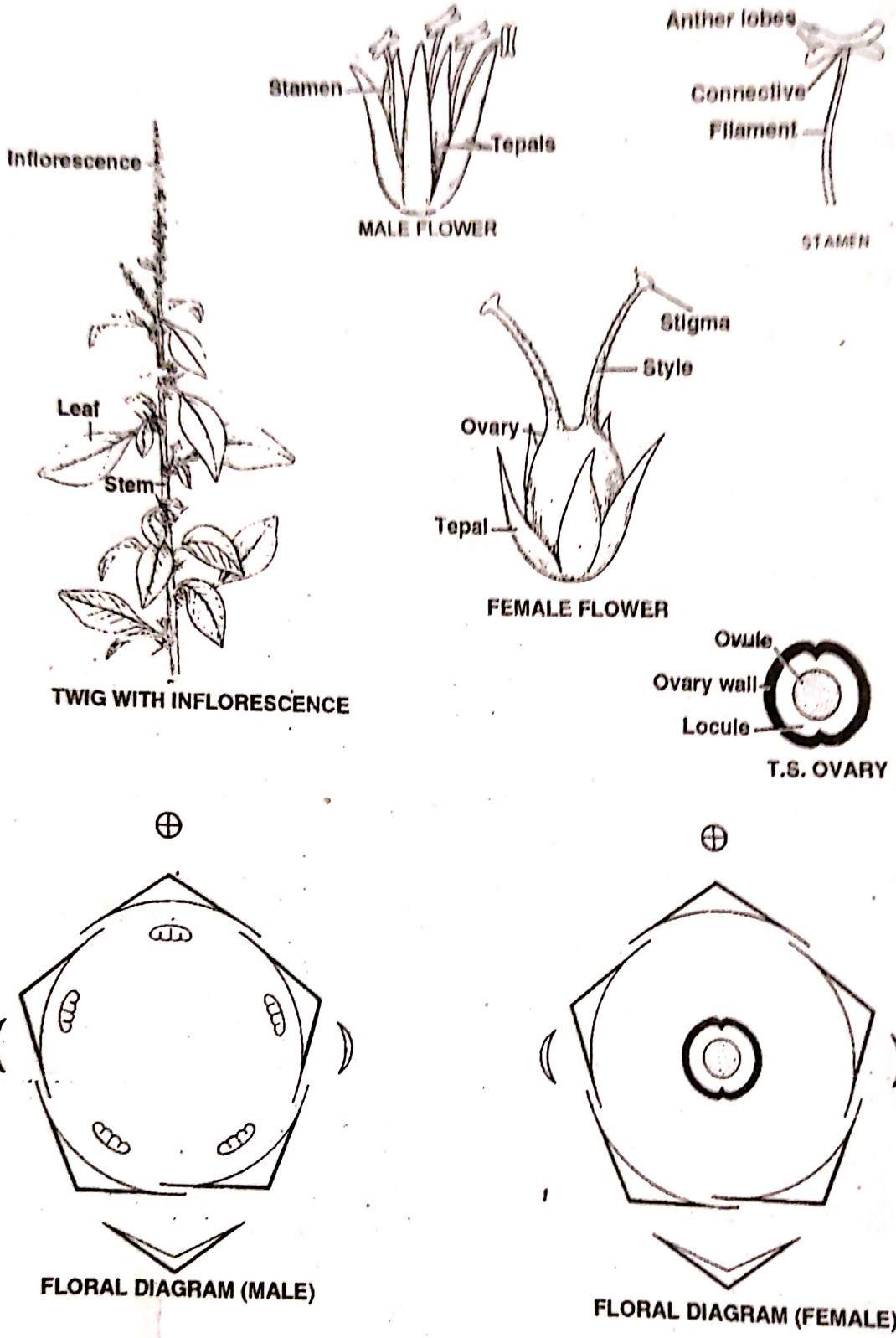


Fig: Amaranthus spinosus

Identification of the family (based on Bentham & Hooker's classification) :

Venation reticulate, flowers pentamerous, cotyledons two.

Class : Dicotyledonae

Flowers with usually one whorl of perianth, commonly sepaloid or none.

Sub Class : Monochlamydae

Embyo curved .

Series : Curvembryae

Leaves opposite or alternate, Flowers small haplochlamydous, bisexual, actinomorphic, Tepals 4 or 5 sepaloid, stamens 1 or 5 antiposed gynoecium bilocular or trilocular with many to one ovule in each locule.

Family : Amaranthaceae

(6) EUPHORBIACEAE

Class	:	Dicotyledonae
Sub Class	:	Monochlamydae
Series	:	Unisexuales
Family	:	Euphorbiaceae

Croton bonplandianum Linn.

Habit : Annual shrub.

Habitat : Mesophytic.

Stem : Herbaceous, aerial, erect, smooth, branched, solid, green.

Leaves : Cauline and ramal, alternate sometimes whorled, stipulate, simple, sub-sessile, elliptic-lanceolate, serrate, acute, membranous, unicostate reticulate.

Inflorescence : Terminal or axillary, recemose.

Male Flower : Bracteate, sessile, incomplete, actinomorphic, staminate, heterochlamydeous, cyclic.

Calyx : Sepals 5, polysepalous, valvate or imbricate.

Corolla : Petals 5, polypetalous, valvate.

Androceium : Stamens 15, polyandrous, filaments are free long, dithecous, basifixed, introrse.

Gynoecium : Absent.

Floral formula : Br Ebr $\oplus$ δ K_5 C_5 A_∞ G_0

Female Flower: Bracteate, sessile, incomplete, actinomorphic, pistillate, monochlamydeous, cyclic.

Perianth : Tepals 5, polysepalous, valvate, membranous.

Androceium : Absent.

Gynoecium : Tricarpellary, syncarpous, superior ovary, trilocular with 1-2 ovules in each locule on axil placentation, style bifid, stigma pointed, a disc is present around the ovary at base.

Fruit : Regma.

Floral formula : Br Ebrl $\oplus$ φ P_5 A_0 $\underline{G_{(3)}}$

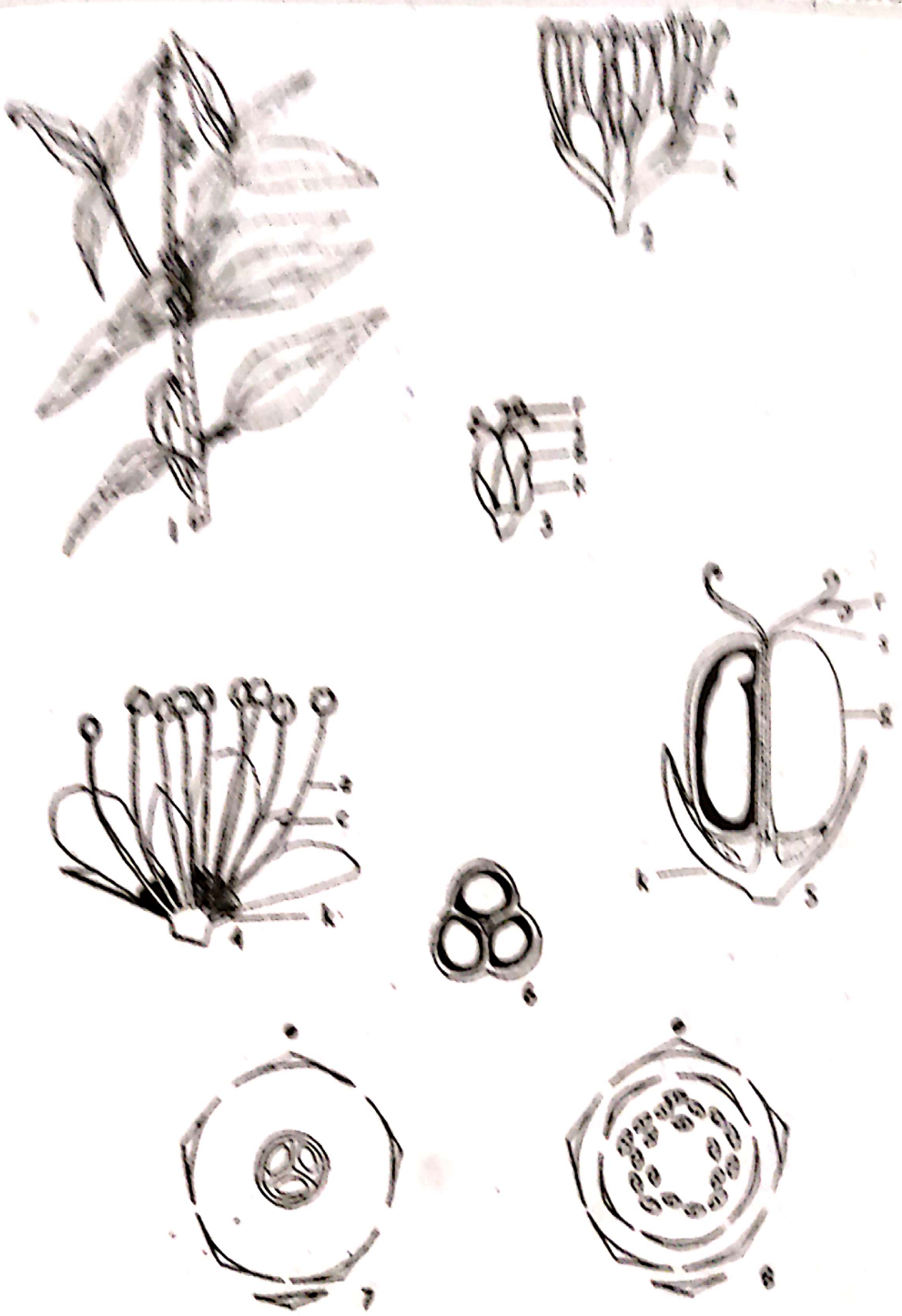


Fig: Croton bonplandianum

1. Twig, 2&4–entire and half flower, male (k–calyx, c–corolla: a–stamens).
3&5 –entire and half flower, female (k–calyx, g–ovary; –style, r–stigma)
6–T.S. of ovary, 7&8–floral diagram of female and male flowers.

(a) *Euphorbia hirta* Linn.

Habit : Prostrate herb.

Habitat : Mesophytic.

Stem : Herbaceous, aerial, prostrate, weak, smooth, branched, solid, green, milky latex present.

Leaves : Cauline and ramal, opposite, superposed, exstipulate, simple, sub-sessile, elliptic-lanceolate, serrulate, retuse, acute, puberulous, unicostate reticulate.

Inflorescence : Cyathium aggregated in axillary clusters. Each cyathium consists of a central single female flower surrounded by several male flowers enclosed by bell shaped involucre.

Male Flower : male flowers are present in the axil of each involucral leaf or bract, in the form of scorpioid cyme placed in a ziz zag manner with a centrifugal order. it is represented only by one stamen with a jointed filament and a anther, dithecous, introrse

Female Flower : It has a long stalk which bends on to one side, and bear the gynoecium at the tip.

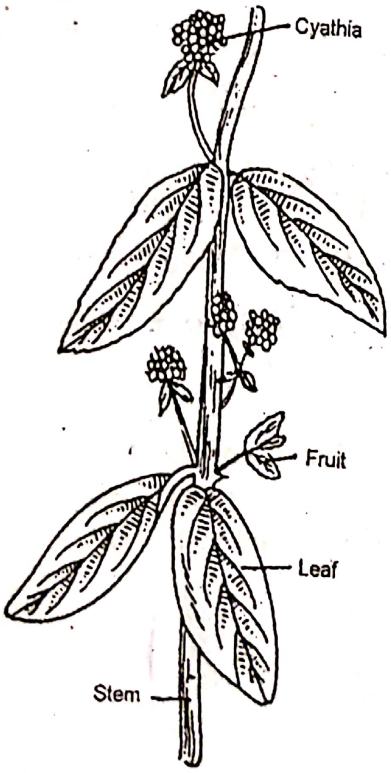
Gynoecium : Tricarpellary, syncarpous, superior ovary, trilocular with 1-2 ovules in each locule on axil placentation, style bifid, stigma pointed, a disc is present around the ovary at base.

Fruit : Regma.

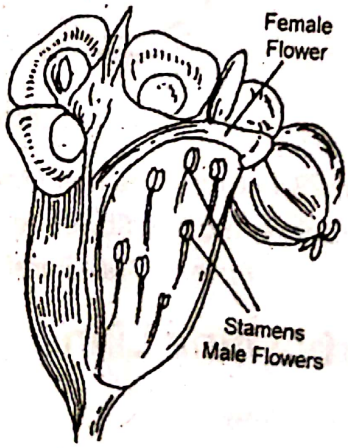
Floral formula :

Male Flower : Br Ebrl % ♂ K_0 C_0 A_1 $\underline{G}_0$

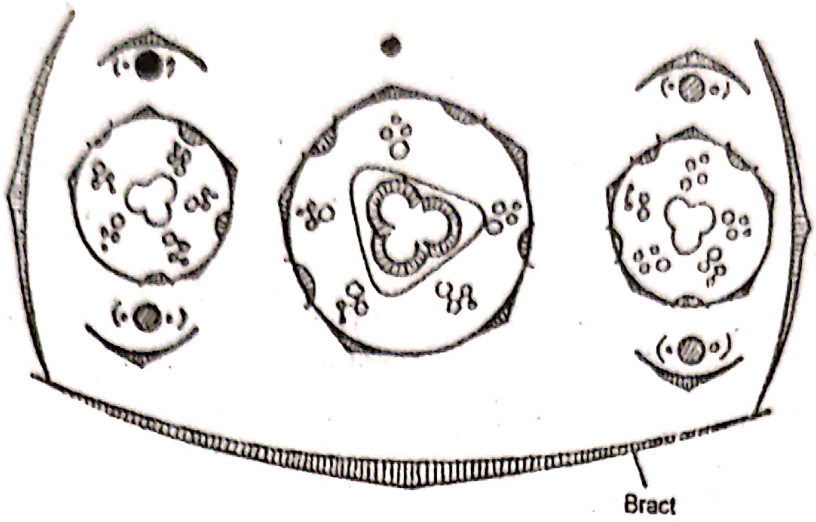
Female Flower : Br Ebrl % ♀ K_0 C_0 A_0 $\underline{G}_{(3)}$



TWIG WITH INFLORESCENCE



L.S. OF THE FLOWER (CYATHIUM)



FLORAL DIAGRAM SHOWING THREE CYATHIA

Identification of the family (based on Bentham & Hooker's classification) :

Venation reticulate, flowers pentamerous, cotyledons two.

Class : Dicotyledonae

Flowers with usually one whorl of perianth, commonly sepaloid or none.

Sub Class : Monochlamydae

Flowers unisexual, Perianth sepaloid or reduced, ovules 1 or 2 in each carpel

Series : Unisexuales

Leaves alternate, stipulate with latex, Perianth in one whorl, stamens 1 to many, free or united, gynoecium tricarpellary, syncarpous, superior, trilocular, with one or two ovules in each locule, styles three.

Family : Euphorbiaceae

7. Cocos nucifera Linn.

Class : Monocotyledonae
Series : Calycineae
Family : Palmae (Arecaceae)

Habit : Big Tree.

Habitat : Mesophytic.

Stem : Woody ; aerial ; erect ; cylindrical ; unbranched; solid; marked by rings left by the leaf bases; bear a crown of leaves at the top in a radial manner.

Leaves : Cauline; exstipulate; unipinnately compound, with a broad petiole which ensheaths the stem, feather type entire, glabrous, venation unicostate parallel.

Inflorescence : Branched spike with a common woody spathe (spadix).

Male Flower : Bracteate; sessile; incomplete; actinomorphic; unisexual, staminate, trimerous, cyclic.

Perianth : Tepals 6 in two whorls of three each, the outer whorl are smaller than the inner, leathery, polyandrous, valvate.

Androecium : Stamens 6 in two whorls of three each, polyandrous, filaments short, dithecous, dorsifixed, introrse.

Gynoecium : Absent.

Female flower : Bracteate; sessile; incomplete; actinomorphic; unisexual ; pistillate ; trimerous ; hypogynous ; cyclic.

- **Perianth :** Tepals 6 in two whorls of three each, the outer whorl are smaller than the inne leathery ; polyandrous ; valvate Androecium ; Absent

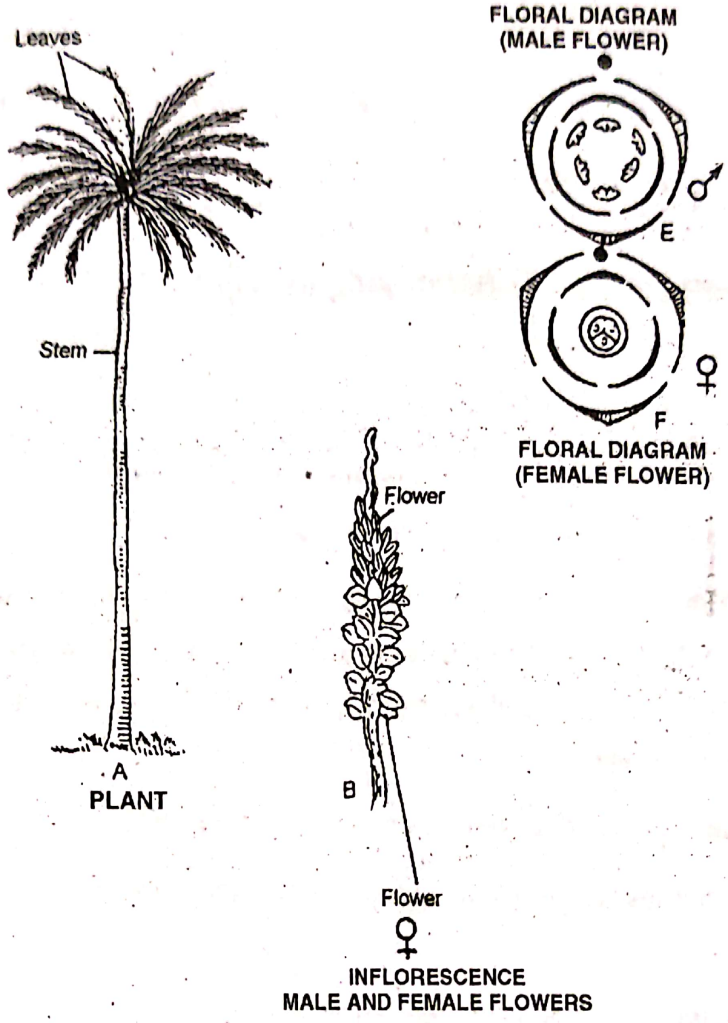
Gynoecium : Tricarpellary; apocarpous, but only one carpel continues development and the other two degenerate, superior ovary, with only one basal ovule, style absent, stigma uncinate.

Fruit : Large drupe.

Floral formula:

Male flower : Ebr Ebrl ⊕ ♂ $P_{3+3} A_{3+3} G_0$

Female flower: Ebr Ebrl ⊕ ♀ P_{3+3} A_0 $G_{(3)}$



Identification of the family (based on Bentham & Hooker's classification) :

Venation parallel, flowers trimerous, cotyledons one and Fibrous root system.

Class : Monocotyledonae

Perianth sepaloid, herbaceous membrane ovary superior

Series : Calycineae

Family : Palmae (Arecaceae)

Tree like plants with crown of leaves at thetop ;

flowers actinomorphic, unisexual present in spikes; perianth sepaloid and occur in two whorls;

stamens in two whorls of 3 or 9 in each whorl gynoecium tricarpellary, tri locular with one ovule in each locule; fruit berry or drupe. *Family : Palmae (Arecaceae)*

(8) POACEAE

Class	:	*Monocotyledonae*
Series	:	*Glumaceae*
Family	:	*Poaceae (Graminae)*

Triticum aestivum Linn. (= *Triticum vulgare* Vill.)

Habitat : Mesophytic.

Stem : Herbaceous, aerial, erect, cylindrical, branched branching only at basal region of the stem and is known as tiller, culm, smooth , green.

Leaves : Cauline, long and linear with a sheathing base covering the entire inter-nodal region, a ligule- membranous outgrowth is present at the joint between lamina and the leaf base, alternate, exstipulate, simple, sessile, lanceolate, entire, minutely hairy, venation multicostate parallel.

Inflorescence : Spike of spikelets. Each spikelet consists of

(a) a pair of glumes at the base, outer one is called first and the inner as second, these are barren.

(b) a lemna or inferior palea is present after glumes.

(c) superior palea or pale is present next to lemna.

(d) In between these two pale the essential parts of the flower are present

Flower : Sessile, complete, zygomorphic, bisexual, hypogynous, cclic.

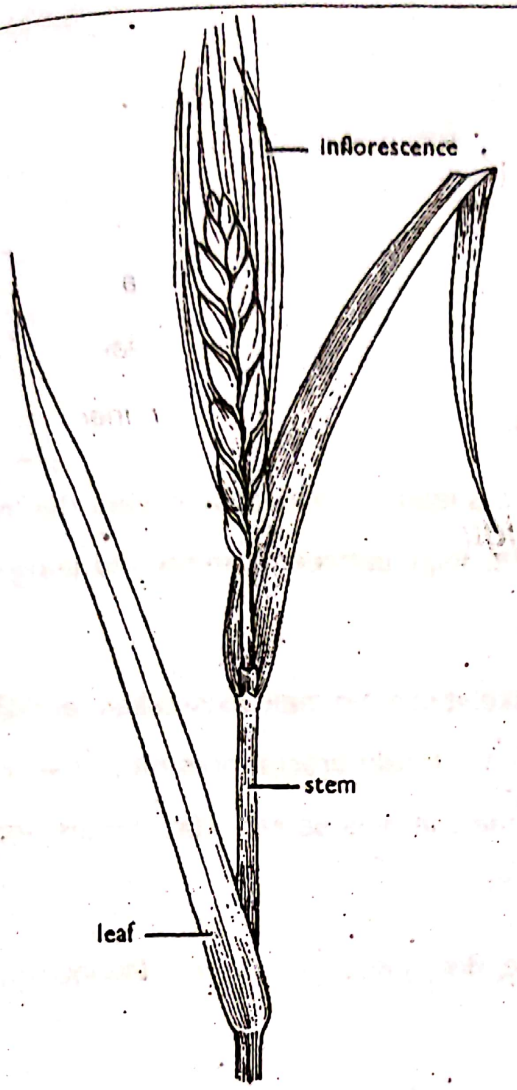
Perianth : Represented by two rudimentory tepals called lodicules

Androecium : Stamens 3, polyandrous, filaments long, dithecous, versatile, introrse.

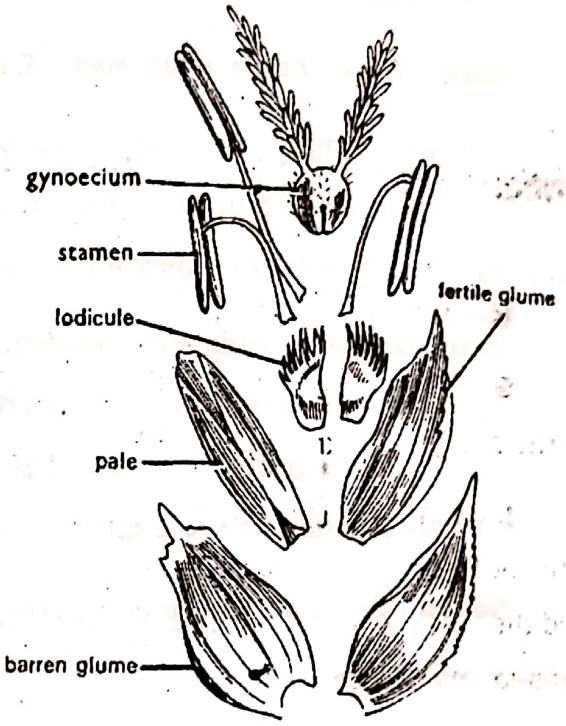
Gynoecium : Monocarpellary, unilocular, superior ovary, with only one marginal ovule, style absent, stigma 2 and feathery.

Fruit : Caryopsis.

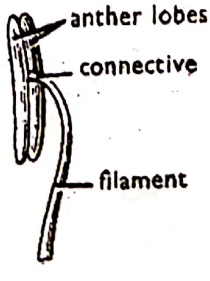
Floral formula : Br Ebr % ♀ P_2 A_3 $\underline{G_1}$



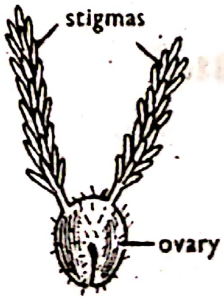
TWIG WITH INFLORESCENCE



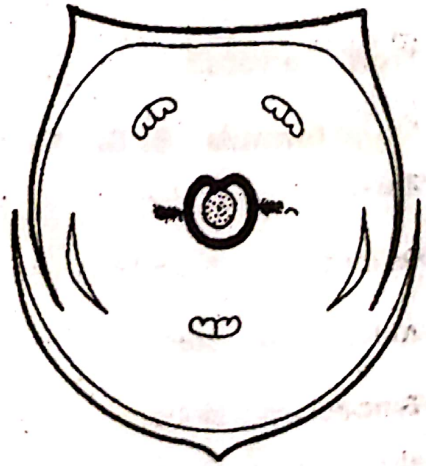
A DISSECTED SPIKELET



STAMEN



GYNOECIUM



FLORAL DIAGRAM

Fig: Triticum aestivum

(a) Chloris barbata

Habit : Annual Herb

Habitat : Mesophyte

Root Stem : Adventitious root system

Stem : Aerial, herbaceous, Hairy, Culum.

Leaves : Simple : Alternate, exstipulate sheathing leaf base covers the internode ligule membranous out growth is present at the joint between lamina and leaves - base lanceolate, hairy multicostate parallel venation.

Inflorescence : Spike with spikelets, Spikelet contain main axis-called rachilla, Sterile bracts present at the base and tip are called glumes fertile bracts, present at the centre are called lemma. Flower present in the axil of lemma contains palea – (bracteoles) lodicules - (perianth) male and female sex organs are present.

Flower : Bracteate, Bracteolate, Complete, Bisexual, Zygomorphic, Monochlamydeous, Cyclic, Hypogynous.

Perianth : 2 lodicules, Polytepalous.

Androecium :3 stamens, Dithecous, Introrse, versatile, longitudinal dehiscence.

Gynoecium : Superior ovary, Monocarpellary unilocular, basal placentation style bifurcated and feathery.

Fruit : Caryopsis

Floral formula : Br Brl % ♂ $P_2A_3\underline{G1}$

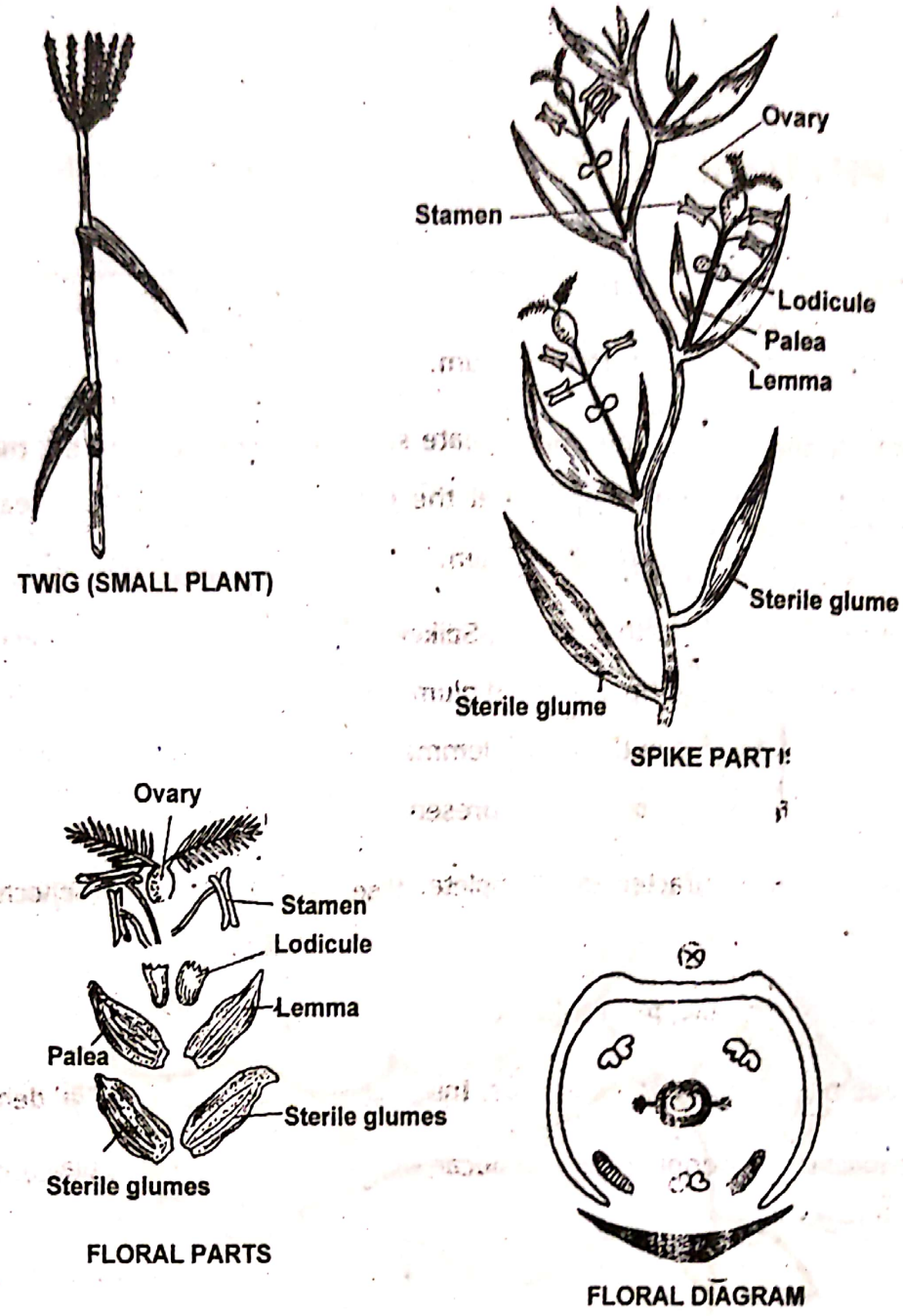


Fig: Chloris barbata

Identification of the family (based on Bentham & Hooker's classification) :

Venation parallel, flowers trimerous, cotyledons one.

Class : Monocotyledonae

Flowers solitary, sessile in the axil of bract; ovary unilocular with only one ovary

Series : Glumaceae

Stems jointed, leaves differentiated into lamina and base with ligule in between, inflorescence spikelet. stamens three; superior ovary with only one ovule, fruit caryopsis.

Family : Poaceae (Graminae)

5

PHYTOGEOGRAPHICAL DISTRIBUTION IN INDIA

I. Phytogeographical regions of India

The vegetation of a region develops according to the environment. India is located between 84°.4' N and 37°.6' N and the altitude varies from sea level to the highest peaks of Himalayas. Therefore, the Indian subcontinent shows a great variation in its climate from extreme cold to hot, and wet to dry conditions in different regions.

The rainfall varies very much. It is the lowest in Rajasthan and highest in Assam. Hence, the vegetation includes tropical, subtropical, temperate and alpine types. The vegetation can be recognised into the following types :

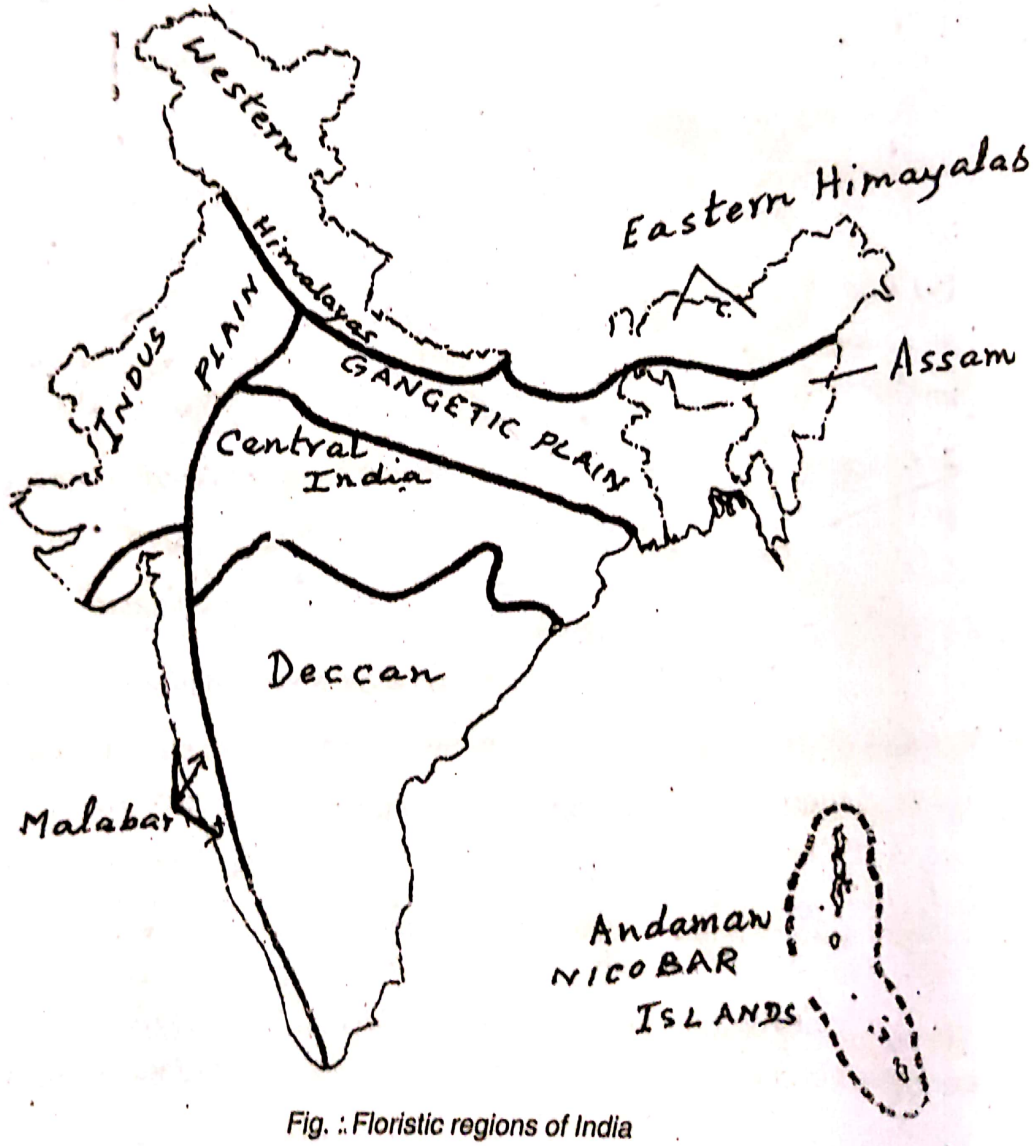


Fig. : Floristic regions of India

1. Western Himalayas : It forms one of the most important botanical regions. The Himalayas form the highest mountain ranges and the vegetation changes with increasing altitude. They are : (a) submontane (300-1500 metres above sea level) (b) temperate or montane zone (between 1500-3500 metres) and (c) alpine zone (above 3500 metres and below snow line).

(a) Sub-montane zone : This lower region is tropical or sub-tropical. In the region of Siwaliks, the forests are dominated by *Shorea robusta* (sal). In the riverian regions *Dalbergia sissoo* dominates but in the more moist regions *Cedrela toona* and *Ficus glomerata* dominate.

There are Savannahs with scattered trees of *Salmalia, Butea monosperma* and *Acacia catechu*. Patches of swamps occur in some regions. In the dry belts of west; *Shorea* does not occur but species of *Zizyphus*, *Acacia* and *Mallotus* are found. At higher elevations (1000-1500 metres), *Pinus roxburghi* and other conifers begin to appear. In these forests, the ground vegetation is usually poor.

(b) Temperate or Montane zone : Around 1600 metres height, the blue pine (*Pinus excelsa*) is found and above this height, *Cedrus deodara* (Deodar) is abundant in the forests. *Quercus incana* (Oak) is abundant at this altitude. In the inner regions, *Betula* and *Salix* are seen. At higher altitudes, other species of *Quercus*, horse chestnut (*Aesculus indica*), *Rhododendron* grow along with conifers like *Picea*, *Abies Taxus baccata* and *Cupressus* sp.

(c) Alpine region : This zone is above 3500 metres. In this region, shrubs of low height and herbs with beautiful flowers are found e g., *Primula, Delphinium, Potentilla, Geranium etc.*

2. Eastern Himalayas : This regions extends from Sikkim to Nepal. It has higher rainfall and warmer conditions compared to E. Himalayas. The vertical zonations of vegetation are similar to those of Western Himalayas but they commence at higher altitude-for example, the temperate region and alpine regions are at 300 metres higher than their corresponding regions in W. Himalayas. The E. Himalayan region is regarded as one of the richest vegetational regions of the world. It has the following three regions:

(a) Submontane region which is warm and humid is tropical with dense sal forests. Riverian forests have *Dalbergia sissoo* and *Acacia catechu*. Mixed forests of deciduous trees are extensively present with species of *Terminalia, Bauhinea, Anthocephalus indica*. Trees like *Albizzia, Salmalia* and bamboos are also common.

(b) Temperate or **montane zone** has a lower zone with several oaks, *Eugenia* and *Michelia*, while the cooler upper zone has several dominant conifers like *Juniperus*, *Picea*, *Tsuga* and *Abies*.

(c) Alpine region which is between 3800 metres and 5000 metres is without trees. *Rhododendron* and *Juniperus* are found in grassy areas.

3. West Indian desert : Deserts are formed in the regions where the rainfall is low (less than 70 cm.). The climate is very hot in summer and cold in winter. Some regions of Punjab, Rajasthan, Delhi and part of Gujarat form the desert region. Plants of desert regions are *xerophytes*. *Prosopis spicigera, Tamarix, Capparis aphylla* and *Salvadora* are common shrubs. Other plants are *Calotropis, Eleusine*, etc. To check the deserts from advancing, species of *Prosopis, Acacia, Tamarix*, etc., are planted to act as wind breaks.

4. Gangetic plain : The Gangetic plain is the most fertile part and it consists of U.P., Bihar and Bengal. Most of the Gangetic plain is under cultivation of wheat, barley, Jowar and other crops. The vegetation varies in different regions due to variations in temperature and rainfall. In the western U.P., *Dalbergia* and *Acacia* species are common along with sal. In the southern region, desert conditions prevail in the eroded regions of the Jamuna where *Capparis aphylla* and *Saccharum munja* occur. In the eastern U.P., the forests have *Butea monosperma*, *Terminalia arjuna, Cordia myxa* and *Acaica catechu*, etc. as common trees. *Carissa spinarum* and *Woodfordia* form the undergrowth.

The swampy regions of the Gangetic delta (Sunderban) support mangrove vegetation. The mangroves like *Rhizophora* sp., *Avicennia, Ceriops* and *Nipa* have special features to adapt to the saline swampy conditions.

5. Assam : This region receives the maximum annual rainfall and Cherapunji records more than 1000 cm. of rainfall. As it is a hilly tract, most of the area is covered by a thick forest consisting of evergreen, broad-leaved angiosperms like *Dipterocarpus, Michelia, Dillenia indica, Mesua, Artocarpus* sp. and several others.

6. Central India : This region, consists of M.P., parts of Orissa and Gujarat. Thorny or mixed or deciduous forests occur in these areas. The common trees are *Butea monosperma*, *Tectona grandis*, *Terminalia arjuna* and *Anogeissus latifolia*. The forests are very much disturbed due to large scale felling of trees and grazing by animals. Due to this, in some areas, dense forests disappear and thorny shrubs like *Carissa spinarum, Zizyphus, Mimosa* and species of *Acacia* appear.

7. Malabar : The west coast of India extending from Cape camorin (Kanyakumari) to Gujarat in the north forms Malabar region. The rainfall is heavy and so the vegetation is luxuriant. There are tropical evergreen rain forests with tall trees like *Cedrela toona, Dipterocarpus indicus* and *Sterculia alata* along with several lianas and epiphytes. The mixed deciduous forests have *Teak* and *Terminalia tomentosa* etc. Evergreen temperate forests called 'sholas' are common, represented by trees like *Shorea Hopea, Artocarpus* and

Salmalia along with twiners and epiphytes. In some regions mangrove forests occur. Malabar coast is unique in having several species of herbs and shrubs characteristic to itself.

8. Deccan : The Deccan region has an average of 100-150 cm. annual rainfall. The region includes Andhra Pradesh, Tamilnadu, Karnataka and parts of M.P., Orissa and Maharashtra. The region has deciduous forests in which Teak or Sal is conspicuous. The Deccan forests consist of *Santalum* in Karnataka. The slopes of E. Ghats show *Dipterocarpus, Pterocarpus, Butea* and others. The black cotton soils prevail over large area of Deccan having distinct species. Mangroves occur in eastern areas. The table land is barren with the hills covered by shrubby vegetation.

9. Andamans : The islands of Andaman group have green forests, beech forests and mangroves. The evergreen forests show *Calophyllum, Dipterocarpus*, etc. A large part of the natural vegetation is cleared for cultivating various crops.

ANTARCTIC KINGDOM :

(i) NewZealand Region (6 provinces)

(a) North Island.

(b) South Island.

(c) Newzealand Alps.

(d) Kermadec Islands.

(e) Chatham Islands.

(f) Auckland & Campbell Islands.

(ii) Patagonian Region

Three Provinces :

(a) Patagonian & Fuegia.

(b) Southern Andes.

(c) Falkland Islands.

(iii) Region of the South Temperate Oceanic Islands.

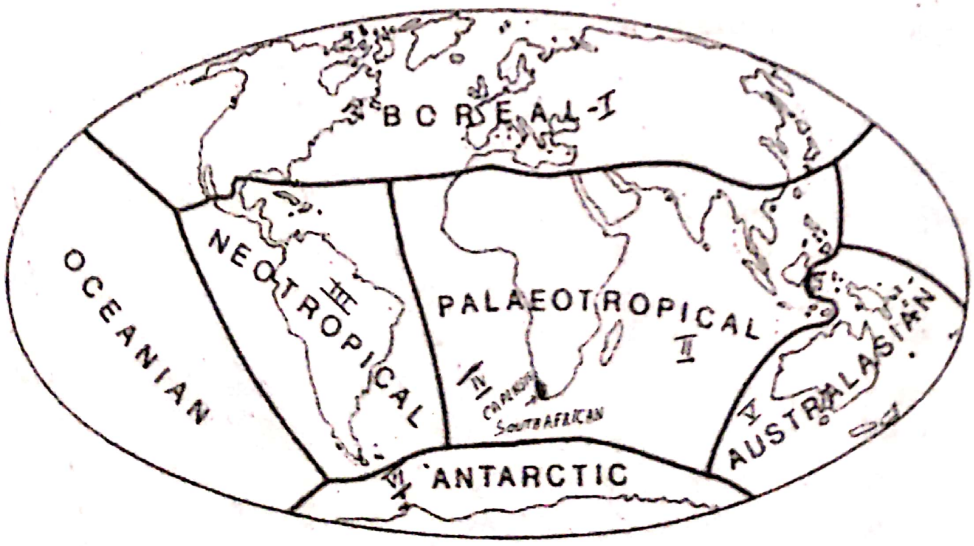


Fig. : MAP showing Phytogeographical kingdoms of the world

II. Phytogeographic Regions of the World - FLORA

In the world Six Floral Kingdoms namely :

1. BOREAL (Holarctic), 2. Paleotropical, 3. Neotropical, 4. South African, 5. Australian and 6.Antarctic are distinguished by Phytogeographers like Ronald Good etc.

These kingdoms are further divided into Sub kingdoms, regions and provinces.

(1) BOREAL KINGDOM (Holarctic) : It includes the temperate to Arctic portions of Eurasia and North America. These two are seperated by the Atlantic ocean and the Bering strait. The differences between the floras, of these two continents are minor inspite of seperation. The temperate zone of the Northern Hemisphere is inhabited by popular families like Betulaceae, Brassicaceae, Rosaceae, Apiaceae, Primulaceae, Ranunculaceae, Saxifragaceae etc. This kingdom is divided into 8 regions.

Flowering plants are poor in diversity in Arctic and subarctic region but cryptogams in this region show high diversity.

Sino-Japanese region of this kingdom show 300 Endemic Genera. Characteristic plant families in this region are Lauraceae, Magnoliaceae and Theaceae, Berberis, Juniperus, Rhododendron are characteristic mountain Genera.

(2) "Paleo Tropical kingdom" extends from Africa excluding strips along the Northern and Southern Edges, thro' the Arabian Peninsula, India, and South East Asia eastward into the Pacific. The common plant families in this kingdom region are Pandanaceae, Nepenthaceae.

(3) "Neotropical Kingdom" covers all but the extreme southern tip and South Western Strips of South America, Central America, Mexico excluding the dry north and centre, and beyond to the West Indies and Southern tip of Florida. It includes mainly south and central America.

Forty seven families and nearly 3000 genera of flowering plants are endemic to this kingdom. Some families, including Bromeliaceae and cactaceae are virtually confined to this Kingdom.

(4) "South African Kingdom" consists of the Southern and South western tip of Africa, the area around the cape of Good Hope. 11 families and 500 Genera are endemic in this kingdom. This is the smallest of the Phytogeographic kingdoms. At the edges of this zone the flora merges into flora of Africa (Paleotropical).

(5) "Australian Kingdom" is sharply district from paleotropic. Rainforest biomes occur along the eastern seaboard. Woodlands of Eucalyptus cover much of the eastern third of the continent. Banksia heathland is found in the South West. About 19 families and 500 Genera are endemic. Common plants are Eucalyptus Acacia, Casuarina.

(6) "Antarctic Kingdom" includes the southern tip of South America, extending some distance north along the Chilean coast. Newzealand and the Antarctic and Sub Antarctic islands. About 500 Genera common in this Kingdom. Cold tolerant plants show greater survival in this region. Most predominant. Genera are Nothofagus and Dicksonia in this floral region. The common endemic families noticed are Holo-Phytaceae. Tribeliaceae and Hectorellaceae.