GURU NANAK COLLEGE (AUTONOMOUS) VELACHERY- CHENNAI – 42.

PLANT BIOLOGY AND PLANT BIOTECHNOLOGY

PRACTICAL NOTES

Course :

ALGAE , BRYOPHYTES , FUNGI , PLANT PATHOLOGY AND LICHENS

Course Code: 19UPBT302P

BY

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GLOSSARY

ALGAE

- Nostoc
- Chara
- Navicula
- Kappaphycus
- Sargassum
- Coleocheate

BRYOPHYTES

- Riccia
- Anthoceros
- Polytrichum

FUNGI

- Pythium
- Mucor
- Aspergillus
- Puccinia
- Cercospora

PLANT PATHOLOGY

- Little Leaf of Brinjal
- Bacterial Disease – Citrus canker
- Bunchy Top of Banana
- Fungal Disease – Red Rot of Sugarcane

LICHENS

- Usnea
- Apothecium

COMPOUND MICROSCOPE

- A compound microscope is an instrument that is used to view magnified images of small objects on a glass slide. It can achieve higher levels of magnification than stereo or other low power microscopes and reduce chromatic aberration.
- The characteristics of a compound microscope

  Two or more convex lenses

  Typical magnification range between 40x and 1000x

  One objective is used at a time

  Two-dimensional images

PARTS OF THE COMPOUND MICROSCOPE

•Eyepiece (ocular lens) with or without Pointer: The part that is looked through at the top of the compound microscope

•Arm: Supports the microscope head and attaches it to the base.

•Nosepiece: Holds the objective lenses & attaches them to the microscope head..

•Base: Bottom base of the microscope that houses the illumination & supports the compound microscope.

•Objective lenses: There are usually 3-5 optical lens objectives on a compound microscope each with different magnification levels.

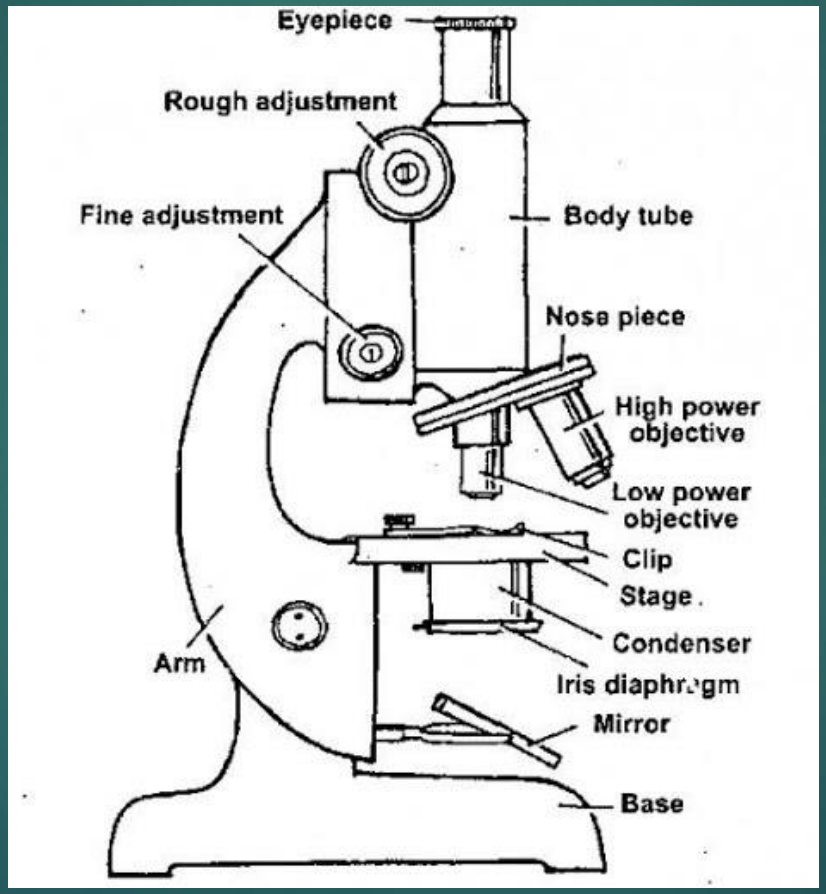
•Specimen or slide: The object used to hold the specimen in place along with slide covers for viewing

•Stage or Platform: The platform upon which the specimen or slide are placed.

•Stage clips or mechanical stage: Clips on the stage that hold the slide in place on the mechanical stage.

•Coarse and fine adjustment controls: Adjusts the focus of the microscope.

COMPOUND MICROSCOPE



NOSTOC

- Kingdom : Plantae
- Sub Kingdom :Cryptogams
- Division :Thallophyta
- SubDivision : Algae
- Class :Cyanophyceae
- Genus : *Nostoc* sp.

NOSTOC

NOSTOC WAS A COLONIAL FILAMENTOUS ALGA FOUND IN THE FORM OF BLUISH GREEN SMALL BALL IN ITS NATURAL HABITAT. IT WAS SLIPPERY AND SHINY STRUCTURE ALSO CALLED MOONSPIT OR STAR JELLY.

THE FILAMENT WAS MULTICELLULAR, UNBRANCHED AND MADE BY UNICERIATE ROWS OF CELLS. THREE DIFFERENT TYPES OF CELLS WERE OBSERVED.

VEGETATIVE CELL: THEY WERE THIN WALLED AND NUMEROUS

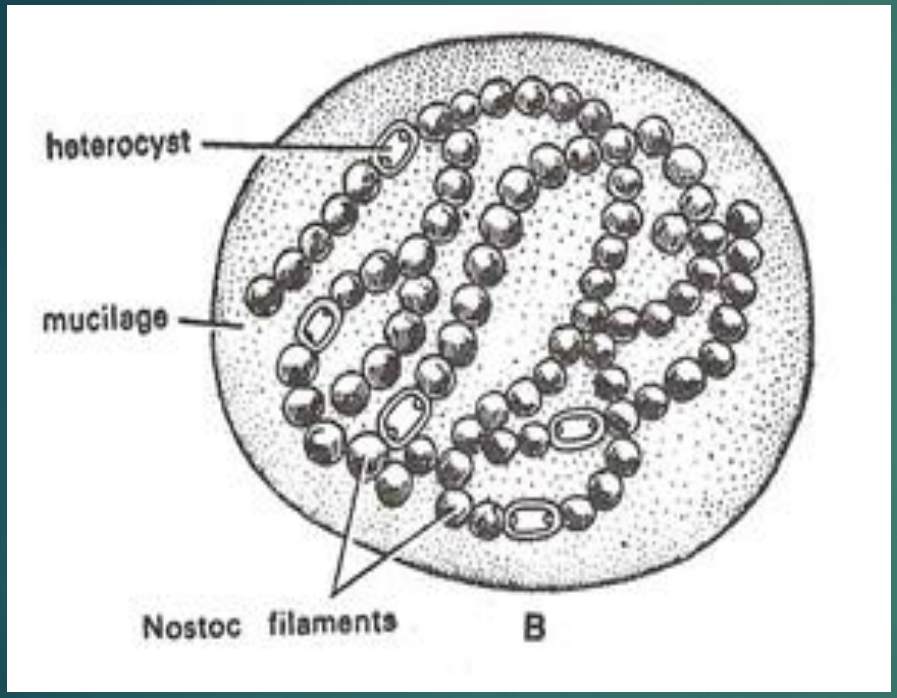
HETEROCYST: THEY WERE MOSTLY INTERCALARY, SLIGHTLY LARGER AND WITH POLAR NODULES

AKINETES: THICK WALLED WITH ABUNDANT RESERVE FOOD MATERIALS AND FOUND IN CHAIN OR SINGLY.

THE FILAMENT WAS ENSHEATED BY MUCILAGINOUS SHEATH, THE CELL CONTENTS WERE NOT CLEAR. *NOSTOC* REPRODUCES BY FORMATION OF AKINETES. DURING ADVERSE CONDITION, THE VEGETATIVE CELL SECRETES THICK WALL, ACCUMULATES RESERVE FOOD MATERIALS AND CHANGE INTO RESTING SPORE CALLED AKINETE. ONSET OF FAVOURABLE CONDITION, IT DEVELOPS INTO NEW FILAMENT.

HETEROCYST ALSO REPRODUCES BY FORMING ENDOSPORE AND HORMOGONIUM AND HELPS IN NITROGEN FIXATION.

NOSTOC



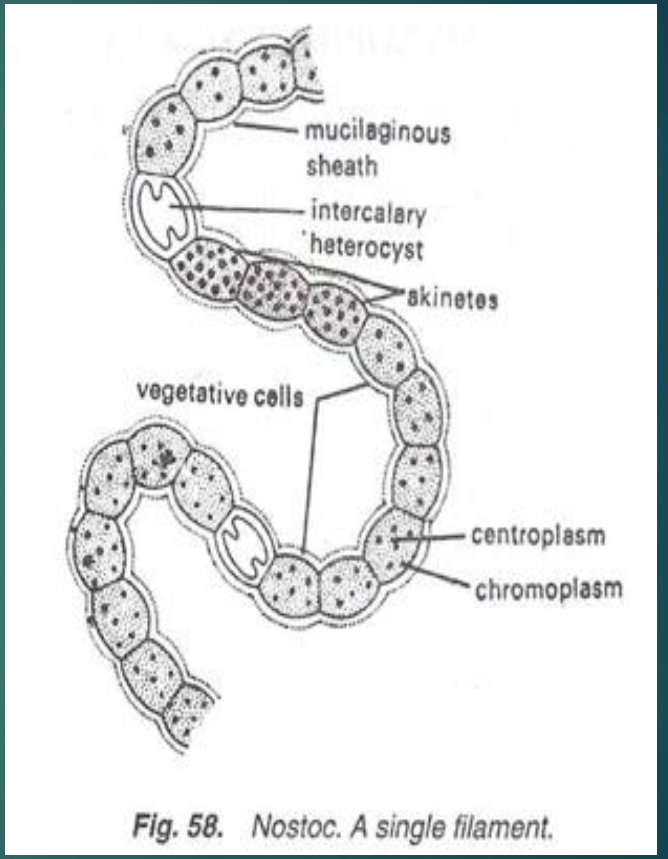


Fig. 58. Nostoc. A single filament.

CHARA

- Division Chlorophyta
- Class Chlorophyceae
- Order Charales
- Family Characeae
- Genus Chara

Chara

- Morphological Features of Chara
- Chara is a fresh water, green alga found submerged in shallow water ponds, tanks, lakes and slow running water.
- Chara is found mostly in hard fresh water, rich in organic matter, calcium and deficient in oxygen.
- Chara plants are often encrusted with calcium carbonate and hence are commonly called stone wort.
- The thallus of Chara is branched, multicellular and macroscopic. The thallus is normally 20-30 cm. in height but often may be up to 90 cm to l m.
- The thallus is mainly differentiated into rhizoids and main axis.
- The rhizoids are white, thread like, multicellular, uniseriate and branched structures. The rhizoids are characterized by presence of oblique septa.
- The main axis is erect, long, branched and differentiated into nodes and internodes.
- The main axes bear whorls of branches in a superficial resemblance to Equisetum (a vascular plant).
- They are typically anchored to the littoral substrate by means of branching underground rhizoids. Chara plants are rough to the touch because of deposited calcium salts on the cell wall. The metabolic processes associated with this deposition often give Chara plants a distinctive and unpleasant smell of hydrogen sulphide.

CHARA

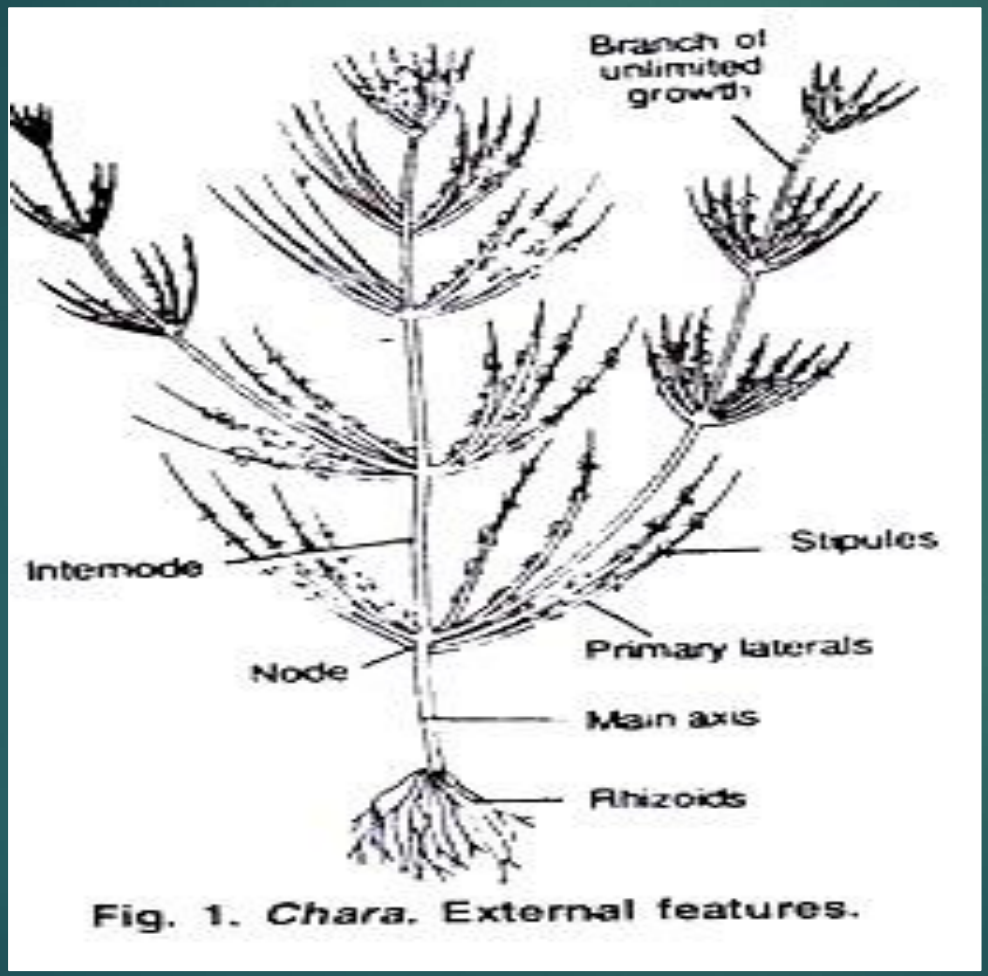


Fig. 1. *Chara*. External features.

T.S. OF INTERNODAL CELL - CHARA

- In the center is a large central, axial or internodal cell
- It is surrounded by corticating threads on all sides
- Internodal cell shows a typical cell structure
- Center of the cell has a big vacuole surrounded by cytoplasm
- In the cytoplasm lies a single nucleus held by thin and delicate cytoplasmic strands.
- Many discoid chloroplast without pyrenoids are scattered in the pheripheral cytoplasm
- The cell has an outermost , thick and frim cell wall .

T.S. OF INTERNODAL CELL - CHARA

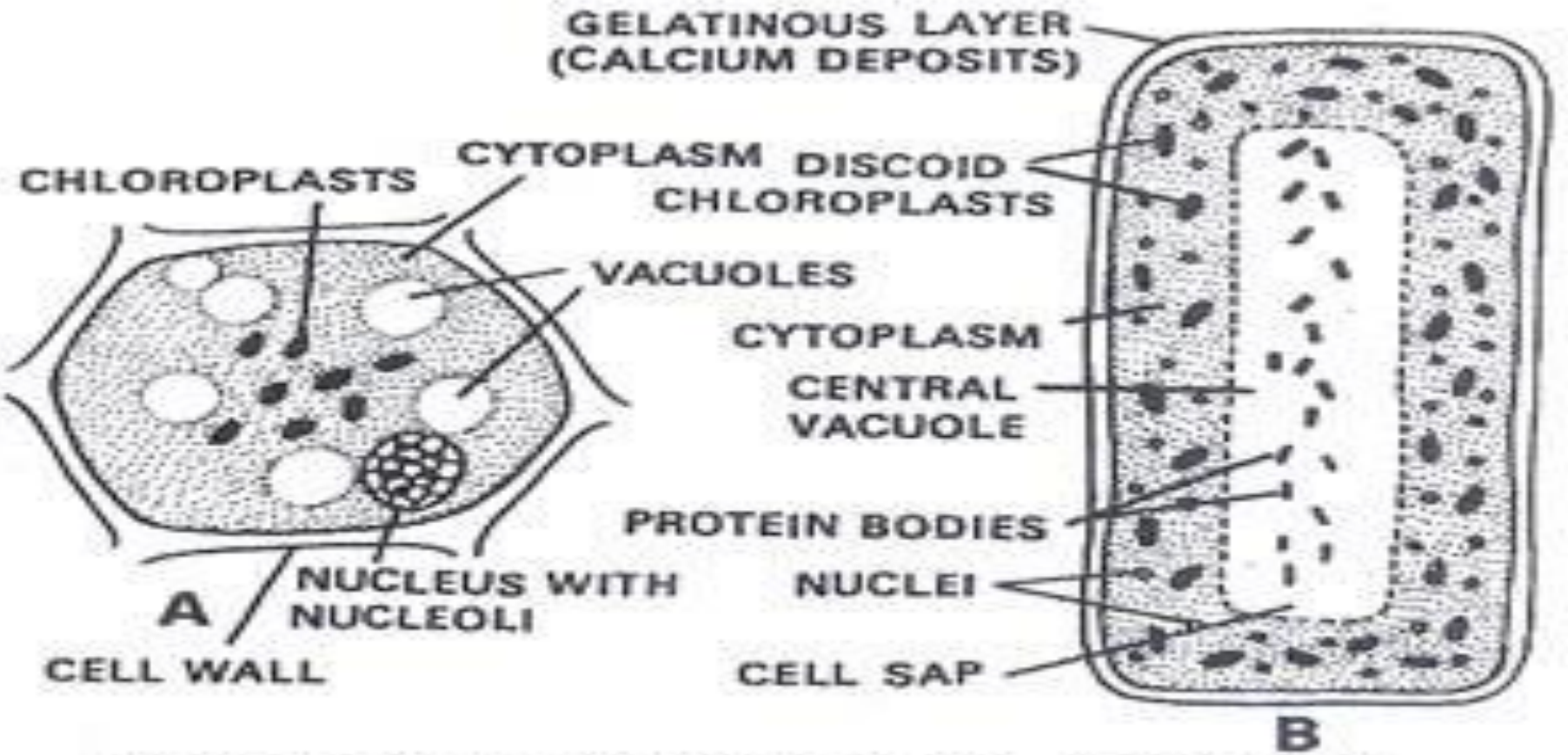


Fig. 4A.6. *Chara* sp. Cell structure. A, nodal cell; B, internodal cell.

amily:
Genus: Navi

NAVICULA

- It is freshwater alga which is commonly found in ponds and rivers usually free floating with other algae. It is found in the marshy and stagnant water
- Cells of *Navicula* are solitary, motile and are in boat shaped. At the central nodule, which is a solid internal thickening of the wall, the two over lying (external and internal) fissures of the raphe approaching from either pole bare connected by a loop like, somewhat sinuous canal .
- Raphe is present in both the side of valve which bears three enlargement or nodules, one central nodules and two polar nodules. Raphe is responsible for the gliding movement in *Navicula*.
- It has two chloroplast at each side of raphe each with single rod-shaped pyrenoids (can be view only through girdle view). The cell wall along with plasma membrane encloses cell protoplast which is further differentiated into a single nucleus and cytoplasm.
- The cytoplasm encloses nucleus which is centrally located and two large vacuoles. They undergo asexual reproduction in favorable condition and sexual reproduction which is very rare.

NAVICULA

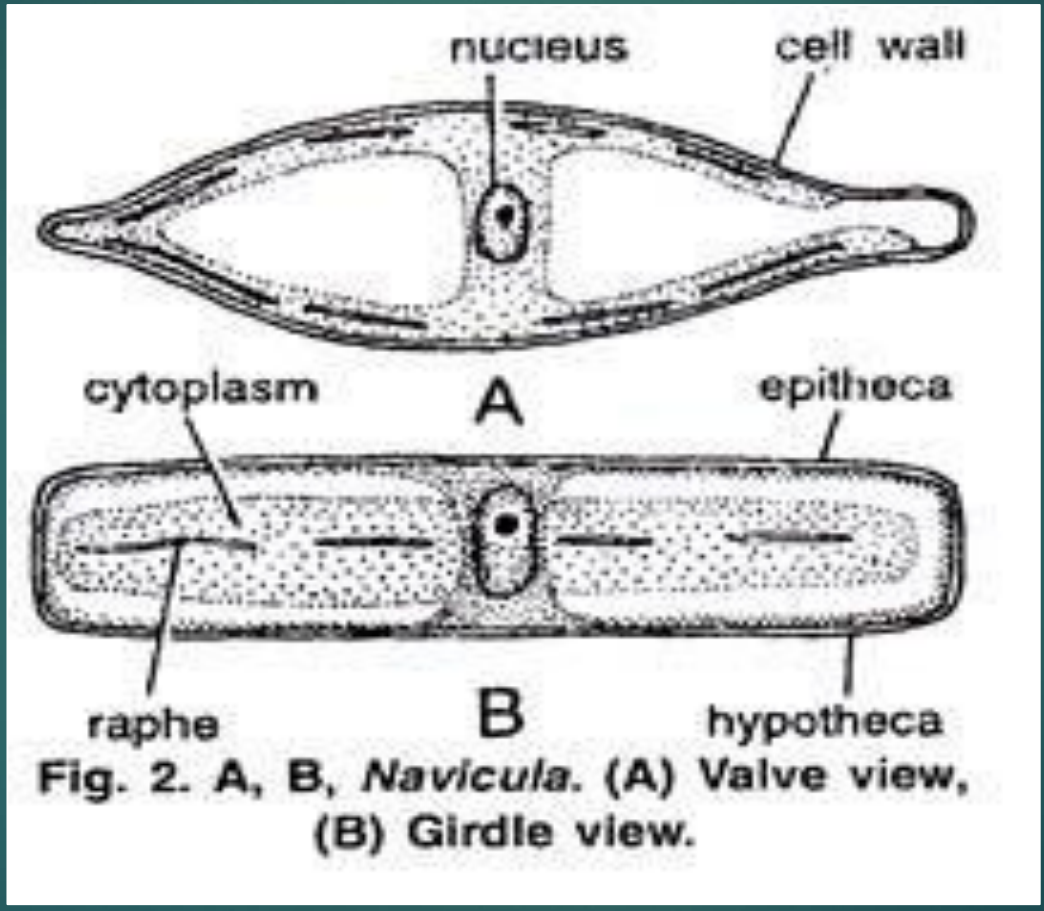


Fig. 2. A, B, *Navicula*. (A) Valve view, (B) Girdle view.

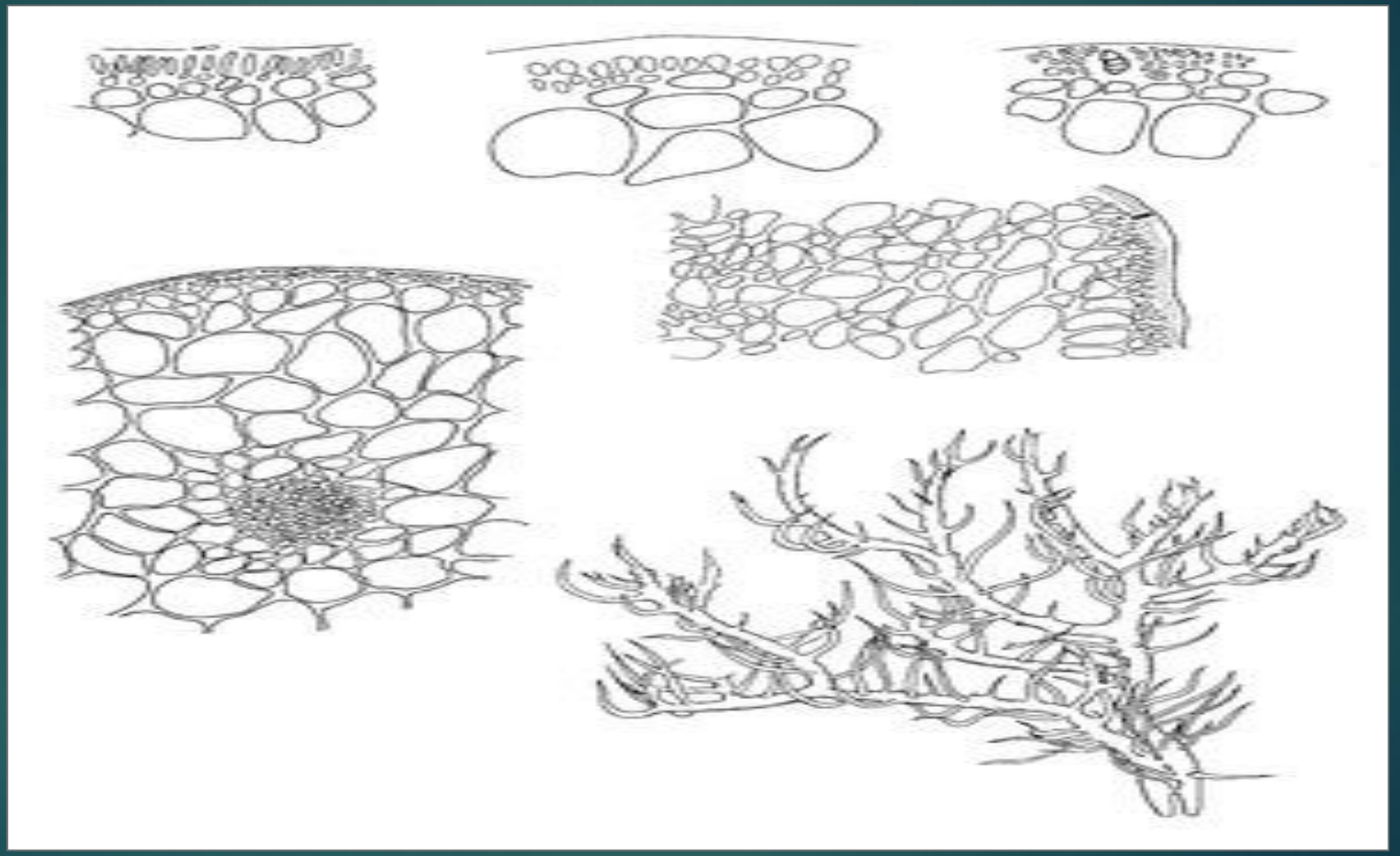
KAPPAPHYCUS

Division : Rhodophyta
Class: Rhodophyceae
Order: Gigartinales
Family: Soliriaceae

Kappaphycus

- The thallus of *Kappaphycus* ranges from 24 to 48 cm. The branches are cartilaginous and pliable, ranging from 8 to 12 cm in length with unilateral to irregular branching type.
- Branch diameter ranges from a few mm at the branch tips to greater than 1 cm in older tissue.
- The branches are smooth and the thallus can be short with many branches to much larger with long smooth branches.
- The diameter of the different types of vegetative cells are as follows: 2-4 µm outer cortex, 30-240 µm inner cortex and, 25-40 µm medulla. Thylles of the medulla are present but rhizoids are absent.

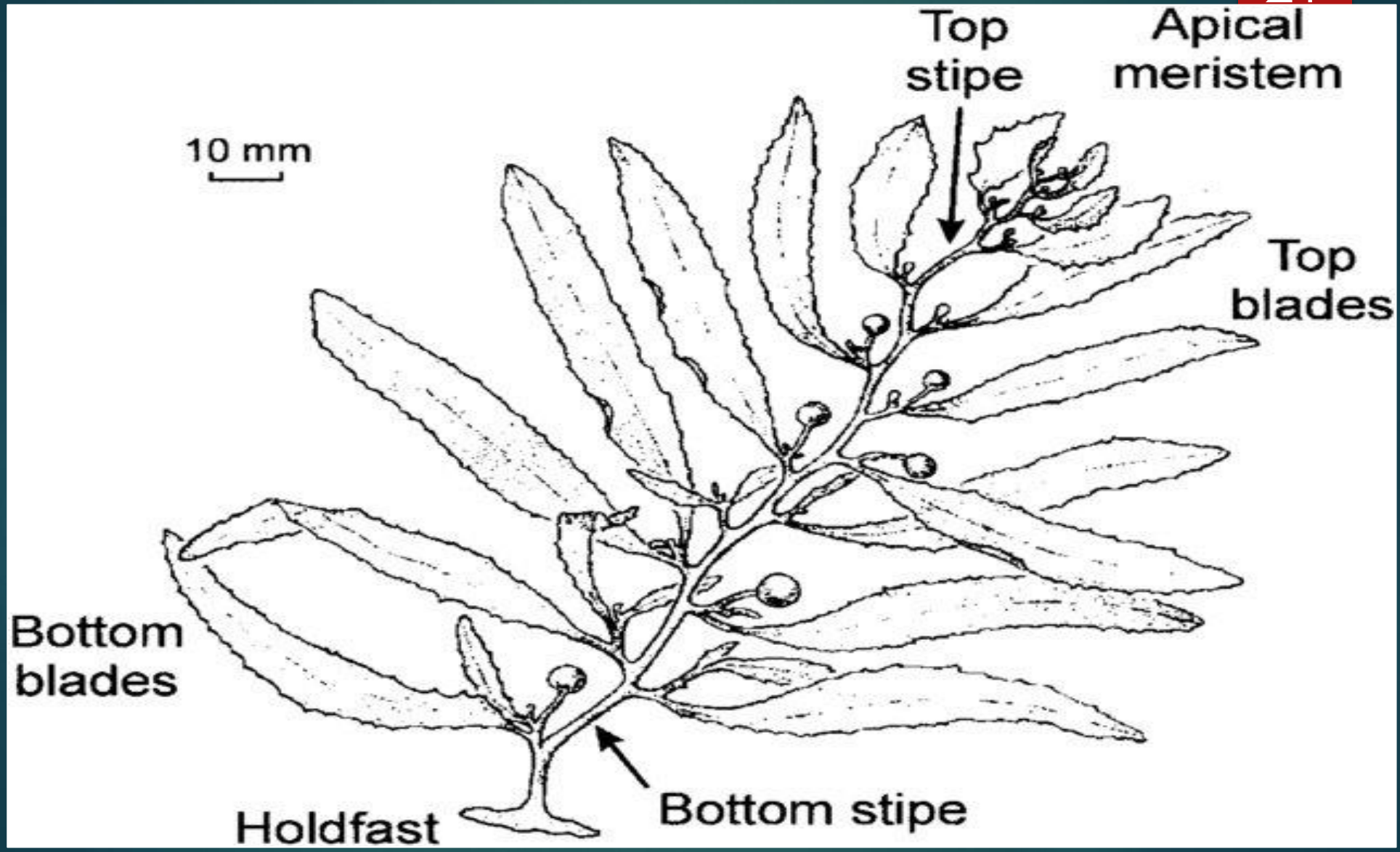
Kappaphycus



Sargassum

- Sub-division Algae
- Class Phaeophyceae
- Order Fucales
- Family Sargassaceae
- Genus Sargassum

SARGASSUM- THALLUS



External features of Sargassum thallus:-

- 1. Thallus is erect, filiod and profusely branched.
- 2. It remains attached to the substratum by a discoid holdfast.
- 3. Main axis stands out from the holdfast. It varies from a few to many centimeters in height.
- 4. Main axis bears large number of primary laterals forming a larger part of vegetative structure. Branches are radially symmetrical and spirally arranged.
- 5. Secondary branches are repeatedly branched.
- 6. Many branches are flattened along the plane of branching into leaf-like structures called 'leaves'.
- 7. Leaves are narrow and their margins are mostly serrate.
- 8. A few species also show a clear mid-rib. In the lower parts, leaves are replaced by air bladders. However, leaf or its part is modified almost at any place into an air bladder.
- 9. Leaves show minute pores on both of the surfaces which are ostioles (or openings) of conceptacles (sterile) or cryptostomata or cryptoblasts.
- 10. In the axils of foliaceous branches (leaves) is situated a series of repeatedly branched receptacles which bear reproductive structures.

T.S. OF AXIS – SARGASSUM

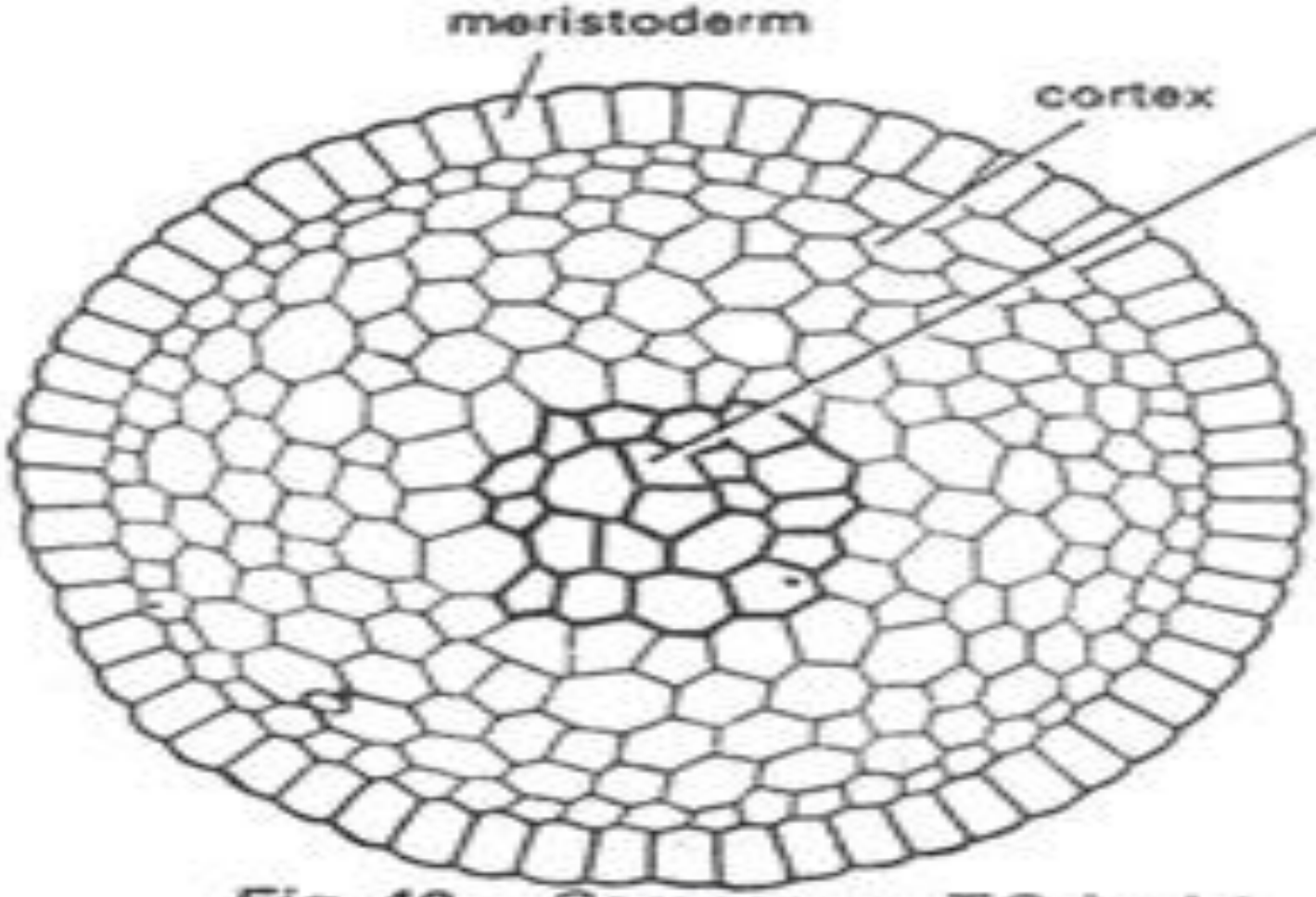


Fig. 40. Sargassum. T.S. 'axis'.

Internal structure of Sargassum axis.

- The section is almost circular in outline.
- 2. It is differentiated into three regions : (i) meristoderm, (ii) cortex and (iii) medulla.
- 3. Meristoderm is the outermost single celled layer of meristematic cells. It consists of many, small and compactly placed cells covered by mucilage. Cells are rich in chromatophores and reserve food material.
- 4. Cells of the meristoderm are photosynth.etically active and, therefore, constitute assimilatory region. S. Cortex forms the major part of the axis.
- 5.Cells are narrow and elongated with many intercellular spaces. Cells possess large amount of reserve food material. This region is also known as storage region.
- 6. Medulla occupies the central part of the axis. It consists of narrow, elongated and doublewalled cells, inner wall being thin than the outer.
- 7. The medulla transports water and essential nutrients. Hence, it is a also called as conducting region.

T.S. OF LEAF – SARGASSUM

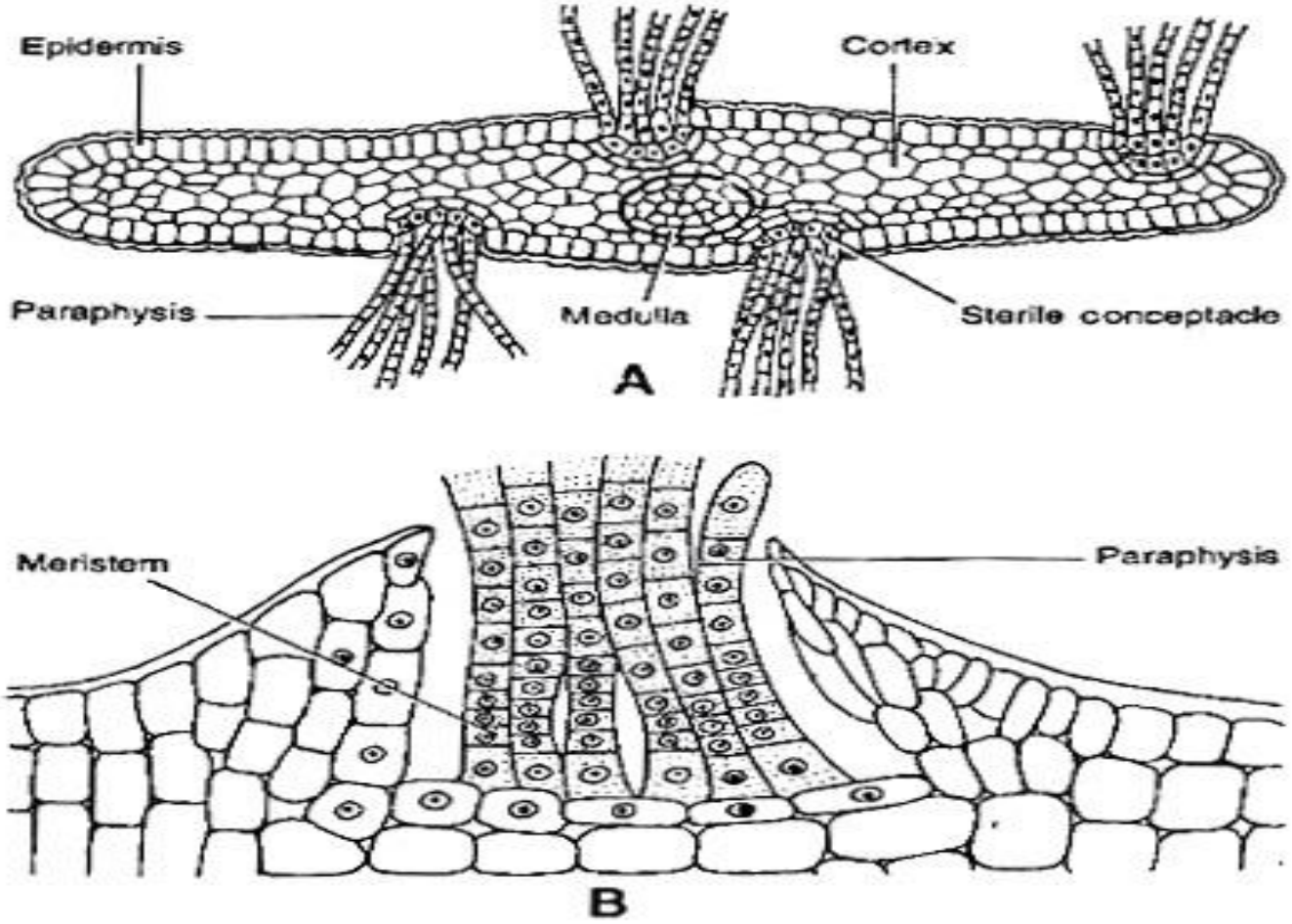


Fig. 4. (A, B). *Sargassum.* (A) Transverse Section (T.S.) of leaf (B) T.S. through a conceptacle

Internal structure of Sargassum Leaf.

- 1.T.s. of leaf shows 3 regions similar to those found in axis. These are-meristoderm, cortex and medulla.
- 2. Meristoderm is the outermost layer. Cells are small, compactly arranged and rich m chromatophores and reserve food.
- 3. Cortex is a major part of the tissues. Cells are thin and contain large amount of reserve food material.
- 4. Medulla occurs only in central region of the leaf indicating mid-rib. It is absent from the wings.
- 5. In the leaf many sterile conceptac1es are distributed on both of its surfaces (also known as cryptostomata or cryptoblasts).
- 6. Each cryptoblat opens to the exterior by an opening--{)stiole (visible externally as black dots or pores).
- 7.Below an ostiole is situated a flask-shaped cavity--conceptacle. The wall of this cavity is lined by cells.
- 8. The floor of the wall bears many multicellular and unbranched hair called paraphyses. These protrude outside through an ostiole.
- 9. Thickness of the leaf is maximum in the midrib region and decreases toward the wings.

Sargassum- Male Conceptacle

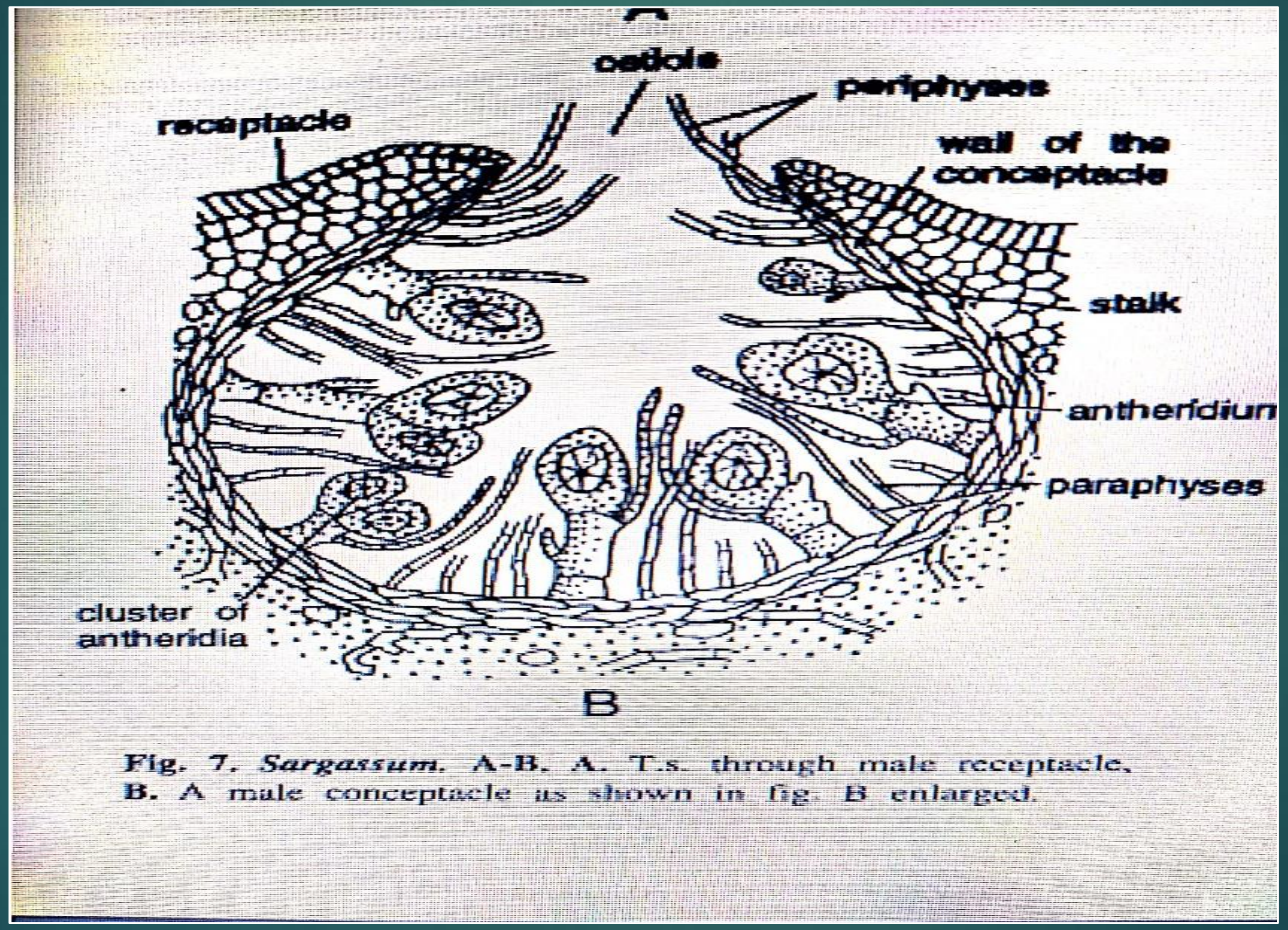
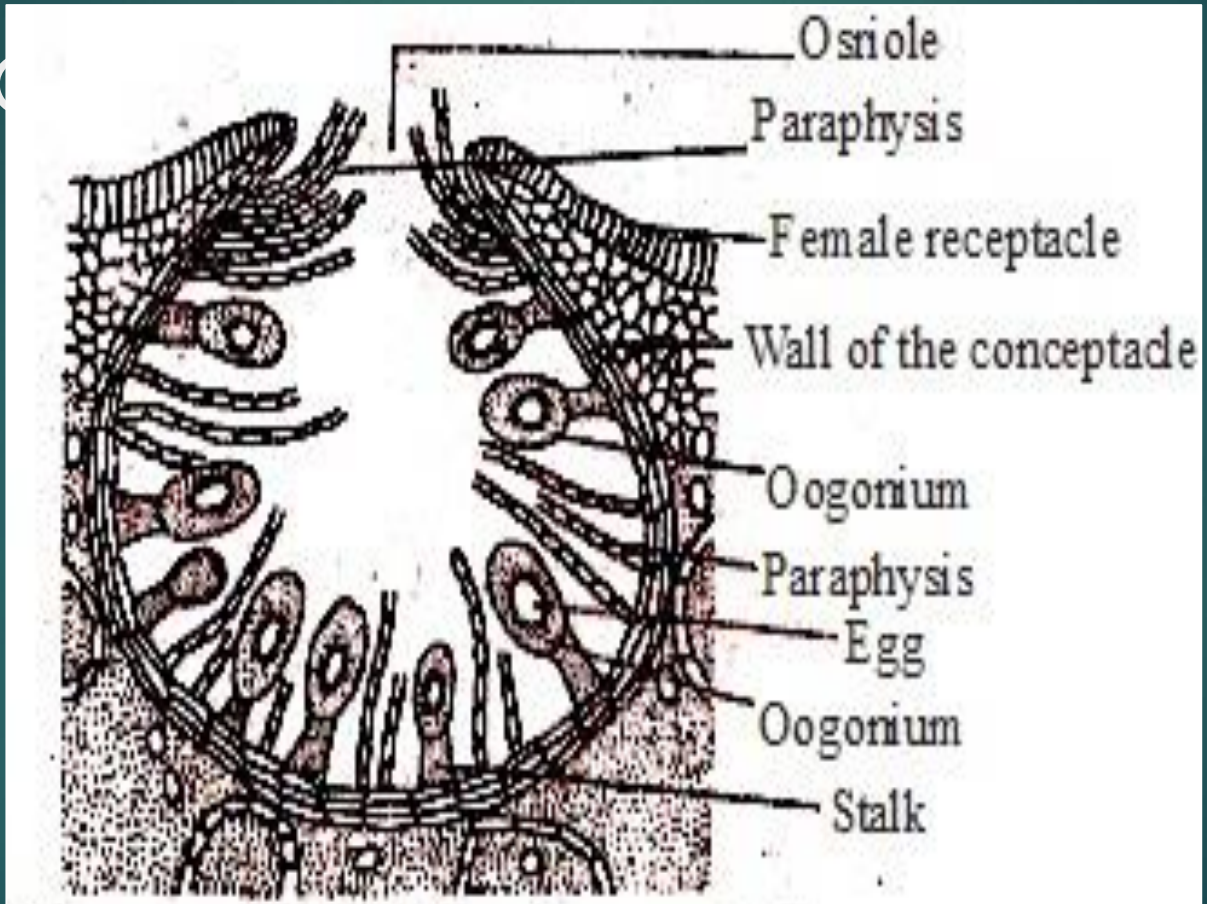


Fig. 7. *Sargassum*. A-B. A. T.s. through male receptacle, B. A male conceptacle as shown in fig. B enlarged.

Internal structure of Sargassum Male Conceptacle.

- 1. Plants may be monoecious or dioecious.
- 2. Antheridia are found in male conceptacles.
- 3. Conceptacles occur only in specialized branch system called receptacle or receptacular branch.
- 4. Male conceptacles are externally smooth.
- 5. Many conceptacles are found in a male receptacular branch.
- 6. Each conceptacle is a flask-shaped cavity opening by a pore called ostiole.
- 7. Wall of the conceptacle is made of small and flat cells rich in chromatophores.
- 8. Numerous multicellular hairs arising from near the ostiole project outside. These are called periphyses.
- 9. Other types of multicellular hairs arising from the floor of the cavity are called paraphyses.
- 10. Some of paraphyses are branched and hold one or more antheridia at the tips of the branches.
- 11. Each antheridium has a thick wall made of two layers.
- 12. On maturity about 64 biflagellate antherozoids are produced.

Internal structure of Sargassum Female Cone



Sargassum : V. S. of female conceptacle

Coleocheate

Division: Charophyta

Class: Coleochaetophyceae

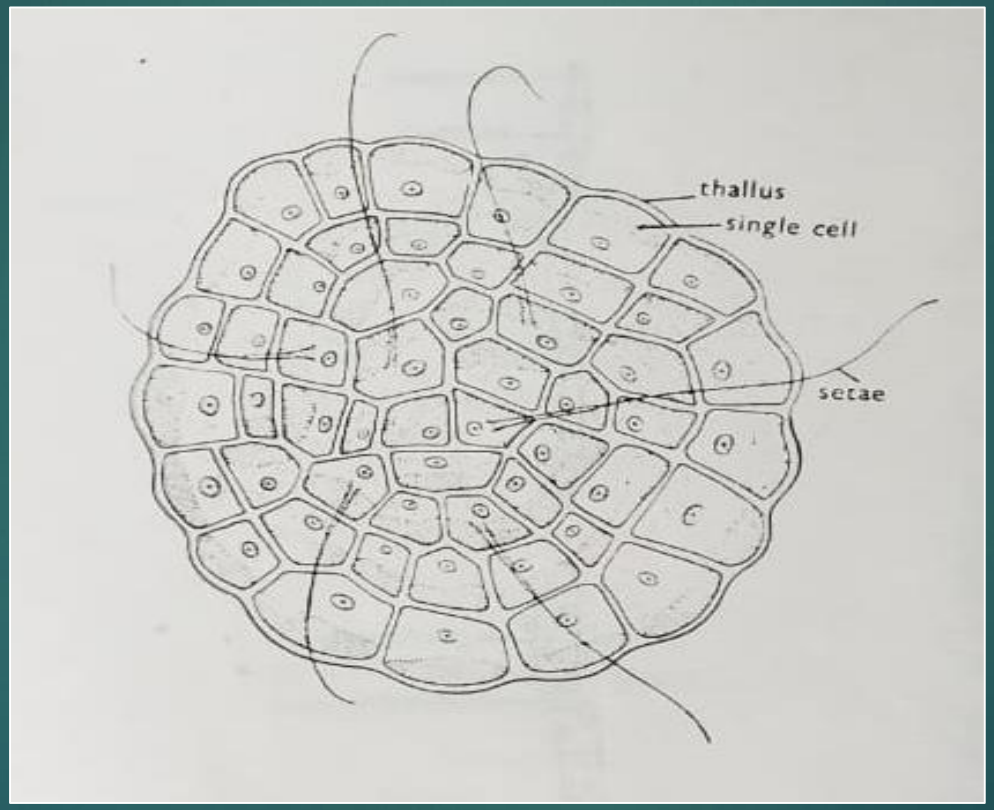
Order: Coleochaetales

Family: Coleochaetaceae

Genus: Coleochaete

- Thallus is multicellular and heterotrichous
- It is either a disc like structure in majority of the species (c. scutata) or cushionoid or filamentous (c.pulvinata)in others
- The thallus is disc like the disc represents only the prostrate system while a few setae or hair , represent erect system
- Filamentous thallus exhibit typical heterotrichous habit with a branched prostrate system and a branched projecting (erect) system
- In both the cases a few cells possess a cytoplasmic outgrowth – setae. Setae are surrounded partly or wholly by a gelatinous sheath at the base
- The thallus is distinctly enveloped by a gelatinous sheath or mucilage
- In discoid species cells of the thallus are joined end to end to form branches . These branches are laterally apposed to one another to form a pseudoparenchymatous disc
- Each cell is uninucleate.it has a single , large laminate and parietal chloroplast with a single pyrenoid.
- Rest parts of the cell is occupied by the cytoplasm

DISCOID THALLUS – COLEOCHEATE



Riccia

- Division Bryophyta
- Class Hepaticopsida
- Order Marchantiales
- Family Ricciaceae
- Genus Riccia

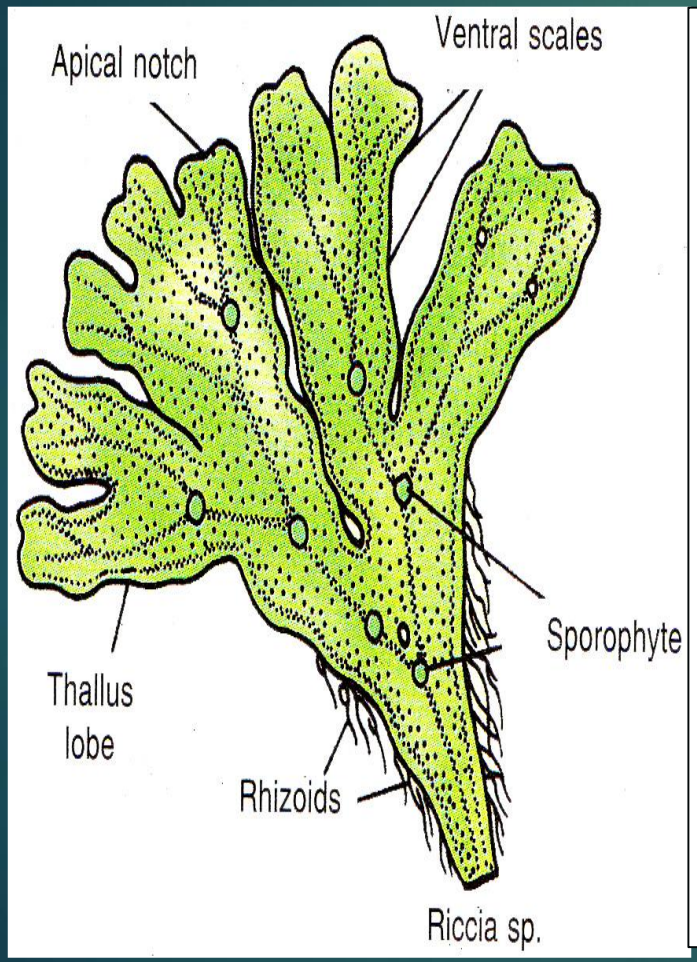
Internal structure of Sargassum Female Conceptacle:

- 1. The plants may be monoecious or dioecious.
- 2. Oogonia are found in female conceptacles.
- 3. Conceptacles occur only in specialized branch system called receptacle or receptacular branch.
- 4. The female receptacular branch is spinous.
- 5. It bears many female conceptacles.
- 6. Conceptacle is a flask-shaped cavity opening by a pore called ostiole.
- 7. Many multicellular, unbranched hairs arising from near the ostiole called periphyses protrude outside.
- 8. The wall of the conceptacle is lined by small and flat cells, rich in chromatophores.
- 9. A few multicellular, unbranched hairs arise from the floor of the cavity and are called paraphyses.
- l0. Numerous oogonia arise directly from the wall of the conceptacle.
- 11. Oogonium is sessile or shortly stalked (most of the stalk cell being embedded in the wall).
- 12. Each oogonium is oval to sub-spherical with a three layered wall.
- 13. At maturity oogonium has a single, large and uninucleate egg.

External features of Riccia gametophyte.

- The plant body is thalloid, dorsi ventral , prostrate and ribbon-like. A rosette is fonned due to repeated dichotomies of the thalli. 3. The thallus is linear to wedge shaped with an apical notch at the apex and thickened midrib in the sagittal axis. On the dorsal side, the midrib is traversed by a mid-dorsal groove. On the ventral side, scales and rhizoids are present. The scales are present at the margins. The rhizoids arise from the midrib region. Each scale is violet coloured, multicellular and one celled thick. 4. 5. 6. Rhizoids are of two types--(i) smooth walled and (ii) tuberculate. The smooth walled rhizoids have inner smooth walls whereas tuberculate rhizoids produce tuber-like or peg-like ingrowths of their inner wall which project into the lumen of the rhizoids. Sex organs are present in the mid-dorsal groove and are embedded in the thallus. The sporophytes, however, may be seen as black dots, when mature, under the dissecting microscope.

Riccia Gametophyte



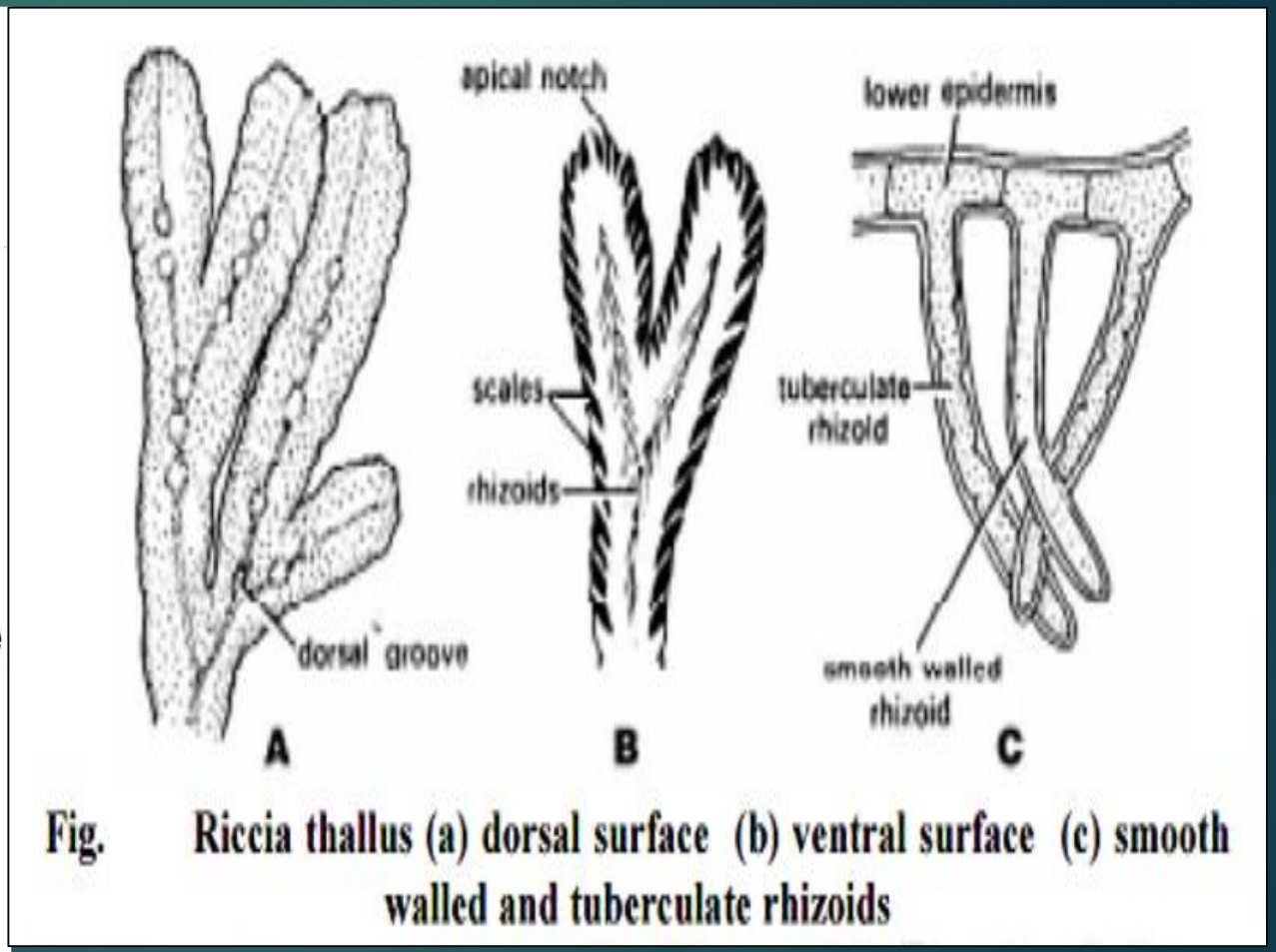
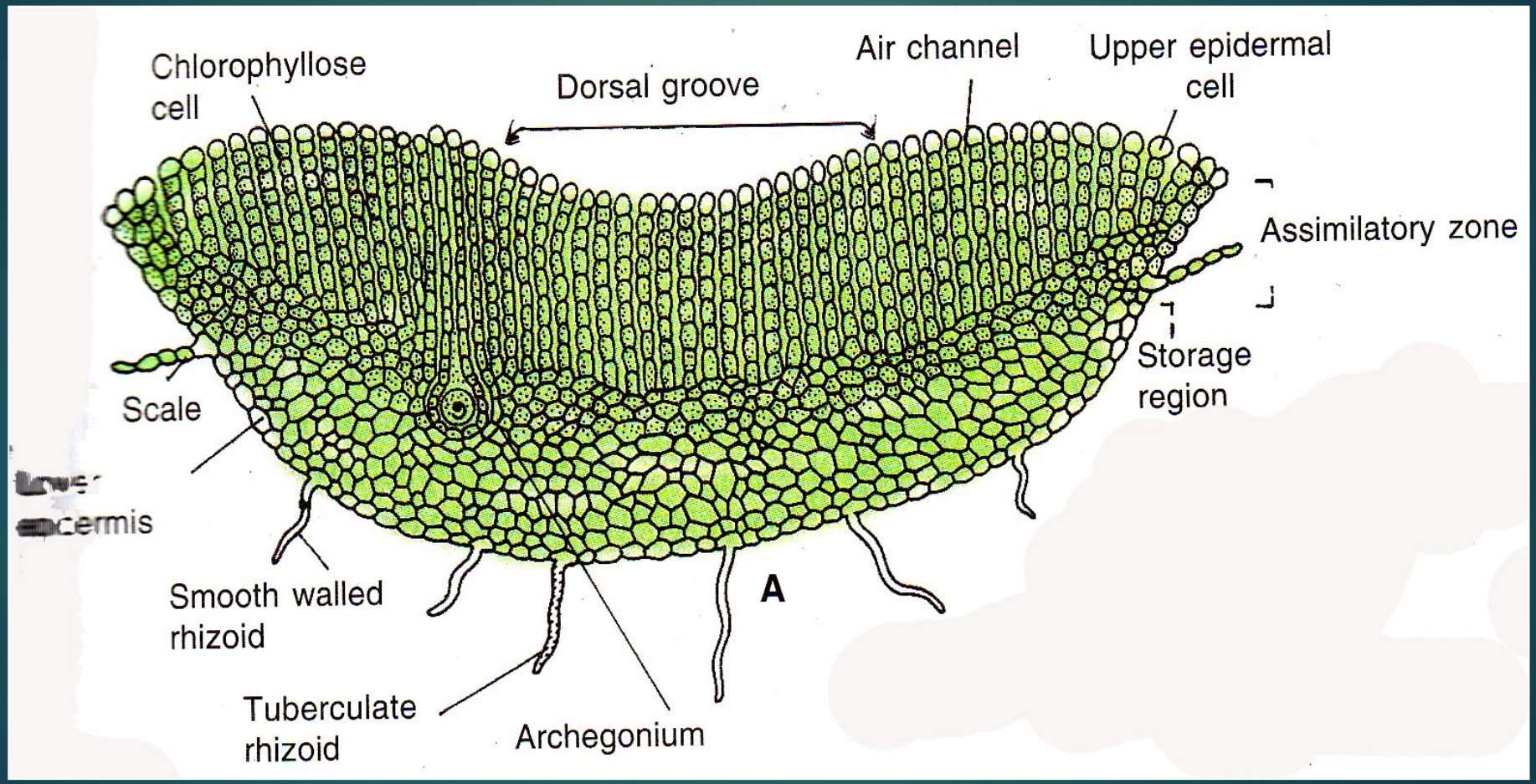


Fig. Riccia thallus (a) dorsal surface (b) ventral surface (c) smooth walled and tuberculate rhizoids

Riccia T.S of Thallus



Riccia T.S of Thallus

- 1. The thallus is boat-shaped in a vertical transverse section.
- 2. It is thick in the midrib region and gradually thins out towards the margins.
- 3. The thallus is dorsiventrally differentiated into an upper green photosynthetic region and a lower colourless storage region.
- 4. The lower epidermis bounds the storage region on the lower side and bears the usual two types of rhizoids (smooth walled and tuberculate) in the centre.

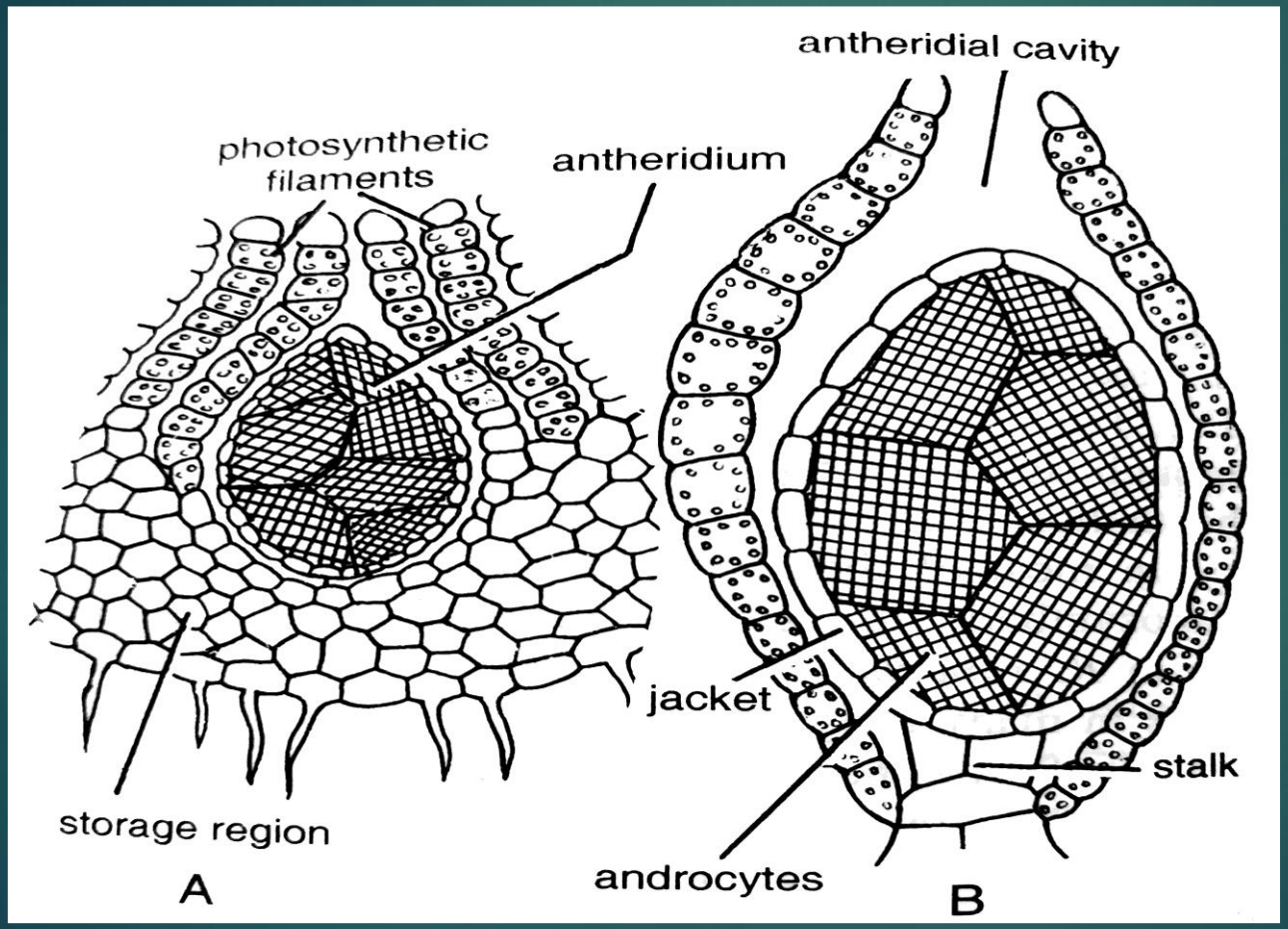
5. The storage region consists of compactly arranged parenchyma. These cells contain starch.

6. The photosynthetic region consists of vertical rows of unbranched assimilatory filaments, separated by narrow air chambers. The cells of the filaments are barrel-shaped and each possesses numerous chloroplasts.

7. The air chambers open to the outside through simple air pores which are the intercellular spaces between the upper epidermal cells.

8. The uppermost cells of the assimilatory filaments are somewhat large. They lack chloroplasts and are thus colourless. These form an ill-defined upper epidermis. 9. On the two margins of the boat shaped section, violet coloured scales are present.

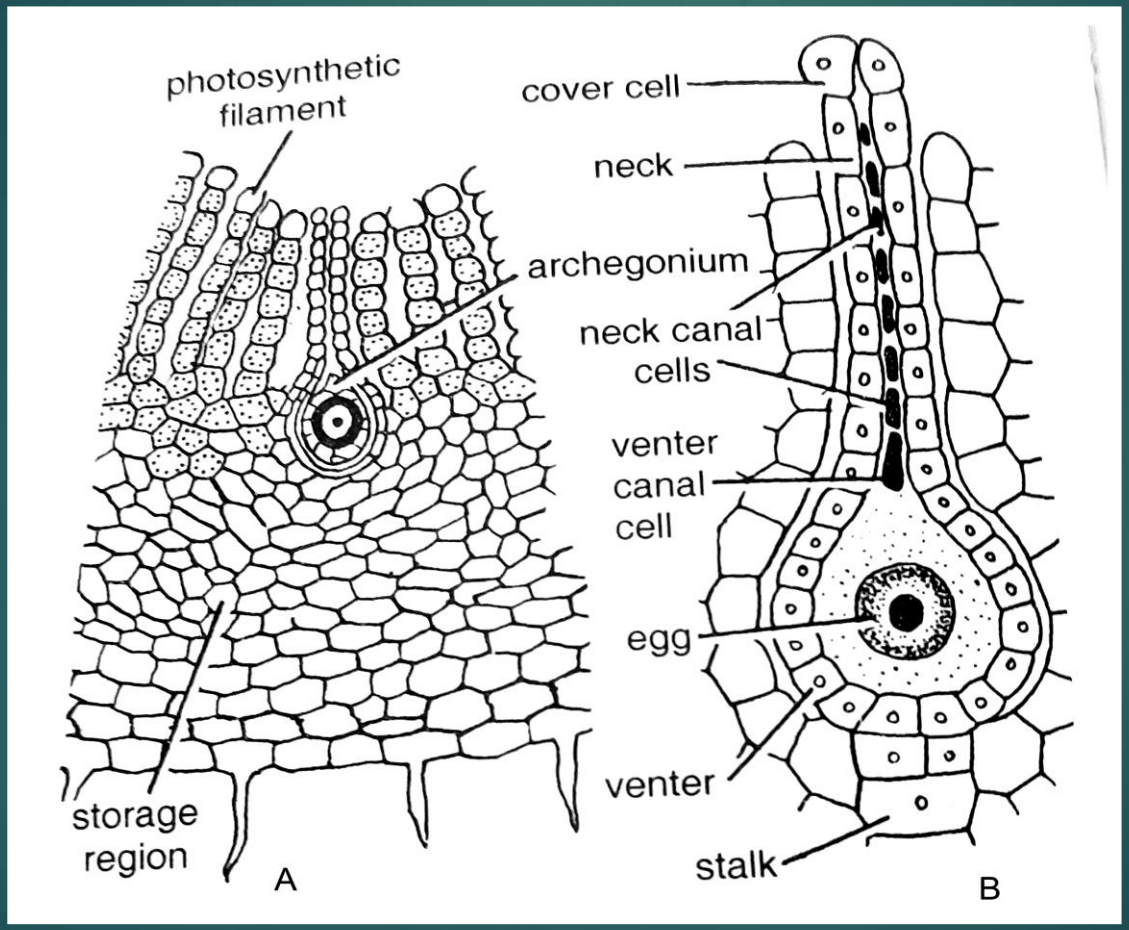
RICCIA ANTHERIDIUM



Riccia- Antheridium

- The thallus is monoecious, both the sex organs being situated in the mid-dorsal groove. (R. bischoffi and R. curtisii are dioecious).
- 2. The antheridium is present inside a cavity called antheridial chamber which opens outside by antheridial pore.
- 3. The antheridial chamber with antheridium, lies embedded partly in the tissue of the photosynthetic region and partly in the tissue of the storage region.
- 4. A mature antheridium consists of a small stalk and a globular or club-shaped body.
- 5. The stalk is short and few celled. The body is composed of a central mass of either androcytes or antherozoids, surrounded by a single layer of sterile jacket. The cells of the jacket are tangentially elongated

RICCIA- ARCHEGONIUM



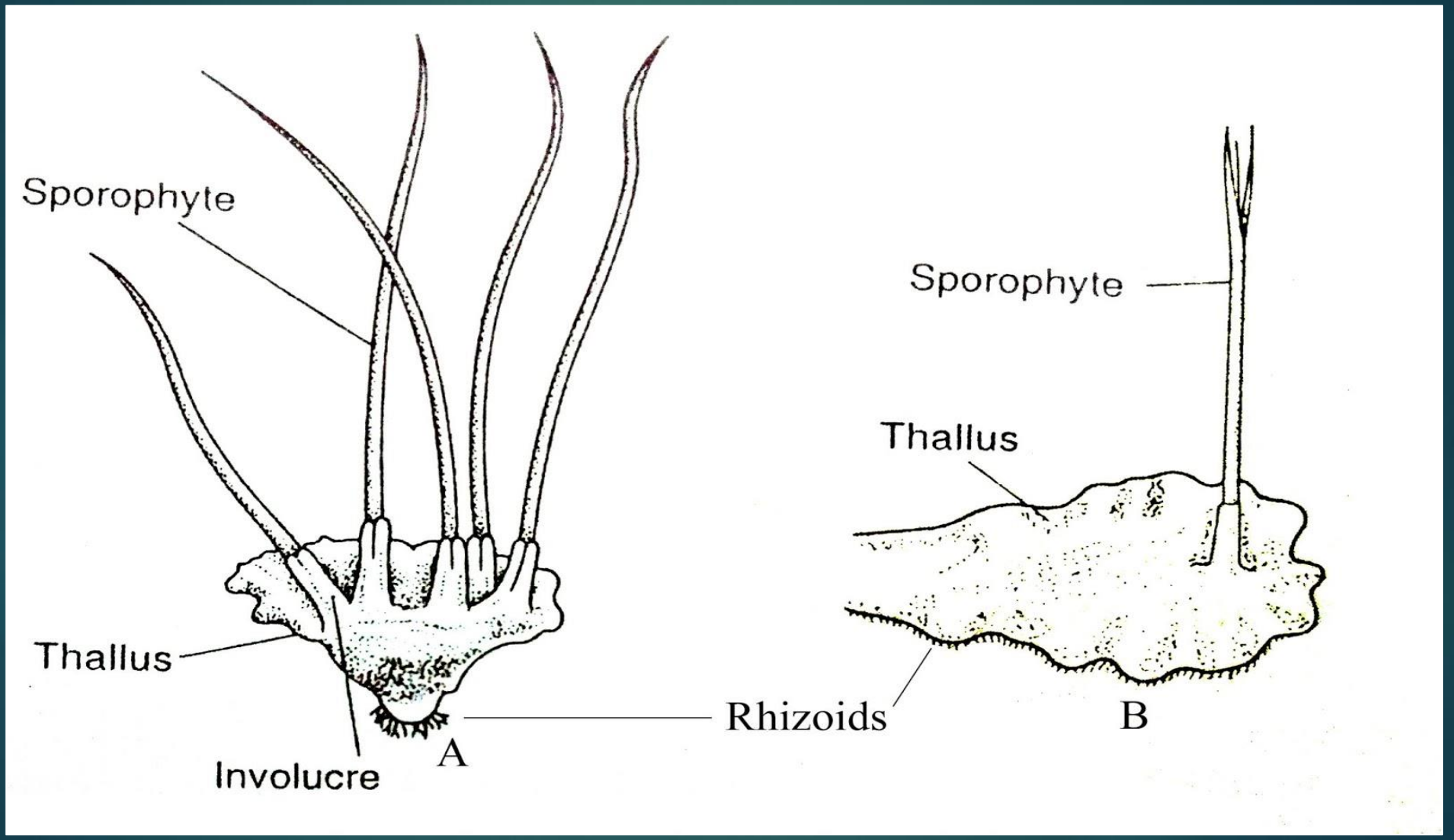
RICCIA- ARCHEGONIUM

- 1. The thallus is monoecious and both the sex organs are situated in the mid-dorsal groove.
- 2. A nearly mature archegonium is flask-shaped.
- 3. Archegonium is shortly stalked and consists of a broad venter and a long neck.
- 4. Wall of the venter is one celled. The venter has one venter canal cell and an egg cell.
- 5. The neck consists of 6 vertical rows of cells and is 6-9 cells in height. It possesses 4 neck canal cells.
- 6. The neck is surmounted by four cover cells.
- 7. Before fertilization, all the axial cells except the egg cell degenerate and the cover cells

ANTHOCEROS

- Division Bryophyta
- Class Anthocerotopsida
- Order Anthocerotales
- Family Anthocerotaceae
- Genus Anthoceros

Anthoceros- Thallus



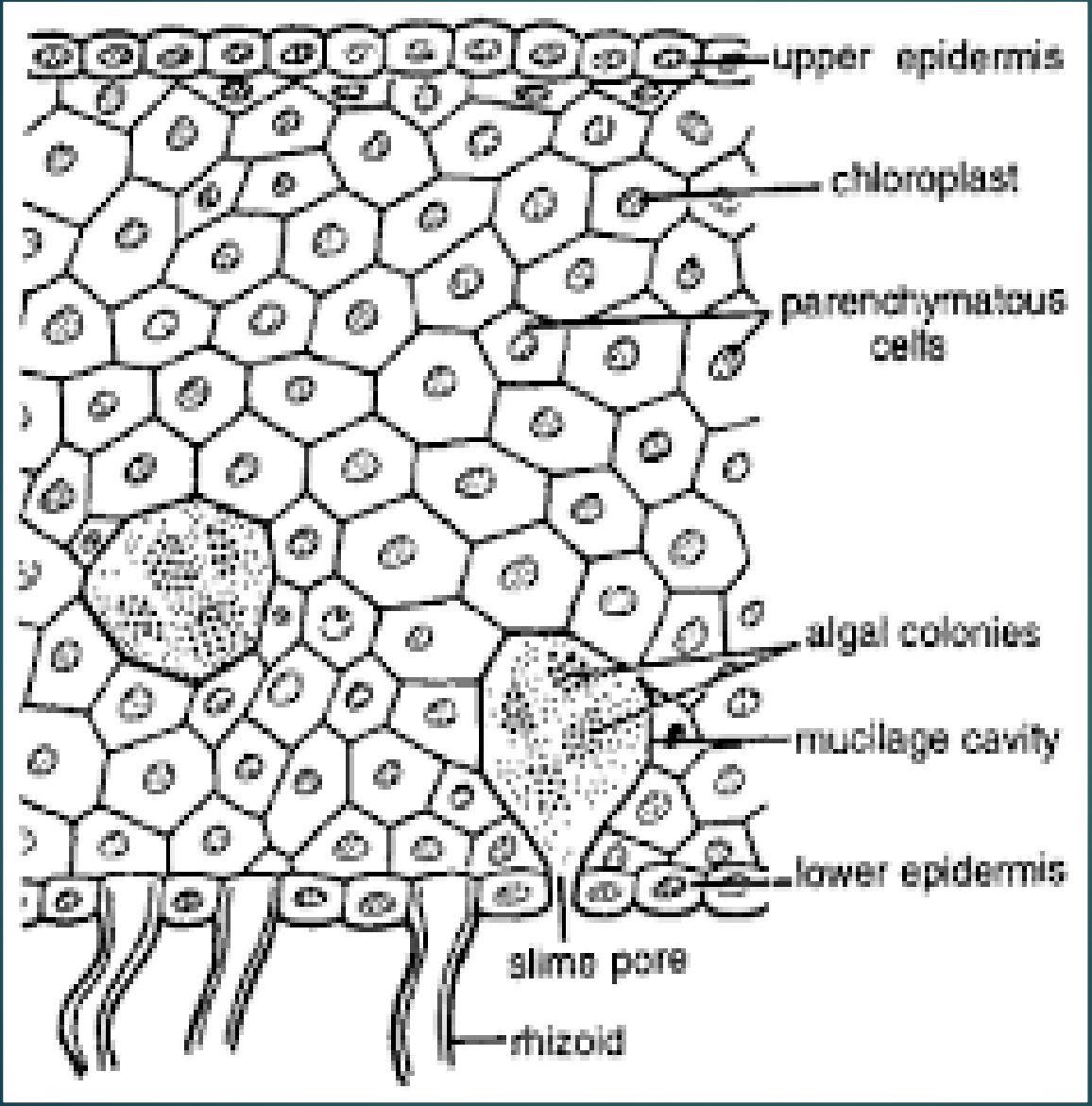
Anthoceros- Thallus

- Plant body is thalloid, somewhat lobed or radially dissected and generally suborbicular. 2. The thallus is less often dichotomously branched and lack a definite midrib
- The dorsal surface of the thallus is generally smooth, velvety or rough. 4. The ventral surface bears smooth walled rhizoids only. 5. On the ventral side, a few bluish spots are seen indicating the presence of filaments of bluegreen-alga (viz. Nostoc or Anabaena). 6. Sex organs are situated on the dorsal side and are embedded in the tissue of the thallus. 7. The sporophyte, however, is linear and elongated structure, arising from the dorsal side.

Anthoceros T.S of Thallus

- 1.Thallus is few cells in thickness in the middle and becomes thinner towards the margins.
- 2. Internal structure is homogeneous (i.e. all cells are alike). Air pores and air chambers are absent.
- 3. On upper side is present upper epidermis and lower epidermis on the lower side.
- 4. Parenchymatous tissue lies between these two layers .
- 5. Each parenchymatous cell has a distinct nucleus and a chloroplast.
- 6. Each of the cells has a large chloroplast with a single pyrenoid except the cells of lower epidermis producing rhizoids. There are two chloroplasts in the cells of A. pearsonii and four in A. hallii.
- 7. On the ventral side there are certain mucilage filled cavities which open by slime pores, through the ventral epidermis.
- 8. The endophytic algae Nostoc or Anabaena present in he mucilage cavities, enter through these slime pores.
- 9. Rhizoids are smooth-walled and arise in the middle region of the thallus from the lower epidermis.

Anthoceros T.S of Thallus



Anthoceros- Antheridium

- 1.Both antheridia and archegonia remain embedded in the dorsal region of the thallus and are acropetally arranged.
- 2.Few species are monoecious (homothallic), but some are dioecious (heterothallic).
- 3. Monoecious species are frequently protandrous (antheridia maturing flrst).
- 4. The antheridia are present in the antheridial cavity or antheridial chamber with a sterile roof
- of 2-3 layers.
- 5. Each antheridial cavity contains about 1-4 or more primary antheridia. Secondary antheridia
- arise from the stalks of primary antheridia and

Anthoceros- Antheridium

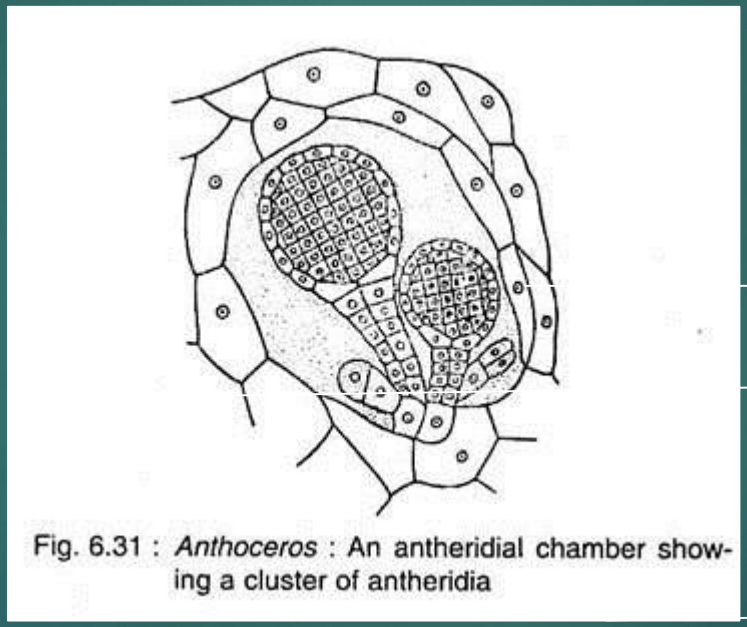
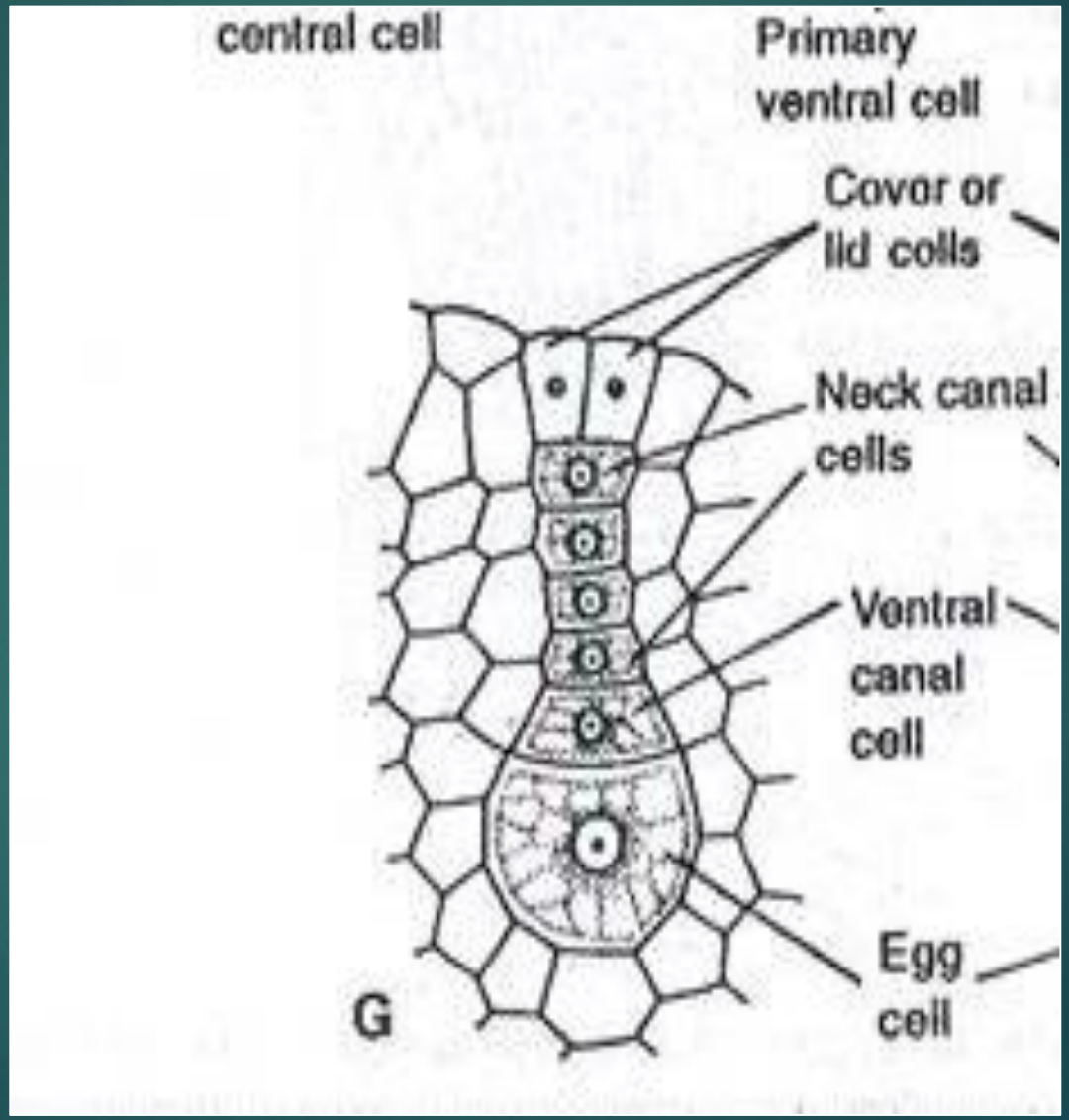


Fig. 6.31 : *Anthoceros* : An antheridial chamber showing a cluster of antheridia

Anthoceros- Archegonium

- 1.The thalli are generally monoecious and protandrous (antheridia maturing fust).
- 2.The archegonia are embedded in the thallus and only the cover cells project beyond the general surface of the thallus.
- 3. They are in direct contact with the vegetative cells, lateral to them.
- 4. Archegonium consists of a neck and a swollen venter.
- 5. The nearly mature archegonium has 4 cover cells, 4-6 neck canal cells, one venter canal cell and one egg cell.

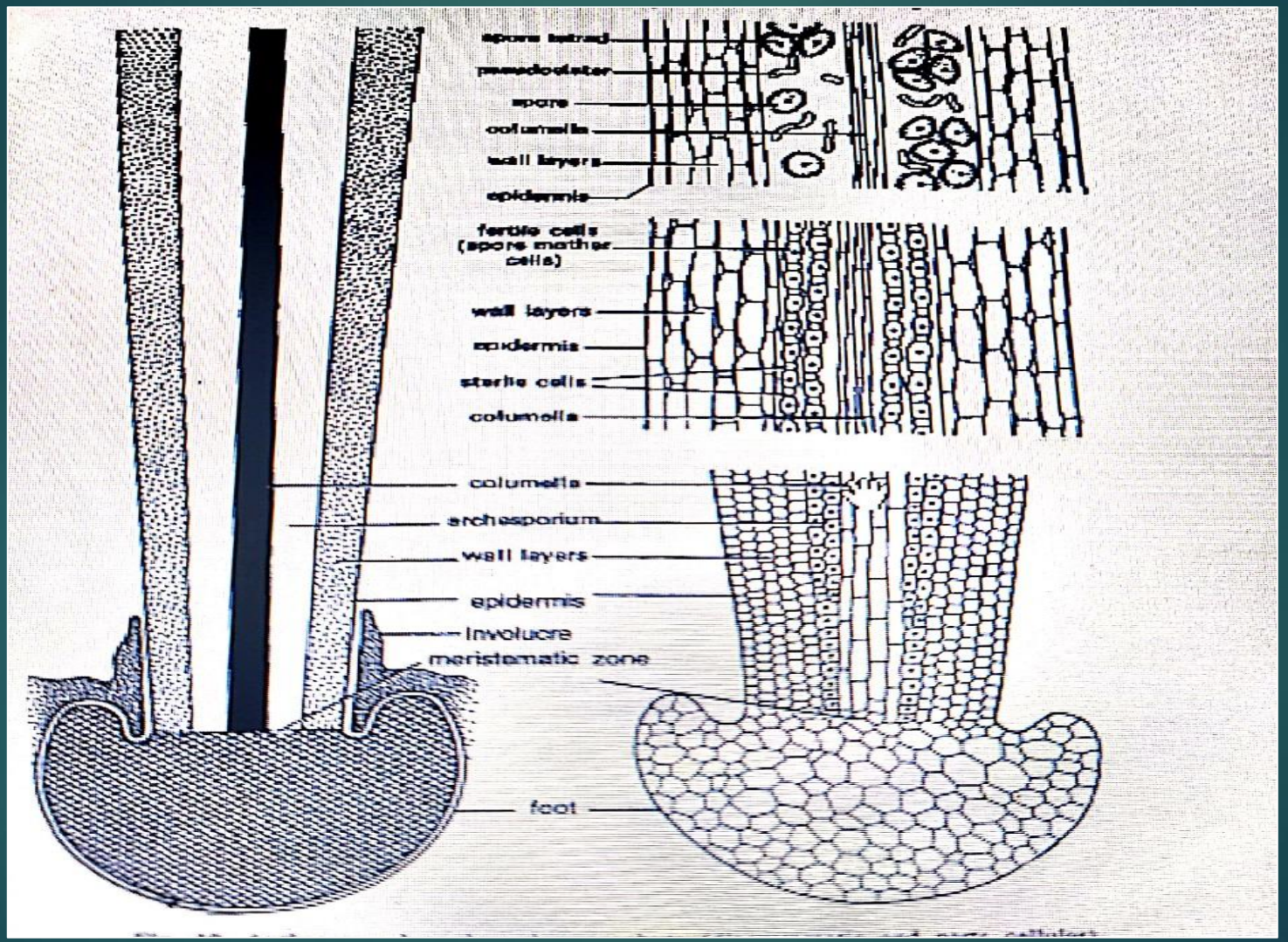
Anthoceros- archegonium



Anthoceros- Sporophyte

- 1.The sporophytes are linear, 2-3 cms long,elongated structure, arising from the dorsal side of the thallus.
- 2. The base of each sporophyte is enclosedby an involucre, made of gametophytic tissue.(The internal structure of the sporophyte can be understood by studying the transverse and longitudinal sections).
- The mature sporophyte is made of a lower foot, middle meristematic zone and upper capsule.
- 4. The foot is bulbous and is deeply rooted inthe gametophytic tissue.
- 5. The seta is absent and instead is present the meristematic zone.
- 6. In the centre is columella, composed of 16 vertical rows of cells, extending from the base
- to the tip of the capsule

Anthoceros- Sporophyte



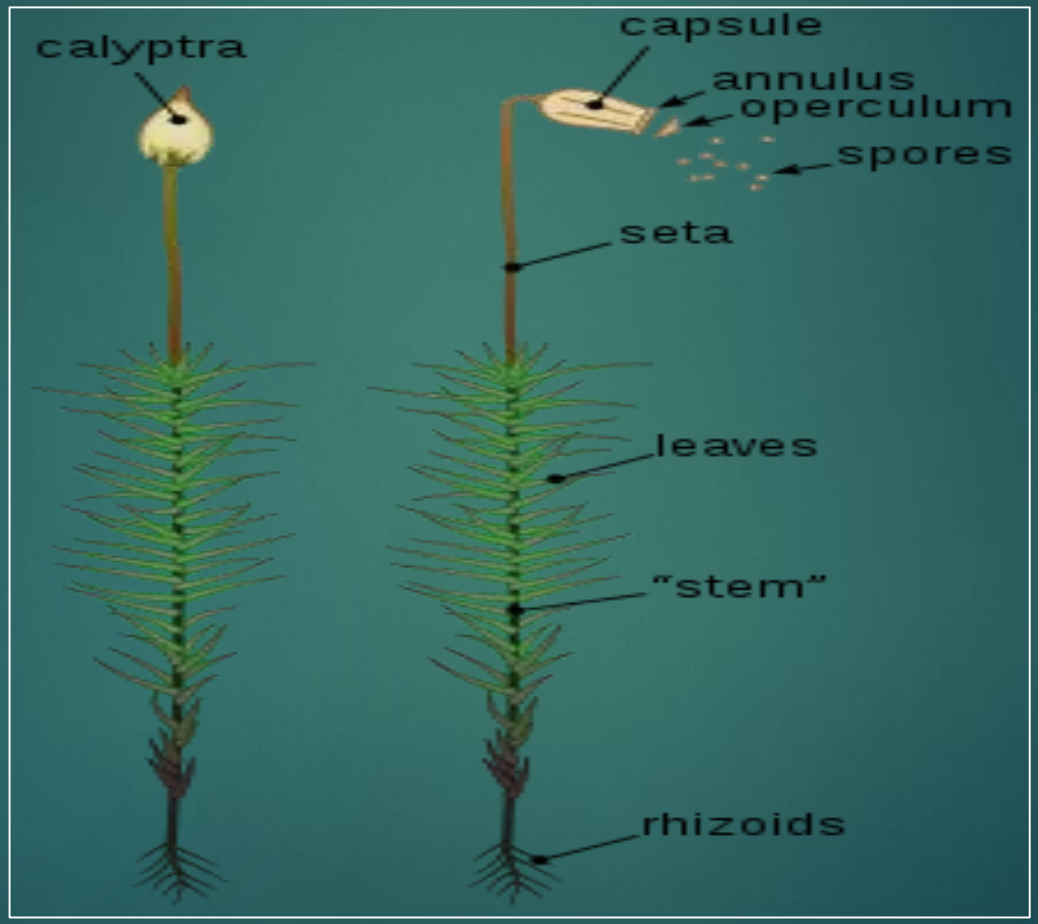
Polytrichum

- Division Bryophyta
- Class Bryopsida
- Sub-class Bryidae
- Order Polytrichales
- Family Polytrichaceae
- Genus Polytrichum

Polytrichum- Gametophyte

- 1.The gametophyte is differentiated into an underground rhizome and aerial, erect, leafy stems 20 cms or more tall. In P. commune, transitional zone between rhizome and upper leafy shoot is present.
- 2. Rhizoids are produced by the rhizome. These are long and thick walled with oblique septa. The rhizoids coil round one another to form a rope like structure. These rhizoidal strands provide mechanical support also.
- 3. The leaves on the rhizome and middle transitional region occur in 3 vertical rows. These are either brown in colour or colurless. The leaves on aerial leafy shoot are green, large and spirally arranged.
- 4. Each leaf possesses a broad, colourless, membranous, one celled sheathing leaf base that narrows above into a lanceolate limb. The margins of the wings are coarsely toothed. The leaf has a dark green midrib.

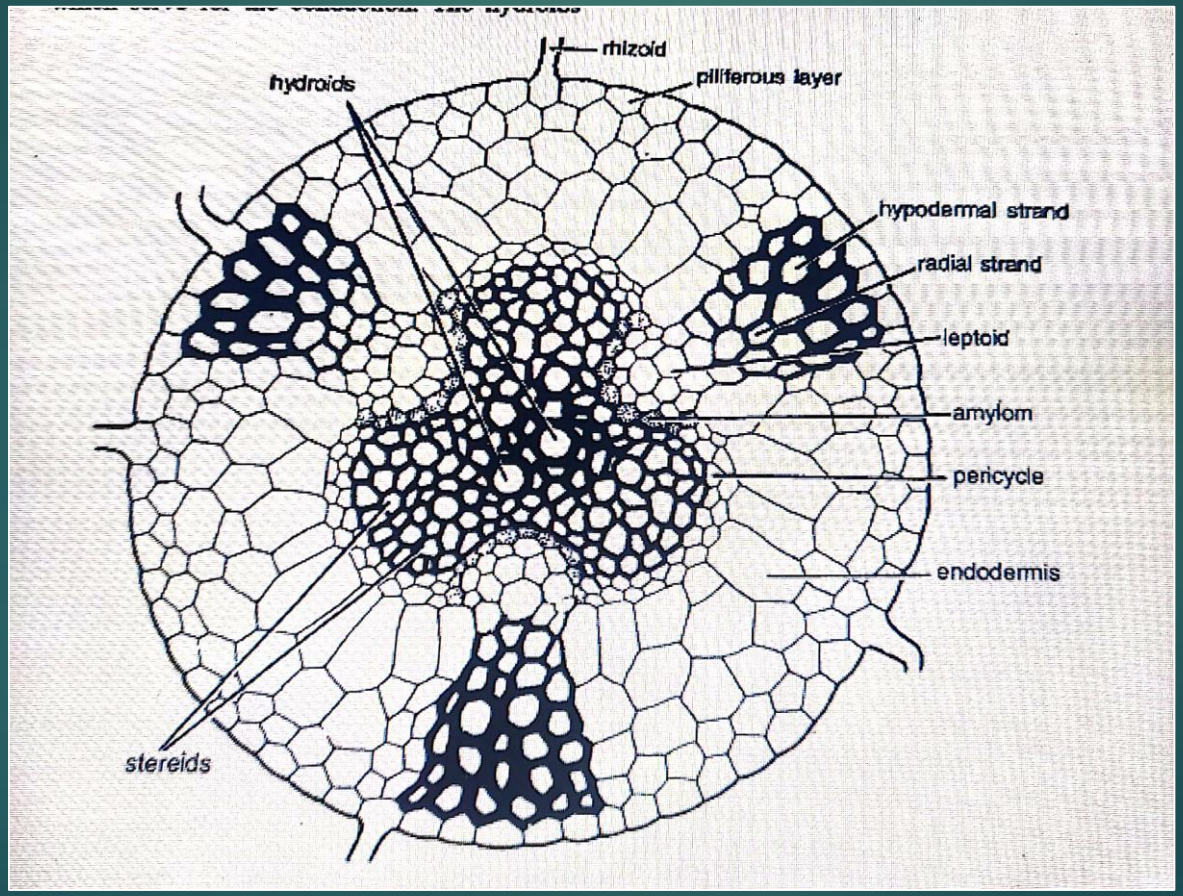
Polytrichum- Gametophyte



Polytricum- T.s of Rhizome

- 1.The transverse section shows an almost circular outline.
- 2. It is differentiated into piliferous layer, cortex, endodermis and the central cylinder. A piliferous layer is the outermost. It bears rhizoids.
- 4. This is followed by two or three layers of cortical parenchyma. It is interrupted by three hypodermal strands, the cells of which are distinctly prosenchymatous with pointed ends.
- 5. Passing radially inwards from the hypodermal strands are cells of greater diameter, which do not show a clear demarcation with the cells of hypodermal strands. These are called the radial strands.
- 6. The cortex is delimited from the conducting strand by large, radially elongated endodermal cells. The endodermis is discontinuous and consists of three arcs separated by radial strands.
- 7. The central cylinder is trilobed. The central mass consists mainly of very thick-walled, elongated living cells (with oblique end walls), known as stereids. The stereids are collectively called as stereom.
- 8. Scattered among the stereids are the hydroids which serve for the conduction. The hydroids are of about the same diameter as the stereids, or slightly bigger and as a whole being called as hydrome.
- 9. Surrounding the trilobed central strand is an interrupted peri cycle composed of 2 or 3 layers.
- 10. The furrows between the lobes are occupied by 6-8 polygonal cells known as leptoids, collectively called as leptom. These cells appear similar to sieve tubes.
- 11. In between the leptom and hydrome is a layer of starchy parenchyma called as amylom.

Polytrichum- T.s of Rhizome



Polytrichum- T.s of Axis

- 1. The outline of the section is irregular due to attachment of leaves.
- 2. The tissues show outermost superficial layer followed by cortex, peri cycle, leptom mantle, hydrom sheath, hydrom mantle and the hydrom cylinder.
- 3. The superficial layer does not form clearly defined epidermis.
- 4. The cortex is divisible into outer and inner cortex. The outer cortex is made of compact, elongated prosenchymatous cells gradually merging into the inner cortex made of parenchymatous cells. Leaf traces are quite common in cortex.
- 5. Following the cortex is present the rudimentary pericycle which is not clearly differentiated.
- 6. Inner to pericycle is the leptom mantle, the cells of which are typical sieve tube-like. The leptom mantle is regarded as equivalent to the phloem of vascular plants.
- 7. Internal to the leptom mantle is the hydrom sheath (amylom layer) composed of one or two layers of cells with prominent starch.
- 8. Immediately following the hydrom sheath is the hydrom mantle which is composed of thinwalled cells without contents.
- 9. The centre of axis is occupied by the hydrom cylinder, made of thick walled cells.

Polytrichum- T.s of Axis

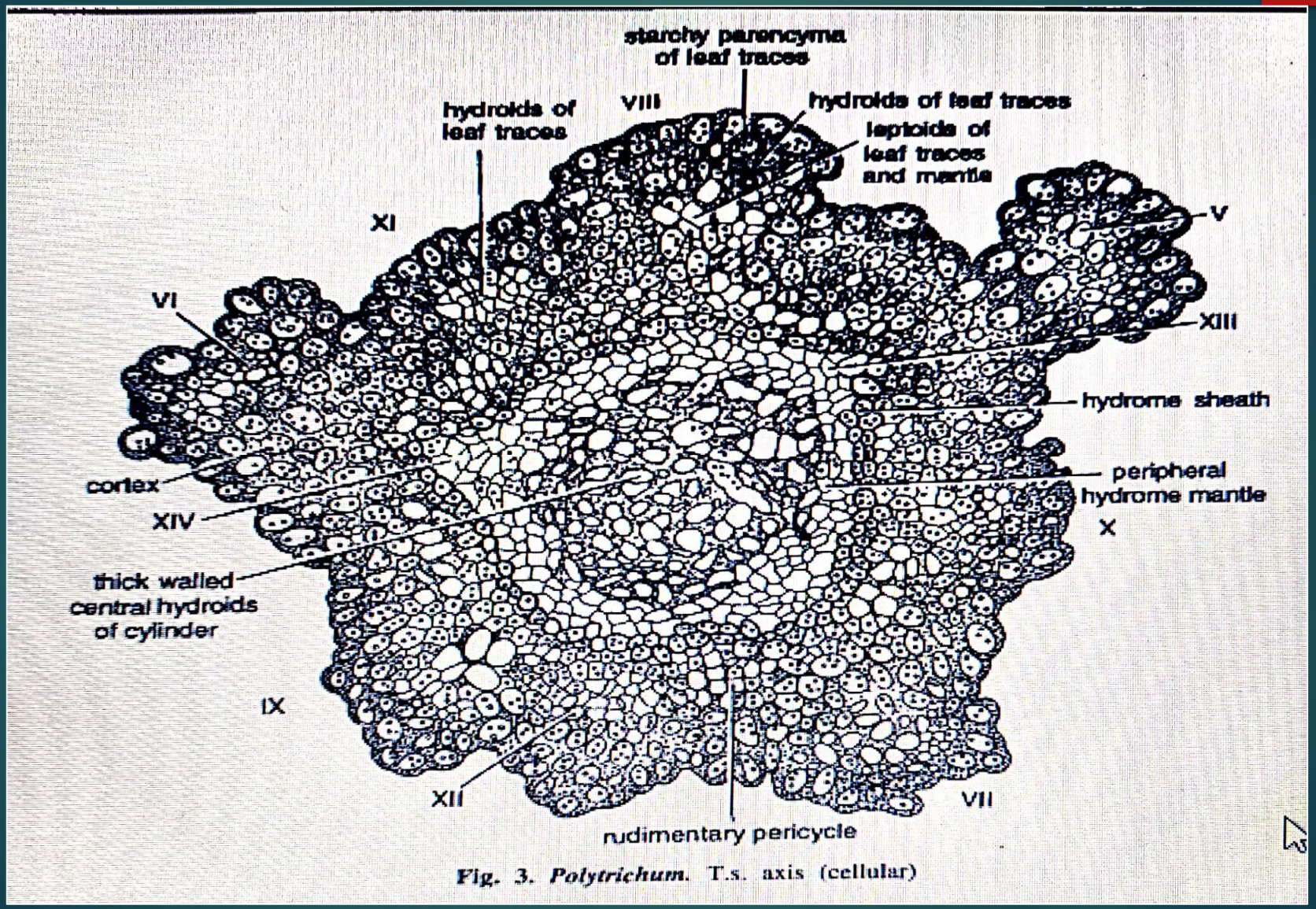


Fig. 3. Polytrichum. T.s. axis (cellular)

Polytrichum- Antheridial head and Antheridium

- Plants are usually dioecious and the antheridia and archegonia are present at the apices of the gametophores. 2. The antheridia are surrounded by specialized leaves known as perichaetial leaves which are usually short and may be pale pink or rose.
- They form a cluster or rosette, superficially resembling a small flower. 3. The antheridia are present in groups at the base of each perichaetial leaf in the position of lateral buds. 4. Intermingled with the antheridia are the paraphyses. Some of the paraphyses are ftlamentous, whereas the others are broadened at their tips. 5. A mature antheridium is usually stalked and somewhat club-shaped structure. 6. It consists of a jacket of cells surrounding a mass of androgonial cells.

Polytrichum- Antheridial head and Antheridium

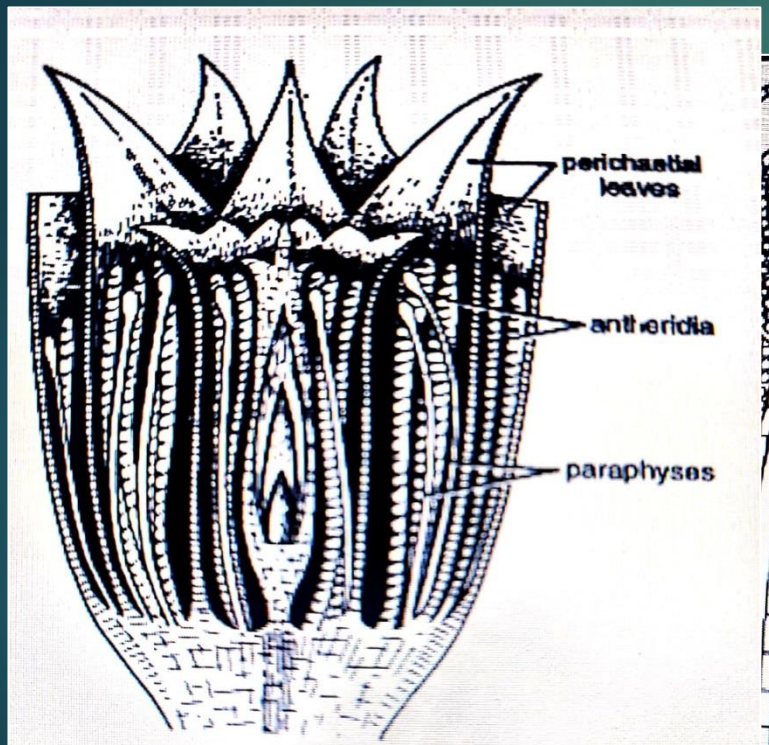
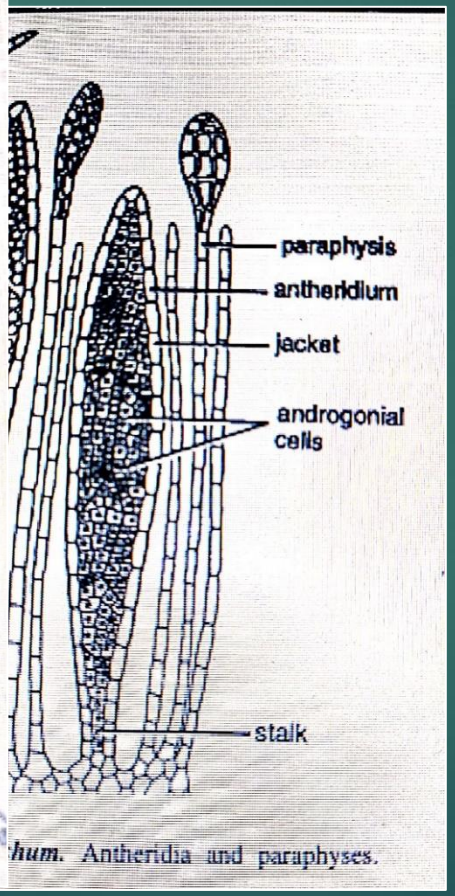


Fig. 5. *Polytrichum*. L.s. through antheridial head.



hum. Antheridia and paraphyses.

Polytrichum- Archegonial branch and Archegonium

- 1. The archegonia are surrounded by coloured perichaetial leaves. This gives the appearance of a small flower.
- 2. The archegonia are found in terminal groups at the apex of the gametophore, thus arresting the further growth of the axis.
- 3. In each group there are usually three archegonia.
- 4. Scattered among the archegonia are modified hair-like structures, the paraphyses.
- 5. The archegonia are "lso stalked and greatly elongated and consist of venter and a neck.
- 6. The venter is several cells thick and contains a venter canal cell and an egg.
- 7. The neck consists of six vertical rows of cells and contains a large number of neck canal cells which disintegrate as the archegonium matures.

Polytrichum- Archegonial branch and Archegonium

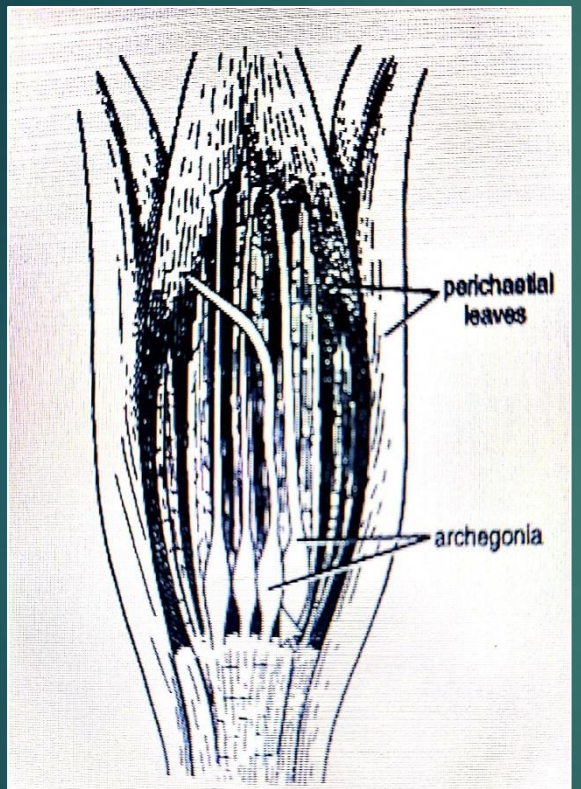


Fig. 7. *Polytrichum*. L.s. through archegonial head.

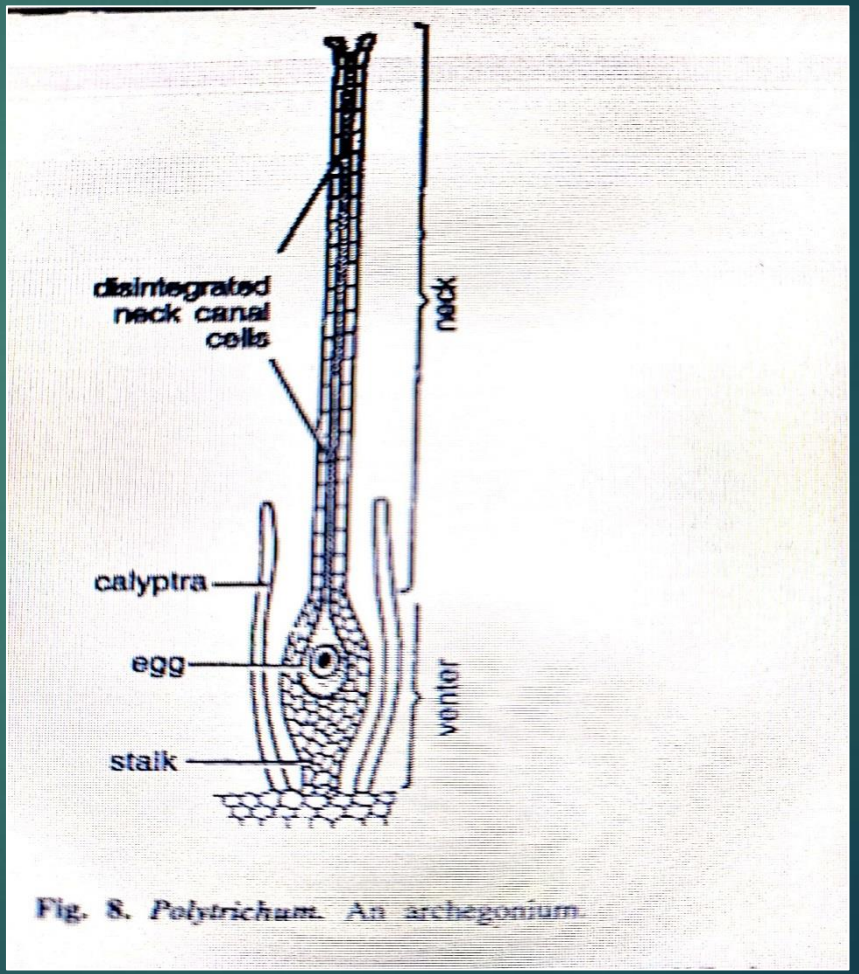


Fig. 8. *Polytrichum*. An archegonium.

Polytrichum - Sporophyte

- 1. The sporophyte is formed after fertilization and consists of foot, seta and capsule.
- 2. The foot is buried in the tissues of the leafy gametophore.
- 3. Just above and in continuation of the foot is the long and slender seta which support the capsule at its apex.
- 4. With the growth of the sporophyte, the lower part of the archegonium enlarges following elongation, and is converted into a calyptra, covering the capsule.
- 5. The wall of the capsule is several layered and the outermost layer is differentiated into an epidermis with thick outer walls. All the cells of the wall layers contain chloroplast.
- 6. Inner to the wall there is an outer lacuna (air space), traversed radially by the chlorophyllous filaments. The filaments are connected internally with the outer wall of the spore sac.
- 7. The spore sac is internally bound by an inner lacuna made of filaments that connect the spore sac with the central columella.
- 8. The spore sac extends the entire length of the capsule. The archesporium (spore producing tissue) is 1 to 16 layered and all its cells develop into spore mother cells which after meiosis, give rise to spores.
- 9. At the top of the capsule is present a lid, the operculum.
- 10. Just below the operculum is present the epiphragm which stretches like a drum head over the opening of the capsule.
- 11. Just within the mouth of the capsule and under the epiphragm is a ring of peristome teeth.

Polytrichum - Sporophyte

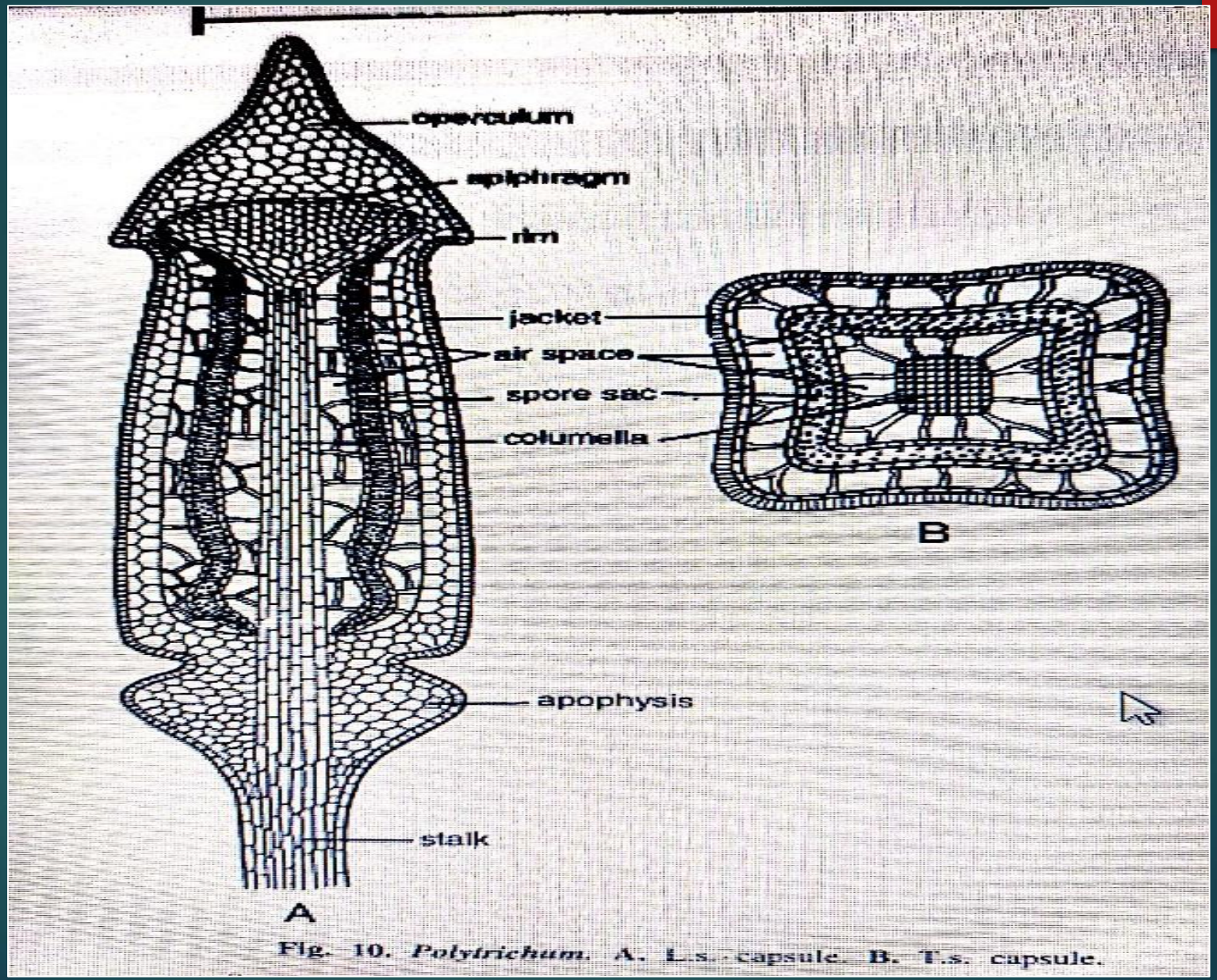


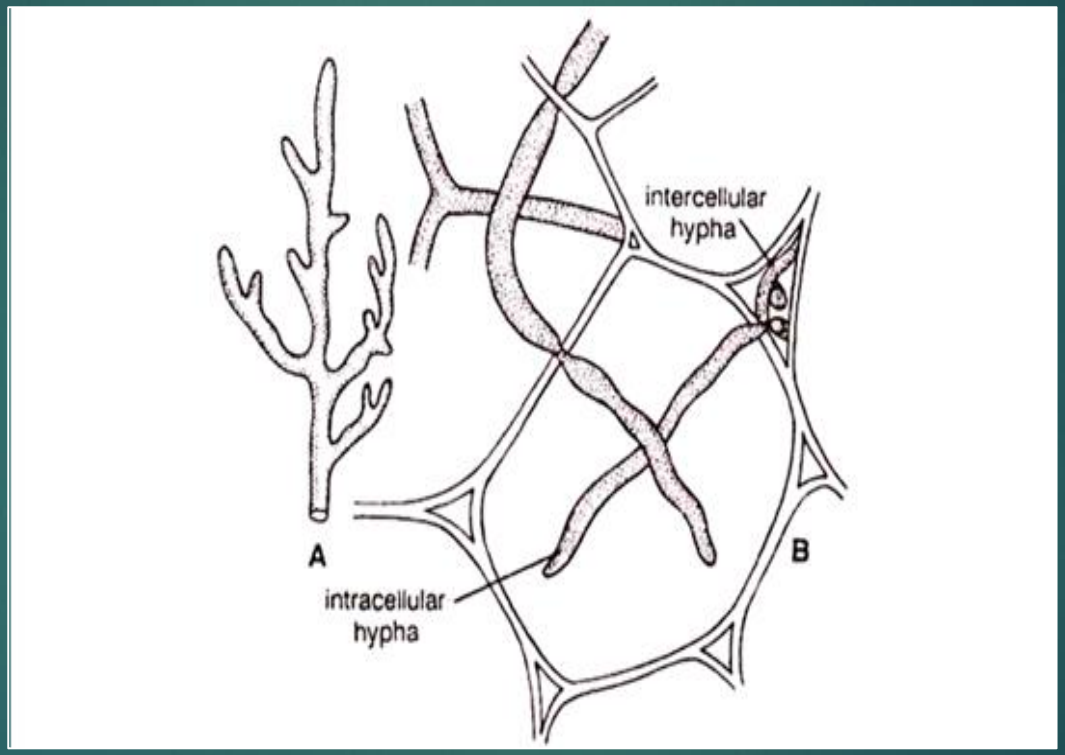
Fig. 10. *Polytrichum*. A. L.s. capsule. B. T.s. capsule.

PYTHIUM

CLASSIFICATION

- *Division- eumycota*
- *Sub diviision- mastigomycotina*
- *Class- oomycetes*
- *Order- peronosporales*
- *Family- pythiaceae*
- *Genus- pythium*

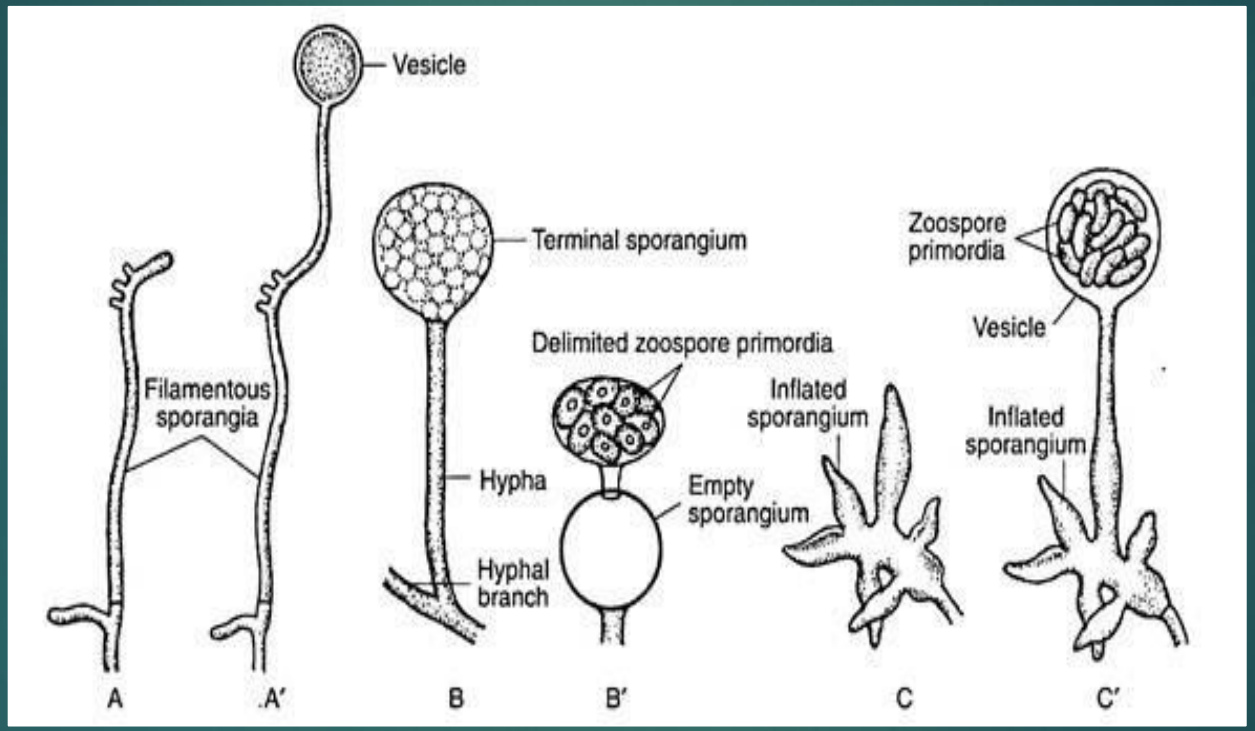
PYTHIUM –VEGETATIVE MYCELIUM



PYTHIUM –VEGETATIVE MYCELIUM

- *Pythium* species are eukaryotes, that have filamentous, coenocytic (non-septate threads lacking cross walls) cell growth.
- The cell wall of many oomycetes is composed of cellulose and β-1, 3 glucan with minimal amounts of chitin.
- Chitin is a major component of the walls of true fungi.
- The mycelium appears as white, fluffy mass. It is well developed, branched, inter- or intracellular , multinucleate
- Haustoria are not produced. Food material is absorbed hyphal walls. Septa appear only in association with the sex organs formation. Cell wall lacks chitin and instead it is composed of glucan and cellulose.
- Cell wall encloses vacuolated cytoplasm, mitochondria, a nuclei, endoplasmic reticulum, ribosomes, oil globules and glycogen in the form of reserve food mater.

PYTHIUM-DIFFERTENT TYPES OF SPORANGIA



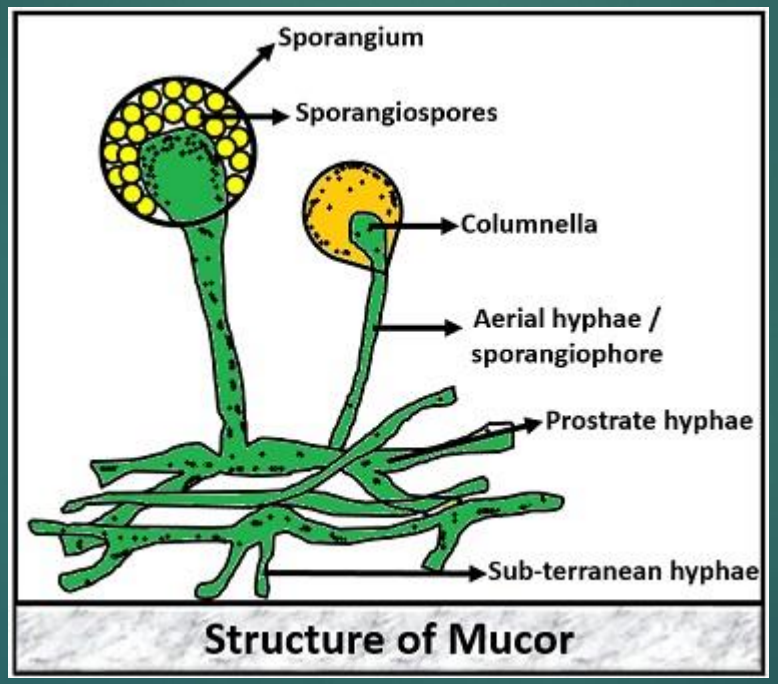
PYTHIUM-DIFFERTENT TYPES OF SPORANGIA

- The asexual or vegetative stage of *Pythium* produces
- I)chlamydospores (thick walled resting spores),
- II)sporangia (that germinate directly to produce a hypha or indirectly to give rise to vesicle outside the sporangium, within which zoospores are formed), The sporangia are globose to oval and are either terminal or intercalary in position on the vegetative hyphae. The terminal or the portion in intercalary region of hyphae swell up and form globose to oval structure, the sporangium
- III)Hyphal swellings (spherical sporangia-like structures that do not give rise to zoospores).

MUCOR

- **Kingdom**: Mycota
- **Division**: Zygomycota
- **Sub-division**: Zygomycotina
- **Class**: Zygomycetes
- **Order**: Mucorales
- **Family**: Mucoraceae
- **Genus**: Mucor

MUCOR



Structure of Mucor

STRUCTURE OF MUCOR

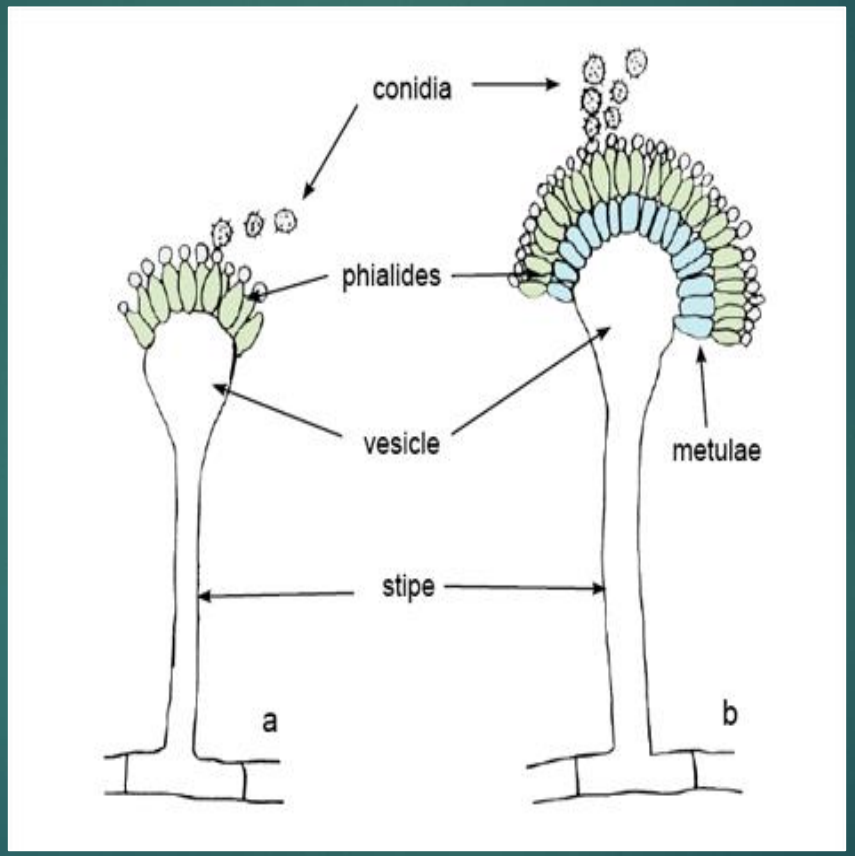
- The genus ***Mucor*** *has* widespread occurrence and are of considerable
- economic importance.
- The aerial mycelium consists of branched hyphae, which grow over the
- surface. Rhizoids are absent in *Mucor*.
- Colonies are very fast growing, cottony to fluffy, white to yellow, becoming
- dark-grey, with the development of sporangia.
- Sporangiophores are erect, simple or branched, forming large (60-300 μm
- in diameter), terminal, globose to spherical, multispored sporangia, without
- apophyses and with well-developed subtending columellae.
- A conspicuous collarette (remnants of the sporangial wall) is usually visible
- at the base of the columella after sporangiospore dispersal.
- Sporangiospores are hyaline, grey or brownish, globose to ellipsoidal, and
- smooth-walled or finely ornamented.
- Chlamydospores and zygospores may be present.

****

ASPERGILLUS

Kingdom: Fungi
Phylum: Ascomycota
Order: Eurotiales
Family: Trichocomaceae
Genus: *Aspergillus*

Aspergillus Head Morphology: (a) Uniseriate, (b) biseriate



Morphological Features of *Aspergillus*

- Macroscopically ***Aspergillus*** colonies are powdery and are of different colours like green, blue, black, yellow, brown, etc.
- Microscopically mycelium consists of branched, bright or pale coloured hyphae some of which grow within the substrate while others grow on the
- substrate.
- From these vegetative hyphae, long, unbranched, nonseptate erect hyphae arise called conidiophores. The cell from which conidiophore arise is called
- foot cell. It is thick walled and T-shaped and one conidiophore arises from each foot cell.
- Conidiophores terminate into a globular structure called vesicle.
- Around the vesicle, there are 1-2 layers of flask shaped structures called phialides or sterigmata.
- At the tip of the sterigmata, a chain of small unicellular spores called conidia arises.
- *Aspergillus* Head Morphology: (a) Uniseriate, (b) biseriate
- These conidia are formed in basipetal manner (oldest is at the top). These are arranged compactly side by side. The whole structure consisting of the
- foot cell, the upright hypha, the vesicle, the metullae and the phialides constitutes the conidiophores.

PUCCINIA

KINGDOM - MYCOTA

DIVISION - EUMYCOTA

SUB-DIVISION - BASIDIOMYCOTINA

CLASS - TELIOMYCETES

ORDER - UREDINALES

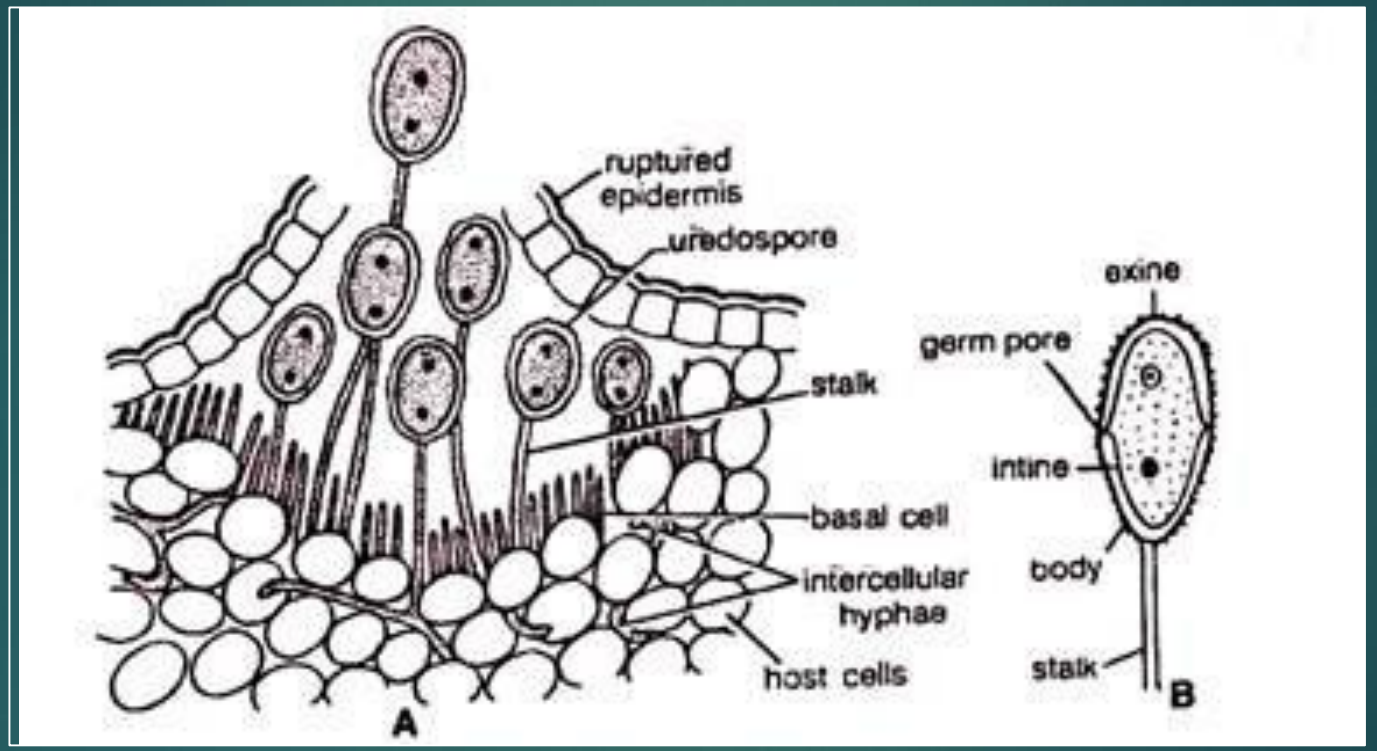
FAMILY - PUCCINIACEAE

GENUS - PUCCINIA

T.s. of the leaf showing Uredosorus

- 1. The uredosori or uredopustules appear as red,oval or lemon shaped lesions on the leaves and leaf sheaths.
- 2. The uredosorus in section reveals the ruptured host epidermis due to the pressure of underlying uredospores.
- 3. The (dikaryotic) intercellular and branched mycelium is aggregated beneath the epidermis host cells
- 4. The uredospores are produced in massive groups from this mycelium.
- 5. Each uredospore is binucleate, stalked and rounded or oblong in shape.
- 6. It has an outer exine which is finely verrucose or echinulate and an has inner smooth intine.
- 7. Each uredospore has four equatorial germ pores.
- 8. The uredospores get disseminated by wind and infect the fresh wheat plants.

T.s. of the leaf showing Uredosorus



T.s. of the leaf showing Teleutosorus

- 1. The teleutosori or teleutopustules appear on leaves, leaf sheaths and stem as black, oval pustules that fuse to form patches in case of severe infection.
- 2. A teleutosorus in a section reveals the (dikaryotic) intercellular, branched mycelium, a bunch of teleutospores and the ruptured host epidermis.
- 3. The host epidermis is ruptured due to the pressure of underlying teleutospores.
- 4. The teleutospores are formed by the same mycelium which earlier produced uredospores.
- 5. Each teleutospore is borne terminally by the mycelium. It is stalked, elongated and bicelled structure.
- 6. The apex of the teleutospore may be rounded or pointed as in *P. graminis* or it may be nearly flat as in *P. recondita* and *P. striiformis*.
- 7. The teleutospore has a very thick but smooth exine and delicate thin intine. The exine turns black at maturity.
- 8. At fIrst each of the two cells of the teleutospore is binucleate but later on, the nuclei fuse making each of them uninucleate.
- 9. Each cell of the bicelled teleutospore has a single germ pore.
- 10. The teleutospores are incapable of infecting the primary host (wheat plant). They germinate to form the basidiospores which infect the barberry plant or *Thalictrum*, etc., the alternate host. (The pycnidial anti-accidial cups are formed only on alternate hosts).

T.s. of the leaf showing Teleutosorus

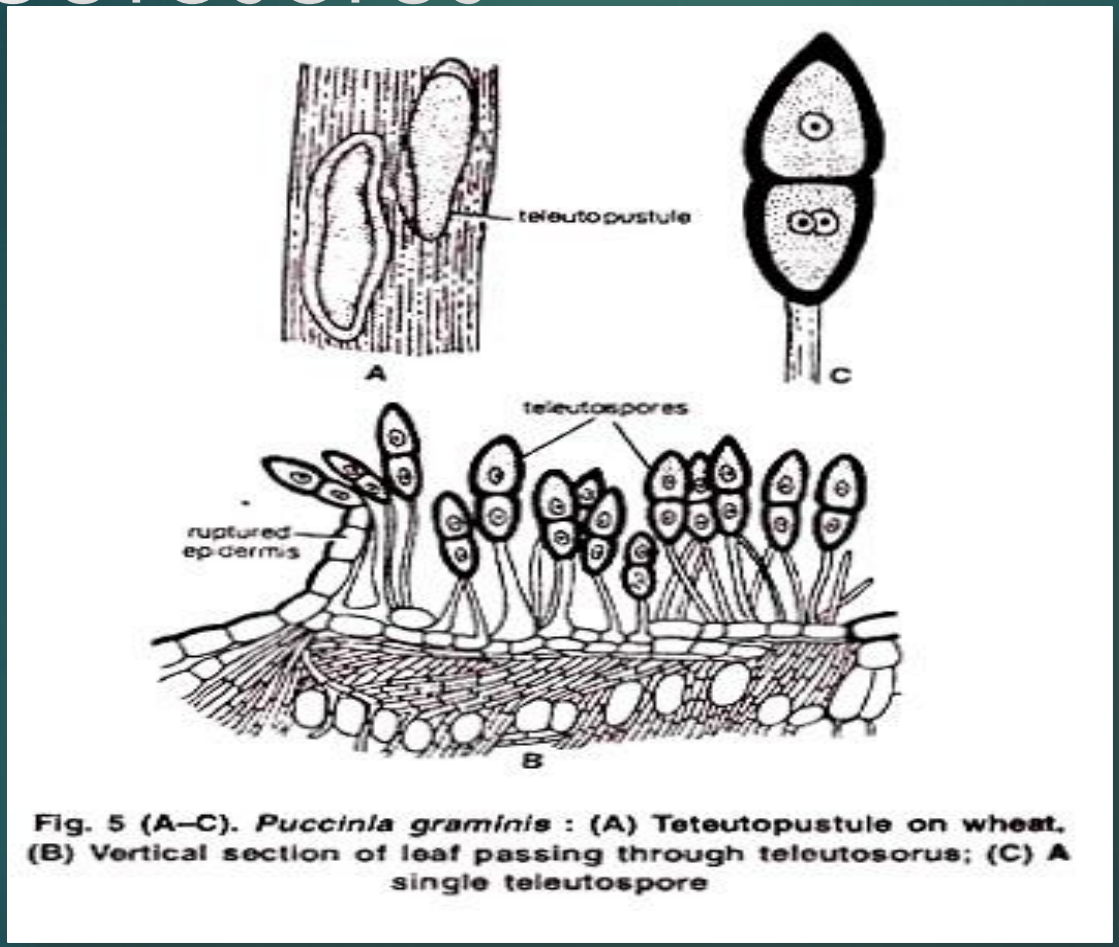


Fig. 5 (A–C). *Puccinia graminis* : (A) Teteutopustule on wheat. (B) Vertical section of leaf passing through teleutosorus; (C) A single teleutospore

CERCOSPORA

- KINGDOM-MYCOTA
- DIVISION- EUMYCOTA
- SUB-DIVISION-DEUTEROMYCOTINA
- CLASS-HYPHOMYCETES
- ORDER-MONILIALES
- FAMILY-DEMATIACEAE
- GENUS-CERCOSPORA

CERCOSPORA

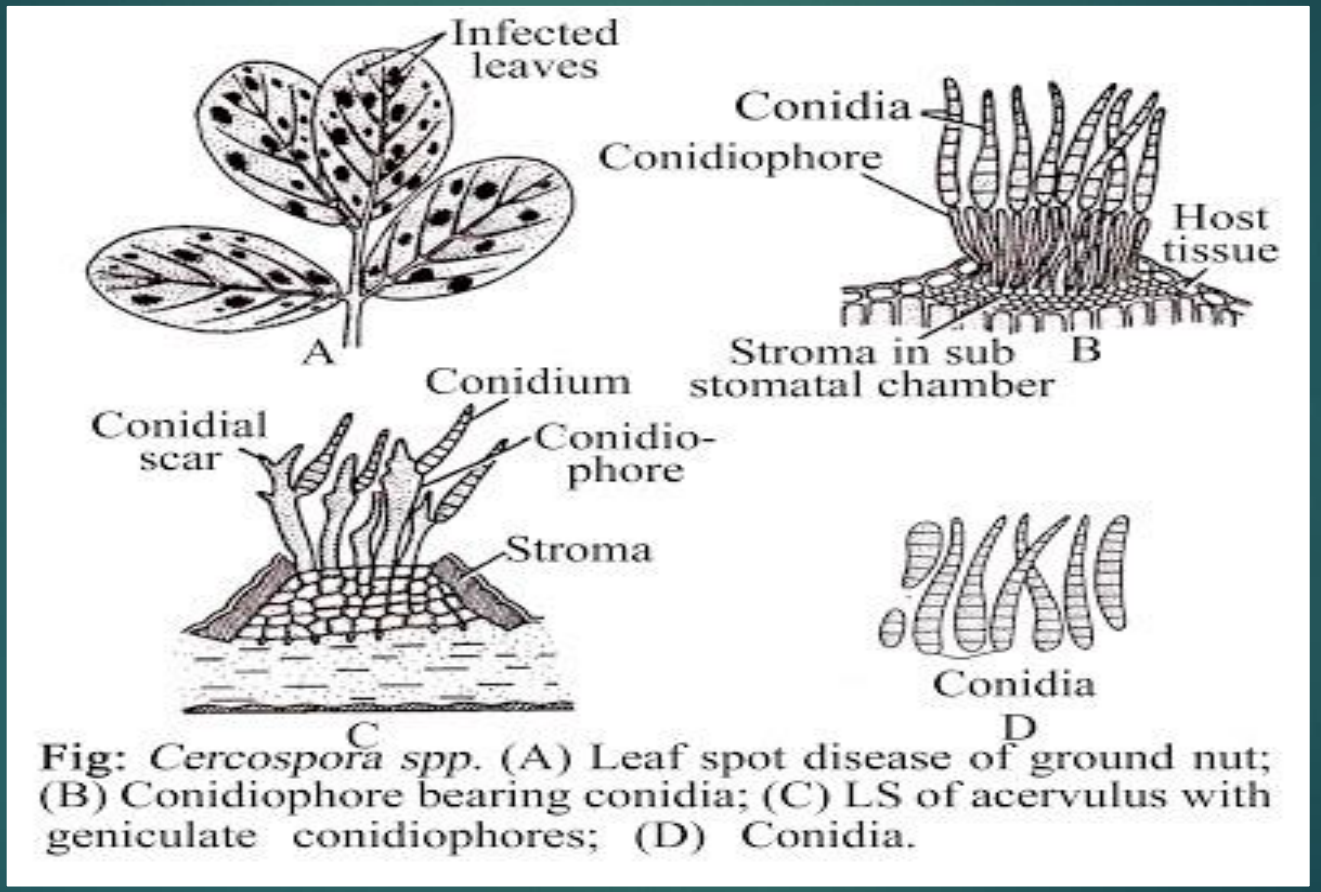


Fig: *Cercospora spp.* (A) Leaf spot disease of ground nut; (B) Conidiophore bearing conidia; (C) LS of acervulus with geniculate conidiophores; (D) Conidia.

CERCOSPORA

VEGETATIVE STRUCTURES OF CERCOSPORA:

1. Mycelium is well-developed, branched, septate, slender, intercellular and brown coloured.
2. Branched haustoria are present in C. personata. In C. arachidicola the haustoria are absent.

Conidiophores and Conidia:

1. Only asexual reproductive bodies, i.e., conidia are present. Sexual reproduction is absent.
2. Conidiophores are septate dark-coloured structures coming out in tufts from
3. Conidia develop on geniculate structures.
4. On liberation from conidiophore, each conidium leaves a small scar at the place of its attachment.
5. Conidiophores are 22-41 µ long and 3-5µ broad.
6. Conidia are hyaline or pale yellow, obclavate, 38- 108µ long and 3-6µ broad. They are 4 to 12-septate

LITTLE LEAF OF BRINJAL - MYCOPLASMA

This is a serious viral disease of brinjal. The disease is transmitted by leaf hopper (*Cestius* (*Hishimonus*) *phycitis* and *Amrasca biguttula* biguttula).

Symptoms of Little Leaf Disease:

The main symptom of the disease is the production of very short leaves by affected plant. The petioles are so much reduced in size that leaves appear sticking to the stem. Such leaves are narrow, soft, smooth and yellowish in colour.

Newly formed leaves are further reduced in size. The internodes are shortened and at the same time large number of axillary buds are stimulated to grow into short branches with small leaves. This gives whole plant a bushy appearance. Usually such plant unable to form flowers. Fruiting is very rare.

Causal Organism:

Mycoplasma like organism (MLO).

Disease Cycle:

The disease is transmitted through by the vector Cestius phycitis. Artificially the disease has been transmitted successfully to tomato, potato and tobacco.

Probably during the season of Brinjal crop, the causal agent survives on weed hosts and from there it is transmitted to main crop by its insect vector.

- ***Control Measures of Little Leaf Disease*:**
  Since no effective control measure is found it is better to eradicate the weed host and remove the diseased Brinjal plants. Tetra-cycline has been reported to control the disease.

Disease Management :-

Removal & destruction of weeds and infected plants

•Spray insecticides for managing insect vector

•Seedling treatment – benomyal + tetracycline @ 1000 ppm

•Spray- tetracycline @ 1000 ppm 3 times at 7 days interval

•Use- disease resistant varieties- BB-7, BWR-12, Pant Ritu Raj & H-8

LITTLE LEAF OF BRINJAL

BACTERIAL DISEASE - CITRUS CANKER

- Citrus Canker Infect all citrus spp. Citrus canker, is characterized by erumpent lesions on fruit, foliage, and young stems of susceptible cultivars of citrus
- ***Symptoms:***

• Firstly symptoms on lower side &later on both side of leaves

• Attack on leaves, twig, petiole, branches, fruit, thrones

• Small, round, watery, translucent raised, yellow brown spots on leaves & old branches

Spots – white to greenish & finally rapture –rough corky

• Rough lesions surrounded by–yellow brown to green raised margin & watery yellow halo

• Crater like appearance is more common than leaves

• Fruit lesion become rough & corky

• Lesion confined only skin

• Defoliation • Less price of fruits due to braking of skin

• Disease – whole the year but more spared in rainy season

- ***Pathogen*** – Xanthomonas axonopodis pv.citri

• Survive – cankered lesion on twig & branches

• Pathogen multiply intercellular (middle lema) & enter through stomata & wounds

• Dissolve the mid lamella & establish in cortex

• Citrus leaf minor – disseminate the disease • High humidity • Temp. 20-30° C

Disease Management • Grow disease free stock in nursery

• Before planting – spray the area with 1% B. M. (5: 5: 50)

• Pruning & burn them before on set of monsoon & spray 1% B.M. during rainy season

• Balance fertilizers & irrigation

• Neem cake @ 160 Q/ha. to control disease & leaf minor

• Spray–Streptomycen sulphate @500 ppm at 15 days interval

• Dis. Res. Var. of Kagji Nimbu – SN-2, Sankar–3, Sankar-4

BACTERIAL DISEASE - CITRUS CANKER

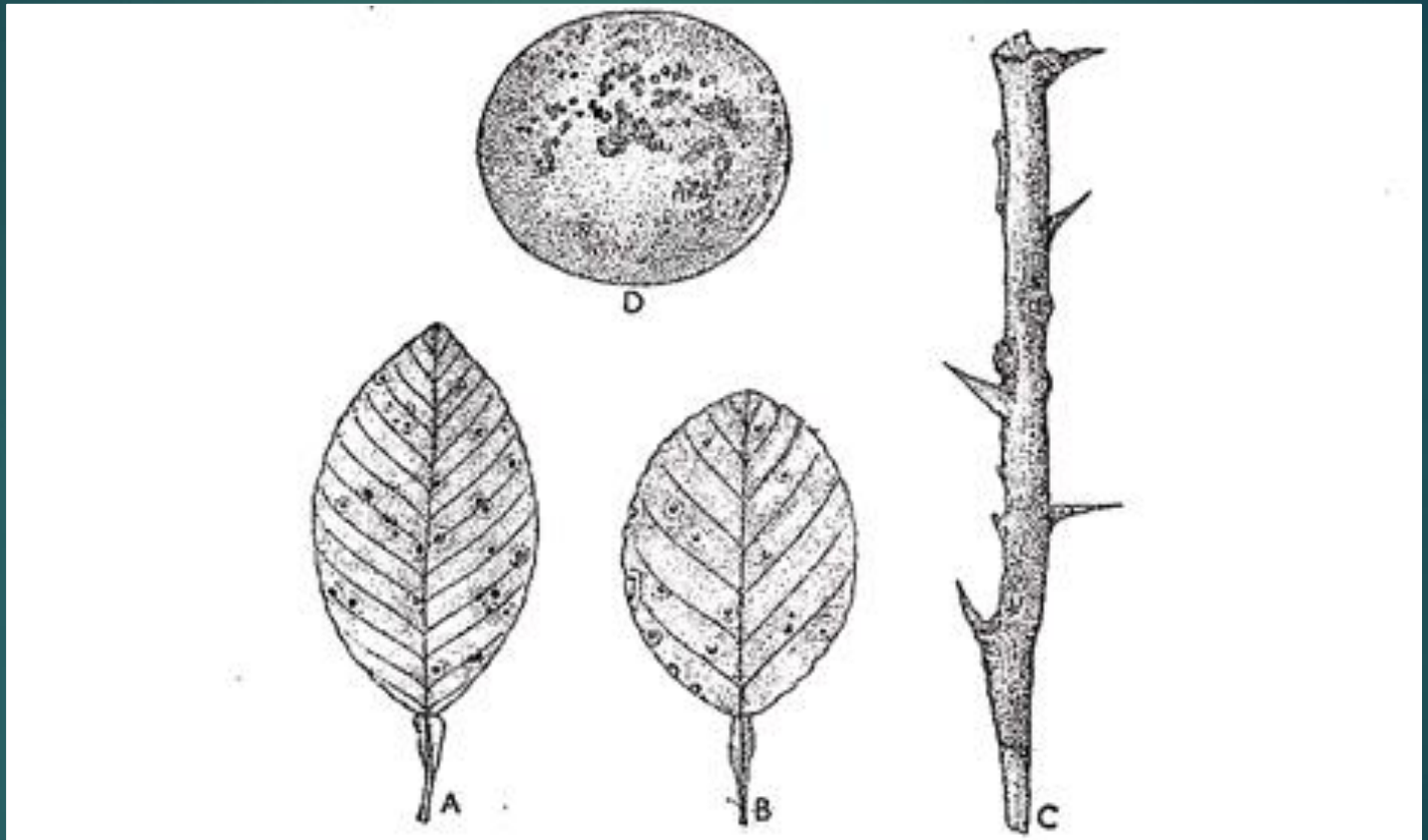


Fig. 390. Citrus Canker. A—D. Disease symptoms. A—B. On leaves. C. On twig. D. On fruit.

BUNCHY TOP OF *BANANA*

- Bunchy top is a viral disease caused by the Banana bunchy top virus (BBTV).
- The disease, often called BBTD for banana bunchy top disease, gets its name from the bunchy appearance of infected plants.
- By that time, however, the virus has most likely been spread to other plants by the banana aphid, Pentalonia nigronervosa.
- Infected plants cannot recover and will serve as a source of viral particles unless they are destroyed. The virus is also spread through infected planting material.
- ***Symptom***: Initially, dark green streaks appears in the veins of lower portion of the leaf midrib and the leaf stem
- They appear to be "bunched" at the top of the plant, the symptom for which this disease is named.
- Severely infected banana plants usually will not fruit, but if fruit is produced, the banana hands and fingers are likely to be distorted and twisted.
- It is transmitted by infected suckers and banana aphid
- ***Management:***
- Use virus free planting materialsRemove and rouging of infected banana plantsMaintain clean, weed free field for early detection of infested suckers.
- The plants should be injected with 4 ml of Fernoxone solution(50g in 400 ml of water)For vector controls.
- Injection of plants with monocrotophos 4 ml (1:4) at 45 days interval from 3rd month till flowering.
- Spraying plants with phosphomidon 1ml /l or Methyldemeton 2ml/ l or monocrotophos 1ml /l

BUNCHY TOP OF *BANANA*

FUNGAL DISEASE -RED ROT OF SUGARCANE.

- Red rot is a very serious disease of sugarcane.
- The surest symptom of the disease is the reddening of the internal internodal tissues with crossbars of white patches in the reddened area. This red colour is caused by a dye which is secreted by the host and is antagonistic to the red rot fungus.
- ***Symptoms*:** The affected canes exhibit leaf colour change, from green to orange and then to yellow in the third or fourth leaf. Then the leaves start drying from bottom to top.
- If the fungal spores enter the leaf sheath through the leaf midrib, then reddish spots can be seen on the back side of the leaf midrib also.
- The external symptoms appear only after16 - 21 days after infection and drying of entire cane takes another 10 days time.
- When the affected cane is split opened, the inner region is reddish in colour with intermittent white tinges across the cane length.
- Sometimes, the pith inside the cane is filled with blackish brown liquid and exhibited alchohol odour.
- ***Pathogen*:**
- Red rot disease is caused by the fungus *Glomerella tucumanensis*. An older name, *Colletotrichum falcatum*, is still preferred by some pathologists.

- Pathogen present on leaf sheaths and blades, solitary or aggregated, often forming short lines between vascular bundles, globose, immersed, dark brown to black 65-250 µm dia.; wall up to 8 cells thick, sclerotia on outside, pseudoparenchymatous within, ostiole slightly papillate, circular.
- ***Management strategies:***
- ***Cultural method:***
- The best way to control red rot is to select setts for planting from healthy plants in a disease- free area.
- The red rot affected field must be rotated with rice for one season and other crops for two seasons.
- ***Physical method***:
- Removal of the affected clumps at an early stage and soil drenching with Carbendazim 50 WP (1 gm in 1 litre of water)
- ***Chemical method:***
- Adopt sett treatment with Carbendazim before planting (Carbendazim 50 WP (0.5 gm in 1 litre of water) or Carbendazim 25 DS (1gm in 1 litre of water) along with 2.5 kg of Urea in 250 litre of water
- Use fungitoxic chemicals like Bavistan, Benomyl, Topsin and Aretan at 0.1 per cent for 18 min. at 52ºC for dipping setts which gave almost complete elimination of rot infection.

FUNGAL DISEASE -RED ROT OF SUGARCANE

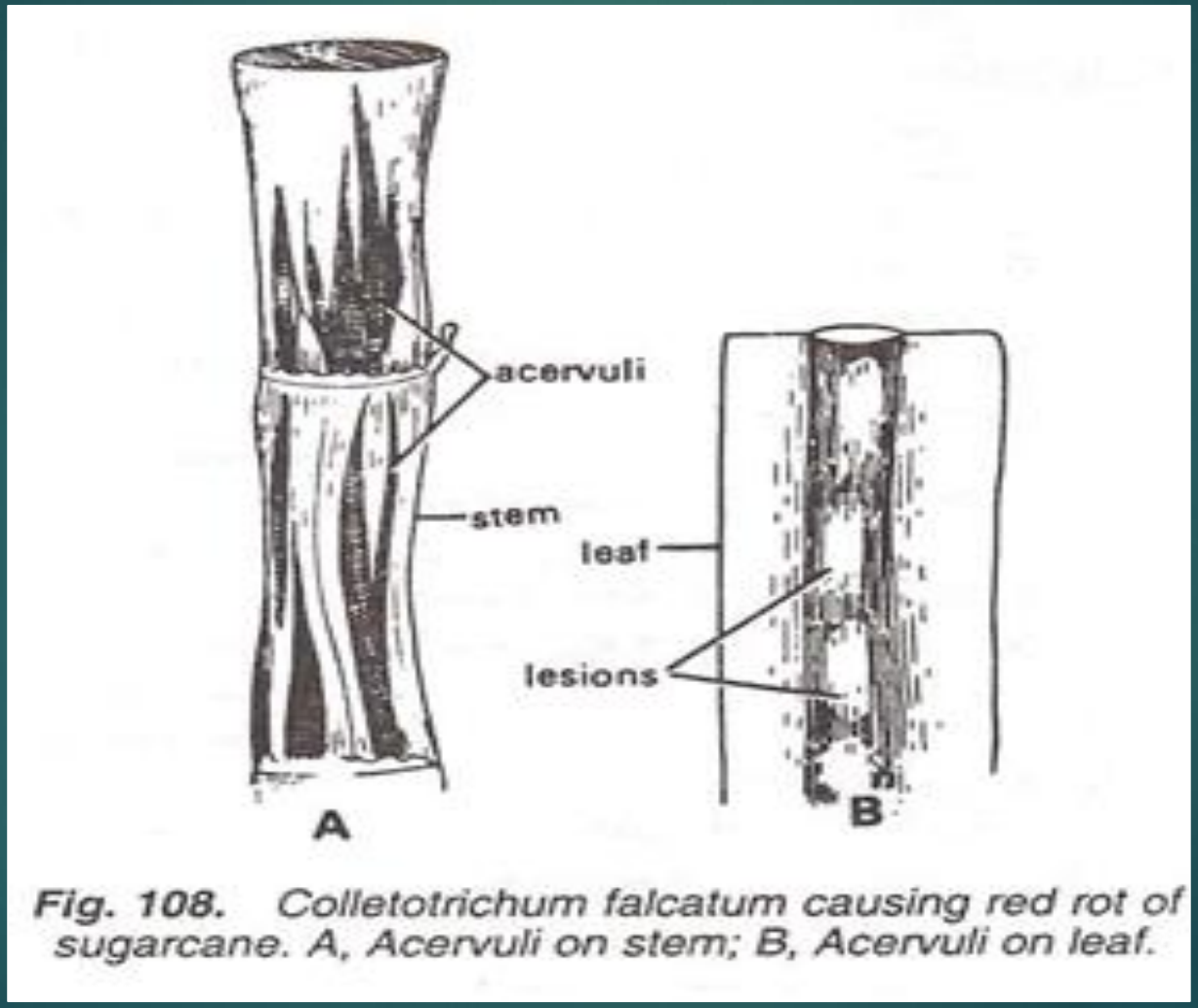


Fig. 108. Colletotrichum falcatum causing red rot of sugarcane. A, Acervuli on stem; B, Acervuli on leaf.

USNEA

- ***Kingdom:*** ***Fungi***
- ***Division:*** ***Ascomycota***
- ***Class:*** ***Lecanoromycetes***
- ***Order:*** ***Lecanorales***
- ***Family:*** ***Parmeliaceae***
- ***Genus:*** ***Usnea***

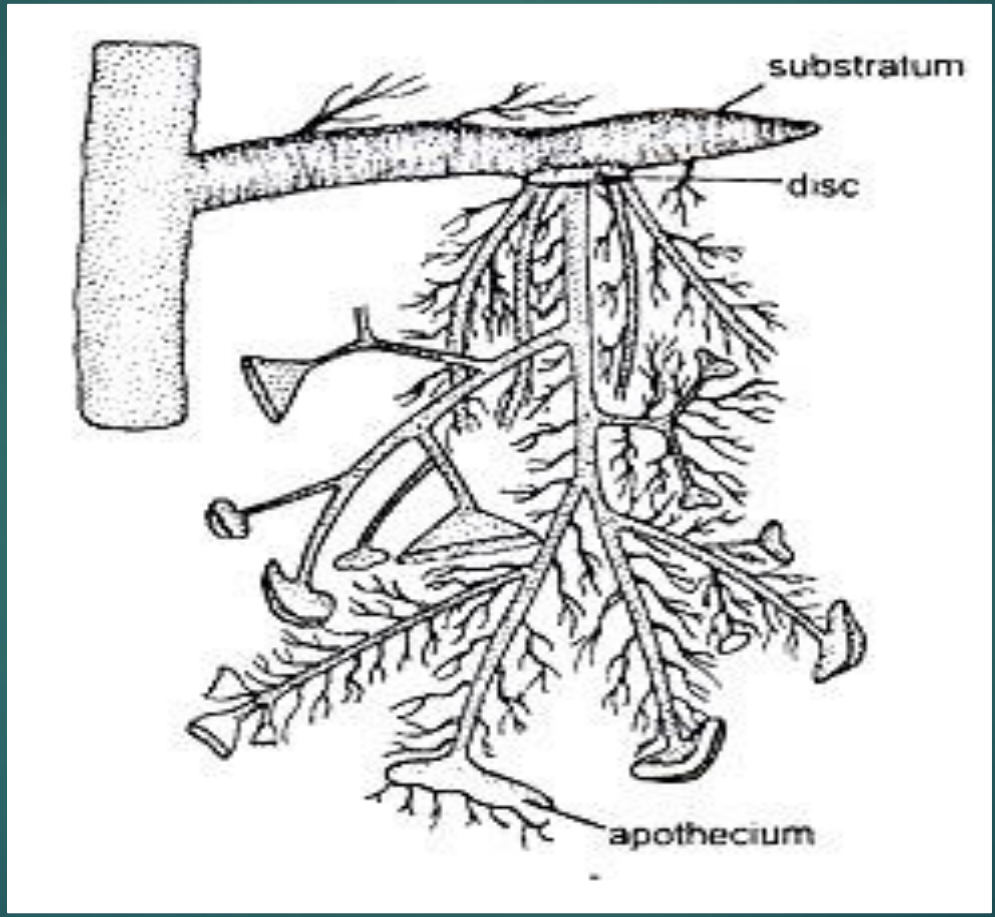
USNEA- THALLUS

- ***Usnea*** is a genus of mostly pale grayish-green fruticose lichens that grow like leafless mini-shrubs or tassels anchored on bark or twigs.
- Members of the genus are commonly called **old man's beard**, or **beard lichen**.
- Like other lichens it is a symbiosis of a fungus and an alga. In *Usnea*, the fungus belongs to the division Ascomycota, while the alga is a member of the division Chlorophyta. A cross section of the thallus reveals a central medullary tissue consisting of loosely arranged hyphae with many interspaces between. It is surrounded by an algal layer with a thin cortex external to it. The phycobiont is a green alga, Protococcus.

- Usnea is an cylindrical to ribbon-like, much branched thallus. It grows erect or pendant attached by a holdfast at the base only to the substratum (branches of trees). The thallus is usually grey-green and consists of a single main stalk or many.
- The stalks arise from the base and fork repeatedly. The main stalks and the branches are covered with conspicuous, branchlet-like bristles or fibrils.
- The thallus reproduces vegetatively by fragmentation. Some species (U. comosa) bear cigar- shaped soredia in whitish soralia.
- The apothecia are large, plate-like and terminal in position. The apothecium has a thalline margin fringed with bristle-like outgrowths which may be simple or branched.

- The growth rate of lichens in nature is slow

USNEA- A FRUTICOSE LICHENS



APOTHECIUM

Apothecium is a cup-shaped body.

In the cavity of the cup are present many asci and sterile paraphyses.

In each ascus are present generally eight uninucleate ascospores.

Other structures of the internal organization are same as that of vegetative thallus.

The apothecia are scattered on the upper surface of the thallus lobes.

They are large, round and have a thalline margin

The asci are usually 8-spored. The ascospores are typically simple and colourless.

V.S. APOTHECIUM

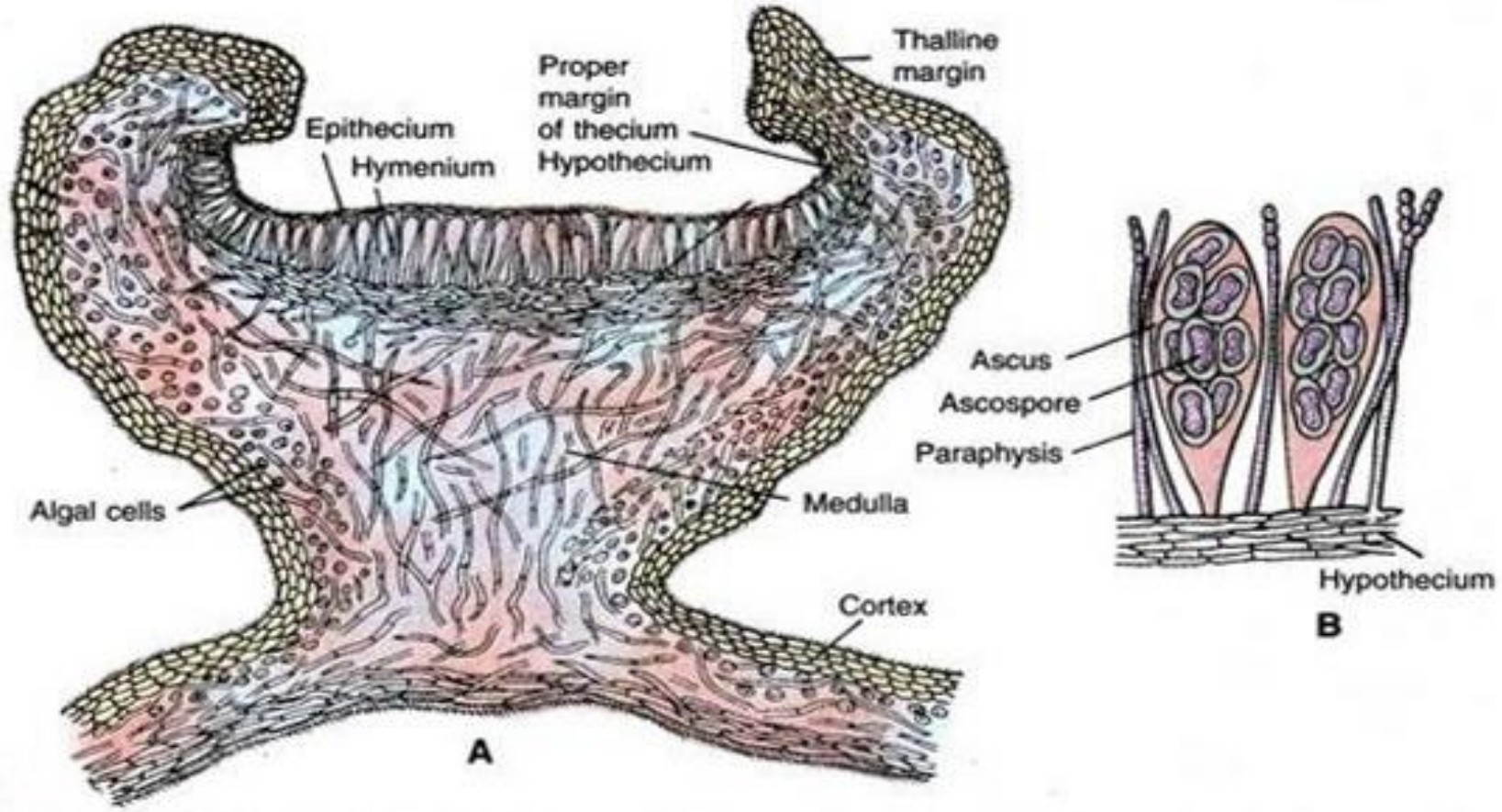


Fig. 20.10 (A-B). *Lichens*. A, V. S. Apothecium showing structure; B, A portion of hymenium (highly magnified).