PERIYAR INSTITUTE OF DISTANCE EDUCATION (PRIDE)

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B.Sc. BOTANY

FIRST YEAR

PRACTICAL – I : MAJOR PRACTICAL I

Prepared by :
A. PADMANABAN
Lecturer (SG) in Botany
Govt. Arts College
Dharmapuri – 636 705

B.Sc. BOTANY

PRACTICAL – I : (MAJOR PRACTICAL – I)

NOSTOC

SYSTEMATIC POSITION

Class : Cyanophyceae

Order : Nostocales

Family : Nostocaceae

Genus : ***Nostoc***

Occurance (Collection of the material Nostoc)

- Occurs as attached irregular balls on moistened walls with continuous supply of water as drops.
- Collected from water pools, paddy fields, waterlogged soil, moist rocks, and stagnant water.
- Found attached on the fallen leaves during the early days of rainy season.
- Some occur in the thallus of the Bryophyte-*Anthoceros*.

Laboratory exercise:

- Stain the material with methylene blue.
- For study of cell structure stain with Iodine (or) aniline blue.
- Study with the help of microscope.

Observations:

Plant body or thallus or colony

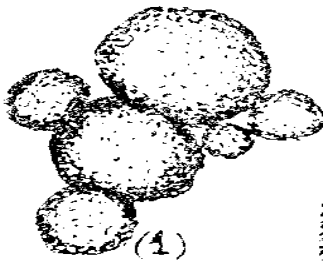


Fig. Mucilagenous balls as seen in natural habitats

1. Algae (*Nostoc*) occurs as colonies.
2. Colonies are embedded in mucilage.
3. Inside the colony, trichomes of algae are noticed (trichome + mucilage sheaths = filament).

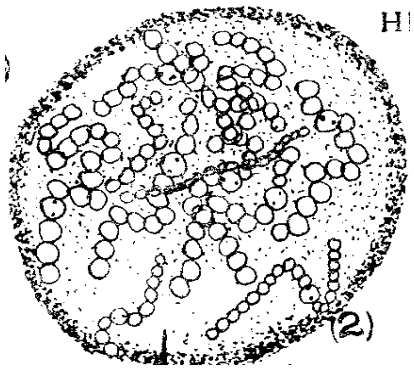


Fig. Details of thallus as seen under low power of microscope.

4. Trichomes are intertwined inside the colony.

Trichome structure:

1. Trichomes are unbranched and are composed of series of cells united end to end.
2. Trichome is individually surrounded by mucilage to form a filament. Filaments are curved and entangled.
3. Filaments are usually short.
4. The cells which constitute the trichome may be spherical or barrel shaped or cylindrical.

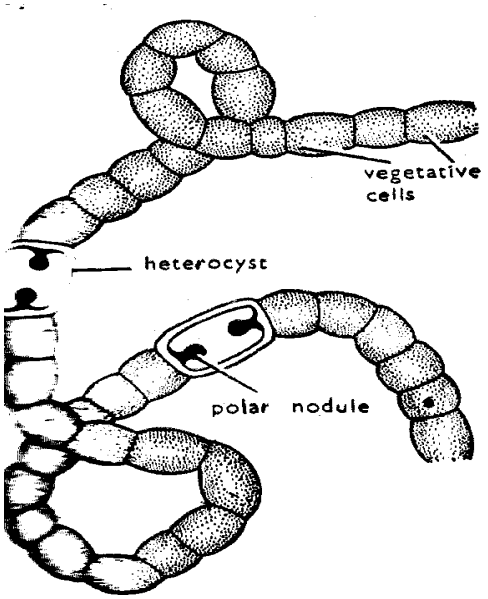


Fig. Single enlarged trichome of *Nostoc* species.

5. Each cell is almost spherical in shape and consists of a firm cell wall made of cellulose and pectic substances.
6. Cell wall encloses cytoplasm.

7. Chromatophores, granules and incipient nucleus are noticed in the cytoplasm. Cyanophycean granules occur as shining bodies.
8. Each trichome has one or two hetrocysts.
9. Heterocysts are intercalary, double walled and pale-yellow in colour.
10. Heterocyst is spherical, hyaline and slightly bigger in size than other vegetative cells.
11. Each hetrocysts posses two shining polar nodules.
12. In a matured colony, double walled akinites are noticed singly or in chains between the heterocysts.
13. Akinetes are thick walled, rich in food reserves and cyanophycean granules. Sometimes they are ornamented.

Identification of *Nostoc*- Reason:

1. True nucleus is absent, hence Cyanophyceae
2. Thallus with trichomes, unbranched, uniseriate and approximately of same diameter throughout.
3. Trichomes not differentiated into base and apex.
4. Trichomes much twisted into a mass of definite form, with a firm colonial envelope.
5. Hetrocysts intercalary mostly single.

CHLAMYDOMONAS

SYSTEMATIC POSITION:

Class	:	Chlorophyceae
Order	:	Volvocales
Sub-order	:	Chlamydomonadineae
Family	:	Chlamydomonadaceae
Genus	:	***Chlamydomonas***

Occurrence or collection of the material:

- *Chlamydomonas* widely distributed in stagnant water ponds suspended or forming a green scum over the surface.
- Occur more commonly during late rainy season.

Laboratory Exercise:

- Green water from any pond is put on a slide.
- Stain with iodine stain and observe under microscope.

Observations:

Structure:

1. *Chlamydomonas* thallus is a unicellular, spherical or oval, motile green alga.
2. Its anterior end is pointed and shows a very small papillate projection.
3. Two threads like structures, called flagella, arise from the pointed end.
4. Each flagellum arises from a basal granule.
5. Flagellum is thick at the base and tapers towards apex.
6. The cell wall is firm, clear and narrow at its anterior end and broad at the posterior end.

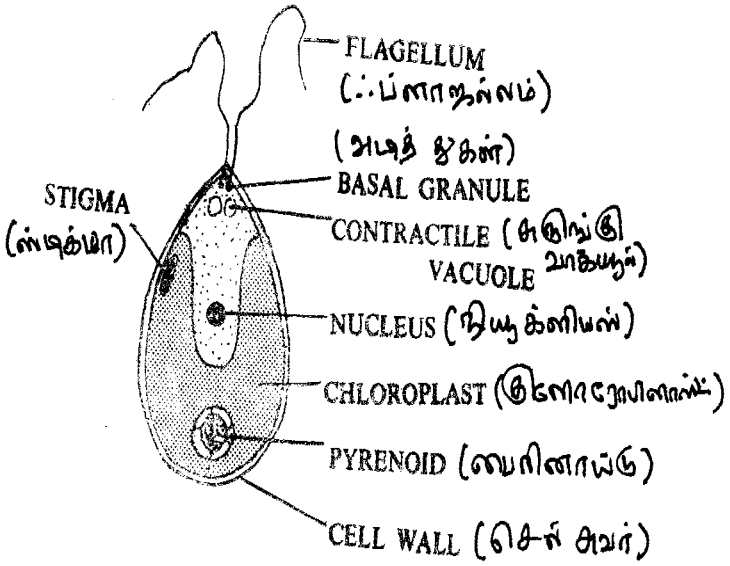


Fig. Detailed structure of *Chlamydomonas* species

7. Cell wall encloses protoplasm which is devisable into outer clear region bearing basal granule and two contractile vacuoles. Inner cytoplasm bears a stigma or eye s pot, centrally located nucleus and a cup shaped chloroplast.
8. A large characteristic pyrenoid is present in the chloroplast.
9. Volutine granule and outer cell inclusions are present in the cell.

Reproductive structure:

Palmella stage(Spotter):

1. Palmella stage is the result of asexual reproduction.

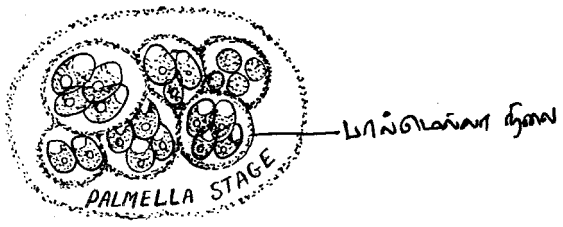


Fig. *Chlamydomonas* : plant showing palmella stage

2. Protoplasm divides to form four daughter bits. The daughter cells remains embedded within gelatinous material to form a colonial structure. This stage is called palmella stage. The cells are non-motile.
3. This stage is a resting stage.

4. Each cell of the group retains the structure of a *Chlamydomonas* cell except the flagella.
5. This stage resembles another alga-*Palmella* of the Order Tetrasporales. Hence, called “Palmella” stage.

Identification of *Chlamydomonas*- Reasons:

1. Due to the presence of simple chlorophyllous thallus and cellulose cell wall- it belongs to Algae.
2. Unicellular oval thallus with cup shaped chloroplast with pyrenoid and the two anteriorly placed equal lengthed flagella, along with Palmella stage, shows it is *chlamydomonas*.

CLADOPHORA

SYSTEMATIC POSITION:

Class : Chlorophyceae

Order : Cladophorales

Family : Cladophoraceae

Genus : ***Cladophora***

Occurrence or collection of the material:

- Found attached commonly on shell of snails and on stem of hydrophytic plants as epiphytes during rainy and winter seasons.

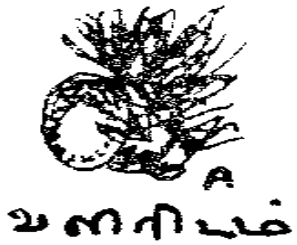


Fig. A. *Cladophora* plant habitat

- Found in fresh, brackish, salt and marine waters, grows attached to stones, shells of snails and rocks.

Laboratory Exercise:

- Stains the material with iodine.

Observations:

Structure of the plant body or thallus:

Fig. Habit of plant

1. The alga is attached by means of branched septate rhizoids.

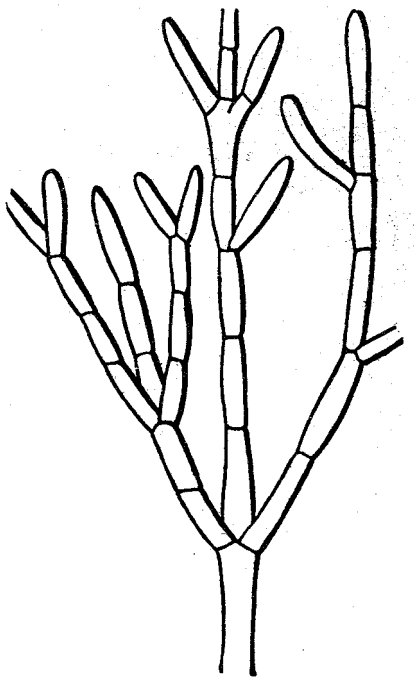


Fig. Enlarged filament with mode of branching

2. Thallus is multicellular, filamentous and branched.
3. Branches arise as outgrowths from the upper end of the cell below the septum and appear as dichotomous.

Cell structure:

1. Each cell is 5 to 20 times longer than its breadth.
2. Cell wall is thick and composed of three layers- inner cellulose, middle pectic and outer chitinous.
3. Cell is coenocytic, central region occupied by a large vacuole surrounded by cytoplasmic lining towards periphery. An elongated parietal reticulate chloroplast with many pyrenoids is present.

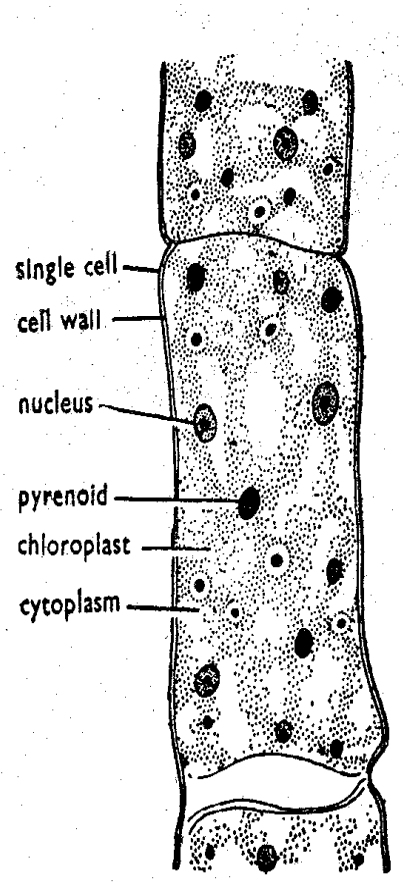


Fig. Enlarged cell of *Cladophora*

Identification of *Cladophora*- Reasons:

- Presence of chlorophyll, filamentous thallus, cellulose cell wall and hence an algae.
- Chlorophyll is definite plastids, presence of pyrenoids, definite nucleus, and starch as reserve food- so it belongs to Chlorophyceae.
- Branched filaments (dichotomous), cylindrical cells more in length, many nuclei, parietal reticulate chloroplast, three layered cell wall, absence of akinetes shows it is *Cladophora*.

ULVA

SYSTEMATIC POSITION:

Class	:	Chlorophyceae
Order	:	Ulotrichales
Family	:	Ulvaceae
Genus	:	*Ulva*

Occurrence or collection of the material:

- Mostly marine distributed in littoral zones.

Laboratory Exercise:

- Studying the external morphology of thallus
- T.S. of thallus and staining it to see the internal structure
- T.S. of rhizoid and studying it under microscope

Observations:

Thallus -external Structure:

1. Thallus is macroscopic consisting of upper expanded sheath of parenchymatous cells and the basal narrowed, short stalked attaching disc. Thallus is thin, flat and lobed.

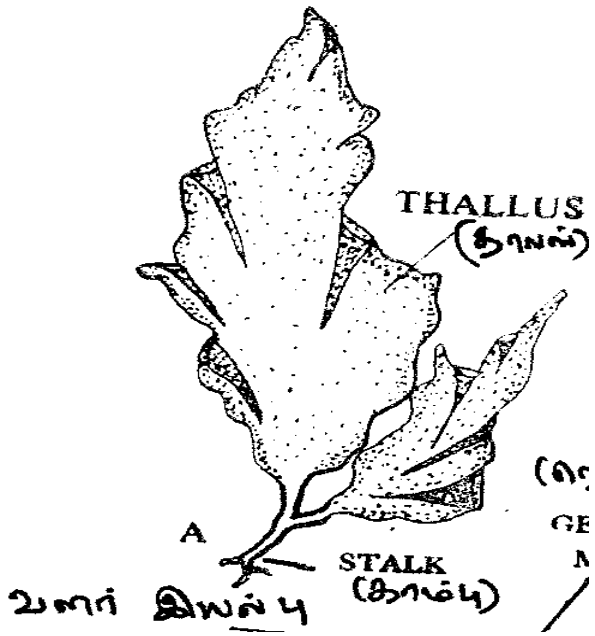


Fig. Habit of *Ulva* species

2. The disc is made up of numerous multicellular rhizoids produced from the lower cells of the thallus.
3. The expanded sheet of thallus is composed of two vertical rows of isodiametric cells.

Cell structure:

1. The lower cells of the thallus produce single multinucleate rhizoids.
2. The pectic substances of outer cell wall forms tough gelatinous matrix.
3. Each cell is isodiametric or elongated.
4. Each cell has a single parietal cup shaped chloroplast with a single pyrenoid.
5. Nucleus lies in the centre surrounded by cytoplasm.

Internal structure:

L.S. of Thallus:

1. Thallus is made up of two vertical rows of cells.

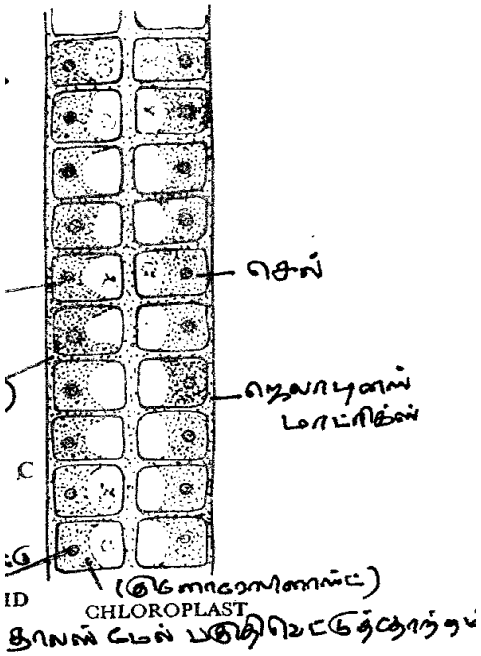


Fig. A portion of section from upper region.

2. Cells are surrounded by gelatinous matrix.
3. In the basal region of thallus, the cells give out long and colourless rhizoidal outgrowths which run downwards between the two rows of cells.

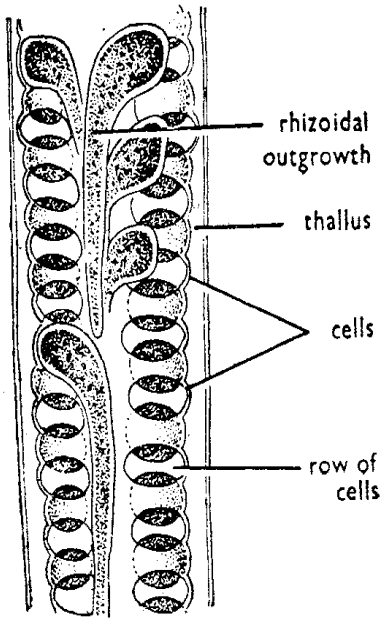


Fig. A portion of thallus through basal region showing rhizoidal cell.

Identification of *Ulva*- Reasons:

- Presence of chlorophyll, simple construction of thallus, cellulose cell wall says it is an alga.
- Chlorophyll in definite plastid, presence of pyrenoids, definite nucleus and starch as reserve food represents it is a member of Chlorophyceae.
- Expanded parenchymatous thallus, thallus consisting of two rows of cells, uninucleate cells, rhizoidal outgrowths grouped to form a disc shows it is *Ulva*.

CHARA

SYSTEMATIC POSITION:

Class : Chlorophyceae

Order : Charales

Family : Characeae

Genus : ***Chara***

Occurrence or collection of the material:

- Abundant in clear, fresh, hard, still and shallow water attached submerged on the muddy or sandy bottoms of pools, ponds and slow flowing regions.
- *Chara baltica* is found in marine water.
- *Chara zeylanica* is common Indian species.

Laboratory Exercise:

- Aniline blue or iodine can be used as a stain.

Observations:

Plant body- Thallus morophological Structure:

1. Thallus is macroscopic, much branched and consists of long, slender and erect main axis upto 20 to 30 cms in length.

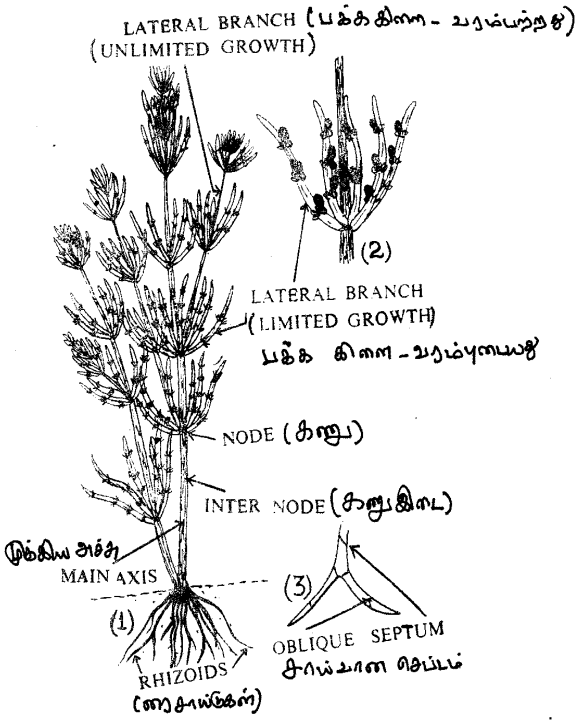


Fig *Chara zeylanica*

1 Entire plant;

2. A portion of the same showing portion of reproductive bodies;
3. A part of rhizoid.
4. Main axis is distinguishable into a series of nodes and internodes.
5. From the nodes, branches of limited and unlimited growth arise.
6. Branches of limited growth arise in form of whorl on node and from their axis branches of unlimited growth (only one or two from each node) arise.
7. A whorl of stipules or appendages like structures arises from the node of branches of limited growth and is known as stipular outgrowths or laterals.
8. The thallus is attached by means of multicellular branched rhizoids which arise from the lower node of the main axis.
9. Rhizoids possess oblique septa. Rhizoids are not differentiated into nodes and internodes.
10. Long internode is composed of a single cell, enveloped by many corticated threads.
11. Nodes are small and multicellular.

Cell structure:

1. Cell wall is thick and firm and made up of cellulose with superficial gelatinous layers and some deposits of calcium carbonate.
2. Cell possess numerous, discoid chloroplasts, devoid of pyrenoids.
3. Chloroplasts are scattered throughout the length of the cell, in the peripheral layer of the cytoplasm.
4. The cell contains a single large central vacuole with granular cytoplasm on peripheral region.
5. The cytoplasm of a rhizoidal cell has a nucleus, situated towards the upper side of the cell.

T.S. of node (spotter only):

1. The centre portion consists of two cells.
2. Two cells at the centre are covered by two to three celled thick cortical layers.

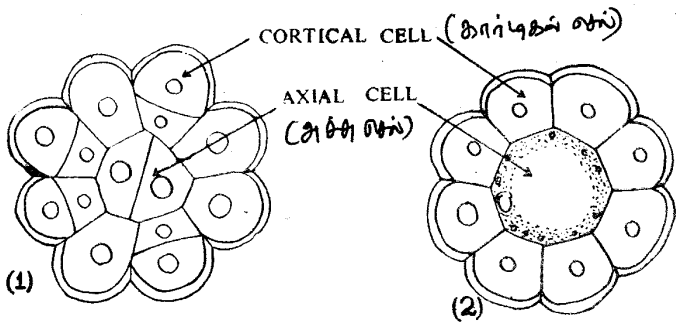


Fig. C. S. of main axis. 1- through node
2- through internode.

T.S. of inter node (spotter only):

1. Centre is occupied by a large central cell or internodal cell.
2. Internodal cell is surrounded on all sides by many cortical cells.

Reproductive structure:

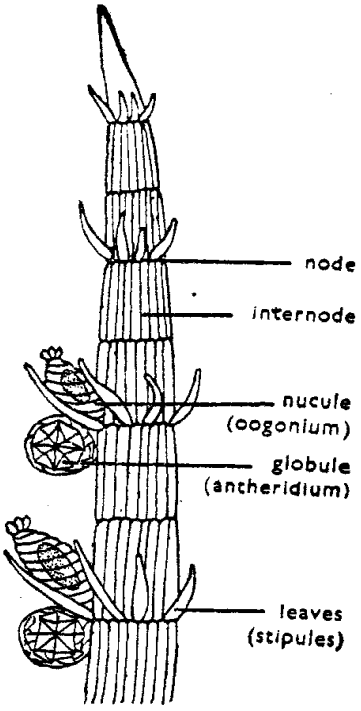


Fig. Apical portion of a branch of limited growth showing position of reproductive bodies.

Male reproductive structure (Globule):

1. Noticed in the nodal regions of the lateral branch of limited growth.
2. Produced towards the adaxial side of the main axis.
3. Globule is spherical in shape, usually red or bright yellow in colour.
4. Noticed below the nucule (oogonium).
5. Globule is attached to the node by a long stalk cell.

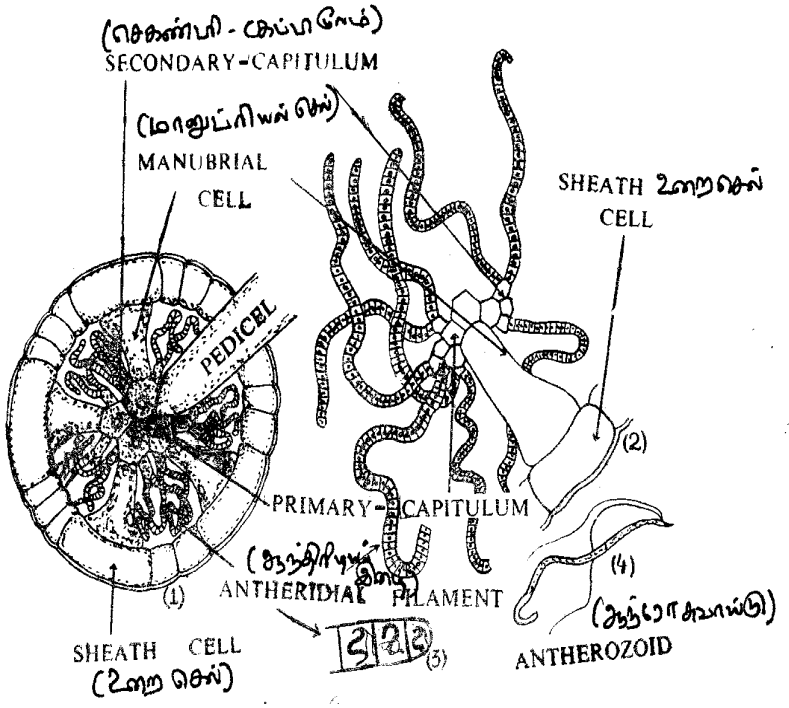


Fig. Details of male reproductive organ:

1. a sectional view of globule showing arrangement of different parts
2. a part of globule with a single manubrium, capitulam and antheridial filaments
3. an apical part of antheridial filament showing antherozoid
4. a single antherozoid.
5. The wall of the globule (anthredium) is composed of single layer of eight, curved plate like shield cells or sheath cells.
6. Shield cell is ornamented.
7. Shield cells are filled with red or yellow pigment.
8. From the centre of shield cells arise rod shaped manubrial cell projecting towards the centre of the antheridial cavity.
9. The tip of manubrium bears two rows of six cells each.

10. The row of cells which are in direct contact with manubrial tip is called primary capitulum while the next row is secondary capitulum.
11. Secondary capitulum produces 2 to 4 long unbranched antheridial filaments.
12. Each antheridial filament is multicellular and it is of nearly 100-200 small cells.
13. Each small cell produces single biflagellate antherozoid.

Female reproductive structure (Nucule):

1. Nucule is noticed in the nodal region of the lateral branch of limited growth.

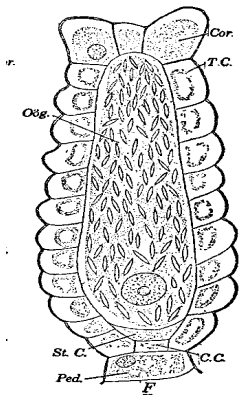


Fig. 16. Details of female reproductive organ, cor-corona; c.c., central cell; oog., oogonium; ped., -pedicel; st.c., stalk cell; T.C. tube cell .

2. Nucule is produced towards the adaxial side of the main axis.
3. Nucule is oval in shape and situated above the globule.
4. At the apex of the nucule is a crown of cells called corona.
5. Oogonium (nucule) is enveloped by clock wisely spirally soiled tube cells.
6. Tube cells are bright green in colour.
7. Oospore is single celled where a single nucleus is present surrounded by cytoplasm.
8. Nucule is situated towards the upper direction of node and is protected by stipular outgrowths.

Sex organs (Spotter only):

1. The reproductive bodies (nucule and globule) arise on the node of lateral branches of limited growth towards adaxial surface.
2. Nucule is situated above the globule.

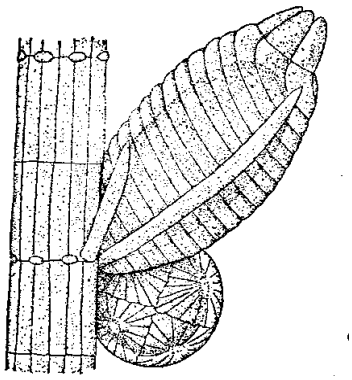


Fig. A portion of a leaf bearing a mature nucule and globule, showing cortical cells derived from upper and lower nodes.

3. Nucule is female reproductive body which consists of single ovum, 5 tube cells and 5 coronal cells.
4. The tube cells twist clockwise around the ovum.
5. Globule is male reproductive body which consists of shield cells, manubrial cells, primary and secondary cpaitula.
6. Secondary capitula of the manubrium bear unbranched multicellular antheridial filaments.
7. Each cell of the antheridial filament produces single biflagellate antherozoid.
8. Nucule is attached on the node by a single stalk cell and globule by single pedicel cell.

Identification of *Chara*- Reasons:

- Thallus nature, presence of cellulose cell wall, green colour chromatophore shows it belongs of Chlorophyceae.
- The differentiation of thallus into nodes and internodes and presence of limited and unlimited growth branches, and sex organ- nucule and globule which can be seen by naked eyes and characteristic features of Charales.
- Nucule lying above the globule, corona of nucule five celled are confirmation of *Chara*.

CAULERPA

SYSTEMATIC POSITION:

Class : Cholorophyceae

Order : Siphonales

Family : Caulerpaceae

Genus : ***Caulerpa***

Occurrence or collection of the material:

- Marine in habitat.
- Noticed in tropical (warm) seas.
- Collected from shallow or moderately quiet waters.
- Some species as epiphytes on roots of mangroves.
- Rhizome deeply rooted in the mud or sand.
- May be collected in winters.

Laboratory Exercise:

- Studying external morphology.
- T.S. of rhizome taken mounted with saffranin and studied under microscope.
- Assimilatory organ observed (Spotter only).

Observations:

Plant body – Thallus morphological Structure:

1. Thallus is one celled, coenocyte with elaborate morphological differentiation.
2. Thallus is differentiated into 3 parts
    a. Prostrate rhizome.
    b. Rhizoids for attachment
    c. Erect assimilatory shoots.
3. Rhizome is prostrate, cylindrical and very long.
4. Rhizome bears on the under side many branched rhizoids.
5. Rhizome bears on the upper side numerous erect assimilatory shoots.
6. Assimilatory shoots (assimilators) are produced by rhizome axes as lateral outgrowths.
7. Assimilators vary in their shape and arrangements.

    a. *C. verticillata* - Assimilators cylindrical arranged in whorls
    b. *C. selago* - Assimilators long and imbricate
    c. *C. hypnoides* - Assimilators like ‘moss’
    d. *C. taxifolia* - Assimilators leaf-like arranged in two rows.

e. *C. scalpelliformis* - Assimilators pinnately branched.

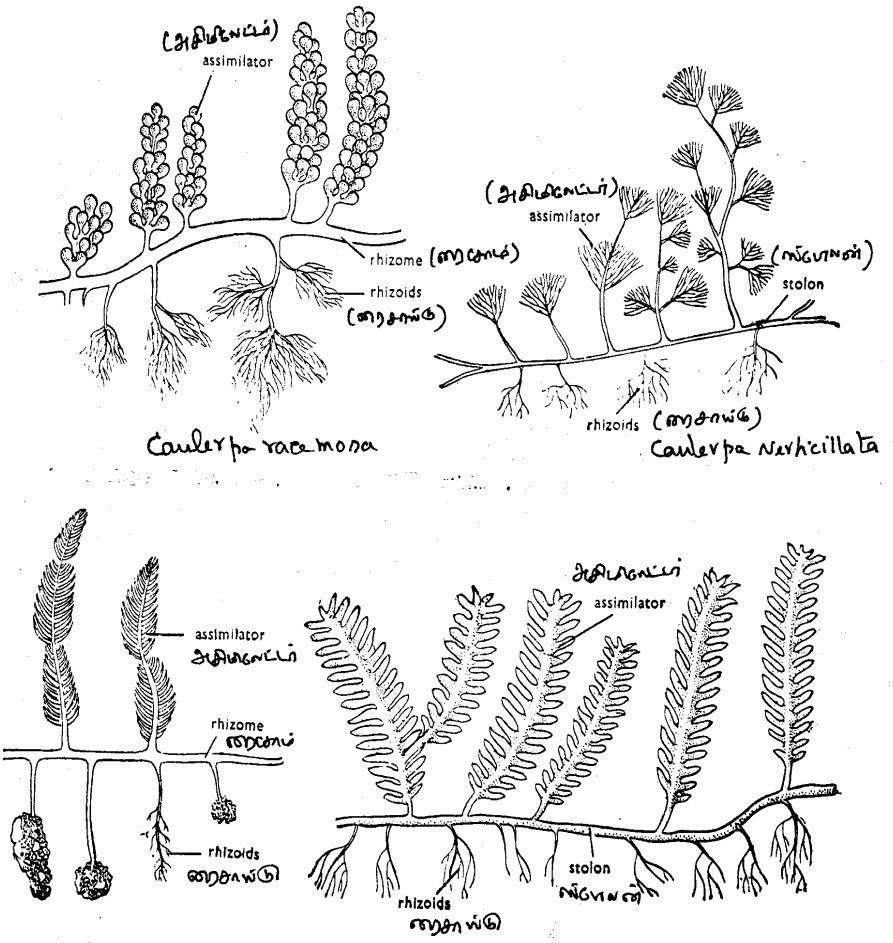


Fig. Habit of Caulerpa- from top clockwise *C. verticillata; C. scalpelliformis; C. taxifolia;* and *C. racemosa*

Internal structure:

T.S. of rhizome (for sectioning):

1. The outline of sections appears almost circular.
2. Outermost layer is thick and has a firm cell wall.
3. The limiting layer of the cell wall shows prominent stratification.

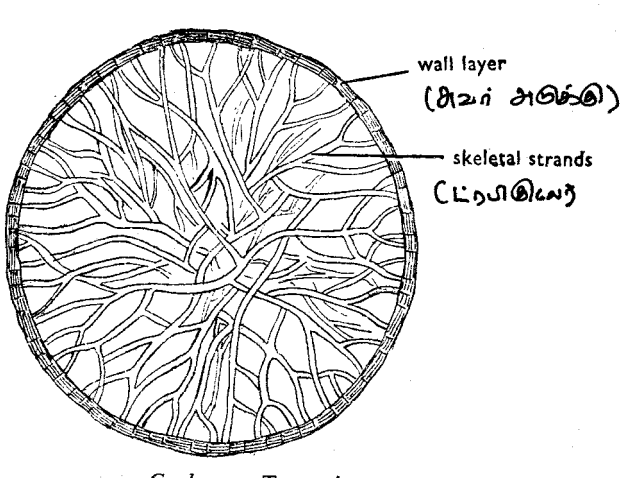


Fig. Section through the stolon of *Caulerpa*

4. Skeletal like strands called trabaeculae arise from the cell wall and run towards the central region.
5. Trabaeculae are cylindrical and their walls show longitudinal stratification.
6. Trabaeculae provide strength to the strands.
7. Besides skeletal strands, a few species show numerous peg-like internal projections.
8. Many chloroplasts distributed in the peripheral lining of cytoplasm.
9. Pyrenoids are absent.

Assimilators- structure:

1. Assimilators are elongated structures
2. These are reproductive bodies.

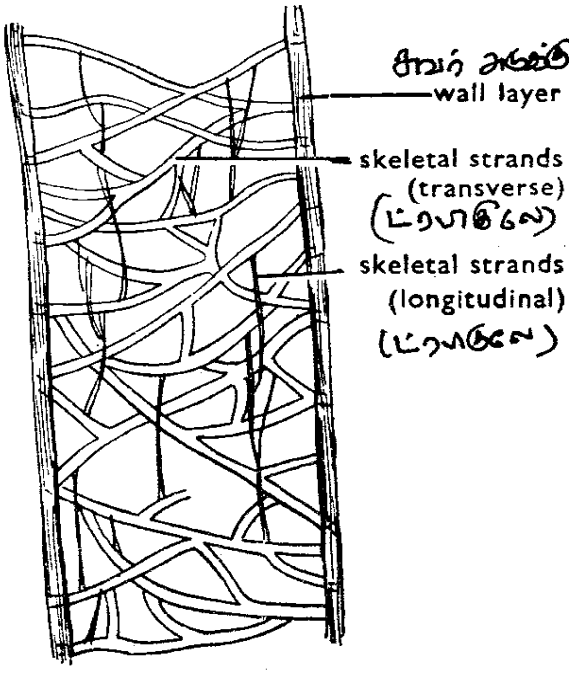


Fig. L.S through assimilators.

3. Elongated extrusion papillae are noticed on the assimilators.
4. Through extrusion papilla biflagellate gametes escape.

Identification of *Caulerpa*- Reasons:

- Presence of chromatophores shows it is a Chlorophyceae member
- Large coenocytic thallus, creeping rhizome, internal trabaeculae and extrusion papillae on assimilators are characteristics of *Caulerpa*.

SARGASSUM

SYSTEMATIC POSITION:

Class : Phaeophyceae

Order : Fucales

Family : Sargassaceae

Genus : ***Sargassum***

Occurrence or collection of the material:

- Marine form.
- Common species in India are

  S. tennerimum

  S. cinerum

Laboratory Exercise:

- Study of external morphology.
- T. S. of main axis.
- T.S. through air bladder.
- Study of internal structure of male and female conceptacle.

Observations:

Plant body or thallus Structure(external morphology):

1. Plant body (thallus) is thalloid and branched.
2. Thallus is attached to the substratum by a discoid holdfast.

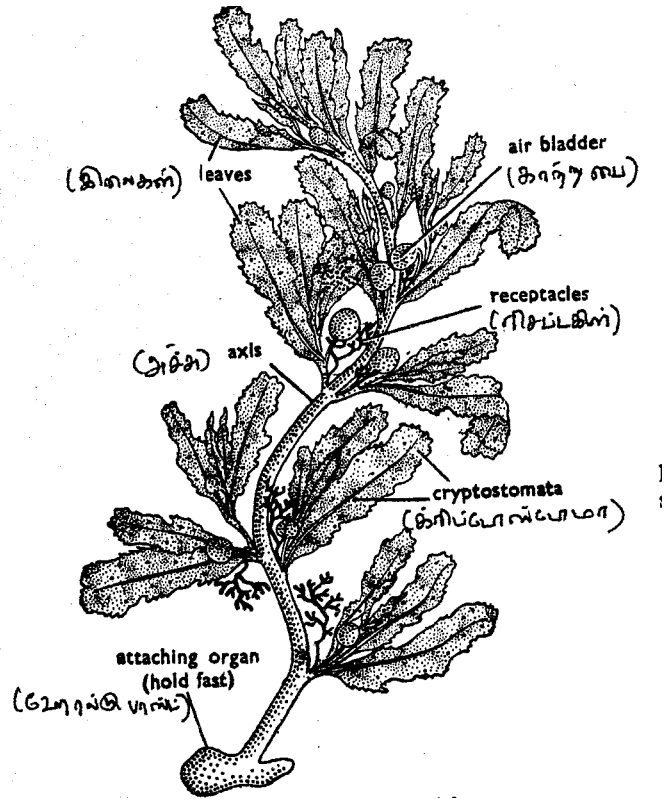


Fig. *Sargassum*, external features

3. Main axis arises from the hold fast.
4. Main axis may be short or long.
5. Main axis bears primary branches and secondary lateral branches.
6. Primary branches are radially symmetrical and spirally arranged.
7. The laterals arise from primary branches and are ‘leaf like’ and are in spiral fashion.
8. Leaves are narrow and their margins mostly serrate having a single midrib in the middle part of it.

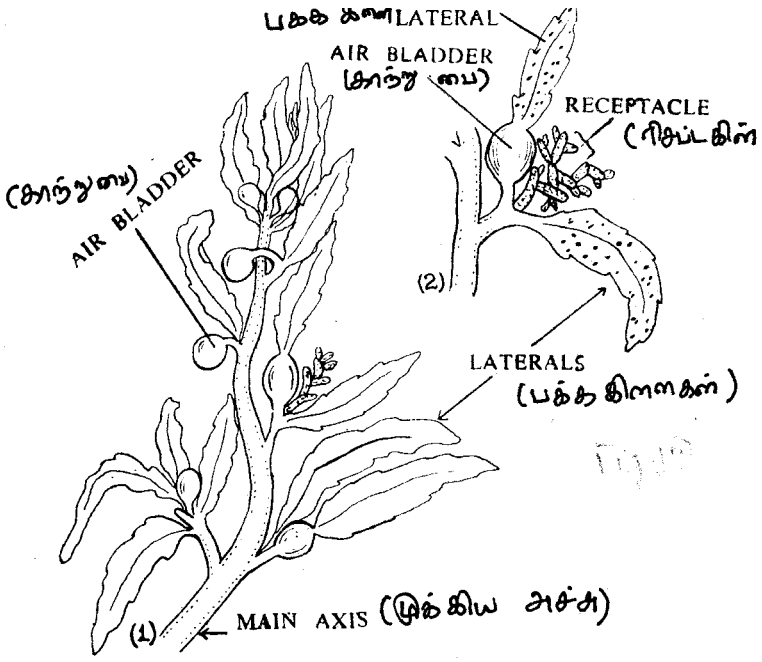


Fig. *Sargassum* a portion enlarged.

1. terminal portion of a branch
2. a part of the same showing details

9. Air bladders are spherical ball like structures and present on short stalk.
10. Sometimes lateral arise from the terminal part of the air bladder.
11. Leaves show minute pores on both the surfaces.
12. Pores are the ostioles or opening of conceptacle (sterile) or ‘cryptostomata’ or ‘cryptoblasts’.
13. In the axil of leaf-like laterals short, profusely branched reproductive organs called receptacle are noticed.

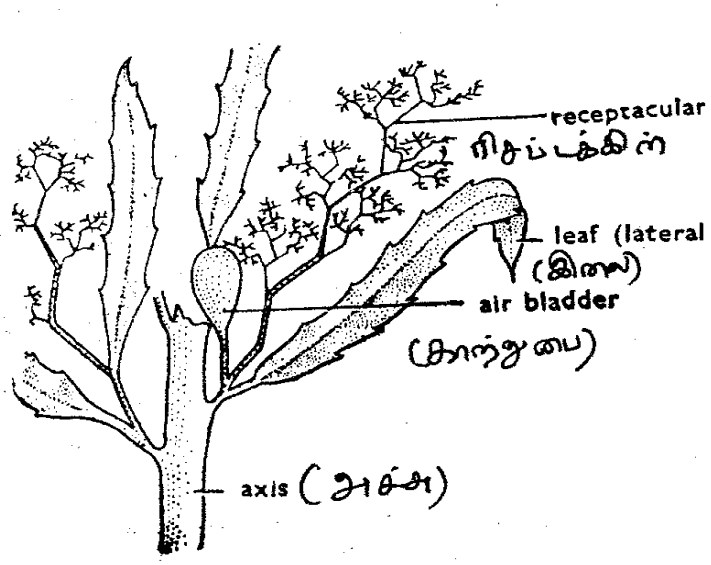


Fig. *Sargassum* external morphology with details

T.S of Main axis structure:

1. The outline is almost spherical in outline.
2. Axis is differentiated into three regions. Meristoderm, cortex and medulla.
3. The outermost layer is meristoderm.
4. Meristoderm is single celled layer consisting of small, compactly arranged columnar cells covered by mucilage.
5. Cells are rich in chromatophores and reserve food materials.

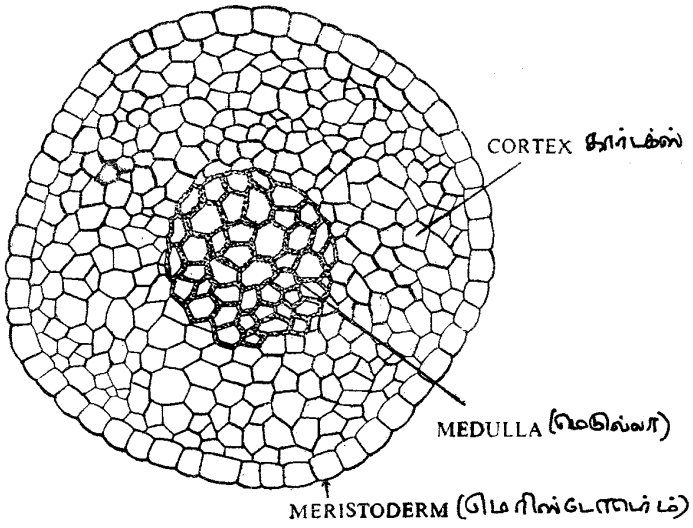


Fig. T.S. of main axis showing details

6. A several layered thick parenchymatous cortex is present below the meristoderm.
7. Cortical cells are narrow and elongated. The transverse septa of the cortical cells are perforated.
8. Cortical cells possess reserve food materials and act as storage regions.
9. The central region of the main axis is occupied by narrow, thick walled and loosely arranged cells and known as medulla.
10. Medulla acts as conducting part.

T.S. of Lateral (leaf) structure:

1. The tissue is differentiated into three regions namely meristoderm, cortex and medulla.
2. Meristoderm forms the outermost layer of the leaf.
3. Meristoderm is interrupted due to the presence of cup shaped sterile conceptacles or 'cryptoblasts'.

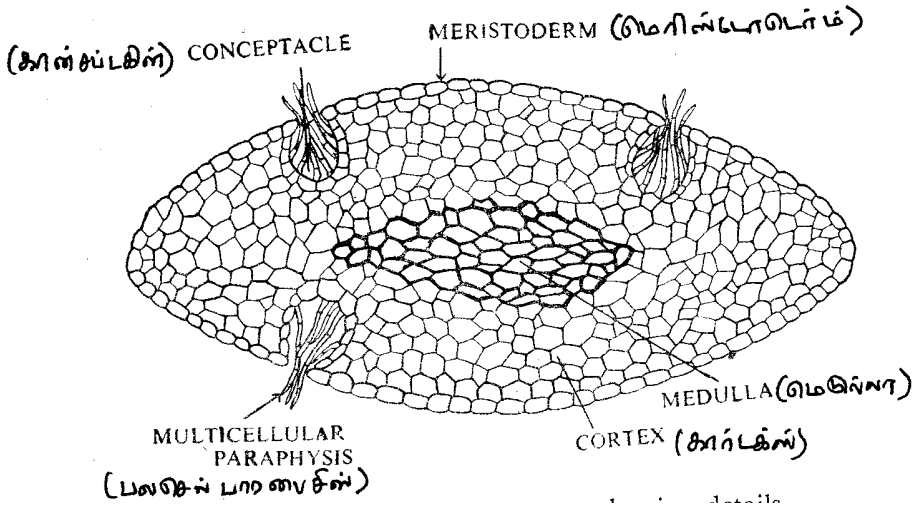


Fig. V.S. of lateral showing details

4. Multicellular hair-like paraphyses arise from the inner layer of conceptacle.
5. Cortex is several layered in thickness and is made up of parenchymatous cells.
6. The centre portion is made up of comparatively thin walled medulla. Cells are compactly arranged in the medulla region.
7. The leaf is more thick in the mid rib region than the wings.

Air Bladder –Cross section:

1. The outermost meristoderm consists of single layer of cells.
2. Meristoderm is followed by four or five layered thin walled parenchymatous cells.

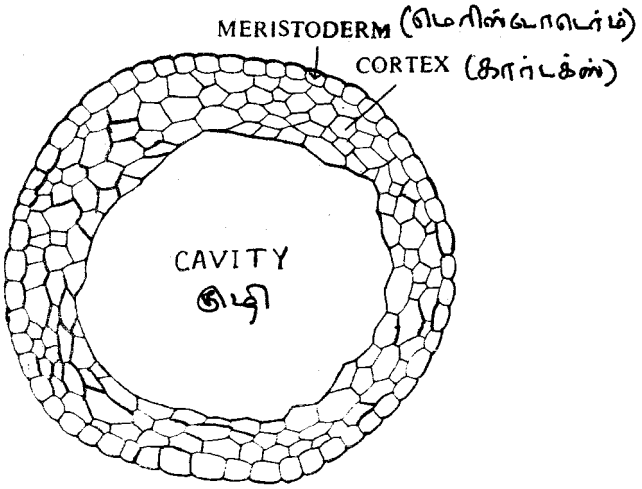


Fig. 26. C.S. of air bladder showing details.

3. The central region is a hollow cavity.
4. Hollow central cavity is filled with air and provides buoyancy to the plant.

Reproductive structure:

T.S. of Receptacle bearing antheridia (Male conceptacle):

1. Receptacles are lateral branch systems arise from the axil of ‘leaves’.
2. Receptacle may be spherical to flattened in shape.
3. Externally male receptacles appear smooth.

4. Male receptacles show many cavities called conceptacles. Besides conceptacles, receptacle consists of meristoderm, cortex and medulla.
5. Mature conceptacle has its own wall.
6. From the wall of the male conceptacle many hair like multicellular paraphyses arise.

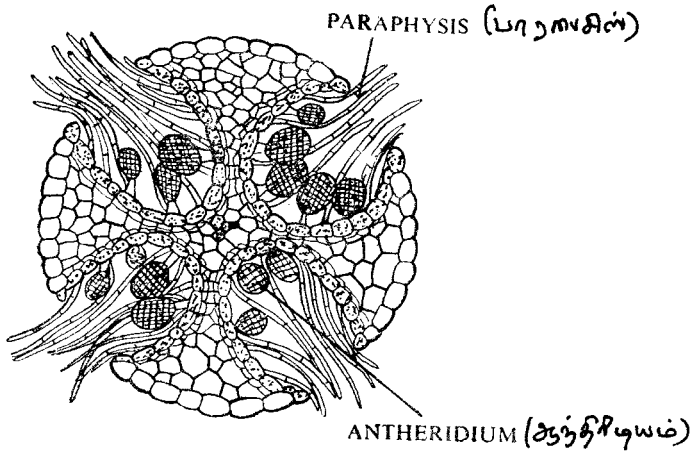


Fig. T.S. of receptacle showing antheridia bearing conceptacles.

7. Each conceptacle opens outside by a pore called ostiole. Near ostiole several colourless hairs arise and these hairs are called 'periphyses'.
8. Several multicellular antheridia are produced from the short terminal branches which arise from the cell wall.
9. The antheridia are ovoid in shape and the wall is two layered. Biflagellate antherozoids are produced from the antheridium.
10. The stalk of the antheridium may be branched to produce paraphyses.

T.S. of Receptacle bearing oogonia (Female conceptacle):

1. Female receptacle arises from the axile of leaf.
2. Receptacle may be spherical to flattened in shape.
3. Externally female receptacles are spinous.
4. Receptacle shows many cavities called conceptacles. Besides conceptacles, receptacles consist of meristoderm, cortex and medulla.
5. Mature conceptacle has its own wall and from its wall arises many multicellular hairs like outgrowths called paraphyses.
6. Each conceptacle opens outside by a pore called ostiole. Near ostiole, several colourless hairs arises called periphyses.

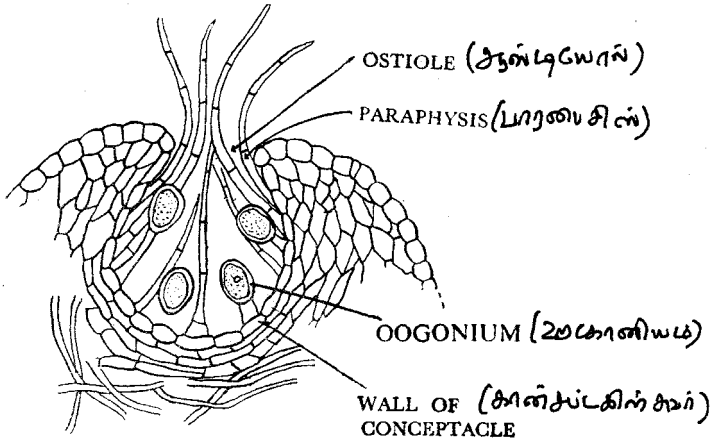


Fig. T.S. of receptacle showing oogonia.

7. Several single celled oogonia arise from unicellular stalk. The stalk is embedded in the wall of the conceptacle and oogonia appear sessile.
8. Oogonia are oval to sub-spherical in shape. Oogonial wall is three layered.
9. Each oogonia is uninucleate.

Identification of *Sargassum*- Reasons:

- Chromatophores yellowish brown hence Phaeophyceae.
- Plant parenchymatous with complex morphological and anatomical differentiation; and presence of receptacles, conceptacles, leaf like laterals with a distinct mid-rib are characteristics of *Sargassum*.

POLYSIPHONIA

SYSTEMATIC POSITION:

Class	:	Rhodophyceae
Sub-class	:	Florideae
Order	:	Ceramiales
Family	:	Rhodomelaceae
Sub-family	:	Polysiphonaceae
Genus	:	***Polysiphonia***

Occurrence or collection of the material:

- Marine. Some are epiphytes on other marine algae.
- *P. urceolata* is epiphytic on *Laminaria.*

Laboratory Exercise:

- Study of external features.
- Study of reproductive structures.

Observations:

External Structure:

1. Plant body is filamentous.
2. Plant body consists of two types of filaments namely prostrate (creeping) and erects filaments.

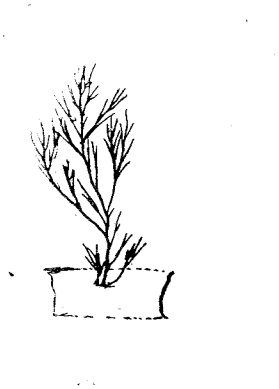


Fig. Habit of the plant.

3. Filaments are multicellular, branched and polysiphonous.
4. Thallus is made up of series of parallel filaments called ‘siphons’.

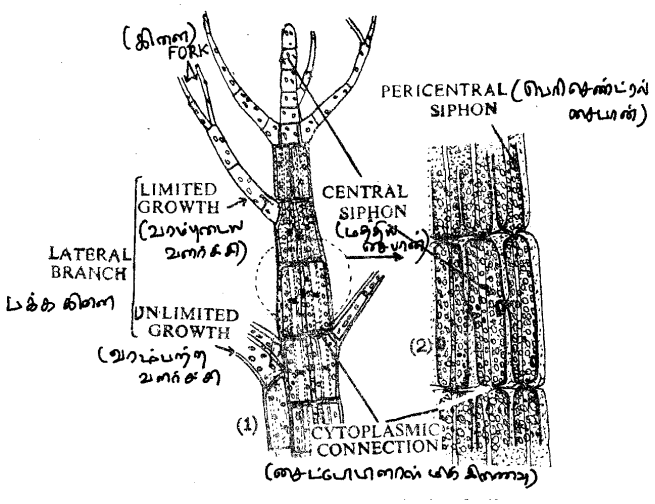


Fig. Enlarged portions of *Polysiphonia* thallus.

1. apical part of the thallus

2. details of cellular arrangement

5. Branching is dichotomous. Each branch terminates into a single celled apex followed by a number of flat cells.
6. The main axis consists of several filaments. Each one is called as siphon.
7. The central siphon is the largest and the main axis ends with it.
8. Except in terminal position, central siphon is surrounded by narrow pericentral siphons. The number of pericentral siphons varies from 4 to 24 in number.
9. Two types of branches arise from main axis.
    a. Branches of unlimited growth and
    b. Branches of limited growth.
10. Branch of unlimited growth always consists of more than one siphon.
11. Branch of limited growth consists of single siphon and is of small size. It ends with characteristic fork called trichoblast.
12. Antheridia are produced on trichoblast.
13. The cell wall is thick. Cell is uninucleate and has a large central vacuole. Chromatophores are small and generally without pyrenoids. Reserve food is in the form of starch grains- floridoside.
14. The neighboring cells are connected with one another by cytoplasmic lining known as pit connections.

Reproductive structure:

- Three different filaments based on reproductive nature:
    a. Male plants bearing antheridia.
    b. Female plants bearing procarp
    c. Tetrasporophyte bearing tetrasporangia
- Male, Female and tetrasporophyte plant all the three are morphologically similar.

Male plant of *Polysiphonia*:

1. The antheridia or spermatia are borne in clusters near the apex of main axis.

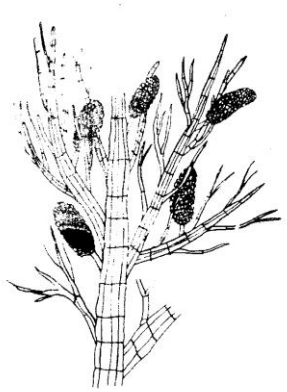


Fig. A male plant, an enlarged portion.

2. Antheridia are produced on short lateral called trichoblast.

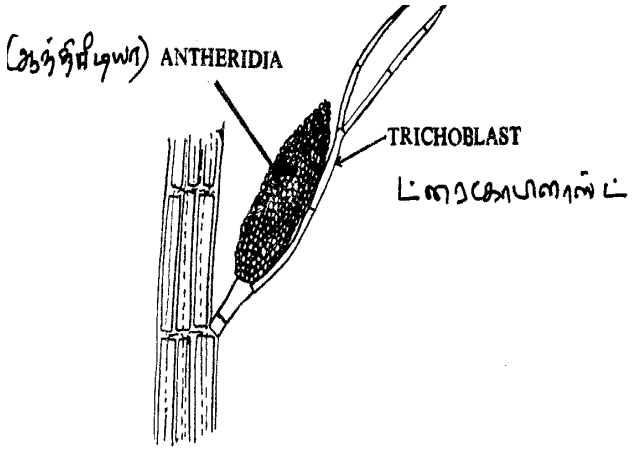


Fig. 32. a branch showing antheridium

3. The antheridia (spermatangia) are spherical or oblong and unicellular and appear like white or pale colour dots.
4. Each antheridium produces a single male cell called spermatium.

5. Each spermatium is small, oval- spherical uninucleate.

Female plant of *Polysiphonia*(Carposporophyte):

1. The filament bears fertilized produce cysocarp.
2. Cystocarp is a flask shaped structure produced on a short branch. The short branch is 3-4 cells in thickness and one cell in height.
3. Cystocarp opens to the exterior by an ostiole.

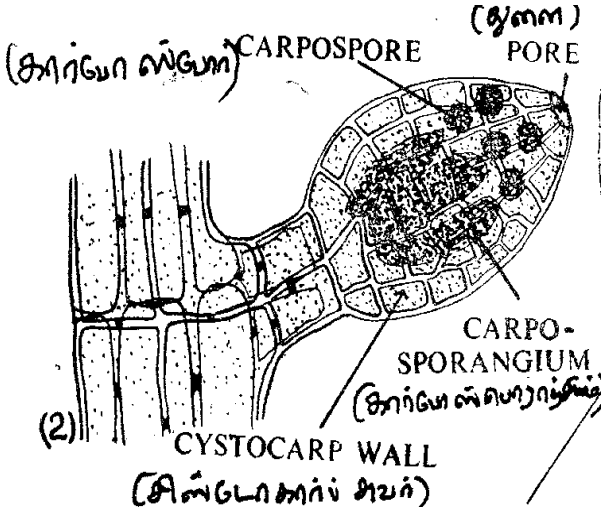


Fig. a portion of female plant showing cystocarp.

4. Wall of the cystocarp, (pericarp) is single layered.
5. Inside the cystocarp, 4-6 carpospores arise from the base of the cystocarp.
6. Carpospores are oval in shape, uninucleate and arranged in a single speherical layer.
7. The cystocarp is partly haploid (wall) and partly diploid sporophyte (Carposporangium and Carpospore). Hence the plant known as 'carposporophyte'.

Tetrasporophyte plant of *Polysiphonia*:

1. These are diploid and produce tetrasporongia.
2. Asexual reproductive bodies are called tetrasporangia.
3. Each cell of one specialized pericentral siphon of main axis produce single tetrasporangium.

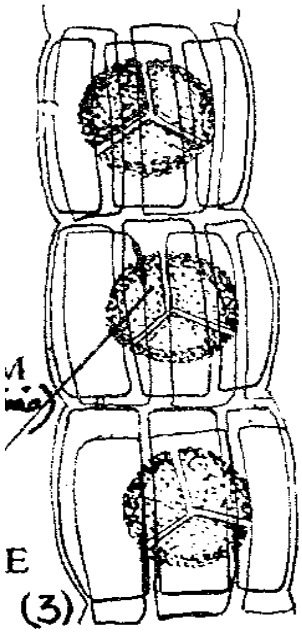


Fig. A portion of main axis of tetrasporophyte plant showing tetraspores with tetrasporangium

4. Tetrasporangia are borne in longitudinal series.
5. Each tetrasporangium is small and spherical body borne on short one celled stalk.
6. Each tetrasporangium produces 4 haploid tetrahedrally arranged uninucleate haploid tetraspores.
7. As the tetraspores are arranged tetrahedrally only 3 spores are visible from one side.

Identification of *Polysiphonia*- Reasons:

- Chromatophores pure red to dark-purple, post fertilization changes resulting into cystocarp and so is a Rhodophycean.
- Multiaxial construction of plant body, ultimate branches uncorticated, Tetrasporangia borne singly show the above plant is *Polysiphonia*.

ALBUGO

SYSTEMATIC POSITION:

Division : Mycota

Sub-division : Eumycotina

Class : Oomycetes

Order : Peronosporalus

Family : Albuginaceae

Genus : ***Albugo***

Occurrence or collection of the material:

- *Albugo* causes leaf spot disease (or) white rust on crucifers.
- *Albugo* is an obligate parasite on crucifers, sweet potato, spinach and some *Amaranthus* species. White rust is caused by *Albugo candida*.

Laboratory Exercise:

- The disease material is collected in winter from cruciferous crops.
- Materials preserved I n F.A.A. and chromacetic fluid.
- Stain used for study the fungal tissue is cotton blue (or) iron haematoxylin. Sections may also be stained with a combination of haematoxylin and orange G.

Observations:

Symptoms on the host leaf :

- Symptoms are noticed on the leaves of

  Cabbage (*Brassica oleracea* var. *capitata*)

  Cauliflower (*Brassica oleracea* var. *botrytis*)

  Mustard (*Brassica campestris*)

  Radish (*Raphanus sativus*)

  Amaranthaceae members

Symptoms on the host leaf :

1. The infected leaf of *Brassica campestris* (mustard) shows yellowish pustules of irregular shape and size.

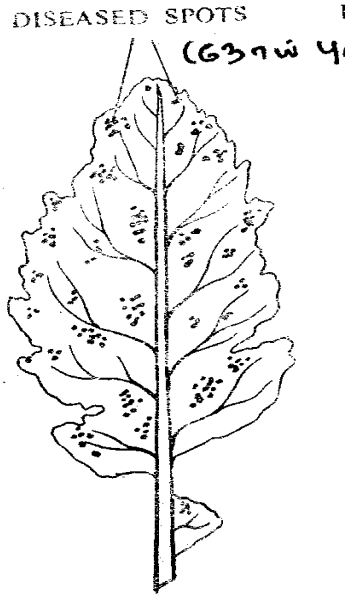


Fig. *Albugo candida* infected mustard leaf.

2. Several of such pustules join and form a patch.

T.S. of leaf showing mycelium :

1. The section of diseased leaf shows intercellular, branched coenocytic and multinucleate mycelium.
2. Mycelium bears knob–like intracellular haustoria.
3. The wall of mycelium is made up of fungus cellulose.
4. The cytoplasm is vacuolated and contains many small nuclei and food materials.

Reproductive structure:

Asexual :

Section of diseased leaf showing conidial stage :

1. The internal mycelium gives off many erect conidiophores.
2. The conidiophores are borne in close proximity to one another immediately below the host epidermis.
3. Each conidiophore is multinucleate elongated structure with swollen thin-walled distal end.

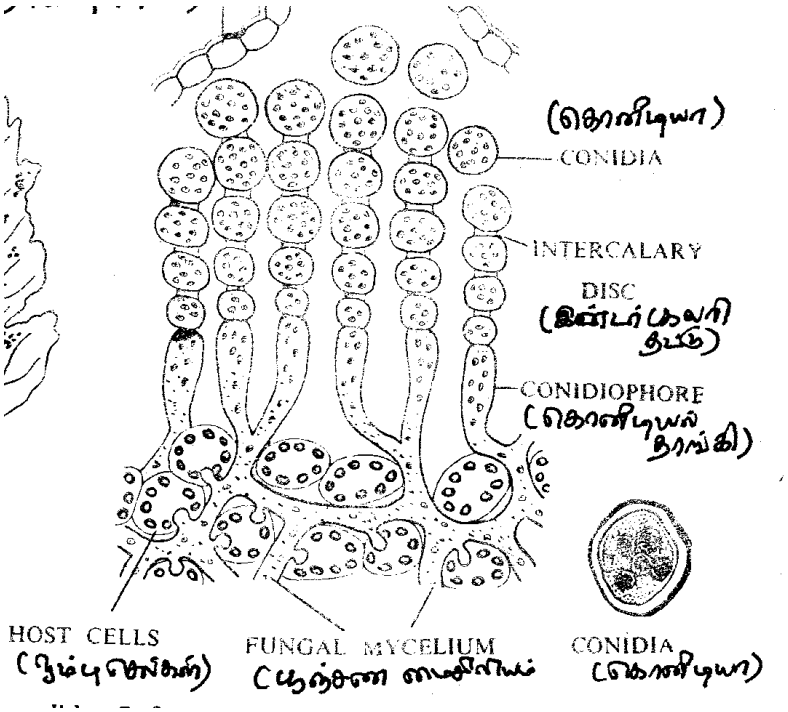


Fig. V. S. of infected mustard leaf through a pustule.

4. The lower part of conidiophore is thick walled.
5. The conidiophores produce chain of conidia at its distal end in basipetal fashion.
6. Each conidium is globose and is multinucleate.
7. In conidial chains the conidia are separated from each other by a sterile intercalary disc.
8. The presence of conidia causes bulging of host epidermis which eventually burst and the conidia are liberated out.

Section of diseased leaf showing sexual stage of fungus:

1. The antheridia and oogonia are produced in close proximity on separate hyphae within the intercalary spaces of host cells.
2. The sex organs are deeply situated within the host tissues.
3. The antheridium is elongated and multinucleate.

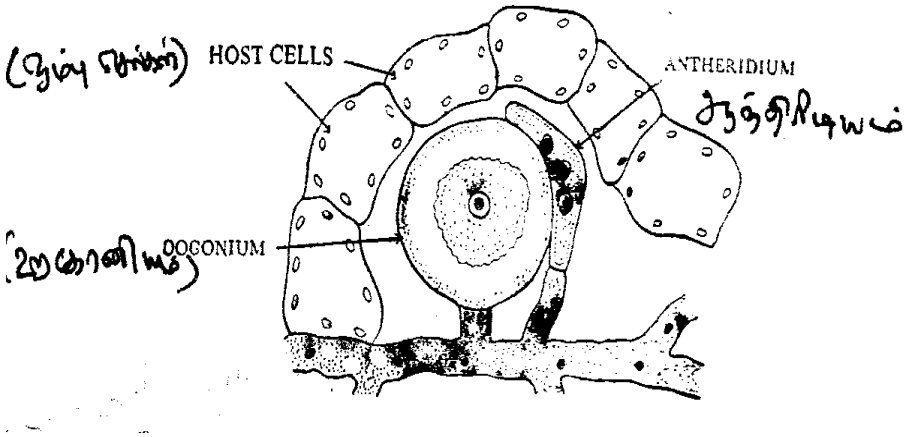


Fig. V. S. of host leaf showing sex organs.

4. At maturity the content of oogonium is differentiated into any outer multinucleate periplasm and an inner uninucleate ooplasm having dense and vacuolated cytoplasm.
5. The fertilized product oospore is formed within the oogonium, situated deeply in host cells.
6. Each oospore is double walled structure; the outer wall exo-spore is thick and spiny, while the inner wall endospore is thin.
7. The outer wall possesses different types of sculpturings.

SACCHAROMYCES (YEAST)

SYSTEMATIC POSITION:

Division	:	Mycota
Sub-division	:	Eumycotina
Class	:	Ascomycetes
Sub-class	:	Hemiascomycetes
Order	:	Endomycetales
Family	:	Saccharomycetaceae

Occurrence or collection of the material:

- Yeast is common in Toddy.
- Fungus leads saprophytic life on sugary substratum like molasses, honey, sugar solution etc.

Laboratory Exercise:

- Isolation of yeasts can be done in any exposed sugary substance.
- May be cultured on Hansen's medium.
- Preparation of Hansen's medium:

Peptone	:	1.0 g
Maltose	:	5.9 g
KH_2PO_4	:	3.3 g
$MgSO_4$	:	0.2 g
Water	:	1000 ml.

- The smear of the fungus is prepared and studies.
- Stain used for study is cotton blue-lactophenol or iron haematoxylin and fast green.

Observations:

Structure of Yeast cell (under high power of microscope):

1. The plant body consists of a unit cell which is hyaline, minute and uninucleate.
2. The cells are small, spherical, oval or ellipsoidal.

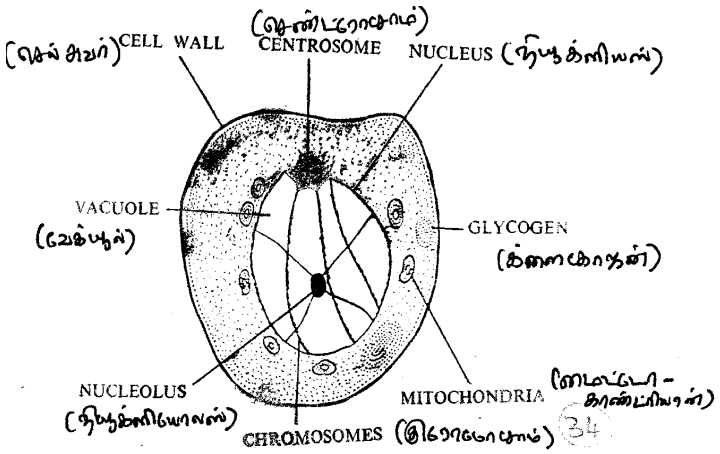


Fig. Structure of a vegetative cell of fungus.

3. The cells are jointed with each other in chain forming a sort of mycelium called pseudomycelium.
4. The cell wall is made up of cellulose-like substances which are thickened in mature cells.
5. Colony of the cells appears somewhat brown.
6. The content of the cell is differentiated into an outer denser region with various inclusions and an inner large vacuole.
7. The cytoplasmic inclusions include glycogen and other food particles.
8. The nucleus is of primitive type but complicated.

Reproductive structure:

Budding:

1. Noticed in budding yeasts.

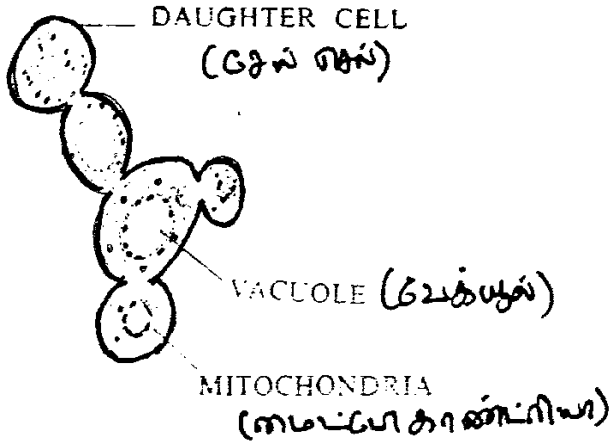


Fig. Budding of the fungus.

2. Protoplasmic bulge is noticed which enlarges to form a bud.
3. Many buds are formed and look like a chain.

Fission:

1. Found in “fission yeast”.
2. The protoplasm of the vegetative cell divides into two equal halves which are separated by a wall developed in between.
3. Both the cells separate and behave as yeast cells separately.

PUCCINIA.

SYSTEMATIC POSITION:

Division	:	Mycota
Sub-division	:	Eumycotina
Class	:	Basidiomycetes
Sub-class	:	Heterobasidiomycetes
Order	:	Uredinales
Family	:	Pucciniaceae
Genus	:	***Puccinia***.

Occurrence or collection of the material:

- *Puccinia* causes 'rust disease' on wheat and other cereals.
- In India, the disease appears on wheat in Feb.-March in northern zone and in November in Southern zone.
- The diseased material collected and preserved in F.A.A.

Laboratory Exercise:

- The stains used are cotton blue, iron haematoxylin or fast green or sometimes a combination of haematoxylin and fast green or haematoxylin and orange G.

Observations:

Vertical section of infected wheat leaf through uredosorus:

1. The epidermis of host is ruptured.
2. Many stalked uredospores are present in cluster below the epidermis.
3. The stalk of uredospore is formed by the aerial branch or hyphae.

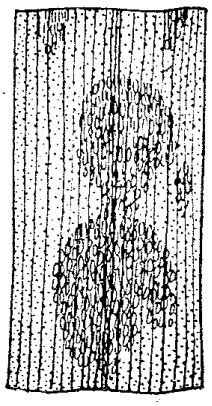


Fig. A portion of leaf showing uredo pustules.

4. Each uredospore is an oval shaped binucleate double walled structure. The outer wall is thick spiny and is called exine. The inner one is thin and called intine. Germ pores are present.

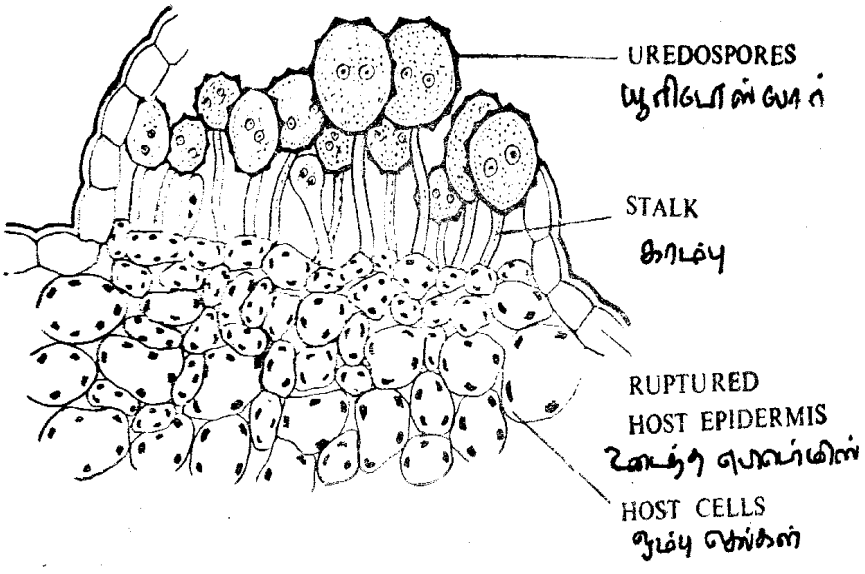


Fig.. V.S. through uredosorus of infected wheat leaf.

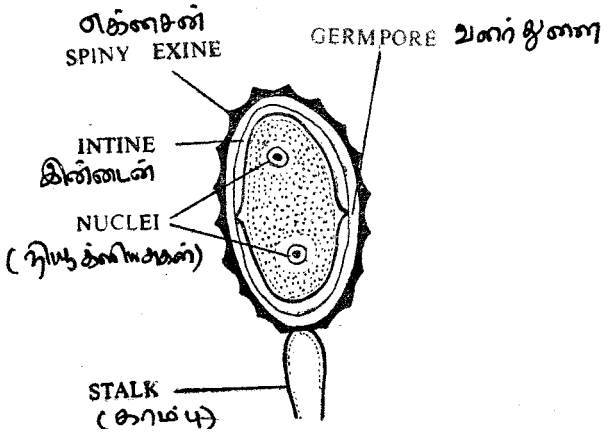


Fig. a uredospore highly magnified.

5. Binucleate septate mycelium lies in intercellular spaces of host cells.

Vertical section of infected wheat leaf through teleutosorus:

1. Host epidermis is ruptured.

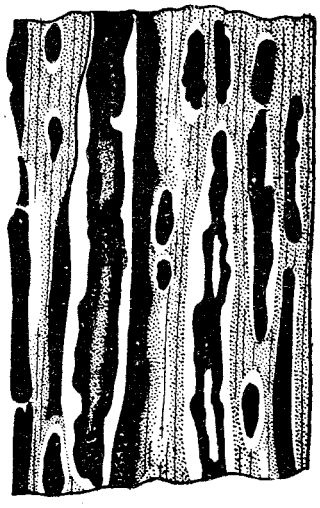


Fig. A portion of stem showing teleuto pustules.

2. Below the epidermis are present long stalked bicelled spindle shaped teleutospores.
3. Each teleutospore has an outer thick smooth wall called exine and an inner wall intine.

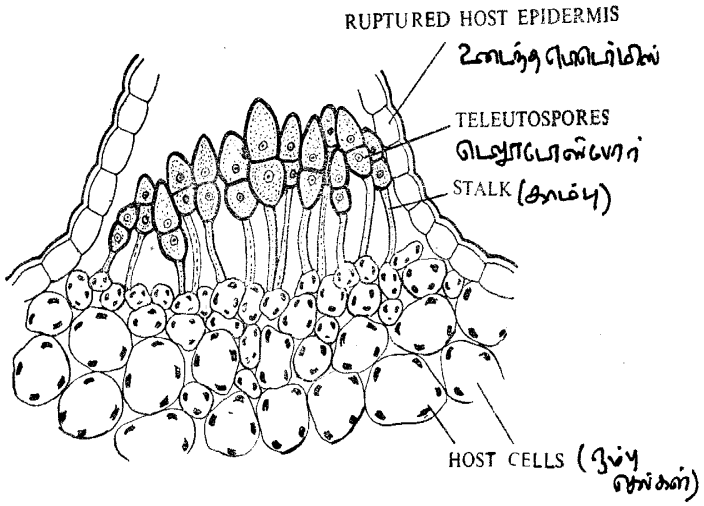


Fig. V.S. through teleutosorus of infected wheat leaf.

4. The apex of the teleutospore may be pointed or rounded.
5. Each of the two cells of the teleutospore is binucleate in the beginning but later on the nuclei fuse making each of them uninucleate.

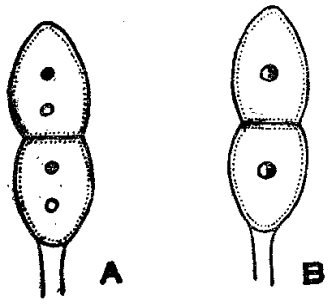


Fig A. Teleutospore with 4 nuclei

B. Teleutospore with fused nuclei

6. Each cell of the bicelled teleutospore has a single germ pore.
7. Binucleate intercellular septate mycelium is present within the host cells.

Vertical section of diseased barberry leaf (alternate host) showing pycnidial cups on the upper dorsal and aecidial cups on the lower side of the leaf:

Pycnidial cup and pycnidiospores:

1. Pycnidial cup is globose and are parallely arranged among the host tissues below the epidermis.

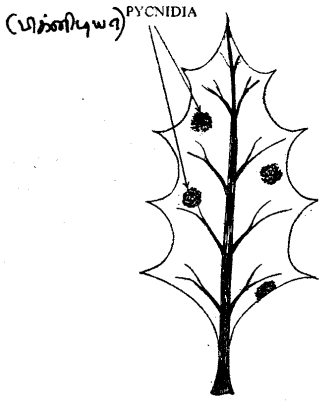


Fig. *P. graminis* : Barberry leaf showing pycnidia

2. Each cup is connected from all sides with uninucleate intercellular mycelium.
3. A matured pycnidium is a flask shaped structure with a pore at its apex. The pore is known as ostiole.
4. The hyphae adjacent to ostiole give rise to pointed periphyses that project through the ostiole.
5. The cavity of the pycnidium contains many slender and elongated spermatiophores or pycnidiophores.

6. The free end of the spermatiophores or pycnidiophores cut off pycniospores or spermatiospores in the lumen of the pycnidial cup.

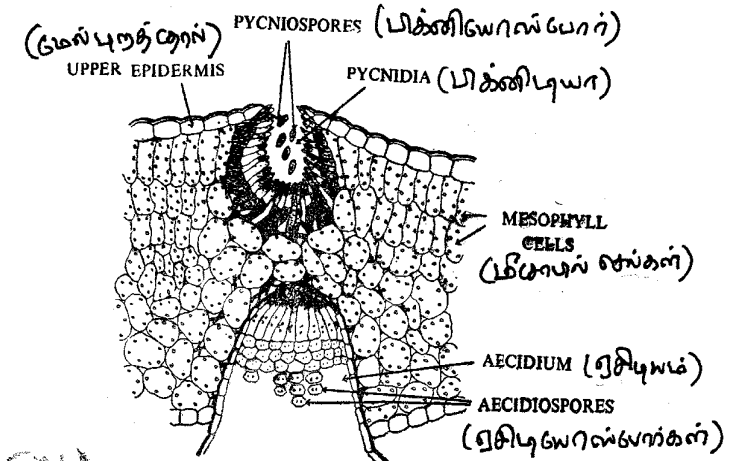


Fig. V.S. through barberry leaf showing pycnicia and aecidia on upper and lower sides respectively

7. The pycnidiophores are arranged in a palisade-like manner.

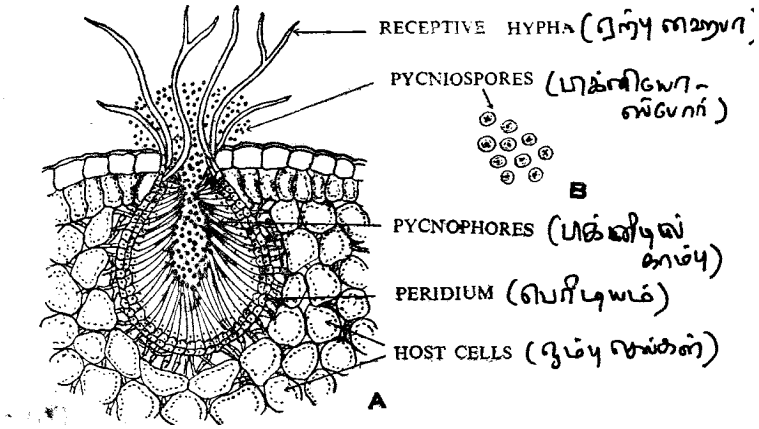


Fig. A pycnidium highly magnified.

8. Many receptive hyphae protrude out through the pore of pycnidia.

Aecidial cup and aecidiospores:

1. Aecial patches are formed on the ventral surface of barberry leaf.
2. Aecidium is cup like structure with an outer protective layer called peridium.
3. The cups are connected with intercellular, binucleate hyphae.

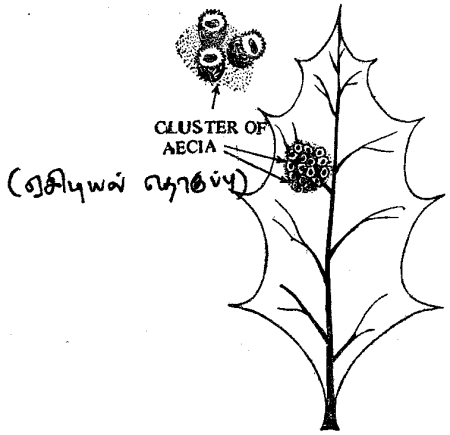


Fig. Ventral side of the barberry leaf showing aecia

4. Each aecidial cup bears many binucleate sporophores which are arranged parallely and connected with each other.

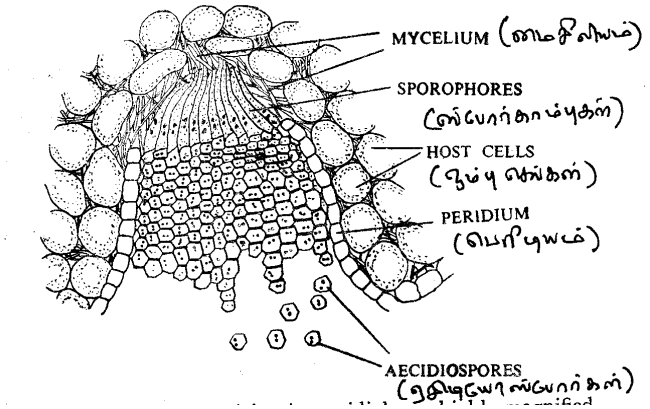


Fig. An aecidial cup highly magnified.

5. Each sporophore has larger and smaller cells arranged alternatively. Smaller cell is the disjunctor whereas the larger polygonal cell is binucleate and is the aecidiospore.
6. The formation of aecidial cup is initiated by pycniospores.
7. The aecidiospores infect the primary host (wheat).

POLYPOROUS

SYSTEMATIC POSITION:

Division	:	Mycota
Sub-division	:	Eumycotina
Class	:	Basidiomycetes
Sub-class	:	Homobasidiomycetes
Order	:	Polyporales
Family	:	Polyporaceae
Genus	:	***Polyporous***

Occurrence or collection of the material:

- Occurs parasitically on the roots, trunks and branches of trees.
- Common on tree trunks or on wood in damp forest.

Laboratory Exercise:

- The stains used are cotton blue, iron haematoxylin or fast green or sometimes a combination of haematoxylin and fast green or haematoxylin and orange G.

Observations:

Fruiting body (Basidiocarp) morphological structure:

1. Basidiocarp is shelf-like, shortly stalked.
2. It is leathery, corky or woody, within or slightly greyish or brownish in colour.
3. **Stipe**: Stipe is brown structure and made up of hyphae which are compactly arranged forming a pseudoparenchymatous tissue. The basal portion of the stipe is connected with the subterranean mycelium on the host tissues. The stipe bears and expanded structure called pileus at its tip.

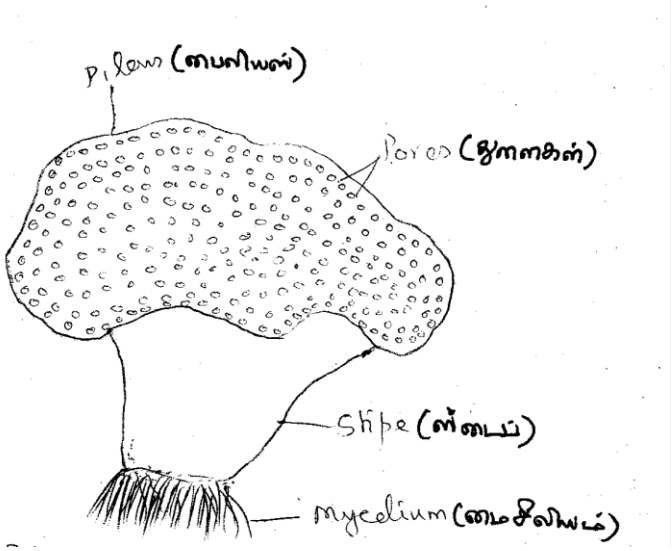


Fig. *Polyporus* –basidiocarp of the fungus

4. **Pileus**:
    a. Pileus is bracket like structure situated on the stipe.
    b. Pileus is brown in colour having few concentric brown rings near the periphery.

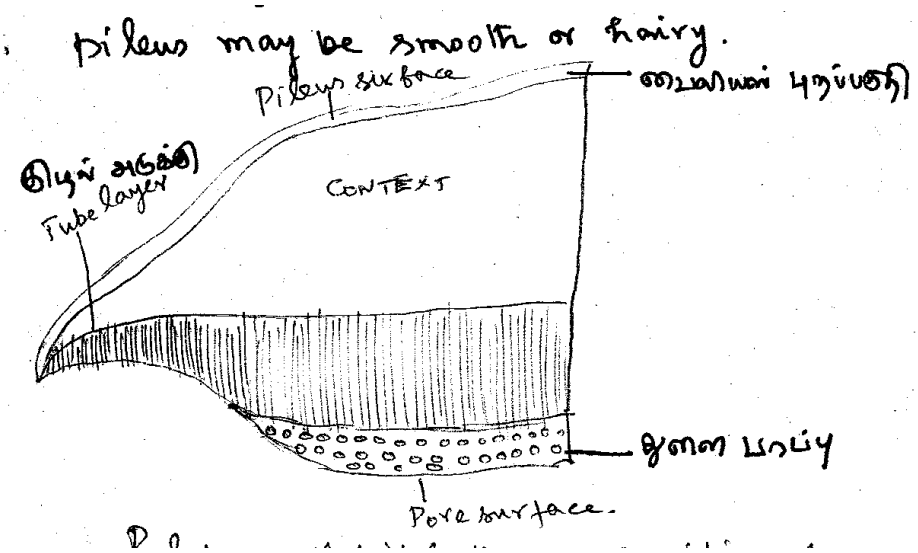


Fig.. V.S. through basidiocarp.

    c. Lower surface of pileus is smooth.
    d. Lower surface bears no radiating gills but numerous fine pores in the form of minute holes giving a porous appearance to the pileus, hence the name *polyporous*.

V.S. of basidiocarp through pileus:

1. **Pileus** surface: The upper surface of the pileus may be smooth or hairy.
2. **Cortex**: This lies just below the pileus surface. It is a thin layer distinguishable into an upper soft layer and a lower hard layer.
3. **Tube layer**: It consists of vertically placed tubes attached to the lower surface of context.

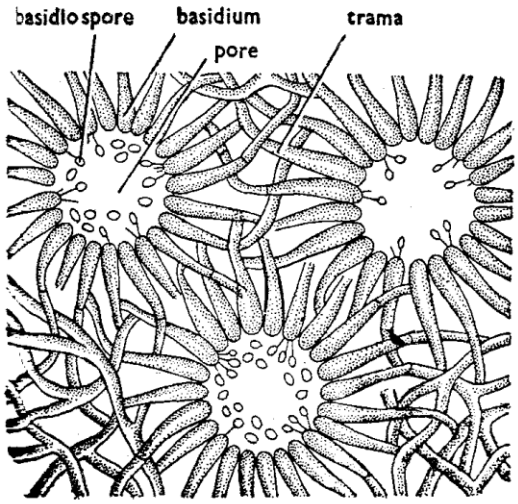


Fig. Basidiocarp in section

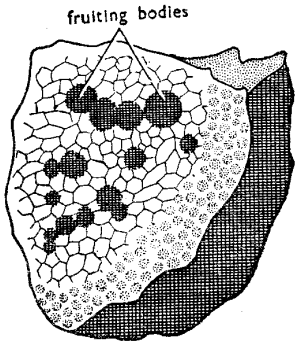
4. **Hymenial layer**: The hymenium is made up of a distinct layer of basidia, lining each pore or tube. The basidia are club shaped and slightly project into the cavity of the pore.
5. **Basidium**: Each basidium has four short sterigmata at its free end, terminating into a basidiospore each.
6. **Basidiospore**: Each basidiospore is small, oval and uninucleate.

LICHENS

Morphological structure:

Crustose: example *Lecidea platycarpa*.

- Closely adhering to the branches of trees or on rocks forming a crust.



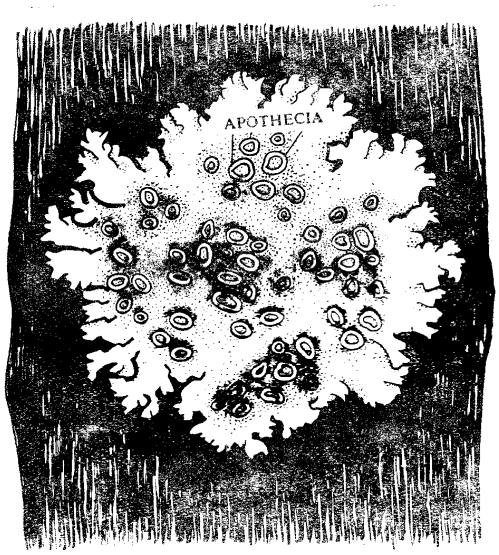
Lecidea platycarpa: plant body with apothecia

ruiting body

- Crustose lichens show very little differentiation between upper and lower surfaces.

Foliose: example *Parmelia flavicens*.

- The thallus is flattened and segmented with free margins.



Parmelia flavicans: Plant body with apothecia.

Fig. a foliose lichen with fruiting body.

- Attached to the substratum by means of rhizenes.
- Apothecia are cup shaped.

Fruticose: example *Cladonia* species.

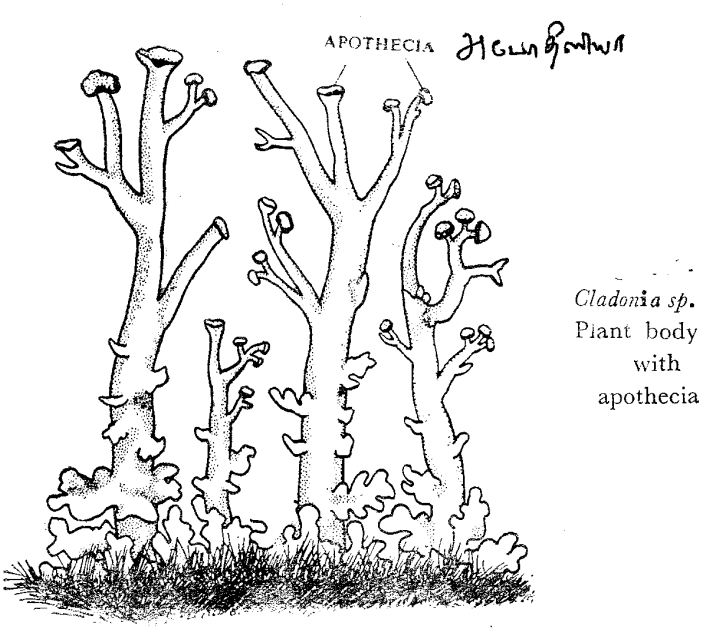


Fig. 56 An erect Fruticose lichen with fruiting body.

- Thallus is aerial, erect and branched.
- Apothecia are produced on ultimate branches of thallus

Anatomy:

Cross section of foliose lichen:

1. Upper cortex is made up of closely packed fungal hyphae.
2. An algal layer is intermixed with fungal hyphae. The algal cells are enclosed by fungal hyphae.
3. Central medulla of thallus is made up of loosely interwoven hyphae of the fungus.

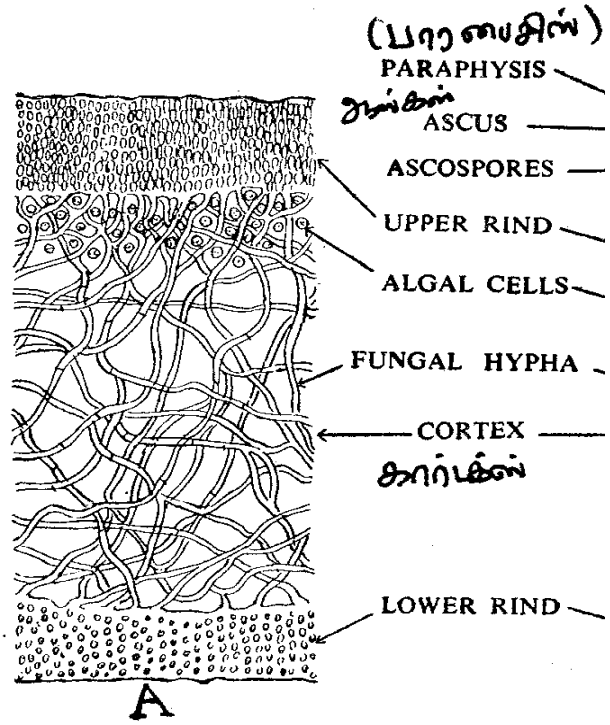


Fig. 57 C.S. of thallus through vegetative region

4. Lower cortex is made up of fungal hyphae.

Section through apothecium:

1. A cross section through apothecium of lichen shows uppermost layer of asci with paraphyses, in addition to the structures present in the vegetative thallus of the lichen.

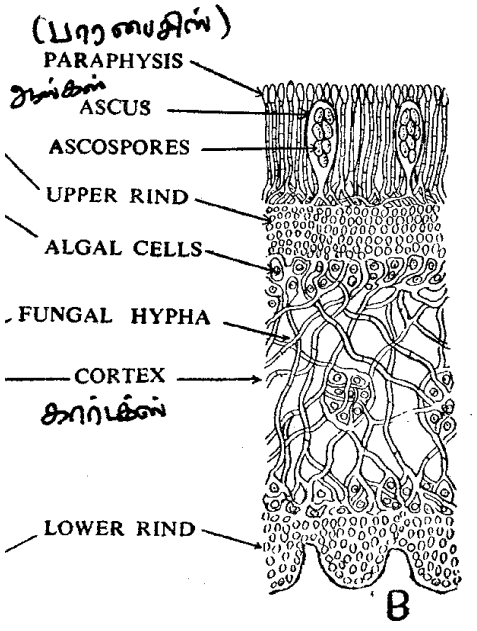


Fig 58. C.S. of thallus through an apothecium

2. Paraphyses are sterile structures and septate.
3. Each ascus consists of 4-8 ascospores.
4. Each ascospore is uninucleate and ellipsoidal in shape.

BUNCHY TOP OF BANANA

(Causes, symptoms and control measures of the diseases)

Causal Organism:

- Bunchy top of banana is caused by a virus Banana bunchy top virus Magee.
- Virus is transmitted by a specific insect vector, *Pentalonia nigronervosa* Coq.
- Virus is not transmitted by mechanical inoculation.
- The aphids generally live around the base of pseudostem.

Symptoms:

1. All varieties of banana are susceptible to banana bunchy top virus.
2. The virus is systemic, and round on all parts of the infected plants.
3. The banana plants may show the symptoms of bunchy top at any stage of their growth.
4. The leaves are bunched together at the base of the plant and a rosette is formed.
5. The further elongation of the leaf-stalks is arrested and therefore, the leaves of infected plants stand more erect than of normal ones.
6. Infected plants are markedly stunted, and they do not usually grow taller than two or three feet.

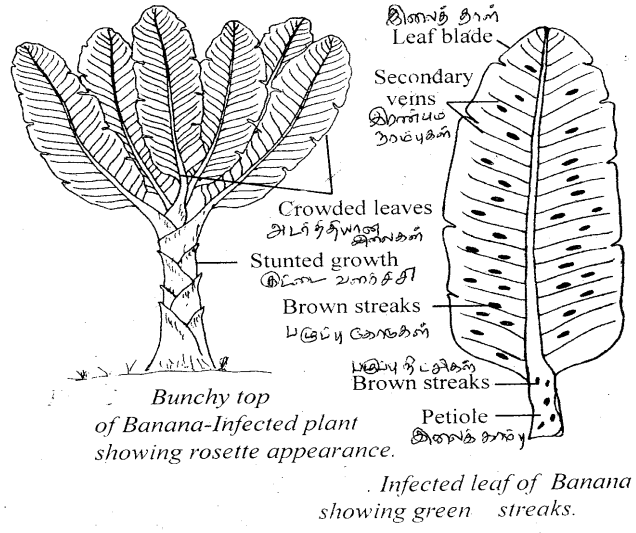


Fig. Disease symptom of whole plant and a leaf enlarged.

7. The infected plants do not bear fruits.
8. The first external symptoms of the disease appear in the leaves of the plant.
9. Irregular, nodular, dark green streaks appear along the secondary veins on the under side of the leaf blade, along the petiole or mid-rib.
10. In the succeeding leaves, the symptoms are more intensified, the leaves become pale-yellow, brittle and much reduced in size, the typical bunching top symptom is evident.
11. The root system of the infected plant exhibits decaying.
12. In the infected plant the phloem is disorganized to some extent.

Control measures:

1. The eradication and rouging of diseased suckers and plants.
2. Exclusion of diseased suckers and plants.

BACTERIAL LEAF BLIGHT OF PADDY

Pathogen:

A bacterium called *Xanthomonas oryzae*

SYSTEMIC POSITION of pathogen:

Class	:	Schizomycetes
Order	:	Pseudomonadales
Family	:	Pseudomonodaceae
Genus	:	*Xanthomonas*

Pathogen structure:

- The bacterium *Xanthomonas oryzae* is rod shaped measuring 0.5-0.8 X1-2 microns.
- They occur singly or in pairs.
- They are gram negative, aerobic and with a single polar flagellum.
- They are non-sporing and not forming chains.

Infection and symptoms:

Infection takes place through wounds.

Symptoms:

1. Small water-soaked spots 5-10 mm in length are formed along the margins of the leaf-blade or along the prominent veins.
2. Gradually several lesions coalesce to form whitish or yellowish patches or stripes.
3. In seedling stage, the tips of the leaves are affected

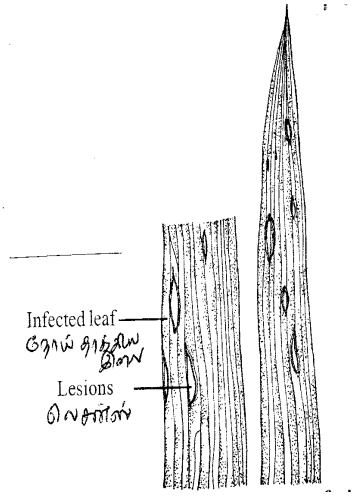


Fig. Blast disease of rice

4. The infection takes place in wounds caused by wind damage, along the margins and prominent veins.
5. Small droplets of bacterial exudate are found on the lesions.
6. These droplets harden into yellowish or amber coloured resinous granules. Ultimately the leaves dry up and the plants die.
7. The vascular bundles remain filled with bacteria.
8. Ultimately the leaves dry up and the plants die.
9. The vascular bundles remain filled with bacteria.

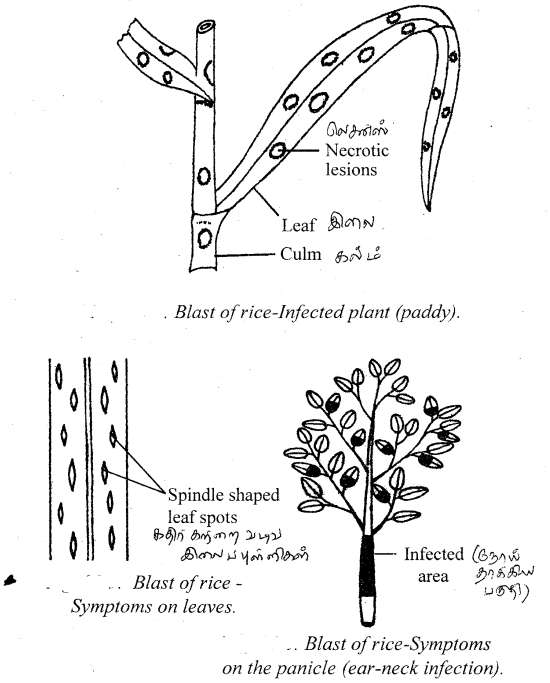


Fig. Blast disease of rice at various stages.

10. In severe infections the pathogen has been found in the glumes and even in the endosperm of the grains.

Control measures:

- To sow resistant varieties
- Spraying of copper fungicides is recommended.
- Soaking of seed for eight hours in Ceresan (0.1%) and Streptocycline has been recommended.

TIKKA DISEASE OF GROUNDNUT

Pathogen:

i) ***Cercospora personata*** (Berk & Curt.) Ell. & Ever.

Perfect stage- ***Mycosphaerella berkleyi*** Jenkins

ii) ***Cercospora arachidicola*** Hori.

Perfect stage- ***Mycosphaerella arachidicola*** Jenkins

SYSTEMATIC POSITION:

Imperfect stage:

Division	:	Mycota
Sub-division	:	Eumycotina
Class	:	Deuteromycetes
Order	:	Moniliales
Family	:	Demartiaceae

Perfect stage:

Class	:	Ascomycetes
Order	:	Sphaeriales
Family	:	Mycosphaerellaceae

Pathogen:

Cercospora personata

1. The mycelium is intercellular, brown, septate, branched and slender, branched haustoria are produced.
2. Conidiophores are 24 to 54 microns long and 5 to 8 microns broad; aseptate or 1-2 times septate.
3. Conidia develop on geniculation of conidiophores.
4. The conidia are terminal and each conidiophore bears a single conidium at its apex.

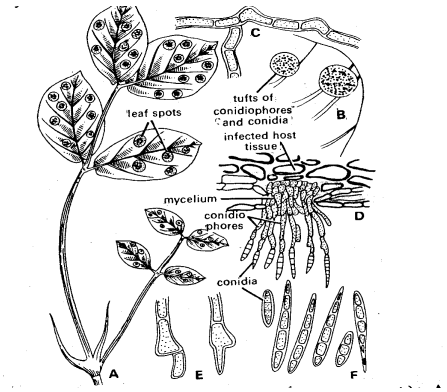


Fig. Tikka disease of groundnut (*Cercospora personata*)

A. infected leaf showing characteristic leaf spots
B. B. round spot surrounded by halo, tufts of conidiophore in dots.
C. Geniculate mycelium
D. V.S. of infected leaf showing mycelium, conidiophore & conidia
E. Apices of conidiophore
F. conidia

5. The conidia are arranged in stromatic structure.
6. The conidia are cylindrical, obclavate, 1-7 times transversly septate, 18 to 60 microns long and 6-11 microns broad.

Cercospora arachidicola:

1. The mycelium is intercellular and intracellular, brown, septate, branched and slender and without any haustoria.
2. Conidiophores are yellowish brown and geniculate.
3. Conidiophores are 22 to 41 microns long and 3 to 5 microns broad; aseptate.

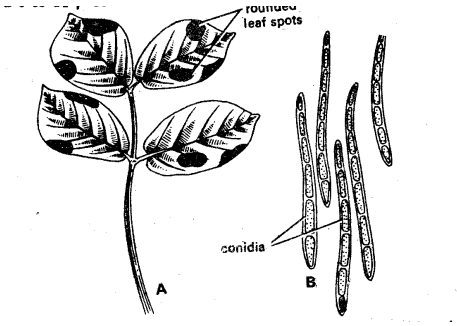


Fig. Tikka disease of groundnut (*Cercospora arachidicola*)

A. affected leaf showing characteristic spots
B. elongated transerversely septate conidia.

4. The conidia are terminal and each conidiophore bears a single conidium at its apex.
5. The conidia are arranged in stromatic structure.
6. The conidia are yellowish, obclavate, 3-12 times transversly septate, curved, 38 to 108□ long and 3-6 □□broad.

Symptoms:

1. All parts of the plant found above the ground are affected, but especially lesions appear on the leaves.
2. Lesions on the leaves, developed by *C. personata* are rounded and 1-6 mm in diameter
3. Diseased spots are dark brown or black and found on both the surfaces of leaf; later on, yellow halo develops around each such leaf spot; the spots surrounded by yellow haloes are restricted to the upper surface of leaf.
4. Lesions developed by *C. arachidicola* are irregular and bigger in size; each spot is rounded and 4 to 10 mm in diameter; the yellow haloes develop around the leaf spots; in conspicuous haloes are seen on the lower surface of the leaf.

Control:

- Controlled by sanitation and crop rotation.
- The use of phosphates and potassium manures, and mixed cropping with arhar, also reduce the disease.
- The spraying with 2:2:5 Bordeaux misture, 0.15 % perenox and 0.15% Cupravit is effective to some extent.
- Sulphur dusting (400 meshes per square inch) is effective.
- Resistant varieties are sown.
- Sowing of early maturing varieties has good results.

RICCIA

SYSTEMATIC POSITION:

Sub-Kingdom : Embryophyta

Division : Bryophyta

Class : Hepaticopsida

Order : Marchantiales

Family : Ricciaceae

Genus : ***Riccia***

Occurrence or collection of the material:

- Most species are terrestrial except *R. fluitans*, which is aquatic.
- Common in moist soil and rocks.

Laboratory Exercise:

- The thallus-tissues are stained with fast-green or iron haematoxylin.

Observations:

External Structure:

1. The plant body is thalloid, dorsiventral, prostrate and ribbon-like.
2. Several thalli of the plant joined together by their edges form a prostrate ribbon-shaped dark green rosette-like structure.
3. Individual thallus is dorsiventral, prostrate and branched dichotomously. The growing apices of thallus bear apical notches in the form of depressions.

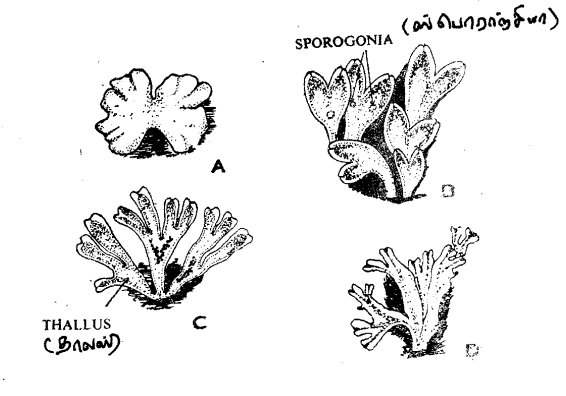


Fig. *Riccia* species A. *R. cruciata*;
B. *R. beyrichiana;*
C. *R. pathankotensis*;
D. *R. plana*

4. A conspicuous mid-rib is present dorsally to the thallus.
5. Sex organs are present in the mid dorsal groove and are embedded in the thallus. Sporophytes are attached dorsally on median longitudinal line.
6. Hair-like rhizoids are present on the median strip of the ventral side of thallus for attachment with the substratum.

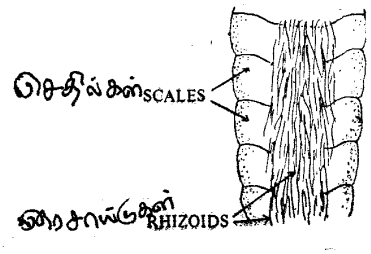


Fig. Ventral side of the thallus

7. Violet coloured scales are present ventrally along the margin of the thallus.
8. Each scale is multicellular and one cell thick.
9. Rhizoids are two types; smooth and tuberculate.
10. The smooth walled rhizoids have their inner walls smooth whereas tuberculate rhizoids possess peg-like ingrowths on their inner wall.

External morphology of *Riccia fluitans*:

- It is a aquatic floating species.

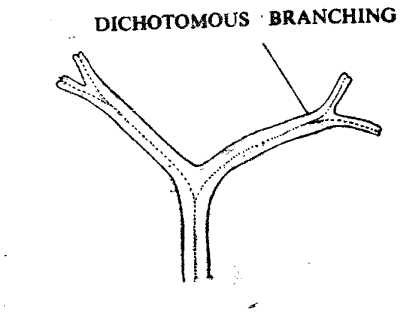


Fig. *Riccia fluitans* thallus

- Thallus is thin, thread like, dichotomously branched and green.
- Rhizoids are usually absent.

Internal structure:

1. Two distince zones are present. The upper one is the assimilatory green photosynthetic zone and lower one is the colourless storage zone.
2. The thallus is thicker in the midrib region and gradually thins out towards the margin.
3. Assimilatory zone consists of green chlorophyllous cells arranged in linear filaments. The uppermost cell of filament is colourless to represent an epidermal cell. These colourless cells constitute a discontinuous epidermis.

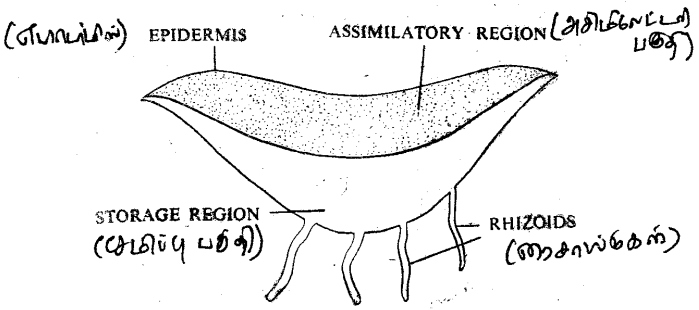


Fig. V. S. the the thallus (diagrammatic)

4. In between green filaments are narrow air canals open externally by air pores which are located between 4-8 cells.
5. Storage zone is compact, parenchymatous and has starch. The cells are polygonal in shape. The intercellular spaces are absent.

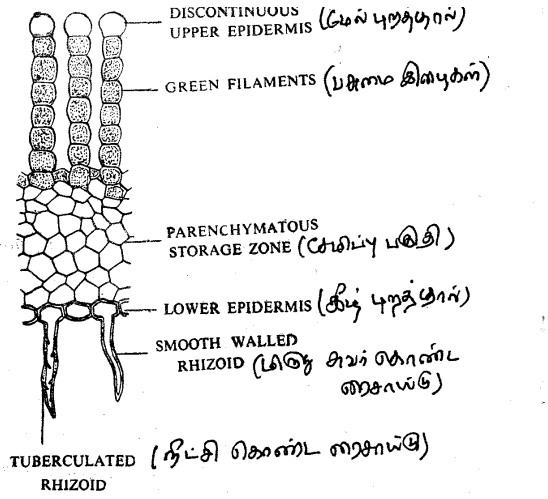


Fig. A portion of V.S. of thallus highly magnified.

6. Lower epidermis is continuous. Some of the cells give out rhizoids.
7. Rhizoids are to two types- smooth walled and tuberculate.

8. Scales are multicellular and dark coloured and attached to both margins of thallus ventrally.

Structure of reproductive parts:

Antheridia:

1. Antheridium lies in a cavity called antheridial chambers.
2. Antheridium communicates to exterior with antheridal pore.

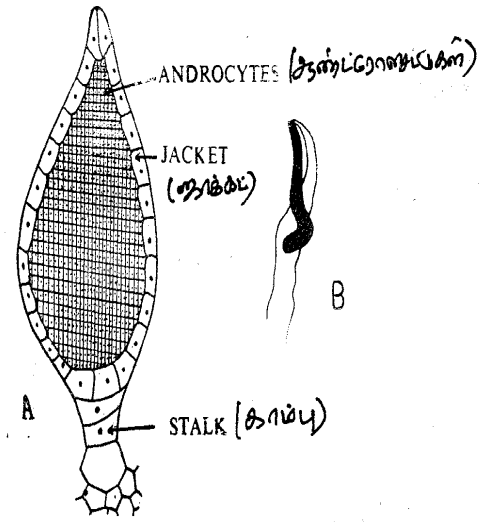


Fig. A. an antheridium
B. an antherozoid

3. The aptheridial cavity with antheridium, lies embedded partly in the tissues of the photosynthetic region and partly in the tissues of the storage region.
4. Mature antheridium is multicellular, stalked and club shaped body.
5. Each antheridium is surrounded by a layer of sterile jacket cells.
6. Within the jacket are rectangular androcyte cells.
7. Each androcyte cell gives rise to a single biflagellate antherozoid.

Archegonia:

1. Archegonia are produced in archegonial chamber which communicates with exterior by pores.
2. Archegonium is primarily deeply embedded in the thallus but at maturity slightly raised from epidermis.

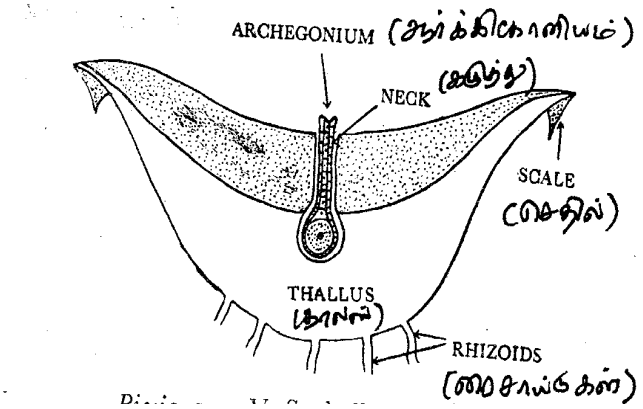


Fig. V.S. of thallus showing an archegonium (diagrammatic)

3. Each archegonium is multicellular, stalked and flask shaped having a broad venter and a long neck.
4. Neck is made up of six tiers of cells arranged vertically.
5. Neck encloses four neck canal cells arranged linearly.

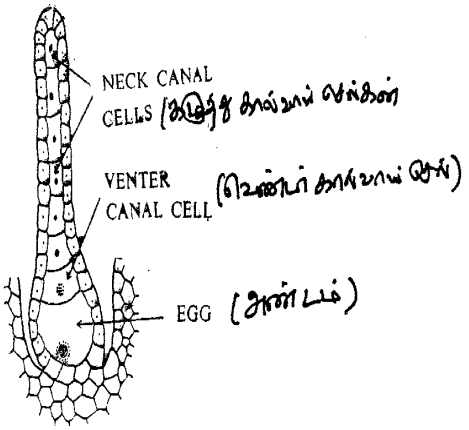


Fig. An archegonium in detail

6. Free end of neck is occupied by four cover cells.
7. The venter bears a large naked egg.
8. At maturity the neck canal cells disorganize and leave a clear canal.

V.S. of thallus through sporophyte:

1. The sporophyte is a globular structure embedded within the thallus.
2. Remnant of neck of fertilized archegonium persists.
3. The sporophyte is represented only by capsule which is surrounded by single layer of jacket. The jacket is again surrounded by multilayered calyptra.

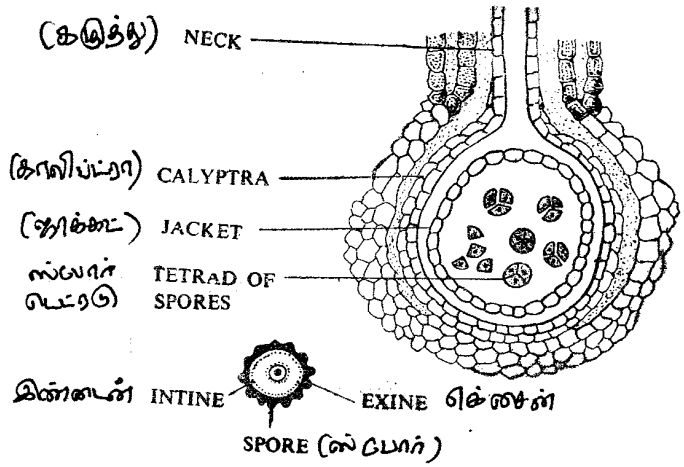


Fig. 72. V.S. of thallus through sporophyte with a spore magnified.

4. The jacket layer and inner layer of calyptra disorganize quite early before the spores have matured.
5. Capsule contains a large number of spores, some of which is tetrad.
6. Each spore has an outer cutinized, spiny, thick exine and a thin intine wall.

MARCHANTIA

SYSTEMATIC POSITION:

Sub-Kingdom : Embryophyta

Division : Bryophyta

Class : Hepaticopsida

Order : Marchantiales

Family : Marchantiaceae

Genus : ***Marchantia***

Occurrence or collection of the material:

- Noticed abundantly in cool and damp climate on the hills, at the banks of stream and rivers and on rocks.
- Seen damp in burnt soil.

Laboratory Exercise:

- Thallus fixed in F.A.A
- Thallus tissues stained with iron-haematoxylin, orange G or fast green.

Observations:

External structure of the thallus:

1. Plants are thalloid, dorsiventral and prostrate.

Fig. Marchantia thallus showing gemma cup and an individual gemmae magnified.

2. Thallus is dichotomously branched dark green with wavy margins. The apex of each branch is notched.
3. Distinct median mid rib is marked on dorsal side by a shallow groove and on the ventral surface by ridge.
4. The dorsal side has a number of polygonal areas each polygonal area represents the underlying air chamber and has a central air pore. Air pores are dot like structures.

5. Cup-like gemma cups are present along the mid rib on the dorsal side of the thallus.
6. The rime of gemma cup is circular and serrated. The cup contains many green gemmae which are the asexual reproductive bodies.
7. Male plant bears a stalked receptacle terminating in umbrella like cap.

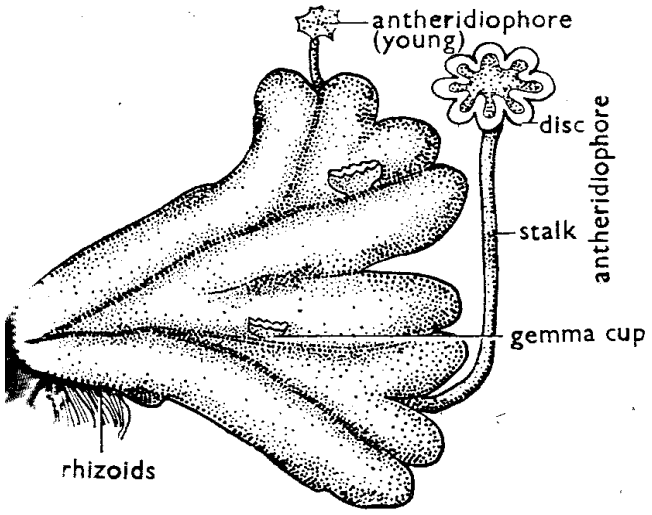


Fig. Marchantia male thallus

8. Female plant bears female receptacle terminates into radiating lobed cup.
9. The sex organs are noticed at the apices of certain branches of the thallus.

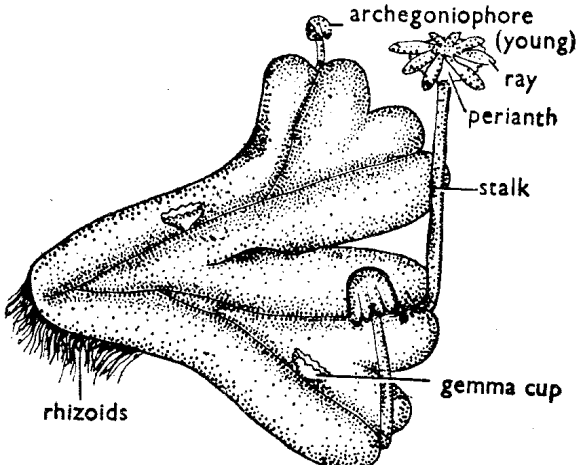


Fig. Marchantia female thallus

10. Numerous rhizoids and scales are attached mid-ventrally to the thallus.

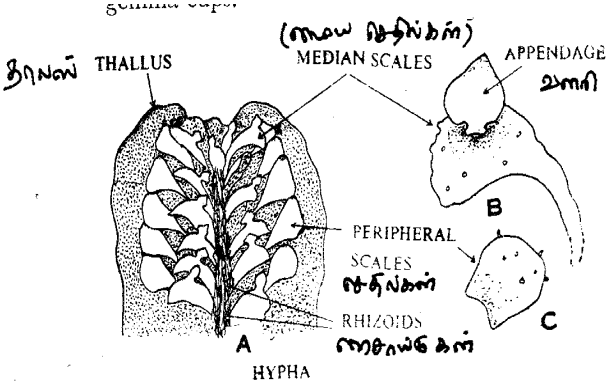


Fig. A. Ventral view of thallus showing scales and rhizoids.

B. Median scale (inner)

C. Peripheral scale (outer)

Anatomical structure:

V.S. of the thallus:

1. The thallus is dorsiventrally differentiated into an upper assimilatory photosynthetic region and a lower storage region.

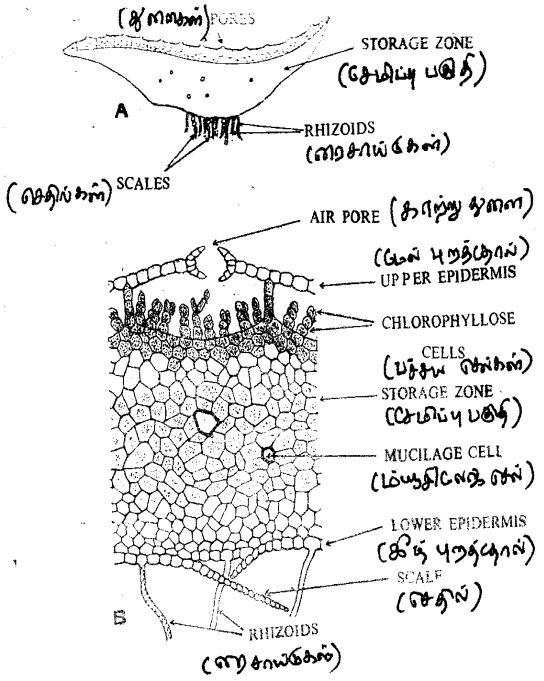


Fig. V.S. of thallus. A. diagrammatic section.

B. a portion of section magnified.

2. Upper epidermis is uniseriate and composed of green square shaped cells containing chloroplasts. Barrel shaped air pores are present in

epidermal layer. Each pore is surrounded by 4-8 superimposed tiers or cells.

3. The photosynthetic assimilatory region is divided into many air chambers by means of multicellular single layered septa. The air chambers communicate outside through air pores. The air chambers are fitted with green branched filaments. The epidermal cells and walls of chambers contain chloroplasts.
4. Storage region is several layered thick. More thickened in the centre and gradually tapers towards the margins. It is made up of compactly arranged hexagonal parenchyma cells. The cells contain starch. Some cells contain oil bodies or mucilage.
5. Cells in the mid rib region are more tangentially elongated and slightly thickened, as compared to other cells.
6. Lower epidermis forms two types of rhizoids: smooth walled and tuburculated in the middle region.
7. Scales are multicellular but one cell thick and are arranged in two or three rows on each side of mid rib ventrally scales near the mid rib are large wedge shaped and appendiculate. Scales situated at peripheral margin are small, ligulate and projecting over the edge of the thallus.

V.S. of thallus through gemma cup:

1. Gemma cup is cup shaped in outline with an outer wall and central cavity.
2. The outer wall is differentiated into outer photosynthetic region and inner storage region.

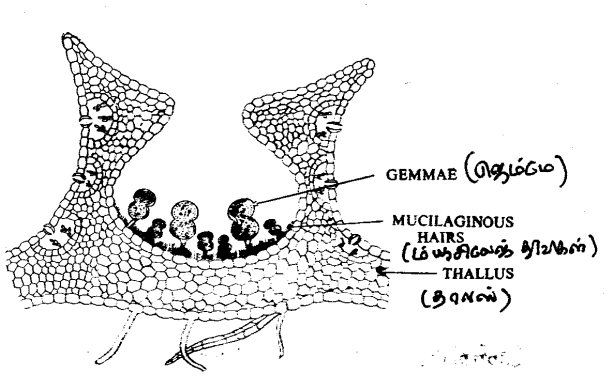


Fig. V.S. of thallus through a gemma cup showing gemmae.

3. The base of the cup on its inner side is occupied by globular multicellular gemmae intermixed with small numerous club shaped mucilaginous hairs.

4. The gemma cup arises as a part of the thallus. Its base remains attached with the thallus.
5. The thallus bears rhizoids and scales on the ventral side.

Gemma:

1. Each gemma is stalked and made up of green parenchymatous cells.
2. Gemma is attached to the base of the gemma cup.
3. Gemma is a discoid form and has two shallow notches on both the lateral sides.
4. Towards the periphery of the gemma colourless oil cells are present. Inner to them rhizoidal cells are present.

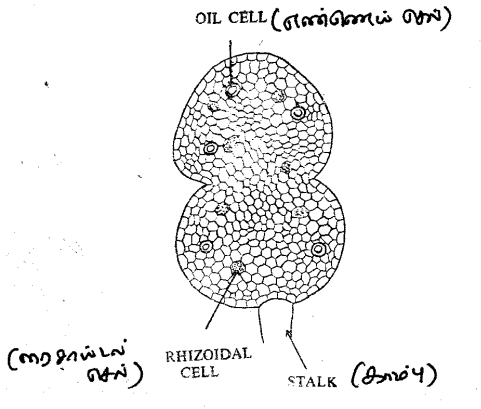


Fig. A mature gemma.

5. All the cells of the gemma except the rhizoidal cells and oil cells contain chloroplast.

Sex organs:

The male and female sex organs are situated separately on the long stalked receptacles on separate thalli as the plants are dioecious.

Male:

Male sex organs are produced on umbrella like lobed cap situated at the apex of elongated antheridiophore, which arise dorsally to the thallus.

V.S. through male receptacle:

1. The receptacle consists of two portions, an upper broad lobed disc and a lower antheridiophore..
2. The antheridiophore is prismatic and have five faces.
3. Out of five three are furrowed and two curved outwardly.
4. Towards the ventral face of thallus, the stalk bears two furrows containing many scales and rhizoids.

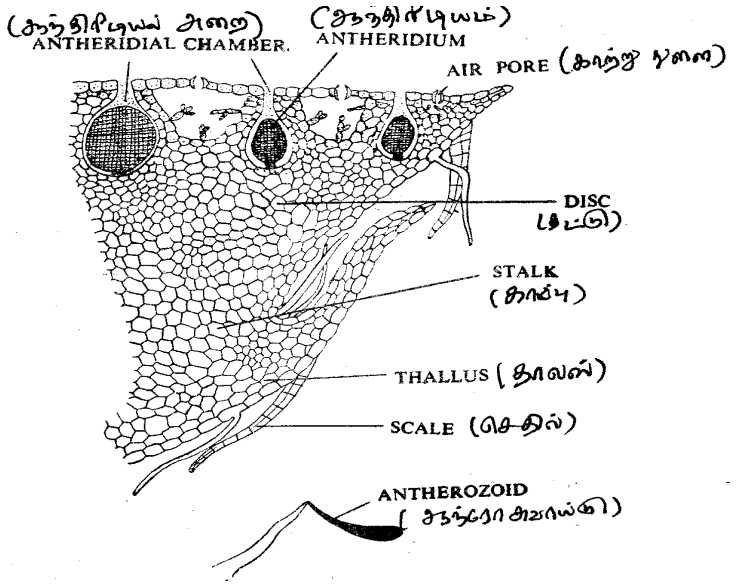


Fig. V.S. through male receptacle and a magnified antherozoid.

5. The disc bears many air chambers filled with green filaments. The air chambers communicate outside by barrel shaped air pores.
6. Alternating with air chambers are present flask-shaped antheridial chambers each open out by single pore on the upper side.
7. Stalked antheridia are attached to the base of the antheridial chambers.
8. Oldest antheridia are at the centre and the youngest at the periphery.
9. Each antheridium is surrounded by a jacket of thin walled cells.
10. Within the jacket are present androcytes, each of which forms a biflagellate antherozoid.
11. Each antherozoid is biflagellate and rod like. The flagellum is composed of several fibrils.

V.S. through female receptacle:

1. Archegoniophore is a stalked structure, possessing a nine rayed stellate disc at the apex.
2. Groups of archegonia are found in between the rays.
3. The ventral side of stalk facing towards ventral side of thallus bears two longitudinal furrows containing scales and rhizoids.
4. The peltate disc is made up of an upper part bearing air chambers with air pores and a lower part bearing archegonia facing downwards enclosed in two lipped fringed involucred sheath called perichactium.

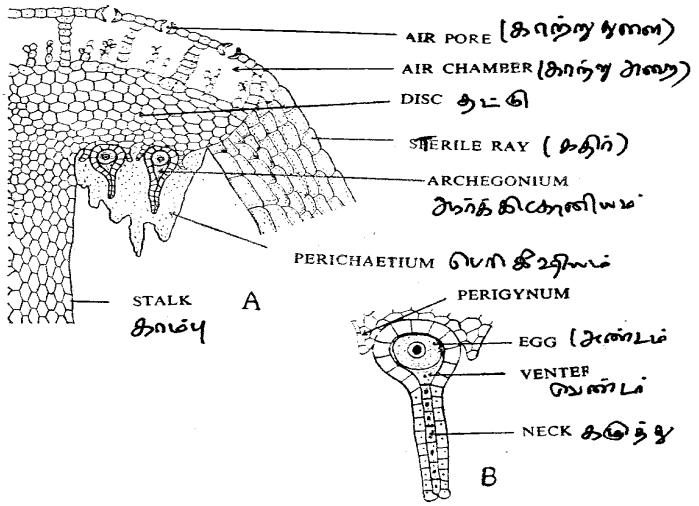


Fig. 81. A. V.S. through female receptacle

B. an enlarged archegonium.

5. Mature archegonium is stalked and has two parts, basal swollen venter and a long neck.
6. venter encloses an egg cell and a venter canal cell. Neck has 4-8 neck canal cells surrounded by six vertical rows of jacket cells.

L.S. of sporophyte:

1. Sporophyte is enclosed by three coverings
    a. calyptra
    b. perigynium (perianth) and
    c. perichaetium (involucre).
2. Sporophyte is differentiated into foot, seta and capsule.

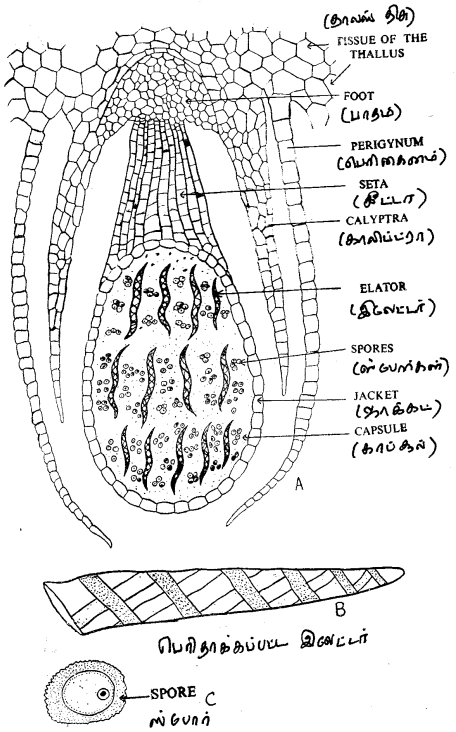


Fig. 82. L.S. of capsule. A. the detailed structure

B An elater highly magnified

C A spore highly magnified.

3. Foot is broad and cellular. It is made up of parenchymatous cells embedded in the tissues of female receptacle.
4. Foot extends as a long seta whose cells are vertically elongated and compactly arranged.
5. The seta terminates into an oval, broad capsule.
6. Capsule has a single layer of sterile jacket cells.
7. Within the capsule many uninucleate spores and elaters are produced.
8. The spores are spherical. The exine of the spore is thick and rough, while the intine is thin. Spores are arranged in tetrahedral tetrads.
9. The elaters are long spindle-shaped, single celled structures with tapering ends. Two spiral thickenings are present in the walls of elaters internally.

FUNARIA

SYSTEMATIC POSITION:

Sub-Kingdom	:	Embryophyta
Division	:	Bryophyta
Class	:	Bryopsida
Sub-class	:	Bryidae
Order	:	Funirales
Family	:	Funariaceae
Genus	:	***Funaira***

Occurrence:

- Grows abundantly in cold and rainy seasons on damp walls, crevices, rocks tree trunks and wooden logs.

Laboratory exercise:

- Thallus fixed in F.A.A
- Thallus tissues stained with iron-haematoxylin, orange G or fast green.

External morphology (gametophyte):

1. Plant grow in tufts.
2. Plant body is erect and foliose.

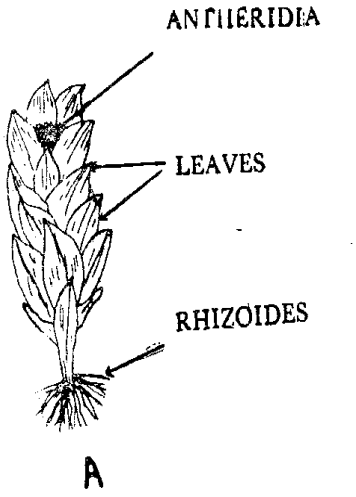


Fig. 83. A gametophyte plant showing male structures

3. The aerial shoot is differentiated into axis and leaves.
4. The axis is erect and branched (nearly 1-3 cm height). The branches arise below a leaf.
5. The axis (stem) and branches are covered with small, simple, sessile and spirally arranged leaves.

6. Leaves form apical tuft and looks like a bud.
7. Each leaf is entire, sessile and has a mid-rib. Mid rib not distinct in young leaves.
8. Rhizoids arise in tufts at the base of stem.
9. Rhizoids are branched, filamentous and bear oblique septa.
10. Sex organs are borne at the apices of the axis.
11. Sporophyte may be attached on the gametophyte plant.

Anatomical structures:

T.S. of stem (Axis)

1. Stem is differentiated into epidermis, cortex and central cylinder.
2. Epidermis is single layered and tangentially elongated (biconvex) cells. Cells are slightly thickened at outer surface. Cells have chloroplasts. Epidermis may be double layered at some places. Cuticle is absent.

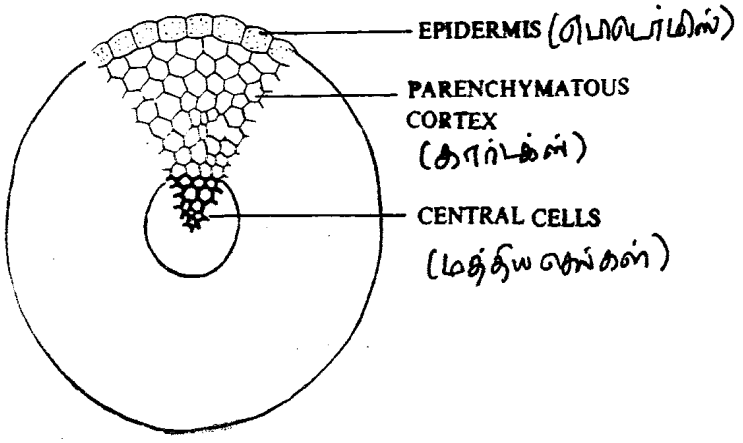


Fig. T.S. of stem.

3. Below the epidermis multilayered parenchymatous cortex is present. The cortical cells have thick walls towards the outer side. Inner cells are thin walled.
4. Cortical cells are green when young but at matured stage cells are non green.
5. Small leaf traces are present near the periphery of the cortex.
6. Central axial strands consists of elongated conducting cells with narrow lumen lacking protoplasm.

T.S. of leaf:

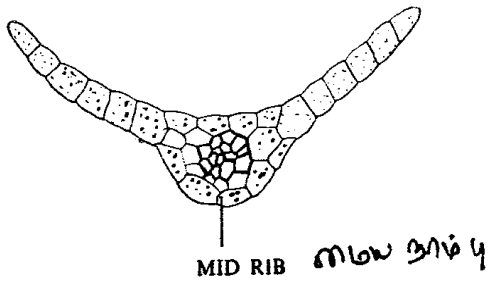


Fig. T.S. of a leaf.

- A single layer of polygonal thin walled cells containing chloroplast except in the middle (mid rib where elongated thick walled cells are noticed.

Sex organs:

- Gametophyte is monoecious and autocious.
- Sex organs are enclosed within the apical crown of leaves.
- Male structures develop at the apex of main axis.
- Female sex organs are situated on lateral branch arising from the base of the male branch.

Male reproductive structure:

L.S. through male shoot:

1. At the apex of the main axis, an expanded convex disc is present in between the leaves.
2. The disc is occupied by antheridia in cluster with paraphyses and look like a flower called as "male flower".
3. In between the antheridia, multicellular hairs called paraphyses are noticed. The apical cells of the paraphyses are globose in nature.
4. Both antheridia and paraphyses are surrounded by large leaves known as "perichaetial leaves".

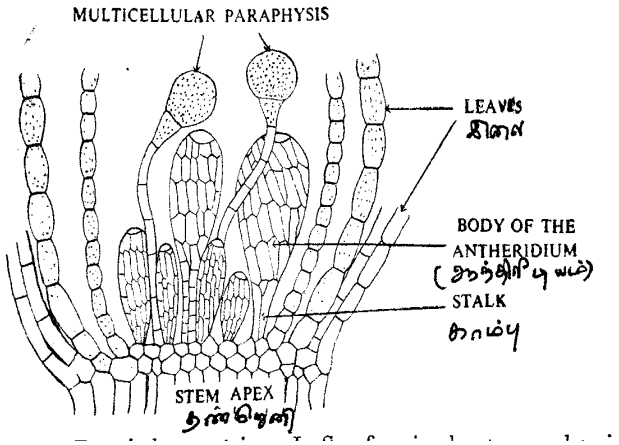


Fig. L.S. of main shoot apex showing antheridia.

5. Antheridia are noticed in various stages of development.
6. Each club shaped antheridium consists of stalk and a body.
7. Stalk is massive and multicellular.
8. Antheridium has a single layered jacket and the jacket cells have chloroplasts.
9. Apex of the antheridium is closed by 1-2 colourless opercular cells with thick walls.
10. Single layered jacket encloses androcytes.

Female reproductive structure:

L.S. of lateral shoot through female structure:

1. Archegonia are noticed at the apex of lateral branch.
2. Archegonia are noticed in clusters. Intermingled with archegonia are paraphyses.
3. Archegonia are noticed in various stages of development.
4. Archegonia are stalked. Stalk is massive.
5. The mature archegonium is a multicellular, stalked structure, with a broad venter and a narrow neck.
6. The wall of the venter is double layered.

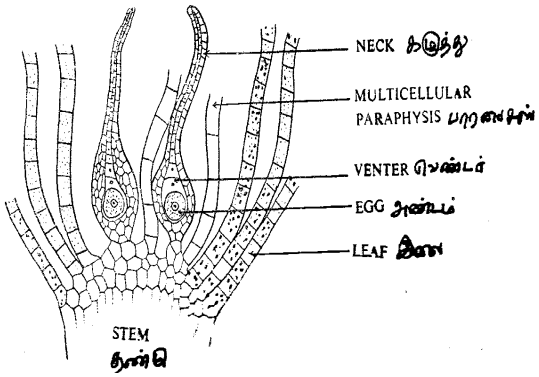


Fig. L.S. of lateral shoot showing female reproductive structures.

7. The neck consists of six longitudinal rows of cells surrounding a central canal.
8. Neck has 6-9 obliquely placed neck canal cells and venter has a venter canal cell and one egg cell.
9. Paraphyses are multicellular, simple and filamentous.

Sporophyte:

External structure:

- Mature sporophyte is very complex and can be recognized into three parts
    - foot
    - seta
    - capsule.

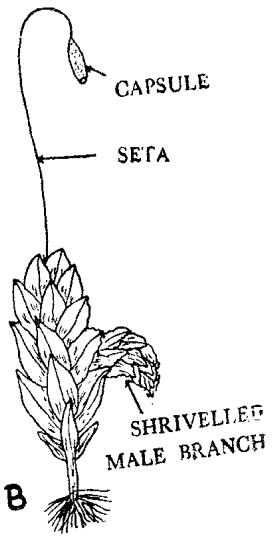


Fig. 88. Plant showing female branch and sporophyte

Foot of sporophyte:

- Foot is embedded in the apex of the archegonial branch.

Seta of sporophyte:

- This is long, slender and twisted.
- Internally made up of two types of cells.
- In the centre the axial cells are vertically elongated.
- The axial tissues are surrounded by parenchymatous cortex and single layered epidermis.

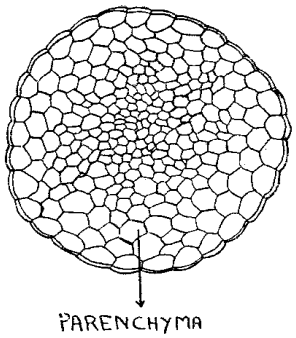


Fig. T. S. of seta of sporophyte.

- The cortical cells are thick walled with no spaces in between.

Capsule:

- Seta bears a capsule at the top.
- Capsule is slightly oblique, pear shaped and droops down.
- Capsule is capped by calyptra.

L.S. of the capsule:

Capsule is divided into three regions.

i) apophysis
ii) central fertile part (theca)
iii) operculum.

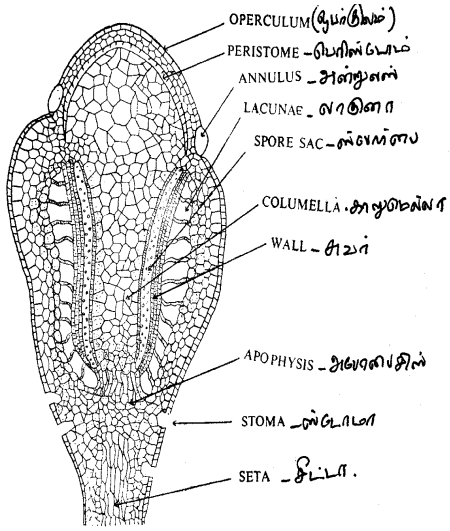


Fig. L.S. of capsule (nearly mature stage).

Apophysis:

1. Apophysis is the lowermost basal sterile portion of the capsule.
2. In the centre, apophysis has a parenchymatous tissue which is the continuation of seta.
3. The central conducting strand id surrounded by green cells. These have intercellular spaces.
4. The epidermis bears stomata.
5. The central region continues upward to form columella.

Central fertile part (theca):

1. The central portion is made up of vertically elongated cells which constitute the columella.
2. The upper part of the columella is cone-shaped projecting into the concavity of the operculum.
3. The lower part of the columella is connected with the central tissue of the apophysis.
4. Columella is surrounded by a spore-sac.
5. Spore-sac is U-shaped, broken by the base.
6. Spore-sac is surrounded by wall layers. An outer wall of 3-4 layers and an inner of one layer.
7. Outer to spore-sac is air spaces (lacunae) which are separated from each other by means of multicellular filaments.
8. The lacunae are surrounded by 3-4 green hypodermal layers of parenchymatous cells.

9. The outermost layer is slightly thickened at periphery and is called epidermis.
10. The spore-sac contains sporongenous cells, which form spores after division. Elaters are absent.
11. Spores are smooth walled and spherical. Each spore has an exosporium and endosporium.

Operculum:

1. Operculum is arch-shaped lid.
2. Below the lid, peristome is situated.
3. The operculum is separated from the rest of the capsule by a constriction.
4. Immediately below the constriction is the rim which is made up of elongated radiating pitted cells.
5. Five to six superimposed layers of cylindrical cells form annulus above the rim.

Peristome:

1. Peristome teeth encircle the operculum on the inner side.
2. The peristome consists of two rows of 16 teeth in each row. The rows are arranged one above the other.
3. The teeth are curved triangular plate like.
4. The inner row is overlapped by the outer.
5. The teeth of the outer row bear transverse bands and twisted spirally to the left and their free pointed ends meet at a central disc.

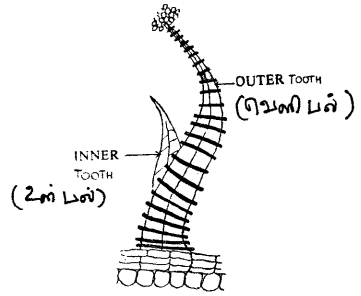


Fig. A portion of peristome showing inner and outer peristomal teeth.

6. The teeth of the inner peristome are colourless, shorter and comparatively more delicate.
7. Slits are formed between the teeth of the upper and lower rows.

8. Each tooth of outer row is made up of two layers, an outer and an inner not affected by moisture.

Protonema (Slide):

1. Protonema is a branched filamentous structure.
2. The aerial filaments are green and septate.
3. Subterranean filaments are non-chlorophyllous and have oblique septa. These branches act as rhizoids.

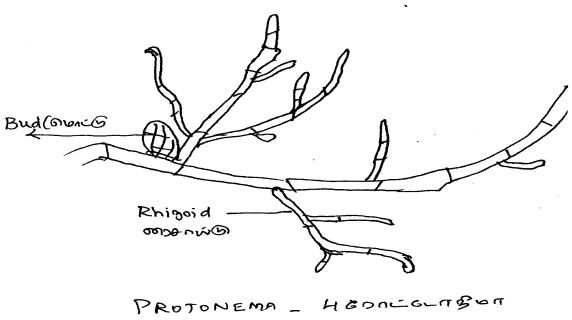


Fig. 92. Protonemal stage

4. Buds are formed near cross-walls at the base of erect filaments.
5. Buds form stem and three rows of leaves.

MAJOR PRACTICAL I

(Algae, Bryophytes, Fungi, Bacteria, Viruses, Lichens and Plant Pathology)

1. Cut transverse section of **A, B** and **C**. Stain and mount in glycerin. Identify giving reasons. Draw diagrams. Leave the slides for valuation.
(51 marks)

2. Draw diagrams and write notes of interest on **D, E, F** and **G**.
(24 marks)

3. Name the genus, group and morphology of given part of **H, I** and **J** (Diagrams not necessary). **(9 marks)**

4. Identify and write notes on economic importance of **K** and **L.**
(6 marks)