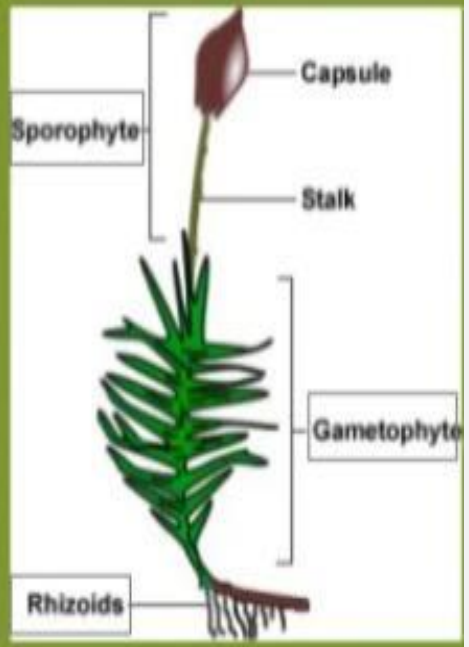
BRYOPHYTES MODULE:6

GENERAL CHARACTERS OF BRYOPHYTES

- Non vascular plants
- Amphibians of plant kingdom
- Simplest and most primitive
- Occur in shady and humid localities
- Bryophytes include:
- Mosses,liverworts,hornworts

- **Absence** of specialized *tissues for transporting water and dissolved food throughout the organism* **limits** terrestrial forms to being very short plants, since the only way to move substances through the plant body is by osmosis and diffusion from surface moisture.
- Bryophytes *do not have roots*, but *have rhizoids*, which are relatively simple, sometimes *multicellular filaments of thin-walled cells*



MOSSES

- **The Moss Body**
  - **Thallus – Body structure**
  - **Rhizoids – hair-like absorptive structures**
  - ***Do not have TRUE roots, stems, or leaves***

-*Many mosses have separate sexes*: male plants and female plants

-The *gametophyte generation is dominant*

LIVERWORTS

Liverworts

- **Thallus**
  - **A body that *lacks roots*, stems, or leaves**
  - **Liverworts get their name from their *liver shaped thallus***
- **Gemmae**
  - **Asexual reproductive structure of liverworts**
  - **Borne in a saucer-shaped structure – gemmae cup**

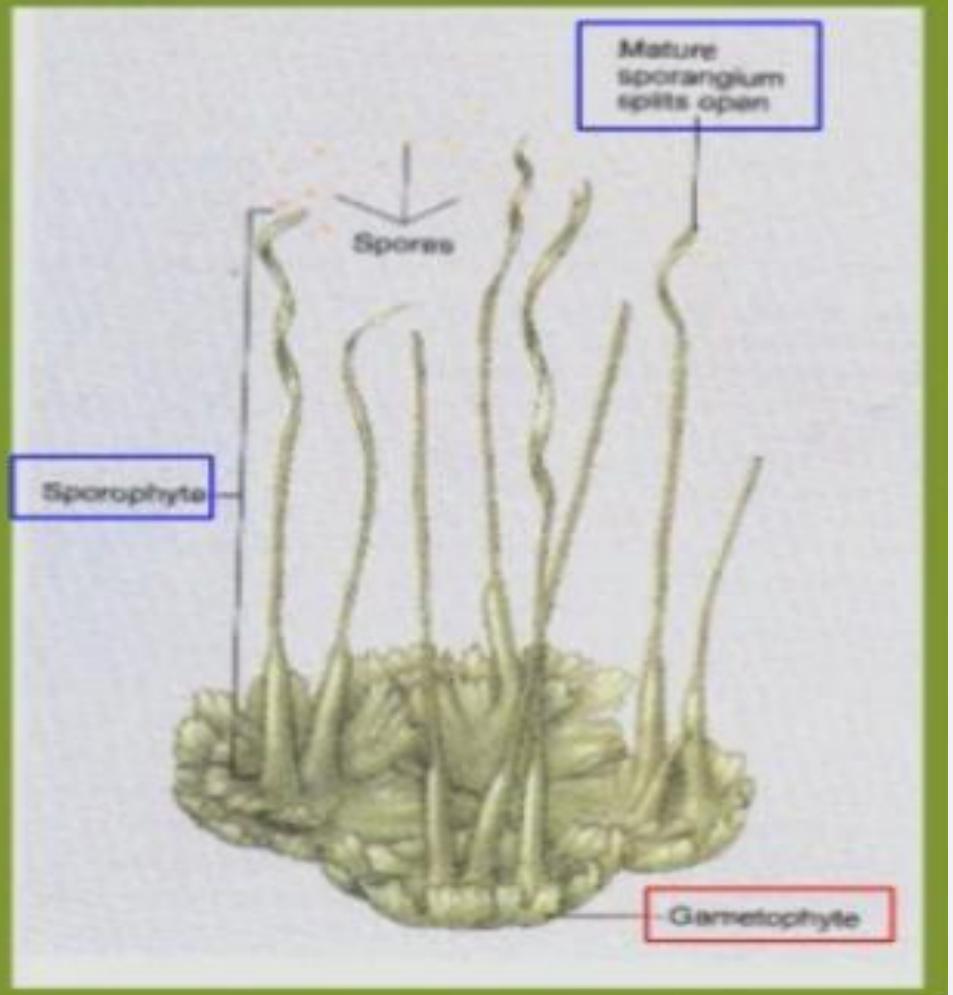
HORNWORTS

Hornworts

-Location: *fields & roadsides*

-Thalloids - 1-2 cm

-Sporophyte generations form hornlike projections out of the gametophyte thallus



- Thallus is not differentiated into roots,stem and leaf parts.
- They have tootlike,leaf like,stem like parts
- Unicellular, unbranched root like structure called rhizoids
- Plant body made up of parenchymatous cells
- Both vegetative and sexual reproduction is present

ALTERNATION OF GENERATION

GAMETOPHYTIC GENERATION

Haploid phase

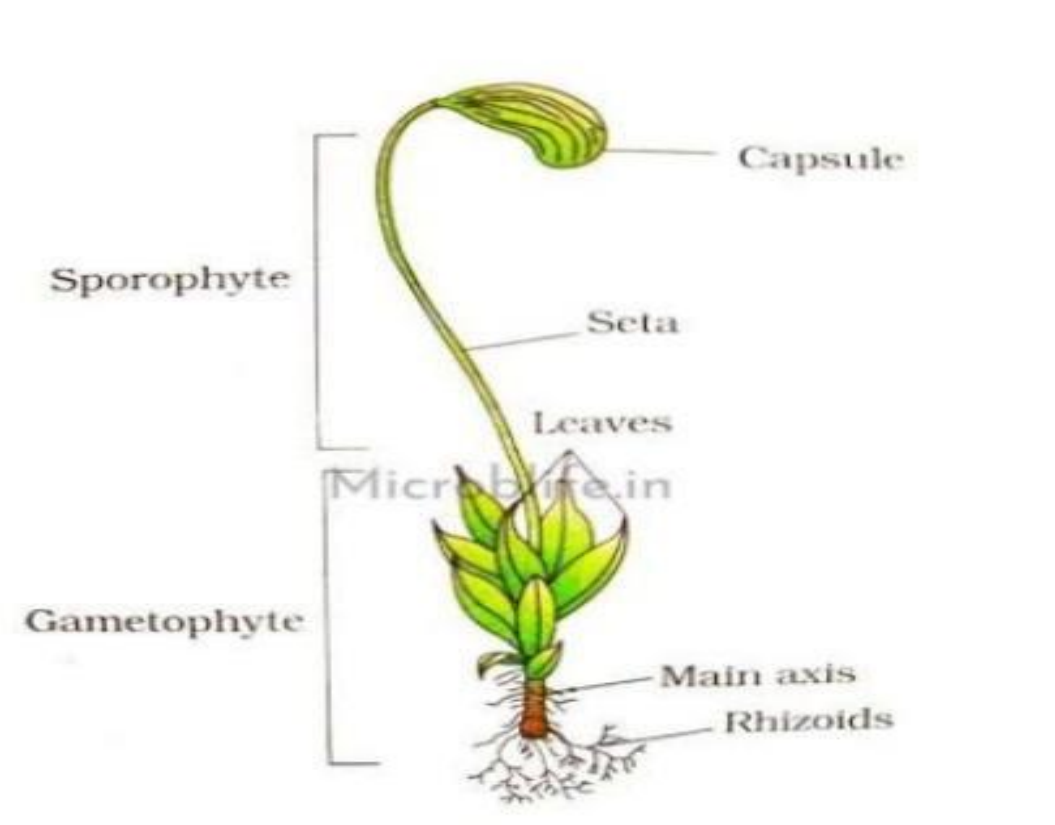
Green coloured,long living

Independent,autotrophic

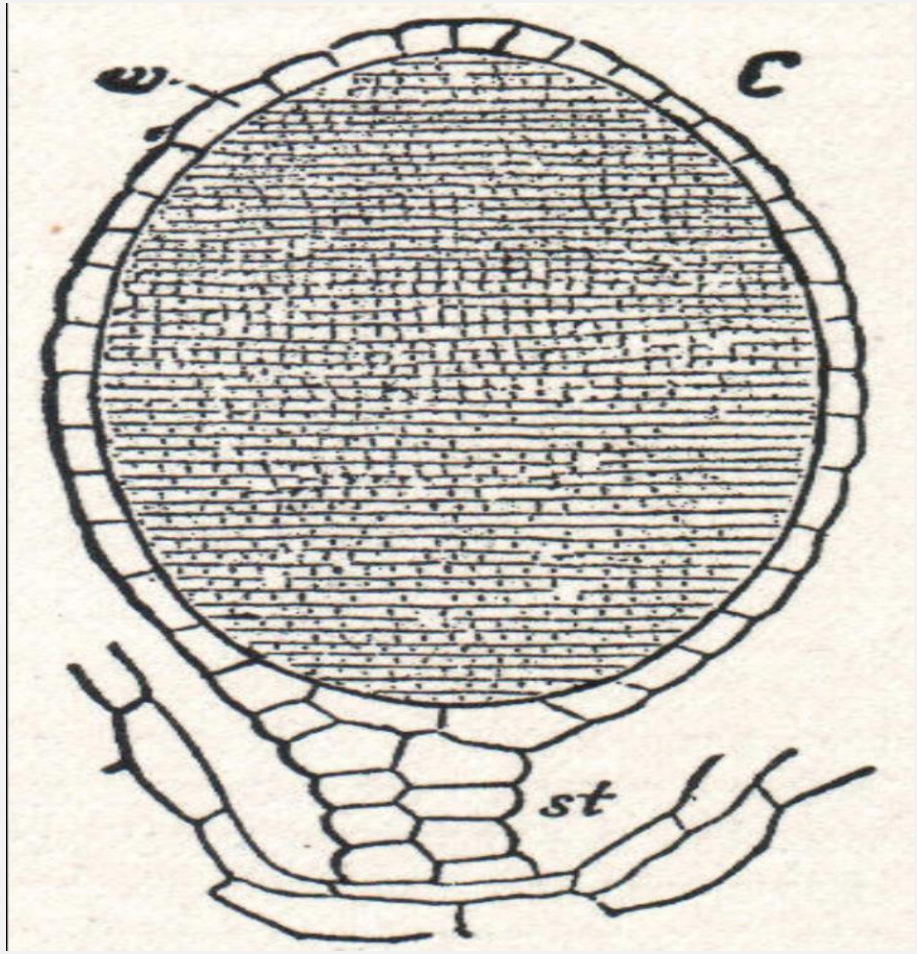
SPOROPHYTIC GENERATION

- Sporophytic phase is diploid
- Short living
- Completely depend on gametophyte

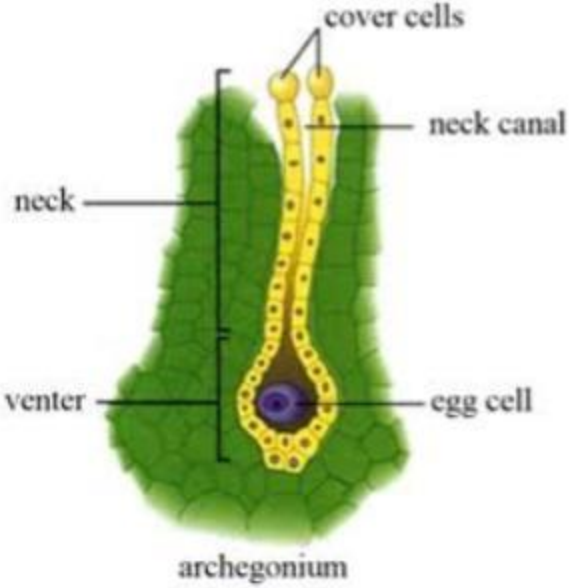
PLANT BODY OF SPOROPHYTE



MALE AND FEMALE SEX ORGANS

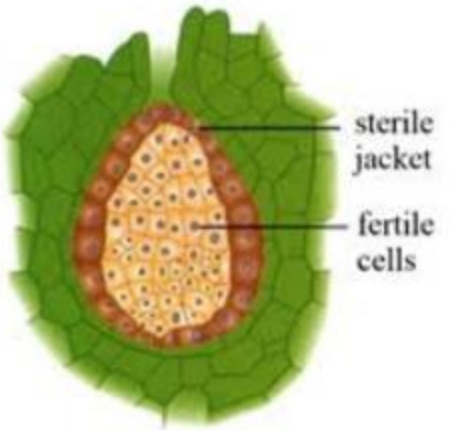


Gametangia and gametes can be embedded in the gametophyte tissue as shown here, or attached at the surface of the gametophyte.



archegonium

Archegonium (Egg-bearing Organ) with a long neck extends beyond the venter, capped at the tip with cover cells.



archegonium

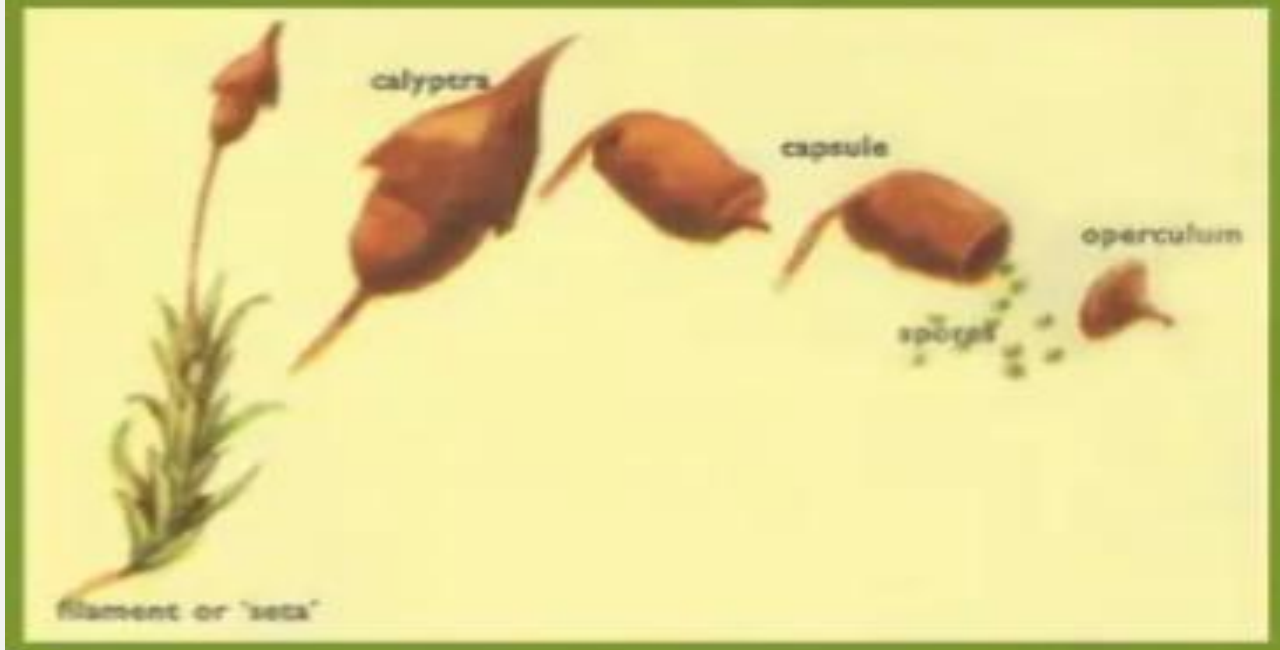
Antheridium (Sperm-bearing Organ) with an outer row of sterile (nonspermforming) cells enclosing inner fertile cells, each of which becomes a sperm gamete.

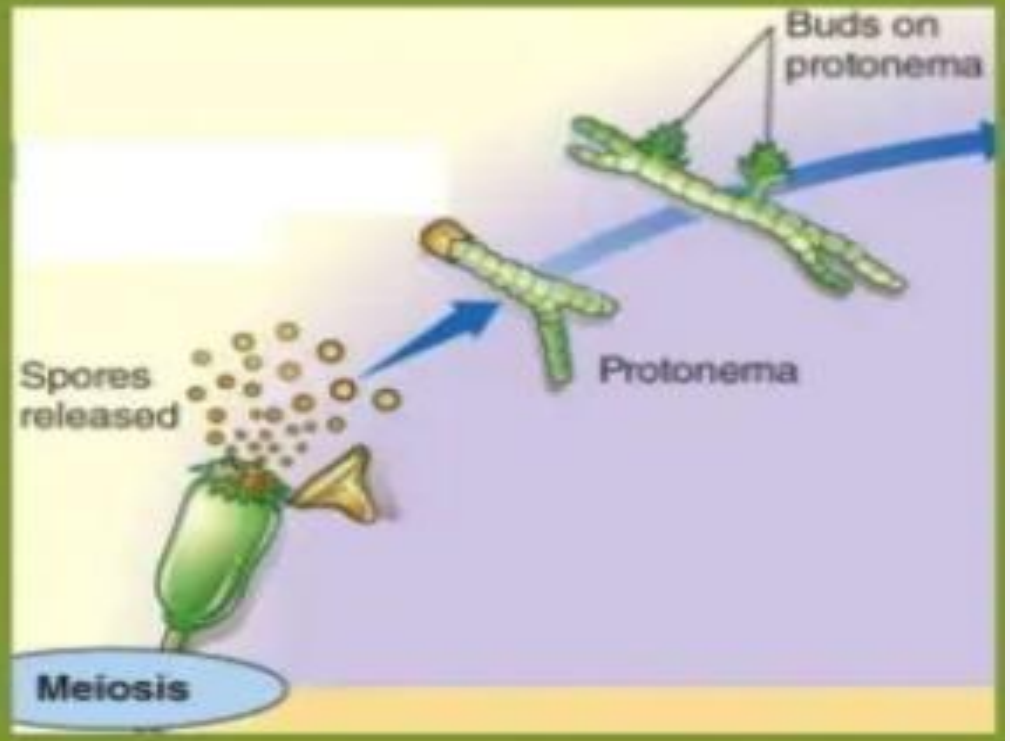
FERTILIZATION

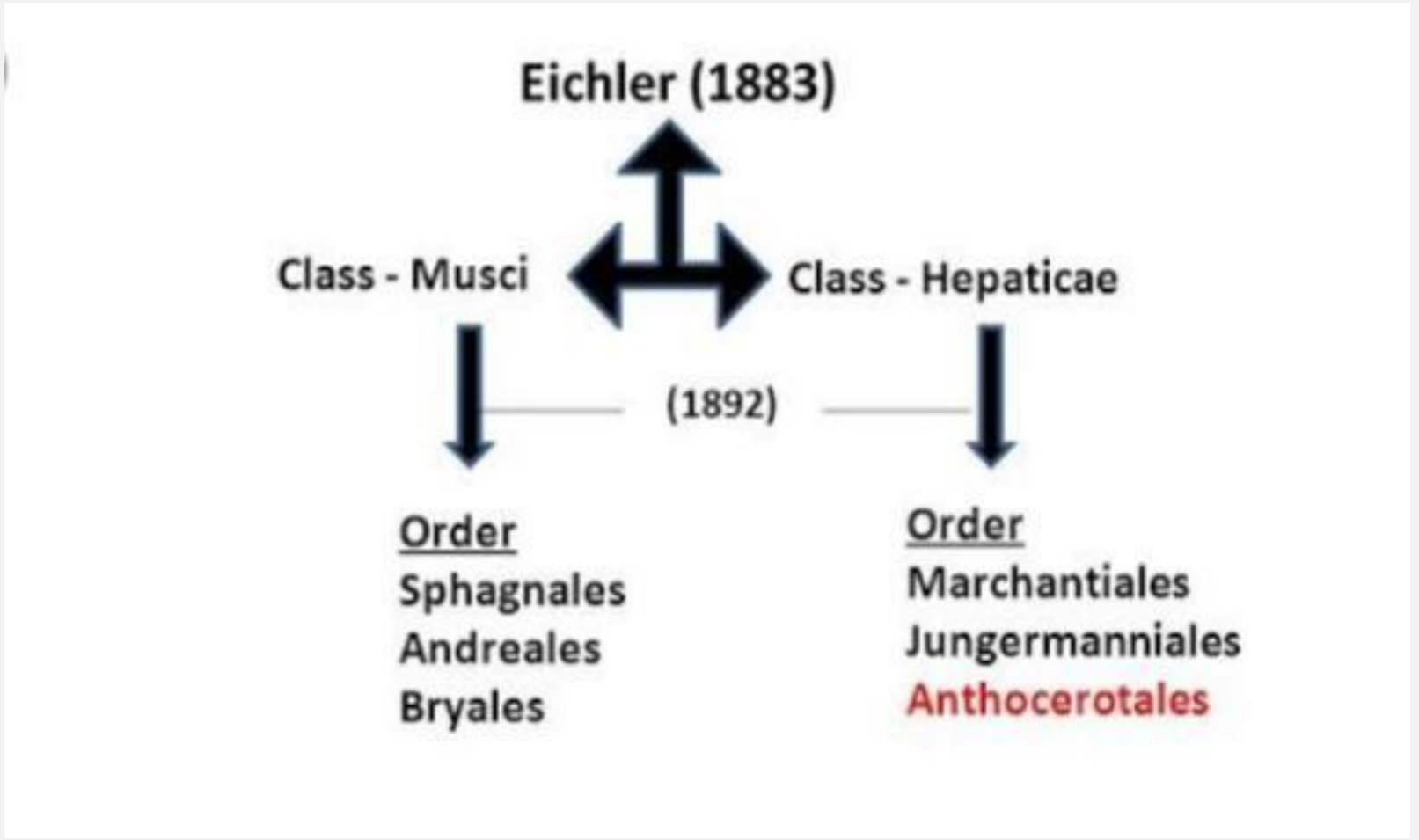
- Sperms release -water-reaches archegonium- cover cells rupters – sperms enters into the archegonia- come in contact with egg- form fertilized egg called zygote (2n)- become embryo(2n)- sporophyte (2n)

- Spore germinates- produce juvenile bryophyte called protonema(n) – become gametophyte (n)

- **A fertilized egg in an archegonium develops into the sporophyte.**
- **The sporophyte consists of a *spore-containing capsule* which, depending on the species, may be stalked or stalkless. Each spore contains a *mix of genes* from the two parents and on successful germination will give rise to a *new gametophyte*.**






Eichler (1883)
Class - Musci
Class - Hepaticae
(1892)
Order
Sphagnales
Andreales
Bryales
Order
Marchantiales
Jungermanniales
Anthocerotales

As per ICBN Bryophyte

Hepaticopsida Liverworts

Order
1. Takakiales
2. Calobyales
3. Jungermanniales
4. Metzgeriales
5. Marchantiales
6. Sphaerocarpales
7. Monocleales

Anthocerotopsida Hornworts

Order
1. Anthocerotales

Bryopsida Mosses

Sub Class
1. Sphagnidae

Order – Spahagnales
2. Andreaeidae

Order – Andreales
3. Buxbaumidae

Order – Buxbaumiales
4. Bryidae

Order – Fissidentales
Dicraneales
Pottiales
Grimmkiales
Funariales
Schzostegales
Tetraphidales
Eubryales
Isobryales
Hookeriales
Hypnobryales
5. Polytrichadae

Order – Polytrichales
Dawsoniales

Adopted by
Takhtajan (1953); Schuster (1953);
Parihar (1965) and Udar (1976)

± 24000 species and 960 genera

- To which of this class, sub class “Metzgeriidae” belongs to
- A) Sphaeropsida B) Jungermanniopsida
- C) Anthoceratopsida D) Bryopsida

SAILENT FEATURES OF MARCHANTIALS

- Haploid(gametophyte)
- Green colour,flat,dictomously branched,marked midrib
- Internally 2 different portions
- Dorsal- green colour,air chamber present
- Ventral – composed of colour less parenchyma and storage tissue scales are usually present on the ventral surface

Rhizoid- smooth,tuberculate

Sex organs scattered or assembled in receptacle which may be sessile or stalked called gametophores

Capsule wall 1 cell thickening .targonia ,cyathodium capsule has lid or operculum at its apex

Columella absent

Gametophyte

Dominant phase in the life cycle of liverworts.

Calobryales, jungermaniales,metzgeriales gametophytic plant is leafy

TYPES TO STUDY IN HEPATICOPSIDA(LIVER WORTS)

- Riccia
- Marchantia
- Order : marchantiales

ASEXUAL REPRODUCTION IN BRYOPHYTES

- Fragmentation: riccia, marchantia,pellia
- Gemmae formation:green multicellular asexual buds called gemmae.Easily detached by water and winds currents to new habbitats.gemmae are developed in gemmae cups
- Adventious branch: they arise from the ventral surface of thallus and become separated by death and decay of parent plant.detached branch grow into new plant

Fig. 14. *Riccia*. Thallus showing apical tubers.

Fig. 13. *Riccia Fluitans*. Thallus showing adventitious branches

- Tuber formation:Special subterian branches are formed towards the end of growing season in certain liver worts well exposed to decication.
- These branches swollen at their tips to form tubers They are buried under ground.tubers remain dormant.
- Tubers are the portion of the thallus modified for food storage and dormancy
- persistant apices:the growing apical portion of the thallus lobes with a certain amount of thallus tissue become thickened or modified
- Regeneration: every living cells of a liver worts thallus is capable of regenerating entire plant.

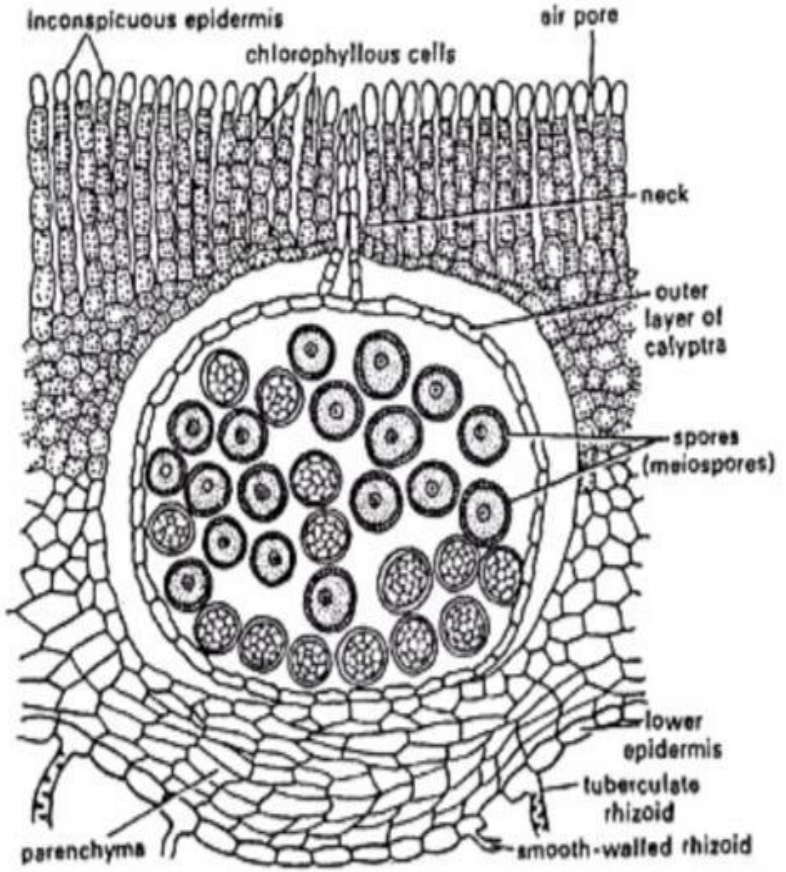
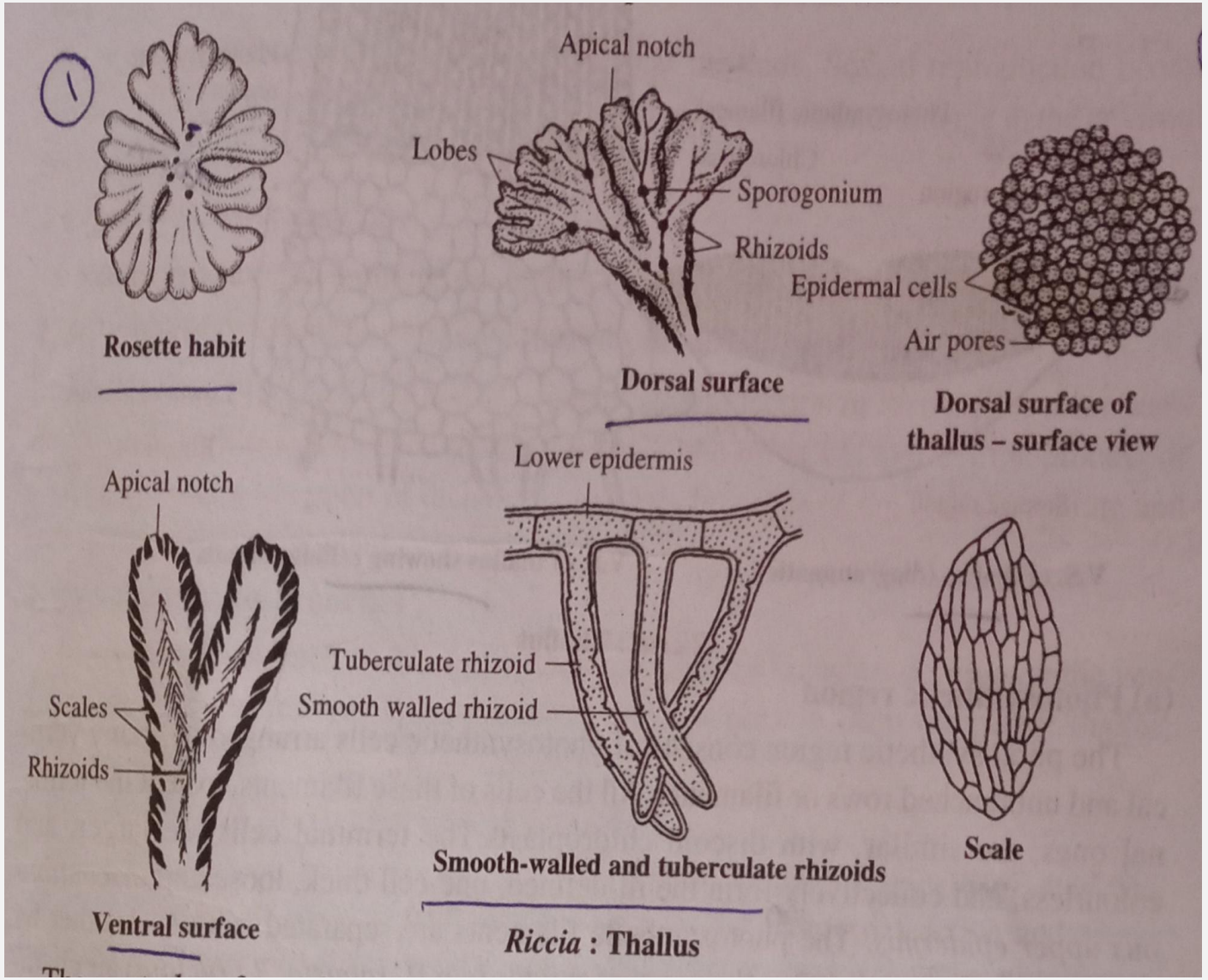


Fig. 19. *Riccia*. Transverse section of thallus passing through mater sporogonium.



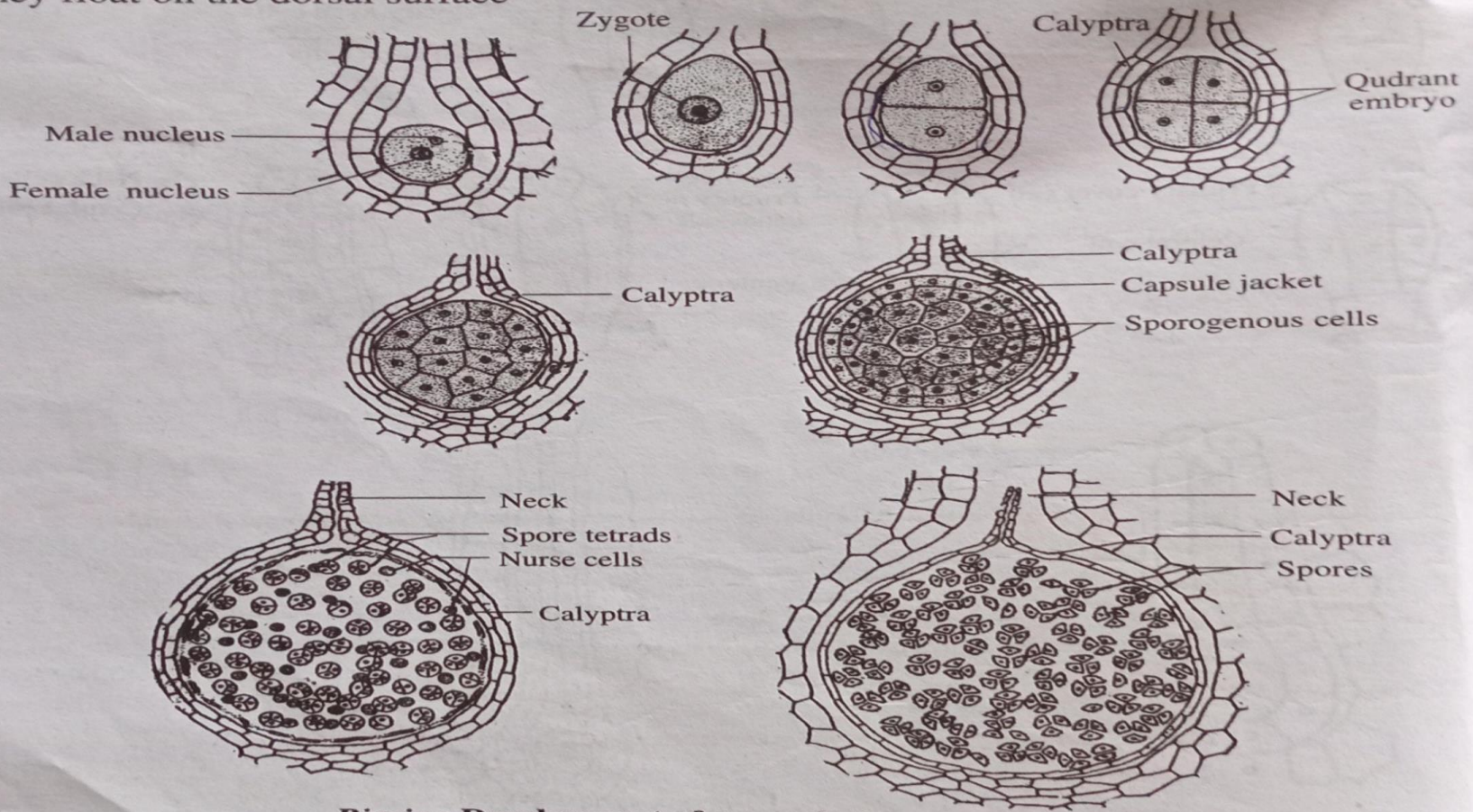
RICCIA SEXUAL REPRODUCTION

- Sexual reproduction takes place by means of male and female reproductive organs.(Antheridium archegonium)

Fertilization

Fertilization takes place only in the presence of water. Water is essential for the liberation of antherozoids from the antheridium, for the swimming movements of antherozoids to the archegonium, and also for the disintegration of neck canal cells and venter canal cell.

As the antheridium matures and the androcytes metamorphose to antherozoids, the sterile jacket cells of the apical region of the antheridium are softened by water. These cells disintegrate forming a pore. Antherozoids are forced out of the antheridium and they float on the dorsal surface

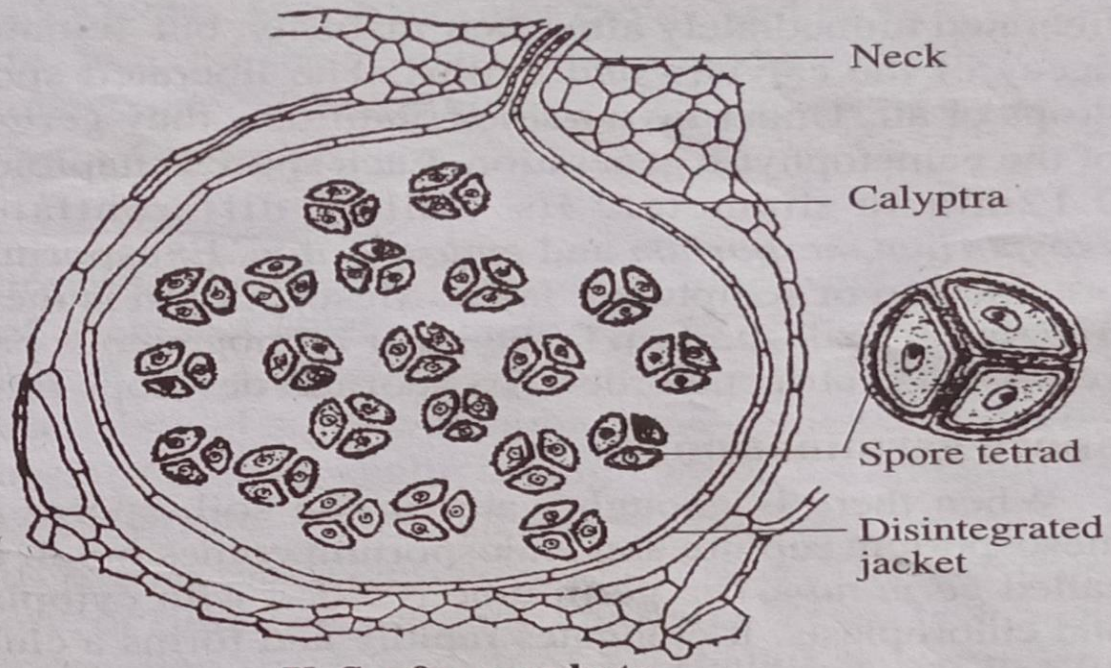


***Riccia* : Development of sporophyte**

Just before fertilization, the neck canal cells and venter canal cell of the archegonium disintegrate to form a mucilaginous substance which imbibes water. This imbibitional force with in the neck causes the seperation of the cover cells from one another. Thus, a free passage, called *neck canal*, is formed for the entry of antherozoids into the archegonium. A few drops of mucilage also come out of the open neck. It contains certain chemicals which attract the free-swimming antherozoids towards the open neck and then direct them towards the egg. Although many antherozoids enter the neck, only one of them fuses with the egg to form a diploid *zygote or oospore*. Zygote represents the first cell of the sporophyte.

The diploid zygote is the mother cell of the sporophytic generation. It secretes a wall around and increases in size and occupies the entire cavity of the venter. Fertilization stimulates the cells of the venter wall. They divide anticlinally and periclinally and form a two-layered *calyptra* around the developing sporophyte.

The mature sporophyte of *Riccia* has a simple organization.It is represented only by *spore sac or capsule*, embedded on the dorsal surface of the thallus. It lacks both *foot* and *seta*. Spore mother cells are enclosed by a single-layered jacket, the *capsule wall*. The capsule, in turn, has a protective covering of calyptra which is a part of the gametophyte.



V. S. of sporophyte

DEVELOPMENT OF SPOROGONIUM

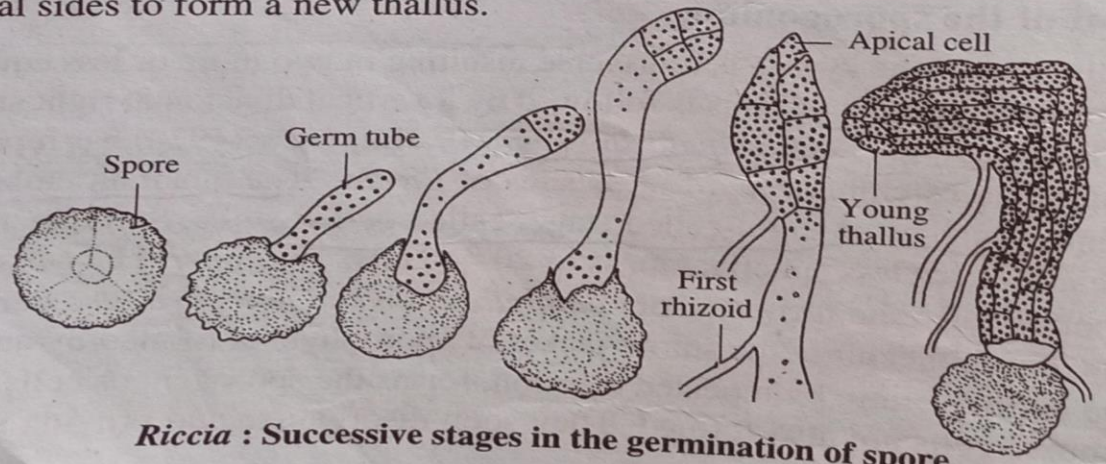
- Four celled quadrant embryo formed
- It divides again and produce an eight celled stage.Divides to form mass of cells,it divides periclinally to form an outer amphithecium and inner endothecium.
- Functional spore mother cell undergoes reduction division of the spore mother cell and after sometime the inner layer of the calyptra also degenerate.
- The mature sporophyte,spore tetrads lie in a cavity enclosed by a single layered calyptra.

Dehiscence of sporogonium

There is no mechanism for dehiscence and dispersal of spores. The spores are not liberated immediately after their maturity, but remain in the spore sac till the death and decay of the calyptra and thallus. The liberated spores are carried by splashing rain drops or air. Under favourable conditions, they germinate. Spores are the mother cells of the gametophytic generation. Each spore is haploid, uninucleate, pyramidal, and 0.5-0.12mm in diameter. Its wall is differentiated into three layers, namely *exosporium, mesporium* and *endosporium*. Exosporium is the outermost cutinized and ornamented or sculptured layer. Mesosporium is the middle layer with three concentric zones. Endosporium is the inner homogeneous pectic layer. These three layers develop in a centripetal order. Exosporium develops first and endosporium develops last.

Spore germination

When there is enough water in the soil, spores germinate. Exosporium and the mesosporium rupture and endosporium comes out in the form of a tubular outgrowth, called *germ tube*. The germ tube is filled with cytoplasm which contains oil globules and chloroplasts. It elongates rapidly and forms a club-shaped structure. A transverse wall at the distal end of the tube forms a small cell which undergoes three vertical divisions. As a result, two tiers of four cells each are formed. One of the four cells of the upper tier becomes the *apical cell*. It regularly cuts off cells on the dorsal and ventral sides to form a new thallus.



***Riccia* : Successive stages in the germination of spore**

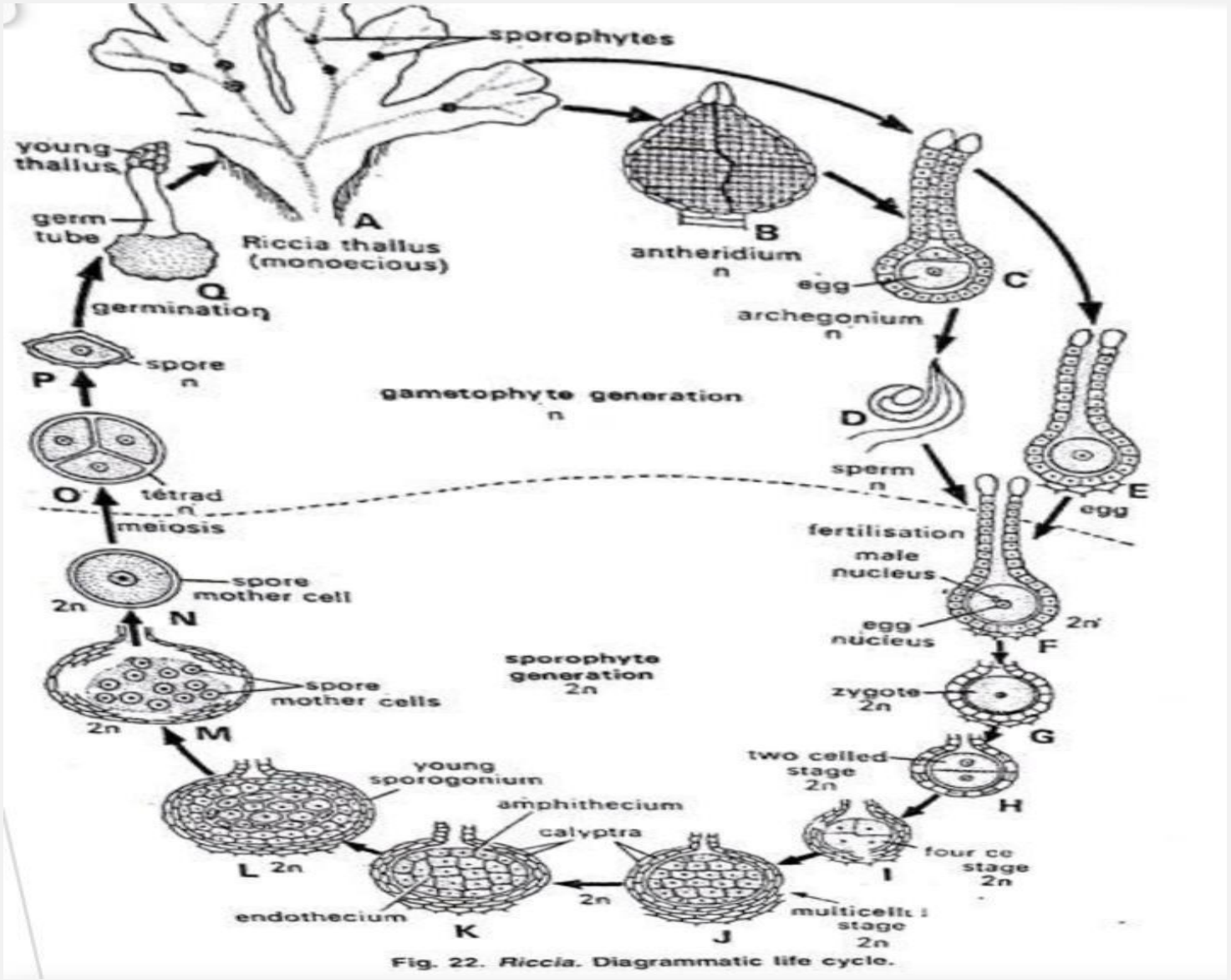


Fig. 22. *Riccia*. Diagrammatic life cycle.

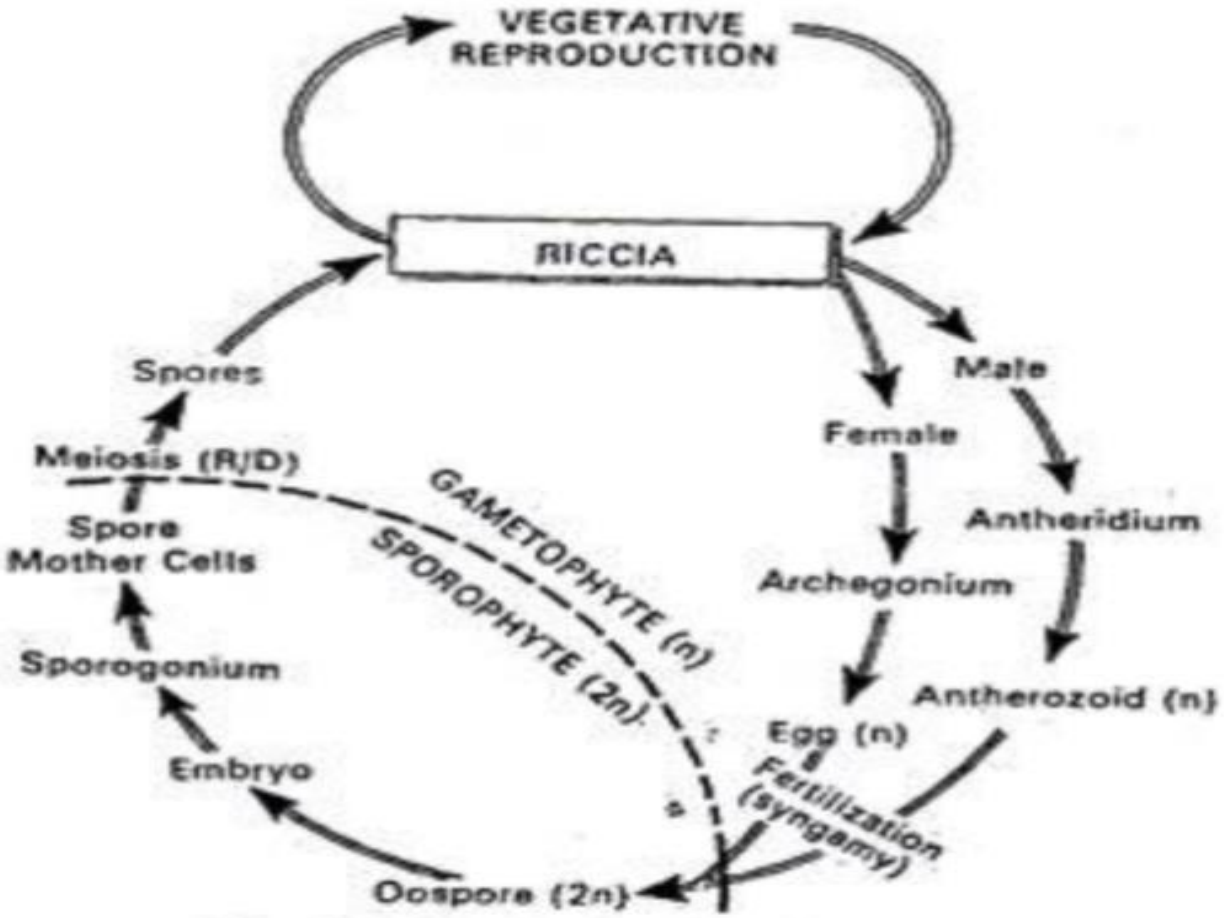


Fig. 23. *Riccia*. Graphic life cycle

LUNULARIA

- Presence of lunar shaped gemmae(asexual reproduction)
- Presence of oil deposit and starch in storage region
- Sexual reproduction antheridium : sessile ,archegonium:: flask shape

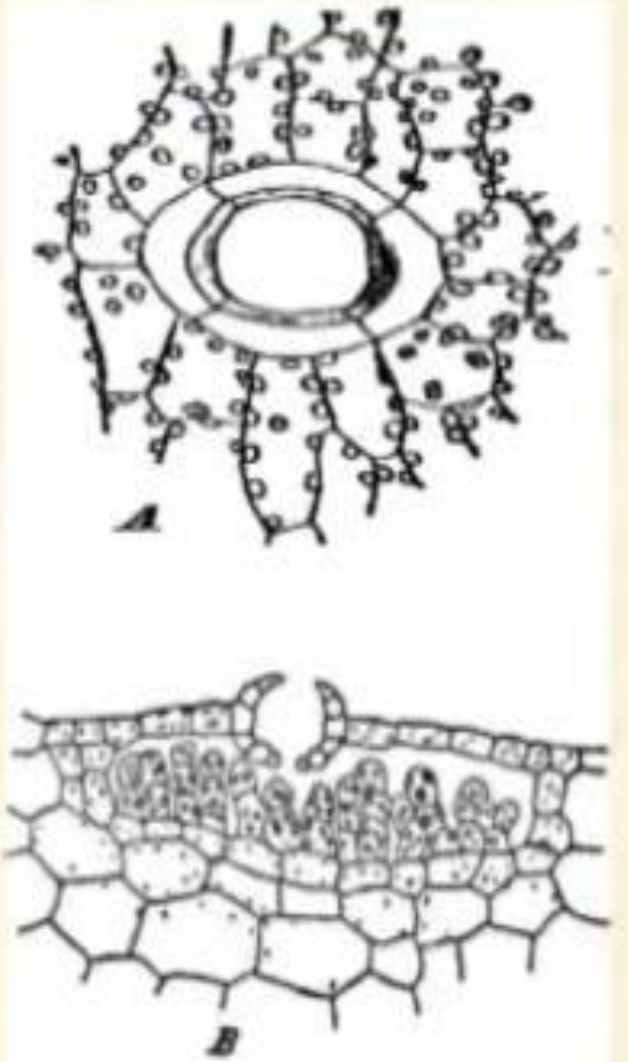
MARCHANTIA

Dorsal Surface:

- A shallow groove marked by the presence of a distinct midrib in each branch
- Many polygonal areas which demarcate the outline of underlying air chambers
- Each polygonal area has a pore in its centre called air pore
- Gemma cups are present along the midrib
- Each branch has a growing point situated at the apex in a groove called apical notch

Air Pores

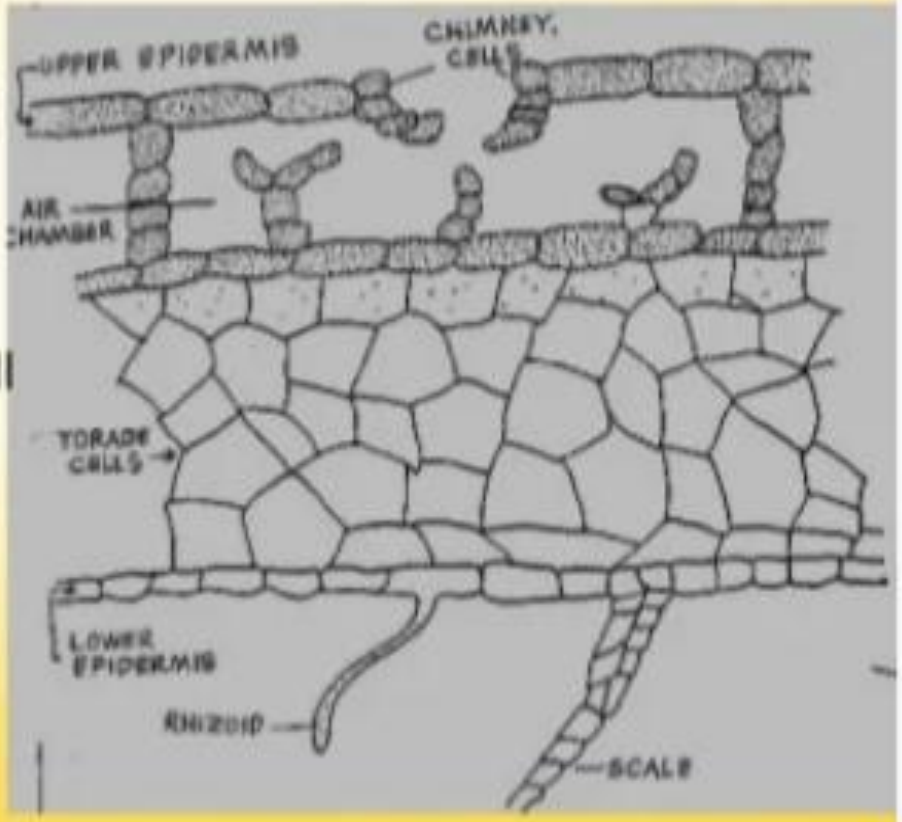
- Barrel shaped
- Each pore has 4-8 superimposed tiers of cells
- Each tier consist of a ring of 4-5 cells
- The cells of lowermost tier project inward giving the pore a star-shaped appearance
- Half of tiers project outward and half project inward
- The pores have comparatively wide pore passage in the middle than on margins
- These are analogous to stomata but they cannot control the pore size like stomata



Anatomy

Photosynthetic region

- Lies below upper epidermis
- It consists of large air chambers separated by single layered partition wall
- Uniform in shape and are arranged in a horizontal row
- Many photosynthetic filaments arise from foot of each chamber
- The filaments are made of chloroplast containing cells

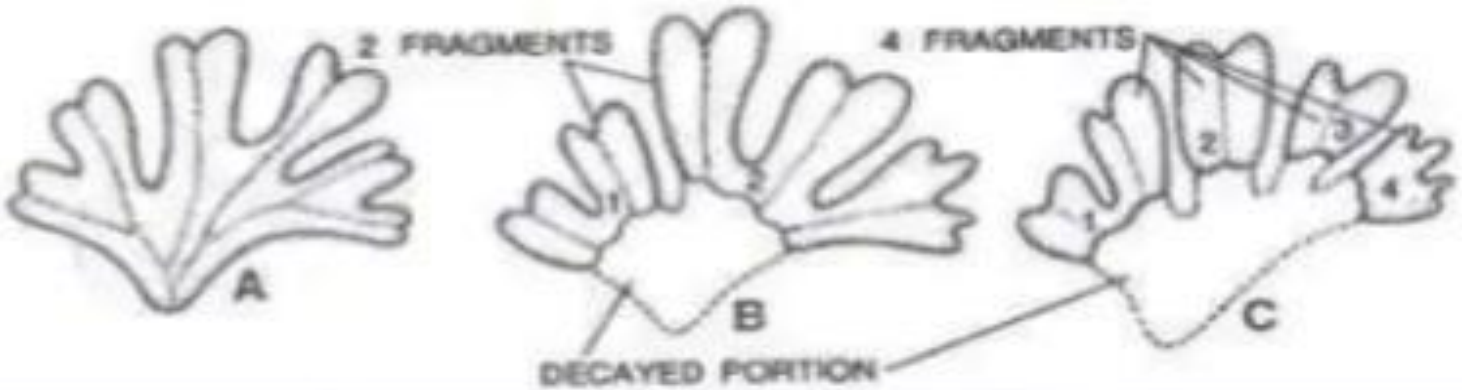


Reproduction

Vegetative reproduction:

By progressive death and decay

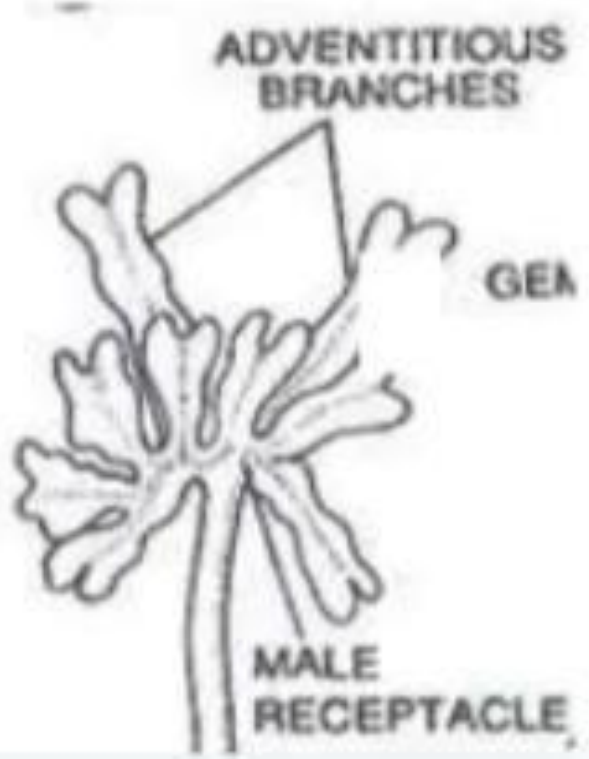
- Mature cells are present at posterior end and are short-lived
- New cells are regularly formed by apical cell
- Death and decay therefore naturally starts from the posterior end
- As the process of decay reaches the point of dichotomy, two apical parts of thallus separate
- Each grows into a new plant



Reproduction

By adventitious branches

- Some species possess adventitious branches on ventral surface
- On separation these grow into new thalli



Reproduction

By Gemma

- Gemma cups(2mm X 3mm) are cupules present on dorsal surface along midrib region
- Margins are hyaline, lobed, spiny or entire
- From floor of gemma cup many small, stalked, discoid & biconvex gemma arise
- Gemma is constricted in middle and 2 notches possess a row of apical cells
- Gemma contains chloroplast containing cells and rhizoidal cells
- Some mucilage hairs also arise from gemma cup's floor which imbibe water and help in deispersal of gemmae
- Gemmae on coming in contact with ground start germinating immediately

Fig: V.S. of thallus through gemma cup

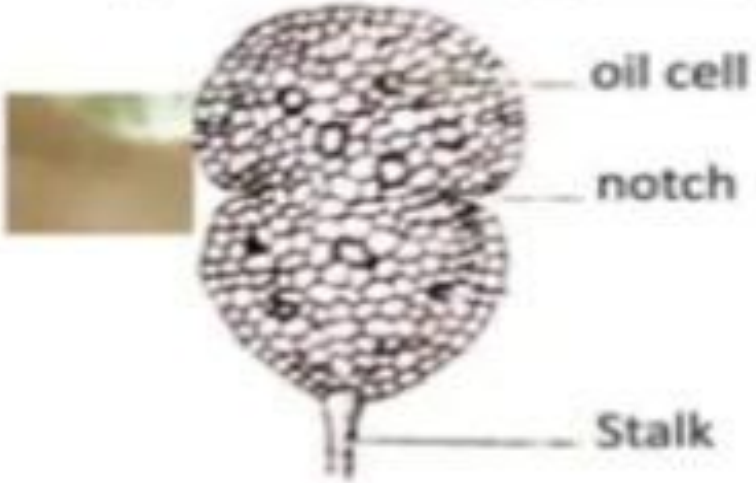


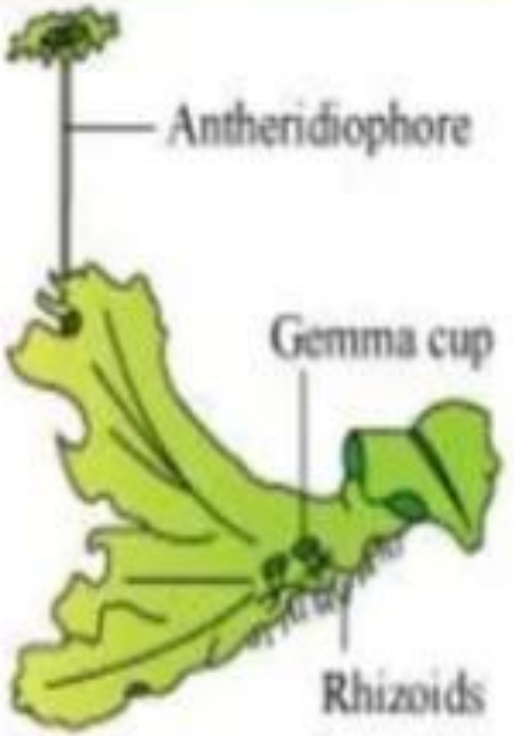
Fig: Gemma

Sexual Reproduction

- Marchantia is a heterothallic or dioecious plant
- Male thallus bears antheridiophores and female thallus bears archegoniophores
- They arise from distal end of thallus from growing point and after their formation growth of thallus ceases

Antheridiophore

- It has 1-3cm long stalk that bears 8 lobed peltate disc
- Inner structure similar to that of thallus with upper epidermis(having air pores), air chambers(having photosynthetic filaments)
- Antheridial chambers alternate with air chambers
- Each antheridial chamber contains a single antheridium and opens externally by a pore called ostiole.
- On each lobe antheridia arise acropetally
- Antheridiophore has 2 longitudinal grooves which contain rhizoids and scales



Antheridium

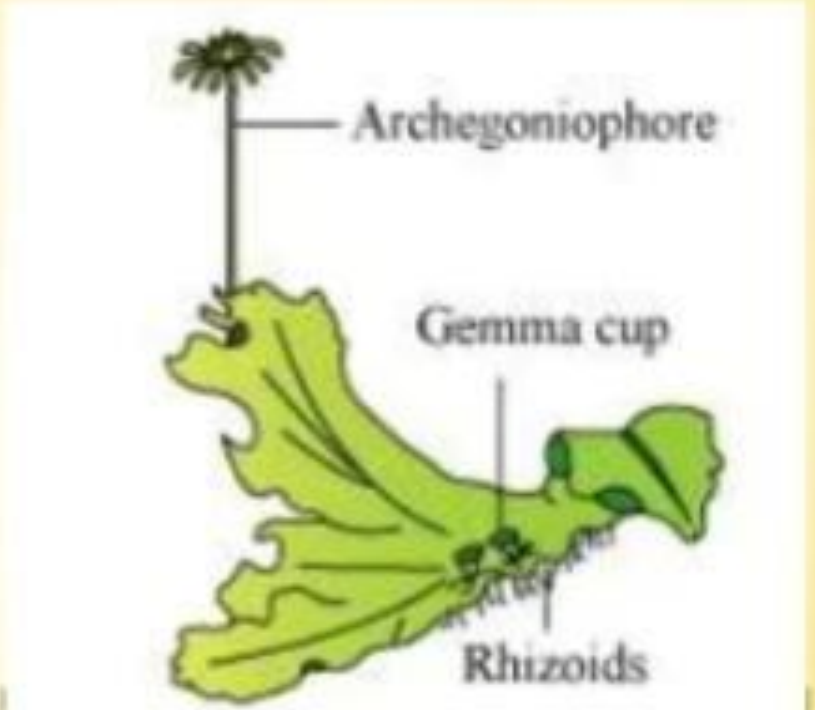
- A mature antheridium is globular or oval with multicellular stalk
- Body of antheridium has a single layered sterile jacket enclosing androcytes which eventually metamorphose into antherozoids
- The antherozoid is a minute biflagellate structure

Dehiscence of antheridium:

- Water enters the antheridial chamber through ostiole
- Some cells at the distal end disintegrate when they come in contact with water and hence antheridium ruptures
- Antherozoids come out of ostiole like smoke column and spread on surface of antheridial disc

Archegoniophore

- It has slightly longer stalk(2-5cm) and a terminal disc which is 8 lobed
- Archegonia are borne on dorsal surface in acropetal succession
- Internal structure is similar to thallus with upper epidermis having air pores and underlying air chambers

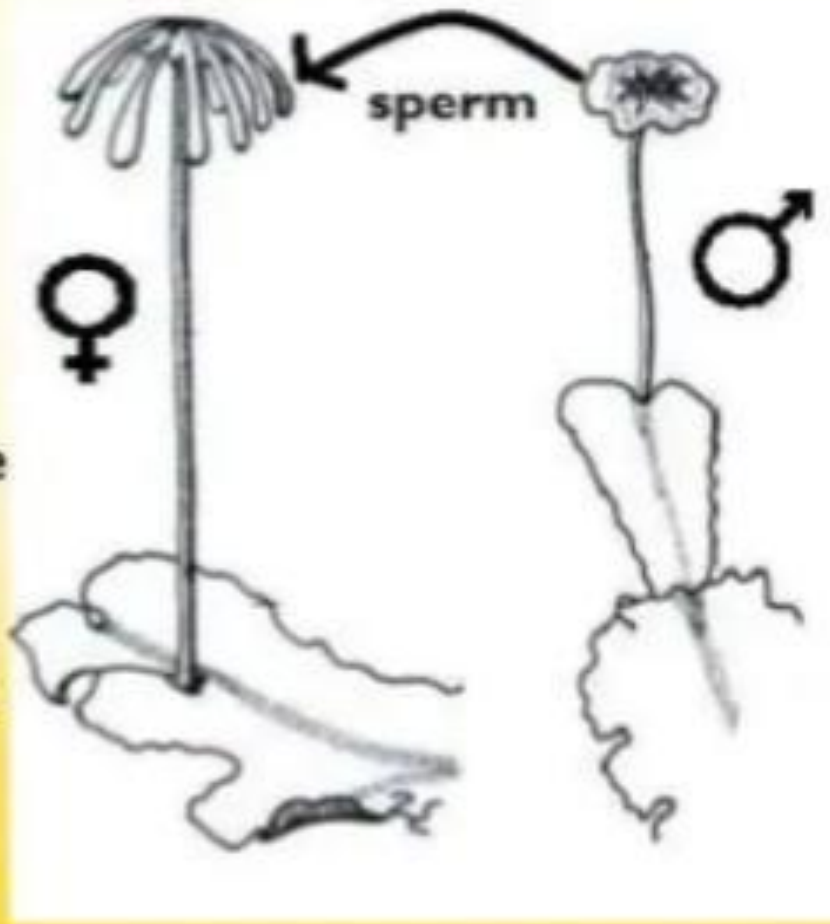


Archegonium

- The archegonium is a stalked flask shaped structure with a basal swollen venter and an elongated neck
- Venter is surrounded by 1 celled thick sterile jacket and contains a large egg cell and relatively small venter canal cell
- The neck consist of 6 vertical rows of cells called neck cells which enclose 4-8 neck canal cells
- Tip of neck has a rosette of 4 cover cells

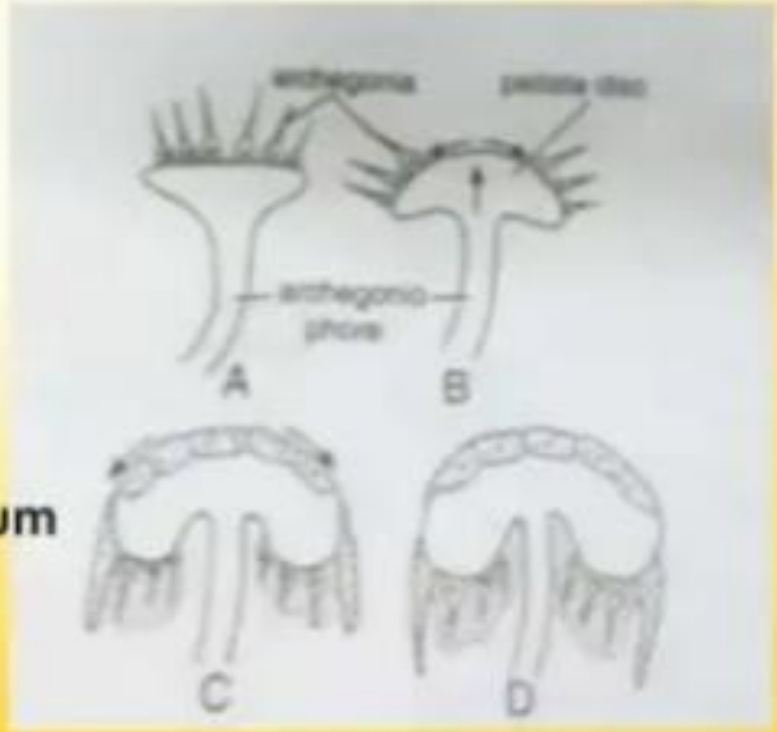
Fertilization

- Water is essential for fertilization
- Archegonia are placed upright on archegonial disc
- Venter canal and neck canal cells degenerate to form a mucilaginous substance which imbibes water and results in sparation of cover cells by pressure
- Antherozoid present on surface of antheridial disc are splashed by rain drops on to the surface of archegonial disc
- They are attracted chemotactically towards the neck of archegonium
- Antherozoids enter archegonium and only one fuses with egg leading to formation of zygote



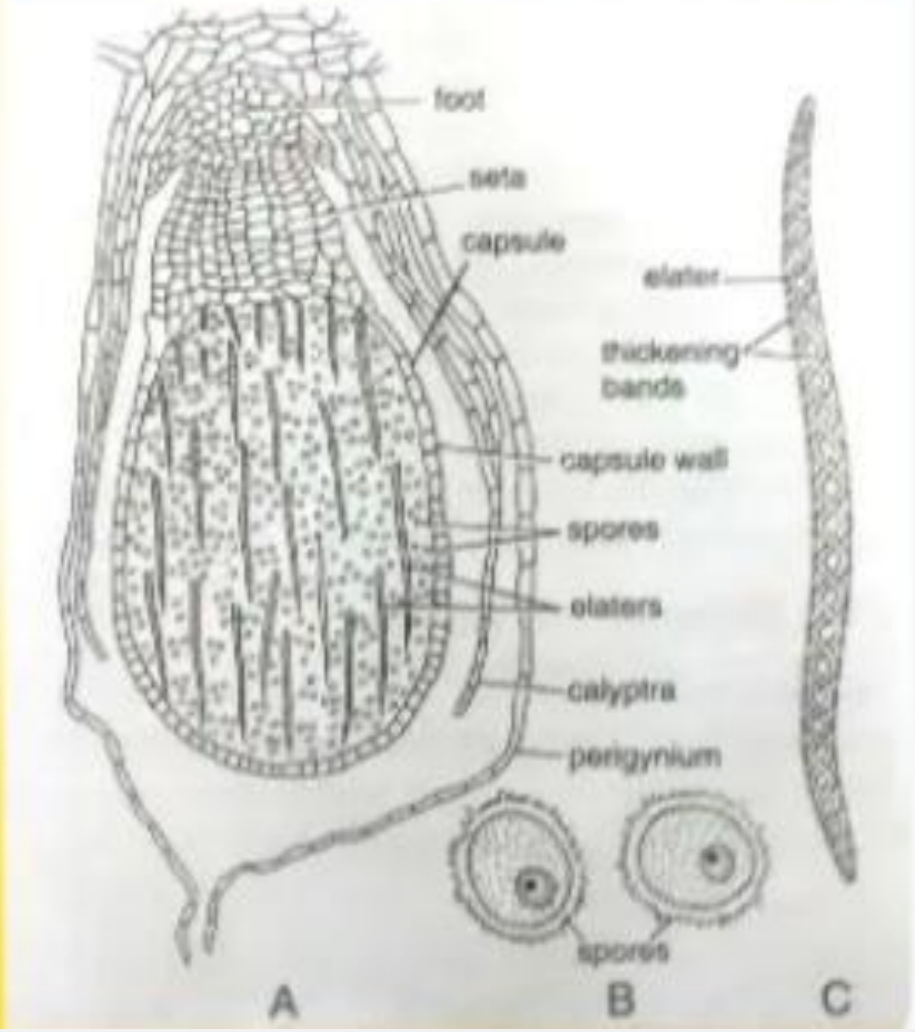
Post fertilization events
(Inversion of Archegonia)

- After fertilization, archegoniophore elongates accompanied by rapid growth of central part of archegonial disc that leads to inversion of archegonia
- The arrangement of archegonia is also reversed from acropetal to basipetal
- This process of inversion is accompanied by development of one cell thick tissue called perichaetium or involucre on both sides of each archegonial row
- Also long, green, finger-like projections arise from margins of disc known as Rays



Sporophyte

- Zygote develops to form sporophyte
- It is differentiated into foot, seta and capsule
- Foot-It is basal bulbous part which anchors and provides nutrition to sporophyte
- Seta-It is short stalk that connects foot to capsule
- Capsule-It is yellow coloured oval structure and has a single layered jacket
- In young sporophyte, capsule encloses sporogenous mass which differentiate into spore mother cells and elater mother cells

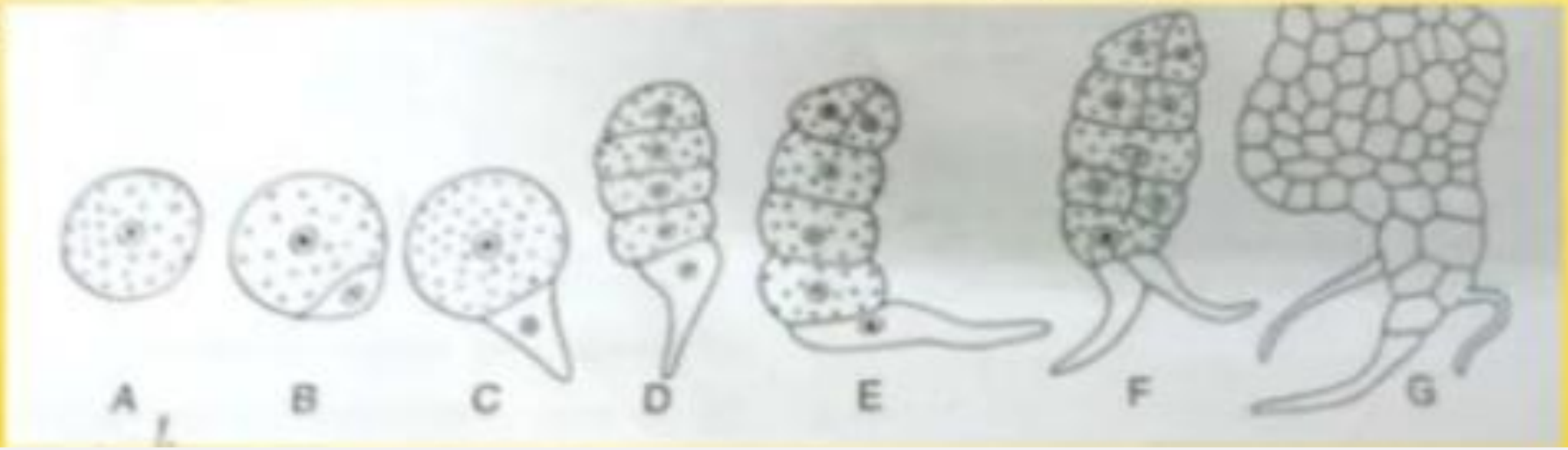


Dehiscence of sporophyte

- Single layered capsule wall splits into a no. of longitudinal valves which extend from apex towards the middle of capsule
- The valves are rolled back due to annular thickenings in jacket cells
- Jerky movement of elaters due to their hygroscopic nature leads to loosening up of spore mass and scattering of spores in air

Germination of Spores

- Spores are viable for about a year
- Under favourable conditions they absorb moisture from substratum and increase in size
- Chloroplasts reappear at this stage
- Spore undergoes repeated divisions to form 6-8 celled filamentous structure with a rhizoid at one end
- The apical cell cuts off derivatives on lateral sides and finally give rise to gametophyte



JUNGERMANIALES

This order includes liverworts.plant body is differentiated into a central Axis .They are called folliose liver worts.

Thallus is prostata in habbit

Showing no internal differentiation

Sex organs are superficial and projecting

Antheridia are axillary in position where as archegonia are terminal in position

- Arrchegonial cluster is enclosed and is protected by envelop called perianth.

archegonia develops from the segment derived from the apical cell or apical cell itself develop into an archegonium this called archegynous.

This achrogynous condition of the archegonia result in the sporophyte being always terminal.

- Air chambers,air Pores, photosynthetic region or storage regions are absent
- Leafs are anisophyllus
- Leafs are arranged in 2 types: succubous (the posterior portion of one leaf is overlaps the anterior portion of another leaf)and (The anterior portion of a leaf overlaps the posterior portion of the other leaf)incubous
- Leaves arranged in spirical manner in 3 rows.3 rd row consist of small,more or less reduced ventral leaf called amphigastria/ underleaves.

TYPES

- Porella
- Pallavicinia

- 50. Amphigastria is a gametophytic character of ---------- bryophyte.
- A) Porella B) Riccardia C) Pellia D) Notothylas

ANTHOCEROS REPRODUCTION

VEGETATIVE REPRODUCTION

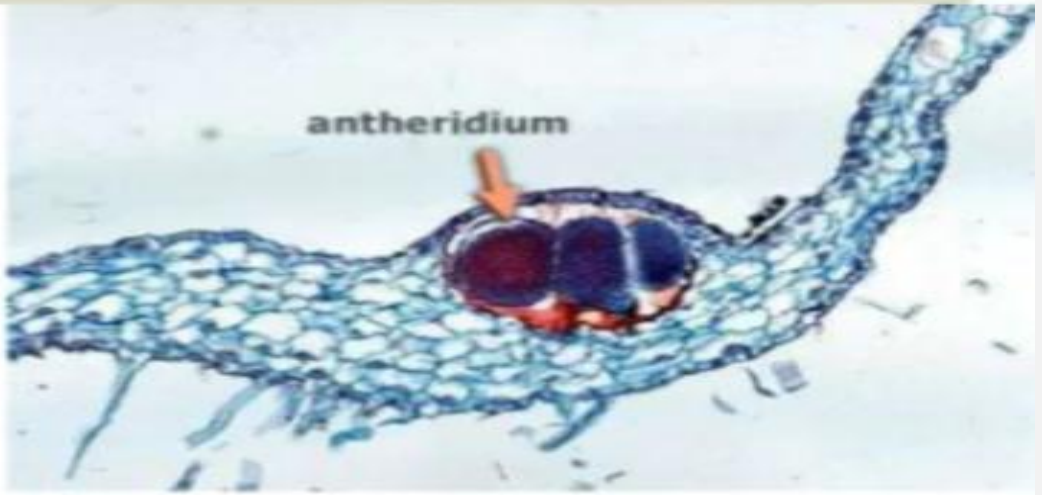
- It takes place by the following methods:

- Progressive death and decay of thallus.
- By tubers.
- By Gemmae.
- By persistent growing apices.

SEXUAL REPRODUCTION

ANTHERIDIA

- They occur endogenously on dorsal surface in a closed cavity called antheridial chambers.
- They enclose mass of androcytes which mature into antherozoids.



DEVELOPMENT OF ANTHERIDIA

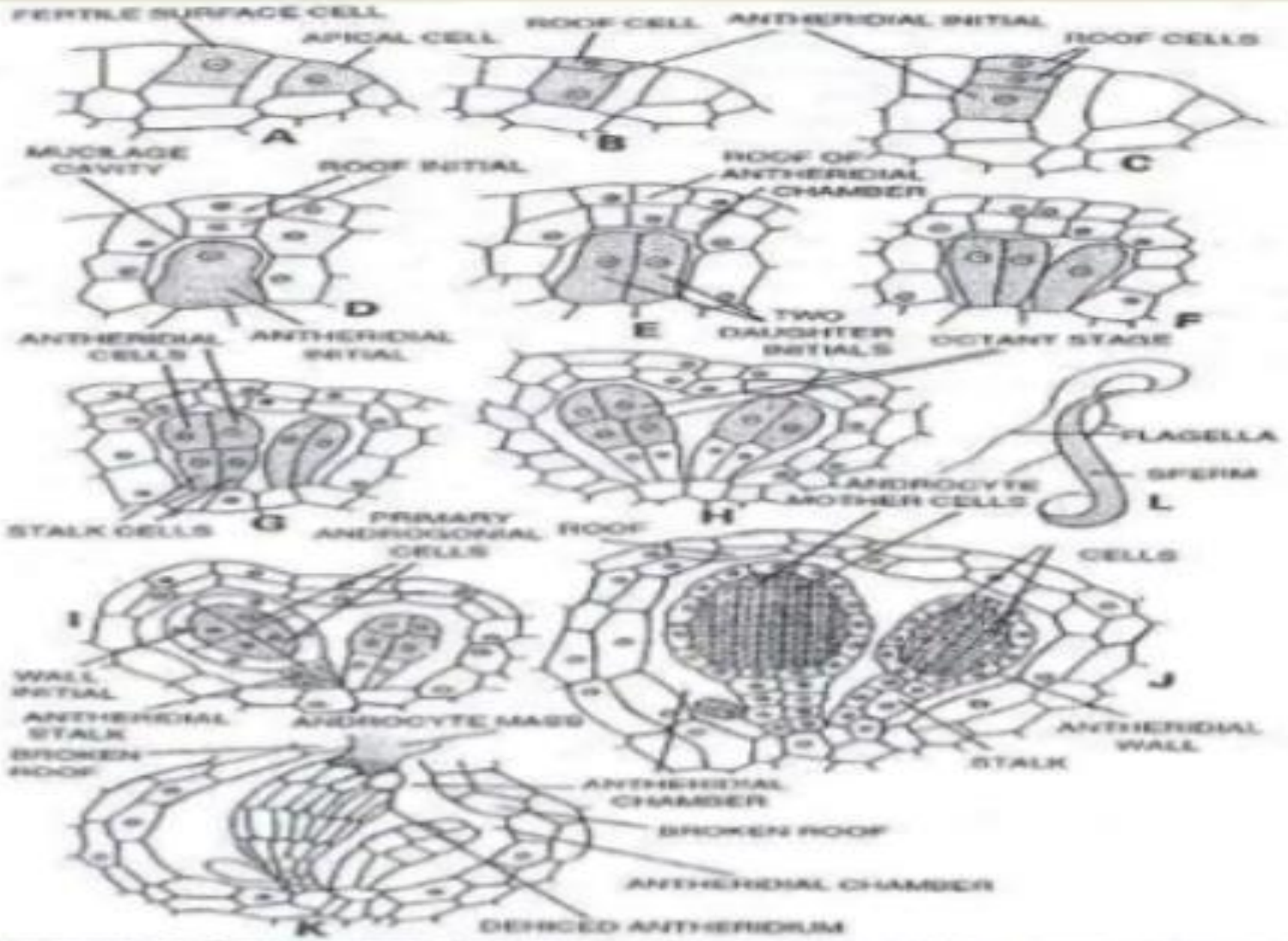


Fig. 22.5. *Anthoceros* sp. Development of antheridium. A, surface cell lies close to the apical cell; B, surface cell divides pericinally into two cells-roof cell and antheridial initial; C–J, further stages in the development of antheridium and roof; K, mature dehisced antheridium releasing out androcyte mass; L, biflagellate sperm or antherozoid with long anterior flagella.

Antheridium after maturation

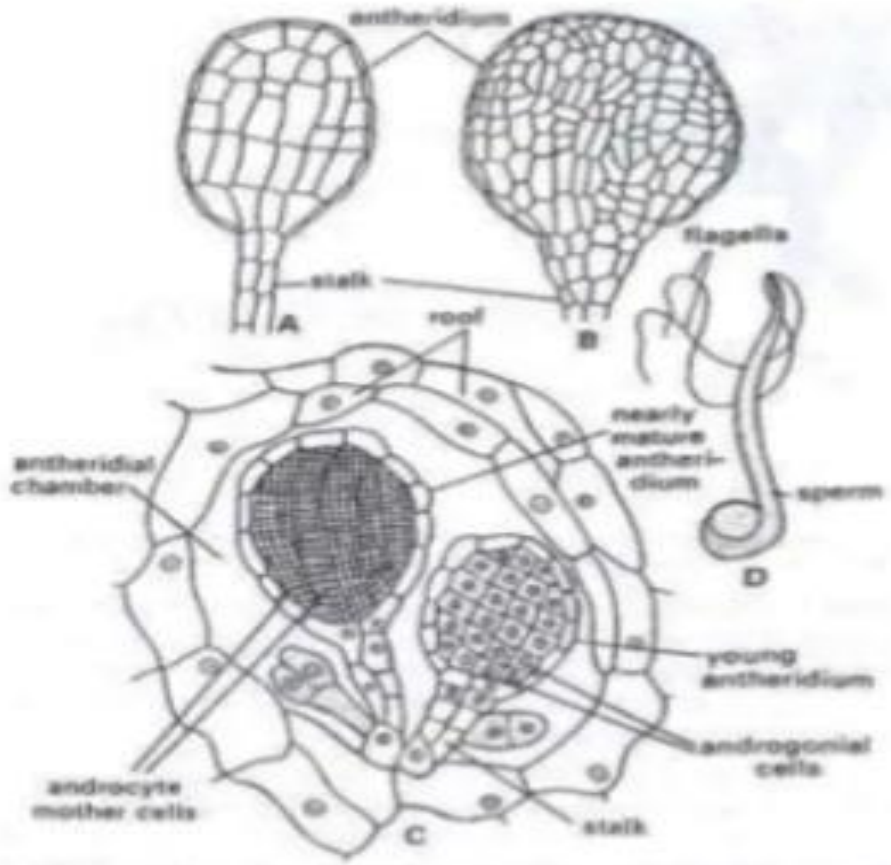


Fig. 22.6. *Anthoceros* sp. Male sex organs. A and B, stalked mature antheridia of *A. crispulus* and *laevis* respectively; C, young and mature antheridia inside the antheridial chamber, secondary bud antheridia are seen on the stalks of primary antheridia; D, biflagellate sperm or antherozoid.

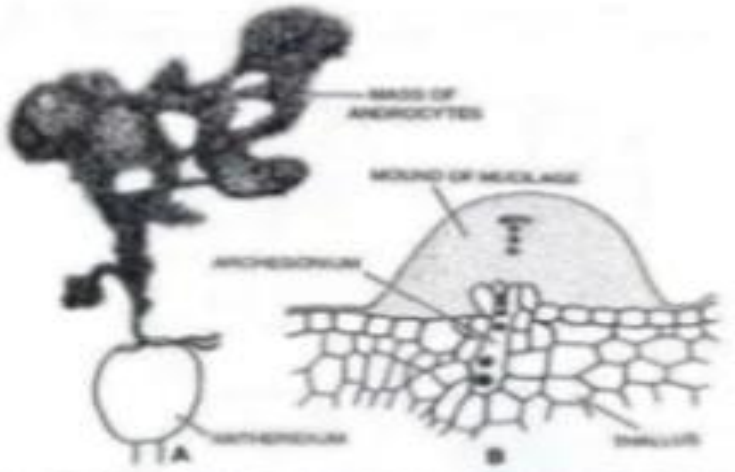


Fig. 22.7. *Anthoceros laevis*. A, antheridium extruding mass of androcytes; B, archegonium showing extrusion of neck canal cells and mucilage mound (After Proskauer).

Antherozoids

- The antherozoid is spindle like and biciliate.
- The cilia are attached to the anterior end of the body.
- The antherozoids swim in the water by the lashing moment of their flagella.

DEVELOPMENT OF ARCHEGONIUM

The development of archegonium begins from a single superficial cell. This cell becomes prominent and acts as archegonial initial.

The archegonial initial first divides vertically, producing three jacket initials which surround an axial cell.

The axial cell divides transversely, producing a cover initial and a central cell. Thereafter, the central cell divides by a transverse wall, giving rise to a primary canal cell and a primary venter cell.

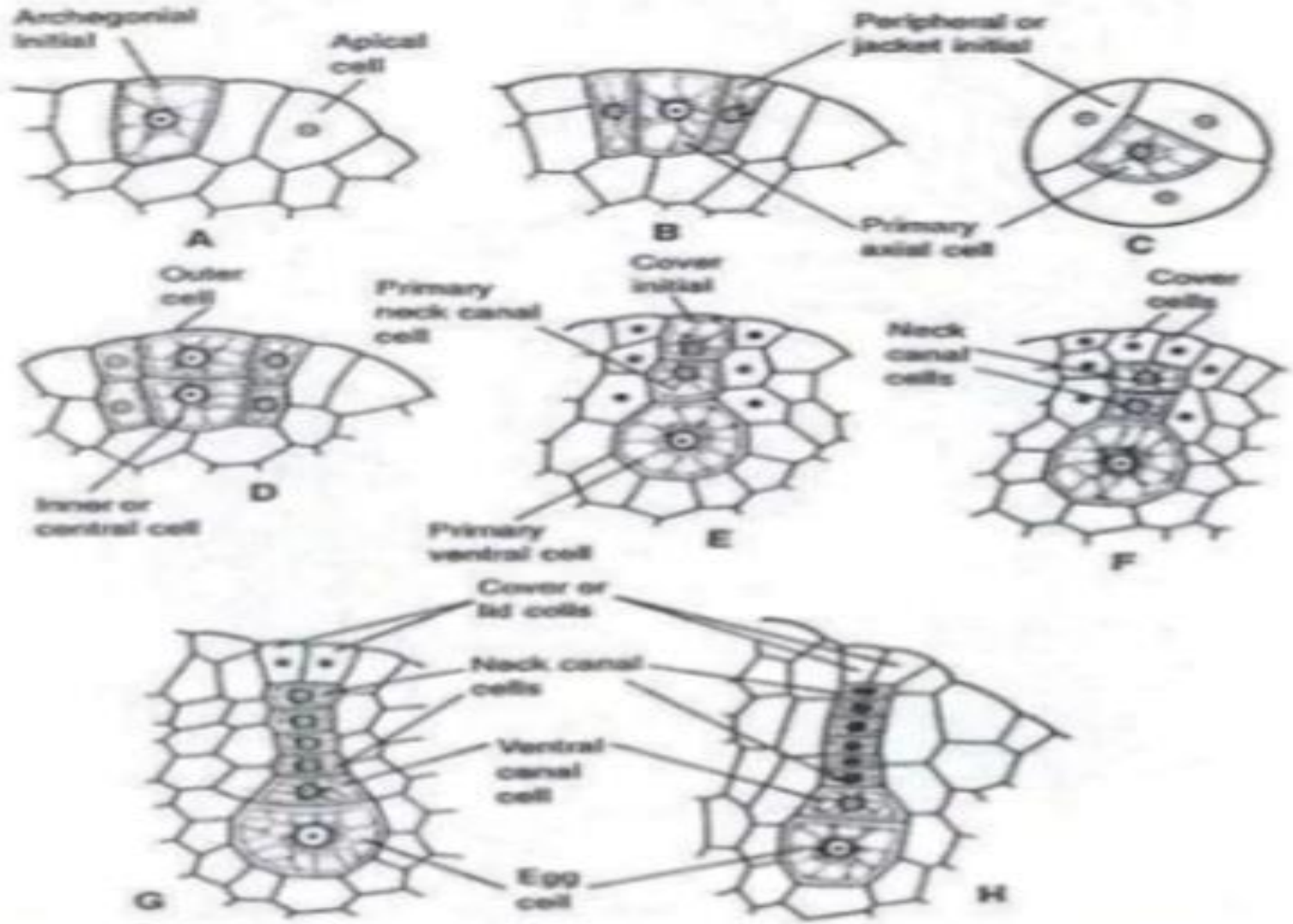
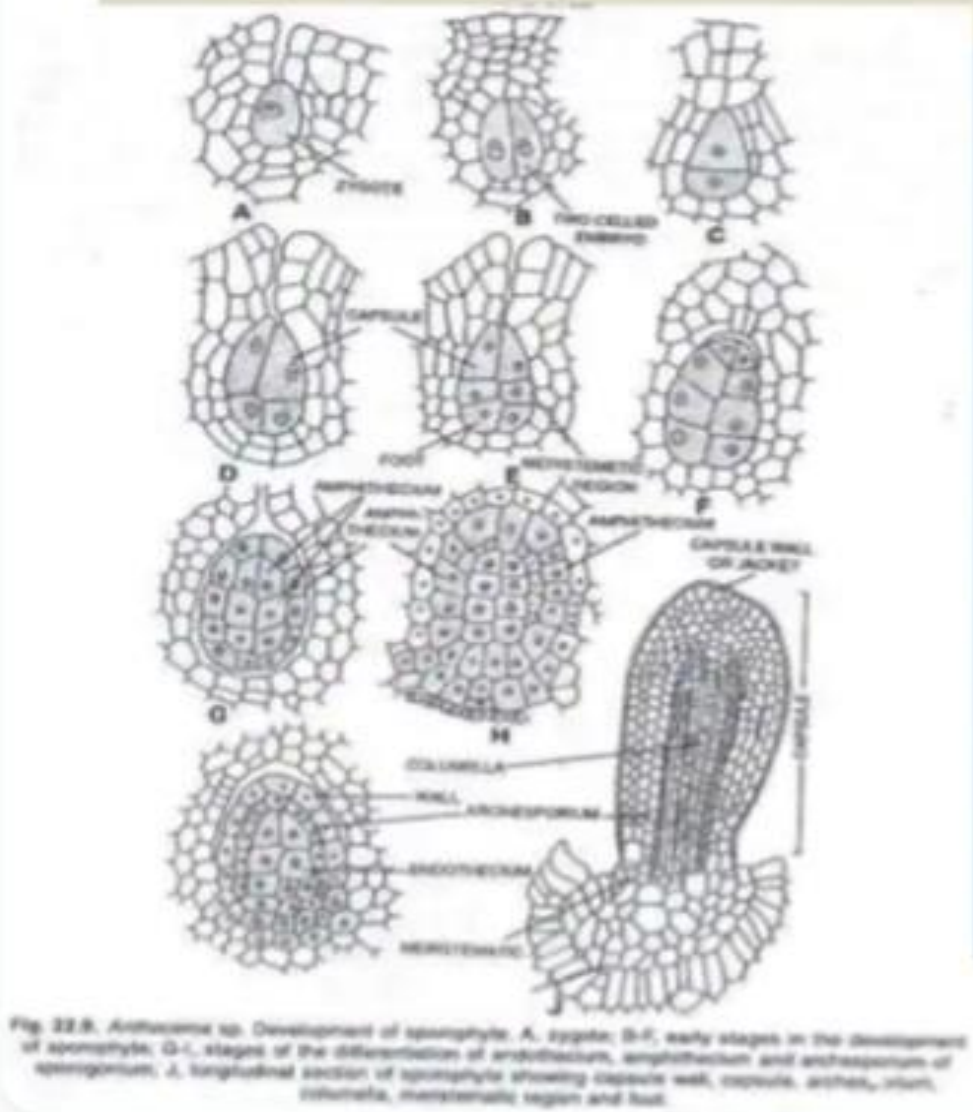


Fig. 22.8. *Anthoceros* sp. Development of archegonium. A, archegonial initial; B, differentiation of primary axial cell in L.S.; C, same in T.S.; D, division of axial cell into inner and outer cell; E, development of cover initial, primary neck canal cell and primary ventral cell; F, archegonium with egg, ventral canal cell, two neck canal cells and cover cells; G, nearly mature archegonium; H, mature archegonium (After Campbell)

Structure of archegonium



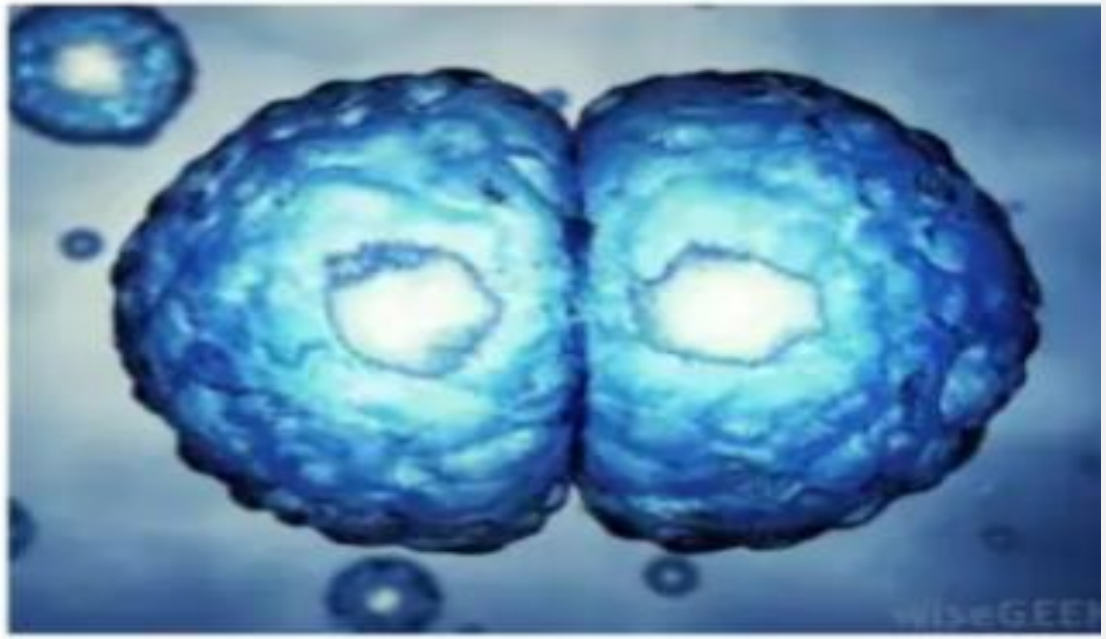
A mature archegonium is flask-like in shape, without neck canal cells and with an egg (oosphere) in its venter.

At the top of the neck of the archegonium there are four cover cells, which become separated from the archegonium, as soon as the gelatinization of the venter and neck canal cells is over.

FERTILIZATION

- Prior to fertilization, the cover cells become detached from the archegonium, and the neck canal cells become gelatinized. Through the medium of water, the antherozoids enter the mouth of archegonium.

- Ultimately, one lucky antherozoid penetrates the egg, and the fertilization is effected. The male and female nuclei unite to each other, producing a zygote (oospore)



SPOROPHYTE

- Mature sporophyte has 3 distincit parts mainly foot, capsule and meristamatic zone
- Foot is made up of parenchymatous cells
- Capsule is made up of 4-6 layers of cells known as capsule wall.
- Inner most layer forms sporogenous cells it contain 50%fertile cell and 50%sterile cell

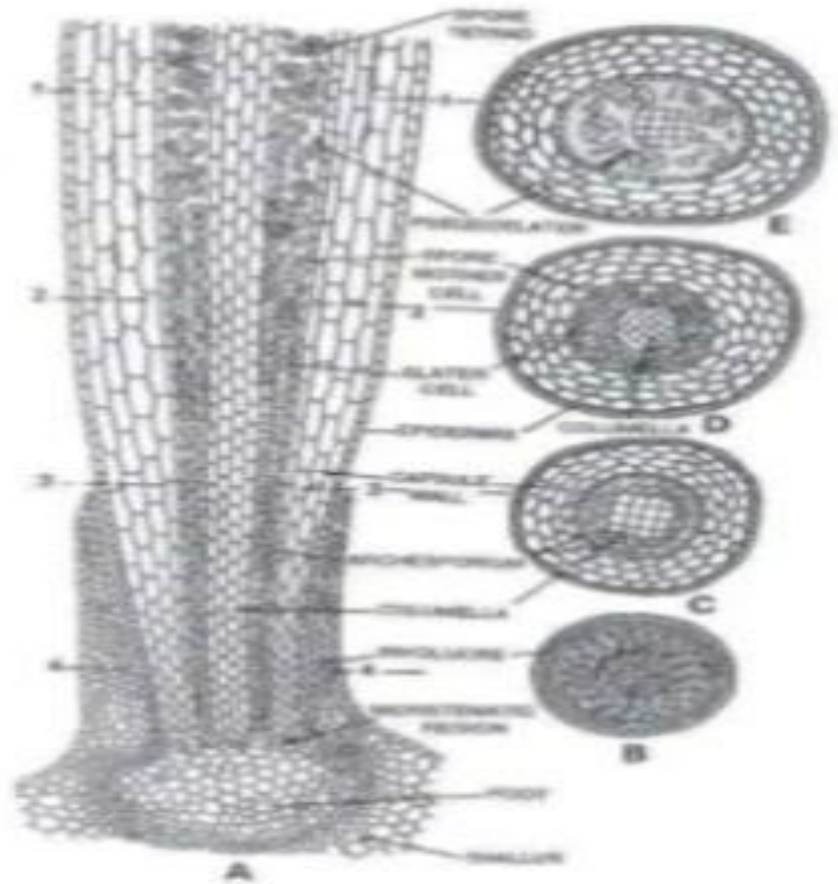
- Sterile region is known as elator mother cell.
- Central region consist of 16 vertical rows of cell these cells forms collumella
- At the junction of the foot and capsule meristamatic region is present

DEHISCENCE OF CAPSULE

- At maturity apex of the capsule turns yellow Black or brown
- Loss of water from the capsule wall collumella spores and elators cause drying, shrinking and dehiscence of capsule.
- Capsule wall split into 2 or 4 valves.the spores are ejected put
- Mature spore is spherical thick walled and represent the mother cell of the gametophytic generation

SPOROGONIUM TISSUE

- In the young sporogonium, the columella consists of four vertical rows of the cells, but later on it is made up of sixteen rows of cells.
- The jacket initials divide again and again periclinally producing the 4 to 6 layered wall of the capsule.
- Later on, the sporogenous tissue becomes differentiated into two types of cells, i. e., (i) the sporocytes (spore mother cells) and (ii) the sterile cells (pseudoelaters).



GERMINATION OF SPORE

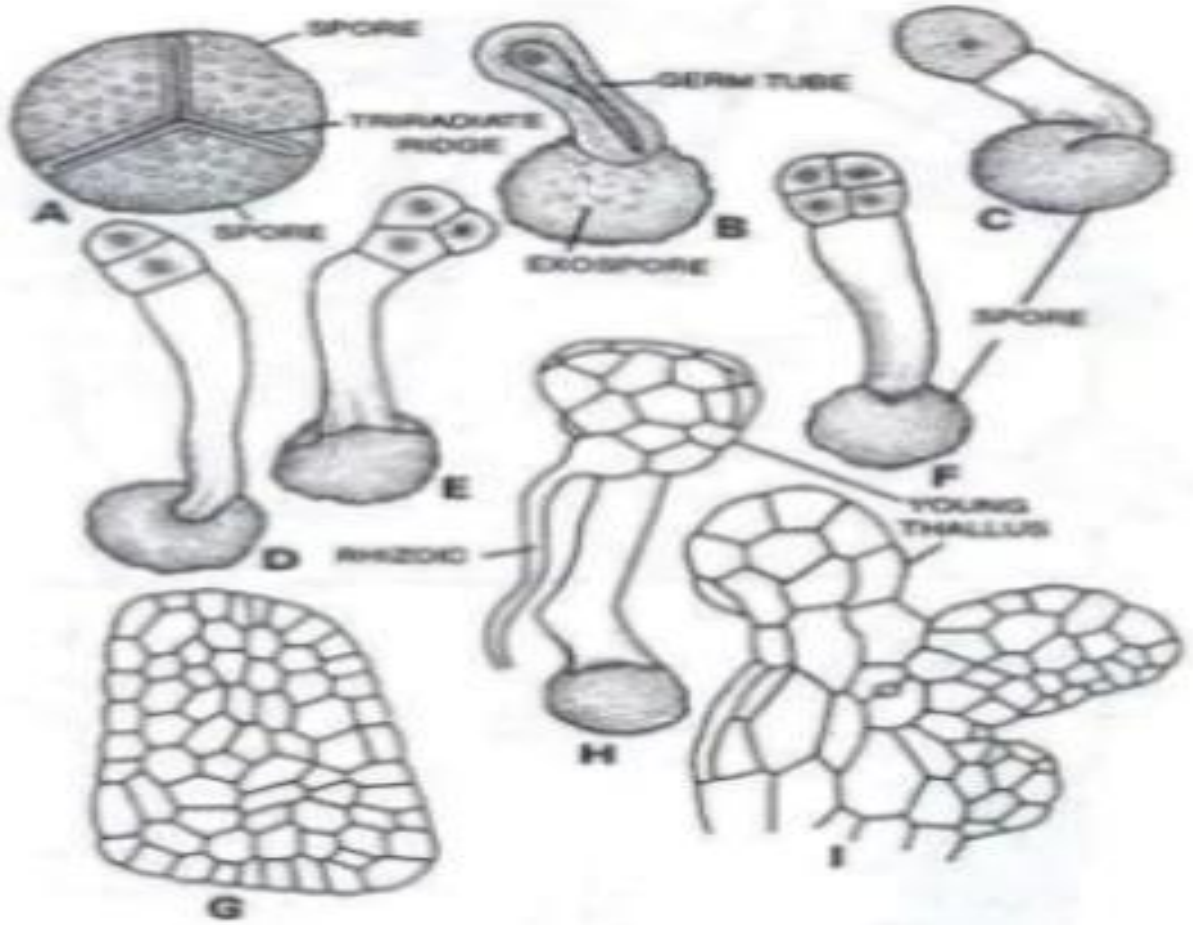


Fig. 22.14. *Anthoceros* sp. Spore and its germination. A, spore with triradiate ridge; B, germinating spore producing germ tube; C-F, further stages of spore germination; G-I, formation of young gametophyte (thallus) and rhizoids.

GERMINATION OF SPORE

- Prior to germination they absorb Water and swells
- Exospore rupture and endospore comes out in the form of a germtube through slit.
- The spore content migrate into the germ tube
- Tip of the germtube divides transversely results into 2 cells in the tip of the gamates and forms 8 celled at the tip .this structure is known as sporelling.then new gametophyte is formed

LIFE CYCLE IN NUTSHELL

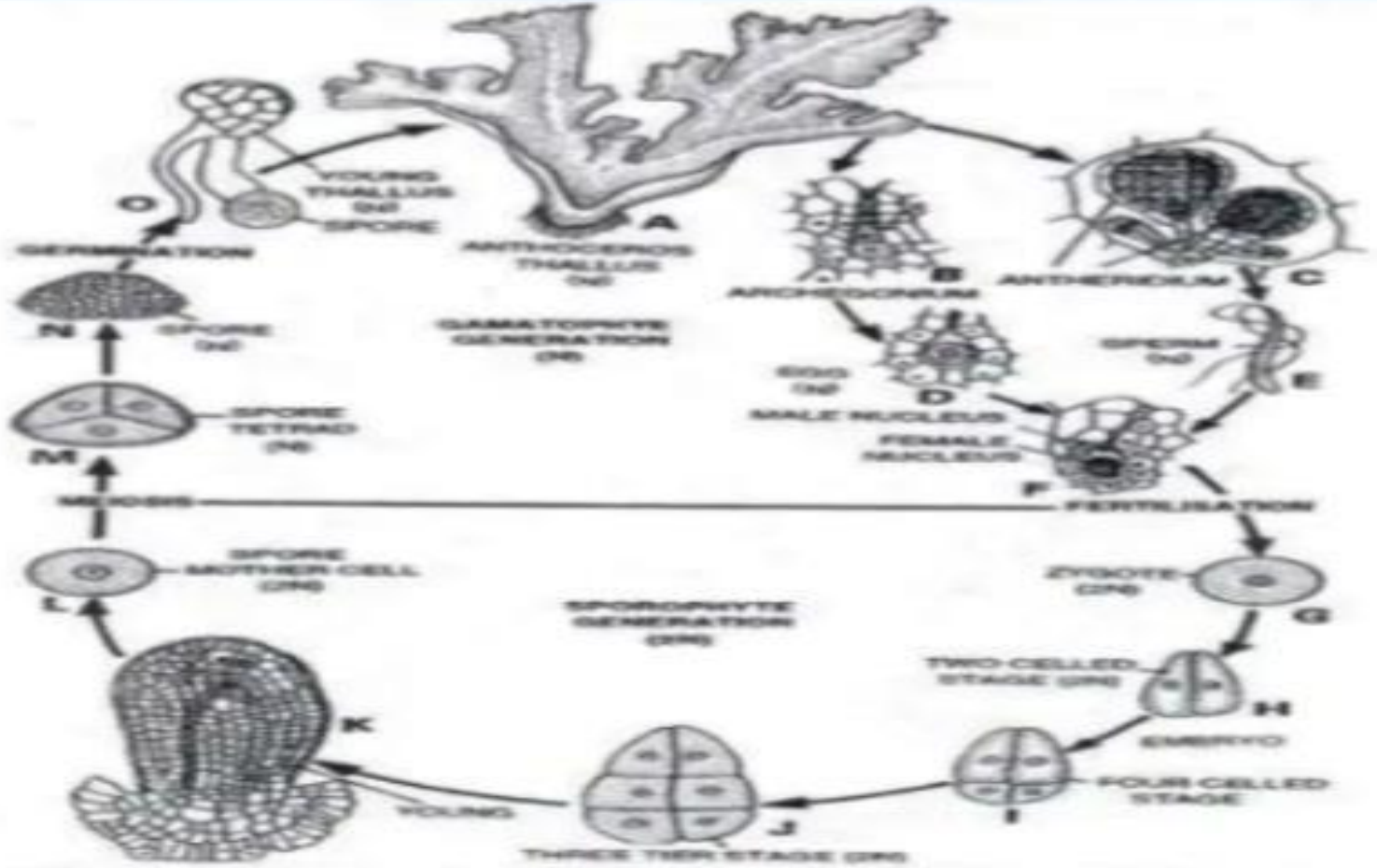


Fig. 22.15. *Anthoceros* sp. Diagrammatic life-cycle A, thallus; B, archegonium; C, antheridium; D, egg within venter; E, sperm or antherozoid; F, male and female nuclei are in close vicinity; G, zygote (2n); H, two-celled embryo; I, four-celled embryo; J, three tier stage; K, young sporophyte in L.S.; L, spore mother cell; M, spore tetrad; N, spore (n); O, germination of spore and development of young

SCHEMATIC LIFE CYCLE

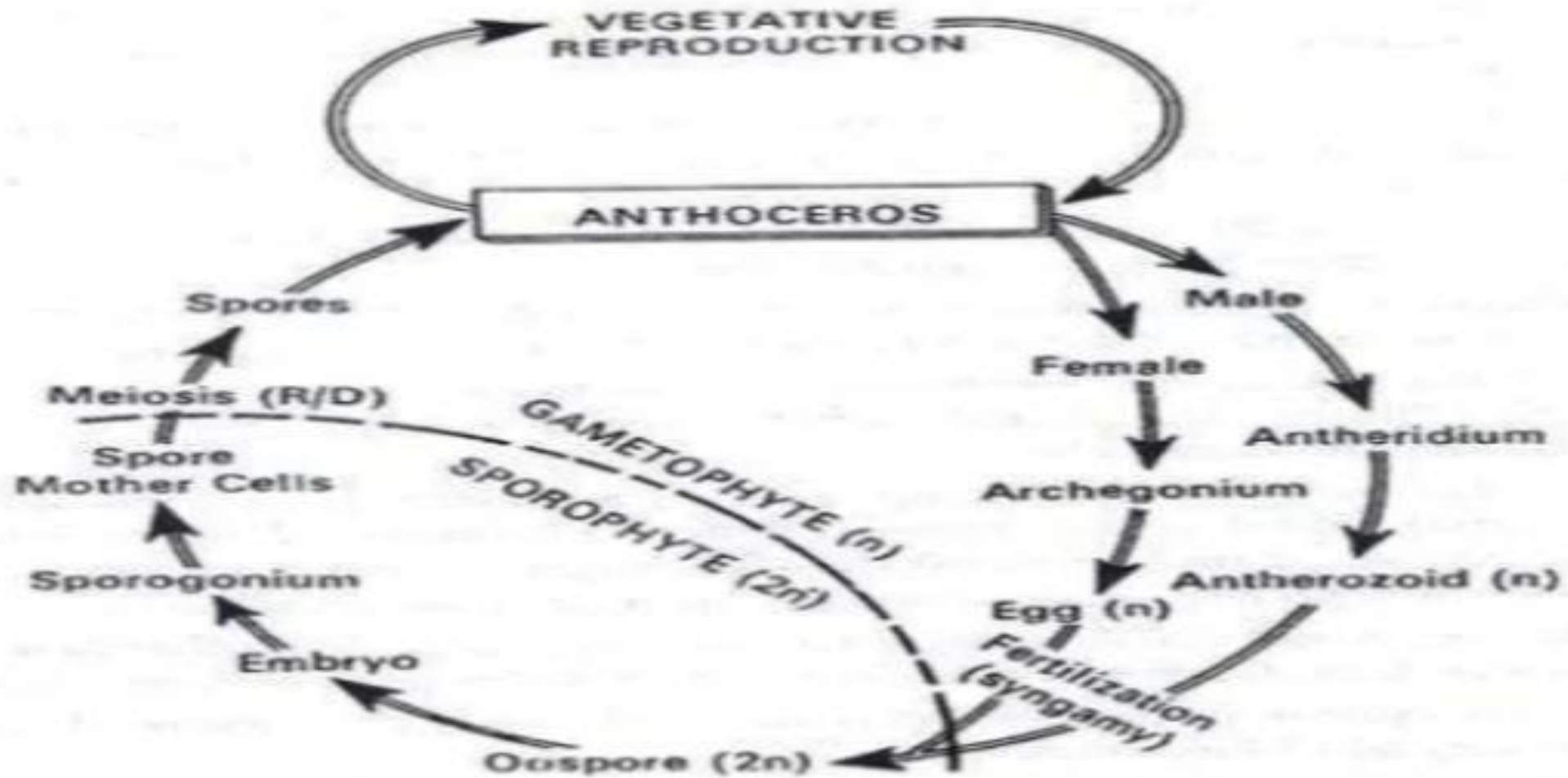
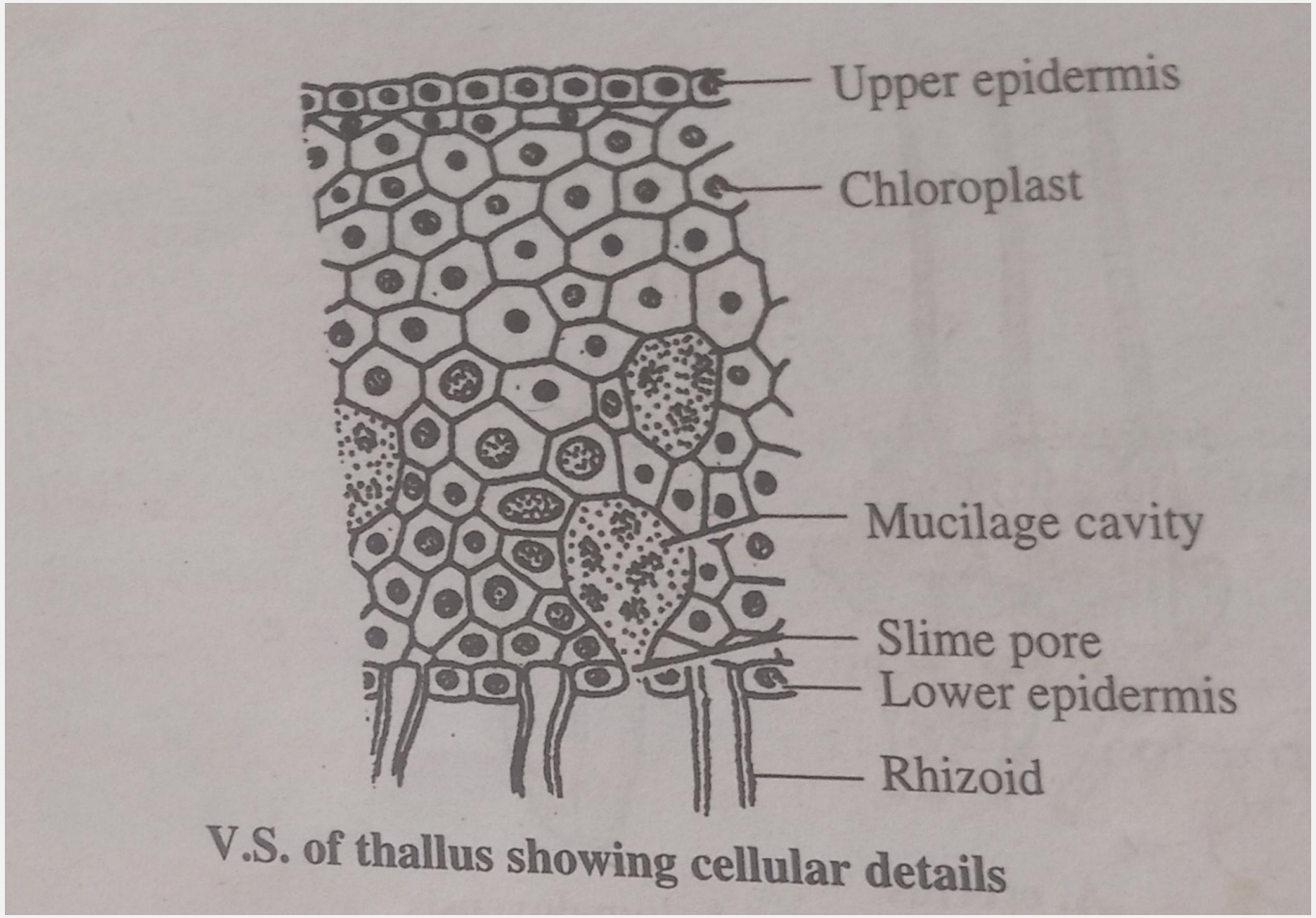


Fig. 22.16. *Anthoceros*. Graphic life-cycle.

- The presence of pyrenoid in the middle of the chloroplast in a bryophyte, a unique feature, makes it apparently resemble with algae is seen in
- A) Funaria B) Riccia
- C) Anthoceros D) Porella



V.S. of thallus showing cellular details

- Cyanobacteria form a variety of associations with bryophytes ranging from the almost accidental to close symbioses. Name the bryophyte that possesses this property
- A) Marchantia B) Anthoceros
- C) Porella D) Polytrichum
- Pseudo-elaters are present in:
- A) Anthoceros B) Andreaea C) Funaria D) Riccia

BRYOPSIDA

Gametophytic Phase Of Pogonatum:

- (i) External Features of Gametophyte:
- The plants are perennial,erect gametophytes and can be differentiated into two regions:
- (a) Rhizome (b) Rhyzoids
- (a) The adult plant has a basal rhizome-like structure which gives rise to many aerial shoots of leafy shoots on the upper side and rhizoids on the lower side.The aerial shoots form thick mat like cushions.

Fig. 2. Pogonatum. A female plant bearing a sporophyte.

Fig. 1. Pogonatum. A batch of gametophytes bearing sporophytes.

- (b)Rhizoids:Rhizome is densely covered with multicellular,thick walled rhizoids with oblique septa.Many rhyzoids coil,twist and inter-wine to form rope-like thick structure.Main functions of the rhizods are anchorage and absorption.
  Aerialshoot: these are erect and arise from the rhizome.It consists of a central axis,the stem which bears scaly and green leaves.Scaly leaves are present on the basal portion of the stem while normal leaves are present on the upper part of the gametophore.

- Reproduction of Pogonatum:
- Pogonatum reproduces by two methods:
- (i) Vegetative Reproduction
- It takes place by following method:
- 1.By the devlopement of bud-like gemmae on the rhizodes.
- 2.By Primary protonema:
- It devlope multi cellular buds which devlope into leafy gemetospore.
- The Fragmentation of Rhizome.

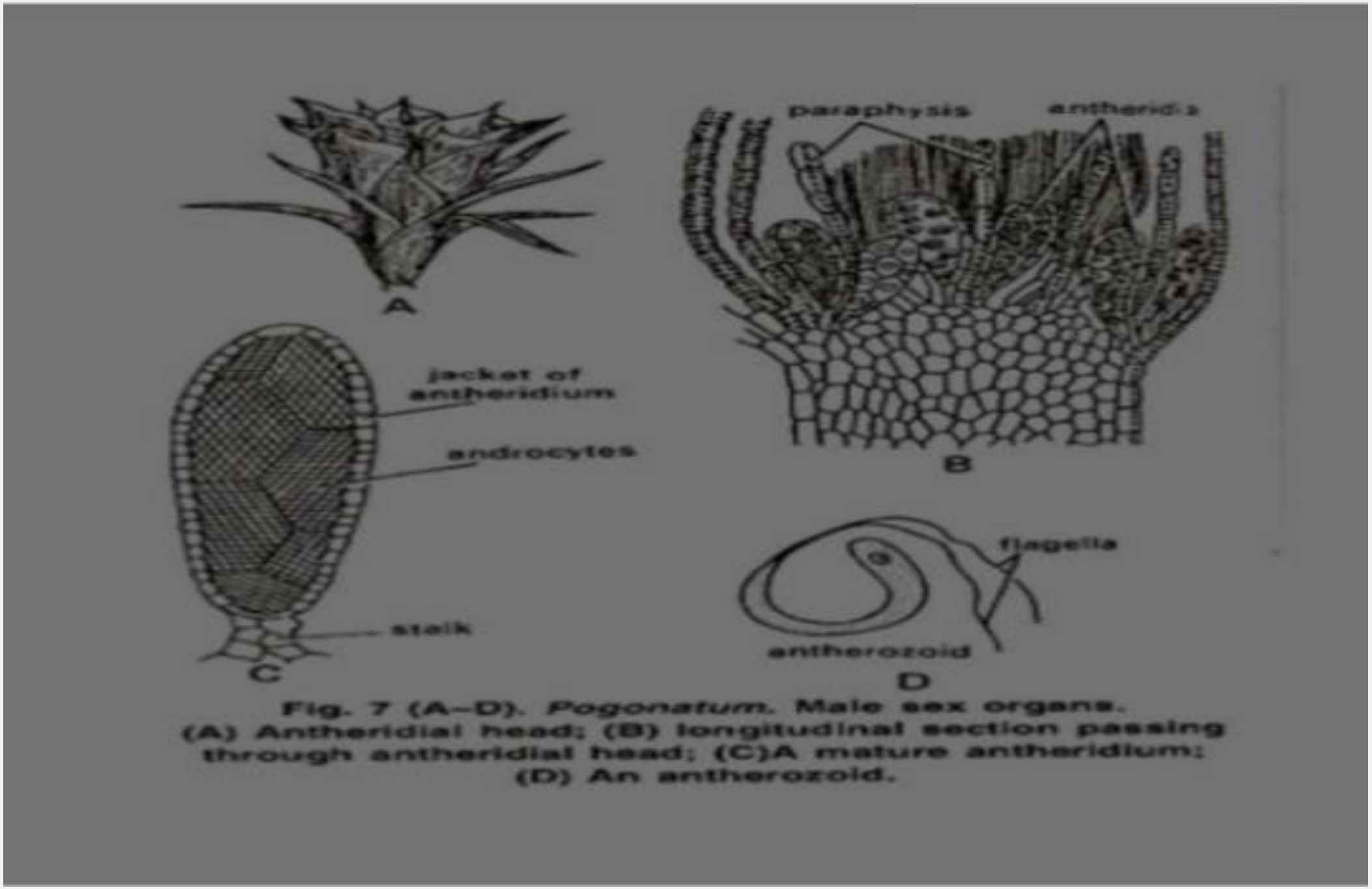
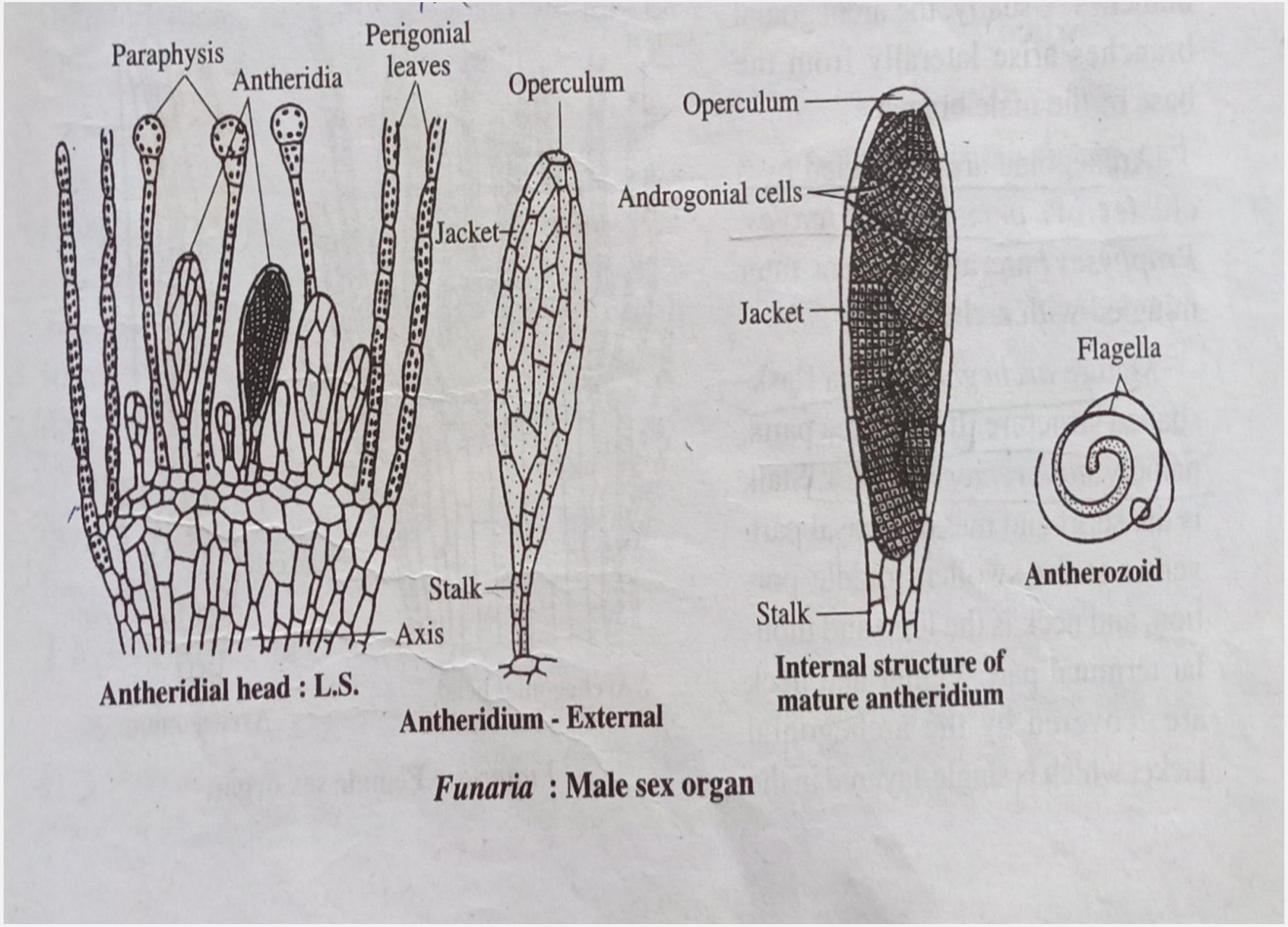


Fig. 7 (A–D). *Pogonatum*. Male sex organs. (A) Antheridial head; (B) longitudinal section passing through antheridial head; (C)A mature antheridium; (D) An antherozoid.

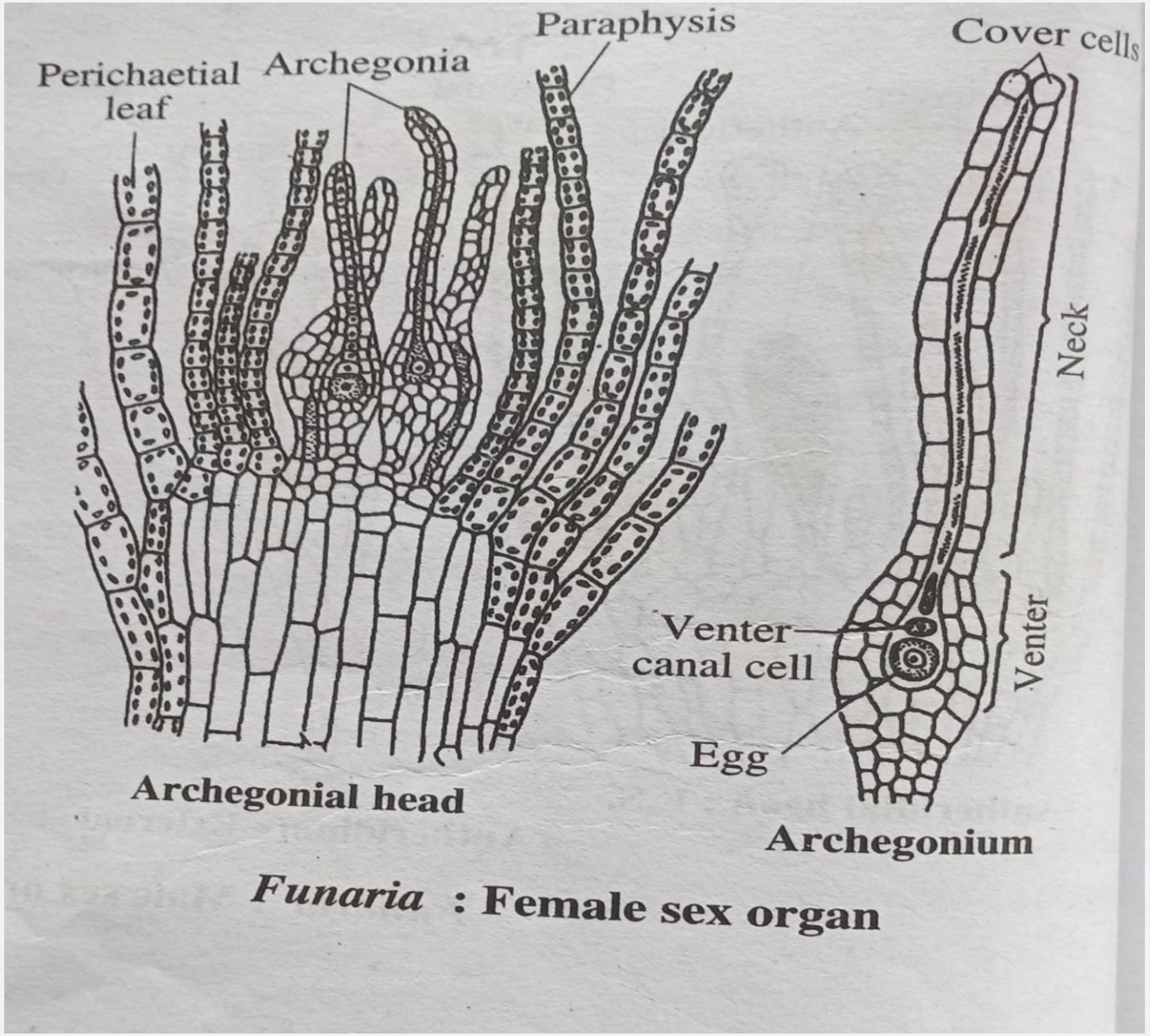
- (ii) Sexual Reproduction:
- It is oogamous.Male reproductive structures are known as antheridia and female reproductive structures are known as archegonia. Majority of the species of pogonatum are dioecious but P.microstomum is monoecious.These sex organs develop in terminal clusters on the separate gametospores.
- Antheridial Head:
- A male plant may have several antheridial heads.The antheridia develop on the tip of the male branches an appar like flower.It is antheridial head.
- Such growth pattern of the gemetospore beyond the antheridial head is know as proliferation.Many sterile,multicellular,hairs like structure are also present in the antheridia.These were called as paraphysis.

FUNARIA


Paraphysis
Antheridia
Perigonial leaves
Operculum
Jacket
Stalk
Axis
Antheridial head : L.S.
Antheridium - External
Operculum
Androgonial cells
Jacket
Stalk
Internal structure of mature antheridium
Flagella
Antherozoid
Funaria : Male sex organ

- **Antheridium:**
- **A mature antheridium can be differentiated into two parts.short stalk and club shaped body.It's body has a single layer jacket which incluses a mass of biflegellate antherozoids.**

FUNARIA



Funaria **: Female sex organ**

- Archegonical Head:
- It is the terminal part of the female Gametophore.It is formed by the perichaetial leaves and gives abud like appearance.
- Paraphyses are sterile structures consisting of a row of uniform cells. There is no proliferation of the archegonial shoot because In the development of archegonia the apical cells of the stem are utilized and thus the growth of the stem ceases after the formation of archegonia.
- Mature Archegonium:
- A Mature archegonium is a flask shaped structure.It remains attached to gemetophyte by a massive stalk.It consists of upper elongated neck and basal globular portion called venter.The neck consists of six vertical rows enclosed within about 6-9 neck canal cells.Venter is multilayered and encloses a small venter canal cell and large egg cell.
- The multilayeredventer forms a calyptra to protect the developing sporophyte.The superficial cells of calyptra produce papillate outgrowths,which elongate and in later stages develop thick walls.Because of these hairy covering on the sporophyte,Pogonatum is known as hair-cup moss.

- **Fertilization In Pogonatum:**
- **Water is essential for fertilization.The uper cells of the antheridium ruptures and release mass of antherozoids.The neck canal cells and venter canal cells disintegrate to form a mucilaginous substance.The apital cells of the neck separate widely from each other and form a passage a leading to egg.**
- **Many antherozoids enter the archegonial neck because of the chemotactic response,but only one of them fuses with the egg to form zygote.More than one archegonia on an archegonical branch may be fertilized,but only one sporophyte reaches maturity.Fertilization ends the gametophytic phase .**

- Sporophytic Phase:
- After fertilization the zygote begins to increase in size and secretes a wall around.It is diplolid oospore.It divides by transverse division to form an upper epibasal cell and lower hypo basal cell.Both these cells devide by two successive oblique interesting walls to form apical cells.Thus,the young embryo has two growing points on either side.
- The derivatives of the upper apical cell form the capsule and operculum of the seta.The derivatives of the lower apical cell form the foot and lower part of the seta,The venter walls develops into calyptra and completely encloses the developing embryo.
- Structure Of Mature Sporophyte:
- A mature sporophyte can be differentiated into foot,seta and capsule.
- (i)Foot:
- It is tepered and embedded in the issue of female gametophyte for anchorage and absorption of mineral nutrients and water for developing sporophyte.
- (ii)Seta:
- In continuation of foot is seta.It is long,slender,stalk like and bears the capsule at the upper end.

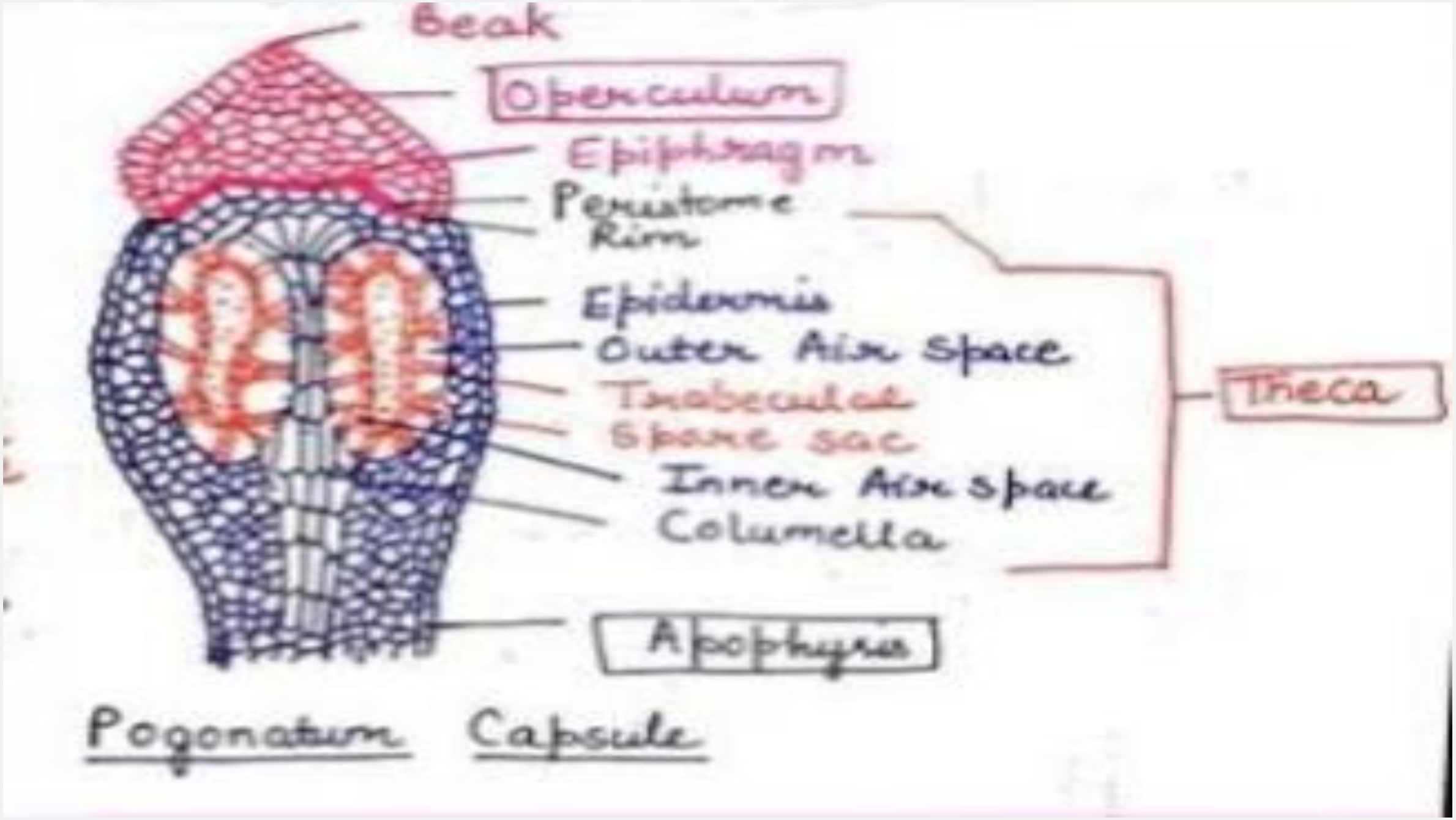
- Internal Structure Of Seta:
- A transverse section of seta shows that it consists of an outer single layered epidermis,parenchymaous cortex with a central stand consisting of hydroids and leptoids.At maturity dew outer layers just below the epidermis become thick walled.Its main Functions are to raise the capsule,conduction of water and mineral nutrients.
- Transverse Section Of Seta
- (iii)Capsule:
- It is elongated cylindrical and can be differntiated into following parts:
- (a) Apophysis:
- In the central region of capsule the seta merges with apophysis.It is the basal sterile part of the capsule composed of perenchymatous cells.In comparison to other hair-cup-mosses it is indistinct in Pogonatum.In the centre conducting stand is present which is continuous with seta and columella.

- **(b)Theca:**

  It is the fertile portion of the capsule.The longitudinal section passing through the region shows the outermost single layer epidermis which lacks stomata.

  It is followed by two-two four celled thick chlorophylls tissue.The central part of theca is occupied by sterile columella.It is made up of paranchymatous cells.The upper part of the columella is in contact with epiphragm restricts the explosure of spore sacs while the basal part is connected with the central tissue of apophysis.Besides providing mechanical support to the capsule,the columella also helps in the conduction of water and nutrients.

- (c)Operculum:
- It is present at the tip of the columella and attached to the mouth of theca.It appears likea lid.At the base of the constriction a rim or diaphragm is present.It is made up2-3 rows of thick walled radially elongated cells.Annulus is absent.Just below the operculum a tissue is present which stretches like a drum head over the opening of the capsule and closes it.It is knows as epiphragm.
- (d)Peristome:
- Amature peristome,consists of 16 to 32 teeth. These arise from the rim of the diaphragm.


Beak
Operculum
Epiphragm
Peristome
Rim
Epidermis
Outer Air Space
Trabeculae
Spore sac
Inner Air space
Columella
Theca
Apophysis
Pogonatum Capsule

- **Dispersal Of Spores:**
- **A maturity the capsule begins to dry up.The culumella and other thin walled tissues lose water,shrivel up and form a space in the centre of the capsule,The spores come to lie in the space.Further drying and shriveling of the capsule wall causes the operculum to fall.It exposes the peristome.At this stage the capsule is horizontally placed due to curvature of the seta below the hypophysis.**
- **Structure Of Spores:**
- **The spores are the first cell of the gemetophyte.The spore wall is differentiated into two layers.The outer exospore and the inner endospore.Cytoplasm contains nucleus,mitochondria,granular endoplasmic reticulum,plastids and ribozomes.The reserve food material is in the form of lipid droplets.**

- Germination Of Spores:
- Spore remains viable for longer period and germinates under favourable conditions.Exospore ruptures and endospore protrudes out the form of one or more germ tubes.
- It soon enlarges and forms a branched filamentous structure called protonema. Filaments of the protonema grow in two different direction.Some filaments grow prostrate on the surface of the substrate or become upright in the air and are known as chloronemal branches,while the other branches grow downward into the soil and are called rhizoidal branches.
- These rhizoial branches have oblique cross walls.If expossed to light, this branches may develop chlorophyll and become transferred into the chloronemal branches.The main functions of the rhizoidal branches are attachment,absoption of minerals and water from soil.Chloronemal branches give rise to many buds.Each buds developes into erect,leafy gemetophore.

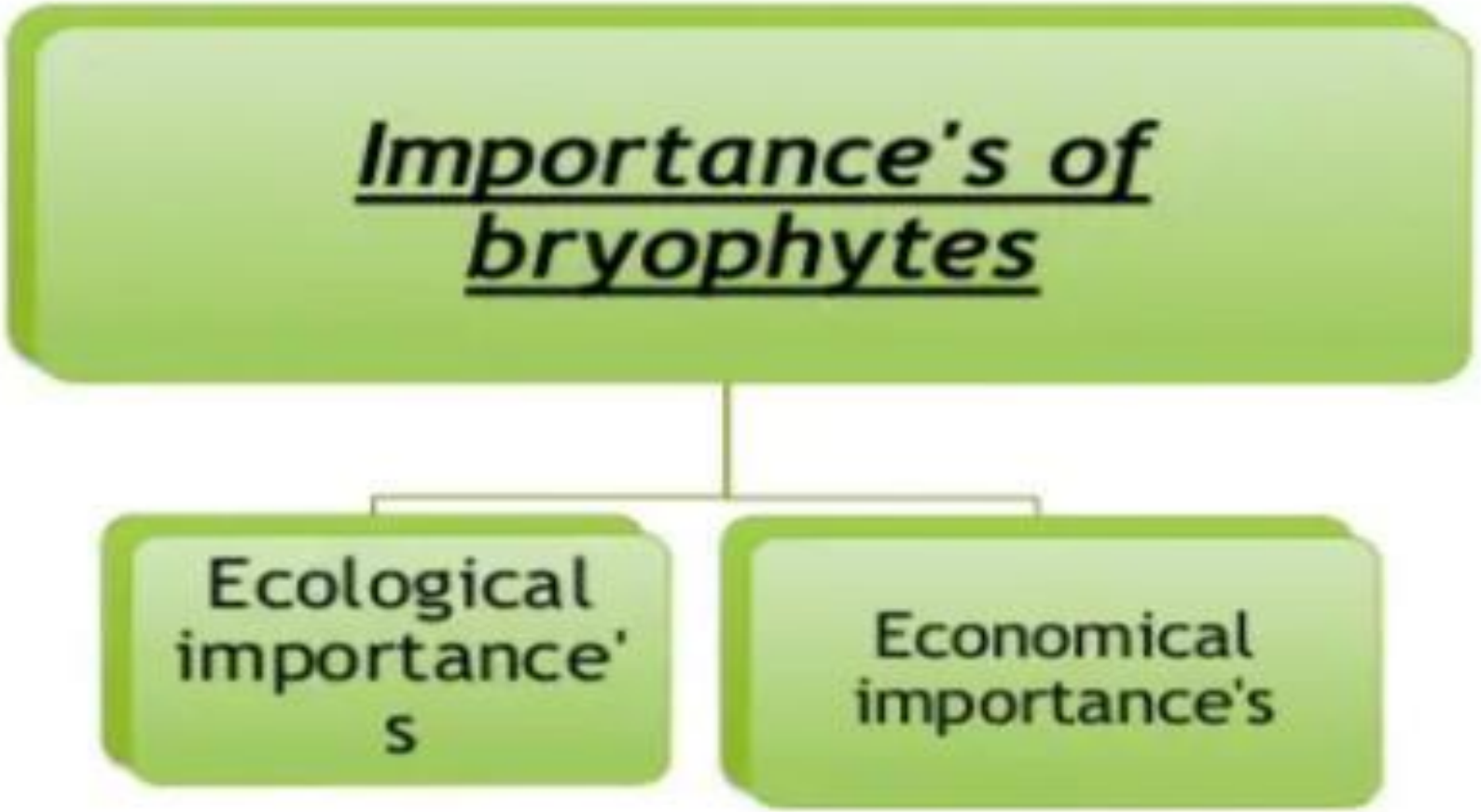
- **Alternation Of Generation In Pogonatum:**
- **The life cycle of pogonatum shows regular alternation of two morphological distinct phases.**
- **(i)Haplophase:**
- **This Phase is dominant,independent,haploid and bears gametes.It developes from the germination of the spores.Male and Female Gemetes fuse to form zygote.**
- **(ii)Diploid Phase:**
- **Zygote is first cell of the sporophytic phase,develops into sporogonium which produces spores.So,in pogonatum the morphologically distinct phases constitute the life cycle.The generation and sporogenic meiosis is known as heteromorphic and diplohaplontic.**

- Diplolepidous peristome teeth is a characteristics feature of --------- moss.
- A) Polytricum B) Pogonatum C) Bryum D) Sphagnum

FOSSIL BRYOPHYTES

- Capsularis gondwamensis
- Sphagnum Papillosum
- Muscites bertraidi
- Hepaticites willsi,H.kidstonii,H.lobatus,H.metzgerioide,H.devonicum
- Intia vermiculari

- A fossil bryophyte identified from Rhaetic, Upper Triassic is
- A) Naiadita B) Plagiochasma
- C) Leucobryum D) Plagiochila


Importance's of bryophytes
Ecological importance's
Economical importance's

Economical Importance's of bryophytes

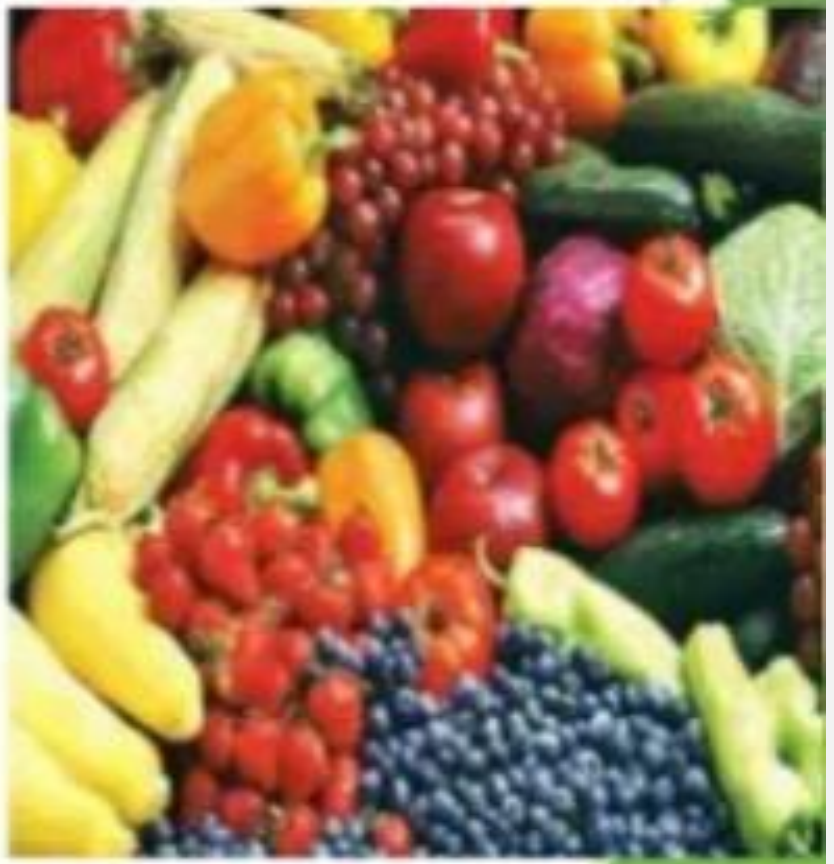
- Source of fuel
- ***Horticulture,***
- Preservative agent
- Household Uses
- House Construction
- ***pharmaceutical industry***
- Moss industry

Bryophytes as Fuel

- Liverworts and mosses have long been tried and used as a fuel in developed countries like Finland, Sweden, Ireland, West Ger-many, Poland and Soviet Union.
- Peat a brown, soil-like material characteristic of boggy, acid ground, consisting of partly decomposed vegetable matter.
- Peat is suitable for production of low and intermediate BTU gas as well as hydrogen, ethylene, natural gas, methanol and Fisher Tropsch gasoline.
- Peat mosses are best suited for the production of methane, and peat is likely to become an important source of fuel for production of heat,methane, or electricity in the future.

Horticultural Uses

- There is a long tradition of use of bryophytes in horticulture as soil additives, because of their high water holding capacity and to air. Peat is an important soil conditioner and is commonly used for agricultural and horticultural purposes around the world.



Bryophytes as ornamental plant

- Bryophytes have also been used for green house crops, potted ornamental plants and seedlings, and in garden soil.

As preservative agent

Bryophytes have excellent power to absorb moisture and can act as a good preservative agent . They not only help to prevent food but also help to preserve death bodies.

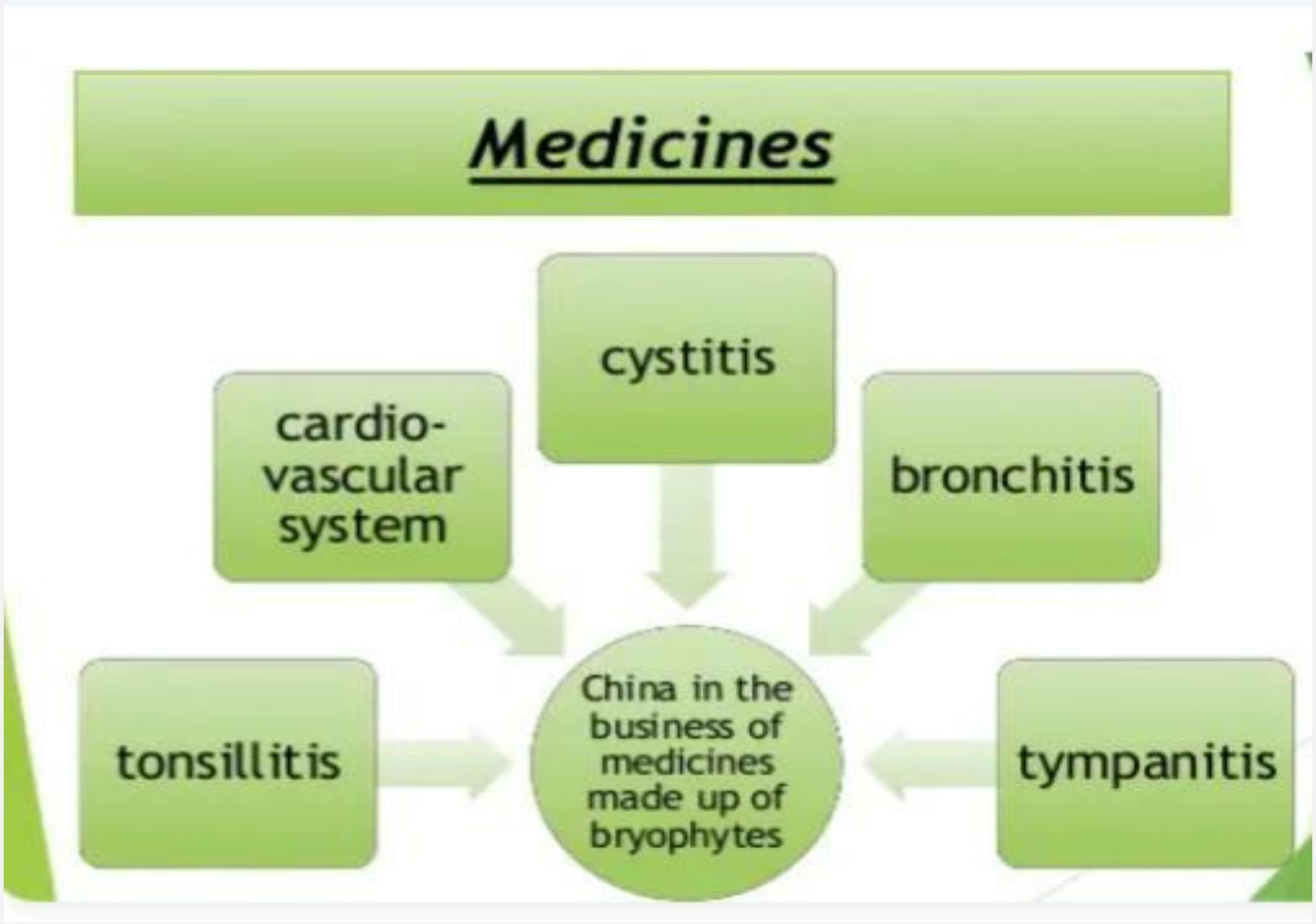
House Construction

•These tiny plants are used in the construction of houses and their furnishings.
•At Kapkot in the Himalayas, villagers use moss mats with shrubs, grasses, and bamboo to make a pharki, a kind of door placed at the openings of their temporary huts. Sphagnumpeat, peatcrete and peatwood are the new material use for making houses ,they are low cost and easy to transport.

Fibre industries

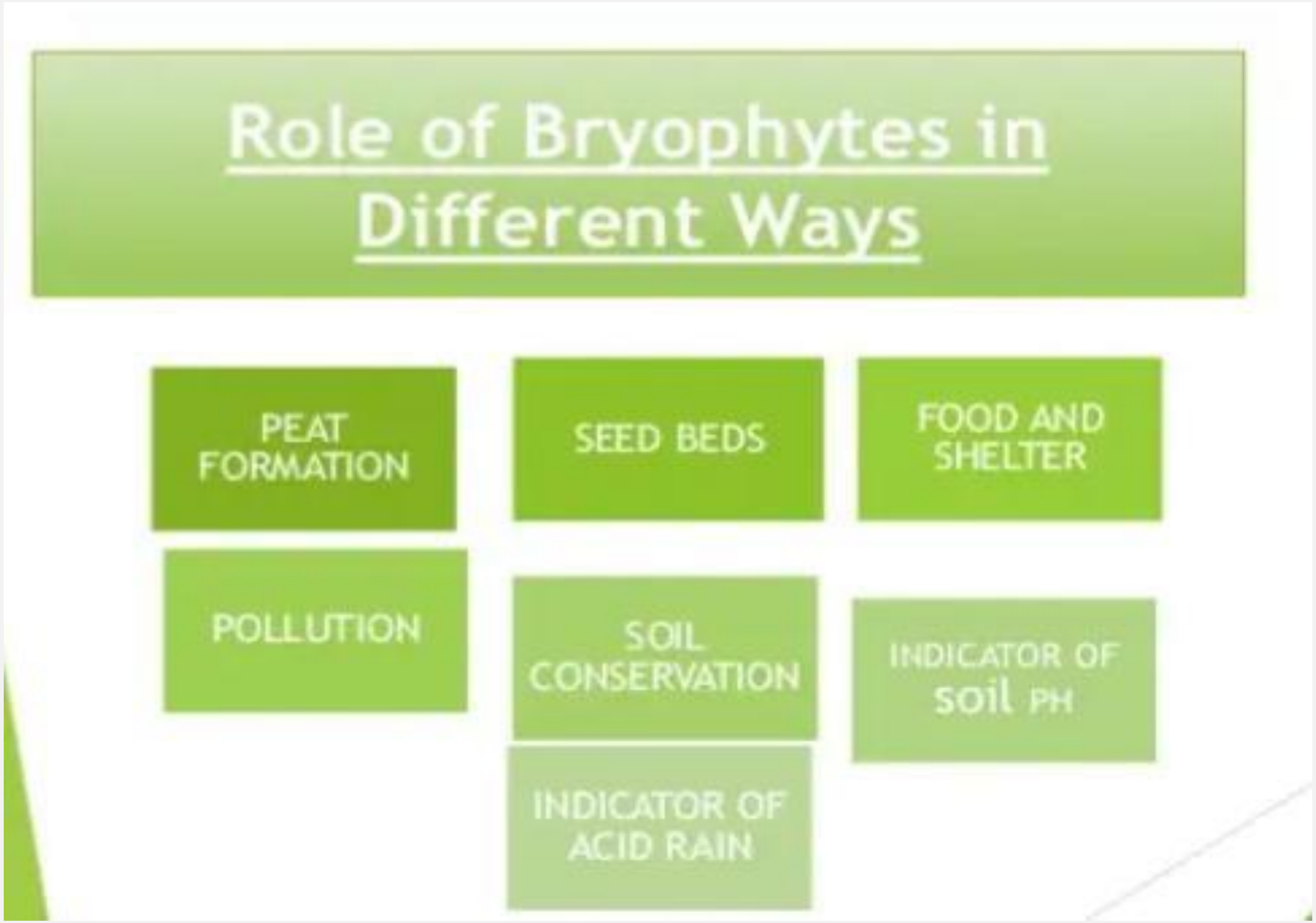
- Mosses are mixed with wool to make cheap clothes.
- They are used in decoration of net bags and other objects.
- Women also wear their steam like structure in their hair and as decorations in bracelets .
- Used in hiking boats to absorb odour and moisture.
- Used in lining of diapers to improve absorbing power.

Medicinal Uses


Medicines
cystitis
cardio-vascular system
bronchitis
tonsillitis
China in the business of medicines made up of bryophytes
tympanitis

Ecological Importance of Bryophytes

Role of Bryophytes in Different Ways



PEAT FORMATION

- Peat is a brown dark colour spongy matter produce due to compression and carbonization by deposits and water.
- Sphagnum and other mosses form peat.
- used in horticulture, making ethyl alcohol and illuminating gas.

Food AND SHELTER

- Many animals make use of bryophytes. Numerous invertebrates eat bryophytes, lay their eggs on them or shelter in them. They form a vital part of the construction material of the nest of some birds

  - In Vertebrates the range of associations is much less.
- Northern Corroboree Frog are found near *Sphagnum* bogs . These endangered frogs breed in *Sphagnum* bogs in the alpine and sub-alpine areas but move away from boggy areas outside c season.

POLLUTION

- Pollutants come in many forms from both urban and rural areas. Sulfur dioxide has been a significant industrial pollutant for many years, being a by-product of the use of high sulfur fuels.
- Sulfur dioxide is very damaging but some bryophytes are highly tolerant of sulfur dioxide pollution and examples of these are the mosses *Funaria hygrometrica* and *Bryum argenteum*

SOIL CONSERVATION

- Bryophytes form a mat and prevent soil erosion.
- The intertwined moss stems and rhizoids bind soil particles firmly.
- Hold large amount of water and reduce run off.

Indicator of soil pH

- Liverworts and mosses are good indicators of soil ph.
- Some bryophytes can grow in narrow and specific range of pH so therefore their presence can be used as an indicator of soil ph.
- For example Campylopus paradxus indicates acidic soil.

- The spore dispersal mechanism of Funaria?
- A) Pseudo elaters B) elaters
- C) Peristomial teeth D) No special mechanism

- Which bryophyte is known for its capacity to hold water and as a source of peat?
- A) Sphagnum B) Marchantia C) Anthoceros D) Porella

- 76. Which of the following is not true about Azolla?
- A) It is an aquatic fern
- B) It hosts symbiotic nitrogen fixing blue-green alga
- C) Its vascular cylinder is siphonostelic
- D) It is an aquatic plant belonging to Aroidae

- `Iris moss' is
- A) Chondrus B) Hydrodictyon
- C) Funaria) D) Sphagnum
- The peat moss belongs to the order
- A) Sphagnales B) Andreaeales
- C) Bryales D) Anthocerotales

- Which among the following is a xerophytic bryophyte?

A) Sphagnum B) Funaria C) Porella D) Riccia

Elators and pseudoelators in the capsules of bryophyte are meant for

A) Nutrient absorption B) Water conduction

C) Spore dispersal D) Mechanical support