COURSE: MSc Part -1

PAPER – 4

TOPIC- Bryophytes (Different topics)

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Content

Topic- 1

1. Vegetative Reproduction in Bryophytes

In Bryophytes three types of reproduction occurs. They are classified as:

1. Vegetative reproduction: A type of asexual reproduction employed by plants where in new independent individuals emerge from the vegetative parts of plants, such as specialized stems, leaves, roots, and not from seeds or spores.

2 Asexual reproduction: A mode of reproduction in which the offspring comes from a single organism and not from the union of gametes as it is in sexual reproduction. This usually takes place at the favourable period of plants. Due to this reproduction large number of progeny is formed.

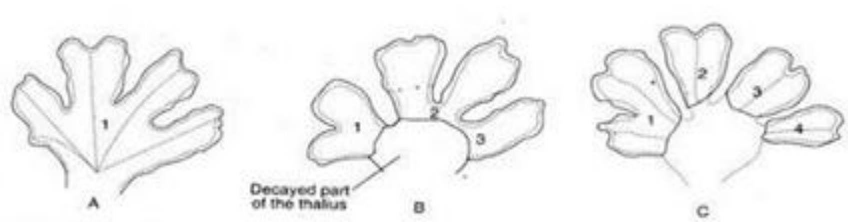
3 Sexual reproductions: In sexual reproduction, two parents are involved in producing a new individual. Offspring is produced by the fusion of gametes (sex cells) from each parent. This usually begins with the onset of unfavourable condition the resultant product is a thick walled Zygote which can tide most adverse condition.

VEGETATIVE REPRODUCTION:

There is various method of vegetative reproduction in Bryophytes which has been described below:

1. By death and decay of the older portion of the thallus or fragmentation.

In Bryophytes the plant body is thalloid and attached to the substratum by hair-like structures called rhizoids (true roots are absent). They show dichotomous branching at the tip of the thallus. The growing point of the plant is located at the junction of dichotomy. The older part of the plant lies opposite to the apical part. Progressive death and decay of the plant starts from the older part . This results into separation of two branches at the dichotomy. This yields two individual plants. This reproduction is commonly found in *Riccia. Marchantia*, *Anthoceros*, *Notothylus*. This reproduction occurs during favourable period.



Riccia : A-C. Vegetative reproduction. Stages of the isolation of younger dichotomies due to progressive decay

2. By persistent apices.

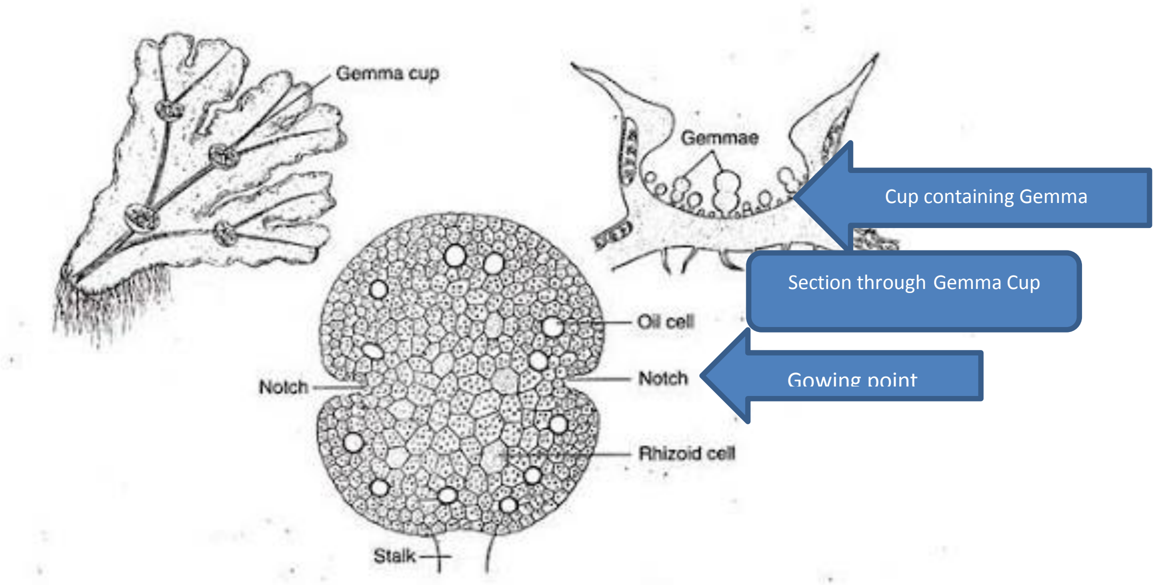
During period of dry condition the thallus dries up due to desiccation. The entire thallus dries up except for the stress bearing growing tip. This growing tip with the return of favourable condition grows into new plant.

3. By tubers.

The plant which is exposed to desiccation often forms tubers to tide over unfavourable condition. The tip of the desiccating thallus accumulates fats, oil and gets clothed by a thick coat. This thick walled structure can stand dry condition for long and gives rise to new thalli in due favourable condition.

4. By gemmae.

Gemmae are green, multicellular reproductive bodies of various shapes. These are produced in gemma cups, on the surface of the leaves, on stem apex or even inside the cells. They get detached from the parent plant and after falling on a suitable substratum gemmae give rise to a new individual directly (e.g., *Marchantia*) or indirectly (e.g., Mosses).Gemma are of various types.



5. By adventitious branches.

The adventitious branches develop from the ventral surface the thallus e.g., *Riccia fluitans*, *Anthoceros*. On being detached from the parent plant these branches develop into new thalli. In *Marchantia*, *Dumortiera* these branches develop from archegoniophore while in *Pellia* these branches arise from the dorsal surface or margins of the thallus.

6. By Regeneration.

In *Riccia* and in *Marchantia* the thallus has unique capacity to regenerate. Any piece of the thallus can regenerate into an individual plant provided it is holding the growing point.

7. By innovation.

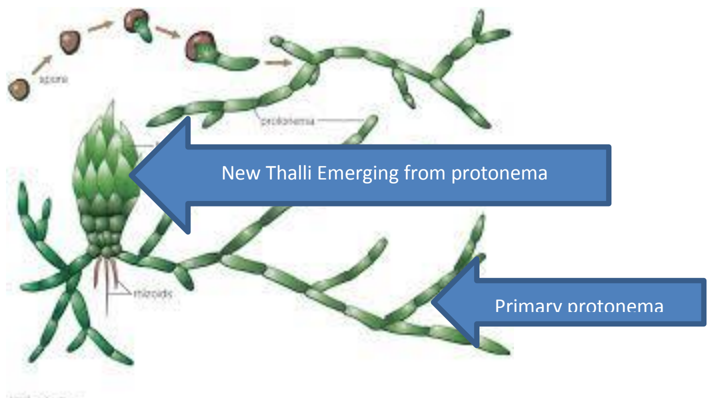
This is a special method of vegetative reproduction in Sphagnum where one of the branches becomes more specialized and more robust compared to other branches. This in due course of time gets separated from the mother plant when it becomes old. This method is called as innovation.

8. By primary protonema.

The spore of most of the bryophytes germinates to form a filamentous, septate, uninucleate and Chlorophyll containing structure called as Protonema. Each unit of the fragmented filament can grow into a new plant.

9. By secondary Protonema.

Protonema formed from the structure other than spore is called Secondary Protonema. Such structures can grow from leaf, stem, and rhizoid. Such structures are found in *Sphagnum*, *Funaria.*



Primary Protonema giving rise to a new thalli

10. By bulbils.

These are small resting buds develop on rhizoids. Bulbils are devoid of chlorophyll but full of starch. On germination bulbils produce a protonema which bears leafy gametophores.

11. By apospory.

The production of diploid gametophyte from the unspecialized sporophyte without meiosis is known as apospory e.g., *Anthoceros*. In *Funaria* green protonemal filaments may arise from the unspecialized cells of the various parts of sporogonium. These protonemal filaments bear lateral buds which develop into leafy gametophores.

12. By rhizoidal tips.

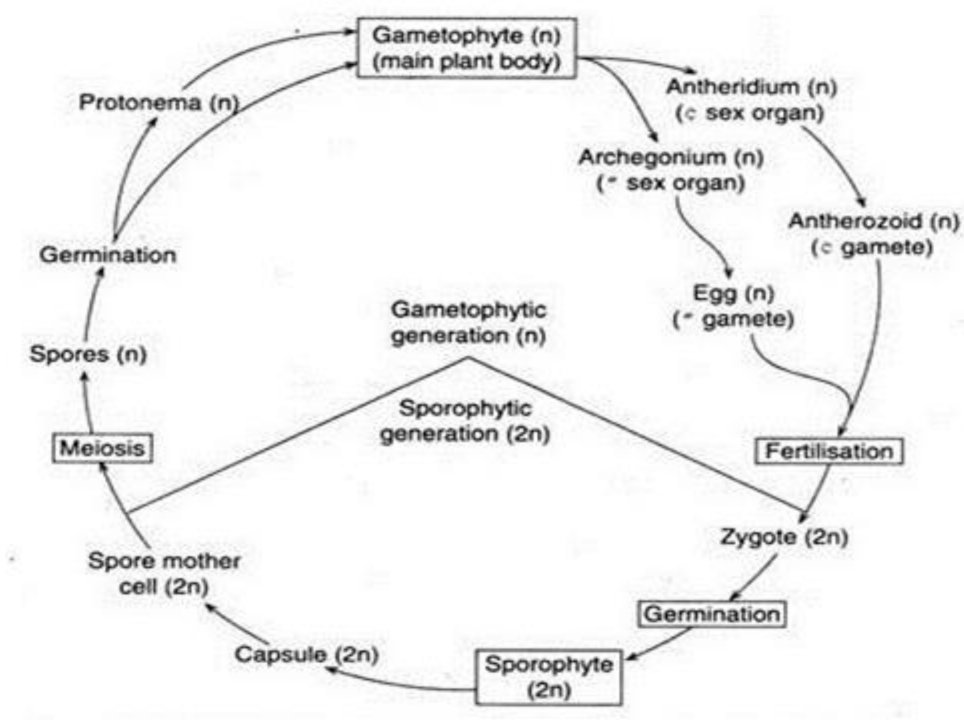
In some members of Bryophytes the tips of the rhizoid divides and redivide to form a gemma like structure from which new thallus can develop.

Topic -2

Sterilization of sporogenous tissue in Bryophytes

This theory was advocated by Bower (1908- 35) and supported by Cavers (1910) and Campbell (1940). According to this theory, the primitive sporophyte of bryophytes was simple and most of the sporogenous tissue was fertile (e.g., *Riccia*) and from such a sporophyte, the more complex sporophytes (e.g., mosses) have been evolved by the progressive sterilisation of potential sporogenous tissue. This theory is also known as "theory of sterilisation".

The general life cycle of Bryophyte can be shown by the diagram given below:



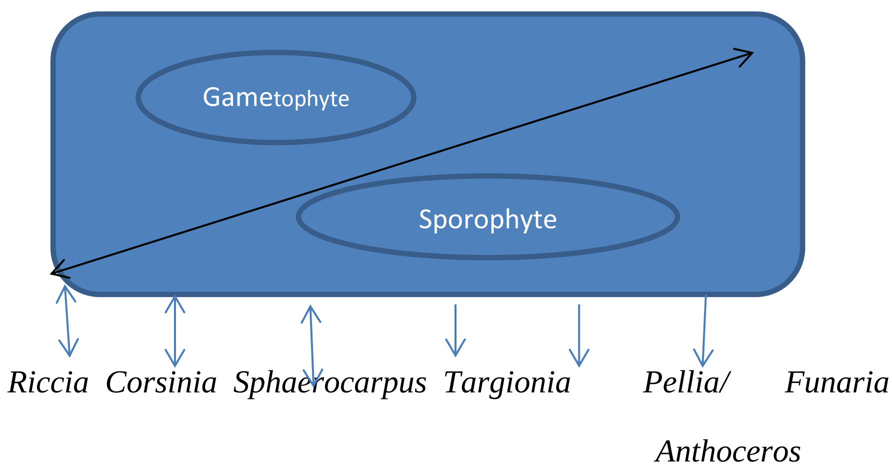
The life cycle of Bryophyte is divided into Gametophytic generation (Partially Haploid) and Sporotophytic generation (Partially Diploid). Zygote lies at the junction of Sporophytic and Gametophytic generation. The zygote gives rise to the sporophyte containing spores. The division of Zygote nucleus and its subsequent differentiation into fertile and sterile tissue differs as one moves from simple genus to developed genus. In *Riccia* the zygote divides by a transverse wall, followed by a vertical wall to form a four-celled embryo. Subsequently 20-30 celled embryo is formed by further divisions, in which periclinal divisions differentiate a single layered outer amphithecium (Sterile part) and the inner multicellular mass, the endothecium (Fertile part).The extent of sterility can be measured as 10%. Intermingled with spores few nurse cells can be found which is concerned with nutrition to the growing spores.

In the next stage of development the zygote divides transversely to form epibasal and hypobasal cell. The hypobasal cell forms the foot which gets anchorage from the host sporophytic plant. The epibasal cells differentiate into an outer amphithecium and inner endothecium. The amphithecium forms a single-layered sterile jacket of the capsule, while the endothe-cium differentiates into fertile sporocytes and long sterile elater-like nurse cells without the thickening bands.

An identical type of sporophyte development as reported on *Corsinia* described above has also been reported in *Sphaerocarpus* where a sterile bulbous foot, a narrow sterile seta developed from hypobasal cell and a fertile capsule developed from endothecium containing sporocytes and sterile nurse cells.

In *Targionia* the hypobasal cell forms bulbous foot and narrow seta. The epibasal cell soon differentiates into amphithecium and endothecium. The endothecium during development gives rise to 50% as fertile spores and 50% as sterile elaters and hence sterility is further increased.

In *Marchantia* the extent of sterility can be noticed as foot, seta, jacket layer and a cap of apical cap further sterilization can also be observed in the form of elaters with spiral thickening.



Riccia(10%), Corsinia---*Anthoceros , Funaria(90%)*

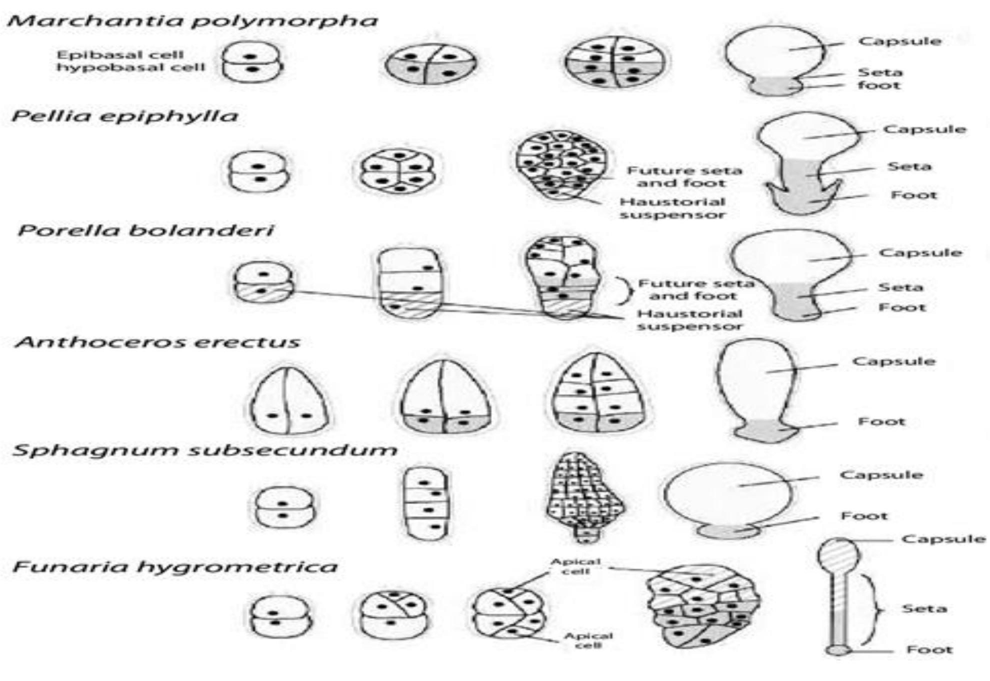
Extent of Sterility in Sporophyte

In *Pellia* and *Riccardia* the sporophyte is differentiated into Foot, Seta and a capsule having multilayered jacket. The sporogenous tissue besides forming few spores also produces sterile elaters and diffuse elaterophores.

In *Anthoceros* which exhibits highest degree of specialization and sterility the endothecium gives rise to central columella composed of 16 vertical rows of sterile cells. The further sterilisation of sporogenous tissue has been observed in the formation of pseudoelaters which are elongated 3-4 celled, simple or branched structure without thickening band.

The members of Bryopsida like *Funaria, Polytrichum, Pogonatum* etc., show the highest degree of sterilisation. The sporophyte is differentiated into a foot, a long seta and a capsule. The sterile tissue of capsule consists of the apophysis, operculum, many- layered jacket, the columella, trabeculae, the wall of spore sac and the peristome. The sporogenous tissue is restricted to the spore sacs only, hence it forms a negligible portion in the sporophyte.

Thus it is evident that sterility of sporogenous tissue can be considered as a parameter for development of Sporophyte in Bryophytes.



The extent of sterility in different sporophytes of Bryophytes

Topic- 3

Economic importance of Bryophytes

1. Protection from soil erosion:

A soil on the hilly tracts is moist and loose and is amenable to erosion. Bryophytes, especially mosses, form dense mats over the soil and prevent soil erosion by running water.

2. Soil formation:

During ecological succession formation of soil is the job of various biological agents. Mosses are an important link in plant succession on rocky areas. They take part in binding soil in rock crevices formed by lichens. It has been reported that mosses and lichens secrete certain acid/base which helps in further break down of rocks and converting into soil.

3. Water retention:

Soil reach in water is a suitable playground for growth and development of flora. Group of Plants classified as Moss has unique capacity to hold water. *Sphagnum* can retain 18-26 times more water than its weight. Hence, used by gardeners to protect desiccation of the seedling during transportation and used as nursery beds.

4. Peat:

It is a dark spongy fossilized matter of *Sphagnum*. Peat is dried and cut as cakes for use as fuel. Peat used as good manure. It overcomes soil alkalinity and increases its water retention as well as aeration. On distillation and fermentation yield many chemicals.

5. As food:

Mosses are good source of animal food in rocky and snow-clad areas. Moss and Lichen are main food of Artic herbivores like hares, Squirrels.

6. Medicinal uses:

Decoction of *Polytrichum commune* is used to remove kidney and gall bladder stones. Decoction prepared by boiling Sphagnum in water for treatment of eye diseases. *Marchantia polymorpha* has been used to cure pulmonary tuberculosis.

7. Other uses:

Bryophytes arc used as packing material for fragile goods, glass wares etc. Some bryophytes act as indicator plants. For example, *Tortell tortusa* grow well on soil rich in lime.

Topic-4

Sporophyte of Anthoceros

1. Zygote is the first stage of development of sporophyte. The first division of the zygote is vertical. In other Bryophytes the first division of the zygote is transverse. This is the important difference in the development of sporophyte of Hornworts and rest ‘of the Bryophytes.

2. The second division is transverse resulting into a quadrant stage. All the four cells divide by vertical walls to produce eight cells (octant stage). The eight cells are arranged in two tiers of four cells each.

3. In majority of the species like *A. fusiformis*, *A. pearsoni* and *A. him*alayensis upper tier of four cells divide by transverse division to form three tiers of four cells each . The lowermost tier forms the foot, the middle tier forms the meristematic zone or intermediate zone and uppermost tier develops into the capsule.

4. The four cells of the lower tier divide by irregular divisions to form broad, bulbous foot, made up of parenchymatous cells. In some species (e.g., A. *punctatus*) the superficial cells of the foot form a palisade layer of cells while in some species (e.g., *A. laevis, A. himalayensi*s) the superficial layer grows into haustoria like projections.

5. The uppermost tier of four cells which forms the capsule divide by one to two transverse divisions to form two to three tiers of cells.

It is followed by periclinal division to form an outer layer of amphithecium and the central mass of cells called endothecium. The entire endothecium develops into the sterile columella. In young sporophyte it is made of four cells but in mature sporophyte it is made of sixteen vertical rows of cells.

The amphithecium divides by a periclinal division to differentiate into an outer sterile layer of jacket initials and inner fertile layer

The cells of the jacket initials divide by anticlinal and periclinal divisions to form four to six layered capsule walls. The outermost layer of the capsule wall is called epidermis. It is characterized by the presence of stomata. The cells of the inner layers of capsule wall have chloroplast.

In the young sporophyte the archesporium over archs the columella. The archesporium may be single layered in thickness throughout in its further development (e.g., *A. erectus*) or become two layered (e.g., *A. pearsoni*) or two to four layered (e.g., *A. hallii*).

Successive Stages in the Development of Sporophyte

On maturity the archesporium gives rise to two types of cells: spore mother cells and elater mother cells. These cells are arranged in alternate manner one above another.

Spore mother cells divide by meiotic divisions to form spore tetrads. Elater mother cells are elliptical with small nuclei. These cells divide mitotically to form four celled elaters. The four cells of the elaters may remain attached to each other or may break into 1-celled, 2-celled or 3-celled units. The broken units are called pseudo elaters. (The elaters are without thickening bands and therefore, called pseudo elaters,

By the activity of the meristematic zone various tissues of the capsule are continuously produced so that it becomes elongated. The young sporophyte of the *Anthocero*s is surrounded by a fleshy covering or sheath. It is called involucre. It is developed partly from the tissue of the archegonium and partly from the tissue of the gametophytic thallus. In young stages the sporophyte is completely surrounded by involucre.

Structure of Mature Sporogonium:

The mature sporophyte consist a bulbous foot and a smooth, slender, erect, cylindrical, structure called capsule. Capsule varies in length from two to fifteen centimeter in different species. The sporogonium appears like a 'bristle' or 'horn', hence; the species are called 'hornworts'

Internal structure:

A mature sporogonium can be differentiated into three parts viz., the foot, seta and the capsule.

Foot:

It is bulbous, multicellular and made up of a mass of parenchymatous cells. It acts as ac haustorium and absorbs food and water from the adjoining gametophytic cells for the developing sporophyte.

Seta:

Seta is represented by meristematic zone. This is present at the base of the capsule and consists of meristematic cells. These cells constantly add new cells to the capsule at its base.Meristematic Zone or Intermediate Zone or Intercalary Zone:

Capsule:

Its internal structure can be differentiated into following parts:

Columella:

It is central sterile tissue, extending nearly to its tip. It is endothecial in origin. In a transverse section these cells appear as a solid square. It provides mechanical support, functions as water conducting tissue and also helps in dispersal of spores.

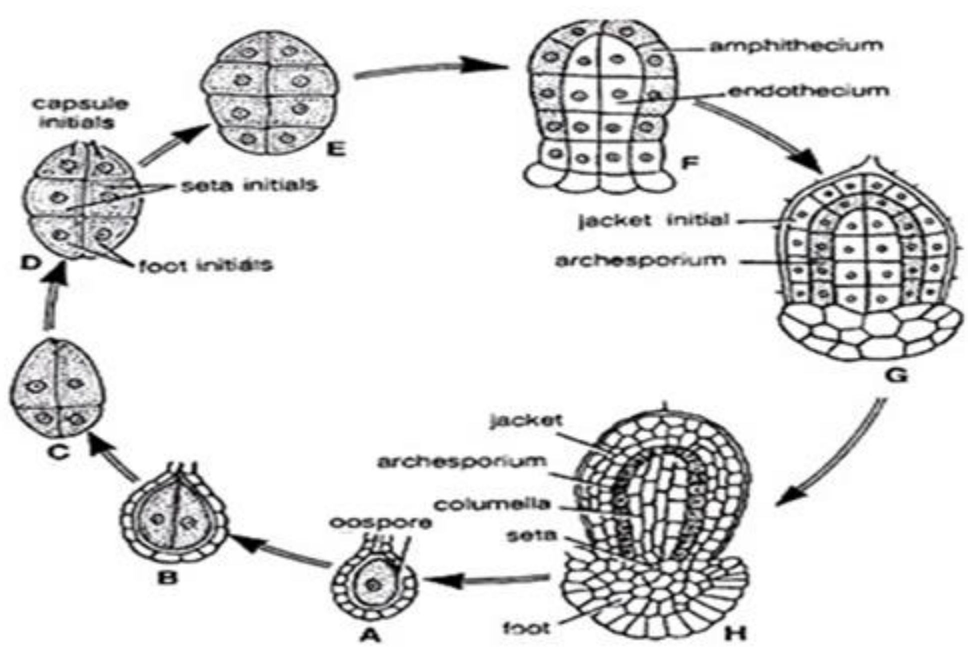
Archesporium:

It is present between the capsule wall and the columella. It extends from base to the top of the capsule. It originates from the inner layer of amphithecium. In the young sporophyte it over arches the columella.

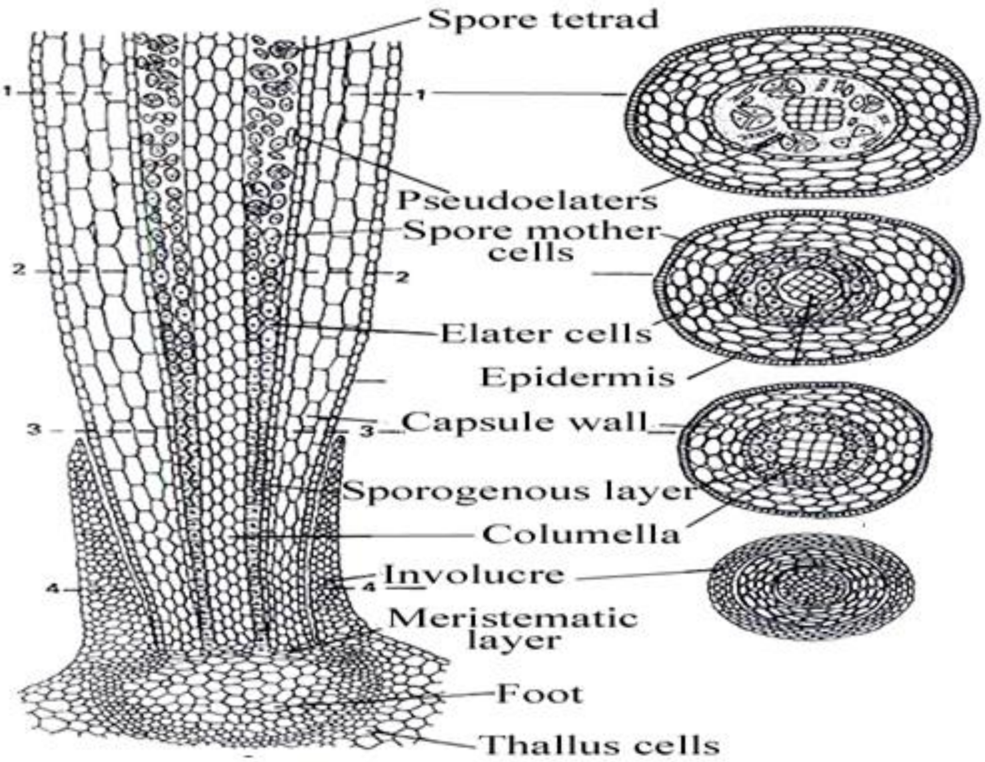
Capsule wall:

It consists of four to six layers of cells, of which the outermost layer is epidermis. The continuity of epidermis is broken by the presence of stomata.

Each stoma consists of a pore surrounded by two guard cells. The cells of the inner layers have intercellular spaces and contain chloroplast. Thus, the sporogonium is partially self-sufficient to synthesize its own organic food but partially it depends on the gametophyte for the supply of water and mineral nutrients. Thus they are also called as Semi parasite on gametophyte.



Successive stage of development of sporophyte of Anthoceros



Internal structure of *Anthoceros* at different regions

Topic- 5

Anthocerophytes a synthetic group of plants

Plants colonized terrestrial environments approximately 480 million years ago. Phylogenetic analyses position one or more groups of Charophyte algae as the sister group to land plants has revealed two distinct groups of land plants: the bryophytes and the monophyletic group of vascular plants. The bryophytes comprise three monophyletic lineages, the liverworts, the mosses and the hornworts. Although subject to much scrutiny, the phylogenetic relationship between these three lineages remains fiercely debated. The widely accepted view, supported by phylogenomic analyses, is that liverworts, mosses and hornworts branch as successive sister groups such that hornworts are the sister to vascular plants. However, more recent analyses based on protein sequences suggested that the position of hornworts as vascular plant sister group is an artefact of convergent codon usage in the two lineages. Moreover, the data supported monophyly of liverworts and mosses, a relationship that is further validated by phylotranscriptomic analyses of a much larger taxon group. Depending on the phylogenetic method used, this latest study identified hornworts as either sister to all land plants, in a clade with mosses and liverworts, or sister to vascular plants . *Anthoceros* due to above described facts are often considered as a synthetic group. The sporophyte of *Anthoceros* shows resemblance to:

Resembling feature of *Anthoceros* to Algae

1. Simple thallus organization with appropriate branching.

2 Every cell contains a single chloroplast with Pyrenoids ,a character found in lower algae.

3. Motile biflagellate antherozoids with anterior whiplash flagella.

4. Antherozoids require water for fertilization.

Resembling feature of *Anthoceros* to Liverworts

1. Thallus having dorsi ventral symmetry.

2. Apical growth of the thallus by single pyramidal apical cell.

3. The plant body is thalloid and subterranean

Resembling feature of *Anthoceros* to the Bryopsida (mosses):

(i) Presence of central columella in both groups.

(ii) Large reduction of the sporogenous tissue in both Anthocerotopsida as well as Bryopsida groups.

(iii) Presence of functional stomata (e.g., in Funaria).

(iv) Differentiation of archesporium from the inner amphithecium as in *Sphagnales*. This feature shows link between Anthocerotopsida and Bryopsida.

(v) The developmental stages of embryo are quite similar. The early divisions are very much alike.

Resembling feature of *Anthoceros* to the Pteridophyta :

(i) The presence of sunken sex organs is common in both groups.

(ii) The presence of similar vegetative structure of the gametophyte in Anthoceros and Fern.

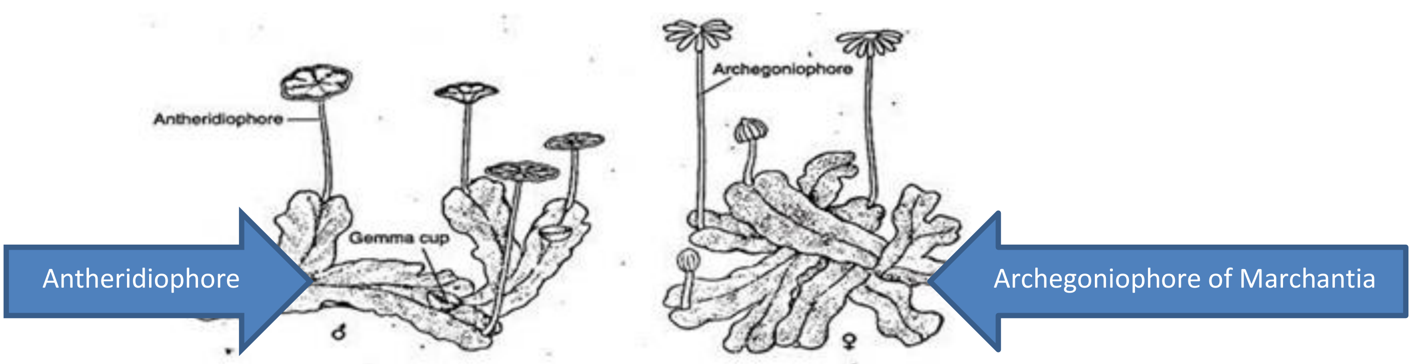
(iii) The presence of highly developed sporogonium with photosynthetic tissue indeterminate growth and functional stomata.

The abovementioned facts support that the Anthocerotopsida are a distinct but synthetic group of plants. It forms a connecting link with liverworts and mosses on one hand and with pteridophytes on the other. There is also a remote connection with green algae (Chlorophyceae). Campbell (1928) suggested, “The fact that the primary sporogenous tissue in the Anthocerotales always arises from the amphithecium, while in all other liverworts it is developed from the endothecium, would seem to be a radical difference”.

Topic- 6

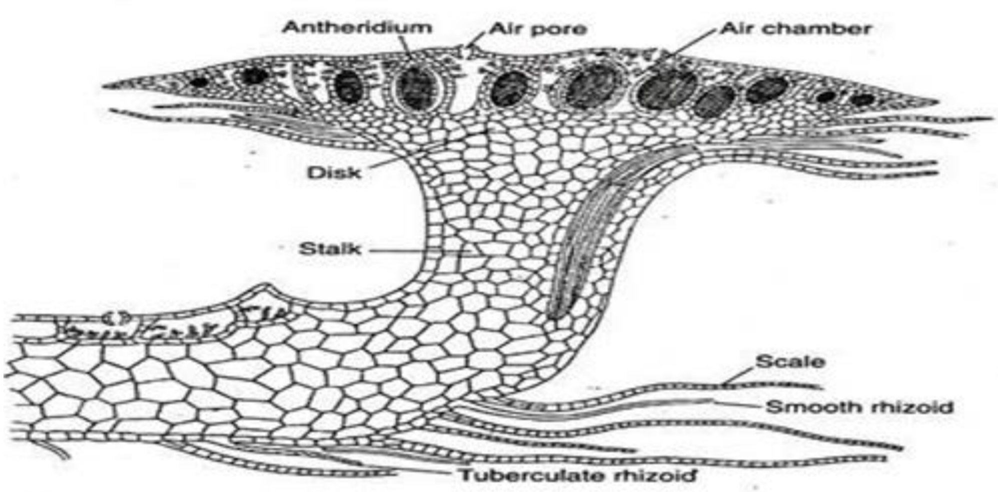
Antheridiophore and Archegoniophore in Marchantia

Marchantia is dioecious, i.e. the male and female sex organs develop on separate thalli. The male sex organs are called antheridia, and the female sex organs are archegonia. Sexual reproduction is Oogamous. The sex organs are born on upright branches called receptacles or gametophores. The gametophore bearing antheridium is called antheridiophore, and that bearing archegonia is called archegoniophore. Sex organs are usually produced during winter to spring in India, mostlyin the months of April or May (Maravolo, 1976), and only once in a year. The production of sex organs is controlled by high humidity, low nitrogen, high carbonate content. Abnormal bisexual receptacles, known as androgynous receptacles have also been reported by several workers in many species of *Marchantia*. However, these abnormalities are considered to be of great phylogenetic importance, denoting reversion to the monoecious condition. The reproductive branches grow vertical and become differentiated into a stalk and a terminal horizontal disc, which is 8 lobed.



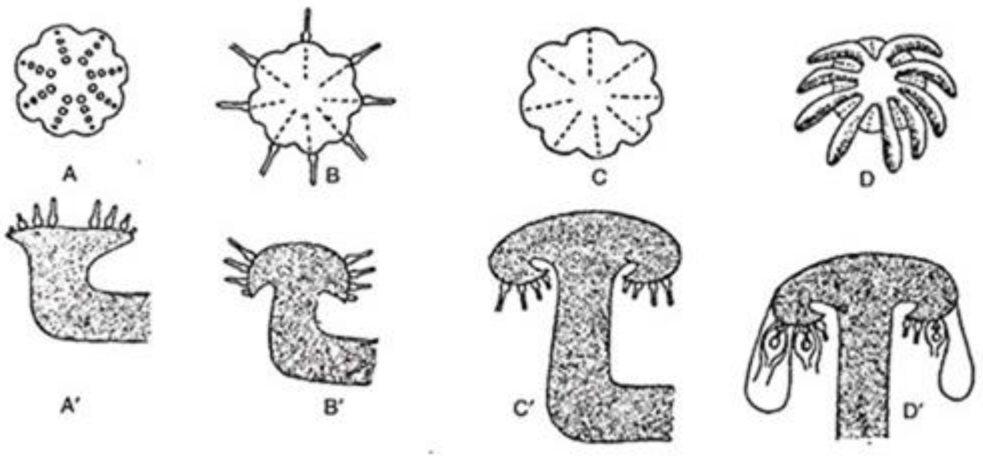
The antheridiophore is the reproductive branch bearing the antheridia. The antheridiophore is differentiated into long stalk and a terminal disc. The stalk is about 1-3cm in length having the dorsiventral surface. The disc of the antheridiophore is eight lobed; the growing points are situated at the apex of each lobe. The upper part of antheridiophore has air chambers alternating with the antheridial chambers. The air chamber is triangular in shape and it possesses the assimilatory filaments which are capable of photosynthesis, whereas the antheridial chamber consists only the antheridia and is formed in acropetal succession in rows. That is older antheridia are formed at the center and the younger ones towards the margins.

The antheridiophore is 1-3 cm long prismatic stalk bearing at its apex a slightly convex (peltate) disc which is usually a 8-lobed structure. Each lobe represents the apex of a branch along whose upper (dorsal) median line the antheridia are borne in a row.The antheridia develop in a acropetal manner i.e., the oldest are being at the center and the youngest ones towards the periphery. The antheridia are within the flask- shaped antheridial chamber. Each antheridial chamber contains a single antheridium. Each antheridial chamber is separated from one another by air chambers with air pores.



Archegoniophore

In *Marchantia*, the archegoniophore is the female reproductive structure. Like the male reproductive structure, the archegoniophore grows upward from the thallus and has a stalk and a head (in this case the archegonial head). Unlike the male structure, the archegoniophore looks somewhat like a palm tree and the archegonia grow on the bottom side of the head.The stalk of the archegoniophore begins to elongate just after fertilisation and the central sterile part of the disc starts to enlarge enor-mously. As a result, the marginal apical region of the disc containing archegonia is pushed down to the lower-side of the disc. The archegonia are hanging upside down — the youngest one being nearer the stalk whiles the older ones towards the periphery. Subsequently, the tissue in between the rows of archegonia develops and hangs down as rays. Initially the number of lobes is 8, later 9 rays are formed by the splitting of one. Rays are long, stout and green finger-like projections that give the mature female receptacle an umbrella-like appearance. The archegonia become inverted by the curvature of the disc. Single layered plate of tissue overlaps on either side of row of archegonia to form perichaetium or involucre. This plate of tissue encloses all the archegonia (about 12 to 14) arranged in a single row.



Stages in the development of Antheridiophore and Archegoniophore in *Marchantia*

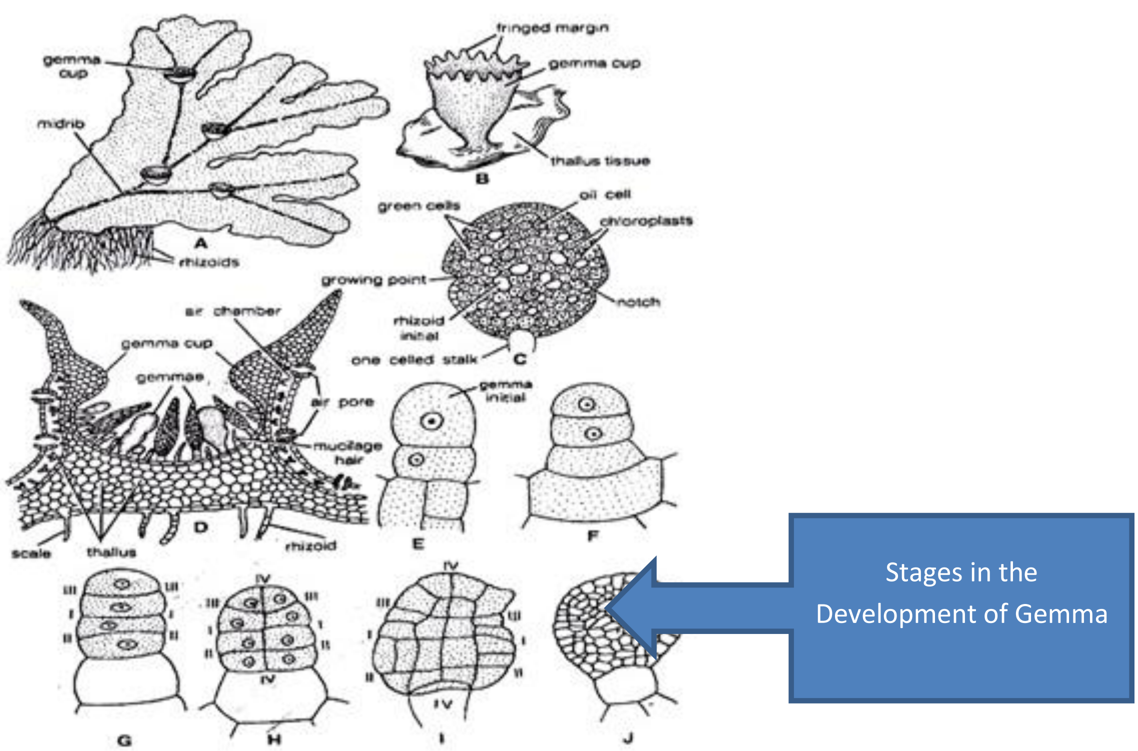
Topic- 7

<u>Notes - Gemmae</u>

Gemma cup are special vegetative ,small cup shaped structures borne along the midrib on the dorsal surface of gametophyte of some bryophytes . Each gemma cup contains a large no. of special vegetative reproductive bodies called gemmae in it.

The gemma cups are cup-like structures containing gemmae. The main function of the Gemma cup is vegetative reproduction. The Gemma is a small cup-shaped cell found on the thalli of bryophytes such as mosses and liverworts. The Gemma cells separated from the parent and develop into a new individual

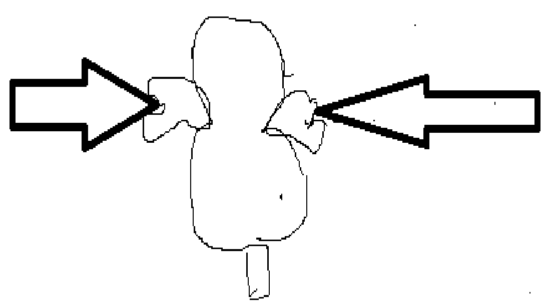
The diploid sporophyte (2n) is surrounded by the enlarged archegonium called the calyptra and is dependent on the haploid tissue of the archegoniophore for nutrients and water. ... Look on the top surface for gemmae cups containing gemmae, tiny green discs of haploid cells



Stages in the development of Gemma cup containing Gemma in *Marchantia*

The gemma develops from a single superficial cell. It develops on the floor of a gemma cup. It is papillate and called gemma initial. It divides by a transverse division to form lower stalk cell and upper cell . The lower cell forms the single celled stalk.

The upper cell further divides by transverse division to form two cells. Both cells undergo by similar divisions to form four cells. These cells divide by vertical and horizontal division to form a plate like structure with two marginal notches. It is called gemma.



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New thalli growing from the growing points of Gemmae

Topic-8

Salient feature of Bryophytes

Bryophytes are the group of seedless plants that are the closest-extant relative of early terrestrial plants. The first bryophytes (liverworts) probably appeared in the Ordovician period, about 450 million years ago. However, because they lack lignin and other resistant structures, bryophyte fossil formation is improbable and the fossil record is poor. Some spores protected by *sporopollenin* have survived and are attributed to early bryophytes. By the Silurian period, however, vascular plants had spread through the continents.

More than 25,000 species of bryophytes thrive in mostly-damp habitats, although some live in deserts. They constitute the major flora of the environments like the tundra where their small size and tolerance to desiccation offer distinct advantages. They generally lack lignin and do not have actual tracheids (xylem cells specialized for water conduction). Rather, water and nutrients circulate inside specialized conducting cells. Although the term non-tracheophyte is more accurate, bryophytes are commonly called non-vascular plants.

1. Bryophytes are of amphibious nature and hence they grow in damp and shady places. Some part of their life is completed due to presence of water. Some part of their life is spent in presence of water (Transfer of antherozoids to Archegonia).

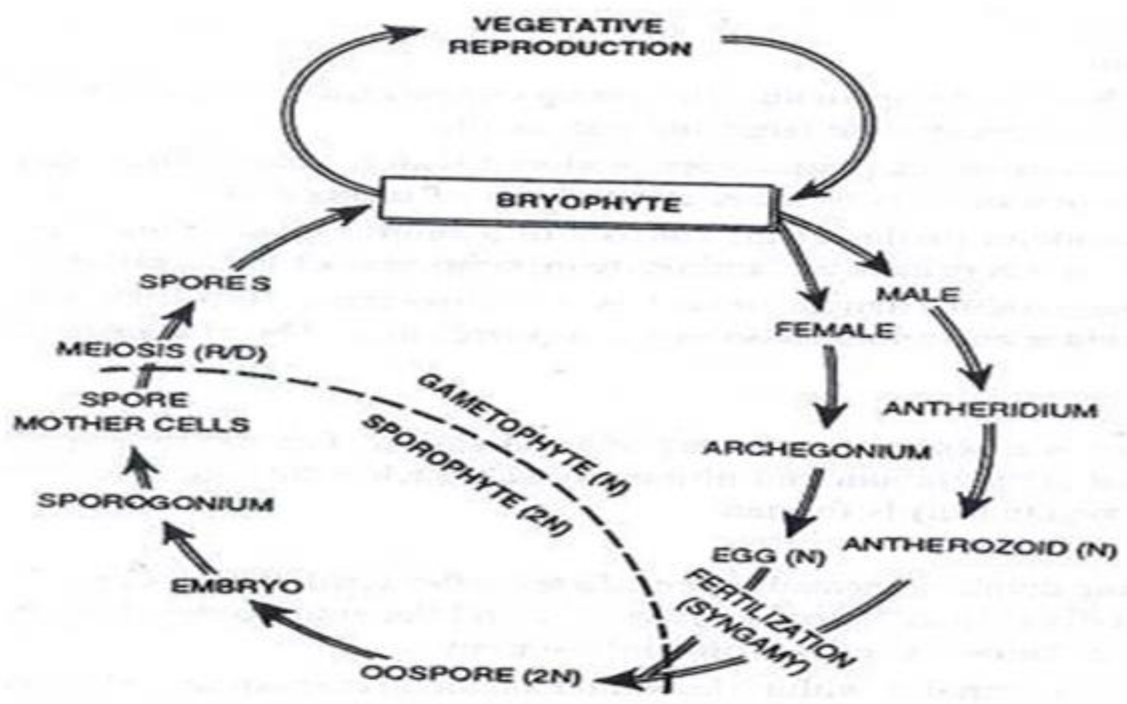
2. They follow heterologous haplodiplobiontic type of life cycle. This means that they have both haploid phase and diploid phase in the life cycle. However the haploid phase is for a very short duration

3. The dominant plant body is gametophyte on which sporophyte is semiparasitic for its nutrition. The gametophytic plant body is diploid on which sex organs borne in Antheridia and Archegonia develop. In most of the members of Bryophytes the sex organs are embedded (Hepaticopsida, Anthoceropsida), they are produced on separate branches along with group of leaves(Bryopsida) . However in *Marchantia* they are situated on specialized branches called as Anthridiophore and Archegoniophore. The Anthridiophore and Archegoniophore bear the Antheridia and the Archegonia respectively. In the Antheridia and Archegonia Meiotic division takes place which results into development of haploid stage in the life cycle.

4. The thalloid gametophyte differentiated in to rhizoids, axis (stem) and leaves. The structure of the thallus ranges from thalloid or foliose. If foliose, the lateral appendages (leaves) are without mid-rib. It always exhibits dorsiventral symmetry. The gametophyte plant bodies have rhizoids without septa. In Anthoceropsida gametophytic plant body is simple, thalloid; thallus

dorsiventral without air chambers shows no internal differentiation of tissues. In this group rhizoids are unicellular. In Bryopsida gametophyte is differentiated into prostrate protonema and an erect gametophores. The Gametophore is foliose, differentiated into an axis (=stem) and lateral appendages like leaves but without midrib. Rhizoids are multi-cellular with oblique septa. Vascular tissues are (xylem and phloem) absent. The gametophyte bears multi-cellular and jacketed sex organs (antheridia and archegonia). Sexual reproduction is oogamous type. Multi-cellular embryo develops inside archegonium immediately after fertilization which marks the end of gametophytic generation and beginning of Sporophytic generation. The gametophytic plant body multiplies rapidly during vegetative reproduction. Some of the common methods of vegetative reproduction are by progressive death and decay of older parts, by branch tips, by gemmae, by tubers and by Protonema.

5. The sporophyte of bryophytes is called sporogonium which generally consists of a single, terminal sporangium (monosporangiate) with a bulbous foot and with or without an unbranched stalk or seta. The sporogonium is very delicate, short-lived and nutritionally dependent on its gametophyte. Sporophyte differentiated into foot, seta and capsule. Capsule produces haploid meiospores of similar types (homosporous). Spore germinates into juvenile gametophyte called protonema. Progressive sterilization of sporogenous tissue noticed from lower to higher bryophytes.



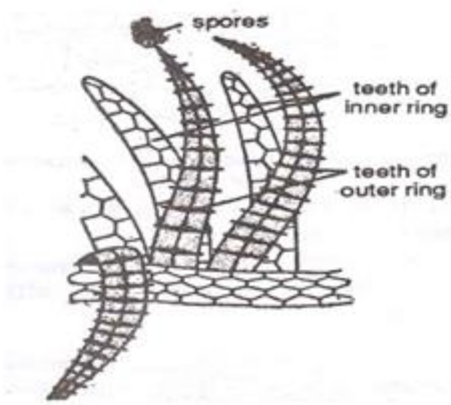
Diagrammatic life cycle of Bryophytes

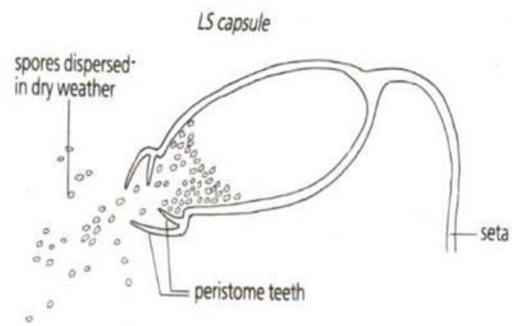
Topic- 9

Peristome teeth of Polytrichum

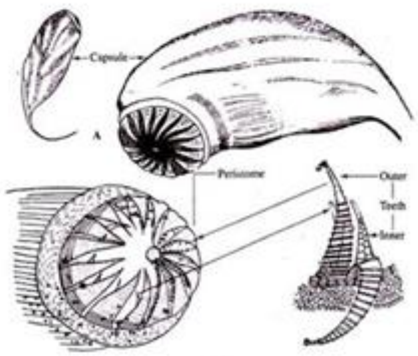
The peristome is a teeth-like projection that surrounds the mouth of capsule in most of the members of Bryidae (Mosses) of Bryophytes. So, it is an important characteristic of the Bryopsida. The peristome teeth spring from the rim or diaphragm. Peristome teeth are part of sporophytic plant body of moss. So it is obvious that it is Diploid because all cells of sporophytic plant body are produced after fertilization. Only spore mother cell by meiotic division form spores which are haploid.

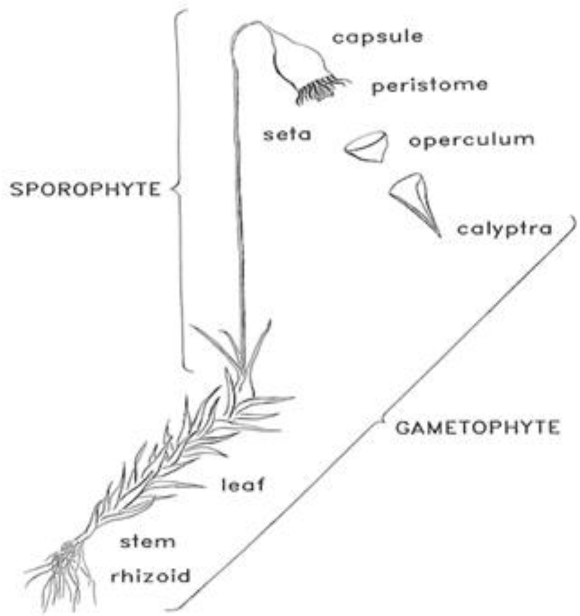
The function of pristome teeth is to close by folding in and open by folding out to open and close the stoma (meaning mouth) under damp conditions to disperse the spores gradually. It is a valve that allows the spores to exit when conditions are right.The peristome is derived from the inner layers of the amphithecium, the tissue surrounding the spore sac, while the epiphragm derives from the expanded apex of the columella, formed from the endothecial layer that also gives rise to the sporogenic tissue. General morphology of the peristome and epiphragm as found in *Polytrichum sensu*, showing the ridge and spur structures on the inner sides of the peristome teeth that alternate with sacculi on the edge and lower surface of the mature epiphragm.





Mode of Dispersal of Spore in *Polytrichum*- the involvement of Peristome





Mode of Dispersal of Spore in Polytrichum- the involvement of Peristome

The sporogonium consists of three parts (Development):

(a) A sac-like upper part, the capsule,

(b) A slender stalk called seta, and

(c) A small foot by means of which it is attached to the gametophyte.

The capsule is at first green in colour owing to the possession of chloroplasts and in its lower portion bears few stomata. Within the capsule the sporogenous tissue develops, from which ultimately spores are formed (four spores from each spore mother cell due to reduction division).

A large part of the central tissue of the capsule remains sterile forming the so-called columella and the conical upper part, the operculum, which becomes detached from the lower part as lid in order to allow these spores to escape; the operculum is prolonged into a beak-like rostrum.

Just beneath the operculum there is a complicated structure known as peristome consisting of 32 or 64 'teeth' in a circle around the mouth of the spore-cavity of the capsule. These are nothing but bundles of thickened fibrous cells, regularly arranged in crescent form resem-bling the spokes in a wheel and have got a profound taxonomic importance. These teeth help to scatter the spores.

The tip of the columella is expanded into the epiphragm, filling the space inside the peristome ring. There are two large intercellular spaces surrounding the sporogenous tissue, one on its outer side and the other between it and the columella, and are traversed by narrow filamentous strands of cells containing chloroplasts. At maturity the capsule finally becomes horizontal and dorsiventral.

Where a seta is present it elongates early, while the spore capsule is still undeveloped, and the elongation is by production of additional cells. In a species with a long seta the growing sporophyte breaks through the enveloping calyptra. The lower part of the calyptra is left around the base of the seta and the calyptra's upper part is carried aloft, still covering the undeveloped spore capsule.. The seta has expanded and there is both a basal calyptral remnant as well as one over the apex of the sporophyte. In this species the calyptra is clearly rather hairy.

The early stage of sporophyte development, where there is a seta, is often referred to as the spear stage because the undeveloped spore capsule typically shows, at most, as a slight thickening at the top of the seta and so resembles a spearhead on a spear shaft. The spore capsule will mature and enlarge atop the seta. The seta and immature capsule in the young sporophyte are both green and contain photosynthesizing cells but the sporophyte is still heavily reliant on nutrients passing to it from the gametophyte. A study into photosynthetic activity of the spore capsules of three moss species showed that the photosynthesizing capsule of *Funaria hygrometrica* contributes about 50% of its nutrition needs during the later stage of capsule expansion.

Peristome teeth on moss spore capsule

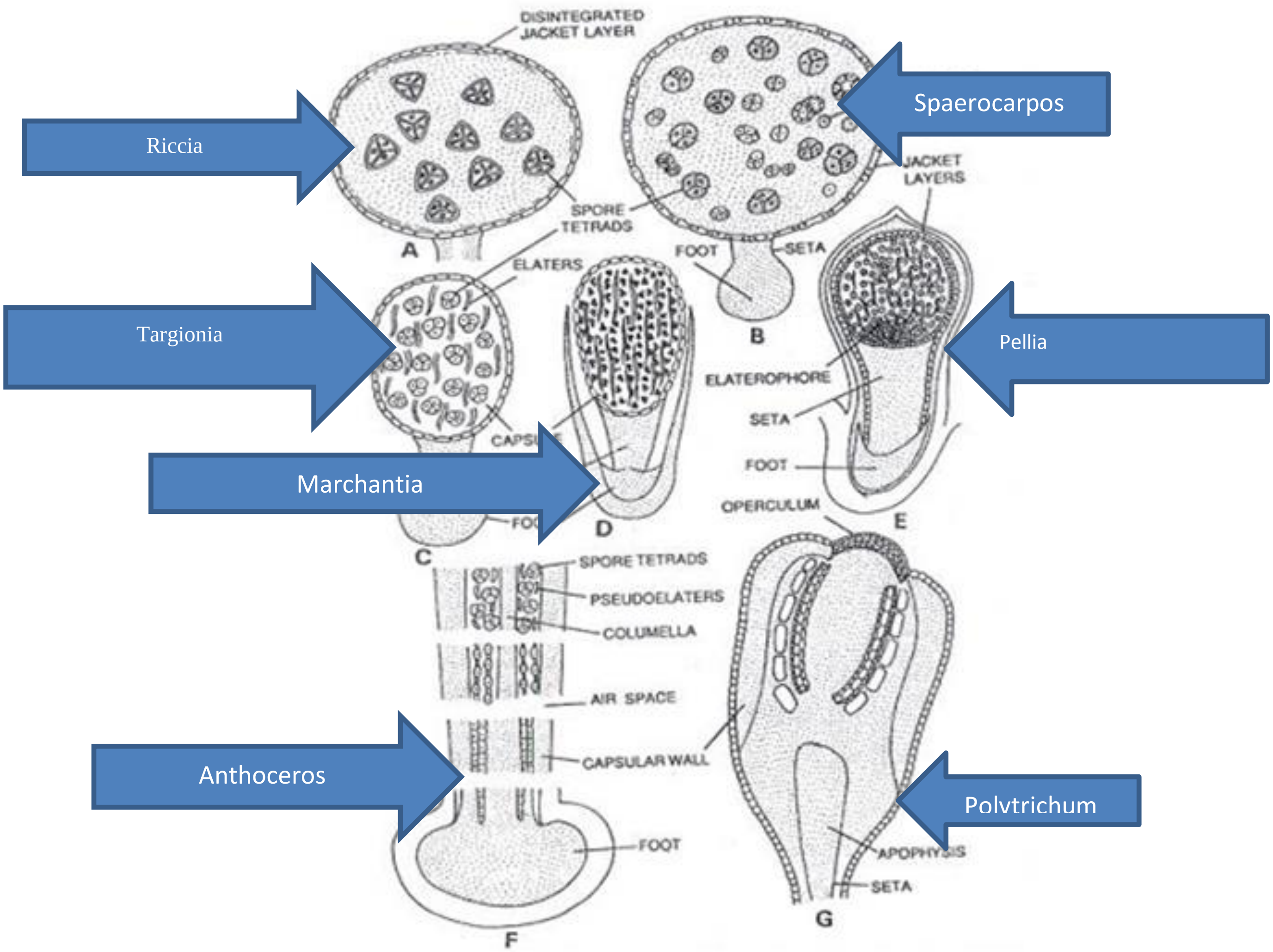
The sporophyte eventually stops photosynthesis and the capsule turns brown late in sporophyte development, as does the seta if present.. Amongst the setae some are green and some are already brown. It is common to see sporophytes in various stages of development.

In a species with no seta, or just a very short seta, it is the enlarging capsule that ruptures the calyptra. In the majority of mosses the spore capsule develops a mouth through which the spores will eventually be released. In a small number of moss genera the capsules simply disintegrate or open by means of slits. Where there is a mouth it is at the opposite side of the capsule to the point where the capsule is joined to the seta. Initially the mouth is covered by a small cap called an operculum. As the spore capsule matures and expands the upper calyptra remnant falls off. When the spores within the capsule are mature the operculum is shed. Once the operculum has been shed the mouth is exposed. In a number of moss species the mouth is surrounded by a bare rim but a greater number of species have capsules with teeth or hairs around the mouth. The teeth are called peristome teeth and, when present, there may be one ring or two rings of teeth around the margin of the mouth. Teeth or hairs around the mouth play a role in spore DISPERSAL.

In many species of the family Polytrichaceae there is a circular membrane or epiphragm that is attached to the ends of short peristome teeth. This leaves just a ring of tiny gaps around the mouth through which spores can be released. Spore capsules mature they dry and shrink. In many species the cells of the operculum are thicker walled than those of the rest of the spore capsule and so shrink less on drying. Around the margin of the operculum is a ring of cells, called the annulus, which connects the operculum to the rest of the capsule. The cells of the annulus are large, thin-walled elastic cells. The difference in shrinking between operculum and the rest of the capsule creates tensions in the annulus which eventually breaks free and uncoils, thereby releasing the operculum

Topic- 10

Sporophyte of important members of Bryophytes



Details regarding development of Sporophyte in types described above can be obtained from SLM provided to every student.