



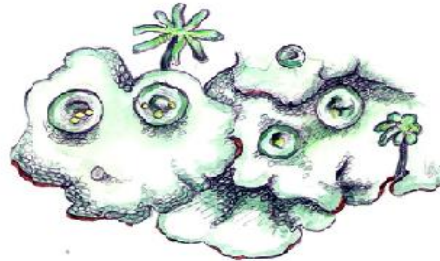
# BRYOPHYTES

# Introduction

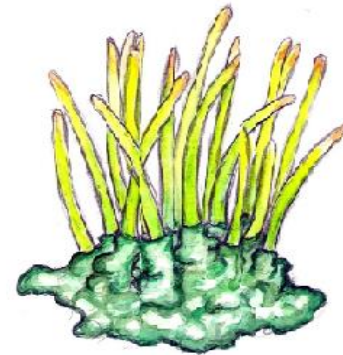
- Bryophytes are mosses, liverworts and hornworts.



Moss



Liverwort



Hornwort



Liverwort

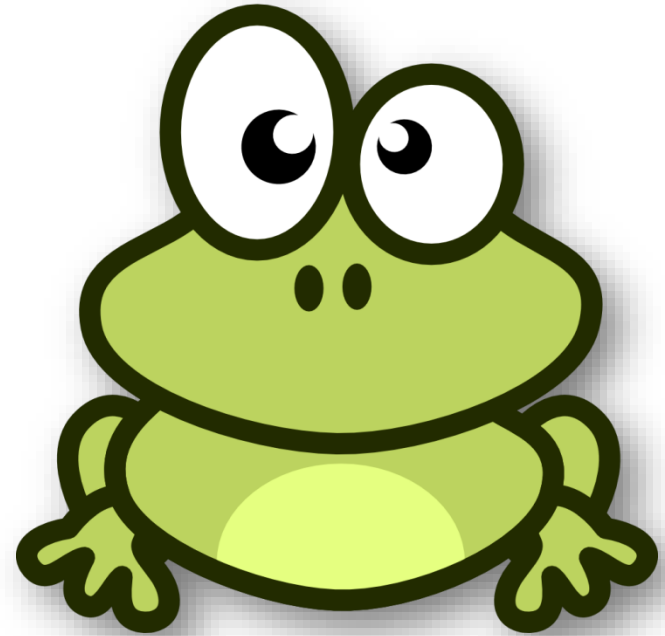


Hornwort



Moss





**BRYOPHYTE: AMPHIBIAN OF PLANT  
KINGDOM**

**FROG: AMPHIBIAN OF ANIMAL  
KINGDOM**

Bryophytes are known as the “Amphibians of Plant Kingdom”

- The term Bryophyte was coined by **Robert Braun** in **1864** from two Greek words;  
    ‘**Bryon**’ meaning Moss and ‘**Phyta**’ meaning plants.
- The most primitive of land plants.
- They are non vascular plants.
- They reproduce via spores not via flowers or seeds.
- The branch of science that deals with the study of bryophytes is called Bryology.

# Pictures of various Bryophytes



Riccia



Targionia



Cyathodium



Marchantia





Lunularia



Dumortiera



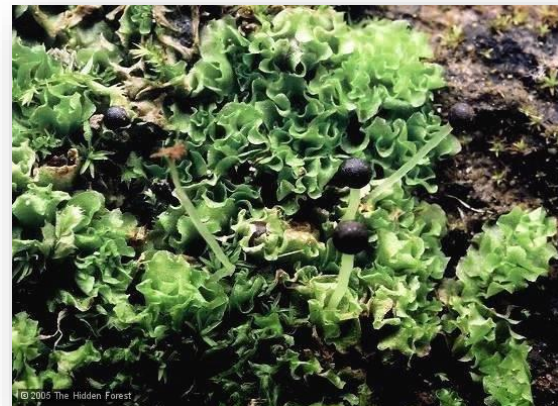
Reboulia



Pallavicinia



Aneura



Fossombronia





Porella



Notothylas



Anthoceros

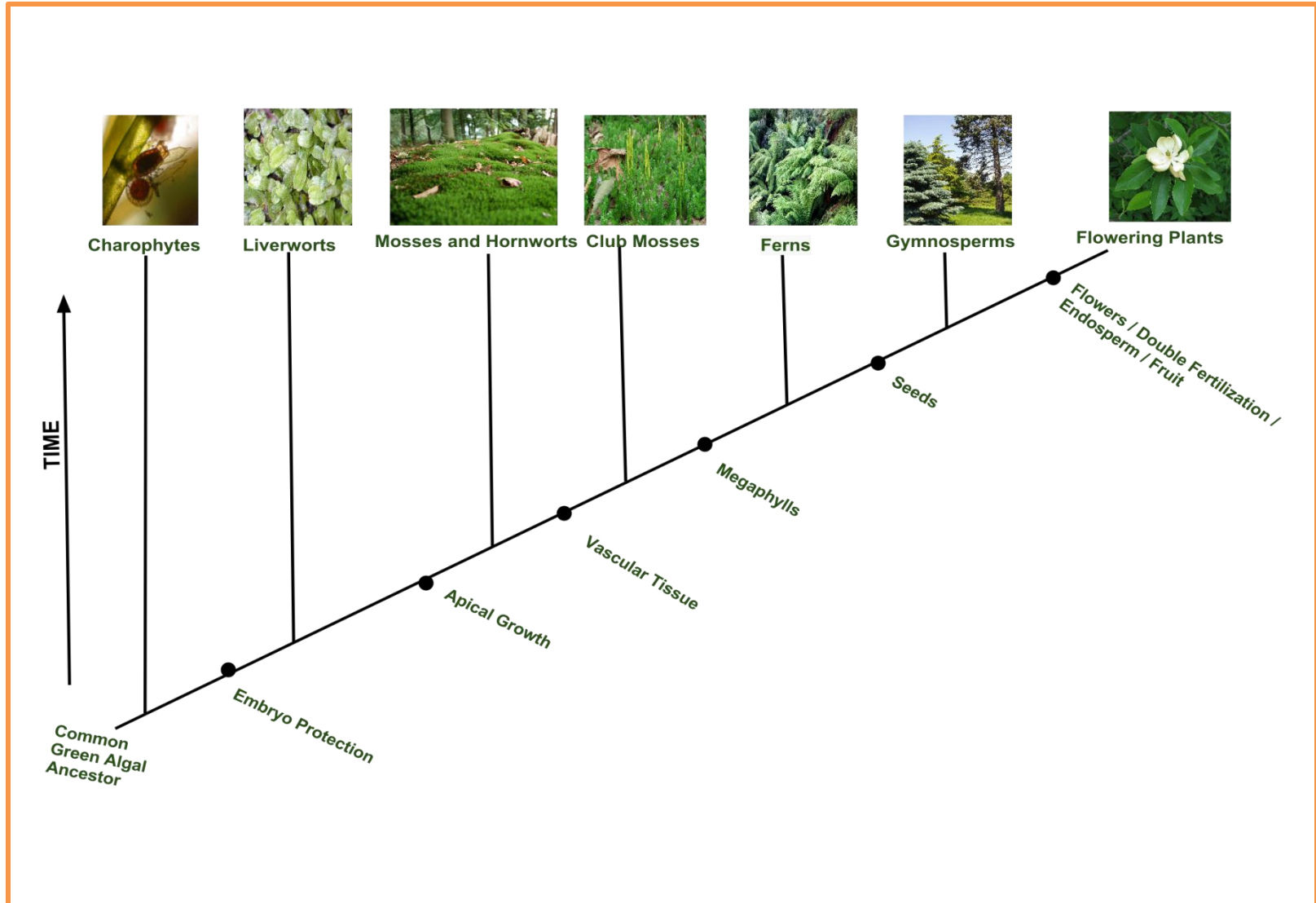


Sphagnum



Pogonatum

# Evolution of Bryophytes





# Similarities of Bryophytes to Algae

- Both are autotrophic.
- Pigments like chlorophyll a, b and also carotene are present in both cases.
- Absence of vascular tissues.
- True roots are absent in both.
- Reserve food is starch.

- Dominant phase of lifecycle is gametophyte.
- Male gametes are ciliated and motile.
- Presence of water is a must for both of their fertilization.
- Protonema of bryophytes similar to that of algal filaments.



# Similarity of Bryophytes to Pteridophytes

- In both cases sex organs are multicellular and are protected by sterile jacket layer.
- Water is necessary to effect fertilization for the movement of male gametes which are ciliated.
- The zygotes develops to form the embryo.
- Similarity exists between the terminal sporangia of psilophytales and the terminal capsule of mosses.
- In both cases a heteromorphic type of alternation of generation is characteristic.

# General Characters of Bryophytes

## Habitat

- Mostly occupy an amphibious zone but exceptions are there.
  - Aquatic Bryophytes: Riccia fluitans.
  - Saprophytic Bryophytes: Buxbaumia, Cryptothallus.
  - Xerophytic Bryophyte: Polytrichum.
  - Epiphyllous Bryophyte: Radula protensa.
  - Desert Bryophyte: Tortula dessertorum.
  - Epiphytic Bryophyte: Dendoceros.
- They inhabit damp shaded or humid localities.
- Plant Body consists of gametophytic and sporophytic generations.

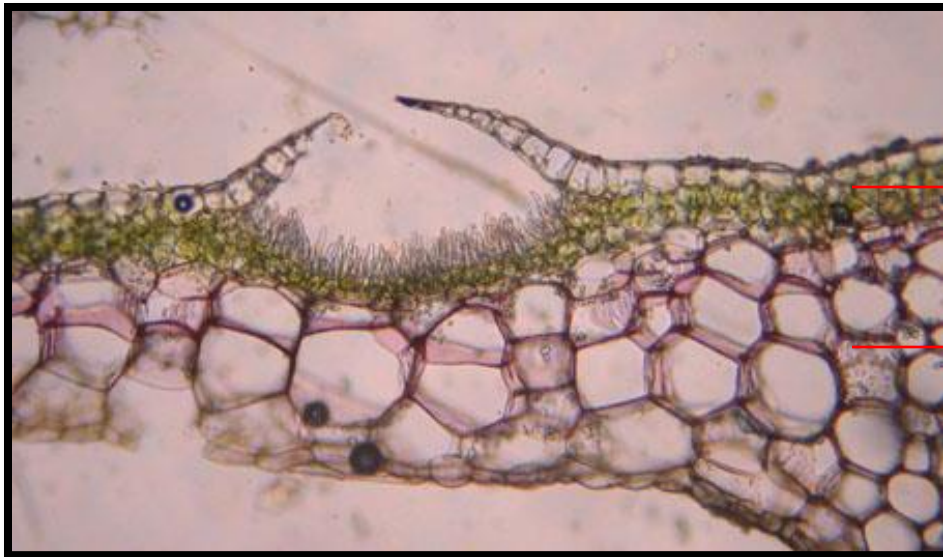


- Gametophyte is the dominant phase in bryophytes life cycle.
- Sporophyte is insignificantly reduced and parasitic upon the gametophyte.



- Simple in lower forms but in majority, plant body is differentiated into stem like, leaf like and root like structures.
- Plant body consists of simple tissues only.

- Xylem, phloem and sclerenchyma are absent.
  - **Hydroids:** Xylem like cells in polytrichum.
  - **Leptoids:** Phloem like cells in polytrichum.
- Thallus consists of mainly 2 zones;
  1. Photosynthetic zone
  2. Storage Region



→ Photosynthetic Zone

→ Storage Zone



# Attachment and absorption organs

## Rhizoids

- Rhizoids are hair like structures present on the ventral side of the gametophyte.
- Rhizoids look like roots, but do not absorb water or nutrients.
- They attach the plants to their substrate and help with external water retention and conduction.
- They are of two types; **Smooth rhizoids** and **Pegged rhizoids**.



## Scales

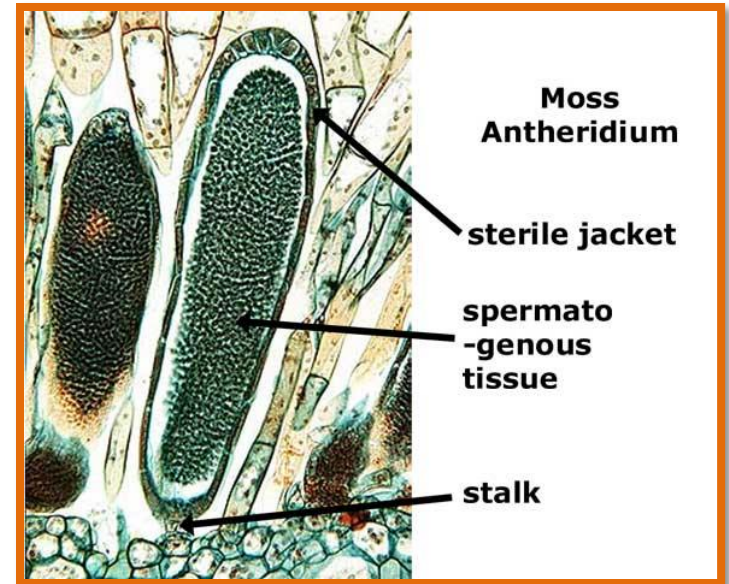
- Scales are seen associated with rhizoids.
- Scales can be easily distinguished from the rhizoids because they are multicellular and are usually pigmented.
- They protect the plant from desiccation.

# Reproduction

- Both Vegetative and sexual methods.
  - Vegetative reproduction: Fragmentation, adventitious branches, tubers, gemme etc.
  - Sexual reproduction is oogamous.
- Male gamete is called **antherozoid** which is small and motile.
- The female gamete is called **egg** which is big and non motile.
- The male reproductive organ is called **antheridium**.
- The female reproductive organ is **archegonium**.
- Both are multicellular organs with sterile jacket for protection.

# Antheridium

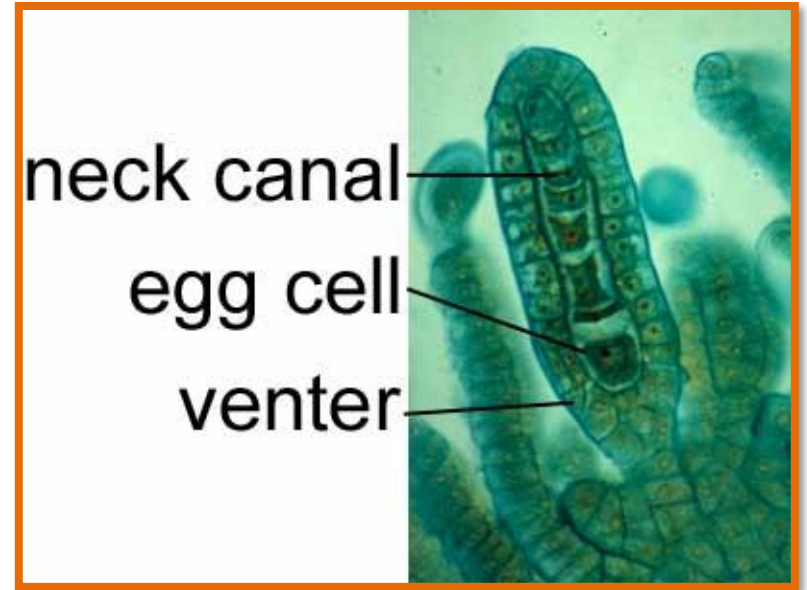
- Multicellular, ellipsoidal club shaped borne on short stocks.
- Body of antheridium has a single layered sterile jacket enclosing androcytes which eventually metamorphose into antherozoids.



- Antherozoids develop into biflagellate male gametes.
- It consists of minute, slender specially curved body with 2 long terminal whiplash type of flagella.

# Archegonium

- It appeared the first time in bryophytes and is continued to pteridophytes and so on.
- Archegonium has a flask shaped structure with upper portion named **neck** and the lower swollen portion called **venter**.
- Neck as a wall made up of single layer of cells surrounding the neck canal cells.
- The venter wall is composed of sterile cells of one or more layers of thickness.



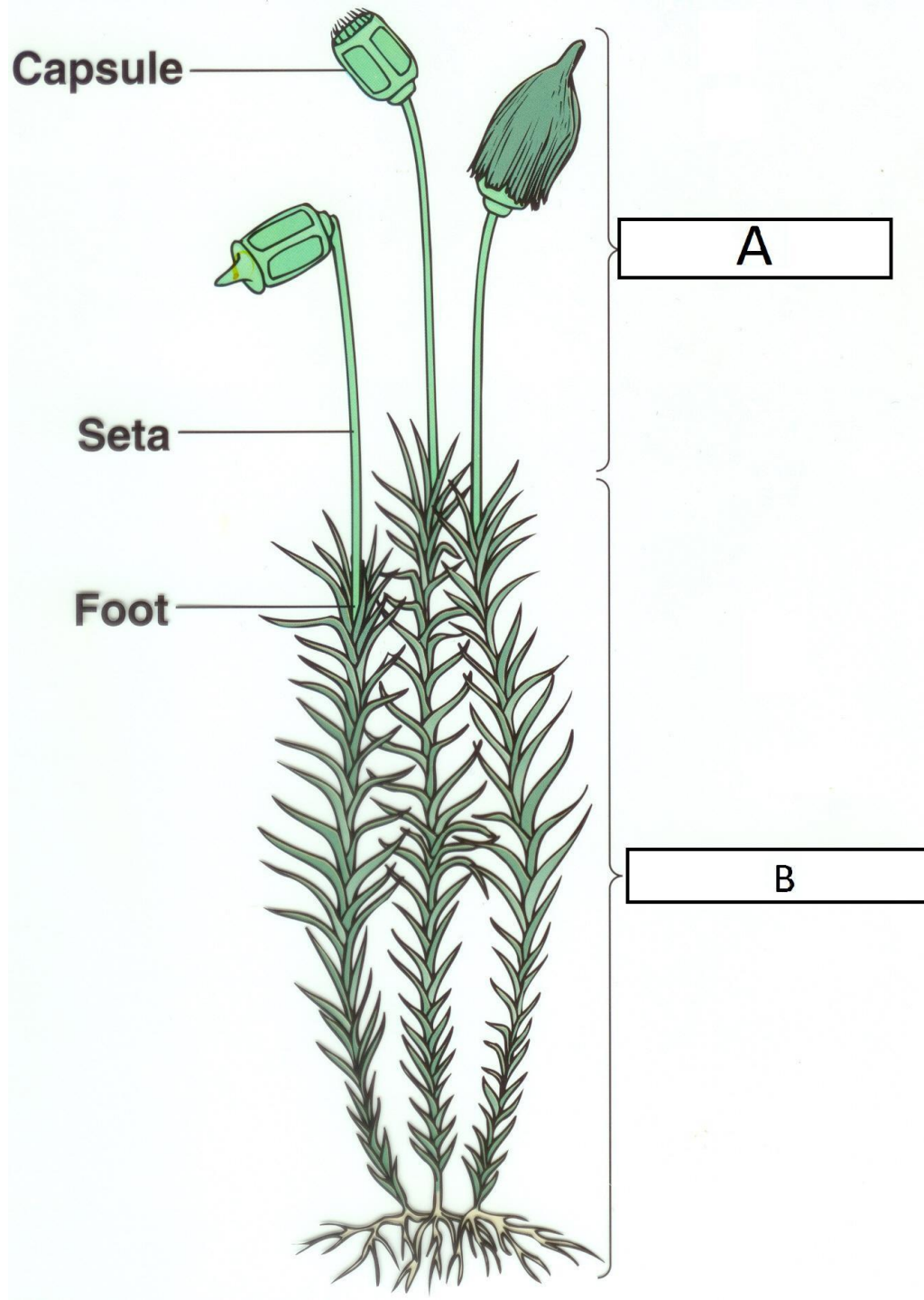


# Fertilization

- Moisture is essential.
- Mature antheridium ruptures at its apex and sperm gets liberated.
- In archegonia, at the same time the axial row of neck canal cells including the venter canal cell gets disorganized.
- The tip of the archegonium opens and the narrow canal acts as a passage for the entry of the sperm leading to fertilization.
- Fertilized egg secretes a cellulosic hard wall around it.
- The fusion product **zygote** undergoes segmentation without a resting period and forms undifferentiated multicellular **embryo**.

## Sporogonium

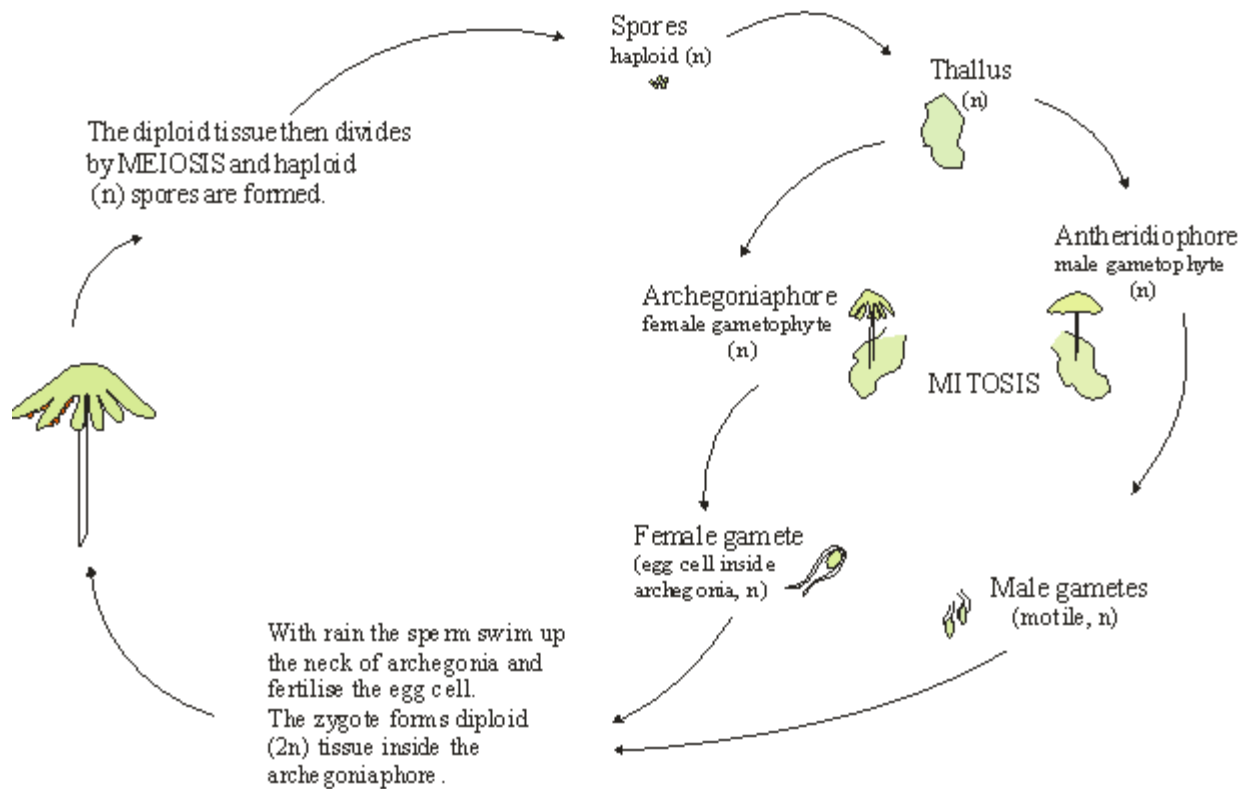
- Sporogonium is the fully grown sporophyte.
- In primitive bryophytes the sporophyte is embedded in the gametophyte itself.
- Most cases it has a distinct foot, seta and capsule.



- Foot maybe embedded in the gametophyte and it absorbs the food for the sporophyte.
- Seta conducts food from foot to capsule.
- Capsule acts as the sporangium which is concerned with the production of spores.
- Spores are highly specialised haploid cells known as **meiospores** or **gonospores**.
- They are the initial cells of gametophytic generations.
- They germinate to give rise to filamentous structures called **protonema** which later give rise to gametophyte.
- **Asexual spores or mitospores are completely absent in bryophytes when compared to thallophytes.**

# Life cycle

- Diplohaplontic life cycle.
- Heterotomorphous/heterologous life cycle.

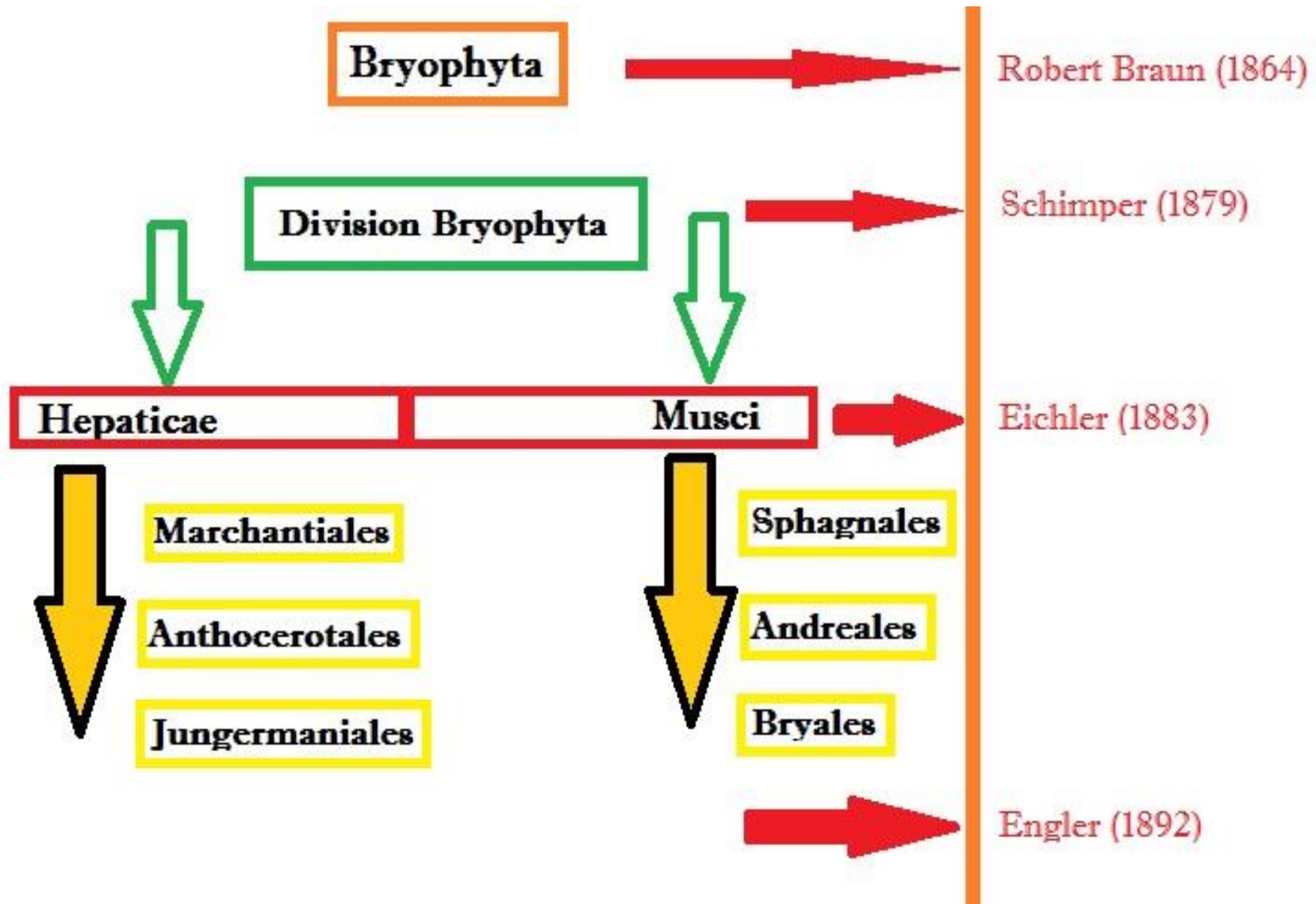




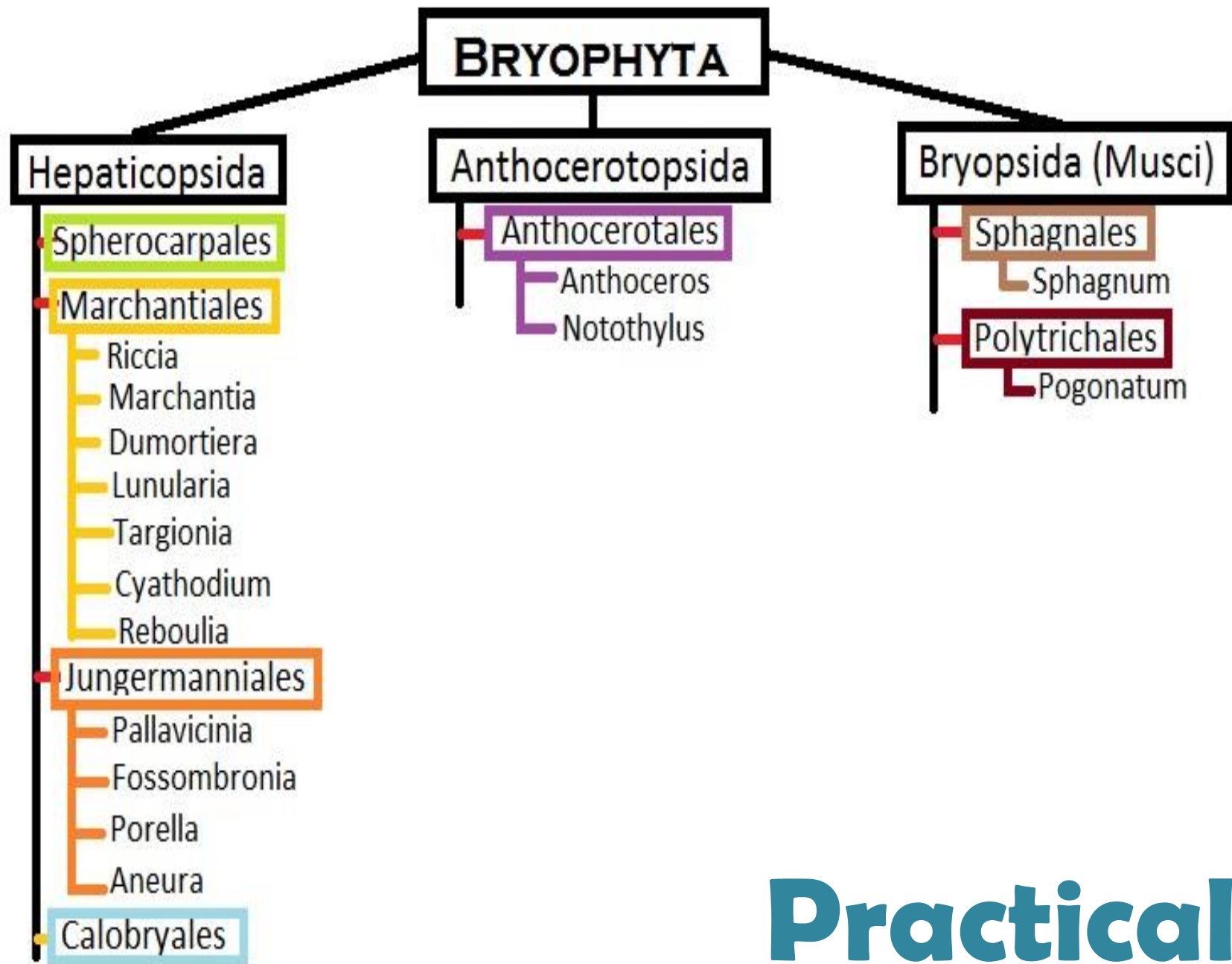
# Salient features of Bryophytes

1. Compact plant body protected by epidermis with air pores.
2. Primitive or ill defined vascular supply and conduction.
3. The fixation and absorptive function is done by rhizoids.
4. The thick walled spores are an adaptation for wind dispersal.
5. Differentiated plant body.

# Classification of Bryophytes



- Takhtajan and Schiester (1958) divided bryophytes into 3 classes;
  - Hepaticae
  - Anthocerotae
  - Musci
- Frank Cravers divided bryophyte into 10 orders;
  1. Sphero carpales
  2. Marchantiales
  3. Jungermaniales
  4. Anthocerotales
  5. Sphagnales
  6. Andreales
  7. Tetraphidales
  8. Polytrichales
  9. Buxbaumiales
  10. Eubryales



**Practicals**



# CLASS: HEPATICOPSIDA

## Occurrence

- Seen towards temperate climate and mostly restricted to shady terrestrial habitats.
- They inhabit the shaded faces of moist cliffs and thickly wooded area.
- Few genera shows aquatic habitat like the Riccia fluitans which floats on water.
- Riella is a water submerged bryophyte.
- Types like Porella is seen growing on the rocks and trunks of trees.

- Also called as liverworts.
- Includes 4 orders; Sphero carpales, Marchantiales, Jungermanniales and Cryobryales.
- Plant body gametophyte and is thalloid or leafy with dorsiventral pattern.
- Leaves may or may not midrib.
- Rhizoids are unicellular organs.
- Sex organs develops from single superficial cells either from dorsal side or from the tip of the thallus.

- Sporophyte primitive and possesses no chlorophyll or stomata.
- Archegonium develops from an endothecium.
- Capsule without columella and meristem.

# Order1: Sphaerocarpaceae

- Plants are thalloid without pores or air chambers.
- Sex organs are enclosed in certain involucre and they develop singly.
- Neck of the archegonium has 6 vertical rows of cells.
- Sporophyte differentiates to foot, seta and capsule.
- This order consists of 2 families: **Sphaerocarpaceae** and **Riellaceae**.



## Family: Sphaerocarpaceae

- Have bilaterally symmetrical thallose gametophytes with cushion like midrib and without internal differentiation of tissues.
- Sex organs surrounded by involucre.
- 2 genera under this family: **Sphaerocarpus** and **Geothallus**.

# Genus: Sphaerocarpus



- Found only in America, northern Africa and Europe.
- Gametophyte is simple small and dichotomously branched.
- Plants usually found in clumps of four in which 2 are male and 2 are female gametophytes.
- Gametophytes with broad midrib which are of several layer thickness and the margins expanded and wing like.
- Dorsal midrib is crowded with flask shaped involucre surrounding each sex organs.
- Scales are absent and rhizoids are of smooth walled.
- All the cells except the rhizoids possess chloroplast.
- Sex determination is first seen in Sphaerocarpus.

## Reproduction

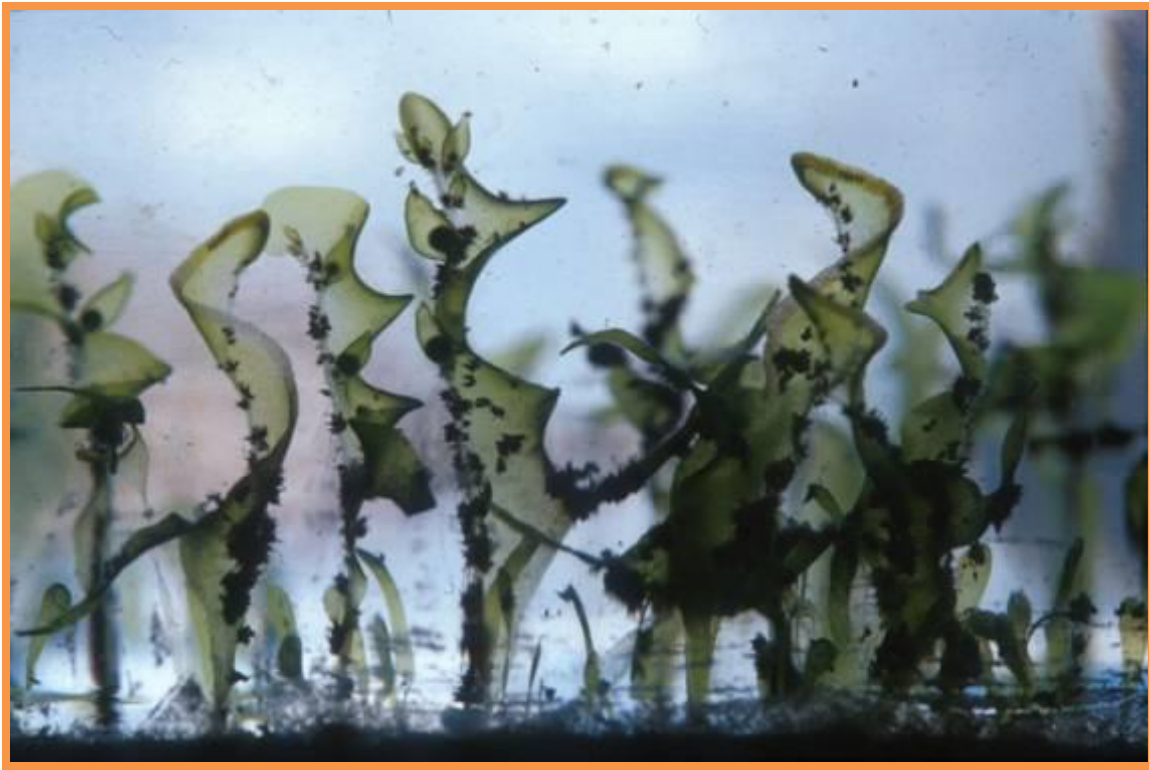
- Male plants are smaller than female plants.
- Mature antheridia are red or orange in colour.
- Androcytes are metamorphosed into antherozoids.
- Archegonial development begins with a capitative enlargement of a dorsal cell.
- In developing archegonium, 6 neck cell initials lie above a tier of six venter initials.
- Vegetative reproduction by means of Adventitious branches, fragmentation etc.

## Family: Reillaceae

## (Genus: Riella)

- Have hairy asymmetrical gametophyte.
- Riella is aquatic with a submerged mode of life.
- The gametophyte is erect with thickened stem like axis with a straight spirally twisted plate like wing with a single cell in thickness.
- Scales seen on the median portion are called ventral scales and the ones on the axis and on the wings are called lateral scales.
- Rhizoids are seen only on the first formed portions.





Riella in its habitat



## Reproduction

- Vegetative propagation is by means of gemme.
- Gemmae is oval and one cell thick, transversely constricted into 2 lobes of unequal sizes.
- Gemmae of Riella is called gemmaling.
- After abscission, the gemmaling becomes meristematic and give rise to new gametophyte.
- Antheridia are born in clusters.
- Development of sex organs and sporophyte is similar to that of sphaerocarpus.

# Order2: Marchantiales

- It's a widely distributed order.
- Members in India include; Marchantia, Pressia, Dumortiera, Conocephalum, Exormotheca, Stephansoniella, Aitchinsoniella, Athalamia, Cyathodium, Reboulia, Plagiochasma, Riccia.
- Nearly all members are terrestrial and inhabit moist.

## Gametophytes

- The plant body is strictly;
  - Thallose
  - Thick
  - Fleshy
  - Dorsiventral
  - Dichotomously branched with prominent lobes.
- Dorsal surface of the body contains polygonal areas called **areolae**, with air pore in centre.
- Air pore maybe simple or compound.
- Unicellular rhizoids arise from the lower surface of the thallus which may be smooth or tuberculated.
- Scales are multicellular.

- Plant body differentiated into dorsal and ventral region.
- The dorsal assimilatory region encloses air chambers and is roofed by single layered epidermis.
- The ventral zone is the storage region made up of colourless parenchyma cells.
- Storage region lacks chloroplasts but may contain starch and oil.
- Archegonial neck with 6 rows of cells.
- Capsule may or may not have valves for opening.



# Riccia



- Very simple and primitive bryophyte.
- It has about 200 species.
- Except *Riccia fluitans*, all grows in terrestrial habit.
- Gametophyte is the real independent plant in *Riccia*.
- Plant body is flat dorsiventral thallus which is dichotomously branched.
- It has a median groove and an apical notch.
- They grows on the surface of moist soil in rosette nature.





# Targionia

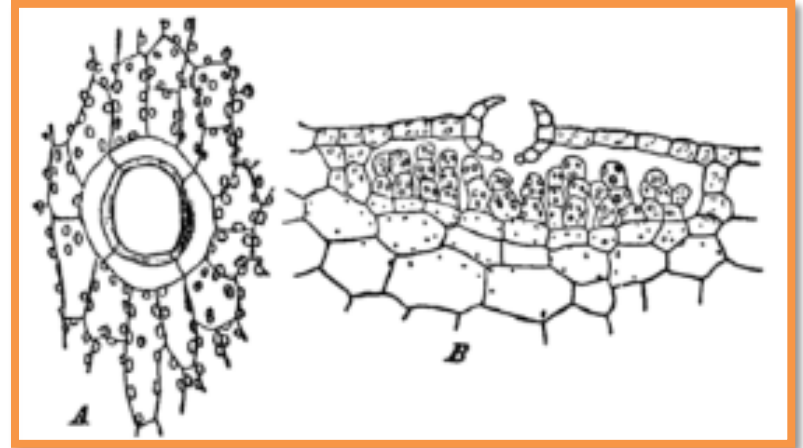








- Belongs to family Targionaceae.
- Family includes 3 genera;
  - Targionia
  - Cyathodium
  - Aitchinsoniella (India)

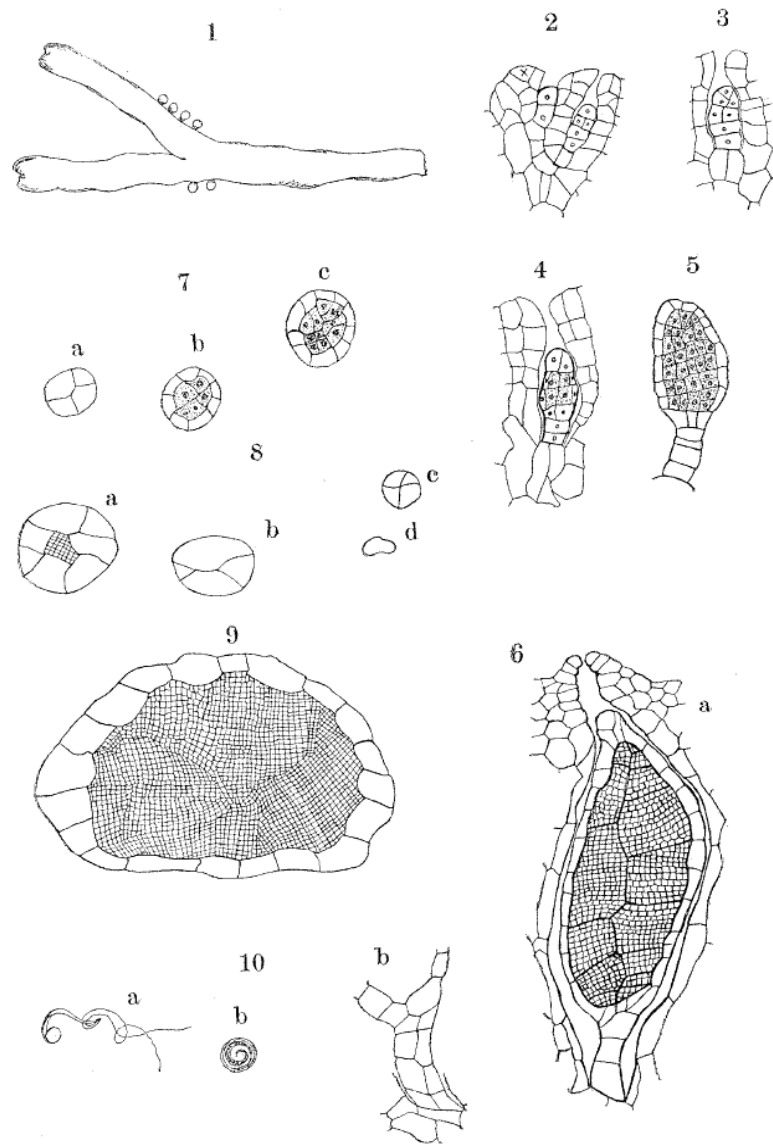


- Thallus is ribbon like dichotomously branched with abundant adventitious branches arising from the ventral surface of the midrib.
- Vegetative propagation by adventitious branches.
- Air chamber open externally by an airpore encircled by 4 to 6 concentric rings of cells.

- The chambers are separated by plates of cells one cell in thickness.
- The floor of the chamber bears erect photosynthetic filaments which are 3 cells in height.
- The tissue below the air chambers are elongated cells parallel to the long axis of the thallus. Towards the extreme margins cells remain isodiametric.
- Cells of the storage region consists contain starch grains an oil bodies.
- Ventral side consists of scales and two types of rhizoids.

# Antheridia

- Produced on short lateral branches which arise adventitiously from the ventral surface of the midrib.
- Development of antheridia are accompanied by upward growth of adjacent vegetative tissues. (Similarity with Sphaerocarpales)
- Antheridium lies within an antheridial chamber.



DEVELOPMENT OF THE ANTHERIDIUM IN *TARGIONIA* HYPOPHYLLA.

# Archegonia

- Archegonium develops from two or three cells behind the superficial apical cell.
- Development similar to Riccia.
- Apical growth is ceased when the archegonia are formed.
- 'Involucre' will be formed and it surrounds the young sporophyte later.
- In addition to involucre, the venter of the archegonium give rise to **calyptra** which is three or four cells in thickness. (Seen in bryopsida member Pogonatum)



# Sporophyte

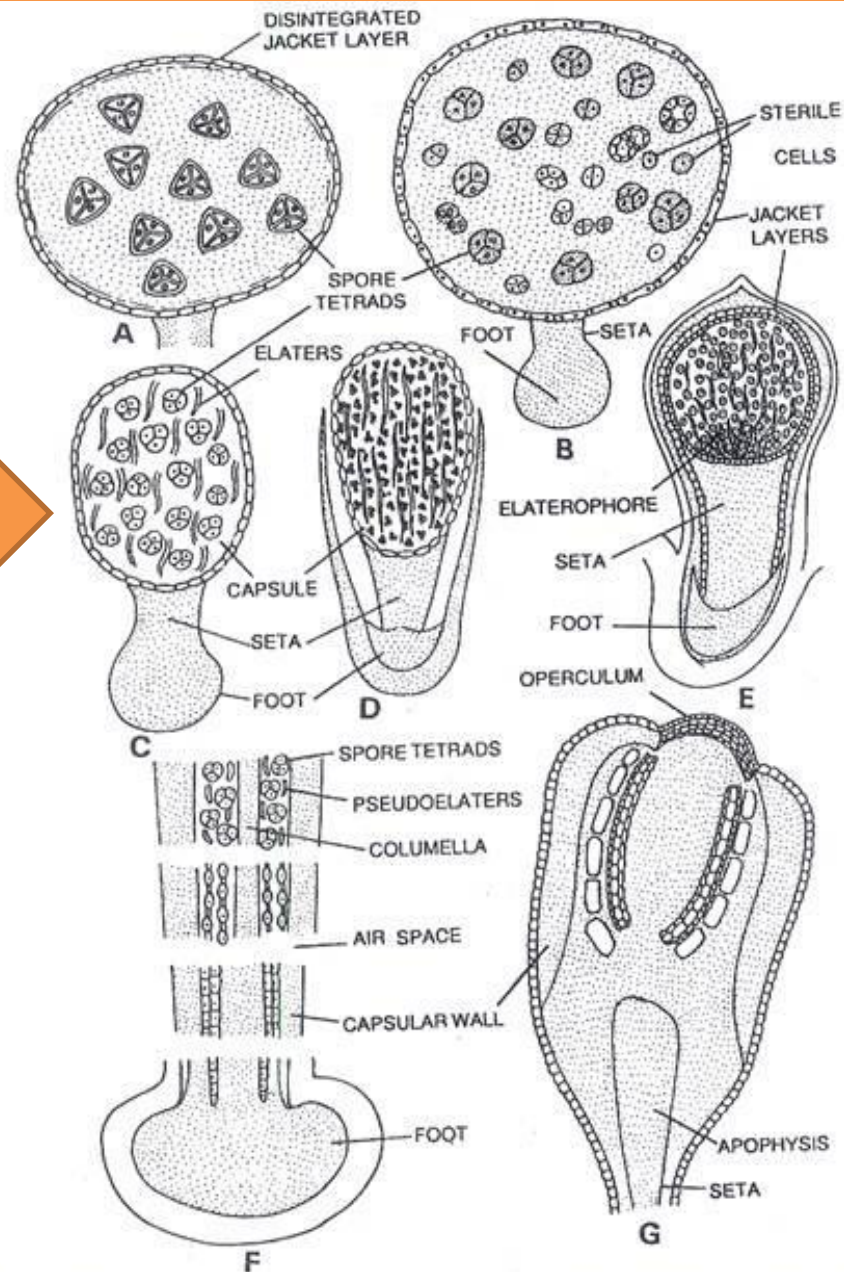


Fig. 24.5. Progressive sterilization of sporogenous tissue in bryophytes. A, sporophyte of *Riccia*; B, sporophyte of *Sphaerocarpos* sp.; C, sporophyte of *Targionia* sp.; D, sporophyte of *Marchantia* sp.; E, sporophyte of *Pellia* sp.; F, sporophyte of *Anthoceros*; G, sporophyte of *Funaria hygrometrica*.

# Cyathodium







- Belongs to family Targionaceae.
- Plants are thin, small tufted over moist places.
- Thallus dichotomously branched.
- Air chamber seen in one layer which are empty with or without air pores.
- Pores when present are large bounded by concentric rings of cells.
- Scales may be minute or even absent.
- Rhizoids are smooth.

- Antheridia maybe terminal, lateral or on the fork between two branches.
- Antheridia maybe numerous and the ostiole by which they opens out maybe papillose.
- Presence of involucre at the apex towards the under surface as in Targionia.
- Achegonia usually seen as clusters.
- Capsule maybe globose with a small foot.
- Seta is small, delicate and slender.

- The wall of the capsule is four layered. The upper part consists of annular bands and the lower portion is thin.
- Capsule has a lid made up of 2 to 3 layers of cells.
- The capsule dehiscence by means of 8 equally large valves after the separation of the lid.
- Spores are spherical and more or less spiny.
- Elators are fusiform or trispiral.



# Marchantia

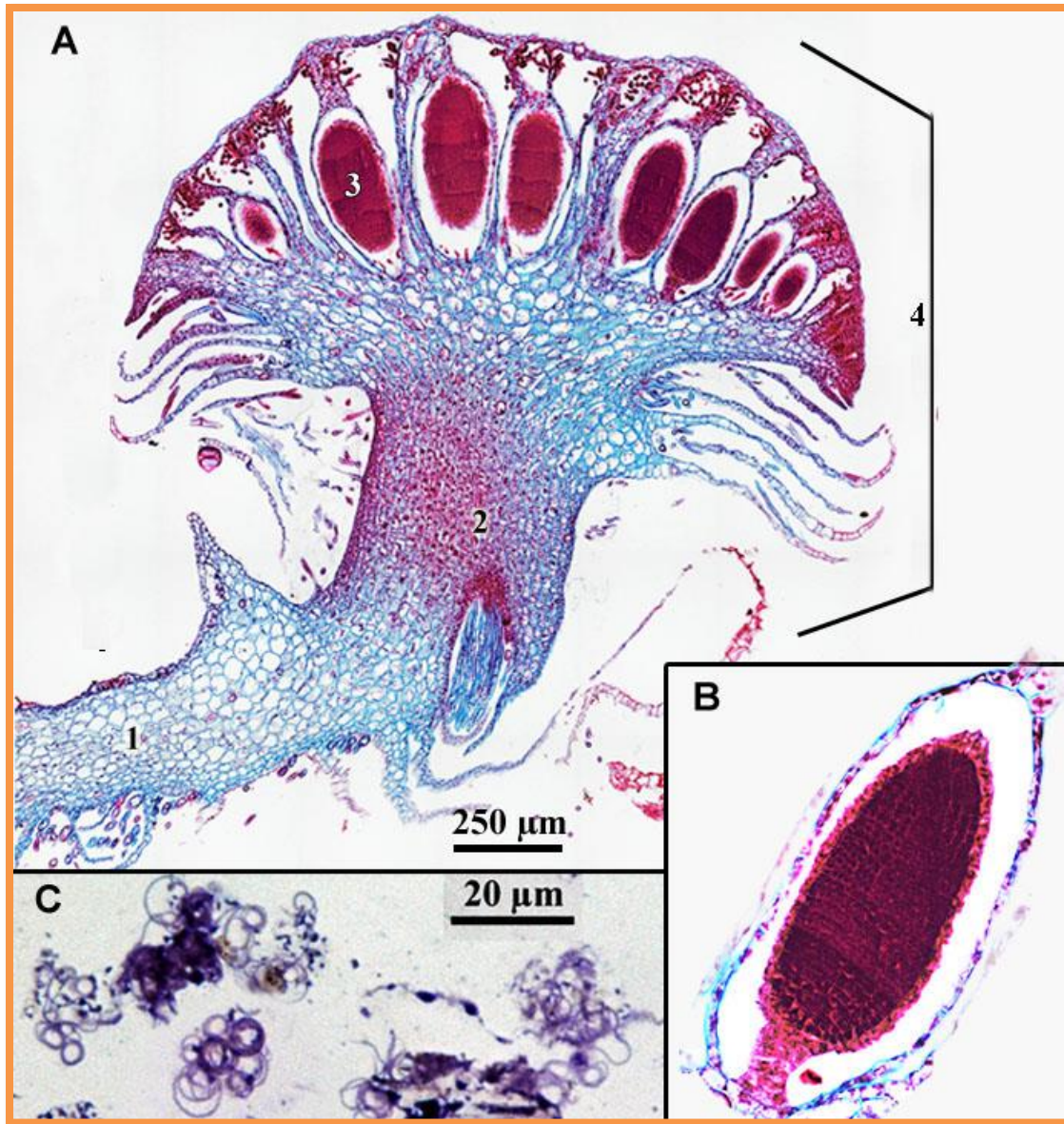


1 Thallus ; 2 Young Archegoniophore; 3 Mature Archegoniophore; 4 Gemma Cups

# Antheridiophore

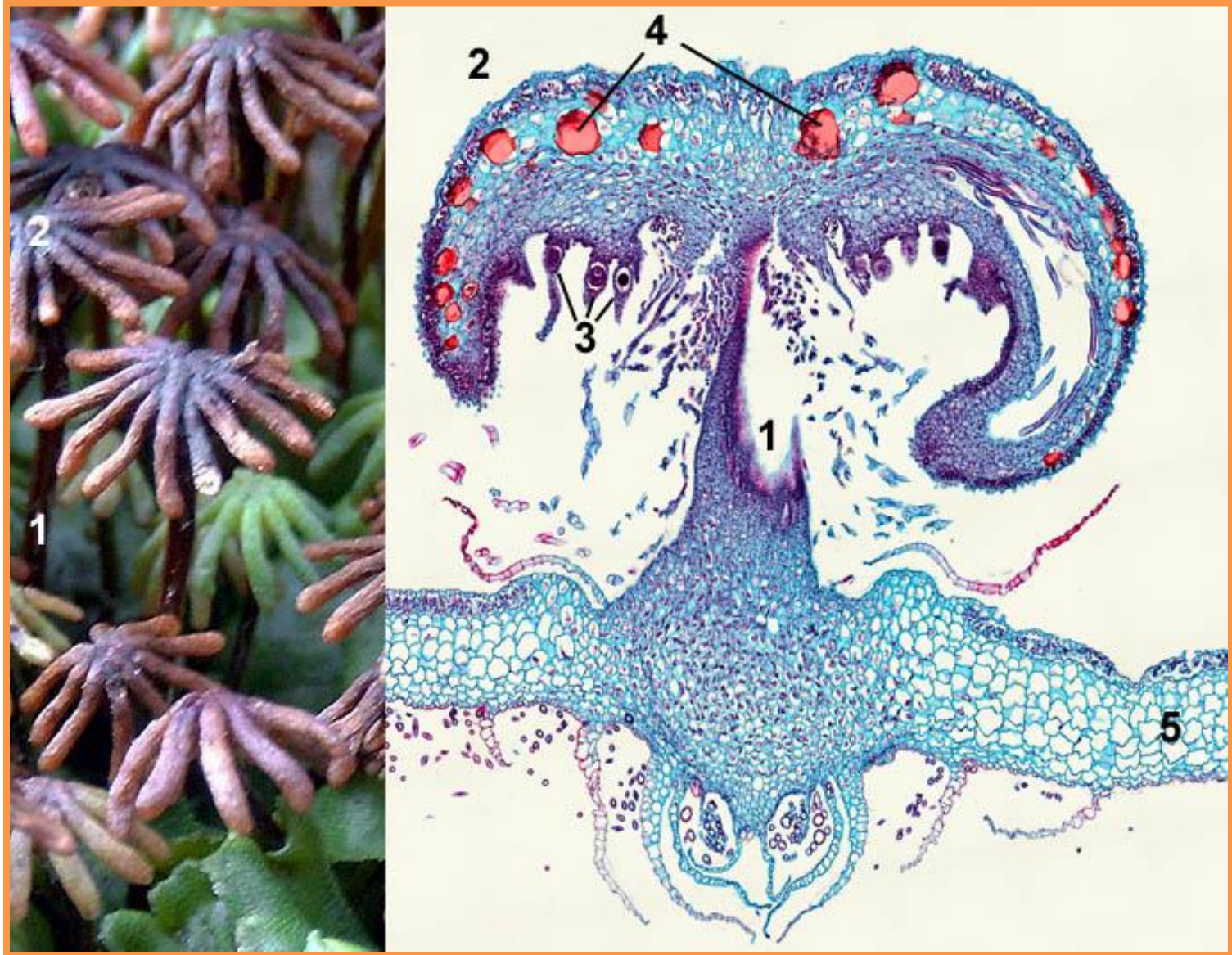






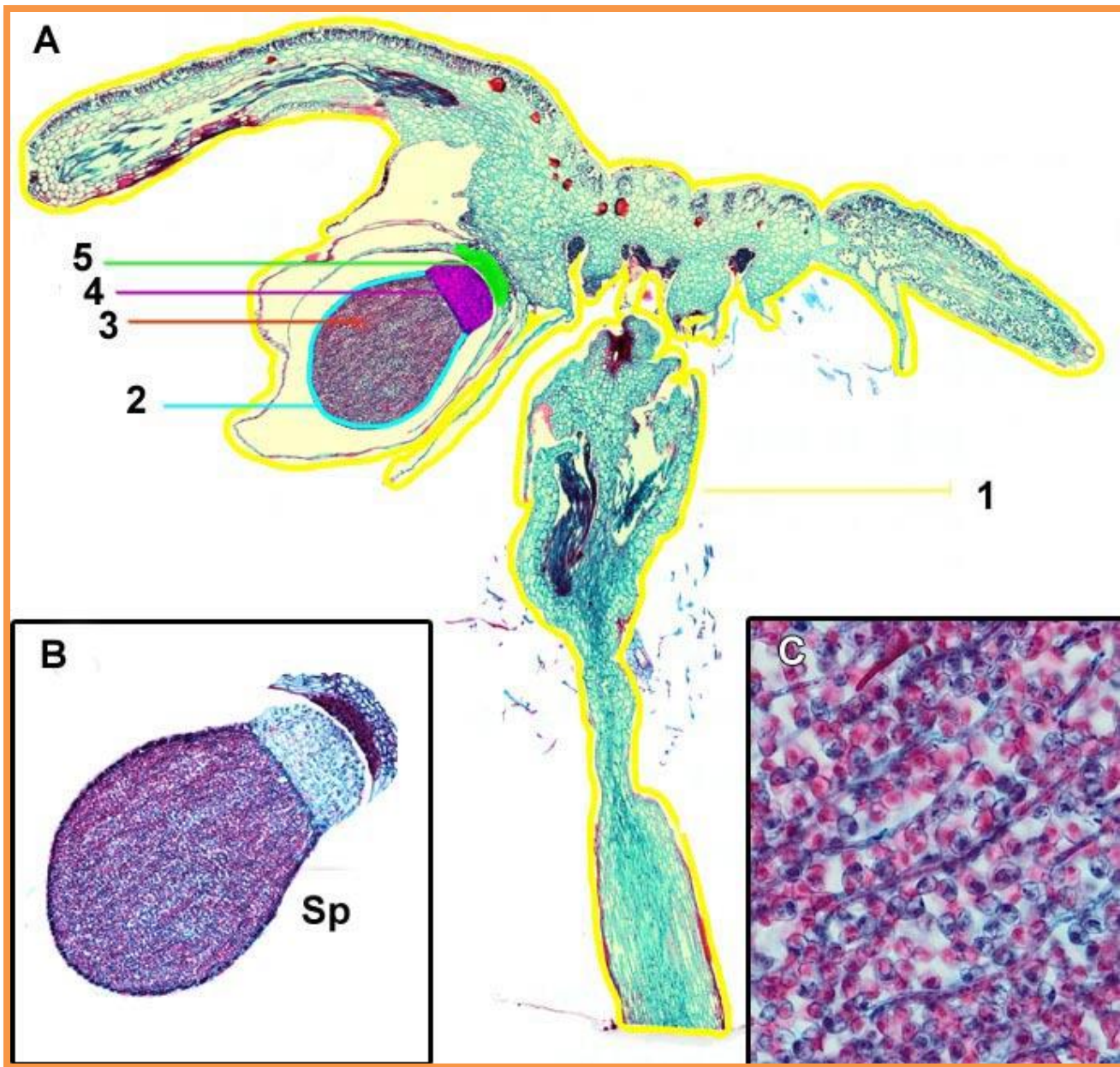
A. longitudinal section: 1 thallus; 2 base of the antheridiophore; 3 antheridia; 4 antheridiophore; B: antheridium with spermatogenic cells; C sperms with flagella

# Archegoniophore



1 stalk; 2 cap; 3 archegonia; 4 slime cells; 5 thallus





A. Longitudinal section: 1 stalk of the archegoniophore; 2 sporangium (spore capsule); 3 spores; 4 seta; 5 base; B detail sporangium; C detail spores and elaters in the spore capsule





Sporophyte



# Dumortiera







J.-P. Frahm

- Plants are thallose, green, near or under flowing water, prostrate overlapping in large expanded patches.
- Thallus is flat or procumbent, repeatedly dichotomous, apex notched, margins undulate, midrib very prominent and air chambers are absent.
- The cells of the outermost layer also consists of chloroplast.
- Scales are reduced, hyaline; occurring as narrow oblique ridges attached to the thallus on each side of the midrib in one row often present towards the apex.

## Reproduction

- Male receptacle is disciform, depressed in the centre, subsessile with bristles on the margin.
- Male receptacles are sessile when young but stalked when mature.
- The top of the stalk is chaffy with hairs.
- The female receptacle is disciform, convex with a few bristle like hairs with 6 to 10 lobes.
- The involucre encloses a single capsule.
- Perianth is absent.

## Capsule

- Shortly pedicellate and capsular wall in one layered with annular bands.
- It dehisces by 4 to 8 valves.
- Elaters are fixed to the bottom and have 2 to 4 spiral thickening and are sometimes branched.
- Spores are tetrahedral, dark brown and warty.



# Lunularia



## Family: Lunulariaceae

## (Lunularia)

- Presence of crescent shaped gemma cups on the dorsal surface.
- Marginal scales are absent on the ventral surface. Scales are seen as two longitudinal rows.
- Air chambers are in single layer with simple or branched photosynthetic filaments.
- The air pores on the thallus are simple or half barrel shaped.
- The antheridial receptacles are disciform, sessile and lack pores.
- The archegonial receptacles are stalked without rhizoidal furrows where as disc is deeply four lobed and without pores and photosynthetic tissues.





## Habitat

- *Lunularia* is a thalloid liverwort that likes to live in areas that have a lot of shade. It can be found growing in shaded areas of gardens, and is a common weed found near greenhouses. Indian species is *Lunularia crusiata*.



- The thalloid body of *Lunularia* is a glossy yellow-green color. This species is easily recognizable by the crescent-shaped gemmae cups on the surface of the thalli.

## Gametophyte

- Thallus is prostrate, dorsiventral flat, large (5-20 cm long and 1-2 cm wide), irregularly dichotomously branched with apical innovations.
- Margin of the thallus is undulate and emarginated.
- Ventral surface consists of smooth walled as well as tuberculate rhizoids.
- Ventral scales are in two longitudinal rows.
- Internally it has two distinct zones, the dorsal photosynthetic zone made up of single layered air chambers which open out by simple or half barrel shaped air pores.

- Air pores are made up of 5 concentric rings of cells and each ring consists of six cells.
- The photosynthetic filament in the photosynthetic chambers are green chlorophyllous with a height of 2-3 cells and they are mostly unbranched.
- The ventral lower region is the storage zone made up of parenchymatous cells which contains starch grains and oil cells.





# Reproduction

## 1. Vegetative Propagation

- Fragmentation
- Gemme formation
  - Gemme are discoid and are seen inside the lunar shaped gemme cup.
  - The detached gemmae when come out of the lunar pockets are dispersed on soil either by wind or water.
  - These gemme germinate to form new thallus.





## 2. Sexual Reproduction

- Lunularia is diaceous (Heterothallic).
- **Antheridia**
  - Are produced on disciform, sessile antheridial receptacle present at the apices of short branches of the main thallus.
  - Each antheridium is enclosed in a chamber called the antheridial chamber which opens out through an ostiole.
  - Development structure and dehiscence is similar to Marchantia.
- **Archegonia**
  - Produced on deeply four lobed, stalked female receptacle which emerges from the sinus of the thallus.
  - Stalk is hairy without rhizoidal furrow and without photosynthetic tissues.
  - The base of the stalk is surrounded by scales.

- Receptacle disc is small each with a row of archegonia which are acropetally arranged.
- The archegonia are covered and protected by horizontal or tubular involucre.
- The disc has no pores and photosynthetic tissue. (Characteristic feature of family Lunulariaceae)

- **Sporophyte**

- Has small foot, long seta and globose capsule.
- Sporophyte is found attached to the arm of female receptacle which is covered and protected by involucre.
- Perigynium is absent.
- The capsule dehisces by detachment of its apical portion which is the operculum/lid and it is bistatose.
- This detachment of the lid leads to the dehiscence of spore by formation of 4 irregular valves on the capsule.
- Spores(yellowish green/brown) and elaters (Spring shaped) are present.

Thank you