Unit - IV

General characteristics of bryophytes

Bryophytes are a group of plant species that reproduce via spores rather than flowers or seeds. Most bryophytes are found in damp environments and consist of three types of non-vascular land plants: the mosses, hornworts, and liverworts.

Bryophyte Characteristics

Bryophytes are non-vascular land plants. Although they do exhibit specialized structures for water transportation, they are devoid of vascular tissue.

Bryophytes grow primarily in damp environments but can be found growing in diverse habitats ranging from deserts, the artic, and high elevations. Since bryophytes do not depend on root structures for nutrient uptake like vascular plants, they are able to survive in environments that vascular plants cannot (e.g., on the surface of rocks).

All bryophytes have a dominant gametophyte stage in their life cycle. During this stage, the plant is haploid and the sex organs that produce the gametes are developed. Bryophytes are unique compared to many other plant species in that they remain in this stage for long periods.

The sporophytes (the diploid form of the plant) of bryophytes are unbranched, producing a single spore-producing capsule (sporangium). Moreover, the sporophytes are dependent on the gametophyte for nutrition and develops within the female sex organ (archegonia).

Bryophyte Life Cycle

The bryophyte lifecycle consists of alternating generations between the haploid gametophyte and the diploid sporophyte. During the gametophyte stage, haploid gametes (male and female) are formed in the specialized sex organs: the antheridia (male) and archegonia (female). The gametes consist of flagellated sperm, which swim via water or are transported by insect species. The two haploid gametes (sperm and egg) fuse, a diploid zygote is formed. As described above, the zygote of bryophytes grows inside the archegonia and will eventually become a diploid sporophyte. Mature sporophytes remain attached to the gametophyte and generate haploid spores via meiosis inside the sporangium. These spores are dispersed, and under favorable environmental conditions become new gametophytes.

Liverworts

Liverworts are extremely small plants characterized by flattened stems and undifferentiated leaves, as well as single-celled rhizoids. Liverworts can be distinguished from other bryophyte species by the presence of membrane-bound oil bodies within their cells, compared to other species which do not contain enclosed lipid bodies.

Mosses

Mosses are green, clumpy plants often found in moist environments out of direct sunlight. Mosses are characterized by leaves that are only one cell wide attached to a stem that is used for water and nutrient transportation. Mosses are able to absorb a substantial amount of water and have historically been used for insulation, water absorption, and a source of peat

Hornworts

Hornworts are named after the characteristic long horn-like sporophyte that develops. In contrast, the gametophyte form is a flat, green-bodied plant. Most hornworts are found in damp environments (e.g., tropical climates), garden soils, or tree bark.

The fossil record indicates that bryophytes evolved on earth about 395 – 430 million years ago (i.e. during Silurian period of Paleozoic era). The study of bryophytes is called bryology. Hedwig is called 'Father of Bryology'. Shiv Ram Kashyap is the 'Father of Indian Bryology'.

Salient features of Bryophytes:

1. Bryophytes grow in damp and shady places.

2. They follow heterologous haplodiplobiontic type of life cycle.

3. The dominant plant body is gametophyte on which sporophyte is semiparasitic for its nutrition.

4. The thalloid gametophyte differentiated in to rhizoids, axis (stem) and leaves.

5. Vascular tissues (xylem and phloem) absent.

6. The gametophyte bears multi-cellular and jacketed sex organs (antheridia and archegonia).

7. Sexual reproduction is oogamous type.

8. Multi-cellular embryo develops inside archegonium.

9. Sporophyte differentiated into foot, seta and capsule.

10. Capsule produces haploid meiospores of similar types (homosporous).

11. Spore germinates into juvenile gametophyte called protonema.

12. Progressive sterilization of sporogenous tissue noticed from lower to higher bryophytes.

13. Bryophytes are classified under three classes: Hepaticae (Liverworts), Anthocerotae (Hornworts) and Musci (Mosses).

Classification of Bryophytes:

According to the latest recommendations of ICBN (International Code of Botanical Nomenclature), bryophytes have been divided into three classes.

1. Hepaticae (Hepaticopsida = Liverworts)

2. Anthocerotae (Anthocertopsida= Hornworts)

3. Musci (Bryopsida= Mosses)

Class 1. Hepaticae or Hepaticopsida:

1. Gametophytic plant body is either thalloid or foliose. If foliose, the lateral appendages (leaves) are without mid-rib. Always dorsiventral.

2. Rhizoids without septa.

3. Each cell in the thallus contains many chloroplasts; the chloroplasts are without pyrenoi.

4. Sex organs are embedded in the dorsal surface.

5. Sporophyte may be simple (e.g., Riccia) having only a capsule, or differentiated into root, seta and capsule (e.g., Marchantia, Pallia and Porella etc.)

6. Capsule lacks columella.

7. It has 4 orders:

(i) Calobryales

(ii) Jungermanniales

(iii) Spherocarpales

(iv) Marchantiales.

Class 2. Anthocerotae or Anthocerotopsida

1. Gametophytic plant body is simple, thalloid; thallus dorsiventra without air cambers, shows no internal differentiation of tissues.

2. Scales are absent in the thallus.

3. Each cell of the thallus possesses a single large chloroplast with a pyrenoid.

4. Sporophyte is cylindrical only partly dependent upon gametophyte for its nourishment. It is differentiated into bulbous foot and cylindrical capsule. Seta is meristematic.

5. Endothecium forms the sterile central column (i.e., columella) in the capsule (i.e. columella is present). 6. It has only one order-Anthocerotales.

Class 3. Musci or Bryopsida:

1. Gametophyte is differentiated into prostrate protonema and an erect gametophores

2. Gametophore is foliose, differentiated into an axis (=stem) and lateral appendages like leaves but without midrib.

3. Rhizoids multi-cellular with oblique septa.

4. Elaters are absent in the capsule of sporangium.

5. The sex organs are produced in separate branches immersed in a group of leaves.

6. It has only three orders:

(i) Bryales,

(ii) Andriales and

(iii) Sphagnales.

Economic importance of Bryophytes:

1. Protection from soil erosion:

Bryophytes, especially mosses, form dense mats over the soil and prevent soil erosion by running water.

2. Soil formation:

Mosses are an important link in plant succession on rocky areas. They take part in binding soil in rock crevices formed by lichens. Growth of Sphagnum ultimately fills ponds and lakes with soil.

3. Water retention:

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.

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.

Ecological aspects and Economic importance of Bryophytes

1. Ecological Importance

Bryophytes are of great ecological importance due to following reasons:

(a) Pioneer of the land plants. Bryophytes are pioneer of the land plants because they are the first plants to grow and colonize the barren rocks and lands.

(b) Soil erosion. Bryophytes prevent soil erosion. They usually grow densely and hence act as soil binders. Mosses grow in dense strands forming mat or carpet like structure.

They prevent soil erosion by:

(i) Bearing the impact of falling rain drops

(ii) Holding much of the falling water and reducing the amount of run-off water.

(c) Formation of soil. Mosses and lichens are slow but efficient soil formers. The acid secreted by the lichens and progressive death and decay of mosses help in the formation of soil.

(d) Bog succession. Peat mosses change the banks of lakes or shallow bodies of water into solid soil which supports vegetation e.g., Sphagnum.

(e) Rock builders. Some mosses in association with some green algae (e.g., Chara) grow in water of streams and lakes which contain large amount of calcium bicarbonate. These mosses bring about decomposition of bi-carbonic ions by abstracting free carbon dioxide. The insoluble calcium carbonate precipitates and on exposure hardens, forming calcareous (lime) rock like deposits.

2. Formation of Peat:

Peat is a brown or dark colour substance formed by the gradual compression and carbonization of the partially decomposed pieces of dead vegetative matter in the bogs. Sphagnum is an aquatic moss. While growing in water it secretes certain acids in the water body.

This acid makes conditions unfavorable for the growth of decomposing organisms like bacteria and fungi. Absence of oxygen and decomposing microorganisms slows down the decaying process of dead material and a large amount of dead material is added year by year. It is called peat (that is why Sphagnum is called peat moss).

Uses of Peat are:

(a) Used as fuel in Ireland, Scotland and Northern Europe.

(b) In production of various products like ethyl alcohol, ammonium sulphate, peat, tar, ammonia, paraffin, dye, tannin materials etc.

(c) In horticulture to improve the soil texture.

(d) In surgical dressings.

3. As Packing Material:

Dried mosses and Bryophytes have great ability to hold water. Due to this ability the Bryophytes are used as packing material for shipment of cut flowers, vegetables, perishable fruits, bulbs, tubers etc.

4. As Bedding Stock:

Because of great ability of holding and absorbing water, in nurseries beds are covered with thalli of Bryophytes.

5. In Medicines:

Some Bryophytes are used medicinally in various diseases for e.g.,

(a) Pulmonary tuberculosis and affliction of liver—Marchantia spp.

(c) Acute hemorrhage and diseases of eye—Decoction of Sphagnum.

(d) Stone of kidney and gall bladder—Polytrichum commune.

(e) Antiseptic properties and healing of wounds—Sphagnum leaves and extracts of some Bryophytes for e.g., Conocephalum conicum, Dumortiera, Sphagnum protoricense, S. strictum show antiseptic properties.

6. In Experimental Botany:

The liverworts and mosses play an important role as research tools in various fields of Botany such as genetics. For the first time in a liverwort, Sphaerocarpos, the mechanism of sex determination in plants was discovered.

7. As Food:

Some Bryophytes e.g., mosses are used as food by chicks, birds and Alaskan reindeer etc.

Distribution of Bryophytes

Bryophytes are distributed throughout the world, from polar and alpine regions to the tropics. Water must, at some point, be present in the habitat in order for the sperm to swim to the egg (see below Natural history). Bryophytes do not live in extremely arid sites or in seawater, although some are found in perennially damp environments within arid regions and a few are found on seashores above the intertidal zone. A few bryophytes are aquatic. Bryophytes are most abundant in climates that are constantly humid and equable. The greatest diversity is at tropical and subtropical latitudes. Bryophytes (especially the moss Sphagnum) dominate the vegetation of peatland in extensive areas of the cooler parts of the Northern Hemisphere.

The geographic distribution patterns of bryophytes are similar to those of the terrestrial vascular plants, except that there are many genera and families and a few species of bryophytes that are almost cosmopolitan. Indeed, a few species show extremely wide distribution. Some botanists explain these broad distribution patterns on the theory that the bryophytes represent an extremely ancient group of plants, while others suggest that the readily dispersible small gemmae and spores enhance wide distribution.

The distribution of some bryophytes, however, is extremely restricted, yet they possess the same apparent dispersibility and ecological plasticity as do widespread bryophytes. Others show broad interrupted patterns that are represented also in vascular plants.

Bryophytes are represented by 960 genera and 24,000 species. They are cosmopolitan in distribution and are found growing both in the temperate and tropical regions of the world at an altitude of 4000-8000 feet.

In India, Bryophytes are quite abundant in both Nilgiri hills and Himalayas; Kullu, Manali, Shimla, Darjeeling, Dalhousie and Garhwal are some of the hilly regions which also have a luxuriant growth of Bryophytes. Eastern Himalayas have the richest in bryophytic flora. A few species of Riccia, Marchantia and Funaria occur in the plains of U.P., M.P. Rajasthan, Gujarat and South India.

In hills they grow during the summer or rainy season. Winter is the rest period. In the plains the rest period is summer, whereas active growth takes place during the winter and the rainy season. Some Bryophytes have also been recorded from different geological eras e.g., Muscites yallourensis (Coenozoic era), Intia vermicularies, Marchantia spp. (Palaeozoic era) etc.

Comparative study of gametophyte and Sporophyte of heopaticapsida, anthocerotopsida and bryopsida

The 3 Most Important Classes of Bryophyta are mentioned below

For the first time Braun in 1864 gave the name Bryophyta of this group of plants. However, he included algae, fungi, lichens and mosses in his Bryophyta. Now, it is an established fact that algae, fungi and lichens comprise the group Thallophyta and the mosses are included in Bryophyta.

Thereafter Schimper in 1879 gave the name Bryophyta which is used in full sense for the plants included in this group. Eichler in 1883 divided Bryophyta into two groups-Hepaticae and Musci. Engler (1892) divided the class Hepaticae into three orders-Marchantiales, Jungermanniales, and Anthocerotales.

However, Bower (1935), Wettstein (1935), Bessey, Fritsch (1929), Evans (1938, 1939) and other bryologists still follow the same old system. Underwood (1894) and Gayeh (1897) however, withdrawn the order, Anthocerotales from class-Hepaticae.

According to Campbell, Smith, Takhtajan and others, the Bryophyta has been divided into three classes-Hepaticae, Anthocerotae and Musci.

In 1951, Rothmaler changed the class names. He recognized Hepaticae as Hepaticopsida; Anthocerotae as Anthoceropsida and Musci as Bryopsida. The above given classes have been also recognized by the international code of botanical nomenclature, 1956. Proskauer (1957) however changed the name Anthoceropsida to Anthoerotopsida and thus, the Bryophyta may be classified as follows

Division

Bryophyta

Class 1.-Hepaticopsida (Hepaticae)

Class 2.-Anthocerotopsida (Anthocerotae)

Class 3.-Bryopsida (Musci)

Class 1: Hepaticopsida

There are 4 orders, 9 families, 225 genera and 8,500 species.

1. The gametophytes are dorsiventrally differentiated. They may be thalloid (thallose) or differentiated into leaves and stem (foliose).

2. In foliose types the leaves are arranged in two or three rows on the axis and are always without mid-rib.

3. The sex organs develop from superficial cells on the dorsal side of the thallus, except when they are terminal in position.

4. The sporophyte may be simple, or differentiated into foot and capsule, or into a foot, seta and capsule.

5. The sporogenous cells develop from the endothecium of sporogonium.

6. The sporophyte is completely dependent on gametophytes for its nutritive supply.

7. The wall of sporogonium is one to several layered thick. The stomata are not present on the wall of sporogonium.

8. The dehiscence of sporogonium is irregular.

The class Hepaticopsida is further divided into several orders – (1) Sphaerocarpales; (2) Marchantiales; (3) Metzgeriales; (4) Jungermanniales; (5) Calobryales and (6) Takakiales.

Order-Sphaerocarpales (3 genera)-two families

1. Family-Sphaerocarpaceae – Sphaerocarpos (seven species) and Geothallus (single species).

2. Family-Riellaceae-Riella (17 species).

The characteristic features of the order are as follows

1. Vegetative structure of gametophyte is similar to that of order-Metzgeriales, but in which development and structure of sex organs, as well as the structure of sporophyte are similar to those of order-Marchantiales, and because of this the genera are placed in separate order Sphaerocarpales.

2. The main diagnostic feature by which the order is recognized is the presence of globose or a flask-like envelope or involucre around each of the sex organs (i.e., antheridia and archegonia).

Order-Marchantiales (32 genera; 400 species)

The characteristic features are as follows

1. The ribbon-like, dichotomously branched and dorsiventral thalli grow prostrate upon suitable substrata.

2. Excluding Dumortiera, Monoselenium and Monoclea, the rest of the genera possess internally differentiated air chambers on the dorsal side of the thallus; such chamber opens outside by an air pore of a particular design.

3. The ventral portion of the thallus consists of parenchyma which acts as storage tissue; oil and mucilage cells may be present in this region.

4. The scales and rhizoids are present on the ventral side of the thallus; the rhizoids are of two types (smooth-walled and tuberculate).

5. The antheridia and archegonia may be found directly on the dorsal surface of the thallus or they may be present on the special branches known as antheridiophores and archegoniophores respectively.

6. In most of cases the capsules of the sporophytes possess single layered jacket.

7. The capsule may be simple as in Riccia or it may be differentiated into foot, seta and capsule as in Marchantia.

8. The elaters may or may not be present. According to Campbell (1940), there are five families in this order. The characteristic features of two families are given here:

I. Family-Ricciaceae (3 genera; 140 species)

1. The gametophyte consists of a rosette-like dichotomously branched thallus.

2. In the thallus, the dorsal portion consists of chlorophyllous strips which may or may not have air canals among them; the ventral portion of the thallus is parenchymatous and acts as storage tissue.

3. The sex organs (antheridia and archegonia) are found in the longitudinal groove on the dorsal side from the growing apex to backward in basipetal succession.

4. The sporogonium consists of a simple capsule which is not differentiated into foot, seta and capsule.

5. Elaters not present.

6. The archesporium produces only the spores.

The important genera aie-Oxymitra, Ricciocarpus and Riccia.

II. Family-Marchantiaceae (23 genera; 250 species)

1. The thallus is dorsiventral; it has distinct assimilatory and storage regions.

2. The assimilatory region remains divided into several chambers and each chamber contains branched assimilatory filaments.

3. The pores of the thallus may be simple or barrel-shaped.

4. The archegonia are borne upon special erect, stalked, vertical branches, the archego- niophores.

5. The antheridiophores may or may not present; however, in Marchantia, the antheridia are borne upon these erect, stalked antheridiophores.

6. The typical sterile elaters are found in the sporogonium mixed with the spores. The important genera are – Conocephalum, Cryptometrium, Lunularia, Marchantia, etc.

Order-Metzgeriales (23 genera; 550 species)

The characteristic features of this order are as follows

1. The gametophyte may be thalloid or differentiated into stem and lateral leaves.

2. In most cases the gametophytes are without internal differentiation of tissues but certain genera have a central strand of thick-walled cells.

3. The ventral surface of a gametophyte bears smooth-walled rhizoids.

4. The sex-organs are found to be scattered on dorsal surface of thallus.

5. The archegonia arise from the young segments cut off by the apical cell.

6. The mature sporophytes lie some distance back from the growing apex of a gametophyte.

7. The sex organs (antheridia and archegonia) are produced on any branch of the gametophyte or only on special branches.

Family-Pelliaceae (Three genera- Pellia, Noteroclada and Calycularia)

1. The thallus is prostrate, dorsiventral and very often lobed by irregular incisions.

2. The rhizoids are simple, non-septate, smooth and thin-walled. The scales are absent.

3. The sex organs (antheridia and archegonia) remain scattered on the dorsal surface of the thallus.

4. The archegonial cluster always remains surrounded by an involucre which is an outgrowth of the thallus.

5. The capsule (sporogonium) is globose or oval in shape. It possesses a basal elaterophore.

Family-Riccardiaceae (two genera)

1. The gametophytes are wholly thallose or have thallose terminal branches.

2. The cells of thallus possess finely segmented oil bodies.

3. The sex organs (antheridia and archegonia) are borne on short lateral branches.

4. A well-developed calyptra is present but there is no involucre.

5. A distal elaterophore is present to which some elaters are attached.

6. The capsule is ovoid to cylindrical and dehisces longitudinally into four parts extending to the base.

Family-Fossombroniaceae (4 genera; Fossombronia, Simodon, Petalophyllum and Sewardiella)

1. Thallus is distinctly foliose.

2. The thallus is dorsiventral and prostrate.

3. The stem is branched. Growth of the main axis and of its branches is by means of an apical cell with two cutting faces.

4. The leaf is thin, one cell-thick except the basal portion which is 2 or 3 cells in thickness.

5. Antheridia develop in acropetal succession singly or in small groups.

6. Archegonia occur in small groups.

7. Young sporophyte remains surrounded by a calyptra and which is ensheathed by a cuplike involucre.

8. The mature sporophyte is surrounded and protected by a bell-shaped sheathing perianth.

9. Important genus-Fossombronia.

Order-Jungermanniales (220 genera; 8, 500 species)

The characteristic features of this order are as follows

1. The gametophyte is differentiated into stem and leaves; the leaves are borne in a regular spiral succession along the stem.

2. The apical cell is pyramid-like with three cutting faces.

3. The stem generally bears three rows of leaves; two rows are lateral and consist of leaves of normal size; the third row consists of the under leaves which are generally smaller than the lateral leaves.

4. The archegonia are always restricted to the apices of the axis and its branches.

5. The sporophytes are always terminal in position.

6. The antheridia are borne singly or in groups in the axis of leaves.

Family-Porellaceae (single gemis-Porella)

1. The leaves are arranged in three rows on the stem; ventral leaves are well developed and usually decurrent at the base; dorsal leaves are incubuous; postical lobe distinct.

2. The rhizoids are scarce and arise from the lower side of the stem in tufts generally near the base of underleaves (ventral leaves).

3. The archegonia are borne in terminal cluster on small lateral branches; the archegonia remain surrounded by a large inflated perianth.

4. The spherical capsule dehisces by four valves which split only to half way down.

Family-Frullaniaceae (three genera; important genus Frullania)

1. The thallus is pinnately branched and differentiated into stem and leaves.

2. The leaves are arranged in three rows two laterals unequally lobed and a ventral lobule.

3. The ventral leaves are bifid and trumpet-shaped.

4. The archegonia develop in a group.

Order-Calobryales (2 genera-Calobryum (8 spp.) and Haplomitrium (single spp.)

The characteristic features are as follows

1. They possess erect leafy gametophytes with leaves in three vertical rows.

2. The leaves are dorsiventrally flattened.

3. They have a pale, substerranean, sparingly branched rhizome from which arise erect leafy branches.

4. Erect branches bearing sex organs have the uppermost leaves close together and in more than three rows.

5. They are devoid of rhizoids.

6. The antheridia are ovoid, stalked, and borne at the apex of the stem.

7. The jacket of the neck of archegonium has only four vertical rows of cells.

8. The sporophyte bears an elongate capsule whose jacket layer is only one cell in thickness except at the apex.

9. The number of chromosomes is-n=9.

Since there is single family Calobryaceae the characters are similar to that of the order. Two genera-Calobryum and Haplomitrium.

Order-Takakiales (1 genus; 2 species)

The characteristic features are as follows

1. They possess cylindrical, rhizomatic and erect gametophores.

2. They are devoid of rhizoids.

3. They possess copious beaked or non-beaked mucilage hairs on them.

4. They possess terete bifid-trifid-quadrifid leaves or phyllids.

5. The gametophores are about 1 to 1.5 cm. in height.

6. The leafless branches facing downward known as 'flagella' or 'stolons' may be present.

7. Asexual reproduction is not known.

8. Only female (archegonial) shoots are known. They bear conspicuous pedestalled archegonia.

9. The male (antheridial) shoots and the sporophytes are not known.

10. They have lowest chromosome number (i.e., n=4).

11. They are supposed to be most primitive and sometimes known as living fossil. There is one family Takakiaceae, and one genus Takakia.

Class II: Anthocerotopsida

There are 1 order, 1 or 2 families, 6 genera and 301 species.

1. The gametophyte is thalloid and dorsiventral, bearing simple and smooth-walled rhizoids; tuberculate rhizoids and ventral scales are altogether absent.

2. The tissues of the thallus are undifferentiated; air chambers and air pores are absent; each cell bears a large chloroplast and a conspicusous pyrenoid within it.

3. The sex organs are found to be embedded in the gametophytic tissue.

4. The antheridia arise from the hypodermal cells of the thallus on the dorsal side of it; they develop within the antheridial chambers, singly or in groups on the dorsal side of the thallus.

5. The archegonia are found in sunken conditions on the dorsal side of the thallus, they develop from superficial cells.

6. The elongated and cylindrical sporogonium arises from the dorsal side of the thallus.

7. The sporogonium consists of foot, meristematic region and capsule; the meristem is intercalary and continues its growth thoughout the growing season.

8. The wall of sporgonium contains chlorophyll.

9. The central sterile portion of sporogonium is columella, which remains surrounded by sporogenous tissue and spores; the elaters are also present.

10. The sporogenous mass develos from amphithecium and arches over the columella. The class Anthocerotopsida includes a single order, the Anthocerotales with the same characters. There are two families 1. Anthocerotaceae and 2. Notothylaceae.

Family-Anthocerotaceae (4 or 5 genera; important genus Anthoceros)

1. The capsule is linear and vertical.

2. The stomata are present on the wall of capsule.

3. The archesporium develops from amphithecium.

4. The eleaters are four-celled, smooth or thick-walled; thickening band may or may not be present.

Family-Notothylaceae (single gemis-Notothylas)

1. The capsule is cylindrical and horizontal.

2. The stomata are not found on the wall of capsule.

3. Archesporium arises from endothecium and amphithecium.

4. Elaters are short and stumpy; they have irregular thickening bands.

Class III: Bryopsida

There are 3 orders, 28 families, 660 genera and 15,504 species:

1. The gametophyte consists of prostrate, thalloid, branched protonema and erect leafy gametophore.

2. The gametophytic plant body consists of the stem, spirally arranged leaves and the sex organs (antheridia and archegonia) at its apical portion.

3. The rhizoids are multicellular, branched and obliquely septate.

4. The sex organs (antheridia and archegonia) develop from the superficial cells of the gametophore.

5. The sporophyte is differentiated into foot, seta and capsule.

6. The capsular wall remains interrupted by stomata at several places.

7. The archesporium or sporogenous mass develops from outer layer of endothecium which in addition forms columella.

8. The elaters are not present in the sporogonium.

The class Bryopsida (Musci) has been divided into three sub-classes (1) Sphagnobrya (Sphagnidae); (2) Andreaeobrya (Andreaeidae) and (3) Eubrya (Bryidae).

I. Sub-class. Sphagnobrya

The sub-class has a single order, the Sphagnales and a single family, the Sphagnaceae. (Single genus Sphagnum with 326 species). The characteristic features are as follows

1. They are called ‘bog mosses’ or ‘peat mosses’.

2. The protonema is broad and thallose; It produces one gametophore; the leaves or gametophores lack mid-rib and usually composed of two types of cells-(i) the narrow living green cells and (ii) large hyaline dead cells.

3. The branches arise in lateral clusters in the axis of the leaves borne on the stem.

4. The antheridia are borne in the axis of leaves on the antheridial branch.

5. The archegonia are terminal and formed acrogynously.

6. The sporogenous tissue of a sporophyte develops from the amphithecium.

7. The sporogonium remains elevated above the gametophyte due to elongation of a stalk of gametophytic tissue, the pseudopodium.

II. Sub-class. Andreaeobrya

This sub-class has a single order, the Andreaeales, and a singly family, the Andreaceceae. The important genus is Andreaea.

The characteristic features are as follows

1. The gametophores are brittle, and can easily be broken.

2. There is practically no tissue differentiation in plant body.

3. The leaves are generally large, erect and convolute.

4. The archesporium and colonmella develop from the endothecium.

III. Sub-class Eubrya (650 genera; 14,000 species)

This sub-class has been further divided into three cohorts and fifteen orders. The true mosses are included in this sub-class. The characteristic features are as follows

1. The leaves of the gametophores are more than one cell in thickness and possess midtrib on them.

2. The protonema are filamentous.

3. The sporophyte bears a well differentiated, elongated seta which pushes out the capsule from the gametophore.

4. The sporogenous tissue is derived from the endothecium.

5. The archesporium does not overarch the columella; the columella continues upto the apex of the capsule; both columella and archesporium have been derived from the endothecium.

6. In between spore sac and columella, the partitioned air spaces are present.

7. The mature capsule possesses the complex structure made of many tissues.

8. The capsule opens at its apex by an operculum; the spore dispersal is regulated by a teeth like apparatus, the persistome.

Order-Funariales (26 genera; 356 species)

Characteristic features

1. The plants are terrestrial; they are small in size and may be annual or biennial.

2. The leaves possess distinct mid-ribs and arranged in rosettes at the apex of the gametophyte.

3. The capsule is wide and provided with an unbeaked operculum.

4. The peristome of the capsule is double and consists of inner and outer peristomes called endostome and exostome respectively.

5. There are five families in this order, of which Funariaceae is most important.

Family-Funariaceae (9 genera; 200 species)

1. The leaves are one cell in thickness except at the mid-rib region.

2. The small mosses form the velvety appearance on the surface of the sustratum.

3. The calyptra are soon detached from the opercula of the capsules; the calyptra are provided with long beaks.

4. The capsules are pyriform and situated on the long, elongated setae.

Order-Polytrichales

Characteristic features

1. The gametophyte is perennial and tall.

2. The leaves are narrow and possess longitudinal lamellae on the upper surface of the midrib.

3. The capsule is terminal.

4. The single annular series of cells gives rise to a peristome in the inner zone of the amphithecium.

5. There are 32 to 64 pyramidal teeth in peristome; the tips of the peristome teeth remain joined above to a thin membrance, the epiphragm covers the mouth of the capsule.

6. There is a single family, the Polytrichaceae in this order; the important genera of this family are — Polytrichum and Pogonatum.

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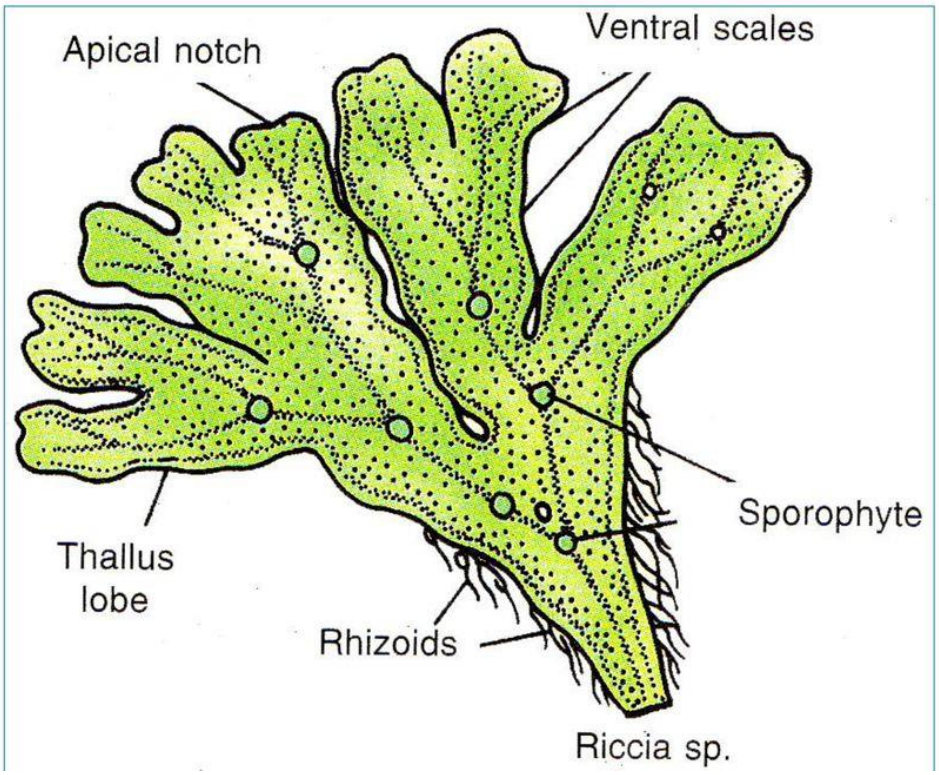


3

Pelia sps

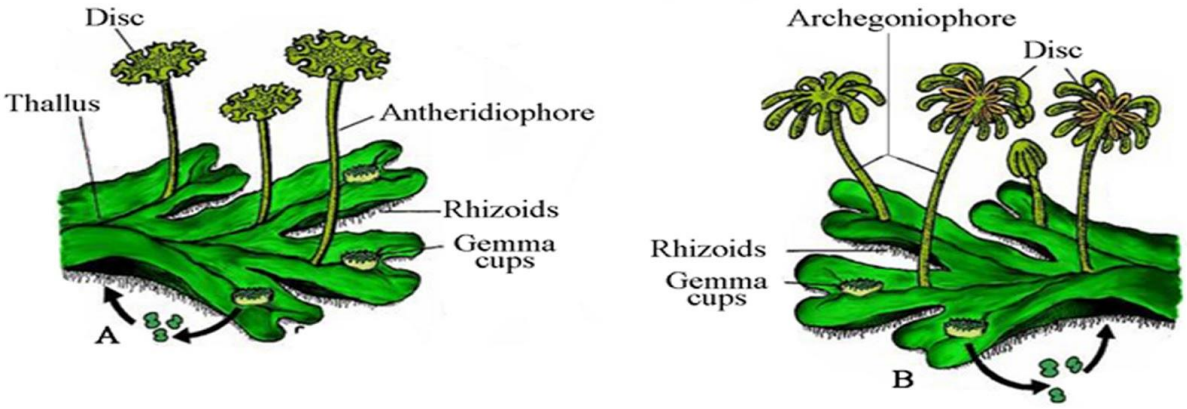


Fig: ***Marchantia spp***. **(A)** Male plant, **(B)** Female plant.

Porella sps

Porella

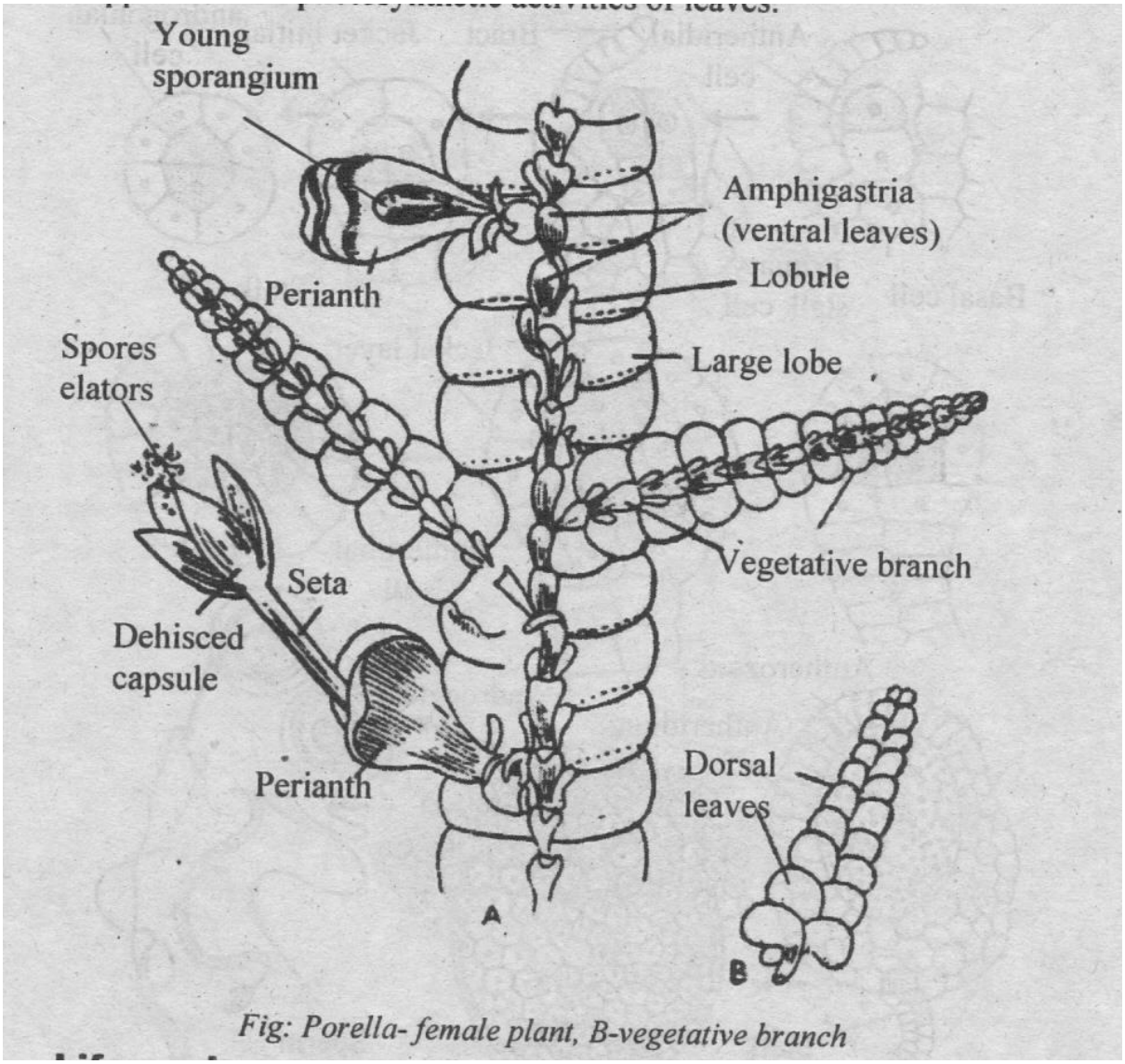
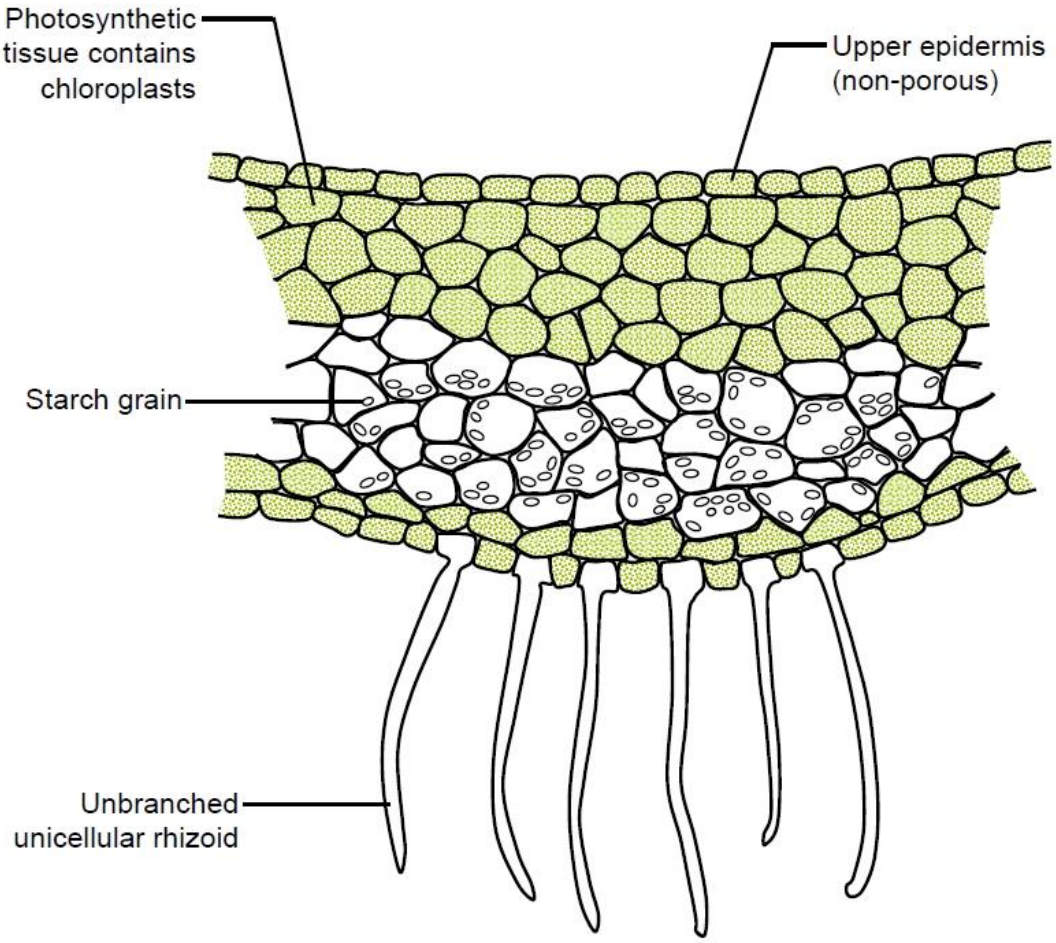
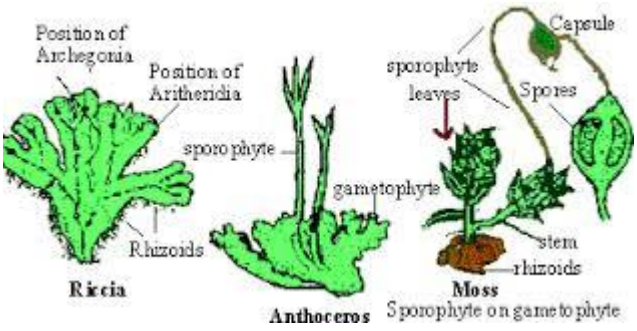


Fig: Porella- female plant, B-vegetative branch



Section through gametophyte thallus of *Pellia epiphylla*



Polytrichum