

## BRYOPHYTES

**Bryophyta (Gr. Bryon = moss; phyton = plant)**, a division of kingdom Plantae comprises of Liverworts, Hornworts and mosses. They are groups of green plants which occupy a position between the thallophytes (Algae) and the vascular cryptogams (Pteridophytes). Bryophytes produce embryos but lack seeds and vascular tissues. They are the most simple and primitive group of Embryophyta. They are said to be the first land plants or non-vascular land plants (Atracheata). Presence of swimming antherozoids is an evidence of their aquatic ancestry.

**Bryophytes are land plants that differ from all other plants lacking lignified vascular tissue by having the gametophyte generation dominant and having unbranched sporophytes that produce a single sporangium.**

### General Characters 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 into 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:
  - (i) Hepaticae (Liverworts),
  - (ii) Anthocerotae (Hornworts) and
  - (iii) Musci (Mosses).

### Classification of Bryophytes:

According to the latest recommendations of ICBN (International Code of Botanical Nomenclature), bryophytes have been divided into three classes.<sup>3</sup>

1. Hepaticae (Hepaticopsida = Liverworts)
2. Anthocerotae (Anthocerotopsida = 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 pyrenoid.
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) Spheroocarpales (iv) Marchantiales

#### Class 2. Anthocerotae or Anthocerotopsid:

1. Gametophytic plant body is simple, thalloid; thallus dorsiventral without air chambers, 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 (iii) Sphagnales.

### **Adaptation to Land Habitat :**

Bryophytes are first land plants. Evidences support that Bryophytes are evolved from Algae. During the process of origin they developed to certain adaptations to land habit.

These are:

1. Formation of a compact multi cellular plant body which helped in the conservation of water by reducing cell surface area exposed to dry land condition. Presence of cuticle further reduces loss of water by evaporation. i.e, Development of compact plant body covered with epidermis.
2. Development of special organs for attachment and absorption of water e.g., rhizoids.
3. Development of photosynthetic tissues into special chambers for the absorption of carbon dioxide without losing much water and exposure to light. i.e, Absorption of carbon dioxide from atmosphere for photosynthesis. e.g, airpores.
4. Gametes are produced and protected by the special multi cellular organs (antheridia and archegonia).
5. Protection of reproductive cells from drying and mechanical injury i.e., jacketed sex organs. Heterogamy (production of two types of gametes) is evolved, forming non motile egg containing stored food and motile sperms.
6. Multi-cellular embryo is formed which is retained and protected inside the female reproductive body during its development, i.e, Retention of zygote within the archegonium.
7. Alternation of spore-producing generation (sporophyte) with gamete producing generation gametophyte enabled the plant to produce and test the best genetic combinations for adapting to the versatile terrestrial conditions.
8. Production of large number of thick walled spores.
9. Dissemination of spores by wind.

### **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 are 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

### Rhizoids and Scales in Bryophytes:

**Rhizoids:** In Bryophytes roots are absent and the functions of the root i.e., anchorage and absorption is performed by the filamentous structures known as rhizoids.

Rhizoids may be unicellular, un-branched (Fig. 3B-D) in thallose forms of Hepaticopsida and Anthocerotopsida (e.g., *Riccia*, *Marchantia*, *Anthoceros*) or multicellular and branched in foliose forms of Bryopsida (Fig. 3 E) (e.g., *Funaria*, *Polytrichum*)

Multicellular rhizoids possess oblique cross walls. Unicellular rhizoids are of two types smooth-walled and tuberculated (Fig. 3 B-D). The members of order Marchantiales (e.g., *Riccia*, *Marchantia*) possess both types of rhizoids while Anthocerotales (e.g., *Anthoceros*) possess only smooth walled rhizoids.

In thalloid forms rhizoids are borne on the ventral surface (Fig. 3 A) along the mid rib, however, in foliose forms rhizoids arise from the base of the 'stem'. In aquatic Bryophytes (e.g., *Riccia fluitans*, *Ricciocarpus natans*) rhizoids are absent.

**Scales:** Scales are present only in the members of order Marchantiales and absent in all Bryophytes. The scales are multicellular, violet coloured and single cell thick. They are violet in colour due to the presence of the pigment anthocyanin. Scales develop on the ventral surface of the thallus (Fig 3A). They may be arranged in one row (e.g., young thallus of *Riccia*) or in two rows on each side of the mid rib (e.g., *Targionia*) or in two to four rows on each side of the mid rib (e.g., *Marchantia*) or irregularly distributed over the entire ventral surface (e.g., *Corsinia*). In *Riccia* the scales are ligulate (Fig. 3G) while in *Marchantia* the scales are of two types—ligulate and appendiculate (divided by a narrow constriction into two parts—body and appendage, Fig. 3F). Scales protect the growing point by covering their delicate cells and secreting slime to keep them moist. The scales are absent in some aquatic members of order Marchantiales. e.g., *Riccia fluitans*.

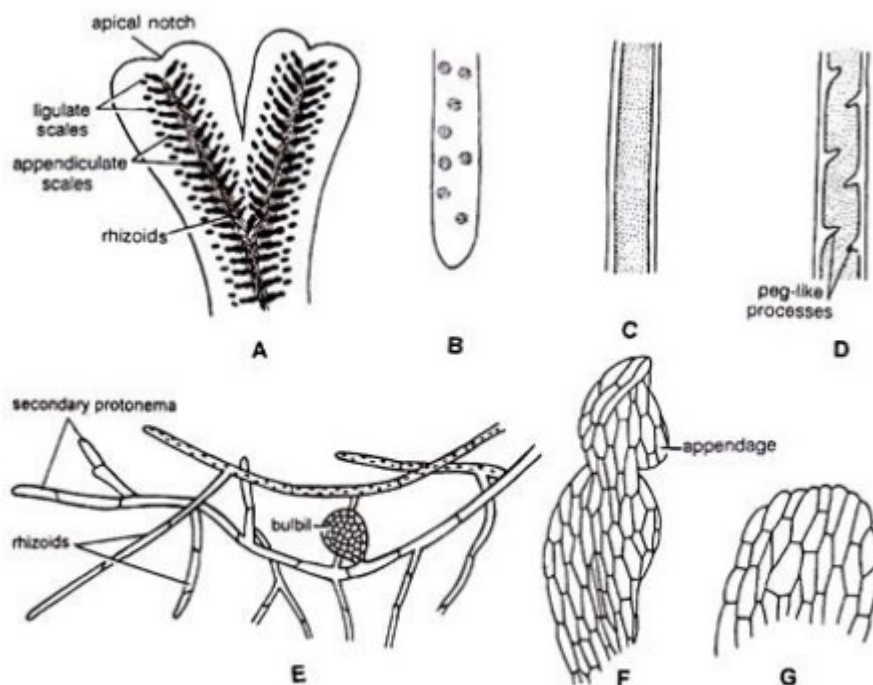


Fig. 3. (A–G) *Marchantia*. Scales and rhizoids. (A) *Marchantia* thallus : Ventral surface showing rhizoids and scales, (B) Tuberculated rhizoid (surface view), (C) Smooth walled rhizoid (surface view), (D) Tuberculate rhizoid (Internal view), (E) Multicellular rhizoids, (F) Appendiculate scale, (G) Ligulate scale.

## Affinities of Bryophytes

From evolutionary point of view Bryophytes occupy an intermediate position between the Algae and the Pteridophytes. They show affinities with both Algae and Pteridophytes.

### Resemblance of Bryophytes with Algae:

1. Plant body simple, thalloid and gametophytic.
2. Autotrophic.
3. Gametophytic phase is dominant.
4. Roots are absent.
5. Cell wall is made up of cellulose.
6. Pigments (chlorophyll a, chlorophyll b,  $\alpha$  and  $\beta$  carotene, Lutin, Violaxanthes and Xeaxanthin) are similar in chloroplast.
7. Vascular tissue is absent.
8. Antherozoids are motile (bi-flagellated).
9. Flagella are whiplash type.
10. Water is essential for fertilization.
11. A filamentous protonema is produced by Bryophytes (juvenile stage in mosses) which resembles with the filamentous green algae.
12. In order Anthocerotales of Bryophytes, plastids are with pyrenoid which is a characteristic of Chlorophyceae (Green algae).

### Resemblance of Bryophytes with Pteridophytes:

1. Plants are terrestrial.
2. Primitive simple leafless and rootless sporophytes of Pteridophytes (members of order Psilophytales) can be compared with the sporophytes of Bryophytes.
3. Sexual reproduction is oogamous.
4. Androcytes are enclosed by sterile jacket layer.
5. Antherozoids are flagellated. 6. Water is essential for fertilization.
7. Permanent retention of zygote within the archegonium.
8. Zygote forms the embryo.
9. Moss capsule is similar to terminal sporangium and columella of Psilophytales.
10. Both Bryophytes and Pteridophytes are characterised by heteromorphic alternation, of generation.