Chapter 8

Bryophyta

- The division Bryophyta (Greek : *Bryon* = moss; *phyton* = plants) includes the simplest and primitive land plants.
- It occupies a position inbetween algae and pteridophyta.
- The group consists of about 960 genera and over 25,000 species, occurring worldwide in distribution.

  - The term Bryophyta was used by **Brown**.
  - The term moss coined by **Jussiau**.
  - **Hedwig** is the **father of Bryology**.
  - **S.R. Kashyap** is the **father of Indian Bryology**.
  - The pteridophytic origin of bryophyte was founded by **Scott**.
  - The algal origin of bryophyte was founded by **Bower**.

Characteristic features

- The bryophytes are fundamentally **terrestrial plants** but required presence of water to complete their life cycle, because they require a moist soil surface for swimming of their sperms and supply of water to all parts.
- Thus, due to peculiar type of their habitats, they are regarded as "**the amphibians of the plant kingdom**".
- Bryophytes are **first amongst land plants which occur in damp and shady habitats**.
- Dominant plant phase in bryophytes is free living thalloid **gametophyte.**
- The gametophyte is **thalloid in primitive forms** (*Riccia*) and **differentiated** into rhizoids, stem and leaves **in higher bryophytes** (mosses).
- From the lower surface of the thallus or from the base of the stem, number of unicellular or multicellular **rhizoids** arise. They are the **organs of absorption and fixation**.
- Many bryophytes, eg. *Riccia*, *Marchantia* etc have scale on ventral surface. Scales are multicellular and to protect the growing point or apical cell of the thallus.
- The plant body has epidermis for protection.
- The thallus has air pores. Moss capsule has stomata for gaseous exchange.
- Nutritionally, the plant body is **independent** and is the conspicuous phase of the life cycle.
- The gametophytes **lack vascular tissues** namely xylem and phloem.
- Stem, leaves and rhizoids of the bryophytes are **analogous** to the stems, leaves and roots rather than root hairs of vascular plants.
- **Scales** or **amphigastria** occur which take part in capillary conduction and protection.
- The higher bryophytes (eg. *Moss*) have primitive vascular strands (conducting tissues).
- They **reproduce by vegetative** and **sexual methods**.

Vegetative reproduction

- Vegetative reproduction occurs by various methods to give rise to new thallus.
- **Death and decay of the thallus** – The older thallus starts dying from lower to upper side. Finally the growing point gets separated and formed fragments develops into a new thallus.
- **Adventitious branches** – Detached from thallus to form new thallus, e.g. *Riccia.*
- **Tubers** – These form during adverse condition, eg. *Anthoceros*.
- **Gemmae** – *Marchantia* thallus has cup like structure, called gemma cup, which bears large gemmae (multicellular).
- **Primary protonema** – Spores on germination give rise to primary protonema which breaks up into segments that give rise to leafy gametophore.
- **Secondary protonema** – Protonema formed from structures other than spores and give rise to leafy gametophore.

Sexual reproduction

- The sexual reproduction is of oogamous type. The sex organs are called antheridia (male) and archegonia (female). They are multicellular and surrounded by a sterile jacket layer.
- **Antheridium**
  - It is stalked (multicellular) pear shaped structure. Its one cell thick jacket surrounds large number of fertile cells called **androcytes**. Each androcyte metamorphoses into a biflagellate antherozoid or male gamete or sperms.
  - Antherozoids are **naked**, **biflagellate** and **motile**. The flagella are long, anterior and whiplash type. They **need water for fertilization**.
- **Archegonium**
  - Archegonium **appears first time in Bryophytes in plant kingdom**.
  - It is a flask shaped structure with swollen base called **venter** and upper elongated **neck**.
  - The archegonium is surrounded by one celled thick sterile jacket layer.
  - The venter contain a ventral canal cell and an egg cell.
  - The neck, made of 4–6 vertical rows of cells, enclosing naked neck canal cells.
  - The tip of neck has 4 covercells or lid cells.
  - During fertilization the cover cells open and neck canal cells and venter canal cell disintegrate to form mucilage which absorb moisture to create pressure which remove lid cells and mucilage comes out of neck.
  - Thus passage is formed for the entry of antherozoids to fertilize the egg.

Sporophytic generation

- Sporophytic generation **starts with zygote**. The zygote immediately secretes cellulosic wall, to develop into embryo or sporophyte.
- The embryo is multicellular. The gametophyte provide protection and nourishment to the developing embryo.
- The **development of embryo is exoscopic**, *i.e.* first division of zygote is transverse and the capsule develops from outer or epibasal cell.
- The embryo is not liberated but is retained within the archegonium where it develops into sporophyte.

Sporophyte or Sporogonium

- The sporangium develops from embryo. It does not has rhizoids, stems and leaves. It is permanently attached to gametophyte and is completely dependent on it.
- But in some Bryophytes like *Anthoceros*, mosses, the sporophyte wall has photosynthetic tissues. Mostly the sporophyte consists of foot, seta and capsule. The **foot** is an **anchorage and absorptive organ** and **remain embedded in gametophyte**.
- The **seta** is small (*Marchantia*) to long (mosses) to **conducts food from gametophyte to capsule**.
- The terminal capsule is either spherical or elongated. Capsule also surrounded by its own jacket (sporophytic in nature) and 2 layered calyptra. The calyptra originate from venter wall, hence gametophytic in nature. The capsule contains large number of spores or meiospores and elaters (absent in *Riccia*). The spores are haploid and wind disseminated. The meiosis is sporogenic.
- The **elaters** are **sterile** and are **diploid**. They **have hygroscopic thickening which helps in dispersal of spores**.
- The haploid spores, germinate to form young gametophyte.
- In mosses, the spores first develop into multicellular, haploid branched filamentous structure called **protonema**, which later gives rise to gametophytic plant.
- The spores are of one kind, hence the bryophytes are **homosporous**.
- All bryophytes exhibit **heteromorphic alternation of generations** *i.e.,* the individuals of each generation are dissimilar.
- Bryophytes resemble pteridophytes in having embryo stage, cuticle, multicellular sex organs with sterile jacket, multicellular sporangia, oogamous reproduction, flagellated male gametes etc.

Similarities between algae and bryophytes

- Both are autotrophic, the plant body is gametophytic.
- Plant body is thallus like and devoid of vascular tissues.
- Root is absent but rhizoids are found for attachment and absorption purpose.
- Both algae and bryophytes have motile sperms and need water for fertilization.

Classification of bryophyta

- Bryophytes have been **divided into three classes** – **hepaticopsida**, **anthocerotopsida** and **bryopsida**.

Hepaticopsida (eg *Riccia*, *Marchantia*)

- The plants for the class **hepaticopsida** are commonly called as **liverworts**.
- The gametophyte is dorsiventrally differentiated without **protonema stage**.
- Internally homogeneous or composed of different kinds of tissues.
- Ventral surface of the thallus shows **unicellular rhizoids** for **anchorage**.
- Sex organs always develop on the **dorsal surface** of the thallus. They are **multicellular**.
- **Water is essential** for the process of fertilization to take place.
- The gametophyte is usually thalloid; it is occassionally leafy (in such forms the leaves are without midrib).
- Rhizoids are without septa.
- Each cell has many chloroplasts; the chloroplasts are without pyrenoids.
- Sporophyte has foot, seta and capsule (except *Riccia*). Growth is determinate and limited. Columella in sporophyte is absent.
- Spore mother cells develop from endothecium of embryo.
- Elaters are hygroscopic and help in dispersal of spores, eg. *Marchantia* (Elaters are absent in *Riccia*)
- Dehiscence is by longitudinal or transverse wall. In *Riccia*, it is by decay of capsule wall.
- The **endothecium** produces sporogenous tissue.
- Sporophyte is **entirely parasitic on the gametophyte**, *e.g., Riccia, Marchantia,* etc.
- *Riccia fluitans* is an **aquatic bryophyte**.
- Thalli of *Riccia* are internally differentiated into upper photosynthetic region and lower storage region.
- The species of *Riccia* may be **homothallic** (monoecious), eg. *R. crystallina* or **heterothallic** (dioecious), eg. *R. discolor.*
- The neck of archegonium is 6-9 cell high and one cell thick. Venter also has one cell thick wall.
- The antherozoid are attracted towards the egg by **chemotactic mechanism**. The chemical stimulus is provided in the form of sugars.
- The venter divides periclinally to form a double layered **calyptra**.
- The species of *Marchantia* are **heterothallic** (dioecious).
- The rhizoids in *Marchantia* are of two **types** – **smooth walled** and **tuberculate**. They are **present in the region of the mid rib**.
- The archegonium in *Marchantia* consists of a neck containing 6-neck canal cells, and a venter containing a ventral canal cell and an egg.

Anthocerotopsida (eg *Anthoceros*)

- "**Hornworts**" is the common name for the members of the class anthocerotopsida.
- The gametophytes are **thalloid, distinctly dorsiventral**.
- Thallus internally shows homogenous tissues, **mucilage cavities** inhabited by some algae.
- Thalloid gametophytes do not possess air chambers and scales.
- Rhizoids are present, scales absent.
- Each cell of the thallus has a single large chloroplast with a pyrenoid.
- Sex organs developed on the **dorsal surface are embedded in the thallus**.
- Sporophyte is horn like. It is long, differentiated into **capsule and meristematic zone**. Instead of seta meristematic zone is present by which its growth is unlimited and indeterminate.
- The wall of the capsule is 4 – 6 layers and consists stomata.
- The amphithecium and endothecium produces **sporogenous tissue and columella** respectively.
- The sporophyte is **partially dependent** on the gametophyte, *eg. Anthoceros.*
- The gametophytes of *Anthoceros* are **thallose**, **dorsiventrally flattened** and **variously lobed**. The dorsal surface is smooth and the ventral is provided with unicelled smooth walled rhizoids. There are **no tuberculate rhizoids** and **scales**.
- The thallus of *Anthoceros* is internally **not well differentiated**. It has **endophytic** *Nostoc* **colonies** and the cavities opening ventrally by slime pores.
- 1 – 3 celled sterile **pseudoelaters** are found in *Anthoceros*.
- **Apospory** is observed in some species of *Anthoceros.*
- Columella is mostly present.
- Dehiscence is by 2-4 longitudinal splits.

Bryopsida or Musci

(eg *Funaria*, *Sphagnum* (bog moss), *Polytrichum*)

- Commonly called **mosses**.

- The gametophyte is differentiated into prostrate protonema and an erect gametophore.
- Gametophore is foliose.
- Rhizoids are multicellular with oblique septa.
- The stem is erect, leafy and bears **radially symmetrical** sexual branches.
- The leaves are arranged in **3-8 rows** on the stem. Each leaf shows a central **midrib only**.
- Sex organs develop near the **tips of sexual branches**.
- The sporophyte is differentiated into **foot, seta and capsule**.
- Sporogenous tissue may be formed from the **endothecium** or **amphithecium**.
- Columella is present. It develops from endothecium.
- Peristome teeth are present in one or two rows and surrounds the terminal opening of the capsule.
- Elaters are absent.
- The sporophyte is **semiparasitic** (as the sporophyte is not completely embedded in the gametophyte.
- The spores on germination produces multicellular, branched, chlorophyllous structure called **protonema**.
- Leafy gametophores grow from protonema, eg. *Funaria, Polytrichum, Sphagnum* etc.
- The sex organs of *Funaria* are of **projecting type and stalked**. They are mixed with sterile hair called **paraphyses**.
- A cluster of **vegetative leaves** surrounds the sex organs.
- The capsule of *Funaria* is distinguishable into an upper **opercular region**, middle fertile or **theca region** and lower **apophyseal region**.
- The opercular region is distinguishable into operculum covering peristome which comprises **sixteen outer** and **sixteen inner teeth**. The outer teeth are thick and **hygroscopic**.
- The **annulus separates** operculum from theca region.
- The fertile region mainly comprises archesporium lined by outer and inner spore sacs. The central sterile region is columella.
- The apophyseal region has **central conducting strands** and stomata in the epidermis.
- The archesporium forms **spore mother cells** which, by meiosis, form tetrahedral tetrads of spores.
- When the capsule is mature, the operculum is removed along the annulus and the spores are dispersed by the **hygroscopic action of peristomal teeth**.
- The spore **forms the chloronema which gives rise to caulonema**.
- Capsule has columella.

Economic importance

- *Sphagnum* is most economically important bryophyte.
- The bryophytes **help in conservation of soil, soil development** and **in succession of plant communities**.
- They are **used in manufacture of paper, fabrics, artificial wood** etc.
- It is **used in horticulture** and added to soil to improve its water holding capacity. It is used as **packing material** for living plants.
- Peat is **antiseptic** and is used in **surgical dressing**.
- *Sphagnum* or peat moss is also known as famine food in China.
- The acidic nature of bog (where *Sphagnum* grows) helps in **fossilization**.
- *Sphagnum* contains sphagnal which is used in skin diseases.
- It is a good absorbant hence also used as bandages.
- As biological material - sex determination in plants was discovered for the first time in *Sphaerocarpus*.

End of the Chapter