Kingdom Plantae - Bryophyte & Pteridophyte

Objectives

After going through this lesson, the learners will be able to understand the following:

- Adaptations in bryophytes that enable them to live on land.
- What are the three groups of bryophytes?
- How do bryophytes reproduce?
- How is vascular tissue important to pteridophytes?
- What are the characteristics of the four phyla of pteridophytes?
- How do pteridophytes reproduce?
- Ecological role of bryophytes and pteridophytes

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Introduction to Bryophytes and Pteridophytes

The kingdom plantae includes eukaryotic, photosynthetic organisms. The kingdom plantae have traditionally been classified broadly into two sub-kingdoms cryptogamae and phanerogamae. As in the previous module we broadly studied the classification of plants with special relevance to the division of Thallophytes. In this module we will learn about the other two divisions in cryptogamae i. e Bryophyta also known as "amphibians of the plant kingdom" and Pteridophyta which are often referred as the "first land plants or vascular cryptogams".

Bryophytes

Bryophytes are simplest or the most primitive non-vascular plants,bryophytes have life cycles that depend on water for fertilization in order to reproduce thus they are mostly found in moist places and thus they are also known as the 'amphibians of the plant kingdom'. These plants completely lack vascular tissue, these plants can draw water by osmosis as they are only a few centimeters above the ground. Bryophytes include the various mosses,hornworts and liverworts that are found commonly growing in moist shaded areas in the hills. In this module we would learn about the general characteristics, habitat and distribution,classification, life-cycle, Ecological and economic importance of Bryophytes.

Habitat and distribution - Bryophytes are widely distributed throughout the world, from polar and alpine regions to the tropics. Bryophytes produce sperms that must swim through water in order to reach egg for fertilization thus bryophytes are not found in extremely arid region or saline water, although some are found in damp environments which are wet throughout the year within arid regions and some species are found on seashores above the intertidal zone. The tropical and subtropical latitudes show a great diversity of Bryophytes.

Bryophytes in India - Out of 16,236 species of 2523 species of bryophytes are found in India with about 629 endemic species and around 80 threatened species. (Source: Chapman, 2009; Singh & Dsah, 2014). Though the species of bryophytes are widely distributed within India the two hotspots of biodiversity one in the north east Himalaya and the other in the Western Ghats show richest diversity of Bryophytes within India.

Classification of Bryophytes- Bryophytes are generally classified into Mosses, Liverworts and Hornworts. Today we classify them into three phyla officially named i) Hepaticopsida (Liverworts), ii) Anthocerotopsida (Hornworts) and iii) Bryopsida (Mosses)

Hepaticopsida or Liverworts – These are commonly called as liverworts as the gametophytic plant body may be thallose mostly foliose or leaf like with aseptate rhizoids gives an appearance of liver as seen in *Marchantia*, *Riccia*,*Pellia*etc. Sex organs are mostly found on the dorsal surface of the thallus. The male Antheridia are borne on antheridiophores which produce flagellated antherozoids or the sperms. The female reproductive organs of archegonia are borne on specialized branches which are called archegoniophores. Each archegonium is differentiated into the neck and the egg is placed inside the venter. Post fertilization the egg becomes zygote (2N) which grows into a sporophyte also called sporangium . The body of the sporophyte is usually differentiated into bulbous foot, setae and an oval capsule as seen in *Marchantia*. Inside the capsule the sporogenous cells develop from the endothecium, the spore mother cell are diploid which divide through meiosis to give rise to haploid cells or the spores that later get dispersed by wind. Some of the liverworts also reproduce asexually by means of gemmae (Singular:gemma) are small multicellular reproductive structures. In some species like in *Marchantia* the gemma are produced in cuplike structures called gemma cup, the gemma can divide mitotically to give rise to new individuals.

Anthocerotopsida or Hornworts – like the liverworts, hornworts are generally found in soil that stays moist and damp throughout the year. Their gametophyte looks quite the same as liverworts i. ethallose with aseptate rhizoids. The sporophyte or sporangium is differentiated into bulbous feet, small meristematic seta and a long cylindrical capsule with pseudo elaters the sporophyte resembles a small horn. Common examples include *Anthoceros*which is long and grows by means of basal meristematic zone. The sporogenous cells develop from amphithecium and endothecium forms sterile columella. The capsule dehisces irregularly basipetally by two valves and shows hygroscopic twisting. Some examples include Anthoceros, Notothylas, Megacerosetc.

Bryopsida or Mosses - These are the most common forms of bryophytes. They are commonly known as mosses. They grow in abundance in areas with water-bogs & swamps near streams and in rainforests. Mosses are able to tolerate low soil nutrient, low temperatures allowing them to grow in harsh environmental conditions. Thus mosses show a wide range of distribution with its presence even in the polar regions the Arctic and the Antarctic. They usually form the green carpets or mats on moist soils, walls and tree trunks. The clumps of

gametophyte grow together in this predominant stage of the life cycle of a moss, the gametophyte consists of two stages. The first stage is the protonema stage, which develops directly from a spore. It is a creeping, green, branched and frequently filamentous stage. The second stage is the leafy stage, which develops from the secondary protonema as a lateral bud. They consist of upright, slender axes bearing spirally arranged leaves. They are attached to the soil through multicellular and branched obliquely septate rhizoids. This stage bears the sex organs. Vegetative reproduction in mosses is by fragmentation and budding in the secondary protonema. In sexual reproduction, the sex organs antheridia and archegonia are produced at the apex of the leafy shoots. After fertilisation, the zygote develops into a sporophyte, consisting of a foot, seta and capsule. The sporophyte in mosses is more elaborate than that in liverworts. The capsule contains spores. Spores are formed after meiosis. The mosses have an elaborate mechanism of spore dispersal. Common examples of mosses are *Funaria*, *Polytrichum* and *Sphagnum*.

Life-cycle of Bryophytes

The life cycle of bryophytes consists of two distinct phases (i) Gametophytic phase and ii) Sporophytic phase. In Bryophytes the gametophyte is the dominant recognizable stage of the life-cycle that carries out most of the plant's photosynthesis. The sporophyte which grows haploid spores grows at the top of the gametophyte plant. Let us first study the gametophytic plant body in bryophytes followed by the study of reproduction in bryophytes, sporophytes and the alternation of generation seen in bryophytes.

The Gametophytic plant body

The haploid gametophyte is dominant, long lived green and independent. The gametophytes are thalloid (i. e Not differentiated into true root, stems and true leaves) or leafy shoot having stem like central axis and leaf like appendages. The roots are completely absent and they are replaced by unicellular or multicellular thread like rhizoids which help in absorbing moisture from the soil through osmosis. The vascular tissues i. e Xylem and Phloem are completely absent.

Reproduction

Bryophytes reproduce through both asexual and sexual methods of reproduction. Asexually bryophytes reproduce through fragmentation, adventitious branches, Gemmae etc.

The sexual reproduction in bryophytes is oogamous i.e. male gametes are smaller in comparison to large female gametes, also male sperms are flagellated and are called as antherozoids and female gametes are large and non-motile. The gametes are produced in multicellular, jacketed sex organs. The male reproductive organs are called antheridia and the female reproductive organs are called archegonia. Each antheridia is a differentiated stalk and body which produce fertile motile antherozoids. The archegonia is flask shaped differentiated into neck and venter, it is the venter that encloses a large naked egg. During fertilization the male gamete released by the antheridia swim in water droplets which when comes in contact with archegonia fertilizes the egg. Since bryophytes require water for fertilization and fusion of gametes in order to reproduce, they are also known as "The amphibians of the plant kingdom".

The Sporophyte

The zygote that results due to fertilization is a diploid cell that becomes the first cell of sporophytic generation that divides further to develop into a sporogonium. The sporogonium gets differentiated into foot seta and capsule, and the cells of the outer wall forms the calyptra that provides protective covering to developing sporogonium. The sporogonium asexually produces haploid spores as a result of meosis that grows into gametophytic plant body.

Alternation of generation

The life cycle of bryophytes shows alternation of the two morphologically dissimilar phases in its lifecycle which is also known as alternation of generations. The alternation of generation in bryophytes is heteromorphic.

Ecological role of bryophytes

i) Formation of soil – Mosses and lichen plays a prominent role in the formation of soil as they grow on rocks and add its debris when it dies as organic matter which makes it suitable for higher forms plants to grow which in turns lead to breaking up of rock into piece which later weather leading to formation of soil.
ii) Soil Conservation- Mosses play a very important role in binding the soil as it forms dense carpet like mats over the soil which prevent soil erosion by water streams.

iii) Pollution Indicators - they are sensitive indicators of atmospheric pollutants. Changes in the distributions of mosses (and lichens) are an early-warning signal increase in atmospheric pollution.

iv) Mineral Indicators – Certain forms of moss grows on soils which are rich in certain specific minerals. Egs Copper Moss growing over region is an indicator of soil being rich in copper.

Economic Importance of bryophytes

- Use in a nursery – *Sphagnum* moss are able to thrive in acidic water in bogs. Dried Sphagnum moss can absorb water many times its own weight in water and thus acts sort of a natural sponge. Thus it is widely used by gardeners to keep cut plants moist during their propagation.
- Peat - *Sphagnum* sometimes accumulates to form peat which is used by farmers to increase soil water holding capacity. and also is used in extraction of several chemical products like tar, paraffin, nitrates, tanning material etc.
- Medicine – Certain forms of mosses help in extraction of antibiotic substances.

Introduction to Pteridophytes

After learning about the Bryophyta we would now be learning about seedless vascular plants called pteridophytes. These are cryptogams having a sporophyte body and inconspicuous gametophyte. They are the first vascular plants **and are often called "botanical snakes ". In the second of this module we would be learning about the general characteristics, habitat & distribution, classification, lifecycle, economic importance and ecological importance of pteridophytes.**

General Characteristics– The term pteridophytes is derived from two Greek word 'pteron' which means feather and 'phyton' which means plants. These plants usually recognized as ferns are diploid sporophytes which constitute the main and the dominant stage. The sporophyte is differentiated into roots, stems and leaves. The roots of pteridophyte are strong, creeping or underground stems called rhizomes, the primary roots are short lived and are usually replaced by adventitious roots. The leaves may be small microphyllous as in case of *Lycopodium*,*Equisetum* or large macrophyllus as in *Pteridium*, *Pteris*. The vegetative parts of the plant contain vascular tissue that is xylem and phloem. In many plants the combination of the thick walls of xylem and lignin enables vascular plants to grow and reach tall.

Habitat and distribution– They grow in a variety of habitats but mostly terrestrial plants and thrive well in abundant moisture & shaded regions. However there are other forms of pteridophyte that are able to flourish in arid conditions. There are about 12000 species of pteridophyte of which 10. 57% i. e1267 have been identified inIndia this includes 47 are endemic and 414 threatened species. Most of the pteridophytes are found in Himalayas and the western ghats. The western ghats of Karnataka show high specie diversity amongst pteridophytes.

Classification of Pteridophytes - Pteridophytes are classified into four groups –

1. **Psilophyta** – These are the oldest land inhabiting plants. Rootless rhizoids are present. These are homosporous most plants are fossils e. g. *Rhynia*, *Homeophyton*etc
2. **Lycophyta**– commonly called club mosses or spike mosses. Roots, stems and leaves are present. *Lycopodium* and *Selaginella*.
    a. ***Lycopodium* Sp-** They have leaves which are small and microphyllous with a long creeping rhizome which gives rise to aerial branches. These aerial branches bear sporangia in terminal clusters called strobili which are club shaped thus it is also called as club moss**.**
    b. ***Selaginella***- They are also called spike moss. Different species of *Selaginella* are widely distributed and are found in varied conditions from moist damp soil to temperate and xerophytic conditions. These plants have the capacity to roll up to assume shape of ball during prolonged dry period and resume to usual form when dipped in water, such plants are also called '**resurrection plants'**. They also show heterospory which step is leading to evolution into '**seed habit**' i. e ability of plants to form seeds.
3. **Sphenophyta**–At nodes whorls of small non photosynthetic leaves are present, Deposition of silica in stems make them rough in touch. Egs. *Equisetum.*
    a. ***Equisetum –*** Commonly known as horsetails or scouring rushes. These are usually found growing in swampy soil growing along the banks of rivers etc. These plants usually may grow about a meter tall. They are called horsetail because its stems look similar to horse tails and due to the presence of abrasive crystals of silica these are also known as scouring rushes, infact during colonial era horsetails were used to scour pots and pans.

4. **Pterophyta (FERNS)** – They have fan-like leaves called fronds, and the underground stem is in the form of a rhizome. They are found in shady and moist regions, are found very commonly in great numbers in tropical rainforests eg. *Marselia*, *Pteris*, *Dryopteris.*

Life-Cycle of Ferns– The dominant phase in ferns as discussed earlier is the sporophyte which is actually diploid. These plants develop spores on the underside of their fronds in structures which are called sporangia. The clusters of sporangia are called sori. The spores are meant for reproduction and germinate to give rise to haploid gametophyte, called prothallus. The homosporous pteridophyte produce bisexual (monoecious) gametophyte whereas heterosporous pteridophytes produce unisexual (dioecious) gametophytes. When the spores germinate they develop into a small gametophyte that produces root-like rhizoids, the gametophyte though is small but still it grows independently of the sporophyte. The gametophyte produces archegonia and antheridia on the underside of the gametophyte. The fertilization is oogamous and requires water as it was in bryophytes to develop into a diploid zygote that develops into sporophyte.

Economic role of pteridophytes

- **Soil Binding**– Pteridophytes bind the soil all along hill slopes thus preventing soil erosion.
- **Food**- Pteridophytes constitute a good source of food for animals. Sporocarp of Marselia are cooked and eaten by certain tribes.
- **Scouring-** Stems of equisetum helps in scouring of utensils and polishing of metals. Egs. *Equisetum*.
- **Nitrogen fixing**– Some ferns e.g. Water fern Azolla form symbiotic association with nitrogen fixing cyanobacterium are used as biofertilizers in paddy fields.
- **Medicines**– Many anthelmintic drugs are obtained from the rhizome and petioles of the fern- *Dryopteris*, *Lycopodium* is used in the treatment of rheumatism and disorder of lungs and kidneys. Adiantum roots are used to cure throat infections.
- **Ornamental**– Ferns are known for their attractive graceful foliage.

Summary

In this module we learnt about two subdivisions under cryptogams i. e Bryophytes and Pteridophytes. Let's recall what we had learn about each of them :

BRYOPHYTES - Bryophytes (division Bryophyta) are the simplest of the terrestrial plants that lack complex tissue organization, yet they show considerable diversity in form and ecology. The division Bryophyta are classified into three phyla-

1. The mosses (class Bryopsida)
2. The liverworts (class Hepaticopsida)
3. The hornworts (class Anthocerotopsida)

The bryophytes show an alternation of generations between the independent gametophyte generation, which produces the sperm and eggs, and the dependent sporophyte generation, which produces the spores. These are known as amphibians of plant kingdom as they need the presence of water for fertilization of gametes.

Bryophytes form mats, spongy carpets. Bryophytes, especially Mosses which play an important key role in forming ecological communities in the environment as they help in formation of soil. Bryophytes are very sensitive to pollution and are bio-indicators of the environment.

Ferns or Pteridophytes are primitive vascular plants that don't have seeds. In pteridophytes the main plant body is a diploid sporophyte which is differentiated into stem, roots and leaves. Pteridophytes are classified into two groups (i) Psilophyta (ii) Lycophyta (Club moss and Spike moss) (iii) Sphenophyta (Horsetails) (iv) Pterophyta(Fern). The sporophyte is the dominant phase and the spores are meant for reproduction which germinate to give rise to haploid gametophyte, called prothallus. The gametophyte produces archegonia and antheridia on the underside of the gametophyte. The fertilization is oogamous and requires water as it was in bryophytes to develop into a diploid zygote that develops into sporophyte.

Pteridophytes have important economic importance as they are used as food, fixing nitrogen, medicine, ornamental purpose and also helps in binding the soil.