

# Hair-cap moss - *Polytrichum*

## Scientific classification

Kingdom: Plantae

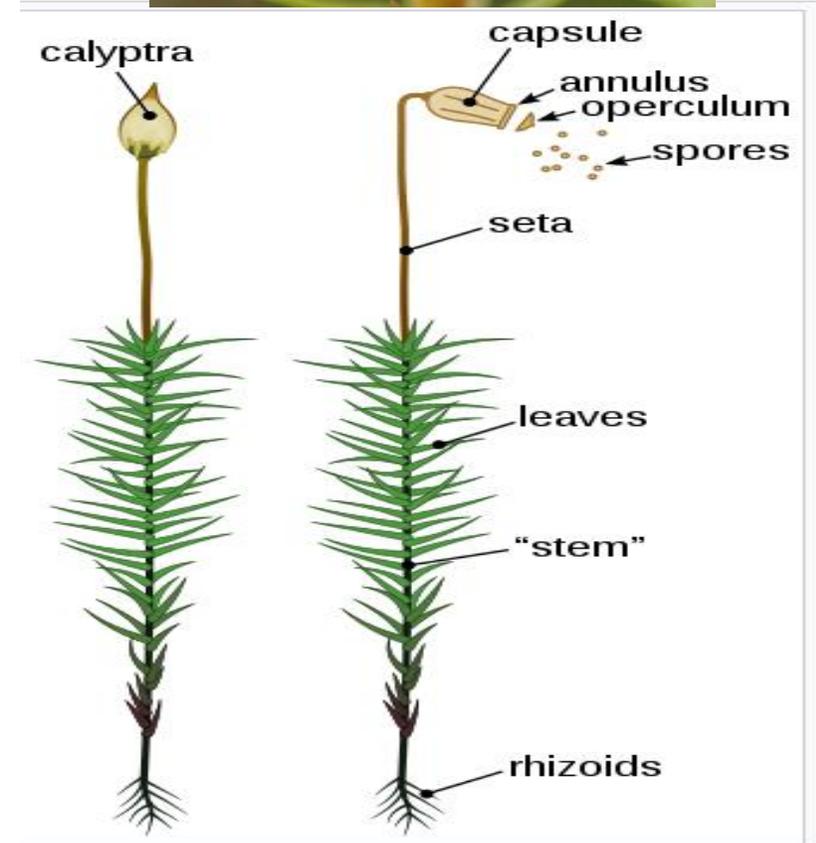
Division: Bryophyta

Class: Polytrichopsida

Order: Polytrichales

Family: Polytrichaceae

Genus: ***Polytrichum***  
Hedw.



## Occurrence

*Polytrichum* have worldwide distribution. They are very common in cool temperature and tropical regions. Plants live in cool and shady places.

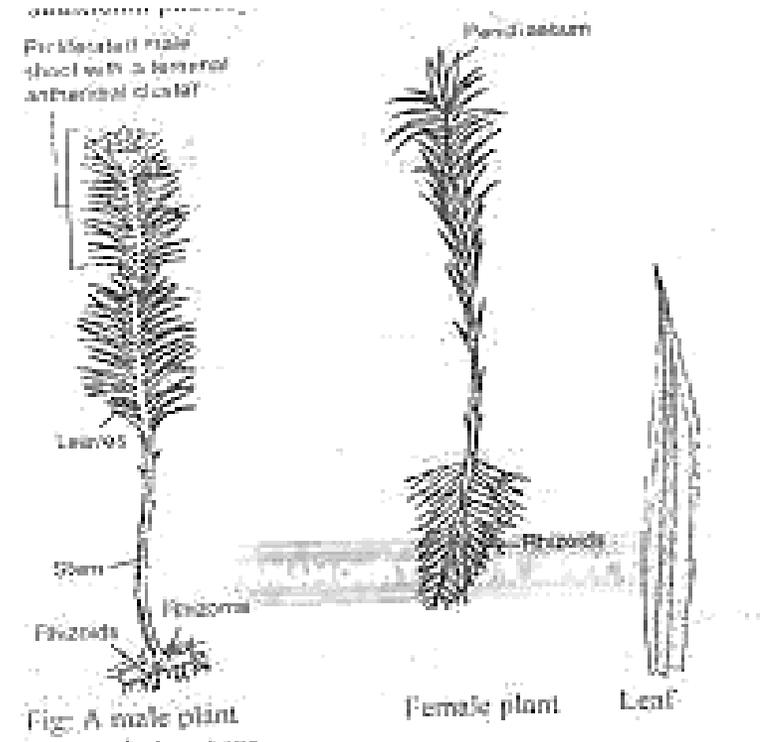
## General structure

The main plant body is gametophyte. The adult plant consists of two parts: rhizome and upright leafy shoot.

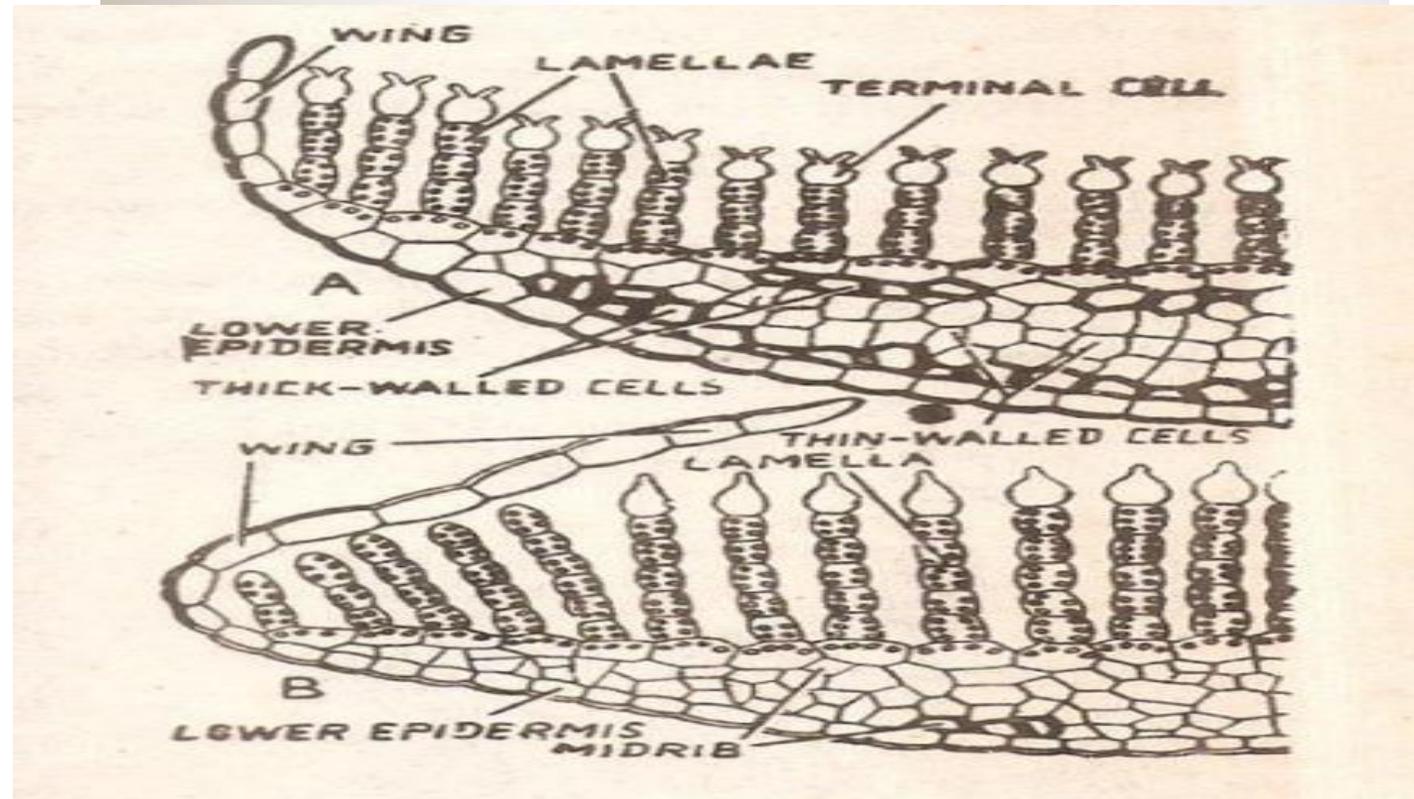
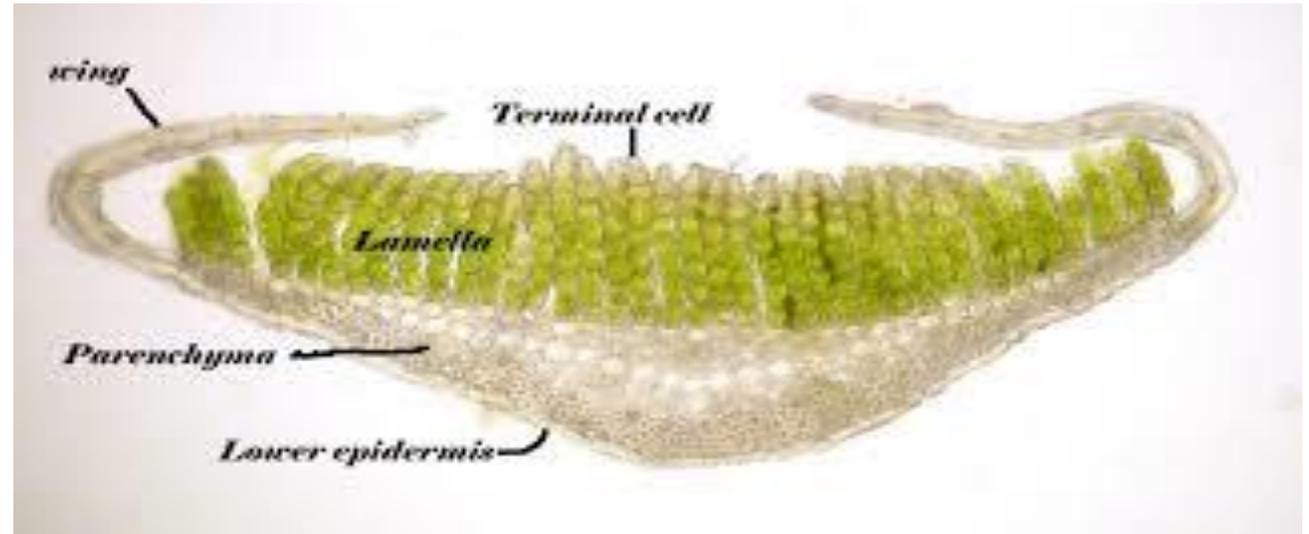
**1. Rhizome:** It is horizontal portion and grows underground. It bears three rows of small brown or colourless leaves. It also bears rhizoids. The cells are rich in protoplasm and oil globules.

**2. Upright leafy shoot:** The leafy shoots are much longer. It is the most conspicuous part of the plant. It arises from rhizome. These branches consist of central axis. These branches bear large leaves arranged spirally.

**3. Leaves:** Leaves have broad bases. Leaves in the upper portion are green. But the lower ones are brown. Each leaf has a broad, colourless sheathing leaf base and narrow distal limb. The mid-rib forms the major part of the leaf. These leaves possess extra photosynthetic tissue in the form of closely set vertical plates of green cells. These are known as lamellae. Green lamellae act as additional photosynthetic tissue.



**Leaf:** Polytrichum have complex internal structure. The mid-rib region is thick. But the margins are only one cell thick. The lower surface is bounded by epidermis. One or two layers of sclerenchymatous tissues are present above the epidermis. The central tissue of leaf is composed of thin-walled parenchymatous tissues. Above this are again sclerenchymatous cells. The upper surface is formed of a layer of large cells from which arise numerous lamellae. This upper portion is the main photosynthetic region of the leaf

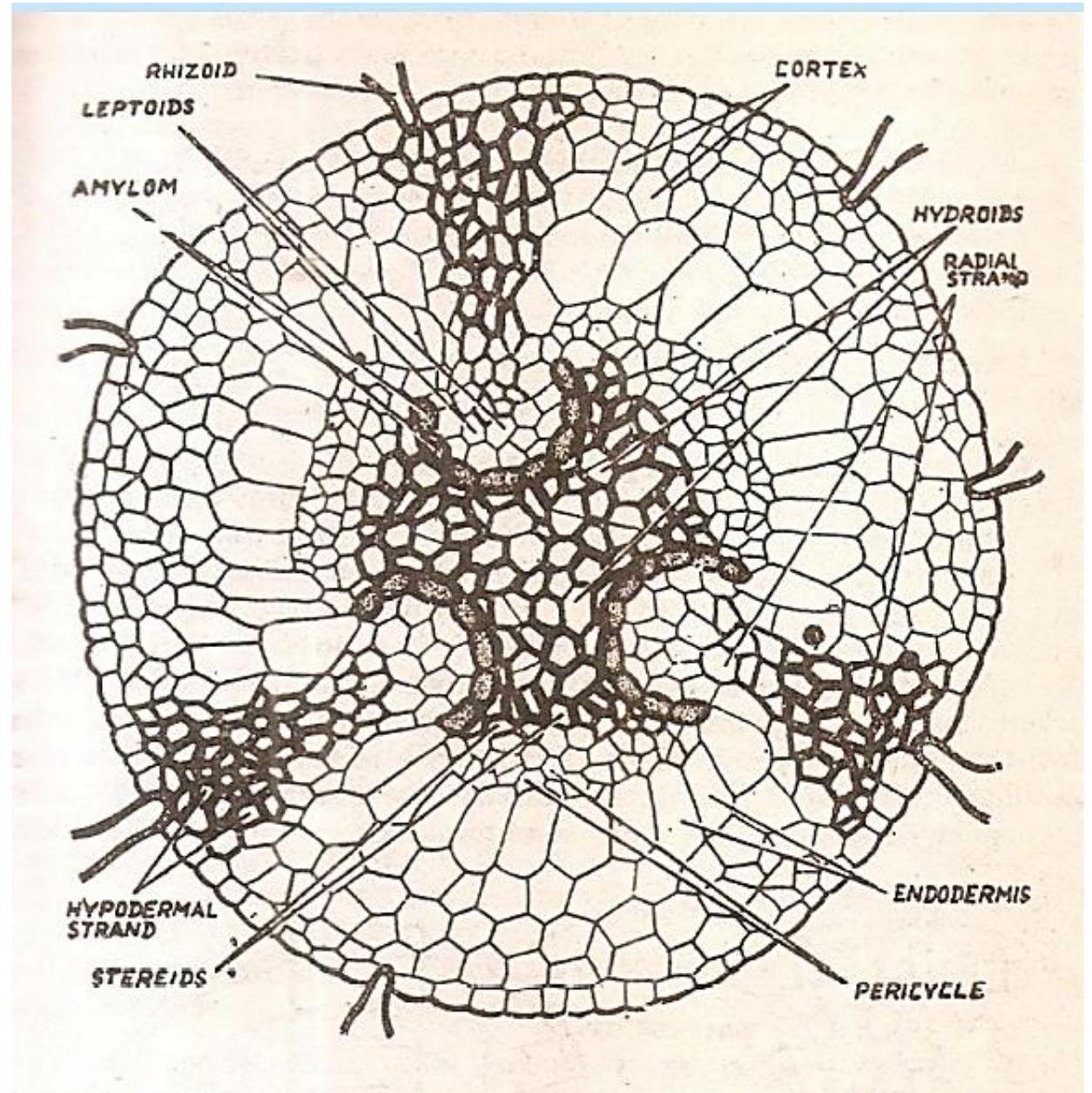


**A cross-section of a mature aerial stem shows three distinct regions:**

- i. A firm epidermis,
- ii. A comparatively thick cortex and
- iii. A central cylinder.

A few outer layers of cells of the cortex are thick-walled and dark-coloured like the epidermis, but more compact than the inner colourless parenchymatous ground tissue.

The central cylinder is composed of two tissue elements; thick-walled, dark-coloured cells with living protoplasts (steries) especially abundant towards the centre, and larger, thin-walled, empty cells (hydroids), almost destitute of protoplasm and resembling vessels of true vascular plants. Starch has been noted in the outer cells of the cortical region. This central cylinder is separated from the cortex by an incomplete pericycle-like sheath of thin-walled living cells. 'Leaf traces' are also present in the cortex and these are structurally similar to the central cylinder.

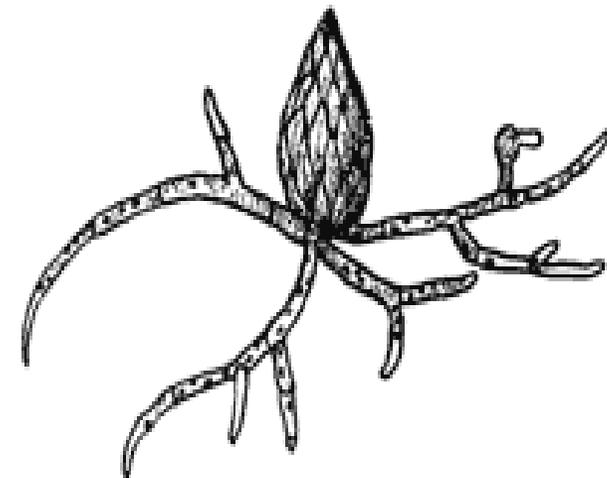
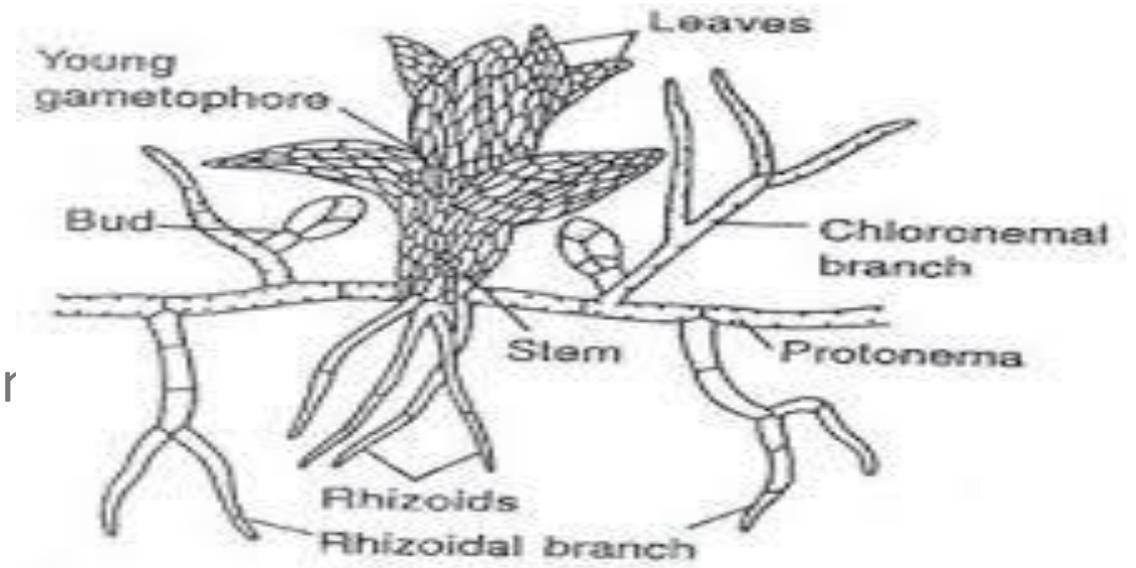


## Life cycle

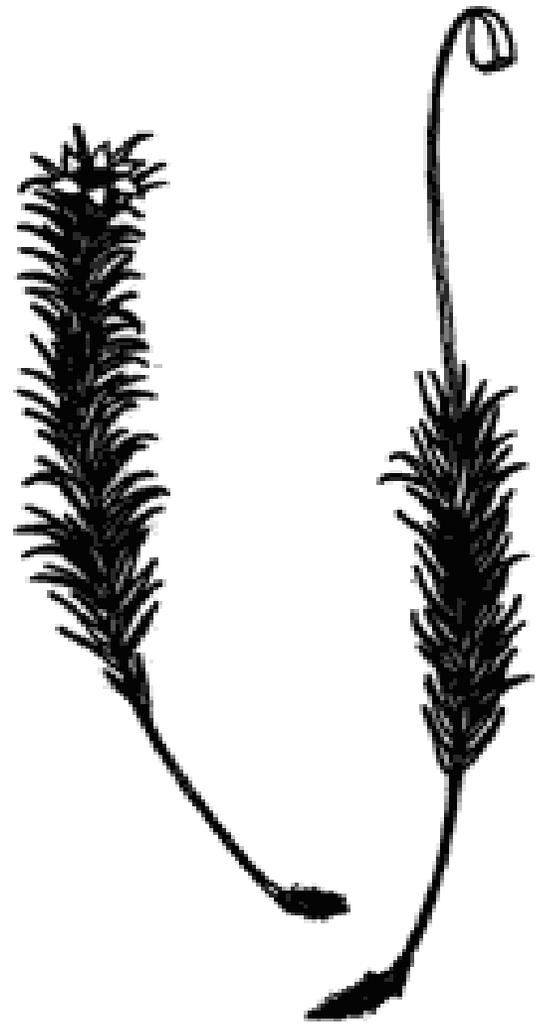
### Vegetative reproduction

Vegetative reproduction takes place by following methods:

- I. **Protonema:** The spores germinate to form protonema. Several buds grow on the protonema. Each bud by of its apical cell develops into gametophyte.
- II. These are also called vegetative buds. They are formed on the rhizoids.
- III. **Fragmentation:** The rhizome gives rise to erect leafy shoots at intervals. Death or breaking of shoots separates the erect branches. These branches behave as independent plants.



*A typical moss protonema with buds (magnified)*



**Polytrichum, showing both male and female gametophytes as separate plants**

additional photos...

Proliferated male shoot with a terminal antheridial cluster

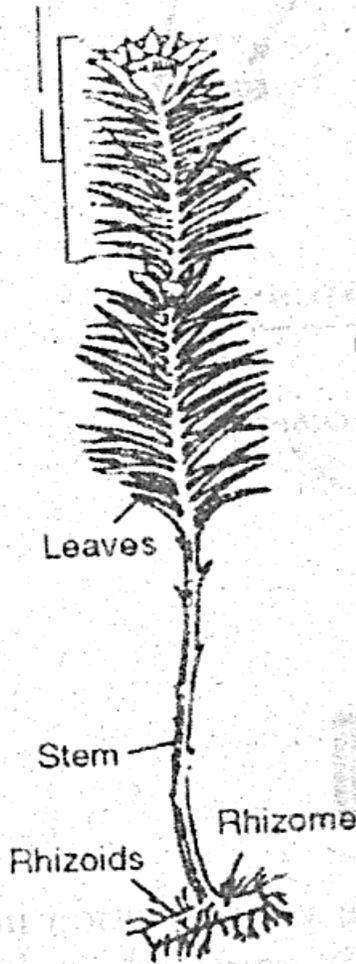


Fig: A male plant

Penchaetium



Female plant

## Sexual reproduction

Polytrichum is dioecious. Antheridia and archegonia occur on different plants.

### Antheridial head

The antheridia are borne in the axillary clusters at the tips of leafy stems. They are surrounded by a rosette of leaves called **perigonial leaves**. These leaves are different from the ordinary vegetative leaves. The perigonial leaves are spirally arranged. The antheridia are produced in groups in the axils of these leaves. Thus the antheridial head has different antheridial groups. **Paraphyses** also occur among the antheridia.

Mature antheridium is club-shaped. It is composed of a short stalk and a club-shaped body. Jacket is present around the capsule. Inside the jacket are present androcyte mother cells. They give rise to biflagellate sperms.

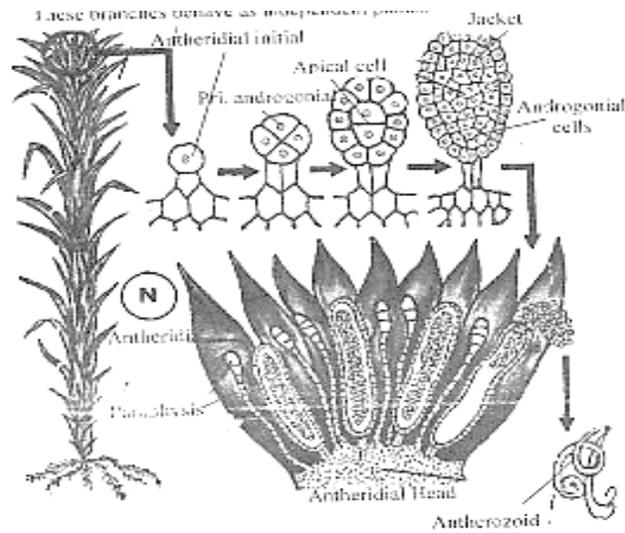
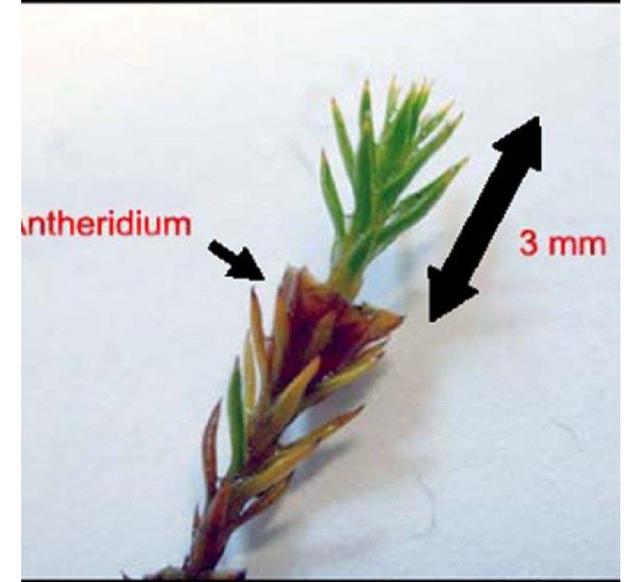
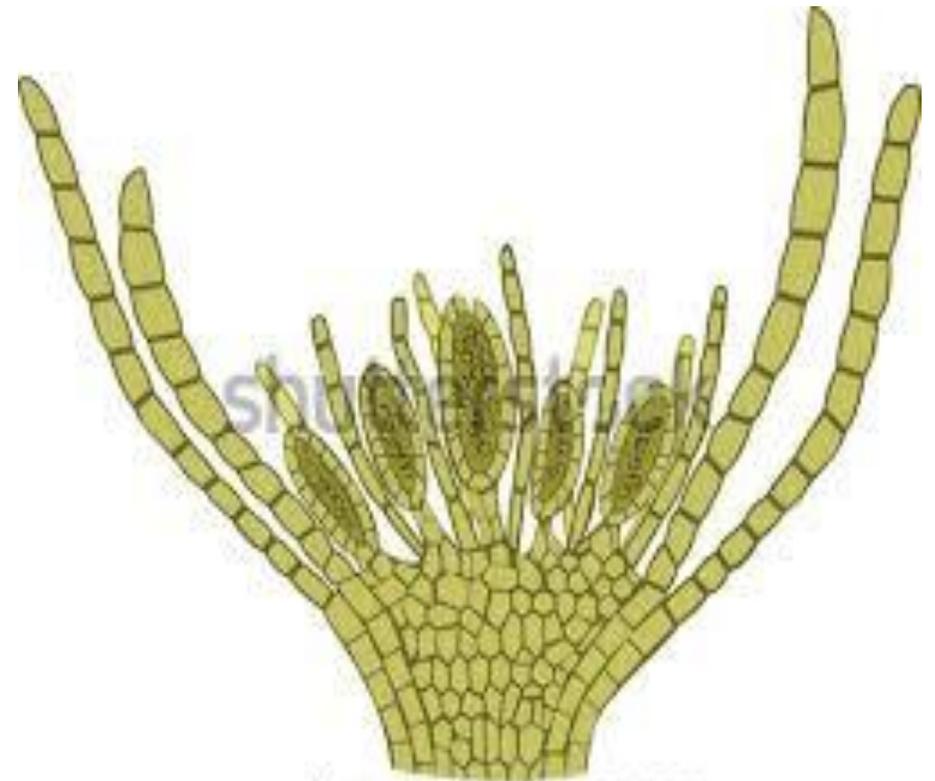


Fig. Male reproductive organs



## Development of antheridium

1. The antheridia arise from the embryonic cells at the tip of male shoot. The embryonic superficial cell forming antheridium is called **antheridial initial**. It increases in size. It undergoes transverse division to form lower primary stalk cell and the upper **antheridial mother cell**.
2. The primary stalk cell forms a few stalk cells. The antheridial mother cell divides to form an apical cell with two cutting faces. The apical cell cut off 3-4 segments. Now this apical cell functions as the **operculum cell**.
3. The last segment divides by two vertical divisions. It forms peripheral **jacket initials** and central **primary androgonial cells**.
4. The jacket initials further divide to form a single-layered jacket. The primary androgonial cells divide to form **androgonial cells**.
5. The last generation of primary androgonial cells is called the androcyte mother cells. Each androcyte mother cell gives rise to two coiled biflagellate sperms.
6. The antheridia always dehisce in the presence or when the operculum cell is thrown out and pore is formed at the apex. Sperm mass contained in mucilage comes out

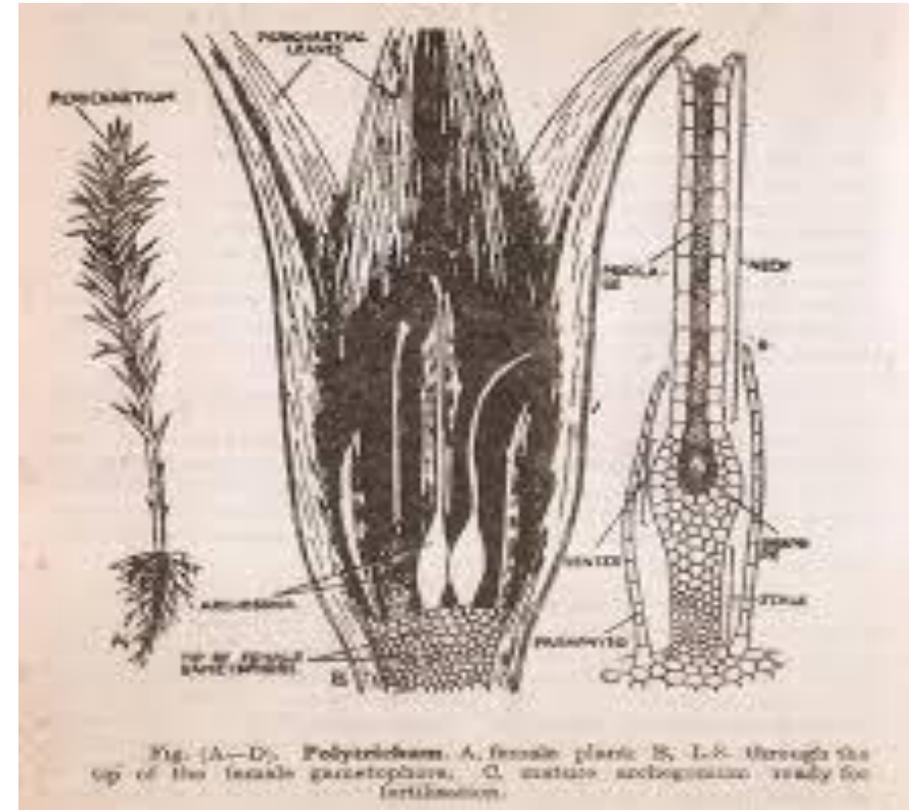


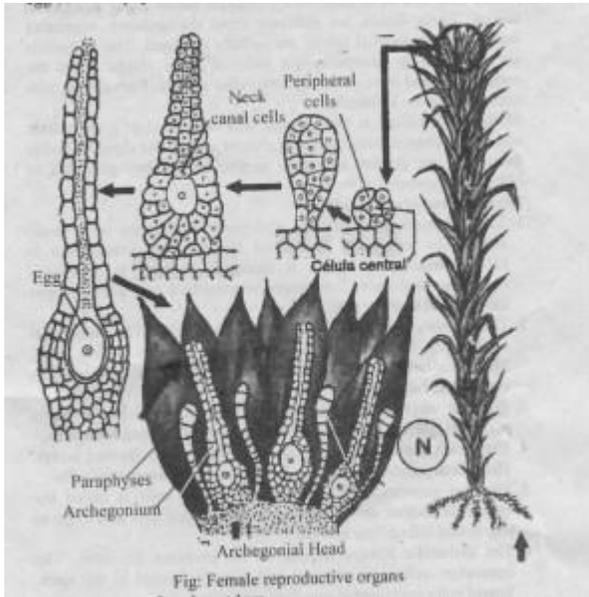
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## Archegonial head

The flask-shaped archegonia *are* borne at the apices of leafy stems. Archegonium is surrounded by **perichaerial leaves**. These leaves overlap to form a closed bud-like structure. The archegonia occur in cluster of 3 to 6.

Mature archegonium is flask-shaped. It has a thick multicellular stalk. The neck is long and twisted. It contains neck canal cells. The neck consists of 6-vertical rows of cells. Neck gradually merges into venter. Venter contains upper small venter canal cell and lower large egg cell. Paraphyses are absent.





## Development of archegonium

1. Any apical cell in the apical region acts as an **archegonial initial**. The archegonial initial enlarges. It divides by a transverse division to form lower **primary stalk cells** and upper **archegonial mother cell**.
2. The primary stalk cell forms a massive stalk. The archegonial mother cell forms the main body of archegonium. It undergoes three vertical divisions to form three peripheral cells surrounding an axial cell.
3. Three peripheral cells divide to form a 2-3-layered jacket around the venter. The axial cell divides transversely to form an inner central cell and an outer apical cell.
4. The central cell forms an upper small venter canal cell and a lower large egg cell. The apical cell divides to form a long neck which consists of six vertical rows of cells. The cells cut off from the base form neck canal cells.

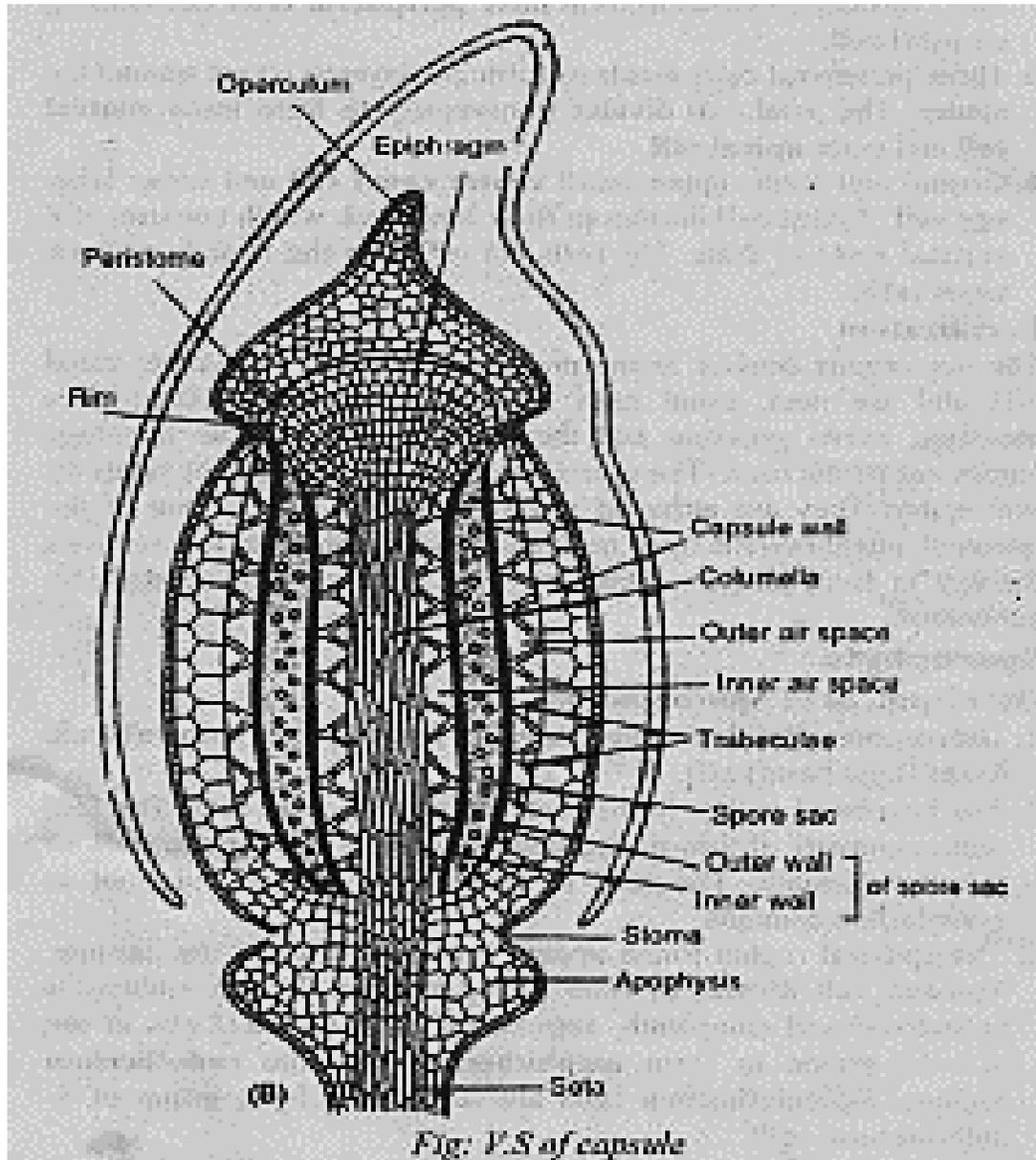
## Fertilization:

The sex organs dehisce in the presence of water. The venter canal cell and the neck canal cells dissolve to form mucilage. This mucilage exerts pressure and the neck opens out. The mucilage comes out of the neck. The sperms reach the archegonial heads by rain water. They are attracted towards the archegonia. One of the sperm swims down the open neck and reaches the base. It fuses with the egg to form an oospore. Oospore is the first stage of the sporophytic generation.

## **Sporophyte**

### Development of Sporogonium

- 1.** The oospore divides transversely to form upper (epibasal) and lower (hypobasal) cell.
- 2.** The hypobasal region forms foot and lower part of seta. The foot region consists of thin-walled cells. It is embedded in the stalk of the archegonium. The cells of the seta are larger and poor in cytoplasmic contents.
- 3.** The epibasal region forms upper portion of seta and the capsule. Epibasal cell divides to form young embryo. Young embryo is cylindrical and completely surrounded by calyptra. Cells of the embryo divide to form amphithecium and the endothecium regions. 8-amphithecium cells are surrounded by a group of 4- endothecium cells.
- 4.** Endothecium forms central conducting strands of apophysis. It forms columella and spore sac of theca. It also forms membranous tissues of the operculum. The outermost layer of endothecium forms archesporium or spore mother cells. These cells divide meiotically to form haploid spores.
- 5.** The amphithecium divides to form seven rings of cells. These cells give rise to spongy tissues and epidermis of apophysis. They also form outer wall of theca.



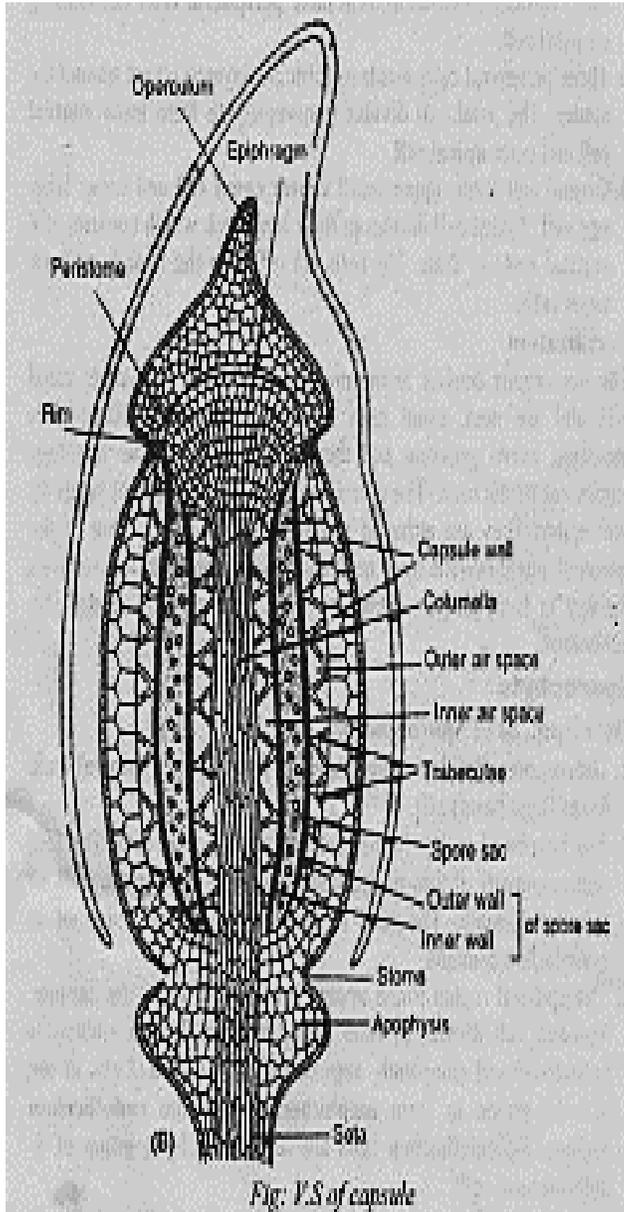
## Structure of Mature Sporogonium (Sporophyte)

The mature sporogonium is differentiated into foot, seta and capsule.

**Foot:** The foot is buried deep in the tissue of gametophyte. It is absorptive in function. It consists of thin-walled narrow cells containing dense cytoplasm.

**Seta:** The seta is several inches long. It carries the capsule high into the air. It also conducts water and food. It consists of epidermis, cortex and central conducting strands.

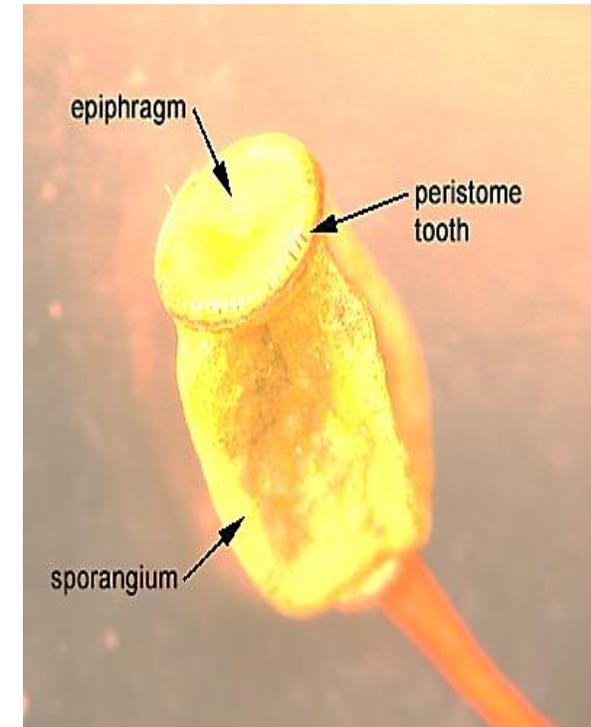
**Capsule:** The upper part is capsule. It is differentiated into three regions: apophysis, theca and operculum.



**1. Apophysis:** It is the lower part of capsule. It is continuous with the seta. It is in the form of a swollen ring-like protuberance. Its cells are thin-walled, green and loosely arranged. The apophysis is the main photosynthetic region of the capsule.

**2. Theca:** It is the middle part of the capsule. It is four-lobed. Its wall is several layered. The outermost layer is epidermis. Trabecular air spaces are present inside the wall layers. These spaces have filaments of thin-walled elongated cells containing chloroplasts. Outer spore sac wall is present internal to outer trabecular spaces. This is followed by spore-sac proper. Then 2-layered inner spore-sac wall is present. Then inner trabecular air space is present. The center is occupied by solid **columella**. All the sporogenous cells are fertile and form spores after reduction division.

**3. Operculum:** This is the uppermost part of the capsule. It is conical. The operculum is covered by **calyptra**. The calyptra forms a hairy structure. So Polytrichum is also known as **hair moss**. A constriction is present between operculum and theta. A **rim or diaphragm** is present at the base of this constriction. The columella of the theca is continuous into the operculum. It expands into a fan-shaped **epiphragm**. **Peristome** is present in the form of a thick rim. It bears a number of rigid teeth. The epiphragm fills the space inside the ring of peristome teeth and is attached to their tips. Peristome teeth arise from the rim or diaphragm.

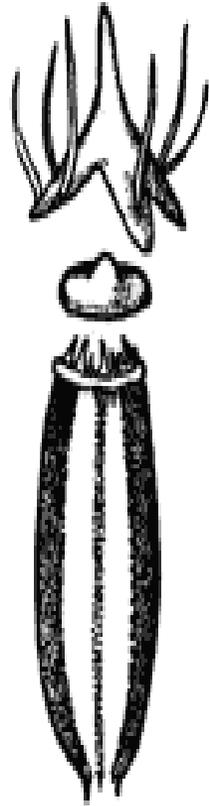


## Dispersal of spores

Cells of the epiphragm dry up during dry conditions. It separates the operculum.

The calyptra falls.

Epiphragm also dries up between the peristome pores. The central tissue of theca region except the spores degenerates. Thus the spores lie free in the centre of the capsule at maturity. Spores come out through pores. They are dispersed by wind.

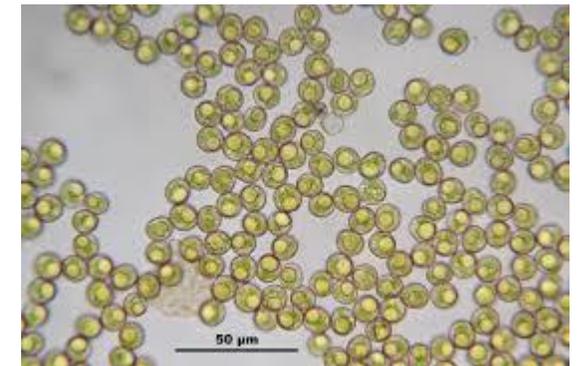


*A spore capsule with calyptra and operculum lifted, peristome teeth ready to assist in dispersal of spores*

## Structure and germination of spores

The spores are yellow. Each spore is uninucleate and has two wall layers. The outer layer is **exosporium** (exine). The inner layer is **endosporium**. The spore germinates under favourable conditions.

Exosporium ruptures and endosporium comes out. It forms protonema. Protonema develops many buds. These buds produce new moss plants.



## The Gametophyte of Polytrichum:

The gametophyte is differentiated into two portions – a prostrate and much-branched alga-like filamentous portion, the protonema, and an upright persistent leafy shoot, the gametophore.

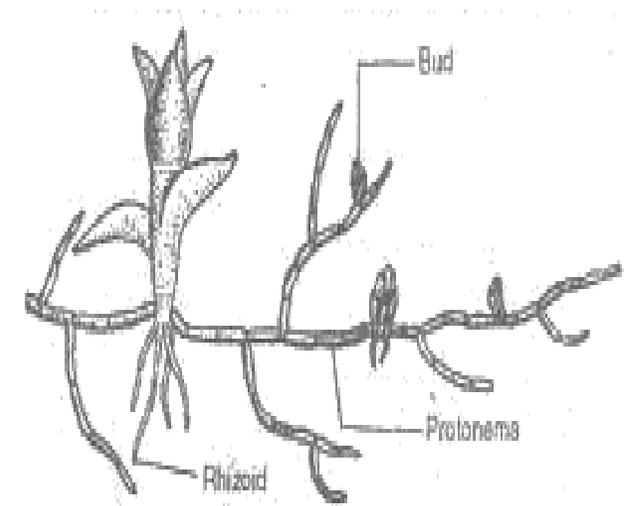
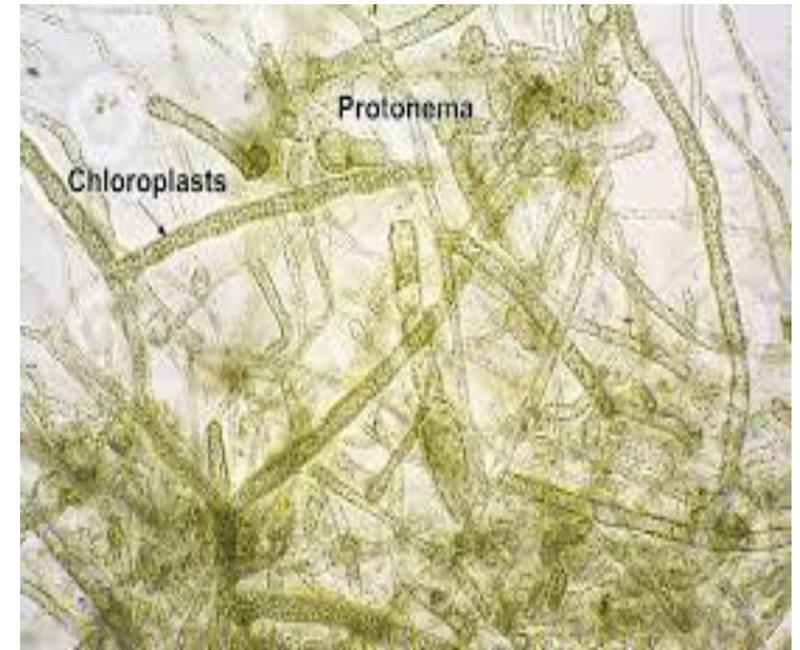
### The filamentous protonema is transitory and shows two kinds of branches:

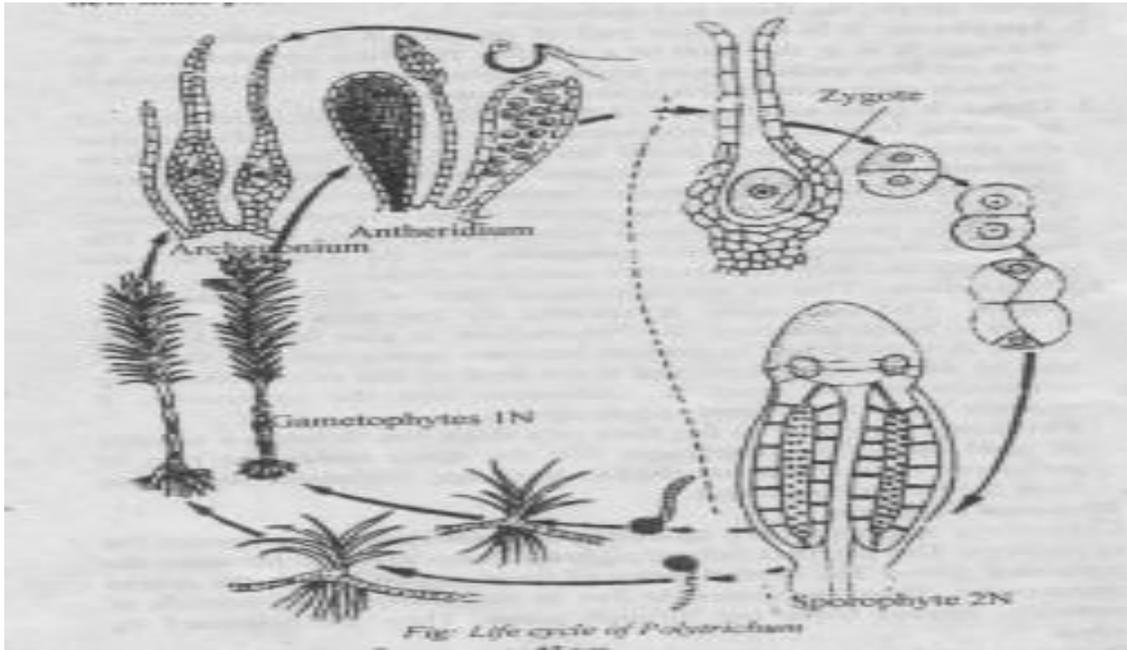
- i. The ordinary green ones with straight transverse septa, and
- ii. The brown-walled ones with strongly oblique septa, the rhizoids.

If abundant moisture is present, this protonema grows to a considerable extent and sooner or later there arise, from its distal end of the cells, lateral pear-shaped multicellular cell-masses (buds), from each of which a leafy gametophore is produced.

The gametophore, which is independent at maturity, often reaches a height of 20-40 cm. and is always differentiated into an angular stem and closely-set, thick, rigid, spirally arranged leaves (with angular divergence  $5/13$ ,  $14/34$ , etc.). The leaves are small, very numerous, lanceolate to linear in outline, and with a very broad and strong midrib, projecting beyond the apex of the lamina.

The lamina which develops only at the extreme margin of the midrib is usually more or less incurved. A leaf, when viewed with a pocket lens, shows that, as if, there are several narrow mid-ribs. But when sectioned and examined under microscope, these are found to be thin vertical plates of chloroplast-containing cells, the lamella, along the middle region of the leaf and are the incurved margins of the lamina, which protect them in dry weather. At the base of the shoot numerous rhizoids develop and these often become closely twisted together to form cable-like strands.





## Alternation of generation

Polytrichum shows heteromorphic alternation of generation.

**1 Gametophyte:** The plant body is gametophytes. Gametophyte is haploid. It develops antheridia and archegonia.

Antheridia produce antherozoids and archegonium produces egg. Antherozoids fuse with egg to produce diploid oospore.

**2. Sporophyte:** The oospore is the first stage of sporophyte generation. It is diploid generation. Sporophyte has three parts: foot, seta and capsule. Haploid spores are produced in the capsule by meiosis. Spore is the first stage of gametophyte. Spores germinate to produce protonema stage. It gives rise to mature gametophyte completing the life cycle.

