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Gametophyte of Psilotum:

Germination of the Spore and Development of Gametophyte:

Germination starts after four months on placing the spores on a suitable substratum. The first sign of germination is the splitting of the outer spore wall and the projection of a small tubular outgrowth.

Later a cross wall cuts off the outgrowth from the remainder of the spore. In this way two cells are formed. Of the two cells, the upper by further divisions establishes an apical cell which produces a mass of tissue. Early in the development, the gametophyte gets infected by the fungus.

Structure of the Mature Gametophyte:

The gametophyte is partly or totally subterranean. It is usually cylindrical in shape with dichotomous branches. The branching however need not be always dichotomous. In size, the gametophyte ranges from 0.5 to 2 mm. The colour of the gametophyte is usually dark brown. This is due to the presence of endophytic fungus.

The gametophyte is wholly parenchymatous with strongly cutinised cell walls. The outermost layer of the cells gives rise to a number of rhizoids. In the hypodermal region the cells have the endophytic fungus. According to Beirhorst (1953) the fungus is probably *Cladochytrium tmesepteridis*. The cells are achlorophyllous and the nutrition of the gametophyte is saprophytic.

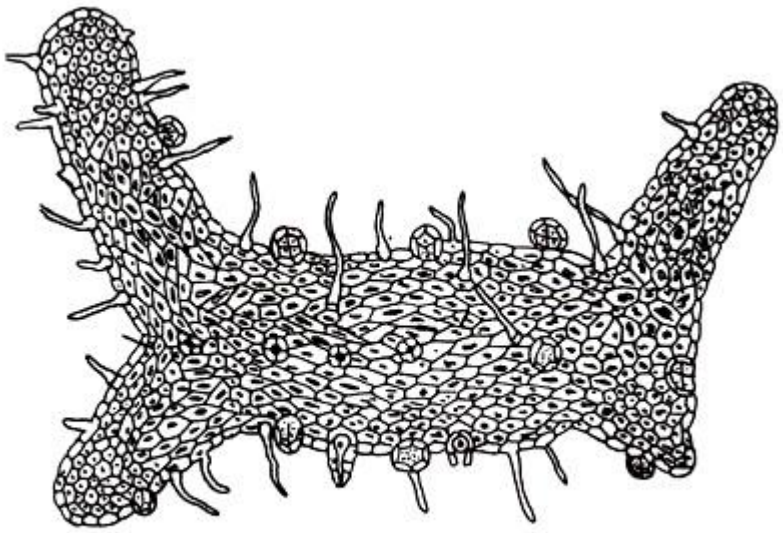

Fig. 26. *Psilotum*, Gametophyte of *P.nudum*

Internal Structure of the Gametophyte:

A transverse section of the mature gametophyte shows that it is wholly parenchymatous. Some of the superficial cells give rise to rhizoids. The outer walls, radial walls and even the inner corner of the walls of the peripheral cells are highly cutinised. Mycorrhizal association is found in some of the cells. The central region of the gametophyte also consists of parenchyma with no trace of any vasculature.

Reproduction:

The gametophyte reproduces by two methods

(1) Vegetative propagation and

(2) Sexual reproduction.

(1) Vegetative Propagation:

Holloway (1939) and Bierhorst (1953) have described the production of gemmae on the surface of the gametophyte. The gemmae arise as proliferations from a rhizoid like structure and are similar to those produced on the rhizome.

A mature gemmae has 8-12 cells, usually spheroidal or occasionally flattened and on germination gives rise to a new gametophyte.

(2) Sexual Reproduction:

This is brought by the formation of antheridia (male) and archegonia (female). The gametophytes are monoecious.

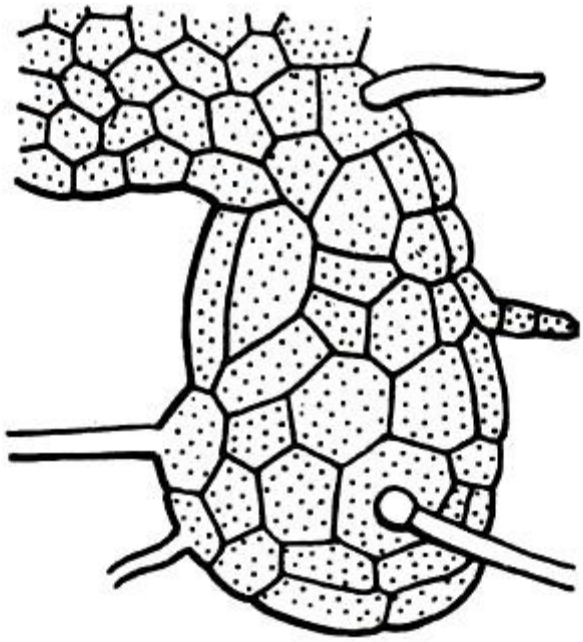

Fig. 27. *Psilotum* : Gametophytic Gemma of *P.nudum*

Development and Structure of the Antheridium:

The antheridium develops from a superficial cell called and anthcridial initial. This undergoes a periclinal division to form two superposed cells (Fig.28a). Of the two cells the outer cell is called the jacket initial and the inner cell is called the primary androgonial cell. The primary androgonial cell divides in all the planes to form a large number of cells. Meanwhile, the jacket initial divides anticlinally to form a jacket layer, one cell in thickness.

The androgonial cells divide further to form the androcytes. These androcytes metamorphose themselves into spirally coiled multi-ciliate antherozoids. When

the antheridium is reaching maturity it bulges out from the surface of the gametophyte.

A mature antheridium is somewhat spherical in shape and projects out of the gametophyte as a hemispherical protruberance. The jacket is made up of about 12 cells and has a special cell called the opercular cell which degenerates at maturity allowing for the liberation of the antherozoids. Approximately about 250 antherozoids are found inside the antheridium.

Development and Structure of the Archegonium:

The archegonia are also produced from the superficial cells of the gametophyte. A superficial cell which is destined to form an archegonium is called an archegonial initial. This undergo periclinal division to form an outer primary cover cell and an inner central cell.

The primary cover fell divides twice vertically where the second division is at right angles to the first one to form four quadrately arranged cells called the neck initials. A long sectional view at this stage however, reveals two neck initials and a central cell. The central cell subsequently extends in between the neck initials so as to form an elongated structure. The neck initials divide several times transversely to form an archegonial neck 4-7 cells in height.

As the archegonial neck is elongating the central cell keeps pace with it by extending into the neck. After sometime the central cell divides transversely to form an upper primary neck canal and a lower primary venter cell. The primary canal cell divides once to form two neck canal cells, whereas the primary venter cell divides once transversely to form an upper short-lived venter canal cell and a lower egg cell with a prominent nucleus.

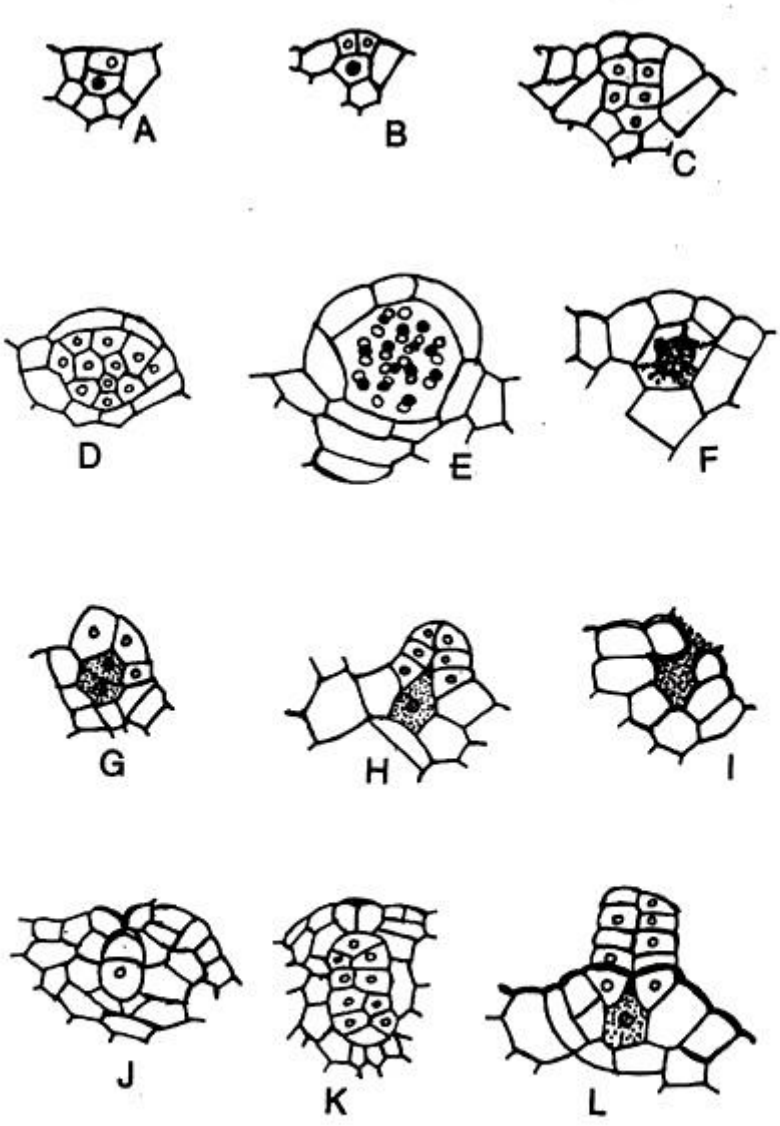

Fig. 28. *Psilotum* : Development of Sex Organs in the Gametophyte of *P.nudum*; A-E. Antheridium, F-J Archegonium, K-I. Archegonium and embryo respectively

As the archegonium is reaching maturity, the neck canal cells degenerate. In some cases they degenerate as soon as they are formed. In a mature archegonium; some of the terminal tiers of the neck slough off leaving only the basal one or two tiers. At this stage except for egg all other cells in the archegonium disintegrate.

Fertilization:

The antherozoids come out of the antheridium through the passage formed by disintegration of the opercular cells. They swim in a thin film of moisture, approach the archegonium, enter into it and fertilize the egg.

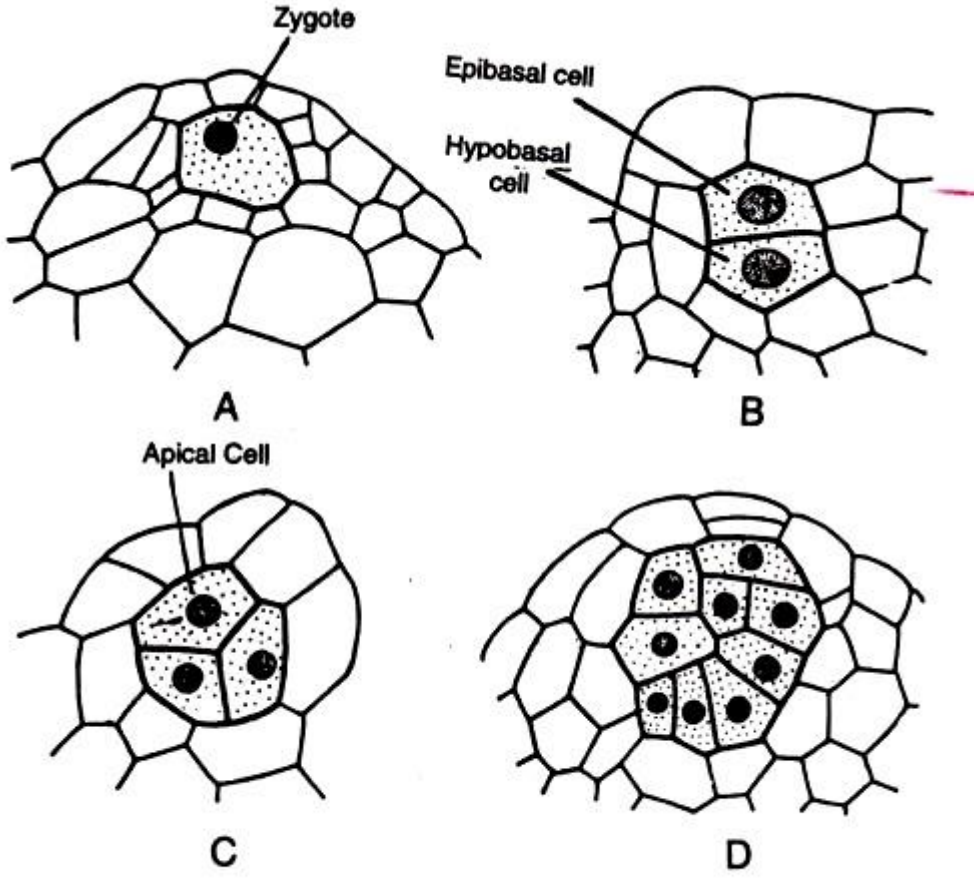

Fig. 29. *Psilotum* : Stages in early Embryogeny of *P. nudum*

Embryogeny:

Soon after fertilization, the zygote enlarges in the cavity of the venter. First division of the zygote is transverse and it results in forming an upper epibasal cell (cell nearer to the archegonial neck) and a lower hypo basal cell (cell away from the archegonial neck). The hypo basal cell gives rise to the foot and the epibasal cell gives rise to shoot.

This type of embryogeny, where the shoot apex is pointed towards the archegonial neck is called exoscopic. There is no formation of root or

cotyledons. The hypo basal cell divides in all the planes to form a bulbous foot which gives rise to haustorial outgrowths into the gametophyte.

Meanwhile, the divisions in the epibasal cell result in the formation of a three sided apical cell. By the activity of this apical cell the shoot apex projects out of the gametophyte. At this stage it gets infected with the mycorrhizal fungus. This assures independent nutrition to the young sporophyte.

When the young sporophyte is about 8-10 mm long, it detaches from the gametophyte and leads an independent life. In the beginning it is subterranean, later some of the branches grow Apo geotropically and form the aerial shoots.

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