Marsilea

By

Dr. P. C. Srivastava
Botany Department , ECC
Prayagraj

Classification

Division : Polypodiophyta
Class: Filicopsida
Subclass: Hydropterangiatae
Order: Marseliales
Family: Marseliaceae
Genus: *Marsilea*

Common name: Water fern

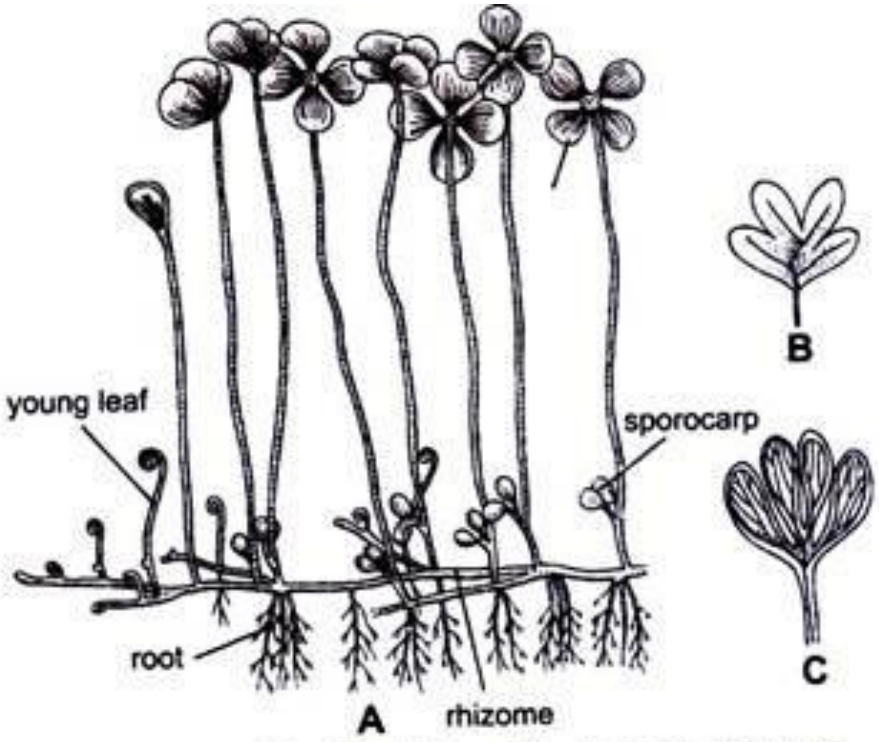
Distribution, Habit and Habitat: About 53 species, cosmopolitan in distribution but abundantly found in tropical countries like Africa and Australia. About 9 species have been reported from India.

Species are hydrophytic they grow rooted in mud or marshes and shallow pools or are completely submerged or partially or entirely out of water in wet habitats.
M. hirsuta is an Australian xerophytic species.
M. hirsuta and *M. quadrifolia* are two most common Indian species usually found growing in marshy places, wet soil or near muddy margins of ponds.

Sporophytic plant body

Herbaceous mature plant body differentiated into root, rhizome and leaves.

Rhizome: Rhizome creeping on or just beneath the soil surface, slender, dichotomously branched with distinct nodes and internodes and is capable of indefinite growth in all directions as a result of which it occupies an area of 25 metre or more in diameter.
In aquatic species the internodes are long while in sub-terrestrial species they are short. Usually from the upper side at nodes, the leaves are given out while from their lower side, the roots.



Marsilea. External features. A. External morphology; B. Leaf showing arrangement of segments as a result of three dichotomies, C. Pinna showing venation.

Roots: The roots are adventitious, arising from the underside of the node of rhizome, either singly or in groups. In certain cases the roots are given out even from the internodes (M. aegyptiaca).

Leaves:

Leaves are borne alternately on upper side of rhizome at nodes, in two rows. Young leaves show circinate vernation (like ferns) (Fig. 1 A). In some species young leaves are covered with multicellular hairs. The leaves are pnnately compound in young stage while at maturity show cruciate arrangement with basal petiole and terminal obovate lamina. The shape of pinna varies from obovate to obcuneate and margin also varies from entire to crenate or crenate to lobed. Veins forked showing rare anastomoses.

In submerged plants the petiole is a long and flexible structure and the lamina floats over the surface of water but in muddy or marshy plants the petiole of the leaf is short and rigid with short lamina spreading in the air.

Sometimes the pinnas are once or twice deeply dichotomously lobed (M. biloba) or toothed (M. minuta). At night the pinna are folded upwardly. This is known as sleeping movement of pinna. Near the base of petiole the stalked bean-shaped sporocarps are borne.

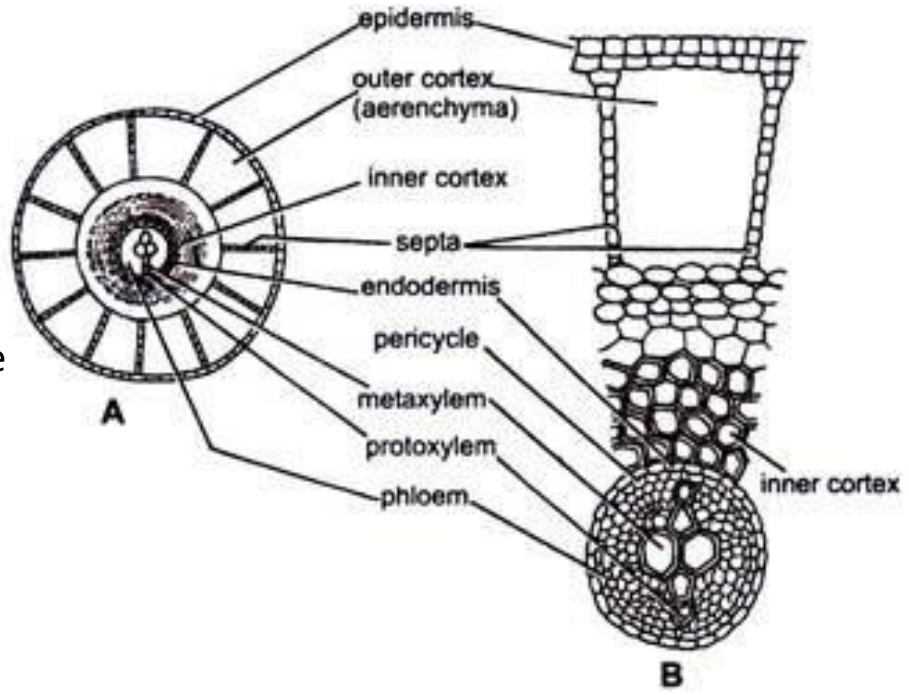
Anatomy of root

T. S. of root is somewhat circular in outline and can be differentiated into epidermis or piliferous layer, cortex and stele.

(i) Epidermis: It is the outermost, parenchymatous, single layered covering.

(ii) Cortex: It can be differentiated into two parts: outer cortex and inner cortex. The outer cortex consists of large air chambers arranged in the form of a ring (parenchymatous). These chambers are separated from each other by longitudinal septa. The inner cortex is differentiated into outer parenchymatous and inner sclerenchymatous regions. The inner cortex is delimited by single layered thick endodermis.

(iii) Stele: It is of protostelic type and occupies the central position. It is devoid of pith. Xylem is situated in the centre which is diarch and exarch. It is surrounded by phloem. The phloem is bounded externally by a single layer of pericycle.

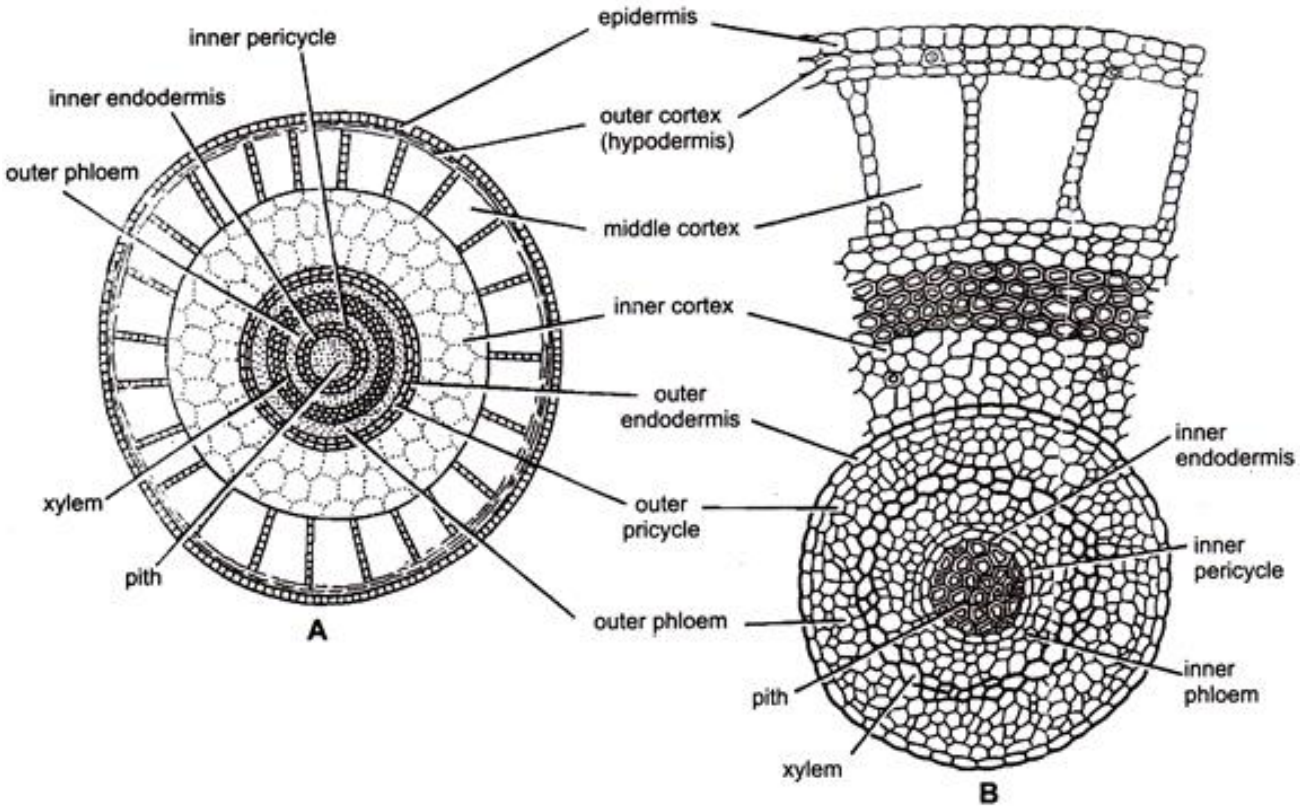


***Marsilea* T.S. Root**

Anatomy of Rhizome

T. S. of the young rhizome shows a protostelic structure i.e., pith is absent and xylem is completely surrounded by phloem but in the old stem pith is developed in the centre and the stele is amphiphloic siphonostelic type.

(i) Epidermis: It is the outermost limiting layer of single celled thick parenchymatous cells. The stomata are absent.



Marsilea. **Internal structure of rhizome. A. Diagrammatic, B. A part cellular.**

(ii) Cortex:

It is differentiated into three regions

Outer cortex: It is parenchymatous and may be one to several cells thick. Some of its cells contain tannin.

Middle cortex: It consists of large air spaces (chambers) separated by one cell thick parenchymatous septa. In the xerophytic species e.g., aegyptiaca the air chambers are obliterated.

Inner cortex: It is a solid tissue of several cells thickness. The outer layers are thick walled (sclerenchymatous) while the inner layer of cells is thin walled (parenchymatous) and compactly arranged. Some of these cells are filled with starch or tannin.

(iii) Stele:

Stele is amphiphloicsiphonostele i.e., in the centre there is a pith which may be either parenchymatous (aquatic species) or sclerenchymatous (terrestrial muddy species). Xylem is present in the form of a complete ring which is surrounded on both sides by a complete ring of inner and outer phloem, pericycle and endodermis.

In this way the continuation of different tissues in the form of complete ring in stele is as follows— outer endodermis, outer pericycle, outer phloem, xylem, inner phloem, inner pericycle and inner endodermis. The protoxylem may be well defined exarch (M.vestita) or mesarch (M.aegyptiaca) or ill defined (M.quadrifolia).

A T. S. of the nodal region shows an amphiphloicsolenostelic condition and is provided with one leaf gap.

T. S. of Petiole:

A T. S. of the petiole is somewhat circular in outline and is differentiated into epidermis, cortex and stele.

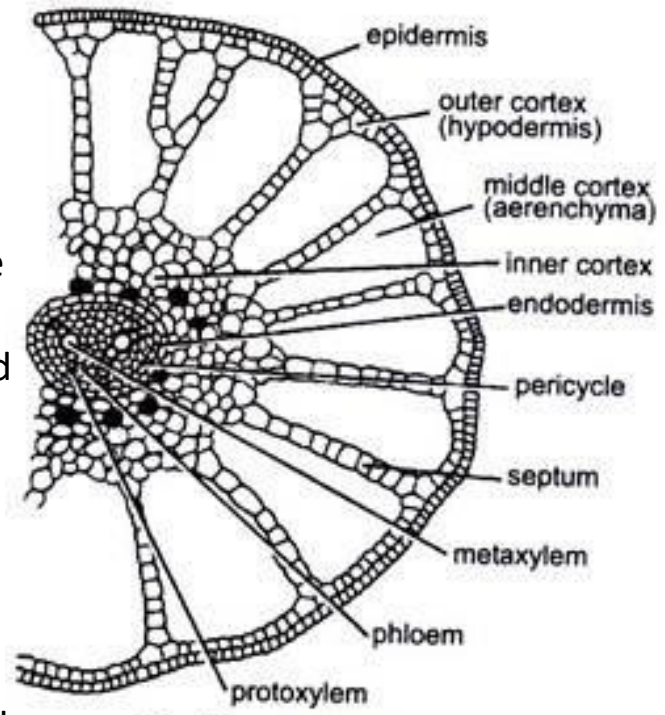
Epidermis: It is the outermost layer of single cell thickness. The cells are parenchymatous and slightly elongated.

Cortex: It is differentiated into three regions: The outer cortex, the middle cortex and the inner cortex.

(a) Outer cortex: It is present just below the epidermis, (also called hypodermis). It is made of thin walled cells (parenchymatous).

(b) Middle cortex: It lies below the hypodermis and called aerenchyma. It consists a ring of air chambers. The air chambers are separated by single layered partitions of thin-walled parenchymatous cells.

(c) Inner cortex: It is a solid tissue of several cells thickness. The cell layers are parenchymatous and contain starch and tannin filled cells. In M.minuta few sclerenchymatous layers are also present just inner to middle cotex.



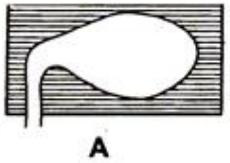
Marsilea quadrifolia. T.S. of petiole

Stele: It is somewhat triangular in outline and is of protostelic type i.e. pith is absent. Xylem is "V" shaped with 2 distinct arms. Each arm is provided with metaxylem elements in the centre and protoxylem is situated at both the margins i. e., protoxylem is exarch. The xylem is surrounded on all sides by phloem. Phloem is externally surrounded by a single layer of parenchymatouspericycle which, in turn, is bounded by a single layered endodermis.

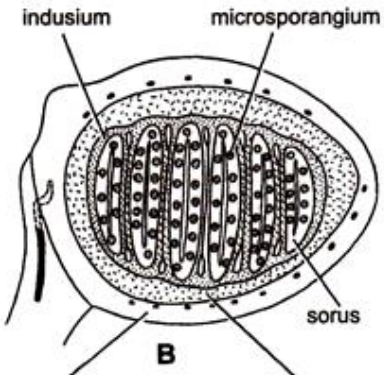
Structure of Sporocarp

Each sporocarp is an oval or bean shaped biconvex, flattened structure. It is green and soft when it is young but at maturity it becomes very hard and brown in colour. It is made up of a short stalk like structure known as peduncle and the body.
The point of attachment of peduncle with the body is called raphe . Slightly above the raphe in a median plane are present 1 or 2 protuberances called tubercles. They are unequal in size and lower one is stouter than the upper one. In some cases the tubercles are absent e.g.,M. polycarpa.
Wall of Sporocarp:It is very hard, thick and highly resistant to mechanical injury. It can be differentiated into three zones—outer epidermis, middle hypodermis and inner parenchymatous zone. Epidermis is single layered made up of broad and columnar cells. Its continuity is broken by the presence of sunken stomata. There is a genlatinous ring in the median plane in vertical orientation

Internal Structure: The sporocarp consists of two equal halves, each containing mixed sori protected by vertically elongated indusia forming soral sacs. In each soral sac the placenta is vertically elongated originating from outer wall with megasporangia arranged in a vertical row and microsporangia below each megasporangium in a ring. Each megasporangium produces single megasopre while each microsporangium produces numerous microspores.

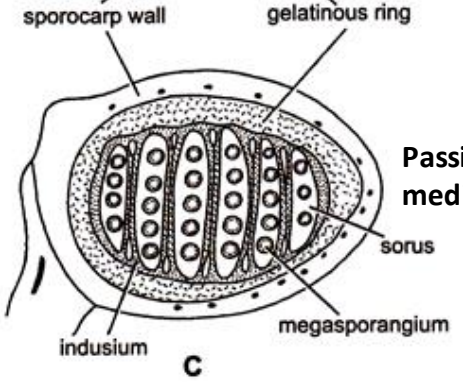


A



B

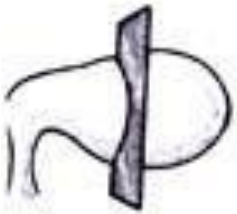
Passing slightly away frommedian plance



C

Passing strictly through median plance

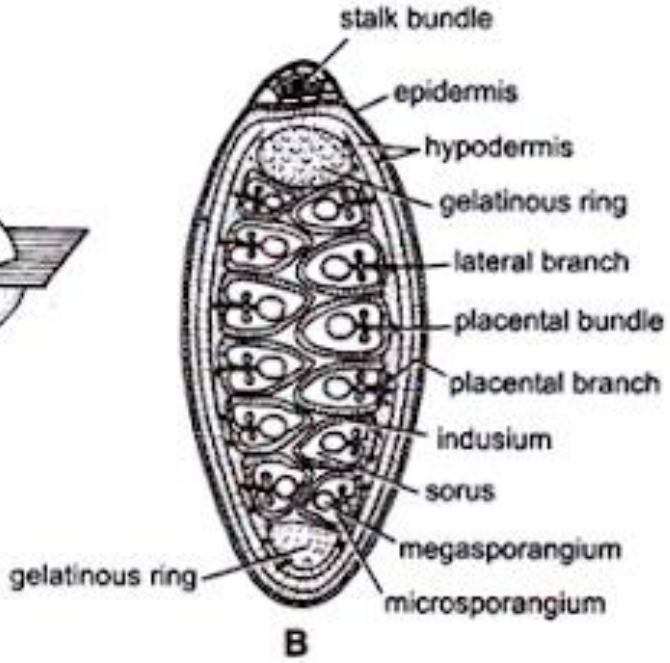
VLS sporocarp



A

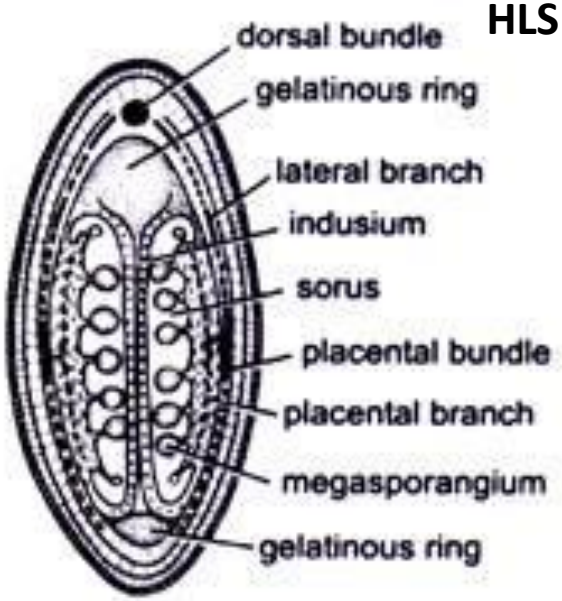
VTS sporocarp

A



B

HLS sporocarp



B

Morphological nature of sporocarp

Morphological nature of the sporocarp:

As regards the morphological nature of the sporocarp, the interpretations have been given by various workers from time to time. There are two main hypotheses:

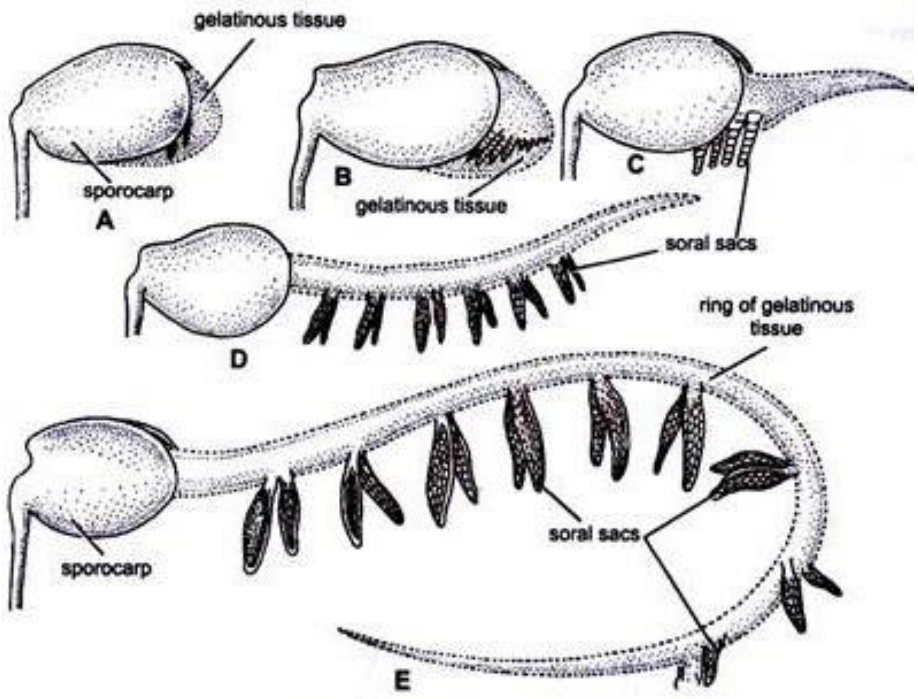
1. Leaf-segment or laminar hypothesis

The sporocarp of Marsilea has been interpreted as a lateral modified segment of the leaf. According to Bower (1926), Busgen (1890), Campbell (1905) leaf segment or laminar hypothesis envisages that the sporocarp has been interpreted homologous with a modified fertile segment from the lower part of a leaf.

2. Petiolar or whole leaf hypothesis-Johnson (1898, 1933) has interpreted the sporocarp to be homologous with an entire leaf.

The argument for the latter interpretation by Johnson is that the apical growth of a sporocarp resembles to that of an entire leaf rather than to of a leaflet or leaf-segment. The leaf-segment or laminar hypothesis is supported by several workers and seems to be more correct. This hypothesis has been discussed in detail in the following lines:

Dehiscence of Sporocarp and liberation of mega- and microspores

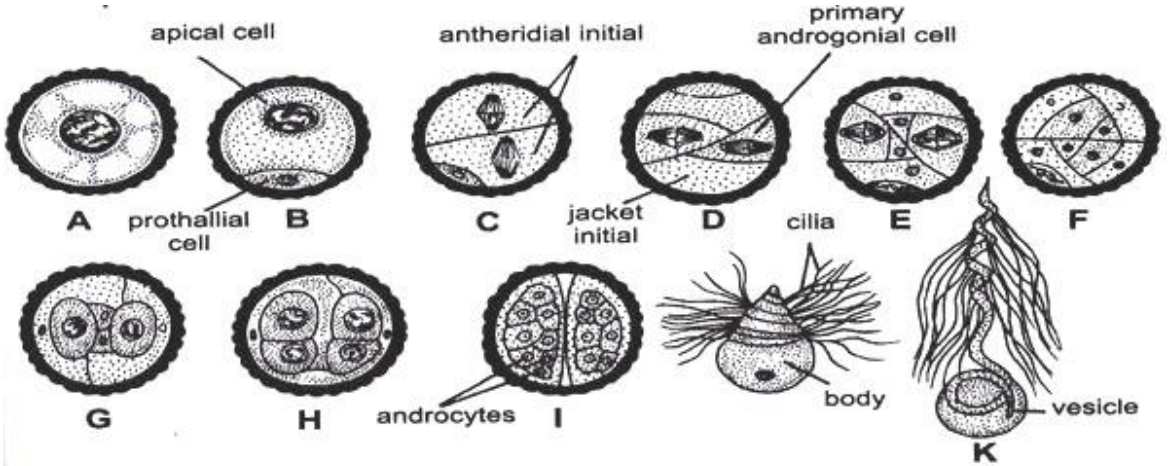


Marsilea. **Successive stages in the dehiscence of the sporocarp**

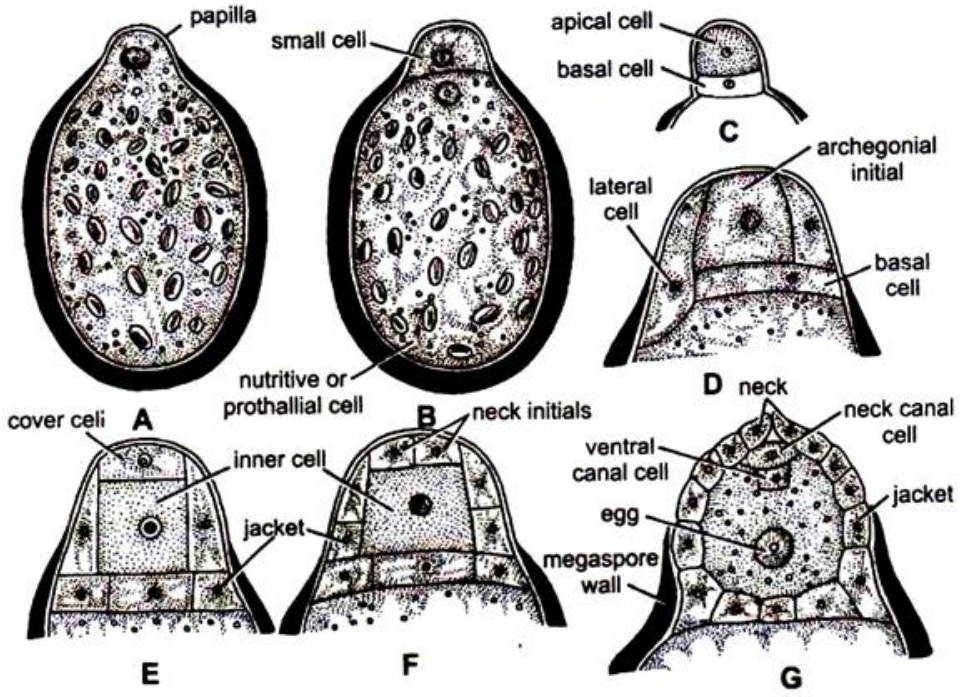
The decaying of the wall of the sporocarp takes place due to bacterial action and thus the sporangia and spores are liberated. The sporocarp bursts open only in water in valvecular manner along the ventral side and apex. The gelatinuous ring absorbs water and extends greatly through the open margins of the sporocarp thus dragging out sori along with it.

It straightens and behaves as **sporophore.** The gelatinous ring bears two alternating rows of sori. The delicate mucilage wall of the sporangia (micro-or mega) opens in water and the spores (micro-or mega are liberated which germinate soon.

Development of male and female gametophytes (through successive mitotic divisions)



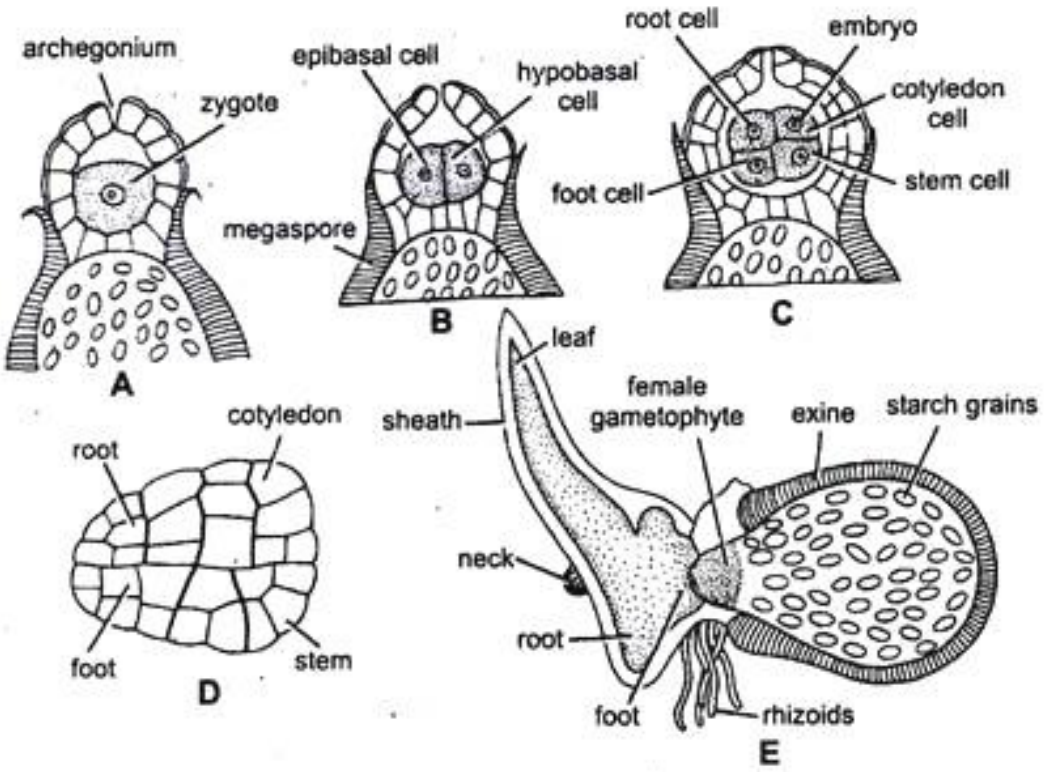
. *Marsilea.* A-I. Successive stages in the development of male gametophyte, J.K. Antherozoids.



Marsilea. A-F successive stages inthe development of female gametophyte G. a mature archegonium.

Fertilization: (by zoidogamy and chemotaxis)
The free swimming antherozoids are attracted chemotactically towards the neck of a mature archegonium but only one enters the neck and reaches the egg. The male and female nuclei fuse to form a diploid structure called oospore or zygote.

Embryogeny: by series of mitotic divisions in zygote as shown in the figure. Prone type.



Marsilea. Successive stages in the development of embryo.