

.Adiantum Structure Internal and External and Reproduction Life Cycle

Occurrence and Distribution of Adiantum:

Adiantum is popularly called 'Maiden hair fern' because of the shiny black rachis of the leaves. It is one of the most widely distributed genera (Other genera are Cheilanthes, Pellaea, Ceratopteris and Anogramma) of the family growing luxuriantly in both tropical and sub tropical regions of the world. It grows ubiquitously wherever nature offers a moist, shaded locality. There are nearly 200 species.

Nayar (1961) has investigated the morphology of 24 Indian species of Adiantum. Some of the common Indian species are – A. capillus-veneris, A. pedatum, A. incisum, A. caudatum, A. venustum, A. lunulatum, A. edgeworthii etc. Species of Adiantum are commonly cultivated in green houses because of their attractive foliage.

Sporophyte of Adiantum:

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Morphology of the plant: The sporophytic plant body consists of an underground rhizome from which are produced leaves and roots. The rhizome is covered with chaffy scales (Paleae). It may be erect (A. caudatum), semi erect (A. pedatum), or creeping (A. capillus-veneris).

Studies of Nicholas (1985) in Adiantum trapeziforme indicate that the erect rhizome of the young sporophyte quickly transforms itself into creeping. The rhizome may be hard or soft and brown in colour.

The chaffy scales that cover the rhizome are of various shapes and sizes. Nayar (1961) has made a detailed study of these scales in 24 species of Adiantum. From the undersurface of the rhizome arise a number of adventitious roots.

The roots are stiff and black in colour. Occasionally they may be branched.

The leaves are produced in acropetalous succession on the creeping rhizome. They show circinate vernation typical of ferns. The rachis of the leaf is hard, wiry, shiny and black or dark brown in colour thus giving the name maiden hair fern. The rachis has a medium dorsal groove, and is covered with paleae at the basal region. In addition to this, glandular hairs may also be present.

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The leaves may be unipinnate (A. caudatum) or bi or tri-pinnate as in A. capillus – veneris (Fig. 149). The pinnae are stalked and have a dichotomous venation. The rachis may terminate in a pinna or may bear a bud. In A. capillus veneris the rachis divides pinnately and the ultimate branches bear pinnae in an alternate fashion.

There is no distinction between fertile and sterile leaves in Adiantum. The whole leaf may be sporangiferous or only certain pinnae may bear sporangia. The soral organisation is very evident. Sori are borne on the ventral surface of the pinnae.

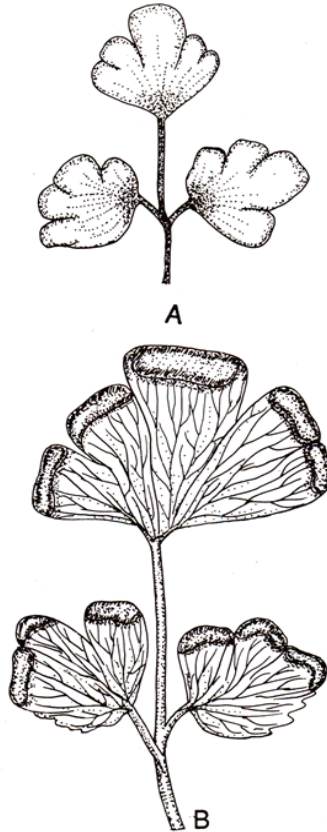


Fig. 149. *Adiantum* : Sterile (A) and Fertile (B) Leaflets of *A. capillus veneris*

Apical Organization:

In a study of apical organisation of rhizome, leaf and root in *Adiantum capillus veneris*, Bir and Randhawa (1984) have reported the occurrence of a single apical cell, which is later replaced by a group of cells.

Internal Structure:

1. Rhizome:

A transection reveals the usual three zones epidermis, cortex and stele (Fig. 150). The outline of the section would be wavy. Epidermis is single layered and the cells may be thin walled or thick walled. There is a cuticle external to the epidermis.

Cortex lies internal to the epidermis. It may be wholly parenchymatous (*A. rubellum*), (Fig. 150) or it may have sclerenchyma and parenchyma. In *A. pectinatum*, scattered masses of sclerenchyma are found embedded in the parenchymatous ground tissue. In *A. caudatum*, sclerenchyma constitutes the hypodermal region.

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The central vascular cylinder exhibits great variety. In *A. capillus veneris*, it is a dictyostele consisting of a ring of meristemes. In the young condition the stele may be a solenostele. In *A. rubellum* the stele is a typical amphiphloic solenostele, with characteristic features such as outer endodermis, outer pericycle, outer phloem, xylem, inner phloem, inner pericycle and inner endodermis lining the parenchymatous pith.

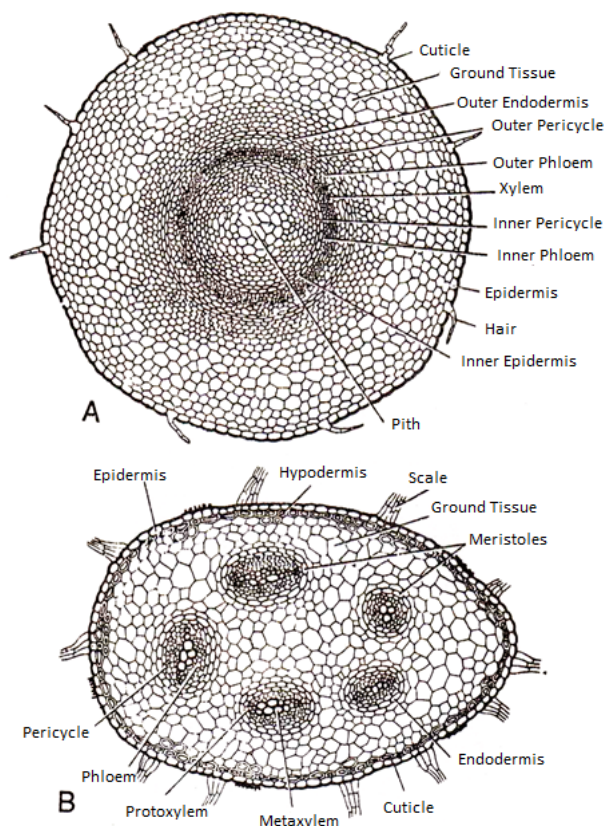


Fig. 150. *Adiantum* : Anatomy of Rhizome
A. Amphiphloic Siphonostele in *A. rubellum*, B. Dictyostele in *A. capillus veneris*

2. Leaf:

The petiole shows an epidermis, parenchymatous cortex and the vascular trace. Srivastava (1979) has studied the foliar epidermis of *Adiantum*. There is a thick walled hypodermis next to the epidermis. The number of leaf traces entering the leaf, varies.

It is single in *A. caudatum* and others and double in *A. capillus – veneris*. Even when there are two leaf traces, both of them unite further up resulting in a single bundle. The xylem is concave at the base but triradiate higher up with three protoxylem groups. Xylem is exarch.

In *A. bausei* there is a patch of included parenchyma in the xylem. Khare and Shankar (1986) studied the vascular organisation of the petiole in *Adiantum caudatum*, *A. edgeworthii*, *A. pedatum*, *A. phillippense*, *A. pubescens* and *A. trapeziforme* and have reported two types of vascular supply to the leaf.

In *A. phillippense*, *A. caudatum* and *A. edgeworthii* there is always a single vascular trace from the rhizome which remains unaltered in the petiole, while in the other three species two distinct traces originate from the rhizome. These two merge into one after entering the petiole. In a comparative anatomical study of the stipe of *Adiantum*, Bidin and Walker (1985) have reported eight different types of xylem configurations. According to them this is of systematic value.

The lamina shows the two epidermal layers upper and lower the mesophyll is generally undifferentiated. It is highly reduced in *A. capillus – veneris*, *A. pedatum*, etc., having only two layers of cells. In *A. pedatum*, in some regions the mesophyll is totally absent and at such places the two epidermal layers are closely appressed to each other.

The mesophyll (when present) as well as the epidermal layers are chlorophyllous. The epidermal layers are chlorophyllous. The epidermal cells over the veins are thick walled. The stomata are scattered throughout the surface of the leaf. Paleae or ramenta may be borne even on the epidermis of the lamina. The vein may or may not have a bundle sheath. The vascular tissues show the characteristic X/P arrangement.

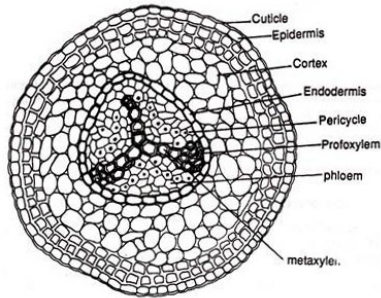


Fig. 151. *Adiantum* : T.S. of Petiole

3. Root:

A transection shows a very prominent piliferous layer, a two zoned cortex and the central protosteles (Fig. 152). The piliferous layer has brown coloured cell walls. Cortex has an outer parenchymatous zone and an inner sclerotic zone. Surrounding the stele is a conspicuous endodermis with prominent casparian thickenings. The xylem is exarch and diarch, phloem completely surrounds the xylem. External to phloem is a single layered pericycle.

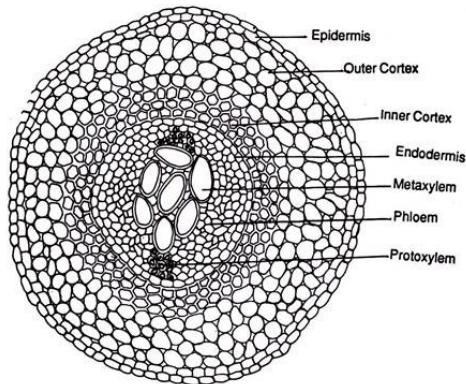


Fig. 152. *Adiantum* : T.S. of Root

Reproduction:

Vegetative propagation is brought about by buds produced at the leaf tips. The buds enter the ground when the leaf bends and touches the soil. There they develop into a new individual. This, in turn may repeat the process leading to the walking Habit. Walking habit is seen in *A. caudatum*.

Spore Producing Organs:

As has already been said there is no distinction into fertile and sterile leaves. The sori are born at the distal end of the pinnae. But the sori are not exactly marginal. They are borne a little behind the tip of the veins.

The sorus bearing margin of the leaf incurls and forms the false inducium. In some cases sporangia may develop at the distal ends of the veins (*A. phillippense*). In the sori paraphyses may be present in between the sporangia as in *A. rubellum*, *A. tenerum*, etc. The sorus is of the mixed type.

Development and Structure of the Sporangium:

The development is similar to what is seen in *Pteris*. A mature sporangium has a stalk made up of three rows of cells. The stalk terminates in a globose or biconvex capsule. The wall is single layered.

There is an obliquely vertical annulus (Fig.153) of 12-24 cells long. The annulus is separated from the stalk by two or three cells. The stomium also is separated from both the stalk, and the annulus. The rest of the sporangial wall is composed of a few large cells.

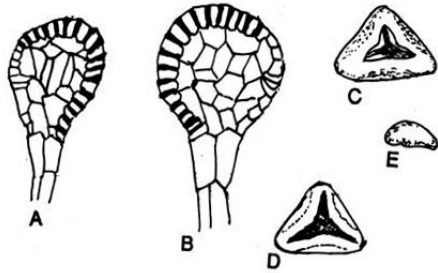


Fig. 153. *Adiantum* : Sporangia and Spores of *A. capillus veneris*
A-B. Sporangia, C-E. Spores

The sporangium dehisces transversely liberating the spores. All the spores are of the same type.

Gametophyte of *Adiantum*:

Structure and germination of the spores:

Spores are tetrahedral in shape. The wall is two layered. Exine is thick and smooth and has a brownish tinge. On falling upon a suitable substratum the spore germinates. The first sign of germination is the rupturing of exine and the protruding out of the germ tube.

The germ tube undergoes several transverse divisions to form a short filament. The lowest cell (Fig. 154a) forms a lateral rhizoid. The terminal cell becomes an apical cell with three cutting faces. By the division of the apical cell, a spatulate pro-thallus is formed first. (Fig. 154).

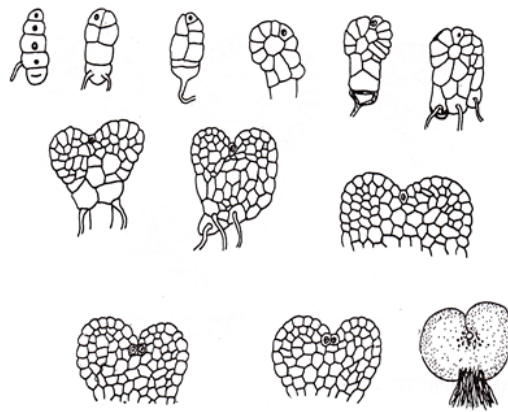


Fig. 154. *Adiantum* : Germination of Spore and Development of the Gametophyte
A-K. Developmental Stages, L. Mature Gametophyte

The mature pro-thallus is cordate, photosynthetic, dorsiventrally flattened and aerial. The growing point is situated in the apical notch (Fig. 154e, 154f). All the cells in the pro-thallus are parenchymatous. The pro-thallus is one celled thick towards the margins but many celled thick towards the centre. In some species collenchyma may be found at the corners. Rhizoids are produced from the ventral surface.

Reproduction:

The prothalli are monoecious. Antheridia are found in between the rhizoids towards the ventral surface. Archegonia are found near the growing point towards the ventral surface. Structure and development of sex organs is same as in *Pteris*.

Embryogeny:

The first division of the zygote is vertical (Fig. 155b). The epibasal half (next to the archegonial neck) forms the leaf and root while the hypo basal half forms the stem' apex and foot (Fig. 155c). Embryogeny is essentially similar to what is seen in *Pteris*.

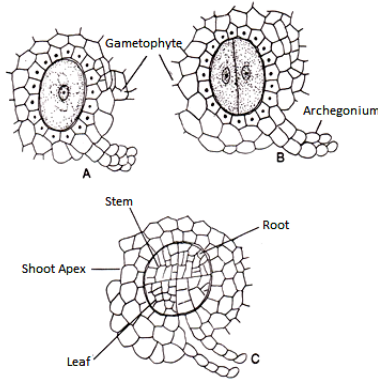


Fig. 155. Adiantum: Embryogeny in *A. capillus veneris*

Generally only one sporophyte is formed per pro-thallus. During embryogeny the root and juvenile leaves make their appearance first, with the stem differentiating late. The primary root penetrates the soil and establishes itself. Apogamy has been reported in *A. philippense*.

Chromosome Number:

In a cytological study of 51 species of ferns from western India, Mahabale and Kamble (1981) have reported polyploidy in *Adiantum*. In another cytological study of the genus (*A. peruvianum*) Sinha and Verma (1984) have reported a chromosome number of $2n = 60$, with an irregular meiosis.

Phylogeny of *Adiantum*:

Adiantaceae seems to occupy a none too high position among the mixtae. The lack of a true inducium is one of the characteristic features of the family. Considering the relationships of polypodiaceae, Eames (1964) opines that gymnogrammoids (to which *Adiantum* belongs) are themselves polyphyletic and are probably associated with osmundaceous and schizaeaceous stock.