

## STUDIES ON THE FERN GENUS *ADIANTUM* L. FROM RAJASTHAN

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Three species of *Adiantum*, *A. incisum*, *A. lunulatum* and *A. capillus-veneris* occur widely distributed throughout the Aravalli Hills and in Chambal ravines. In addition to ecomorphological variations the plants also show differences in anatomy and sex expressions in gametophytes. Phytochemical studies are also described.

**Keywords :** Rajasthan; *Adiantum*; Eco-morphology; Anatomy; Gametophyte; Phytochemistry.

### Introduction

Approximately 50 species belonging to 22 genera of Pteridophytes are known from Rajasthan (Bir and Verma, 1963; Mital, 1968; Sharma and Bohra, 1977; Bohra *et al.*, 1980; Bhardwaja *et al.*, 1979, 1987; Sharma *et al.*, 1988). Among these, *Adiantum* occurs most frequently throughout the Aravalli Hills and in Chambal ravines. It is represented by three species *A. incisum* (*A. caudatum*), *A. lunulatum* (*A. philipense*) and *A. capillus-veneris* (Singh *et al.*, 1984). A number of papers have been published on the morphology of tracheary elements (Purohit and Sharma 1980; Purohit *et al.*, 1981), anatomy (Singh *et al.*, 1984), epidermal structure in relation to drought resistance (Sharma *et al.*, 1987) and structure of gametophytes (Sharma and Sharma, 1992) of this genus collected from Rajasthan. In the present paper further observations are given on the eco-morphological variations, anatomy of apices, structure of gametophytes and phytochemical investigations.

### Materials and Methods

The material of all the three species have been collected from different places in the Aravalli Hills and Chambal ravines. For anatomical studies microtome sections have been cut at 8  $\mu$ m and slides prepared following Johansen (1940). Gametophytes are raised by sowing spores on agar medium supplemented with Knop's solution (half strength). Phytochemical analysis have been made using standard methods e.g. pigments by Arnon (1949) and Robbelen (1957), soluble proteins by Bradford (1976), using comassive brilliant blue G 250 as colour developer, total aminoacids by Moore and Stein (1954), free proline by Bates *et al.* (1973), total phenols by Mahadevan (1982) and total carbohydrates by Plumer (1971).

### Description

**Eco-morphology:** The three species of *Adiantum* flourish in different habitats. *A. incisum* grows on exposed but moist rocks during rainy season and in the

crevices of dry rocks during the winters in the Aravalli Hills. Morphologically the plants show variations with the change in ecological habitats. Plants at Mt. Abu have thick tuberous rhizome and the laminae are slightly to deeply incised (Fig. 1A). Walking habit through vegetative buds produced at the apical portion of leaf is common. Plants at Goramghat (District Pali- on way from Marwar to Udaipur) have small ascending tuberous- erect rhizome and a number of leaves are seen arising from the apex of rhizome (Fig.1B) occurrence of apical vegetative buds not common.

Plants of *A. incisum* collected from Menal (District Chittorgarh on way from Bhilwara to Bundi) have cylindrical ascending rhizomes with large leaves. Pinnae are deeply incised; apical buds common (Fig.1C).

*Adiantum lunulatum* grows on moist rocks only during rainy season at Mt. Abu, Sundhamata (Jalore), and Todgarh (Ajmer). The plants show wide variations in size and morphology of leaves (Fig.2A-F). Rhizome is small ascending and leaves are pinnate, with (Fig.2B- D) or without (Fig.2A) apical buds. The pinnae are stalked or sub-sessile; sori are marginal, continuous or interrupted.

*Adiantum capillus-veneris*- This species occurs along water falls and in very moist places e.g. Goramghat, Menal, Chittorgarh, Gawaparanath (Kota) and Takhaji (Jhalawar). Rhizome is cylindrical and leaves are tripinnate (Fig.3A) with slightly lobed (Fig.3C) to

deeply incised stalked laminae (Fig.3B). Apical buds do not appear i.e. this species does not show walking habit.

*Anatomy*: Both in *A. incisum* and *A. lunulatum* the rhizome apex has a distinct apical cell but in the former the apex is pyramid or dome like (Fig.4A), similar to that of *Equisetum* (Sharma *et al.*, 1986) while in the latter it is flat plate-form with a row of cells (Fig.4 C,D). The rhizomes show variations in anatomy from an amphiphloic solenostele (Fig.4B) as in *A. incisum* to a dictyostele (Fig.4 F) made up of number (4-5) meristemes (*A. capillus veneris*). In *A. lunulatum* only 2 or 3 leaf gaps are produced (Fig.4 E) (Singh *et al.*, 1984). Occurrence of vessel elements in *A. incisum* (Purohit and Sharma, 1980) has been related to the ecology of the plant.

*Spore germination and Gametophyte development*: Generally spores start germination between 8-10 days and plate formation takes place by 20th day. The gametophytes produced in *A. capillus-veneris* and *A. lunulatum* are non-cordate (Fig.5B) or partly cordate (Fig.5A). In both these species the gametophytes are protogynous and apogamous sporophytes occur frequently (Mehra and Gupta, 1986; Sharma and Sharma, 1992). Antheridia are produced after 45 to 50 days and are typical polypodiaceous type i.e. the wall is made up of only three cells.

*Physiological studies*: Physiology from the point of drought resistance has been studied of all the three species of *Adiantum* and noticed that *A. incisum* is the



FIGURE 1(A-C). *ADIANTUM INCISUM* A, FROM MT. ABU, B, FROM GORAMBHAT C FROM MENAL.



FIGURE 2(A-F). *ADIANTUM LUNULATUM* FROM MT. ABU SHOWING MORPHOLOGICAL VARIATIONS IN PLANTS COLLECTED FROM ONE SITE (SUN-SET POINT).



FIGURE 3(A-C). *ADIANTUM CAPILLUS-VENERIS* A, FROM MENAL. B, FROM TAK-HAJI. C, FROM GWAPARANATH.

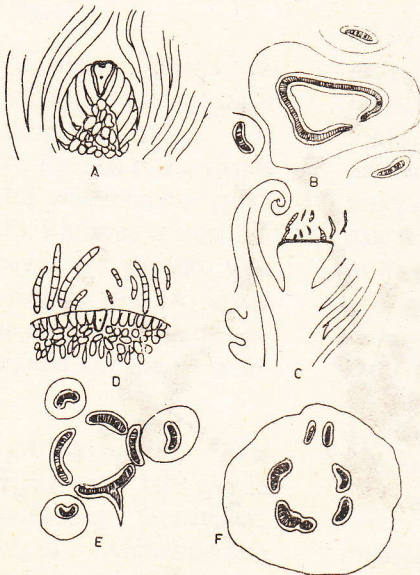
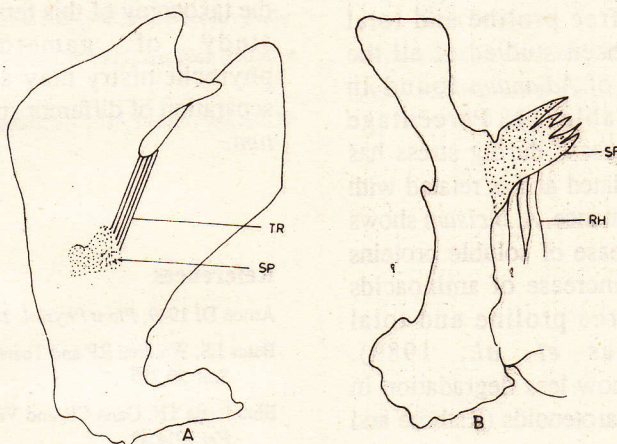


FIGURE 4(A-F). A. *Adiantum Incisum* Dome Shaped Apical Gall Of Rhizome. B. Same, C.S. Rhizome With Amphiphloic Solenostele. C,D. A. Lunulatum Flat Apex Of The Rhizome. E. Same, C.S. Rhizome. D. A. *Capillus-Veneris*. C.S. Rhizome Showing Dictyostele And Double Leaf Trace.

**Figure 5(A-B).** A. *Adiantum lunulatum* partially cordate rhizome with tracheids (TR) and apogamous sporophyte (SP). B. *A. capillus-veneris*-non-cordate gametophyte with an apogamous sporophyte (SP) having rhizoids (RH).



**TABLE 1**  
**PHYTOCHEMICAL STUDIES OF ADIANTUM SPECIES FROM RAJASTHAN**

Species	Total chlorophyll (mg/g f.wt)	Carotenoids (mg/g f.wt)	Total sugars (mg/g f.wt)	Soluble Proteins (mg/g d.wt)	Amino acids (mg/g d.wt)	Free Proline ( $\mu$ g/g d.wt)	Total Phenols (mg/g d.wt.)
<i>Adiantum incisum</i>	4.320	1.990	38.5	40.00	19.5	1.75	30.5
<i>A. lunulatum</i>	3.610	1.670	129.5	42.5	17.0	1.14	32.8
<i>A. capillus-veneris</i>	6.232	1.360	106.0	58.3	10.0	1.10	42.5

most hardy species. Its leaf water deficit has been related with the resurrection habit found in this plant (Sharma and Purohit 1985). *A. capillus-veneris* is most susceptible to drought and its leaves show minimum resaturation because of the compact arrangement of mesophyll cells (Sharma *et al.*, 1987).

*Phytochemical studies:* Leaf pigments, total carbohydrates, soluble proteins, amino acids, free proline and total phenols have been studied of all the three species of *Adiantum* found in Rajasthan (Table 1). Percentage decrease or increase during stress has also been calculated and is related with the drought resistance. *A. incisum* shows maximum decrease of soluble proteins and sufficient increase of aminoacids specially of free proline and total phenols (Vyas *et al.*, 1989). Chlorophylls show less degradation in comparison to carotenoids (Rathore and Sharma, 1991).

### Discussion

Though a number of papers have been published during recent years on the genus *Adiantum* from Rajasthan yet many aspects are remained either untouched or there are left many gaps in our knowledge e.g. cytology, responses of plant growth regulators on sex expression in gametophytes, and secondary metabolites specially the flavonoids. The plants of *Adiantum* are of medicinal importance (Sharma and Vyas 1985; Vyas and Sharma, 1988) and further investigations on the species

of this genus from Rajasthan shall enhance our knowledge about the academic as well as applied aspects of this commonly occurring fern of the state. The eco-morphological variations described in the present paper likely to prove useful in the systematic study of this genus. The anatomical parameters like the structure of rhizome apex and stelar organization are found useful in the taxonomy of this fern. Similarly, the study of gametophytes and phytochemistry may also be used in separation of different species of *Adiantum*.

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