

Comparative Anatomical Study of *Marsilea* Populations Growing in Selected Localities of Kota District, Rajasthan

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ABSTRACT

A comparative anatomical study of various organs (Root, rhizome and petiole) of the five *Marsilea* populations of Hadauti region has been carried out. Hadauti is a region of Rajasthan state in western India. It includes the districts of Bundi, Baran, Jhalawar and Kota. This study was aimed at evaluating the degree of variations in relative development of aerenchyma and stellar tissues in the wake of habitat variation. It has been found that although aerenchyma is present in all the populations but it is well developed in cortical regions of rhizome in the population growing in Talwandi, Anantpura (aquatic form) localities while the relative area occupied is lesser in *M.cf.coromandelina*. But the relative area occupied by stellar region shows a reverse trend. It occupies somewhat higher area in *M.cf.coromandelina* than *M.minuta*. It has been concluded that the basic anatomical plan is retained in all the populations while significant variations have been observed in these populations pertaining to their morphological plasticity.

Keywords: *Marsilea* population, habitat variation, aerenchyma, morphological plasticity.

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INTRODUCTION

Marsilea minuta belongs to family Marsileaceae, is a common plant which is widely distributed in India, throughout Africa, Madagascar and Comoros. In India, it usually grows as a weed in wet rice fields and flooded low lands. *Marsilea minuta* is cosmopolitan and frequently found fern growing in the ditches and pond all around the year and *Marsilea cf. coromandelina* is found growing in a small patch enroute Borawas village in the months of Aug-Sep and Dec-Feb [1]. Anatomical studies of ferns and fern allies with special reference to the stellar system have been extensively investigated during the present century. Pande reported the presence of a dictyostele in the tubers of *M.erosa* and oil as a storage product in its cortex [2]. Puri *et.al.* studied a detailed account of the anatomy of the sporocarp of *M.minuta* and gave a new interpretation to the morphology of sporocarp stating it was equivalent to a single leaflet [3]. Vascular tissue morphology of land and water forms of *M.aegyptica*, *M.diffusa* and *M.muticah* have been studied with a view to understand the effect of habitat variations on vascular tissue morphology of this plastic genus which is well known for its adaptive capabilities of growing on land as well as in aquatic habitats[4]. A comparative analysis of the ultra-structural peculiarities of *Marsilea quadrifolia* L. mesophyll cells of the leaves belonging to the plants grown in *in-vitro* system and in natural habitat has been recently described [5]. S.Madhu *et.al.* [6] analysed *Marsilea minuta* leaves for pharmacognostical studies such as organoleptic, morphologic, microscopic and

physicochemical parameters. Mangestuti *et al.*[7] investigated possible phenotypic variation profile of *Marsilea crenata* Presl. cultivated in water and in the soil, to find alternative cultivation techniques to fulfill the increasing demand for pollutant-free plants. To investigate the adaptation traits of three distributed in different geographic regions, to terrestrial conditions, morphological features, optical properties and photosynthetic performance of leaflets of the three species of *Marsilea* (*M. crenata*, *M. quadrifolia*, and *M. schelpiana*), grown in terrestrial environment was investigated and the results showed that leaflets of the three species had significant differences in some of the ecophysiological traits [8]. Comparative anatomical study of *Marsilea* populations growing in Hadauti plateau was done for the first time, therefore, this study was aimed at evaluating the degree of variations in relative development of aerenchyma and stellar tissues in the wake of habitat variation.

SURVEY AND COLLECTION

Kota (Fig-1,2) is situated at the edge of Malva plateau at 23°45’ to 25°53’ N latitudes and 75°09’ to 77°26’ E longitudes in south eastern corner of Rajasthan state. Kota city is situated on the banks of the Chambal river. Selected populations of *Marsilea* species growing at different habitats viz. aquatic, amphibious and terrestrial were taken up for the present study.

1. *M. minuta* Linn. (Aquatic & terrestrial)
2. *M. minuta* (hybrid) (Amphibious)
3. *M. cf. cormandelina* complex. (Terrestrial)

The plants collected from the selected localities have been depicted in table 1.

Figure-01: Map of India showing Rajasthan with Hadauti Plateau (Figure was reproduced from the paper Priyanka Sharma & Nilima Bhardwaj, Int. J. Pure App. Biosci. 2 (2): 254-261 (2014))

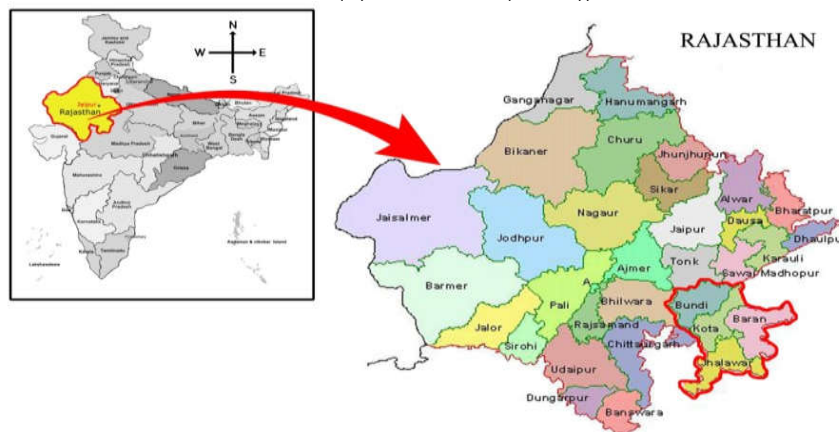


Figure-02: Map of Kota district showing surveyed localities (Figure was reproduced from the paper Priyanka Sharma & Nilima Bhardwaj, Int. J. Pure App. Biosci. 2 (2): 254-261 (2014))

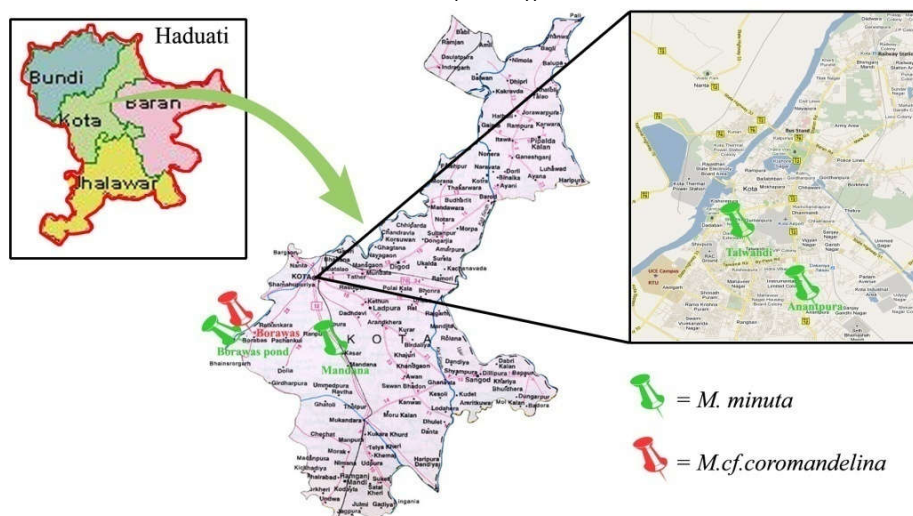


Table 1: Description of surveyed localities of *Marsilea* populations

S.No.	POPULATION	LOCALITY	SITE
A	<i>M.minuta</i>	Talwandi	A large area on the road side of the centre of the city. Talwandi region remain flooded with water all through the year
B	<i>M.minuta</i>	Anantpura	A small patch on the City Mall road showing both hydrophytic and xerophytic population of <i>Marsilea</i> .
C	<i>M.minuta</i> (hybrid)	Mandana	A small patch of <i>Marsilea</i> near Mandana bus stand
D	<i>M.cf.coromandelina</i>	Borawas	A small patch located ahead of Borawas, 27 Kms away from Kota along Rawatbhata route on the roadside.
E	<i>M.minuta</i>	Borawas pond	Dense patch along the edges of the Borawas pond. Flooded with water during the rainy season.

MATERIALS AND METHODS

Sections of root, rhizome, petiole, of each population of *Marsilea* were cut at 10-15 um thickness using microtome. Safranin-fast green combination was employed for staining and mounting was done in DPX following Johansen's method [9]. Some handmade sections were also observed under the binocular microscope and pictures were taken.

RESULTS AND OBSERVATION

The roots, rhizomes, and petioles of the five investigated populations of these selected localities have been studied. The results of the anatomical study are shown in table 2 and plate 1. The comparative anatomical features thus indicated displays inter-population variations to some extent.

1. **Petiole:** (Table-2,Plate-1)

The comparison of the petiolar anatomy among the five populations has revealed that while the epidermal cells and cuticle is almost round and well defined in all the populations' cuticle of *M.cf.coromandelina* population (Borawas) is not well defined. The shape and width of air chambers also show variation. They are irregularly round in 'A' 'B' And 'C' while squarish in 'D' and large and rectangular in 'E'.

The thick walled zone in the middle cortex is single layered in 'A' while 2-3 layered in 'C'. However it is not significant in 'B', 'D' and 'C' populations. The width of vascular zone is found to be maximum in population 'C' (Mandana locality) while minimum in population 'E' (Borawas pond). Thus, the petiolar anatomy seems to provide some dependable anatomical features for taxonomic comparison [10]

2. **Rhizome** (Table-2,Plate-1)

The epidermis of all the population is continuous and single layered. Air chambers show variation in shape and size. These are irregularly round in 'A', small and obliterated in 'B', squarish in 'C' & 'D' while large and rectangular in 'E'. the cortical region consists of a middle zone which is 2-3 layered thick in all the populations. The xylem ring is single layered in all populations, while the tracheidal cell size varies. Tracheidal cells are larger in 'B', medium in 'A', 'C' and 'D' while these are smaller in 'E'. Phloem is 2-3 layered and has wider sieve cells in all these populations of *Marsilea* while it is exceptionally 3-4 layered in population 'D' (*M.cf.coromandelina* locality). It is clear from table=3 that rhizomes of all populations show sclerotic pith, the number of cells varying between 15-30 with the maximum number being found in population of 'B' and 'D' locality.

3. **Root-** (Table-2,Plate-1)

Root anatomy reveals a zone of thick walled cells in the inner cortex which is 2-layered in 'A' and 'C' populations while it is 3-layered in 'B', 'D' and 'E' populations. The stele is diarch and exarch in all the investigated populations. It may be stated by way of a general conclusion that the comparative study of root anatomy of the five populations' does not provide any distinctive morphological criteria of diagnostic relevance in interspecific delimitations in different species of *Marsilea*.



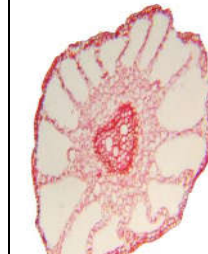
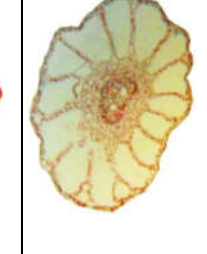



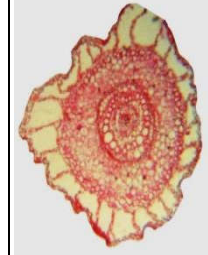

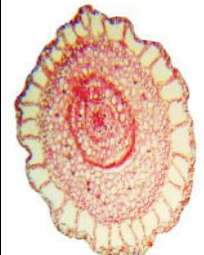

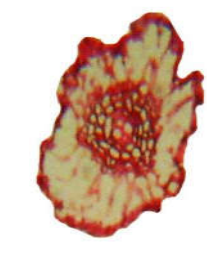
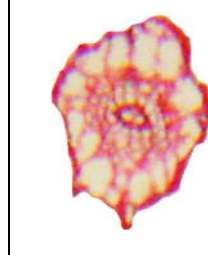
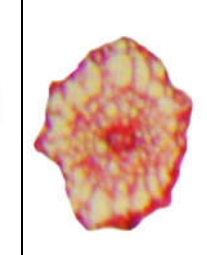

Table 2- Anatomical features of selected localities of *Marsilea* population of Kota

Anatomical parameters	Locality				
	Talwandi (aquatic) [A]	Anantpura [B]	Mandana [C]	Borawas [D]	Borawas pond [E]
PETIOLE Epidermis Shape of cells	Round	Almost round	Oval	Oval	Round
Cuticle	Well defined	Well defined	Well defined	Not well defined	Well defined
Cortex Air chamber	Irregularly round	Roundish in shape	Irregularly round	squarish	Large and rectangular in shape
Thick walled zone in middle cortex	Single layer of thick walled cells	Not significant	2-3 layer of thick walled cells outside vascular zone	Not significant	Not demarcated
Width of vascular zone	Average	Average	Maximum	Average	Minimum
RHIZOME Epidermis	Continuous single layered	Continuous single layered	Continuous single layered	Continuous single layered	Continuous single layered
Air chamber	Irregularly around	Small obliterated	Squarish	squarish	Large and rectangular
Cortex	Middle zone thick walled 3-layered	Middle zone thick walled 2-3 layered	Middle zone thick walled 2 layered	Middle zone thick walled 2-3 layered	Middle zone thick walled 3 layered
Vascular zone Xylem	Single layered ring	Single layered ring	Single layered ring	Single layered ring	Single layered ring
Tracheidal cells	Tracheidal cells medium size	Tracheidal cells large	Tracheidal cells medium size	Tracheidal cells medium size	Tracheidal cells smaller
Phloem	2-3 layered with larger sieve tubes	2-3 layered with some larger sieve tubes	3 layered middle layer of larger sieve cells	3-4 layered larger sieve tubes	2-3 layered with medium size sieve cells
Pith	Sclerotic more than 20 cells	Sclerotic 27-30 cells	Sclerotic 20-25 cells	Sclerotic 28-30 cells	Sclerotic 15-20 cells
ROOT Cortex	Thickened zone 2 layered thick	Thickened zone 3 layered thick	Thickened zone 2 layered thick	Thickened zone 3 layered thick	Thickened zone 2-3 layered thick
Stele	Diarch, exarch	Diarch, exarch	Diarch, exarch	Diarch, exarch	Diarch, exarch

DISCUSSION

Anatomical studies of *Marsilea* have received considerable attention in India [2, 3]. The present study deals with the aspect of comparing the anatomical differences which have revealed notable habitat based anatomical variations. It is interesting to note that aerenchyma does occur in both the land and water forms of *Marsilea* species but the area occupied by aerenchyma has been found to be more in water forms, maximum seen in population occupied at Borawas pond. Similarly, well-developed xylem and phloem are observed in the land forms of *Marsilea* (*M.cf. coromandelina*) while the stelar region gets reduced in *M.minuta* (aquatic form). This adaptation shows direct correspondence to habitat factors. *Marsilea coromandelina* complex population is morphologically different from other populations having silver shining streaks (pellucid streaks) between the veins of the leaves and squarish ribbed sporocarp [12]. *Marsilea* shows morphological variation within species and as such, it is difficult to distinguish species depending on traditional morphology only. Molecular methods were used to enrich this study and testify molecular methods as a tool to find the genetic bases of the differences and similarities among species [11].

Plate-1: Pictures showing anatomical variations among selected localities of *Marsilea* population of Hadauti plateau

Plant organ T.S	<i>M.minuta</i> (Talwandi)	<i>M.minuta</i> (hybrid) (Anantpura)	<i>M.minuta</i> (Mandana)	<i>M.cf.coromandelina</i> (Borawas)	<i>M.minuta</i> (Borawas pond)
Petiole					
Rhizome					
Root					

Anatomical studies do not indicate any significant feature of systematic relevance in rhizome, but the petiolar anatomy shows certain features of comparison. The width of the vascular zone was found to be smaller in *M.minuta* as compared to *M.cf.coromandelina*. Similarly, air chambers have been observed to be rectangular in *M.cf. coromandelina* while they are irregular round and more in number in *M.minuta*. The air chambers are separated by thin walled parenchyma cells. It is reported that the parenchyma cells surrounding the air chambers are comparatively thinner in *M.cf.coromandelina* than the single layered or sometimes double layer parenchyma cells in *M.minuta*. likewise, presence of tannin cells has been recorded in water forms only. Tannin is known to provide protection against microbial growth in water plants [13]. Nicotraet. al. [14] also founded a phenotypic variation profile caused by different cultivation methods of *M. crenata*. Such variation showed plant's response to changes through environmentally induced shifts of its phenotype.

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