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RESEARCH ARTICLE

AQUATIC PTERIDOPHYTES DIVERSITY OF HOSHANGABAD MADHYA PRADESH, INDIA

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ABSTRACT

Pteridophytes are the seedless vascular cryptogams which occupy a position between the lower non-seed bearing and higher seed bearing plants. They grow in terrestrial, epiphytic, lithophytic and aquatic habitat. The present study mainly focused on the diversity of aquatic pteridophytes of Hoshangabad, Madhya Pradesh, India. The main River in this region is Narmada, which flows in the depression between the Satpura and Vindhya ranges; forming the northern boundary of district. Average rain fall in the region is 134 cms., and the average maximum and minimum temperatures are 32°C and 19°C respectively. Overall, the climate of the district is tropical except in the Pachmarhi where winter is cooler. There are 37 water bodies in the district major water bodies are Tawa dam, Dokarikheda dam, Narmada and Tawa River. The pteridophytic flora of Satpura region is very rich, as various gorges provide ideal habitat for the growth of such plants. The pteridophytes considered to be the primitive vascular plant group is scattered all over the world. More than 1200 species of fern and fern allies have been reported from India (Dixit 1984, Chandra, 2000), though new genuine findings are also made from time to time. This place is one of the richest in flora, in India, representing elements of both northern and southern Indian flora. Observations on seven aquatic pteridophytic species belonging to six genera and six families are presented in this paper. Their botanical names, family names, local names, habit, and distributions in big and small water bodies of Hoshangabad are provided.

Key words: Pteridophytes, Hoshangabad, Water bodies, aquatic diversity.

INTRODUCTION

Hoshangabad district lies in the central Narmada Valley and on the northern fringe of the Satpura Plateau. It lies between the parallels of 22º 15' and 22º 44' north. In shape, it is an irregular strip elongated along the southern banks of Narmda River. Its greatest length from south-east to north-east is 160 kms. Northern boundary of the district is river Narmada. Across this the district of Raisen and Sehore lies. The district of Betul lies in the south, where as the Harda district faces with the western and south-western boundaries and Narsingpur and Chhindwara districts, close to the north-eastern and south-eastern sides of the district respectively. Pachmarhi is a hill stationis in the *Satpura* range of hills.

It is situated in Pipariya tehsil. It is on the way of Piparia-Matkuli- Pachamrhi road, at a distance of 123 kilometer from district head-quarters. It is connected with rail upto Piparia railway station en-route of Hawrah-Mumbai rail route. Pachamrhi is at a distance of about 52 km. from Piparia railway station and 211 km. from state capital Bhopal. It is also known as "*Queen of Satpura*". By popular belief the name *Pachmarhi* is a derivation of 'Panch-Marhi' or the five caves of the *Pandava* brothers. During the British regime, Pachmarhi was the summer capital of the Central Provinces.

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MATERIAL AND METHOD

The plants were collected from different localities situated water bodies of Hoshangabad in many subsequent trips during August 2009 to August 2010. The photographs of the plants were taken by Sony DSC-W120. The detailed observations made during present investigation have provided additional information on taxonomic characters, local name are distributional patterns. The observations were made from diversity of aquatic pteridophytic plants as well as the herbarium specimens. The taxonomic characters considered in the investigation includes habit and habitat, shape and size of the plants, rhizome and petiole length, scales, leaflets and venation pattern, fertile spike, spike length and shape and size of spores. After identification, the plants were properly processed, mounted on sheet and deposited in the department of Botany, Government post graduate college Hoshangabad (M.P.)

Observations

There is many small and big water bodies situated in Hoshangabad some water bodies are human made but some small and big water bodies are natural. This water bodies are very rich for aquatic diversity of pteridophytes.

Isoetes panchananai Pant & Srivastava in Proc. Natn. Inst. Sci. India 28 B(3) : 243,t. XIII, fig. 1-4, t XVI, f. 41, text-feg. 1, 2 A-I. 1962; Ladha in Acta Bot. Indica 5: 86. 1977. (Isoetaceae)

No.	Small water bodies	Places	Species
1	Pachlawara pond	Pachlawara	*Marsilea minuta, Azola pinnata*
2	Dokarikhrdea dam	Dokarikheda	Not found
3	Korani river	Pipariya	*Marsilea minuta*
4	Semari talab	Semari	*Marsilea minuta*
5	Denva river	Pachmarhi	*Marsilea minuta*
6	Amadehi pond	Pachmarhi	Not found
7	Dudhi river	Bankhedi	Not found
8	Puraina pond	Puraina	Not found
9	Pachua pond	Pachua	Not found
10	Samnapur pond	Samnapur	*Marsilea minuta*
11	Tinsari pond	Tnsari	*Marsilea minuta*
12	Ghuma pond	Ghuma	*Marsilea minuta*
13	Palakmati river	Sohagpur	*Marsilea minuta*
14	Punour pond	Punour	*Marsilea minuta*
15	Kalmesra pond	Kalmesra	*Marsilea minuta*
16	Gotikheda dam	Gotikheda	*Marsilea minuta*
17	Sukha river	Sohagpur	*Marsilea minuta*
18	Jasalpur pond	Jasalpur	*Marsilea minuta, Azola pinnata*
19	Gunjol river	Banapura	*Marsilea minuta*
20	Hinoutiya	Hinoutiya	*Marsilea minuta*
21	Vasniya	Vasniya	*Marsilea minuta*
22	Dandivada	Dandivada	*Marsilea minuta*
23	Kasada	Kasada	*Marsilea minuta*
24	Jamundole	Jamundole	*Marsilea minuta*
25	Sarradeh	Sarradeh	*Marsilea minuta*
26	Chichvani	Chichvani	Not found
27	Kubadakhedi	Kubadakheda	*Marsilea minuta*
28	Bhamkapura	Bhamkapura	*Marsilea minuta*
29	khoripura	Khoripura	*Marsilea minuta*
30	Pathrouta	Pathrouta	*Marsilea minuta*
31	Bariaam	Pachmarhi	*Azolla pinnata, Isoetes panchananai, I. coromanelina*
32	Solameel pond	Pachmarhi	*Marsilea minuta, Isoetes panchananai, I. coromanelina*
33	Manjushri Nala	Pachmarhi	*Equisetum ramosissimum, Isoetes panchananai, I. coromanelina*
34	Sunder kund Nala	Pachmarhi	*Equisetum ramosissimum, Isoetes panchananai, I. coromanelina*
35	Pahadiya jheel	Hoshangabad	*Azolla pinnata, Marsilea minuta,*
	Big water bodies	**Places**	
1	Narmada river	Hoshangabad	*Marsilea minuta, Azolla pinnata, Solvinia auriculata, Equisetum ramosissimum*
2	Tawa dam	Tawa nager	*Equisetum ramosissimum*

Rhizomorph 2-lobed; leaves up to 2-4 cm long, 4-38 in number, peripheral strands absent, velum almost complete. Megasporangia ovoid, 3-5 mm long, 2-3 mm broad; microsporangia not known; megaspore white when dry, black when wet, dimorphic; larger ones 330-400 µm in diameter; smaller ones 240-230 µm in diameter; surface to larger ones reticulate, smaller ones with branched ridges formed by confluence tubercles; microspores not known, sterile cell absent.

Isoetes coromanelina L.f. in Suppl. Pl. Syst. Veg. ed. II: 447.1781. *I.coromandelina* var. *raipurensis* Unni in j. Bomb. Nat. Hist. Soc. 64:590.1967. (Isoetaceae)

Rhizomorph 3-lobed, rarely 4-5 lobed; peripheral stands present; leaves 30-60 (-80) cm long, 20-60 in number, velum absent; megasporangia circular to oval, 12x9 mm; megaspore white when dry, grey when wet, dimorphic; larger ones 465-660 µm in diameter, smaller ones 356-458 µm in diameter, surface tuberculate, tubercle ends blunt and rounded, microspores red brown in colour, 26-33 µm in diameter, smooth to papillate.

Marsilea minuta L, Mant. Pl. 308. 1771. *M. quadrifolia sensu* Subr. & Henry in Bull. Bot. Surv. 8: 209. 1966. (Marsileaceae)

Rhizome long creeping, branched, subterranean, about 30cm long, green in aquatic plant, pale or dark brown in terrestrials, covered by about 5×0.25mm, whitish, soft, slender hairs sparsely or densely all over; roots borne usually on nodes, rarely on internodes. Stipes scattered, about 1cm apart, usually green, rarely pale or dark brown, terete, glabrous or whitish few hairs as in rhizome. Leaves four, sessile, arranged at the tip of the stipe in clover leaf model, obovate or wedge shaped, base cuneate, lateral margin entire, veins distinct above and below, flabellately branched, leaves pale or dark green, glabrous with few hairs; texture thin, soft herbaceous. Sporocarps borne at the nodes in clusters alternately, five per cluster, peduncle 7×1mm; microsporongia and megasporongia enclosed in the same sporocarp and covered by gelatinous layers; microspores yellowish-brown, globose, 40µm in diameter with distinct exine and intine; megaspores ovate, starch granules and numerous oval-shaped oil globules

Azolla pinnata R. Br. In Prod. Fl. N. Hill. 167. 1810. (Azollaceae)

Small aquatic plants 1.5-2 cm long and 1cm wide, rhizome very slender, zigzag, branched, branches alternate, roots numerous hanging downwards bearing several root hairs. Leaves in two rows, alternate bilobed with one floating and one submerged lobe, close together, upper surface papillose,

elder leaves dull red in colour. *Azolla pinnata* have crowded mass like leaves borne on a fragile free-floating rhizome with submerged roots. The leaves are arranged in alternate rows and each leaf is divided into two lobes of which the upper lobe is Arial and lower lobe is submerged in water. The Arial lobe is more than one cell thick and is photosynthetic in nature with stomata on both surfaces. The submerged lobe is one cell thick only. Branching is free and occurs at the nodes. The roots are borne on the lower side, close to the point of origin of branches.

Salvinia auriculata (Salviniaceae)

Small, floating aquatics with creeping stems, branched, bearing hairs but no true roots; Leaves in whorls of 3, with 2 leaves green, sessile or short-petioled, flat, entire, and floating, 1 leaf finely dissected, petiolate, rootlike, and pendent. Submerged leaves bearing sori that are surrounded by basifixed membranous indusia (sporocarps); sporocarps of 2 types, bearing either megasporangia that are few in number each with single megaspore, or many microsporangia, each with 64 microspores. Spores are 2 kinds and sizes, both globose, triplet. Megagametophytes and microgametophytes protruding through sporangium wall; megagametophytes floating on water surface with archegonia directed downward; microgametophytes remaining fixed to sporangium wall. The small, hair like growths, known as microgametical follicles, are not known to have any productive function, and are currently a biological mystery.

Equisetum ramosissimum Desf. (Equisetaceae)

The main stems 50–70 cm in height; grayish green; very rough to slightly rough bearing whorls of slender branches at the nodes persisting through the winter; the main stem internodes not swollen; 8–20 grooved; grooves moderately deep. The teeth black, with narrow white margins and a hair like apex; persistent The main stem internodes with a central hollow; central hollow about half the diameter of the internodes to more than half the diameter of the internodes (1/2 to 2/3); endodermis comprising two layers, one outside and the other inside the ring of vascular bundles. Stomata sunken The main stem sheaths green at first, then brown with a black band at the bottom; about 8 mm long. The primary branches numerous. The internodes of first branch are much shorter than the subtending sheaths the primary branch internodes hollow a fern ally with many hollow, fluted aerial stems growing from a perennial rootstock. Stems evergreen, with stomata arranged in lines. Leaves minute, whorled to form toothed cylindrical or dilated sheaths; as the sheaths mature, the teeth break off to leave a truncated margin Spores in terminal cones

Ceratopteris pteridoides (Hook.) Hiern, Bot. Jahrb. 34: 561(1905). (Parkeriaceae) *Synonym: Parkeria pteridoides* Hook. (1825).

Aquatic fern; fronds dimorphic-sterile fronds mostly simple or palmately lobed, fertile fronds dissected. Sori protected by reflexed lamina margin. Aquatic or semi-aquatic mostly rooted on substratum. Grows on humus deposits in the old ponds and on the soil of cultivated rice fields

RESULT AND DISCUSSION

The pteridophyte richness in the world is estimated in about 12,000 species (Wilson, 1997). There are about 3,250 species in America, with 3,000 of them in the tropics. The southeastern Brazil (from Minas Gerais to Rio Grande do Sul) contains about 600 species (Tryon & Tryon, 1982). Cook *et al*. (1974) identified six families of aquatic pteridophytes (Azollaceae, Equisetaceae, Isoetaceae, Marsileacea, Parkeriaceae and Salviniaceae). A series of lists of macrophytes species is known for Rio Grande do Sul, not existing specific research on the richness of aquatic pteridophytes in Brazil. The majority of published work on diversity and distribution of aquatic pteridophytes in Rio Grande do Sul (Sehnem, 1979a; Sehnem, 1979b; Sehnem, 1979c; Sehnem, 1984; Fuchs-Eckert, 1986) is out of date. Many wetlands disappeared in the last twenty years in Rio Grande do Sul, due to the update of biodiversity surveys is an important tool for the conservation strategies. *Isoëtes brasiliensis* Fuchs, *I. fusco-marginata* Fuchs, *I. ramboi* Herter, *I. sehnemii* Fuchs, *I. smithii* Fuchs (Isoetaceae); *Ceratopteris thalictroides* (L.) Brongn (Parkeriaceae); *Pilularia americana* A. Br. (Marsileaceae); *Azolla caroliniana* Willd. (Azollaceae) and *Salvinia auriculata* Aubl. (Salviniaceae) were not found in this study, but they were previously recorded in the state (Sehnem, 1979a; Sehnem, 1979b; Sehnem, 1979c; Fuchs-Eckert, 1986). The aquatic pteridophytes tolerant of flooding (e.g. some species of Blechnaceae, Pteridaceae and Thelypteridaceae) and species associated with brackish environment (e.g. *Acrostichum danaeifolium* Langsd. & Fisch) were not considered in this work. Ecological factors and climate are known to constrain the distribution of plant species (Walter, 1973). While some families have higher species diversity in tropical latitudes, others present higher diversity in temperate latitudes (Crow, 1993).

The U.S. Army Corps of Engineers uses size as the primary consideration in wetland regulations (Snodgrass *et al*., 2000). In wetlands, the relationship between species richness and ecosystems area was observed for waterbirds, mammals, reptiles and plants (Findlay & Houlahan, 1997), such studies being nonexistent for pteridophytes. The lack of relationship between pteridophyte richness and wetland area in Rio Grande do Sul can be due to the low number of pteridophyte species recorded in the studied ecosystems (in general, 1 species in each wetland). The pteridophyte frequency was low in Rio Grande do Sul, occurring mainly in areas of low altitude, besides the Highlands. This result indicates that altitude can be a limiting element to pteridophyte establishment in southern Brazil. However, physico-chemical parameters of surface water should also be considered. Many aquatic plants have broad worldwide or continental ranges (Hutchinson, 1975) and local endemism is rare, although their abundance seems to increase in the tropics (Cook, 1983; 1985). Camenish & Cook (1996) regarded that even rare and endemic species tend to have large geographic ranges, e.g. *Wiesneria triandra* (Dalzell) Micheli which occupies a geographic range of approximately 900 km. *Regnellidium diphyllum* Lindm. is considered endemic to the southern Brazil and surrounding countries (Argentina and Uruguay) (Viana, 1974; Tryon & Tryon, 1982). In spite of the low occurrence of aquatic pteridophyte species in the studied

area, some species had a wide distribution in southern Brazil, occurring in different wetland classes, areas, and altitudes. *Azolla filiculoides*, *Regnellidium diphyllum*, *Salvinia herzogii*, and *Marsilea ancylopoda* were found in different wetland classes, areas, altitude and geomorphologic units. In this sense, these species have a wide distribution at State level, including *Regnellidium diphyllum*, characterized as endemic to southern Brazil, Uruguay and Argentina. *Equisetum giganteum* and *Salvinia minima* have a low distribution in Rio Grande do Sul, and they are restricted to the Coastal Plain. Nevertheless, both species have a broad continental range (Tryon & Tryon, 1982). In Hoshangabad district Aquatic Pteridophytes diversity is very rich due to water bodies are abundantly. There are 3 large and 35 small water bodies. These water bodies contain *Salvinia auriculata, Marsilea minuta Marsillea pinnata, Azolla pinnata ceretophillum, Isoetes panchananai, I. coromanelina,* and *Equisetum ramosissimum. Marsillea pinnata* is present frequently and *Salvinia auriculata* is found vary rare. *isoetes, Ceratopteris* are rare in central India. *Marsillia pinnata, Azolla pinnata* and *Ceratopteris* are found in ground level water bodies while *Eqiesetum, Isoetes panchananai, I. coromanelina* is found in mountain area.

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