

# DISTRIBUTION AND RICHNESS OF WETLAND PTERIDOPHYTES OF UTTAR PRADESH, INDIA

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## ABSTRACT

A survey and description of the aquatic and wetland families of Pteridophytes in Uttar Pradesh is presented herein. A brief description of each family, genus and species with appropriate keys for genera and species is given. The distribution of each species is also documented along with herbarium and a few ecological characteristics of each species.

**Keywords:** Pteridophytes, aquatic plants, distribution, Uttar Pradesh, India.

## INTRODUCTION:

The concept of aquatic and wetland habitats has been subjected to various interpretations and definitions. Similarly, the concept of aquatic and wetlands pteridophytes is difficult to define precisely because of complex life cycles and diversified ecological habitats. In general, it may be allowed that all aquatic and wetland pteridophytes require soils with high water-holding capacity and with high relative humidity. The aquatic and wetland flora, as interpreted in this paper, are those species which live in bodies of water such as lakes, lagoons, dams, marshes and swamps. In the present study description of aquatic and wetland Pteridophytes of Uttar Pradesh and their documented distribution is given. The study area Uttar Pradesh is bounded by Nepal on the North, Uttarakhand on the North- East, Himanchal Pradesh on the North –West and Bihar on the East. They are situated between 23° 52'N and 31° 28'N latitudes and 77° 30'E and 84° 39'E longitude. During the recent exploration between 2012 to 2016 9 species of aquatic pteridophytes from different locations of Uttar Pradesh have been collected.

## MATERIALS & METHODS:

Floristic and ecological survey on the wetlands of Uttar Pradesh was initiated by this laboratory earlier in 2012 and is continued till date (Singh et al., 2014a, b, 2015a, b, 2016), mainly through random sampling. Plants were collected from different water bodies and processed to prepare mounted herbarium sheets. Identification was done by using different taxonomical literature. All voucher specimens are deposited at St. Andrew's college herbarium (SACH).

## OBSERVATION AND ENUMERATION:

The present study is focused mainly on true aquatic ferns epiphytes, i.e. hyperhydrates and pleustophyte and wet loving or terrestrial invaders are not included in this study. Considering this, nine species of six genera representing 6 families were recorded during this study. Keys of recorded taxa, taxonomic details, vernacular names, photographs are provided for their easy recognition.

## KEY TO THE AQUATIC AND WETLAND GENERA OF PTERIDOPHYTES OF UTTAR PRADESH:

1. Plants floating, sometimes rooted in the mud..... 2
  - Plants always rooted..... 4
2. Small floating aquatic plants, entire fronds ..... 3
  - Larger aquatic ferns, leaves dissected, soft fronds..... 4. *Ceratopteris*
3. Leaves in whorls of three, one of them with root-like filaments ..... 2. *Salvinia*
  - Leaves alternating in rows, leaves divided into two lobes ..... 3. *Azolla*
4. Fronds typically four foliate ..... 1. *Marsilea*
  - Blade compound veins free..... 5
5. Fertile portion simple pike ..... 5. *Helminthostachys*
  - Leaves in whorls, more than five forming..... 6
6. Sheaths at nodes; stem hollow, grooved ..... 6. *Equisetum*

## 1. FAMILY MARSILEACEAE:

Aquatic or semi aquatic herbs, with longate, branches and hairy rhizomes. Fronds circinnate in bud, long-stipitate and 2-4 foliate, segments with flabellate venation. Fertile plants bearing one or more sessile or stalked, capsule-like sporocarps at the base of the stipes or along the lower part. Sporocarps variously

septate within, the sori solitary within the compartments, each sorus with two kinds of sporangia: megasporangia each containing a single large megaspore coated with mucilage, and microsporangia containing numerous minute microspores. A small family of 3 genera and about 56 species. Only one genus and two species in Uttar Pradesh.

#### KEY TO GENERA- *MARSILEA*

Leaflets 4, sporangia in sporocarp, at the base of the stipes ..... *Marsilea*

#### KEY TO SPECIES

1. Rhizome long creeping, branched thick, terrestrials Leaves four, sessile, lateral margin entire, veins distinct above and below, flabellately branched, Sporocarps borne at the nodes in clusters..... *minuta*

2. Plant small, creeping fern with erect leaves much resembling four-leaf clover, Rhizome long-creeping, irregularly branched, rooting at the nodes, of few mm in diameter and indefinite length, with pale whit brown hairs..... *crenata*

*Marsilea minuta* L. Mant.308 (1771); Sledge, Bot. J. Linn.Soc.84: 22 (1982); Dixit, Cens.Ind.Pterid. 85 (1984)

Rhizome long creeping, branched subterranean, about 30 cm. long up to 2 mm thick, green in plants, pale or dark brown in terrestrials, covered by about 5 x 0.25 mm, whitish, soft, slender hairs sparsely or densely all over; roots borne usually on nodes, rarely on internodes; Stipes Scattered, about 1 cm apart, up to 16 x 0.2 cm, usually green rarely pale or dark brown, terete, glabrous or with few hairs as in rhizome. Leaves four, sessile, arranged at the tip of the stipe in clover leaf model, lateral margin entire, outer margin usually entire, veins distinct above and below, flabellately branched, connected occasionally by lateral veins; 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 x 1 mm; adnate to the peduncle laterally and perpendicularly, more or less bean shaped, up to 5 x 4 mm, black or dark brown, very hard, densely hairy when young, sparsely or rarely so when mature, slightly, vertically ridged on both convex surfaces; microsporangia and megasporangia enclosed in the same sporocarp and covered by gelatinous layer; microspores yellowish brown, globose, 40 µm in diameter with distinct exine and intine; megaspores ovate, up to 0.65 x 0.5 mm.

*Marsilea crenata*: C. Presl : *Marsilea quadrifolia* Blume non L. (1828), *M. minuta* Raciborski non L. (1898), *M. elata* A. Braun var. *crenata* (C. Presl) Sadeb. (1900).

A small, creeping fern with erect leaves much resembling four-leaf clover. Rhizome long-creeping, irregularly branched, rooting at the nodes, of few mm in diameter and indefinite length, with pale brown hairs; the nodes 3-5 cm apart when submerged, much closer when terrestrial. Leaves arising from the nodes of the rhizome, solitary or clustered; petiole 2-4 cm long on terrestrial plants, 6-30 cm long on aquatic plants, pale to green, darker towards the base, glabrous or sparsely scaly; lamina symmetrical quadrifoliate with the four leaflets broadly obovate, flabellate, 3-25 mm x 2-23 mm, base cuneate, distal margin entire, subentire or sinuate, apex rounded, thin, coriaceous, glabrescent or hairy; veins anastomosing with narrow areoles without included veinlets. Sporocarp oblong, 3-4 mm long, stalk 1-5 mm long, attached to the base of the petiole, apex rounded with 2 small teeth, not ribbed, covered with caducous hairs, with the entire base perpendicularly attached to the stalk, solitary or in groups of 2-5; sporangia of 2 different kinds, one kind producing smaller spores (microspores) which give rise to prothalli bearing only male gametes, the other kind producing much larger spores (megaspores) which develop into prothalli producing only female gametes.

## 2. FAMILY SALVINIACEAE:

Small floating plants with dorsoventral structure. Stems horizontal bearing fronds in whorls of three, two of them green, entire, the third submerged, finely dissected and hairy. Floating fronds with a reticulate venation, the upper surface covered by erect papillae, the under-surface with septate hairs. Plants monoecious, sori in clusters on the submerged frond. A family of a single genus.

#### KEY TO GENERA- *SALVINIA*

Rhizome long creeping, repeatedly dichotomously branched, Leaves in whorls of three, two floating and one submerged. Floating leaves simple 2 cm long and a much broad, ovate/ oblong, leaves flat or infolded along the mid rib ..... *Salvinia*

**KEY TO SPECIES**

Leaves flat or infolded along the mid rib, base cordate, lamina crowded wider than long, upper surface papillate, Fronds 5-15 mm long, hairs fre.....*natans*

*Salvinia natans* (L.) Alioni, Fl. Pedem 2: 289 (1785).

*Marsilea natans* L. Sp. Pl: 1099 (1753).

Rhizome long creeping, repeatedly dichotomously branched, 0.1 cm diameter. Hairy, hairs brown. 7-9 or more celled. Leaves in whorls of three, two floating and one submerged. Floating leaves simple 2 cm long and a much broad, ovate/ oblong, leaves flat or infolded along the mid rib, base cordate, margin entire especially in the older and closely arising leaves, basal margins slightly curved up wards texture thick herbaceous, upper surface hairy, hairs multicellular, in oblique rows between the main lateral veins, with a short stalk and four free spreading branches, greenish- white, lower surface almost glabrous or with brownish acicular hairs; submerged leaves: axis 2-4 mm long 1mm diameter, terminating in 2 or 3 sporocarp bunches subtended by a tuft of (up to 15) root like simple filiform 2-3 cm long branches, covered densely with long acicular hairs, hairs 0.2-0.3 cm long, brown, fine. Sporocarps 2-6, globose, sessile, clustered; megasporocarps 1-2 at base, rest all microsporocarps.

**3. FAMILY AZOLLACEAE:**

Small or minute, floating or subaquatic, heterosporous plants. Habit dorsoventral, stems branching pinnately or dichotomously, bearing stems and roots. Fronds imbricate, alternate in two rows, each frond divided into two lobes, the lobes opposed, unequally developed, the upper ones covering the stem, with a cavity filled with mucilaginous material containing filaments of symbiotic cyanobacteria, the lower ones submerged, without cavities. Sori in pairs on submerged frond-borne lobes, each pair consisting of two microsporocarps, or two megasporocarps. A family with a single genus.

**KEY TO GENERA- AZOLLA**

Leaves many, minute (mm in size) normal, free floating,  
Sporocarp in pairs Leaves covered by simple trichome above.....*Azolla*

**KEY TO SPECIES**

Floating, Stem horizontal, profusely branched, zig- zag, bearing roots which are densely covered by about 2 mm long hairs, veins distinct, anastomosing, Brownish, glabrous; microsporocarps globose.....*pinnata*

*Azolla pinnata* R. Br., Prodr. Fl. Nov. Holl. 167 (1810). Holttum, Fl. Mal. 2: 621 (1954); De Vol, Fl. Taiwan 1: 60 (ed. 2) (1980); Dixit, Cens. Ind. Pterid. 174 (1984); Jamir and Rao, Ferns Nagaland, 405 (1988).

Stem horizontal, profusely branched, zig- zag, bearing roots which are densely covered by about 2 mm long hairs, young roots protected by cone-shaped root cap which encloses a bundle of root hairs; young leaves not in circinnate venation. Leaves alternate, arise from the dorsal lobe, aerial, more or less rectangular, up to 1 × 0.75 mm, sessile, margin entire with a narrow whitish, transparent membranous border, grey- green, thick, enclosing large mucilage filled cavities that harbour blue-green algae, upper surface of the aerial lobe with dense, short blunt, whitish trichomes or with their scars; veins indistinct; ventral lobes submerged, broadly ovate, up to 1 × 1 mm, base cuneate, margin entire, veins distinct, anastomosing, lobes thin membranaceous, transparent, brownish, glabrous; microsporocarps globose, 1 mm in diameter, brown with two layered wall, containing numerous microsporangia which arise from the central columella; megasporocarp smaller than the microsporocarps, ovate, enclosing a single megasporangium

**4. FAMILY PERKERIACEAE:**

Aquatic or subaquatic ferns, subsucculent with soft fronds. Rhizome short, floating. Fronds dimorphic; sterile blades simple to 3-pinnate, broadly divided, bearing proliferous buds; fertile blades longer than the sterile ones, finely-divided, margins reflexed, enclosing 1-4 rows of sporangia. A genus of perhaps 4 species, widely distributed. Two species in Uttar Pradesh.

**KEY TO GENERA- CERATOPTERIS**

Plants floating, sometimes rooted in the mud, soft fronds, dimorphic fronds narrowly divided.....*Ceratopteris*

**KEY TO THE SPECIES OF CERATOPTERIS**

1. Plants usually rooted in mud, sterile fronds lanceolate, fertile fronds up to 3.....*C. thalictroides*

- Plants usually floating, sterile fronds large and deflate fertile fronds up to 5.....  
 pinnate..... **C.gaudichaudii**

**Ceratopteris thalictroides** (L) Brongn. Bull. Soc. Philom. 186 (1821); Clarke in Trans. Linn. Soc. Lond. II Bot. 1: 471 (1880); Beddome, Ferns Br. India, t. 75 (1864); Holttum, F1.Mal.2: 578 (1959); Baishya and Rao, Ferns & Fern Allies Meghalaya 148 (1982); Dixit, Cens.Ind. Pterid.(1984); Manickam, Fern F1.Palni Hills, 31 (1986); Jamir&Rao, Ferns Nagaland, 179, P1.42 (1988).

**Acrostichum thalictroides** L. Sp. P1.2 : 1070 (1753).

Aquatic plants; erect or suberect, bearing, thick fibrous or fleshy, long roots densely on the abaxial side, apex covered by scales; scales soft. Uniformly pale brown, about 2×4 mm, ovate, acute, entire, comprising small, curved cell all over. Fronds arranged in rosette; stipes up to 20 × 1.5 cm, terete, fleshy, pale green, densely ridge all over with few scattered scales. Lamina dimorphous; sterile lamina bipinnatifid or tripinnate, ovate, about 32 × 20 cm, acute, cuneate; primary pinnae about five pairs, slightly ascending, alternate, up to 8 cm apart, distinctly stalked, up to 10 × 6 cm, secondary pinnae about four pairs, alternate, shortly stalked, broadly deltoid or ovate, about 4 × 4 cm, pinnatifid about 2- 3 mm to the costa, ultimate lobes linear, oblong or variously shaped, about 1.5 × 0.7 cm, apex acute, margin entire; veins slightly distinct above and below, copiously anastomosing to form rectangular to hexagonal, elongated areoles of up to 0.5 × 2 mm. Lamina glabrous above and below, pale green; texture soft herbaceous. Fertile lamina ovate, up to 40 × 23 cm, tripinnate, ultimate segment needle like, up to 6 × 0.2 cm, acute, margin reflexed and completely covering the lower surface on which two rows of larger sporangia are borne; spores trilete, 120 µm in diameter, pale green, exine with thick dense, convexed ridges.

**Ceratopteris gaudichaudii** Brongn. Bull. Soc. Philom. 187 (1821)

Floating plants sometimes submerged. Fronds few; stipes 9-33 cm; sterile blades 1 pinnate, deltate to ovate, 20-50 cm long; fertile blades longer than the sterile ones, 4-5 pinnate; pinnae narrowly linear, margins convolute. Sporangia ordered in 1-4 rows. Floating in free water or rooted in mud of swamps.

##### 5. FAMILY HELMINTHOSTCHYCAEAE:

The family is composed of only one genera, widely distributed throughout the world, and *Helminthostachys* in the wet tropics of east Asia and the western Pacific. The spores are consistently trilete with the sporoderm largely formed by an elaborate exospore of three layers, including cavities in the middle layer. The perispore is composed of a thin, fibrillar material that follows the exospore contours. The sporoderm structure in the family is one of the most elaborate types in the Filicopsida.

##### KEY TO GENERA- HELMINTHOSTACHYS

Spike simple; sporangia dehiscing by a longitudinal slit;

lamina glabrous above and below.....**Helminthostachys**

##### KEY TO SPECIES

Rhizome short creeping, terete, Lamina more or less orbicular in outline, up to 30 cm in diameter, ternately divided, each branch shortly stalked; oblong lanceolate, apex acute base cuneate, margin irregularly wavy with sharp edges.....**zeylanica**

**Helminthostachys zeylanica** (L.)Hook. Gen. Fil. t. 47 (1840); Beddome Handb. Ferns Br. India, 467. t. 292 (1883); Suppl. 109 (1892); Thothathriet. al. Bull. Bot. Surv. India, 15 (3 & 4): 243 (1973); Sldge, Bot. J. Linn. Soc. 84: 9 (1982); Dixit.Cens.Ind.Pterid.20 (1984).

**Osmundazeylanica** L. Sp. P1.2: 1063 (1753).

Rhizome short creeping, up to 1 cm diameter, tuberous, terete with about 3 mm thick fleshy roots arranged in two alternate rows on the abaxial side; adaxial side with single row of closely arranged stipe scars; apex covered by oblong, up to 10 × 7 mm, pale brown entire, rounded scales; stipe solitary, produced annually from the same rhizome, up to 30 × 0.6 cm, pale brown at the base, greenish above, terete, glabrous. Lamina more or less orbicular in outline, up to 30 cm in diameter, ternately divided, each branch shortly stalked; lateral branch bears an accessory leaf at the basal basicopic region, forked equally about 4 cm above from the base the accessory branches of lateral branches pendent, basicopic lobe resulting from the forking more or less patent while the acroscopic lobe ascending; middle branch bears a pair of opposite basal leaves and then it forks equally 1.5 cm above from the base; ultimate segment up to 15 × 3 cm, oblong lanceolate, apex acute base cuneate, margin irregularly wavy with sharp edges; veins distinct both above

and below, forked once or twice, free, parallel, up to 1 mm apart reaching the margin; lamina pale green, glabrous above and below, texture thin herbaceous. Fertile branch solitary, arising from the sterile lamina with 11 × 0.2 cm stalk, and 7 × 0.9 cm spike; sporangia in small crested clusters forming a loose spike; sporangia in group of four, green group with a small sterile lobe at apex; spores trilete; exine reticulate.

#### 6. FAMILY EQUISETACEAE:

The horsetail produces two different stalks. One is the fertile "joint-grass", the other is the sterile "horsetail." The fertile stalk produces a cone-like structure at the top, which is covered with spore-producing scales. The spores are wrapped with small bands. These bands unwrap in dry weather to function as a parachute to carry the spores on the wind. Multiple spores frequently become entangled and travel together. The spores germinate into a thallus, cross-fertilize, then develop into a new plant. The word *thallus* is used to describe a plant part that is not differentiated into leaves or a stem.

#### KEY TO GENERA- *EQUISETUM*

Rhizome long creeping, subterranean, branched dark brown, terete with ridges and furrows, stem distinguished in nodes & internodes.....*Equisetum*

#### KEY TO SPECIES

1. Long creeping rhizome, dark brown, lateral branches borne on the nodes; cones borne at the tip of the main stem or branches.....*ramosissimum*

1. Rhizome long creeping nodes & internodes present  
2. Fronds monomorphic, to more than 1 m tall; stems with grooves and ridges, the nodes bearing roots, branches, Cones solitary.....*debile*

*Equisetum ramosissimum* Desf. Fl. Atlant. 2: 398 (1800); Hauke, Amer. Fern Journ. 51 (3): 132, 133, 136 (1961); Hauke, New Botanist, 1(1-2): 93 (1974); Dixit, Cens. Ind. Pterid. 20 (1984).

Rhizome long creeping, subterranean branched, dark brown terete with ridges and furrows, up to 0.8 cm thick with nodes and internodes, bearing fibrous roots and aerial stem, internodal length up to 3 cm, each node bears up to 0.5 cm tall cylindrical sheath. Aerial stem up to 140 × 1 cm. distinguished in to nodes and internodes; internodal region tubular, up to 8 cm. long surface with many ridges and furrows, nodal region not distinguishable, concolorous with internodal part, the dark brown upper edge of the nodal sheath apparently looking like the node; lateral branches one to five, borne around the nodes at the nodal sheath, erect or pendent, up to 30 × 0.3 cm. similar to the main stem; leaves scale like borne on the upper edge of the nodal sheath up to 8 × 1 mm, narrowed, dark and opaque with a thin, membranaceous border at the basal half, margin incised at the distal half; aerial stem pale green, glabrous, coriaceous, cones borne at the tip of the main stem or branches, about 1 × 0.4 cm; sporangia borne on underside of closely fitted, peltatesporophylls with sporophore; spores homosporous, green, up to 30 μm in diameter with four, up to 6 μm wide elators coiling around the spore.

*Equisetum debile* Roxb. Ex. Vauch., Mon. preles : 387 (1821); Clarke, Trans. Linn. Soc. Lond. 2. Bot. 1: 594 (80); Dutie, Cat. P1. Kumaun: 246 (1906).

*Equisetum ramosissimum* Desf. Subsp. (Roxb. Ex Vauch.) Hauke, Amer. Fern J. 52: 33 (1962); Dixit, Census Indian Pterid.: 20 (1984)

Fronds monomorphic, to more than 1 m tall; stems with grooves and ridges, the nodes bearing roots, branches, and leaves in whorls; main stems with 8-25 grooves, (0.2-) 4-7 mm in diameter, dark towards base, bearing (0-) 2-5 branches at the nodes; sheath about 8 mm long, with the teeth up to 7 mm in length, green or brown in the upper portion; teeth pale green to brown, caducous. Cones solitary, terminal on the stems or their branches, about 1 cm long, oblong, cuspidate at apex, subsessile. Sporangioophores hexagonal, peltate, bearing several sporangia; spores isosporous, mixed with the elators cone 8-18 mm long.

## COLLECTION PLACE AND SPECIES RICHNESS:

S. No.	Place of Collection	Plant Name	Species Richness				
			Nil	Rare	Occasional	Common	Abundant
1.	Gorakhpur	<i>Marsilea minuta</i>					++++
		<i>Marsilea crenata</i>		+			
		<i>Salvinia natans</i>			++		
		<i>Azolla Pinnata</i>					++++
		<i>Ceratopteris thalictroides</i>				+++	
		<i>Ceratopteris gaudichaudii</i>			++		
		<i>Helminthostachys zeylanica</i>			++		
		<i>Equisetum ramosissimum</i>				+++	
		<i>Equisetum debile</i>			++		
2.	Maharajganj	<i>Marsilea minuta</i>					++++
		<i>Marsilea crenata</i>	0				
		<i>Salvinia natans</i>			++		
		<i>Azolla Pinnata</i>					++++
		<i>Ceratopteris thalictroides</i>			++		
		<i>Ceratopteris gaudichaudii</i>	0				
		<i>Helminthostachys zeylanica</i>			++		
		<i>Equisetum ramosissimum</i>				+++	
		<i>Equisetum debile</i>			++		
3.	Gonda	<i>Marsilea minuta</i>					++++
		<i>Marsilea crenata</i>	0				
		<i>Salvinia natans</i>	0				
		<i>Azolla Pinnata</i>					++++
		<i>Ceratopteris thalictroides</i>				+++	
		<i>Ceratopteris gaudichaudii</i>		+			
		<i>Helminthostachys zeylanica</i>			++		
		<i>Equisetum ramosissimum</i>				+++	
		<i>Equisetum debile</i>			++		
4.	Lakhimpur - kheri	<i>Marsilea minuta</i>					++++
		<i>Marsilea crenata</i>	0				
		<i>Salvinia natans</i>			++		
		<i>Azolla Pinnata</i>					++++
		<i>Ceratopteris thalictroides</i>				+++	
		<i>Ceratopteris gaudichaudii</i>			++		
		<i>Helminthostachys zeylanica</i>			++		
		<i>Equisetum ramosissimum</i>				+++	
		<i>Equisetum debile</i>			++		
5.	Bahraich	<i>Marsilea minuta</i>					++++
		<i>Marsilea crenata</i>	0				
		<i>Salvinia natans</i>	0				

		<i>Azolla Pinnata</i>					++++
		<i>Ceratopteris thalictroides</i>			++		
		<i>Ceratopteris gaudichaudii</i>	0				
		<i>Helminthostachys zeylanica</i>			++		
		<i>Equisetum ramosissimum</i>				+++	
		<i>Equisetum debile</i>			++		
6.	Chandauli	<i>Marsilea minuta</i>					++++
		<i>Marsilea crenata</i>	0				
		<i>Salvinia natans</i>	0				
		<i>Azolla Pinnata</i>					++++
		<i>Ceratopteris thalictroides</i>			++		
		<i>Ceratopteris gaudichaudii</i>		+			
		<i>Helminthostachys zeylanica</i>			++		
		<i>Equisetum ramosissimum</i>				+++	
		<i>Equisetum debile</i>			++		

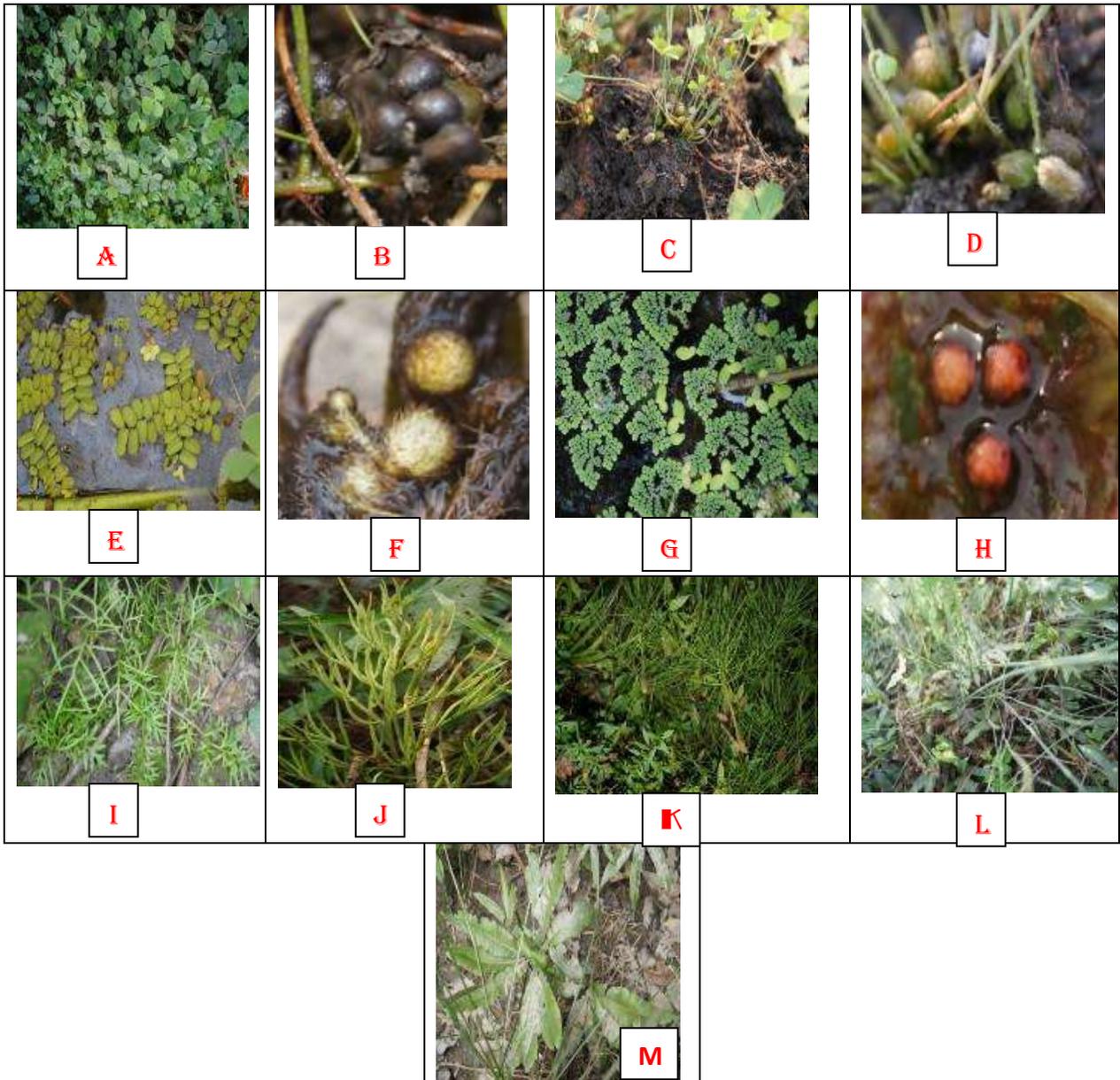
Among the six geographical locations within Uttar Pradesh, Gorakhpur has been observed to with all 9 species and their distribution has also been rich.

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#### REFERENCES

1. Singh S. K., Rajkumar S. D., Srivastava S. K., and Gautam R. P. 2014 a. New record of tetraploid cytotype of *Ampelopterisprolifera*(Retz.) Copel. Pteridophyta from India. Indian Forester140 (9) : 941-942.
2. Singh S. K., Rajkumar S. D., Srivastava S. K., and Gautam R. P. 2014 b. Discovery of diploid cytotype of *Helminthostachys zeylanica* (L.) (Helminthostychaceae- Pteridophyta).Indian Fern Journal 31: 124-131.
3. Singh S. K., Rajkumar S. D., Srivastava S. K., and Gautam R. P. 2015 a. *CheilanthesBicolor*(Roxb.) Fraser Jenkins (Sinopteridaceae -Pteridophyta): A New Record to the Fern Flora of Uttar Pradesh. International Journal of Research Studies in Biosciences 3 (1): 198- 200.
4. Singh S. K., Srivastava S. K, Rajkumar S. D. 2015, b. A New Diploid Cytotype of *Lygodium Flexuosum* (L.) Sw.(Lygodiaceae - Pteridophyta). International Journal of Research Studies in Biosciences 3 (5): 33-36.
5. Singh S. K., Rajkumar S. D., Srivastava S. K., and Gautam R. P. 2016. *Aspliniumdalhousiae*(Hook.) C. Chr. (aspleniaceae): anaddition to the fern flora of Uttar Pradesh - 2. International Journal of Research in Engineering and Biosciences 4 (3): 22-25.



**Legends:**

- A. Habit of *Marsilea minuta*.
- B. Sporocarps of *Marsilea minuta*.
- C. Habit of *Marsilea crenata*.
- D. Hairy Sporocarps of *Marsilea crenata*.
- E. Habit of *Salvinia natans*.
- F. Synangium of *Salvinia natans*.
- G. Habit of *Azolla pinnata*.
- H. Synangium of *Azolla pinnata*.
- I. Habit of *Ceratopteris thalictroides*.
- J. Habit of *Ceratopteris Subspecies gaudichaudii*.
- K. Habit of *Equisetum ramosissimum*.
- L. Habit of *Equisetum debile*.
- M. Habit of *Helminthostachys zeylanica*.