

**Research Article**

## **AQUATIC AND MARSHY ANGIOSPERMIC DIVERSITY OF EASTERN UTTAR PRADESH**

**\*Sanjay Mishra and Satya Narain**

*Duthie Herbarium, Department of Botany, University of Allahabad, Allahabad-211002, India*

*\*Author for Correspondence*

### **ABSTRACT**

As producers, aquatic and marshy angiospermic plants are most important component in aquatic and wetland ecosystems. It is therefore necessary to record and to assess the diversity and potentiality of these aquatic plant communities. In the present study on aquatic and marshy angiosperms of Eastern Uttar Pradesh, 201 species belonging to 115 genera of 50 families were identified. Out of total 201 species, 107 were dicot species belonging to 65 genera of 33 families while 94 species were monocot belonging to 50 genera of 17 families. During the survey of studied area *Ceratophyllum submersum* L. was first time reported from Gangetic plain. Two species were found to be new record for Uttar Pradesh viz. *Alternanthera philoxeroides* (Mart.) Griseb. and *Synedrella vialis* (Less.) A. Gray while *Ranunculus cantoniensis* DC. was found to be extending its distribution in Uttar Pradesh.

**Keywords:** *Aquatic and Marshy Angiosperm, Eastern Uttar Pradesh*

### **INTRODUCTION**

Aquatic and wetland ecosystem which were once considered useless, water logged, unproductive and sometimes even as deleterious are now looked upon as ecosystem with specific ecological characteristics, functions and values (Mishra and Narain, 2010). The aquatic and marshy angiospermic plants are most important component of aquatic and wetland ecosystem. They increase productivity of the aquatic ecosystem and help to maintain ecosystem balance. The importance of aquatic diversity for sustainable life support system is an acceptable fact throughout the world. But these aquatic resources have hardly been given due attention for scientific studies and thus their potentiality remains still underutilized. Aquatic and marshy angiospermic plants comprise a perplexing assemblage of growth habits, often very flexible morphology. The wide phenotypic variations found in these plants pose challenge for taxonomist in their identification. Compared to land plants, these plants exhibit numerous structural modifications which might have adaptive significance.

India constitutes major portion of the Indian sub-continent having such a landmass in the world, which is blessed with a variety of geographical land and much cultural diversity. The wide range of climatic conditions, dense forests, rich and tranquil expanses of meadows, perennial rivers and fertile soil helps India boasts of its rich variety of vegetation that no other country in this world can boast of. The vegetation of Indian flora fluctuates from one region to other. In this regard, an up to date and comprehensive flora is an essential tool for the study of plants of any area and to assess their utility. The comprehensive account of hydrophytic plants of India and Burma were published by Biswas and Calder (1937). Later, Subramanyam (1962) published a volume on aquatic plants of India, followed by an enumeration of aquatic plants of India by Deb (1976). Cook (1996) published a volume on aquatic and wetland plants of India covering northern boundary of India (Arunachal Pradesh, Himanchal Pradesh, Jammu & Kashmir and Sikkim). Monographs have been prepared for only a few groups of aquatic plants (Subramanayam & Balakrishnan 1962, Subramanyam & Abraham 1968, Singh 1972, Subramanyam 1979, Kumar & Banerjee 1999, Kothari 2001).

Uttar Pradesh is one of the largest states of Gangetic Plain. Several botanists and plant explorers have contributed to the flora of various part of Uttar Pradesh. With special reference to aquatic and marshy angiospermic plants the prominent workers are Maliya & Singh (2004), Singh & Srivastava (2007a, 2007b). District Mainpuri has been explored by Maliya (2006), district Lalitpur has been explored by Ranjan (1996), district Hamirpur by Bhattacharyya and Malhotra (1964), Narain (2006), district Eatwah

## Research Article

by Narain & Singh (2008) and Bundelkhand by Narain & Mishra (2008). District Sitapur has been explored by Maheshwari & Tomar (1983), district Shahjahnapur has been explored by Sharma & Dhakre (1993).

Among the regions under the studied area *i.e.* Eastern Uttar Pradesh district Allahabad has been explored by Dubey & Agrawal (1978), district Raebareli by Sinha *et al.*, (1989), Sinha *et al.*, (1990), Singh (1994), Sinha & Dixit (2000), district Lucknow by Trivedi & Sharma (1965), district Jaunpur by Singh & Singh (1972), Mishra & Maurya (2002), district Deoria by Singh & Singh (1991), district Varanasi by Singh (2006b), district Gorakhpur by Sen & Chatterjee (1959), Sen (1960), Dixit *et al.*, (1966), Sahai & Singh (1968), Srivastava *et al.*, (1987), Srivastava *et al.*, (1991), Siddiqui & Dixit (1996), Singh & Srivastava (2000), Srivastava & Srivastava (2007).

Treatments of all the aquatic plants of any considerable area are few. Floras and catalogs frequently reveal a paucity of information about the aquatic phanerogams and their distribution. On many occasions it was found that in study of the flora of a region the aquatic angiosperms frequently received the least consideration. The perusal of literature indicates that Uttar Pradesh has received due attention from botanical point of view, yet there is lack of comprehensive floristic account for various remote localities. Considering the vast stretch of Uttar Pradesh, it is desirable to make proper investigation by selecting certain specified areas with limited boundaries to explore extensively. Due to rapid pace of urbanization, formation of new human settlements and industrialization these aquatic habitat are in severe threat of extinction. It is therefore an urgent and utmost need to record and to assess the diversity and potentiality of these aquatic plant communities before they will vanish forever. The present study which is the result of six year of extensive collection is an effort to do proper investigation, record and assess the diversity and potentiality of these aquatic plant communities in Eastern Uttar Pradesh.

## MATERIALS AND METHODS

### Studied Area

The eastern part of Uttar Pradesh has been considered as a structural entity on the basis of topography, climate, soil, geography and socio-cultural profile. It is one of the richest and interesting regions and has quite varied flora. The area is surrounded by Bihar in the east, Madhya Pradesh in the south, Banda, Fatehpur, Unnao, Lucknow, Barabanki, Bahraich, and Sravasti district of Uttar Pradesh in the west and Nepal in the north. It lies between about 23° 52' N to 27° N latitude and about 82° E to 84° 39' E longitude. The Eastern Uttar Pradesh has an altitude upto 150m above sea level. However some regions of Mirzapur and Sonbhadra range from 300-600m. The studied area is spread over 83,651 sq. km which comprises 26 districts viz. Sonbhadra, Mirzapur, Allahabad, Kausambi, Sant Ravi Das Nagar, Jaunpur, Chandauli, Varanasi, Pratapgarh, Raebareli, Sultanpur, Faizabad, Azamgarh, Ghazipur, Ballia, Basti, Ambedkarnagar, Gonda, Siddarthnagar, Maharajganj, Kusunagar, Deoria, Sant Kabir Nagar, Gorakhpur, Mau, Balrampur are the eastern part of Uttar Pradesh (Figure 1).

### Methodology

#### Field Survey

A systematic, intensive and critical floristic and ethnobotanical exploration of study area *i.e.* Eastern Uttar Pradesh was done in the time span of five years. During the exploration all areas were explored in all the three seasons, so as to collect plants in flowering and fruiting and to note the seasonal changes. Generally 4-6 specimens for each species of plants were collected after making observation on the habit, habitat, frequency of occurrence, association, color of the flowers, which cannot be observed from dried herbarium sheets. Information regarding medicinal or other uses, if any and vernacular names were gathered from local people. All these information's were recorded in field notebook.

#### Preparation of Herbarium Specimens

All the collected specimens were dipped in 10% Hg Cl<sub>2</sub> in alcohol solution before pressing them in blotting papers. The papers were changed in every alternate day till specimens became completely dry. After perfect drying, one set of the specimens were mounted on hand made Herbarium sheets of 42 x 28 cm size with the help of modern synthetic adhesives like fevicol. Each mounted specimen was provided

## Research Article

with a label wherein data pertinent to field number, date of collection, botanical name, family to which it belongs, place of collection, brief diagnostic description, uses if any, local name(s) etc. is mentioned. Fleshy specimens, delicate flowers and large plant parts like tubers, rhizomes, corms, fruits, etc which could not be mounted on herbarium sheets were preserved in jars following customary preservative methods.

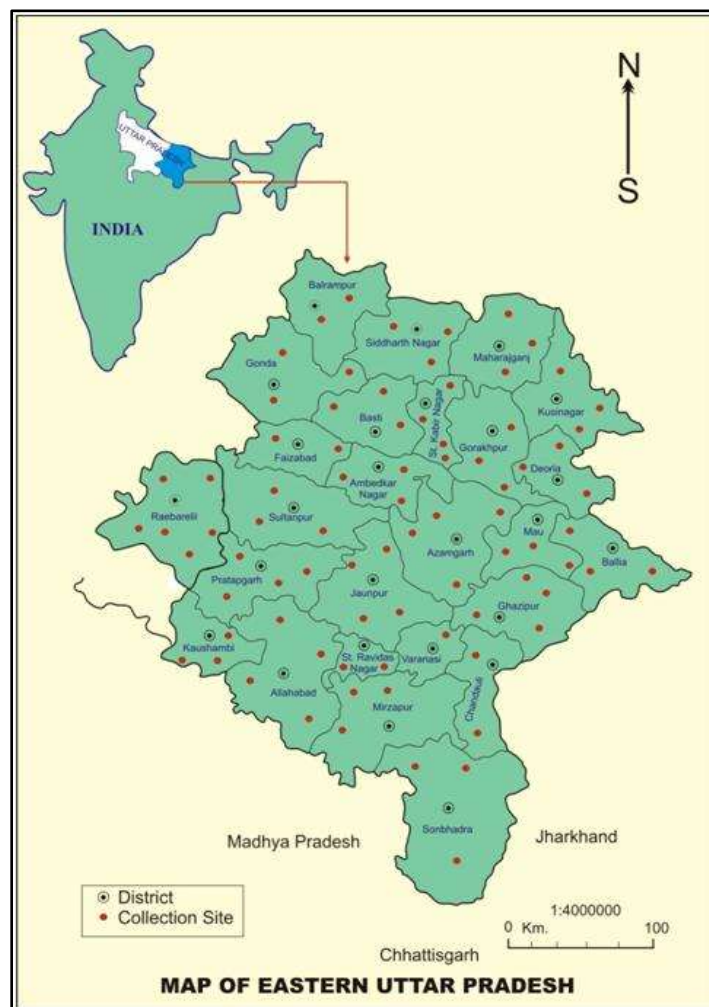


Figure 1: Map of study area

## Identification

Identification is the process through which a specimen is identified by its characters with the help of standard worldwide or Indian flora viz. Hooker (1872-1897), Bailey (1949), Benthams (1866), Dassnayake & Fosberg (1991), Duthie (1903-1929), Fasset (1940), Raizada (1976), Cook (1996) and local flora viz. Mishra & Verma (1992), Verma *et al.*, (1997), Singh *et al.*, (2001) and others. The specimen were identified by the genus and species keys and compared with full description and illustrations, thereafter it was carefully compared with earlier identified plants of that species or variety as the case may be. Literature was consulted and collected from library of National Botanical Research Institute (NBRI), Lucknow, Botanical Survey of India (BSI), Central Circle, Allahabad, and Library of Department of Botany, University of Allahabad. Herbarium specimens kept in Herbaria of NBRI, BSI (Central circle) and Duthie herbarium of University of Allahabad were studied for identification and matching of plants.

## Research Article

All the collected plants, on which this work is based, have been deposited in Duthie Herbarium, Department of Botany, University of Allahabad, Allahabad, India, for future record. The plants associated with this work have been enumerated according to Bentham and Hooker's system of classification.

## RESULTS AND DISCUSSION

The present study is based on the results of extensive survey and study on aquatic and marshy angiospermic plants of eastern Uttar Pradesh. The plants which have been included in the present study are those plants normally found in nature growing in association with running or standing water whose level is at or above the surface of the soil. The plants may be floating, completely submerged or partly submerged in the water. In some instances the plants may merely be growing near the water but in definite association with it. However, individual plants found growing under these conditions have not been included if it was not their normal habitat.

During the present study on aquatic and marshy angiosperms of Eastern Uttar Pradesh, 201 species belonging to 115 genera of 50 families were identified. Out of total 201 species, 107 were dicot species belonging to 65 genera of 33 families while 94 species were monocot belonging to 50 genera of 17 families (Table 1).

S.No.	Name	Life Form	Life Period	Fruit Type
1	<i>Ranunculus cantoniensis</i> DC.	WL	A	Achene
2	<i>Ranunculus sceleratus</i> L.	WL	A	Achene
3	<i>Nymphaea nouchali</i> Burm	FLA	P	Berry
4	<i>Nymphaea pubescens</i> Willd.	FLA	P	Berry
5	<i>Nymphaea rubra</i> Roxb. ex Andrews	FLA	P	Berry
6	<i>Nelumbo nucifera</i> Gaertn.	FLA	P	Achene
7	<i>Coronopus didymus</i> (L.) Sm.	WL	A	Silicle
8	<i>Rorippa indica</i> (L.) Hiern	WL	A/B	Siliqua
9	<i>Spergula fallax</i> (Lowe) E. H. L. Krause	WL	A	Capsule
10	<i>Stellaria media</i> (L.) Vill.	WL	A	Capsule
11	<i>Bergia ammannioides</i> Roxb.	EA	A	Capsule
12	<i>Bergia capensis</i> L.	EA	A	Capsule
13	<i>Melochia corchorifolia</i> L.	WL	A	Capsule
14	<i>Corchorus capsularis</i> L.	WL	A	Capsule
15	<i>Corchorus olitorius</i> L.	WL	A	Capsule
16	<i>Oxalis corniculata</i> L.	WL	P	Capsule
17	<i>Oxalis corymbosa</i> DC.	WL	P	Capsule
18	<i>Aeschynomene aspera</i> L.	EA	P	Pod
19	<i>Aeschynomene indica</i> L.	EA	P	Pod
20	<i>Desmodium triflorum</i> (L.) DC.	WL	P	Pod
21	<i>Sesbania bispinosa</i> (Jacq.) W. F. Wight	WL	A/B	Pod
22	<i>Smithia conferta</i> J. F. Smith	WL	A	Pod
23	<i>Neptunia oleracea</i> Lour.	FF	A/P	Pod
24	<i>Ammannia auriculata</i> Willd.	EA	A	Capsule
25	<i>Ammannia baccifera</i> L.	EA	A	Capsule
26	<i>Ammannia multiflora</i> Roxb.	EA	A	Capsule
27	<i>Rotala indica</i> (Willd.) Koehne	WL	A	Capsule
28	<i>Ludwigia adscendens</i> (L.) Hara	FSA	P/A	Capsule
29	<i>Ludwigia hyssopifolia</i> (G. Don) Exell	EA	A	Capsule
30	<i>Ludwigia octovalvis</i> (Jacq.) Raven	EA	A	Capsule
31	<i>Ludwigia perennis</i> L.	EA	A	Capsule
32	<i>Ludwigia prostrata</i> Roxb.	EA	A	Capsule



# Research Article

33	<i>Trapa natans</i> L.	FLA	A	Drupe
34	<i>Glinus lotoides</i> L.	WL	A	Capsule
35	<i>Centella asiatica</i> (L.) Urban	WL	A/P	Cremocarp
36	<i>Oenanthe javanica</i> (Bl.) DC.	WL	P	Cremocarp
37	<i>Seseli diffusum</i> (Roxb. ex Sm.) Sant. and Wagh	WL	A	Cremocarp
38	<i>Dentella repens</i> (L.) J. R. & G. Forst.	WL	A	Capsule
39	<i>Oldenlandia corymbosa</i> L.	WL	A	Capsule
40	<i>Adenostemma lavenia</i> (L.) Kuntze	WL	A/P	Cypsela
41	<i>Caesulia axillaris</i> Roxb.	EA	A/P	Cypsela
42	<i>Centipeda minima</i> (L.) A. Br. & Aschers.	WL	A	Cypsela
43	<i>Chrysanthellum americanum</i> (L.) Vatke	WL	A	Cypsela
44	<i>Cirsium verutum</i> (D. Don) Spreng	WL	A	Cypsela
45	<i>Cotula anthemoides</i> L.	WL	A	Cypsela
46	<i>Cotula hemispherica</i> (Roxb.) Wallich ex C. B. Clarke	WL	A	Cypsela
47	<i>Eclipta prostrata</i> (L.) L.	WL	A/P	Cypsela
48	<i>Enhydra fluctuans</i> Lour.	EA	A/P	Cypsela
49	<i>Gnaphalium luteo-album</i> subsp. <i>affine</i> (D. Don) Koster	WL	A	Cypsela
50	<i>Gnaphalium luteo-album</i> subsp. <i>luteo-album</i> L.	WL	A	Cypsela
51	<i>Gnaphalium pensylvanicum</i> Willd.	WL	A	Cypsela
52	<i>Gnaphalium polycaulon</i> Pers.	WL	A	Cypsela
53	<i>Gnaphalium pulvinatum</i> Delile	WL	A	Cypsela
54	<i>Grangea maderaspatana</i> (L.) Poir.	WL	A	Cypsela
55	<i>Soliva anthemifolia</i> (Juss.) R. Br.	WL	A/B	Cypsela
56	<i>Sphaeranthus senegalensis</i> DC.	WL	A	Cypsela
57	<i>Spilanthes ciliata</i> H. B. K.	WL	A	Cypsela
58	<i>Spilanthes oleracea</i> L.	WL	A/P	Cypsela
59	<i>Spilanthes paniculata</i> Wallich ex DC.	WL	A	Cypsela
60	<i>Spilanthes radicans</i> Jacq.	WL	A	Cypsela
61	<i>Synedrella vialis</i> (Less.) A. Gray	WL	A	Cypsela
62	<i>Vernonia cinerea</i> (L.) Less.	WL	A	Cypsela
63	<i>Xanthium indicum</i> Koenig in Roxb.	WL	A	Cypsela
64	<i>Sphenoclea zeylanica</i> Gaertn.	WL	A	Capsule
65	<i>Anagallis arvensis</i> L.	WL	A	Capsule
66	<i>Canscora decurrens</i> Dalzell	WL	A	Capsule
67	<i>Canscora decussata</i> (Roxb.) Roem. & Schult	WL	A	Capsule
68	<i>Nymphoides hydrophylla</i> (Lour.) Kuntze	FLA	A/P	Capsule
69	<i>Nymphoides indicum</i> (L.) Kuntze	FLA	A/P	Capsule
70	<i>Hydrolea zeylanica</i> (L.) Vahl	EA	A	Capsule
71	<i>Evolvulus nummularius</i> (L.) L.	WL	P	Capsule
72	<i>Ipomoea aquatica</i> Forssk.	FSA	P	Capsule
73	<i>Ipomoea carnea</i> Jacq.	WL	P	Capsule
74	<i>Bacopa monnieri</i> (L.) Wettst.	WL	P/A	Capsule
75	<i>Dopatrium junceum</i> (Roxb.) Buch.-Ham. ex Benth.	WL	A	Capsule
76	<i>Limnophila indica</i> (L.) Druce	EA	A/P	Capsule
77	<i>Lindernia anagallis</i> (Burm. f.) Pennell	WL	A/P	Capsule
78	<i>Lindernia ciliata</i> (Colsm.) Pennell	WL	A	Capsule
79	<i>Lindernia crustacea</i> (L.) F.V. Muell.	WL	A	Capsule
80	<i>Lindernia procumbens</i> (Krock.) Borbas	WL	A	Capsule
81	<i>Mazus pumilus</i> (Burm. f.) Steenis	WL	A	Capsule

# Research Article

82	<i>Veronica anagallis-aquatica</i> L.	WL	A/P	Capsule
83	<i>Utricularia australis</i> R. Br.	SH	P	Capsule
84	<i>Utricularia exoleta</i> R. Br.	SH	A/P	Capsule
85	<i>Utricularia stellaris</i> L. f.	SH	A/P	Capsule
86	<i>Hygrophila auriculata</i> (Schumach.) Heine	WL	A/P	Capsule
87	<i>Hygrophila polysperma</i> (Roxb.) T. Anderson	WL	A	Capsule
88	<i>Justicia quinquangularis</i> var. <i>peploides</i> (Nees) C. B. Clarke	WL	A/P	Capsule
89	<i>Phyla nodiflora</i> (L.) E. Greene	WL	A	Drupe
90	<i>Pogostemon stellatus</i> (Lour.) Kuntz.	WL	A/P	Nut
91	<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	EA	P	Utricle
92	<i>Alternanthera pungens</i> Kunth	WL	P	Utricle
93	<i>Alternanthera sessilis</i> (L.) R. Br. ex DC.	WL	P	Utricle
94	<i>Polygonum barbatum</i> var. <i>barbatum</i> Khan & Hassan	WL	P	Nut
95	<i>Polygonum barbatum</i> var. <i>stagninum</i> (F. Ham. ex Meissn.) Stewart	WL	P	Nut
96	<i>Polygonum glabrum</i> Willd.,	WL	P	Nut
97	<i>Polygonum hydropiper</i> L. subsp. <i>microcarpum</i> Danser var. <i>triquetrum</i> Danser	EA	A	Nut
98	<i>Polygonum limbatum</i> Meisn.	WL	A	Nut
99	<i>Polygonum lapathifolium</i> var. <i>lanatum</i> (Roxb.) Steward	WL	A	Nut
100	<i>Polygonum plebeium</i> R. Br., var. <i>effusa</i> (Meisn.) Hook. f.	WL	A	Nut
101	<i>Polygonum plebeium</i> R. Br., var. <i>elegans</i> (Roxb.) Hook. f.	WL	A	Nut
102	<i>Polygonum pulchrum</i> Blume	WL	A	Nut
103	<i>Polygonum serrulatum</i> Lag.	WL	P	Nut
104	<i>Rumex dentatus</i> L. subsp. <i>klotzschianus</i> (Meisn.) Rchb.	WL	A	Nut
105	<i>Peperomia pellucida</i> (L.) Kunth	WL	A	Berry
106	<i>Ceratophyllum demersum</i> L.	SH	P/A	Nut
107	<i>Ceratophyllum submersum</i> L.	SH	P/A	Nut
108	<i>Hydrilla verticillata</i> (L. f.) Royle	EA	P	Capsule
109	<i>Lagarosiphon alternifolia</i> (Roxb.) Druce	SA	A	Utricle
110	<i>Ottelia alismoides</i> (L.) Pers.	SA	A	Capsule
111	<i>Vallisneria natans</i> (Lour.) Hara	SA	A	Berry
112	<i>Asphodelus tenuifolius</i> Cav.	WL	A	Capsule
113	<i>Eichhornia crassipes</i> (Mart.) Solms	FF	P	Capsule
114	<i>Monochoria vaginalis</i> (Burm. f.) K. Presl	EA	A/P	Capsule
115	<i>Commelina benghalensis</i> L.	WL	A	Capsule
116	<i>Commelina diffusa</i> Burm. f.	WL	A	Capsule
117	<i>Commelina erecta</i> L.	WL	A	Capsule
118	<i>Commelina hasskarlii</i> C. B. Clarke	WL	A	Capsule
119	<i>Commelina longifolia</i> Lam.	WL	A	Capsule
120	<i>Commelina paludosa</i> Blume	WL	A	Capsule
121	<i>Juncus bufonius</i> L.	WL	A	Capsule
122	<i>Typha angustifolia</i> L.	WL	P	Nutlet
123	<i>Acorus calamus</i> L.	WL	P	Berry
124	<i>Pistia stratiotes</i> L.	FF	P	Berry

# Research Article

125	<i>Lemna perpusilla</i> Torr.	FF	P	Utricle
126	<i>Spirodela polyrhiza</i> (L.) Schleid.	FF	A	Utricle
127	<i>Wolffia arrhiza</i> (L.) Horkel ex Wimm.	FF	A	Utricle
128	<i>Caldesia parnassifolia</i> (Bassi ex L.) Parl.	EA	P/A	Achene
129	<i>Limnophyton obtusifolium</i> (L.) Miq.	EA	A/P	Achene
130	<i>Sagittaria guayanensis</i> Humb.	FLA	A	Achene
131	<i>Sagittaria trifolia</i> L.	EA	P	Achene
132	<i>Butomopsis latifolia</i> (D. Don) Kunth	EA	A	Nutlet
133	<i>Najas graminea</i> Delile	SA	A	Achene
134	<i>Najas indica</i> (Willd.) Cham.	SA	A	Achene
135	<i>Najas minor</i> All.	SA	A	Achene
136	<i>Aponogeton crispum</i> Thunb.	FLA	P	Follicle
137	<i>Aponogeton natans</i> (L.) Engl. & K. Krause	FLA	P	Follicle
138	<i>Potamogeton crispus</i> L.	SA	P	Drupe
139	<i>Potamogeton nodosus</i> Poir.	SA	P	Drupe
140	<i>Potamogeton pectinatus</i> L.	SA	P	Drupe
141	<i>Potamogeton perfoliatus</i> L.	SA	P	Drupe
142	<i>Zannichellia palustris</i> L.	SH	P	Drupe
143	<i>Eriocaulon cinereum</i> R. Br.	EA	A	Capsule
144	<i>Bulbostylis barbata</i> (Rottb.) C. B. Clarke	WL	A	Nut
145	<i>Cyperus alulatus</i> Kern	WL	A	Nut
146	<i>Cyperus brevifolius</i> (Rottb.) Hassk.	WL	P	Nut
147	<i>Cyperus flavidus</i> Retz.	WL	A/P	Nut
148	<i>Cyperus iria</i> L.	WL	A	Nut
149	<i>Cyperus kyllingia</i> Endl.	WL	P	Nut
150	<i>Cyperus laevigatus</i> L.	WL	P	Nut
151	<i>Cyperus michelianus</i> (L.) Delile	WL	A	Nut
152	<i>Cyperus niveus</i> Retz.	WL	P	Nut
153	<i>Cyperus rotundus</i> L.	WL	P	Nut
154	<i>Eleocharis acutangula</i> (Roxb.) Schult.	WL	P	Nut
155	<i>Eleocharis atropurpurea</i> (Retz.) J. Presl & K. Presl	WL	A	Nut
156	<i>Eleocharis dulcis</i> (Burm. f.) Hensch.	WL	P	Nut
157	<i>Eleocharis palustris</i> (L.) R. Br.	WL	P	Nut
158	<i>Fimbristylis dichotoma</i> (L.) Vahl	WL	A/P	Nut
159	<i>Fimbristylis miliacea</i> (L.) Vahl	WL	A/P	Nut
160	<i>Fimbristylis schoenoides</i> (Retz.) Vahl	WL	P	Nut
161	<i>Scirpus articulatus</i> L.	WL	A/P	Nut
162	<i>Scirpus grossus</i> L. f.	WL	P	Nut
163	<i>Scirpus lacustris</i> L.	WL	P	Nut
164	<i>Scirpus lateriflorus</i> J. F. Gmelin	WL	A	Nut
165	<i>Scirpus litoralis</i> Schrad.	WL	P	Nut
166	<i>Scirpus maritimus</i> L.	WL	P	Nut
167	<i>Scirpus mucronatus</i> L.	WL	P	Nut
168	<i>Scirpus roylei</i> (Nees) Parker	WL	A	Nut
169	<i>Scirpus tuberosus</i> Desf.	WL	P	Nut
170	<i>Arundo donax</i> L.	WL	P	Caryopsis
171	<i>Brachiaria distachya</i> (L.) Stapf	WL	A/P	Caryopsis
172	<i>Brachiaria ramosa</i> (L.) Stapf	WL	A	Caryopsis
173	<i>Brachiaria reptans</i> (L.) Gard. & Hubb.	WL	A	Caryopsis
174	<i>Coix gigantea</i> Koenig ex Roxb.	WL	P	Caryopsis

# Research Article

175	<i>Coix lachryma-jobi</i> L.	WL	A	Caryopsis
176	<i>Echinochloa colonum</i> (L.) Link	WL	A	Caryopsis
177	<i>Echinochloa crusgalli</i> (L.) P. Beauv.	WL	A	Caryopsis
178	<i>Echinochloa stagnina</i> (Retz.) P. Beauv.	WL	A/P	Caryopsis
179	<i>Eragrostis atrovirens</i> (Desf.) Trin. ex Steud.	WL	P	Caryopsis
180	<i>Eragrostis pilosa</i> (L.) P. Beauv.	WL	A	Caryopsis
181	<i>Eragrostis unioides</i> (Retz.) Nees ex Steud.	WL	A	Caryopsis
182	<i>Eriochloa procera</i> (Retz.) Hubb.	WL	A	Caryopsis
183	<i>Hygroryza aristata</i> (Retz.) Nees ex Wight & Arnott	FF	A	Caryopsis
184	<i>Ischaemum rugosum</i> Salisb.	WL	A/P	Caryopsis
185	<i>Iseilema laxum</i> Hack.	WL	P	Caryopsis
186	<i>Lolium temulentum</i> L.	WL	A	Caryopsis
187	<i>Ophiuros exaltatus</i> (L.) Kuntze	WL	P	Caryopsis
188	<i>Oplismenus burmannii</i> (Retz.) P. Beauv.	WL	A	Caryopsis
189	<i>Oryza rufipogon</i> Griff.	WL	P/A	Caryopsis
190	<i>Oryza sativa</i> L.	WL	A/P	Caryopsis
191	<i>Panicum paludosum</i> Roxb.	WL	A	Caryopsis
192	<i>Paspalidium flavidium</i> (Retz.) A. Camus	WL	P	Caryopsis
193	<i>Paspalidium punctatum</i> (Burm. f.) A. Camus	WL	P	Caryopsis
194	<i>Paspalum paspaloides</i> (Michx.) Scribner	WL	A	Caryopsis
195	<i>Paspalum scrobiculatum</i> L.	WL	A	Caryopsis
196	<i>Phragmites karka</i> (Retz.) Trin. ex Steud.	WL	P	Caryopsis
197	<i>Saccharum spontaneum</i> L.	WL	P	Caryopsis
198	<i>Setaria intermedia</i> Roem. & Schult.	WL	A	Caryopsis
199	<i>Setaria pumilla</i> (Poir.) Roem. & Schult.	WL	A	Caryopsis
200	<i>Urochloa panicoides</i> Beauv.	WL	A	Caryopsis
201	<i>Vetivaria. zizanioides</i> (L.) Nash	WL	P	Caryopsis

Life Form - WL: Wetland, EA: Emergent, SA: Submerged Anchored, FLA: Floating leaved Anchored, FF: Free Floating, SH: Submerged Hydrophytes, FSA: Floating Shoot Anchored

Life Period - A: Annual, P: Perennial, A/P: Mostly Annual Sometimes Perennial, P/A: Mostly Perennial Sometimes Annual, A/B: Mostly Annual Sometimes Biennial

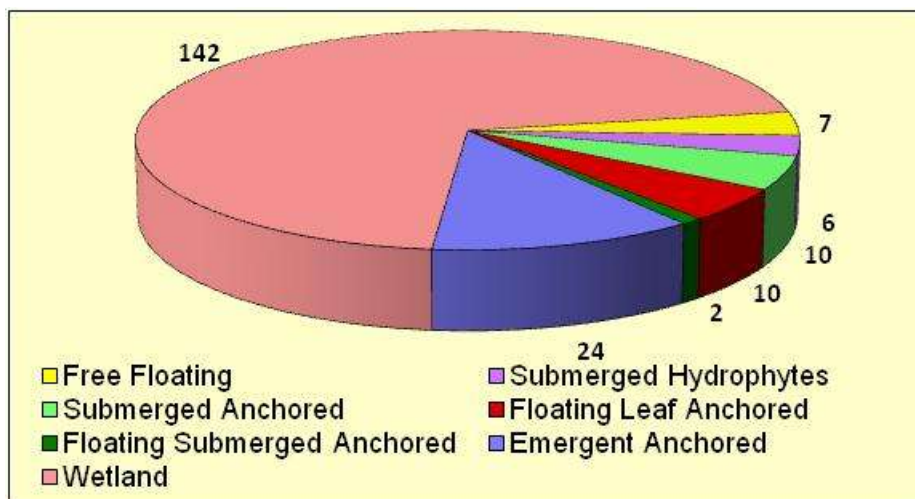
In the analysis of families, Poaceae turned out to be the most dominant family having 32 species followed by Cyperaceae with 26 species, Asteraceae with 24 species, Polygonaceae with 11 species and Scrophulariaceae with 9 species are other dominant families. Among the dicot families, Asteraceae turned out to be most dominant family with 24 species followed by Polygonaceae with 11 species and Scrophulariaceae with 9 species. Fabaceae, Onagraceae each with 5 species and Lythraceae with 4 species are other dominant families. Among the monocot families, Poaceae turned out to be the most dominant family with 32 species followed by Cyperaceae with 26 species and Commelinaceae with 6 species. Hydrocharitaceae, Alismataceae and Potamogetonaceae each with 4 species are other dominant families. Out of total 50 families, 15 families turned out to be pure aquatic i.e. all the species belonging to these families are aquatic. Among these 6 are dicot families while 9 are monocot families. An analysis of total 115 genera collected and identified during the study shows that *Polygonum* is the most dominant genera with 10 species followed by *Cyperus* and *Scirpus* with 9 species each. *Commelina* with 6 species, *Ludwigia* and *Gnaphalium* with 5 species each are other dominant genera.

In the present study, aquatic and marshy angiospermic plants have been classified into seven life forms depending upon nature and type of habitat and their contact with soil, air and water. Among 201 species collected during the survey, 142 species have been recorded as wetland hydrophytes (WL) as they grow in soil saturated with water. Next to them are emergent amphibious hydrophytes (EA) with 24 species. The roots, the lower portion of the stem and in some cases even the lower leaves of these plants are



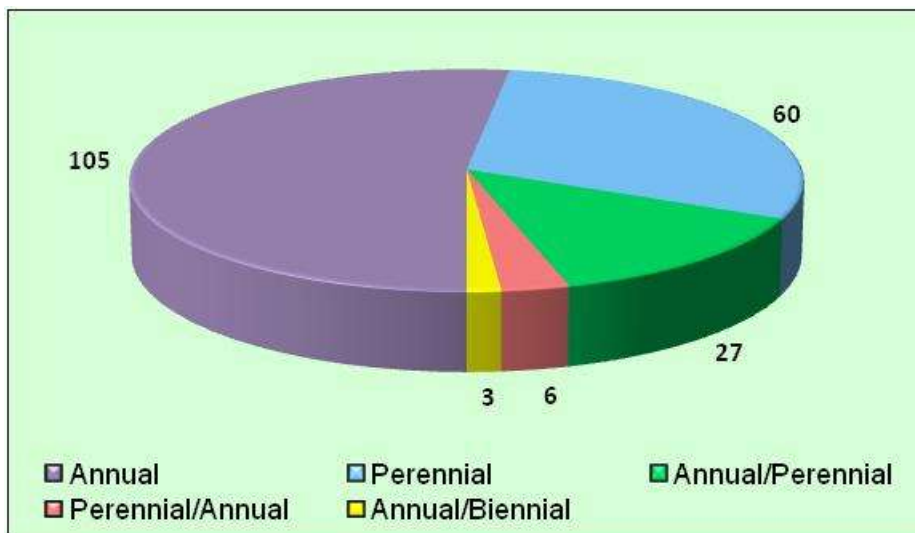
## Research Article

submerged under water. 10 species have been recorded as submerged anchored hydrophytes (SA). These species are entirely or for the most part of their life cycle in contact with soil and water only. 10 species have been recorded as floating leaved anchored hydrophytes (FLA). These are in contact with soil, water as well as air. 7 species have been recorded as free floating hydrophytes (FF). These plants are in contact with water and air only. 6 species have been recorded as suspended hydrophytes (SH) as these plants are rootless and are in contact with water only. Only 2 species have been found to be floating shoots anchored hydrophytes (FSA). These plants are rooted in the muddy substratum with their shoots floating on the water surface (Figure-2a).



**Figure 2: (a) Life forms of aquatic and marshy angiosperms**

An analysis of the life period of aquatic and marshy angiospermic plants revealed that 106 species (52.23%) are annual. 60 species (29.85%) have been recorded as perennial. 27 species (13.43%) have been found to be annual plants which on availability of water and favourable conditions may behave as perennials. 6 species (2.98%) have been found to be perennial plants which sometimes behave as annuals if conditions are unfavourable. 3 species (1.49%) were found to be annuals but sometimes behaving as biennials on the availability of water and favourable conditions (Figure-2b).



**Figure 2(b): Analysis of Life Period**

## Research Article

An analysis of types of fruits found in collected plants reveal that capsule is the most common type of fruit followed by nut. Caryopsis, characteristic fruit of Poaceae and cypsela, characteristic of Asteraceae family are other dominant types of fruits.

Phenological analysis of collected plants shows maximum flowering and fruiting in November with 68.81% followed by the month of October with 67.82% and December with 65.34%. An increasing trend is evident in flowering and fruiting from July to November. November is the month in which maximum species show flowering. After November a gradual decline is evident and it reaches to its lowest in the month of June with only 18.81% of flowering. It can be concluded from the analysis that the best period for the collection of aquatic and marshy angiospermic plants is September to December. The plant species which shows flowering and fruiting throughout year are *Ludwigia octovalvis*, *L. hyssopifolia*, *Glinus lotoides*, *Eclipta prostrata*, *Ipomoea aquatica*, *Ipomoea carnea*, *Phyla nodiflora*, *Alternanthera pungens*, *Alternanthera sessilis*, *Typha angustifolia*, *Cyperus brevifolius*, *Fimbristylis dichotoma*, *Scirpus lateriflorus* (Figure -3), (Table-2).



Figure 3: Phenological analysis of aquatic and marshy angiosperms

Table 2: Percentage of Monthly Flowering and Fruiting

Month	No. of Species	Percentage Flowering
January	111	54.95
February	102	50.49
March	89	40.05
April	74	36.63
May	53	26.23
June	38	18.81
July	48	23.76
August	95	47.02
September	121	59.90
October	137	67.82
November	139	68.81
December	132	65.34

During the survey of studied area *Ceratophyllum submersum* L. was first time reported from Gangetic plain (Narain & Mishra 2006). Two species were found to be new record for Uttar Pradesh viz.

### Research Article

*Alternanthera philoxeroides* (Mart.) Griseb. (Kumar *et al.*, 2008a) and *Synedrella vialis* (Less.) A. Gray (Lata *et al.*, 2008). *Ranunculus cantoniensis* DC. was collected from Ghazipur district and found to be extending its distribution (Kumar *et al.*, 2008b) as Earlier it was reported only from the district Lakhimpur Khiri which comes under Terai region while district Ghazipur is situated in Upper Gangetic plain.

### ACKNOWLEDGEMENT

The author express their sincere gratitude to CSIR, New Delhi and Uttar Pradesh State Biodiversity Board (UPSBB) for providing fund and Head, Department of Botany, University of Allahabad, Allahabad for providing laboratory facilities.

### REFERENCES

- Bailey LH (1949).** *Manual of Cultivated Plants* 2 edition (New York).
- Bhattacharyya UC and Malhotra CL (1964).** Botanical exploration in Hamirpur district (U.P) with special reference to Mahoba aquatics. *Bulletin of the Botanical Survey of India* **6** 23-41.
- Biswas K and Calder CC (1937).** *Hand-book of Common Water and Marshy Plants of India and Burma* (Govt. Press, Delhi).
- Cook CDK (1996).** *Aquatic and Wetland Plants of India* (Oxford University Press London).
- Dassanayake MD and Fosberg FR (1991).** *Flora of Ceylon* (Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi).
- Deb DB (1976).** A study on the aquatic vascular plants of India. *Bulletin of the Botanical Society of Bengal* **29** 155-230.
- Dixit SN, Verma SD and Srivastava TN (1966).** Additions to the rainy season weeds of Gorakhpur. *Proceedings of the National Academy of Sciences, India* **36**(2) 14-56.
- Dubey RP and Agarwal R (1978).** Studies in the Aquatic and Lowlying vegetation of Allahabad. *Geobios* **5** 234-235.
- Duthie JF (1903-1929).** *Flora of the Upper Gangetic Plain and of the Adjacent Siwalik and Sub-Himalayan Tracts* Calcutta.
- Fassett NC (1940).** *A Manual of Aquatic Plants* (New York and London).
- Hooker JD (1872-1897).** *The Flora of British India* **7** London.
- Kothari MJ (2001).** A revision of Family Potamogetonaceae of India. *Bulletin of the Botanical Survey of India* **43**(1-4) 151-194.
- Kumar P, Mishra S and Narain S (2008a).** *Alternanthera philoxeroides* (Mart.) Griseb. - An Addition to Uttar Pradesh. *Journal of Indian Botanical Society* **87**(3 & 4) 285-286.
- Kumar P, Mishra S and Narain S (2008b).** Extended Distribution of Rare and Little Known *Ranunculus cantoniensis* DC. - In Uttar Pradesh. *Journal of Phytological Research* **21**(1) 147-148.
- Kumar PS and Banerjee LK (1999).** *Potamogeton* L. the common pond weed in Eastern India. *ENVIS* **6** 12-14.
- Lata K, Mishra S and Narain S (2008).** Notes on occurrence of *Synedrella vialis* (Less.) A. Gray in Uttar Pradesh, India. *Journal of Economic and Taxonomic Botany* **32**(3) 610-612.
- Maheshwari, J. K. & R. P. S. Tomar (1983).** A contribution to wetland flora of Sitapur district. U.P. *Journal of the Bombay Natural History Society* **80** 529-538.
- Maliya SD (2006).** The Aquatic and Wetland Flora of Mainpuri district, U. P. India. *Journal of Economic & Taxonomic Botany* **30**(3) 533-546.
- Maliya SD and Singh SM (2004).** Diversity of aquatic & wetland macrophytes vegetation of Uttar Pradesh (India). *Journal of Economic & Taxonomic Botany* **28**(4) 935-975.
- Mishra KN and Maurya LP (2002).** Phytodiversity in relation to ecovariability of two wetlands of Jaunpur (U.P.). *Journal of Phytological Research* **15**(2) 201-208.
- Mishra S and Chauhan DK (2013).** Role of sedges (Cyperaceae) in wetlands and their economic, ethnobotanical, importance. *Proceedings of UPSBB on Water and Biodiversity* **1** 61-70.

### Research Article

- Mishra S and Narain S (2010).** Floristic and ecological studies of Bakhira wetland, U.P. *Indian Forester* **136**(3) 375-381.
- Misra BK and Verma BK (1992).** *Flora of Allahabad district, Uttar Pradesh, India* (Bishen Singh Mahendra Pal Singh, Dehradun).
- Narain S (2006).** Additions to the aquatic and marshy plants of Hamirpur and Mahoba district (U. P.) India. *Journal of Phytological Research* **19**(1) 135-137.
- Narain S and Mishra S (2006).** First report of *Ceratophyllum submersum* L. from Gangetic Plain. *Rheedea* **16**(2) 115.
- Narain S and Mishra S (2008).** A list of Aquatic & Marshy Plants of Bundelkhand Region (U. P.). *Indian Journal of Forestry* **31**(2) 301-308.
- Narain S and Singh SM (2008).** Aquatic and Marshy Angiosperms of Sarsainawar wetland of Etawah district Uttar Pradesh India. *Journal of Indian Botanical Society* **87**(3 & 4) 157-161.
- Raizada MB (1976).** *Supplement to Duthie's Flora of Upper Gangetic Plains & of Adjacent Siwalik and Sub-Himalayan Tracts* (Bishen Singh Mahendra Pal Singh, Dehradun).
- Ranjan V (1996).** Aquatic, marshy and wetland and plants of Lalitpur district. *Geobios New Reports* **15** 44-48.
- Sahai R and Singh AB (1968).** A supplement to the aquatic & swampy vegetation of Gorakhpur India. *Indian Forester* **94** 819-821.
- Sen DN (1960).** Systematics and ecology of Indian plants I. On rainy season weeds of Gorakhpur. *Journal of the Bombay Natural History Society* **57**(7) 144-172.
- Sen DN and Chatterjee UN (1959).** Ecological studies on the aquatic & swampy vegetation of Gorakhpur. *Agra University Journal of Research: Science* **8** 1-14.
- Sharma JP and Dhakre JS (1993).** Aquatic angiosperm of Shahjahanpur district, U.P. *Higher Plant Indian Subcontinent* **4** 223-233.
- Siddiqui MO and Dixit SN (1996).** Some interesting *Polygonums* from Gorakhpur. *Bulletin of the Botanical Survey of India* **11** 432-433.
- Sikarwar RLS and Kaushik JP (1997).** Aquatic and semi-aquatic plants of Morana district (M. P.). *Journal of Economic & Taxonomic Botany* **21**(3) 639-647.
- Singh AK (2006).** A Contribution to the Aquatic and Wetland flora of Varanasi. *Journal of Economic & Taxonomic Botany* **30**(1) 6-24.
- Singh AK and Singh SK (1991).** Aquatic & semi-aquatic plants of Deoria district. *Journal of Economic & Taxonomic Botany* **21**(3) 639-647.
- Singh NP and Srivastava RC (2000).** Diversity and economic importance on wetland flora of Eastern Uttar Pradesh. *Bulletin of the Botanical Survey of India* **42**(1-4) 91-108.
- Singh NP, Khanna KK, Mudgal V and Dixit RD (2001).** *Flora of Madhya Pradesh* **3** (Botanical Survey of India, Calcutta).
- Singh NP, Mudgal V, Khanna KK, Srivastava SC, Sahoo AK, Bandopadhyay S, Aziz N, Das M, Bhattacharya RP & Hajra PK (2001).** *Flora of Bihar: Analysis* (Botanical Survey of India).
- Singh OP and Singh SK (1972).** Aquatic angiosperm of Jaunpur. *Bulletin of the Botanical Survey of India* **14**(1-4) 104-113.
- Singh SC (1994).** Ornamental plants of Lucknow district. U.P. India. *Journal of Economic & Taxonomic Botany* **18**(3) 677-690.
- Singh V (1972).** The identity of *Aponogeton crispus* Thunb. *Current Science India Sect. B. Biological Science* **36** 329-344.
- Singh VP and Srivastava RC (2007a).** A census of the genus *Juncellus* C.B. Clarke (Cyperaceae) in Uttar Pradesh. *Journal of Economic & Taxonomic Botany* **31**(1) 1-4.
- Singh VP and Srivastava RC (2007b).** A census of the *Schoenoplectus* (H.G.L. Reichbach) Palla (Cyperaceae) in Uttar Pradesh. *Journal of Economic & Taxonomic Botany* **31**(1) 1-12.
- Sinha AK, Srivastava A and Narayan R (1990).** Ecological studies on lakes of Rae Bareilly – II. Khur lake, Shivgarh. In: *Recent Trends in Limnology* 407-409.

**Research Article**

**Sinha AK, Srivastava AK, Pandey DP and Srivastava RK (1989).** Ecological studies on lakes of Rae Bareli – I. Samaspur Lake. *Research Journal of Plants and Environment* **5**(2) 31-34.

**Sinha BK and Dixit RD (2000).** Floristic and Ecological studies of Salon Wetland, Uttar Pradesh. *Prof. D. D. Nautiyal Communication Volume Recent Trends in Botanical Research* 255-267.

**Srivastava AK, Dixit SN and Singh SK (1987).** Aquatic angiosperm of Gorakhpur. *Indian Journal of Forestry* **10**(1) 46-51. (Title and Author are same)

**Srivastava AK, Dixit SN and Singh SK (1991).** Aquatic angiosperm of Gorakhpur. *Higher Plants of Indian Subcontinent* **2** 87-100. (Title and Author are same)

**Srivastava RC and Srivastava C (2007).** Diversity and economic importance of wetland Flora of Gorakhpur district (U.P.). *Journal of Economic & Taxonomic Botany* **31**(1) 70-77.

**Subramanyam K (1962).** Aquatic Angiosperms: a systematic account of common Indian aquatic angiosperms. *Botanical Monograph* **3**(1-6) 1-190. CSIR, New Delhi.

**Subramanyam K (1979).** Studies on Indian *Utricularia* Linn. A review. *Journal of the Indian Botanical Society* **58**(1) 1-16.

**Subramanyam K and Abraham V (1967-1968).** Studies on the traps of some Indian Species of *Utricularia* L. *Bulletin of the Botanical Survey of India* **9** 201-205.

**Subramanyam K and Balakrishnan NP (1962).** The genus *Nechamandra* in India. *Bulletin of the Botanical Survey of India* **3**(1) 23-24.

**Trivedi BS and Sharma PC (1965).** Studies on the hydrophytes of Lucknow & environs. *Proceedings of the National Academy of Sciences, India* **35** 1-14.

**Verma DM, Balakrishnan NP and Dixit RD (1997).** *Flora of Madhya Pradesh* **1** (Botanical Survey of India, Calcutta).