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Floristic Diversity in the Wetlands of Kota District, Rajasthan –A Survey of Abhera Pond

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ABSTRACT: An attempt has been made to prepare a floristic account of aquatic and wetland plants of Kota district of Rajasthan. Extensive wetland surveys were conducted in different seasons for two consecutive years to assess the aquatic plant wealth of the district. During investigation 113 species of vascular wetland plants belonging to 90 genera and 50 families were identified.

Key words: Aquatic macrophytes, Floristic, Wetland macrophytes

I. INTRODUCTION

The importance of aquatic and wetland plant diversity for sustainable life support system is an acceptable fact throughout the world. But it is very difficult to define aquatic plants exactly because aquatic habitats cannot be sharply distinguished from terrestrial ones (Sculthorpe, 1967) [13]. Hydrophytes are those species 'which normally stand in water and must grow for at least a part of their life cycle in water, either completely submersed or immersed'. Cook (1996) has been defined aquatic vascular plants which photosynthetically active parts are permanently or at least for several months each year partly or wholly submerged with water [3]. Studies on the aquatic and wetland vascular plants of India were done by Biswas and Calder (1936), Deb (1976), Cook (1996) and Chowdhary *et.al.* (2013) [1, 3, 2].

According to the proposals is approved by Ramsar convention (1971) "Wetlands are transitional zone which occupy intermediate position between the dry land and open water". Wetlands also considered as ecotone between terrestrial and aquatic ecosystems (Odum,1971) [8]. Therefore wetlands ecosystems are dominated by the influence of water and encompass of heterogeneous habitat. Considering these interesting habitats, the survey of near Kota district was undertaken. But unfortunately the aquatic habitats of the district like ponds, marshy places etc. are under threat at present. This is due to increase in human population, rapid urbanization and for other biotic interference. Filling up of the water bodies thus causes gradual loss of hydrophytic species diversity. It is, therefore, an urgent need to assess the vascular plant resources of these aquatic habitats before they are vanished. For this reason the present work has been undertaken. In the present paper, an attempt has been made to record the floristic diversity of aquatic plants of Abhera pond of Kota district of Rajasthan.

II. MATERIALS AND METHODS

A. Study area

The district Kota lies between 24°25' and 25°51' North latitudes and 75°31' and 77°26' East longitudes with total area of 5767.97 Sq Kms. "Kota City" is located at extreme South of it at 25°11' North latitude and 75°51' East longitude occupying total area of 238.59 Sq Kms with average height 253.30 meters from sea level. The district Kota ends with boundaries of Sawai Madhopur, Bundi and Tonk district in North West, Chittorgarh in West, Jhalawar in South and Baran in East. Abhera pond is a perennial pond located near village Nanata, 7 Kms away in south west direction from Kota city. The pond has got an approximate area of 25 hectares, but nearly 13 hectares of the area is covered with water. Maximum depth of pond is only 10-12 feet now-a-days because of its continuous silting in rainy seasons.

The city has extreme climate. Temperature varies between 6°C-48°C; the average rain fall is about 880 mm and humidity annually ranges from 8-88%. Summers are full of dust storms. Wind velocity varies from 2 to 22 Km/hour. According to 2011 census total population of district was 1748592. Kota is a prime industrial town of Rajasthan with historical importance of its own. In last decade, Kota city has emerged as "Educational City" of India mainly because of its excellence in coaching for entrance examination of national and state level technological institutes for engineering and medical courses.

Kota's name is also well known for its "Kota Sarees", "Kota Stone" and now for Kota's Kachouri. Geomorphologically Kota City situated in Northman part of Malwa Plateau. The only perennial river "Chambal" originating from the hills of Western Madhya Pradesh passes through the district. Kota district is rich in aquatic and semi-aquatic vegetation due to presence of rivers, artificial lakes, ponds and canal.

The present work is outcome of exhaustive plant survey and exploration in the study area by the author in 2014-2016. During the plant collection tours the plant specimen were carefully collected, pressed and mounted. The collected plants were identified with the help of different floras and consulting regional herbaria (Shrama, 2004, Singh and Shetty Vol. I, II, III 1987,1991,1993) [11,12]. Herbarium specimens were prepared following the standard method (Jain & Rao, 1978) [7] and deposited in the Gov. College Kota. Literature (Pandey & Pandey, 2011, Singh & Satyanarayan, 2012: Jadhav, 2016) search made to document the aquatic and wetland species of Abhera pond. Botanical names, family phenology and habitat of aquatic and wetland taxa of Kota district is enumerated in Table 1 [9, 10, 6]:.

Table 1: Aquatic and Semi-aquatic Plants of Study Area.

S. No.	Botanical Name	Family	Phenology	Flower colour	Habitat
1.	*Ageratum conyzoides* L.	Asteraceae	All year	White,purple	WL
2.	*Alternanthera sessilis* L. R.Br.ex Dc	Amaranthaceae	All year	White	WL
3.	*Alternanthera paronnichioides* St. Hill	Amaranthaceae	All year	Shining white	WL
4.	*Amaranthus tenuifolius* Willd.	Amaranthaceae	Aug-Nov	Green	WL
5.	*Amaranthus virdis* Hook.L.	Amaranthaceae	Aug-Nov	Pale green	WL
6.	*Ammania baccifera* L.	Lytheraceae	Aug-Feb	Red cluster	SAP
7.	*Ammania multiflora* Roxb.	Lytheraceae	All year	Red	SAP
8.	*Anagalis arvensis* L.	Primulaceae	Nov-April	Bright Blue	WL
9.	*Asphodelus tenuifolius* Caven.	Liliaceae	Dec-March	White	WL
10.	*Arnudo donax* L.	Poaceae	Aug-Nov	Spiklet brown	SAP
11.	*Bacopa monnieri* L. Wet.	Scrophureaceae	All year	Bluish purple	SSSP
12.	*Bergia ammanioides* Roxb.	Elatineace	Aug-Dec	Reddish	SSSP
13.	*Brachiaria ramosa* L. Stapf	Poaceae	July-Oct	Spiklet green	SAP
14.	*Bulbostylish barbata* Clarke	Cyperaceae	Aug-Nov	Green	SAP
15.	*Caesulia axillaris* Roxb.	Asteraceae	Aug-Dec	Bluish white	SAP
16.	*Cardiospermum halicacabumbum* L.	Sapindeacea	Aug-Dec	White	WL
17.	*Centella asiatica* (L.) Urb.	Apiaceae	May-Jan	Pink	SAP
18.	*Ceratophyllum demursum* L.	Ceratophyllaceae	Sep-Jan	Greenish brown	TAP
19.	*Chenopodium album* L.	Chenopodiaceae	Nov-Feb	Green panicle	WL
20.	*Chenopodium murale* L.	Chenopodiaceae	Nov-March	Green panicle	WL
21.	*Chloris virgata* Sw.	Poaceae	July-Dec	Spiklet green	SSP
22.	*Coix aquatica* Roxb.	Poaceae	Feb-March	Spiklet green	SSP
23.	*Coix lacryma-jobi* L.	Poaceae	Aug- Nov	Whitish green	SSP
24.	*Coldenia procumbence* L.	Boraginacea	Dec-March	Yellow	DBP
25.	*Colocasia esculenta* L.	Arecaceae	Dec-April	White	SSP
26.	*Commelina bengalensis* L.	Commelinaceae	July- Oct	Purple Blue	SSP
27.	*Commelina erecta* L.	Commelinaceae	Aug-Oct	Purple Violet	SSP
28.	*Coronopus didymus* (L.) Sm.	Brassicaceae	Nov-Mar	Pale Greenish	SSP
29.	*Corchorus astuans* L.	Tiliaceae	Sep-Jan	Yellow	WL
30.	*Corchorus capsularis* L.	Tiliaceae	Sep-Nov.	Yellow	WL
31.	*Cotula hemispherica* (Roxb.) Wall.e.Clarke	Astraceae	Jan-March	Yellow head	SSSP
32.	*Crinum defixum* Ker-Gawl L.	Amaryllidaceae	Aug-Oct	White	SSP
33.	*Cynotis cristata* (L.) D	Commelinacea	Nov-Mar	Pink	SSP
34.	*Cyperus digitatus* Roxb.	Cyperaceae	Aug-Dec	Green spike	SSP
35.	*Cyperus exalatus* Retz.	Cyperaceae	Aug-Oct	Green spike	SSP
36.	*Echinochloa colona* (L.) Link	Poaceae	Aug-Oct	Purplish green	SSSP
37.	*Eclipta prostrata* L.	Astraceae	All year	White	WL
38.	*Eichhornia crassipes* Mart.	Pontederaceae	Sep-Dec	Liliac blue	TAP
39.	*Eleocharis atropurpurea* Retz.	Cyperaceae	Aug-March	Glumes green	SSP
40.	*Fimbristylis umbellta* Frosk.	Cyperaceae	July-Dec	Glumes green	SSP

S. No.	Botanical Name	Family	Phenology	Flower colour	Habitat
41.	*Fumaria indica* Hassk. pugsely	Fumeraceae	Dec-March	Pink	WL
42.	*Glinus lotoides* L.	Molluginacea	All year	Pale Greenish	DBP
43.	*Gnaphalium leuto-album* L.	Aesteraceae	Jan-April	Yellow head	DBP
44.	*Gnaphalium pulvinatum* Del.	Aesteraceae	Jan -April	Greenish head	SSP
45.	*Grangea maderaspatana* (L) Poir.	Aesteraceae	All year	Yellow head	SSP
46.	*Heliotropium supinum* L.	Boraginaceae	Oct-Feb	White	SSP
47.	*Hydrilla verticillata* (L.f.) Royle	Hydrocharitaceae	Sep-Jan	Pale White	TAP
48.	*Hygrophila auriculata* (Sch.) Heine	Acanthaceae	Aug -Dec	Purple blue	SAP
49.	*Ipomoea aquatica* Forsk.	Convolvulaceae	All year	Pale purple	TAP
50.	*Ipomoea carnea* Jacq.	Convolvulaceae	All year	Pink purple	WL
51.	*Justicia diffusa* Willd.	Acanthaceae	Aug-March	Bluish purple	WL
52.	*Justicia procumbence* Jacq.	Acanthaceae	Aug-March	Pink spike	SAP
53.	*Justicia quinueangularis* Koenig ex. Roxb.	Acanthaceae	Sep-Feb	Pink purple	WL
54.	*Lemna perpussila* Torrey	Lemnaceae	Sep-Dec	-----	TAP
55.	*Limnophila aquatica* Roxb.	Scrophulriaceae	All year	Pink purple	SSSP
56.	*Limnophyhila indica* L.	Scrophulriaceae	All year	Pale white	SSSP
57.	*Lindernia ciliata* Pennel.	Scrophulriaceae	Aug-Dec	White	SSSP
58.	*Lindernia crustacea*	Scrophulriaceae	Aug-Dec	White	SAP
59.	*Ludwigia perennis* L.	Onagraceae	Aug-Oct	Yellow	SAP
60.	*Lucas aspera* (Willd) Link	Lamiaceae	All year	White	WL
61.	*Medicago polymorpha* L.	Fabaceae	Dec-June	Yellow	WL
62.	*Melilotus alba* Desr.	Fabaceae	Feb-April	White raceme	WL
63.	*Monocharia vaginalis* Burm.f.	Pontederaceae	Sep-Dec	Blue	SAP
64.	*Murdannia nudiflora* L.	Commelinaceae	Aug-Oct	Blue	SAP
65.	*Najas graminea* Del.	Najadaceae	Oct-April	Greenish brown	TAP
66.	*Najas indica* L.	Najadaceae	Sep-Dec	Greenish brown	TAP
67.	*Nelumbo nucifera* Gaertrn.	Nelumbonaceae	June -Aug	Pink white	TAP
68.	*Neptunia oleracea* Lour.	Mimosaceae	Oct-Jan	Yellow	TAP
69.	*Nymphae nauchali* Burm.	Nymphaeaceae	July -Dec	White	TAP
70.	*Nymphae pubescens* Willd.	Nymphaeaceae	Aug_Oct	Pale white	TAP
71.	*Nymphoides indica* Lour O.ktze	Menhyanthaceae	All the year	White	TAP
72.	*Oldenlendia umbelleta* L.	Rubiaceae	Aug_Oct	White	SSSP
73.	*Oryza rufipogon* Griff.	Poaceae	Aep-Nov	Awned green	SAP
74.	*Ottelia alsinoides* (L.)Pers.	Hydrocharitaceae	All Season	White	TAP
75.	*Oxalis corniculata* L.	Oxalidaceae	Jan- March	Yellow	DBP
76.	*Oxalis corymbosa* Dc.	Oxalidaceae	Dec-March	Pale rose	DBP
77.	*Oxystelma secamone* (L.) K. schum	Asclepideaceae	Aug Feb	Purplish white	SAP
78.	*Panicum psilopodium* Trin.	Poaceae	Aug-Dec	Spikelet green	SSSP
79.	*Pandanus fasicularis* Lam	Pandanaceae	April-July	White spathe	SAP
80.	*Pistia stratiotes* L.	Araceae	April-July	Greenishwhite	TAP
81.	*Phragmites karka* (Rtz.) Trin	Poaceae	Seo-Nov	Spikelet silky	SAP
82.	*Phyla nodiflora* (L.) E.Green	Verbenceae	All year	Whitish pink	SAP
83.	*Physalis minima* L.	Solanacea	Aug-Feb	Yellow	WL
84.	*Polypogon monspeliensis* (L.) Desf.	Poaceae	March -Sep	Silky glumes	SSP
85.	*Polygonum barbatum* L.	Polygoneaceae	Sep-June	Pale white	SAP
86.	*Polygonum glabrum*WIlld.	Polygoneaceae	All Seaons	Pinkish	SAP
87.	*Polygonum plebium* R.Br.	Polygoneaceae	Dec-April	Pinkish	DBP
88.	*Potamogeton crispus* L.	Potamogetonaceae	Aug-Oct	Greenish brown	TAP
89.	*Potamogeton perfoliatus* L.	Potamogetonaceae	Dec-April	Greenish yellow	TAP
90.	*Potentilla supina* L.	Rosaceae	Jan-May	Yellow	DBP
91.	*Ranunculus sceleratus* L.	Rannculaceae	Sep-Nov	Yellow	TAP
92.	*Rumex denatus* L.	Polygoneaceae	Dec-Feb	Green	SAP
93.	*Rotala indica* (willd)Koech.	Lythraceae	Aug-Jan	Pink raceme	SAP
94.	*Rungia repens* L. Nees	Acanthaceae	Nov-March	Pinkish purple	SSSP
95.	*Sagittaria guagynensis* Kunth	Alismataceae	Aug-Oct	White	SAP

S. No.	Botanical Name	Family	Phenology	Flower colour	Habitat
96.	*Scripus articulatus* L.	Cyperaceae	July- Oct	Spiklet brown	WL
97.	*Scripus litolaris* Schard.	Cyperaceae	Oct-Feb	Red Brown	SAP
98.	*Scripus roylei* (Nees.) Parkar	Cyperaceae	Seo-Nov	Spiklet	WL
99.	*Sesbania bispinosa* (Jacq.) Wight	Fabaceae	Sep-July	Yellow	SAP
100.	*Solanum nigrum* L.	Solanaceae	June –Feb	White	WL
101.	*Sphenoclea bispinosa* (Jacq.) Wight	Sphenocleaceae	Aug-Nov	Greenish spike	SAP
102.	*Spirodela polyrhiza* L.	Lemnaceae	Sep-Dec	Purple green	TAP
103.	*Sporobolus diander* (Retz) P. Beauv	Poaceae	All year	Spiklet reddish brown	SAP
104.	*Trapa natus var.bispinosa* (Roxb.)Makino	Trapaceae	Sep-Nov	White or purple	TAP
105.	*Trigonella occulata* Delile	Fabaceae	Sep-Feb	Yellow	SSP
106.	*Typha angustifolia* L.	Typhaaceae	Sep-Nov	Brown spike	SSSP
107.	*Utricularia aurea* Lour.	Lentibulreaceae	Nov-March	Pale yellow	TAP
108.	*Utricularia stellaris* L.f.	Lentibulreaceae	Nov-March	Yellow	TAP
109.	*Vallisnaria spiralis* L.	Hydrocharitaceae	All Season	Pale white	TAP
110.	*Vernonia cinerea* L.	Asteraceae	Dec.-March	Purple head	WL
111.	*Verbascum chinese* (L.) Santapau	Scrophulriaceae	Dec.-June	Yellow raceme	WL
112.	*Vernonika anagallis-auatica* L.	Scrophulriaceae	Jan-April	White	SSP
113.	*Wolffia arrhiza* L.	Araceae	July-Oct	------	TAP

Pteridophytes -*Azolla pinnata* - Salviniaceae, Nov-Dec., *Marsilea minuta*- Marsilliaceae, April-June

III. RESULTS AND DISCUSSIONS

The present study revealed that the occurrence of 51 aquatic and semi aquatic families with 90 Genera and 113 species of angiosperm and two species of pteridophytes were identified. The most dominant vascular family with respect to number of species is Poaceae with 11 plants. 34 families were dicot, remaining 16 were monocot and rest of two families were Pteridophytes. Verma, 1998 have been identified and mentioned 81 genera in order to aquatic biota in Rajasthan. Study indicates that the proportion of monocots to dicots decrease from an aquatic to a terrestrial habitat. With respect to different seasons, the maximum numbers of plant species were recorded during winter and rainy seasons followed by summer seasons. Various phenological characters of each species are regulated by environmental parameters. Analysis of color representation revealed that with white cream flowers having 30 species, 25 green, 18 species with yellow flowers and 12 species having pink flowers. During the course of present study the wetland plants were classified in to following categories based on the water structure in their specific habitats [14].

- Totally aquatic plant (TAP)- These plants species are completely submerged in water eg. *Nymphae nauchali* Burm. f.i, *Ipomoea aquatica* Forssk., *Trapa natus var bispinosa* (Roxb)., *Ceratophyllum demursum* L., *Eichhornia crassipes* (Mart) Solm., *Hydrilla verticillata* (L,f.) Royle, *Lemna minor* L., *Ottelia alismoides* (L.) Pers., *Potamogeton crispus* L., *Spirodella polyrhiza* (L.), and *Vallisaneria spiralis* L.
- Semi aquatic plant (SAP)- Those plants species which are rooted in mud, in marshy habitats eg. *Polygonum plebium* R.Br., *Hygrophila auriculata* (Schum), *Limnophila indica* L. and *Ludwigia perennis* L. *Caesulia axillaris* Roxb. and *Marsilea minuta*.
- Super saturated soil plant (SSSP)- These plants are found just away from mud, in shallow marshes with slightly compact texture eg. *Bacopa monnieri* L., *Phyla nodiflora* L. E Greene., *Marsilea minuta* and *Limnophila indica* (L.) Druce.
- Saturated soil plants (SSP)- These species are found in totally wet soils along with muddy banks of the water bodies *Potentilla surpinaL., Gnaphalium pulvinatum* Del., *Trigonella occulata* Delile, *Oldenlendia umbelleta* L. and *Marsilea minuta, Sesbenia bispinosa* Jacq. Wight and *Typha angustifolia* L.
- Dry bed plants (DBP)- These species make their appearance after the receding water leveling the soil cracks of water bodies or bit far away at dried water beds eg. *Polygonum plebium* R.Br, *Glinus lotoides* L. and *Heliotropium supinum* etc.
- Wetland plants (WL)- These plant species are found along the wetland area eg. *Ageratum conyzoides* L., *Centella asiatica* (L.) Urb., *Eclipta prostrata* and L. *Vernonia cinerea* L.

Common hydrophytes in the pond a troublesome exotic species *Eichhornia crassipes* Mart. with floating leaves. Due to over growth of water hyacinth, the drainage system has been badly affected. *Ipomoea aquatica* Forsk. and *Trapa natus* L. mostly seen in wetlands with abundant of *Ludwigia perennis* L., *Nymphoides indica* Lour O.ktze and *Nymphaea pubesncens* Willd. are the common free floating species. Besides, this depth zonation has been marked in the growth of vegetation in which shallow water usually shows species *Ottelia alsinoides* (L.) Pers, *Sagittaria guagynensis* Kunth and *Utricularia* species. While deep water is characteridzes by *Hydrilla verticillata* (L.f.) Royle and *Potamogeton crispus* L

Macrophytes are beneficial to others because they provide food for fish, aquatic animals and human beings. Some wetlands plants having nutritional values provide scope of utilizing as foods like *Amaranthus virdis* Hook. f., *Chenopodium album* L., *Echinochloa colona* (L.) Link. *Nelumbo nucifera* Gaertrn., *Spirodela polyrhiza* L. and *Trapa natans* var *bispinosa* (Jadhav, 2010, 2016) [5,6].

The pollution of water bodies affects the vegetation growing near by along its banks. Some species are sensitive to pollution and while other shows tolerance behavior. Tolerant plant species survives well by adapting to changing environmental conditions. *Ipomoea carnea* Jacq., *Polygonum glabrum* Willd., *Typha angustifolia* L., *Trapa natus* L. *and Ludwigia perennis* L. are tolerant with contamination. These plant species under unfavorable condition have a wide range of tolerance. Some aquatic plants accumulate chemical pollutants and heavy metals in their tissues. *Ludwigia perennis* L., *Polygonum glabrum* Willd. These plant species are use in water bodies can accumulate the contaminants through as bioremediation.

Submerged aquatic plants produce oxygen in the process of photosynthesis at the littoral zone of ponds. They also increase productivity of aquatic ecosystem and thus help to maintain ecosystem balance. Some of them are *Ceratophyllum demursum* L., *Eichhornia crassipes* Mart., *Hydrilla verticillata* (L.f.) Royle, *Lemna perpussila* Torrey *Ottelia alsinoides* (L.) Pers., *Potamogeton crispus* L., *Vallisaneria spiralis* L, *Wolffia arrhiza* L. etc. Aquatic plants increase productivity of aquatic ecosystem and thus they help in ecosystem maintenance. This baseline data to open new perspective for the wetlands plants of their utilization for the welfare of mankind and conservation of biodiversity.

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