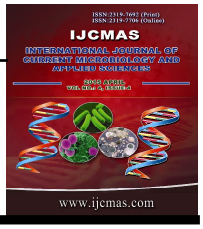
Int.J.Curr.Microbiol.App.Sci (2015) 4(4): 494-505

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 4 Number 4 (2015) pp. 494-505**
http://www.ijcmas.com



Original Research Article

Diversity of Aquatic macrophytes of Aligarh, U.P. India

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Keywords

Diversity of Aquatic macrophytes, *Ecchhornia crassipes, Pistia stratioes, Lemna sp*

A B S T R A C T

The study of the Diversity of Aquatic macrophytes being diverse, macrophytes have been grouped into three general categories, submerged: plants that primarily grow completely below the water surface; emergent: plants that are rooted in the sediments and protrude up at the water surface; floating: plants that can be rooted to the bottom but have leaves floating on the water surface or plant may be completely free floating. Aligarh district is a part of Central Ganga Plain of Utter Pradesh covering an area of 5,498 square kilometer and lies between North, latitude 27°28´ and 28°10´ and East, longitude 77°29´ and 78°36´. ANOVA indicated significant difference in density of Submerged Macrophytes between ponds ($F=13.44$; $P<0.05$) and insignificant between months ($F=1.98$; $P>0.05$). In the present study a total of 13 species of aquatic macrophytes were recorded. The density of total Emergent macrophyte varied, from 28 No/m2.

Introduction

Aquatic macrophytes are plants that grow in or near water. Being diverse, macrophytes have been grouped into three general categories, submerged: plants that primarily grow completely below the water surface; emergent: plants that are rooted in the sediments and protrude up at the water surface; floating: plants that can be rooted to the bottom but have leaves floating on the water surface or plant may be completely free floating. In a dataset, species diversity is the number of different species that are represented by a collection. The abundance of native plant communities typically maintain a balance within the ecosystem encouraging their own success along with other species at varying trophic levels (Ahmad & Parveen, 2013).

In India such plants are primarily herbs and shrubs. Many species occur on margin, some appear during the rains while some resistant species flourish even in dry season. The most conspicuous and universally occurring species are *Ecchhornia crassipes, Pistia stratioes, Lemna sp, Azola sp, Salvinia sp, Typha sp, Panicum sp, Nympaea sp, Ottelia sp, Enhydra sp, Ipomoea sp.* These plants use light energy, water and carbon dioxide to synthesize carbohydrates and release oxygen into the aquatic environment during photosynthesis which is utilized by the biota

of the same aquatic ecosystem. Further, these plants can change water temperatures and available oxygen in water, thus indirectly influencing growth and survival of fish. Besides, providing food and habitat to fish, wildlife and other aquatic organisms, macrophytes stabilize sediments, improve water clarity and add diversity to the shallow areas of lakes.

Macrophytes are the chief exploiters of the nutrients from the sediments, which otherwise are lost temporarily from the water. These nutrients are released only after death and decay of macrophytes and subsequent mineralization. Thus, role of macrophytes in nutrient dynamics and primary productivity of shallow aquatic ecosystems is far more significant than one can visualize.

Study area and location:

Aligarh district is a part of Central Ganga Plain of Utter Pradesh covering an area of 5,498 square kilometer and lies between North, latitude 27°28´ and 28°10´ and East, longitude 77°29´ and 78°36´. The entire district falling in Upper Ganga doab, represents flat topography and receives a normal rainfall of 708 mm with 46 rainy days, experiences sub-tropical climate. Selected ponds are shallow sewage fed perennial ponds, with irregular shore line having a central deep area.

The basin of these ponds is flat and sloping, water supply is regulated through rain water and drainage into which the surface runoff and domestic sewage from the surrounding area enters. Human excreta from the surrounding locality is washed into these ponds during rainy season thereby increasing the nutrient concentration in these ponds.

Macrophyte collection, identification and eneumeration:

For the investigation three freshwater ponds infested with aquatic macrophytes namely, Chautal pond, Laldiggi pond and Chherat pond located in the vicinity of Aligarh were selected. For Identification, different types of macrophytes were handpicked from the pond and sorted out in laboratory, the taxa were identified with the help of Fasset (1998), Cook, 1990 and Adoni (1985). After having the preliminary knowledge of macrophytes present in the water body, the abundance of macrophyte taxa was recorded in situ i.e., three randomly selected quadrats, 1m x 1m, and average abundance was expressed as No./quadrat.

Results and Discussion

In the present study a total of 13 species of aquatic macrophytes were recorded in all the selected ponds, out of which, two species belong to free floating, three species belong to submerged and eight species to emergent macrophytes in both Chherat and Chautal ponds whereas Laldiggi pond showed complete absence of free floating macrophytes throughout the study period (Tables 1-3).

Spatially, these macrophytes showed the following order of abundance; Chherat pond > Laldiggi pond >Chautal pond (Tables 1-3).

The total macrophytes density varied, from 28 No./m^2 in June, 2010 to 156 No./m^2 in October, 2010 in Chherat pond, from 30 No./m^2 in June, 2010 to 204 No./m^2 in October, 2010 in Laldiggi pond and from 30 No./m^2 in May, 2010 to 166 No./m^2 in September, 2010 in Chautal pond during the course of study (Tables 1-3).

Table.1 Monthly distribution and abundance of Aquatic Macrophytes (No/1m×1m quadrat) in Chherat Pond from February, 2010 to July, 2011

Aquatic Macrophytes	Family	Feb. 2010	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 2011	Feb.	Mar.	Apr.	May	Jun.	Jul.
Free Floating																			
Eicchornia Crassipes	*Pontederiiaceae*	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Ipomoea aquatica	*Convolvulaceae*	37	18	15	16	13	10	26	29	31	28	27	21	15	12	11	13	18	20
Submerged																			
Hydrilla sp.	*Hydrocharitaceae*	11	18	24	15	00	00	00	00	25	23	19	04	09	11	07	12	19	31
Ceratophyllum sp.	*Caretophylaceae*	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Potamogeton sp.	*Potamogetonaceae*	00	00	00	00	00	00	00	00	00	00	00	00	25	23	00	00	00	00
Emergent																			
Typha sp.	*Typhaceae*	16	25	22	20	15	05	04	17	29	12	12	11	26	21	19	10	07	12
Polygonum sp.	*Polygonaceae*	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Phragmitessp.	*poaceae*	06	05	00	00	00	00	15	15	28	26	38	25	15	17	14	13	20	21
Callitriche sp.	*plantaginaceae*	18	23	08	00	00	06	13	31	42	33	31	29	27	23	12	00	00	00
Rorripa sp	*Brassicaceae*	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	19
Rannunculus sp.	*Ranunculacae*	13	27	11	00	00	24	17	00	01	03	05	07	15	11	00	00	00	00
Alisma aquatica	*Alismata*	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Nasturtium sp.	*Brassicaceae*	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Total		101	116	80	51	28	45	75	92	156	125	132	97	132	118	63	48	64	103

Table.2 Monthly distribution and abundance of Aquatic Macrophyte (No./1m×1m quadrat) in Laldiggi Pond from February, 2010 to July, 2011

Aquatic Macrophytes	Family	Feb. 2010	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 2011	Feb.	Mar.	Apr.	May	Jun.	Jul.
Free Floating																			
Eicchornia crassipes	*Pontederiiaceae*	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Ipomoea aquatica	*Convolvulaceae*	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Submerged																			
Hydrilla sp.	*Hydrocharitaceae*	20	17	04	00	00	00	09	29	36	31	27	23	13	10	07	00	00	31
Ceratophyllum sp.	*Caretophylaceae*	17	11	07	03	07	20	24	26	28	15	19	11	04	00	00	00	00	07
Potamogeton sp.	*Potamogetonaceae*	11	10	19	08	02	21	25	29	24	23	19	30	08	03	00	00	00	21
Emergent																			
Typha sp.	*Typhaceae*	09	11	19	09	11	13	21	29	25	11	17	23	19	19	21	19	16	23
Polygonum sp.	*Polygonaceae*	12	05	05	02	01	21	18	20	27	32	32	25	00	00	00	00	00	00
Phragmites sp.	*poaceae*	19	17	13	00	00	00	28	27	31	16	14	10	18	27	33	18	09	11
Callitriche sp.	*plantaginaceae*	00	00	00	00	00	00	00	00	00	00	00	00	11	09	00	00	00	17
Rorripa sp.	*Brassicaceae*	00	00	00	00	00	00	00	00	00	00	00	00	09	05	00	00	00	10
Rannunculus sp.	*Ranunculacae*	11	09	07	03	00	00	17	18	14	12	12	19	10	18	14	05	00	09
Alisma aquatica	*Alismata*	14	13	13	11	09	11	21	19	19	21	23	28	09	17	17	09	07	21
Nasturtium sp.	*Brassicaceae*	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Total		113	93	87	36	30	86	163	197	204	161	163	169	101	108	92	51	32	150

Table.3 Monthly distribution and abundance of Aquatic Macrophyte (No/1m×1m quadrat) in Chautal Pond from February, 2010 to July, 2011.

Aquatic Macrophytes	Family	Feb. 2010	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 2011	Feb.	Mar.	Apr.	May	Jun.	Jul.
Free Floating																			
Eicchornia crassipes	*Pontederiiaceae*	28	25	14	17	20	11	19	22	05	31	22	18	31	27	14	18	11	06
Ipomoea aquatica	*Convolvulaceae*	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Submerged																			
Hydrilla sp.	*Hydrocharitaceae*	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Ceratophyllum sp.	*Caretophylaceae*	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Potamogeton sp.	*Potamogetonaceae*	27	17	00	00	00	00	17	46	31	27	21	28	00	00	00	00	00	00
Emergent																			
Typha sp.	*Typhaceae*	23	13	19	07	00	19	22	30	10	8	16	13	23	19	11	25	12	02
Polygonum sp.	*Polygonaceae*	20	19	10	02	14	16	26	27	18	22	00	05	35	33	00	24	11	03
Phragmites sp.	*Poaceae*	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Callitriche sp.	*plantaginaceae*	07	18	00	00	00	00	00	00	00	00	00	00	21	00	13	00	00	00
Rorripa sp.	*Brassicaceae*	20	19	20	04	07	21	11	29	10	20	17	09	17	19	20	11	10	00
Rannunculus sp.	*Ranunculacae*	00	00	2	0	00	19	21	12	08	13	07	07	00	20	00	00	00	00
Alisma aquatica.	*Alismata*	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Nasturtium sp.	*Brassicaceae*	22	00	00	00	00	00	00	00	12	00	00	00	29	00	12	00	11	00
Total		147	111	65	30	41	86	116	166	94	121	83	80	156	118	70	78	55	11

Table.4 Monthly variation in different diversity indices of Aquatic macrophyte in Chherat Pond in 2010 and 2011.

Months	Species Richness	Species Evenness	Shannon Diversity
Feb'10	1.08	0.85	1.64
Mar	1.05	0.91	1.705
Apr	0.91	0.92	1.53
May	0.50	0.99	1.09
Jun	0.30	0.99	0.69
Jul	0.78	0.81	1.18
Aug	0.92	0.88	1.48
Sep	0.66	0.95	1.33
Oct	0.99	0.84	1.62
Nov	1.03	0.85	1.63
Dec	1.02	0.86	1.64
Jan'11	1.09	0.83	1.61
Feb	1.22	0.94	1.88
Mar	1.25	0.95	1.89
Apr	0.96	0.95	1.56
May	0.77	0.99	1.38
Jun	0.72	0.93	1.32
Jul	0.86	0.95	1.56

Table.5 Monthly variation in different diversity indices of Aquatic macrophyte in Laldiggi Pond in 2010 and 2011

Months	Species Richness	Species Evenness	Shannon Diversity
Feb'10	1.48	0.96	2.04
Mar	1.54	0.94	2.02
Apr	1.56	0.87	1.94
May	1.39	0.84	1.61
Jun	1.17	0.78	1.36
Jul	0.89	0.96	1.57
Aug	1.37	0.96	2.03
Sep	1.32	0.98	2.06
Oct	1.31	0.96	2.04
Nov	1.37	0.93	2.00
Dec	1.37	0.95	2.03
Jan'11	1.36	0.94	2.02
Feb	1.73	0.92	2.11
Mar	1.49	0.84	1.91
Apr	0.88	0.89	1.49
May	0.76	0.88	1.26
Jun	0.57	0.93	1.03
Jul	1.59	0.90	2.09

Table.6 Monthly variation in different diversity indices of Aquatic macrophyte in Chautal Pond in 2010 and 2011

Months	Species Richness	Species Evenness	Shannon Diversity
Feb'10	1.20	0.94	1.88
Mar	1.06	0.98	1.77
Apr	0.95	0.85	1.44
May	0.88	0.75	1.11
Jun	0.53	0.92	1.01
Jul	0.89	0.97	1.58
Aug	1.05	0.96	1.76
Sep	0.97	0.93	1.72
Oct	1.32	0.85	1.78
Nov	1.04	0.92	1.71
Dec	0.90	0.94	1.55
Jan'11	1.14	0.85	1.63
Feb	0.99	0.97	1.76
Mar	0.83	0.97	1.58
Apr	0.94	0.97	1.58
May	0.68	0.95	1.34
Jun	0.99	0.99	1.60
Jul	0.83	0.90	0.99

Aquatic Macrophyte

Free floating

Ipomoea

Eicchornia

Submerged Macrophyte

Hydrilla

Ceratophyllum

Potamogeton

Emergent Macrophyte

Typha

Polygonum

Phragmities

Callitriche

Rorripa

Alisma aquatica

Ranunnculus

Statistically total macrophytes recorded significant negative correlation with water temperature in Chherat Pond r = - 0.683, Chautal pond in r = - 0.511 and in Laldiggi pond r = -0.478; with nitrate in Chherat Pond, r = - 0.629; Chautal pond, r = - 0.542 and Laldiggi pond r = -0.505 and with Phosphate in Cherrat Pond r = - 0.544; Chautal pond, r = - 0.577 and Laldiggi pond, r = -0.566. However, with dissolved oxygen correlation was found significant positive *i.e.* Chherat Pond (r = 0.555), Laldiggi pond (r = 0.527) and Chautal pond (r = 0.563).

Shannon- Wiener's index values for Aquatic macrophytes varied from a minimum of 0.69 in June, 2010 to a maximum of 1.89 in March, 2011 in Chherat pond, from 1.04 in June, 2011 to 2.12 in February, 2011 in Laldiggi pond and from 0.99 in July, 2011 to 1.89 in February, 2010 in Chautal pond (Tables 4-6). Aquatic macrophytes species evenness varied from a minimum of 0.82 in July, 2011 to a maximum of 0.99 in June, 2010 in Chherat pond; from 0.84 in May, 2010 to 0.98 in September, 2010 in Laldiggi pond and from 0.76 in May, 2010 to 0.99 in June, 2011 in Chautal pond (Tables 4-6). Species richness index values for aquatic macrophyte varied from a minimum of 0.30 in June, 2010 to a maximum of 1.22 in Feburary, 2011 in Chherat pond; from 0.57 in July, 2011 to 1.73 in Feburary, 2011 in Laldiggi pond and from 0.53 in June, 2010 to 1.32 in October, 2010 in Chautal pond (Tables 4-6).

ANOVA indicated significant difference in density of total Macrophytes between ponds ($F=3.05$; $P=0.05$) and between months ($F=4.12$; $P<0.05$).

Free floating macrophytes

Two species of free floating aquatic macrophytes namely, *Echhornia crassipes* and *Ipomoea aquatica* were recorded in Chautal and Chherat pond respectively. The density of Free Floating macrophytes ranged from a minimum of 10 No/m^2 in July, 2010 to maximum of 37 No/m^2 in February, 2010 in Chherat pond, from of 5 No. /m^2 in October, 2010 to a maximum of 31 No./m^2 in November, 2010 and February, 2011 in chautal pond whereas in Laldiggi pond the complete absence of free floating macrophytes were recorded during the study period (Table 1-3).

Total macrophytes showed significant positive correlation with free floating macrophytes in Chherat Pond (r =0.569) and in Chautal pond (r=0.676), with submerged macrophytes in Chherat pond (r = 0.485), Chautal pond (r = 0.578) and in Laldiggi pond (r = 0.931), with emergent macrophytes positive and significant correlation in Chherat pond (r=0.955), in Laldiggi pond (r=0.939) and in Chautal pond (r=0.924).

ANOVA indicated significant difference in density of free floating macrophytes between ponds ($F=60.42$; $P<0.05$) and insignificant between months ($F=1.28$; $p>0.05$).

Submerged Macrophytes

In the present study submerged aquatic macrophytes were represented by *Hydrilla sp, Potamogeton sp* and *Ceratophyllum sp* across the selected waterbodies. However *Potamogeton* was encountered in Chautal pond only whereas in Chherat pond submerged macrophytes were represented by *Hydrilla sp. Potamogeton sp. and Ceratophyllum sp.* Laldiggi pond showed presence of all the three macrophytes during most of the study period.

The total submerged macrophyte density varied, from a minimum of 4 No/m^2 in

January, 2011 to maximum of 31 No/m^2 in July, 2011 in Chherat pond, from 7 No/m^2 in April, 2011 to 88 No/m^2 October, 2010 in Laldiggi pond; from 17 No/m^2 in March, 2010 and August, 2010 to 46 No/m^2 September, 2010 in Chautal pond (Tables 1-3).

ANOVA indicated significant difference in density of Submerged Macrophytes between ponds ($F=13.44$; $P<0.05$) and insignificant between months ($F=1.98$; $P>0.05$).

Emergent Plants:

A total of eight species of Emergent aquatic macrophytes were recorded during the course of study across the selected water bodies. These are *Typha sp, Polygonum sp, Phragmities sp, Callitriche sp, Rorripa sp, Rannunculus sp, Alisma aquatica,* and *Nasturtium sp*.

Out of eight recorded species, five encountered in Chherat, seven in Laldiggi and six in Chautal pond (Tables 1-3).

The density of total Emergent macrophyte varied, from 28 No/m^2 in June, 2010 to 156 No/m^2 in October, 2010 in Chherat pond, from 21 No/m^2 June, 2010 to 116 No/m^2 October, 2010 in Laldiggi pond; from 13 No/m^2 May, 2010 to 125 No/m^2 February, 2011 in Chautal pond (Tables -1-3).

ANOVA indicated significant difference in density of Emergent Macrophytes between ponds ($F=3.75$; $P<0.05$) and between months ($F=3.61$;$P<0.05$).

Acknowledgements

The authors are thankful to the Chairman, Department of Zoology, Aligarh Muslim University, Aligarh for providing necessary laboratory facilities.

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