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STUDY OF MACROPHYTE DIVERSITY FROM THE RESERVOIRS OF SHIVAJI UNIVERSITY CAMPUS, KOLHAPUR (MAHARASHTRA)

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Abstract: The present work is an attempt to the study of Macrophyte diversity from Shivaji University campus reservoirs. They showed total number of 106 species from 60 families with 4 different groups of vegetation viz. algae, bryophyte, pteridophyte and angiosperms. The macrophytes are also classified on the basis of their habitat status. The results of the study reveal that the highest percent contribution to the macrophytes is protected by angiosperms. The species which have marginal habitat status are dominant in present work. According to present study Rajaram reservoir having great macrophyte diversity.
Keywords: Macrophyte diversity, k-Dominance.

Introduction

Macrophytes are integral components of aquatic ecosystem because they provide food, nutrients and habitats to the aquatic organisms which enhance biodiversity of aquatic ecosystems. Macrophytes constitute one of the major components of freshwater environments; because they help to maintain the biodiversity (Agostinho et.al.2007a, Theel et.al.2008). They oxygenate the water and are important for different activities of aquatic animals. They inflict tremendous influence and drive an ecosystem in a particular direction, ultimately providing a definite shape to reservoires.

Macrophytes are highly productive in floodplains (Junk and Piedade, 1993). Aquatic communities reflect anthropogenic effects and are very useful to determine and evaluate human impacts (Solaket.al., 2012) Aquatic macrophytes respond to the changes in water quality and have been used as bio-indicator of pollution. They also dynamically guide the cycling of minerals and other organic constituents, thereby influencing over all biomass production of water bodies and can serve as indicator for monitoring the degree of damage in the ecosystem. These are considered as an efficient accumulator of heavy metals (Devlin, 1967). These are also helpful to reduce different kinds of pollutants from polluted water.

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Macrophytes sustain the clear-water state by various mechanisms whose relative importance is possibly variable (Ozimeket al., 1990, Vermaatet al.,2000, Madsen et al., 2001).

Taking into consideration the significance of the macrophyte diversity the present investigation was undertaken. This aims to brief summerisation of macrophytes and their categorisation which will give us baseline data about species diversity.

Study Area

The campus of Shivaji University, Kolhapur lies between $16^0$40'35.45" North latitudes and $74^0$15'06.04" East longitudes. This campus area is about 853 acres. In this area there are four reservoirs located, which supplies water to the University for various purposes. The reservoirs of Shivaji University campus are as follows...

Sr.No	Name and Code of Reservoirs	Latitude	Longitude
1.	Reservoir behind Bhashabhavan (R1)	$16^0$40'24,31"N	$74^0$15'10,80"E
2.	Reservoir behind Music department (R2)	$16^0$40'59,55"N	$74^0$15'03,57"E
3.	Lead garden Reservoir (R3)	$16^0$40'27,34"N	$74^0$15'03,57"E
4.	Rajaram Reservoir (R4)	$16^0$40'46,41"N	$74^0$15'56,22"E

Materials and Methods

Macrophytes were recorded through a survey of study area for one year (2012 to 2013) during which regular excursion were made at short intervals to collect and photograph the plants of the area. Plants were identified with the help of available literature of Subramanyam (1962), Jain and Rao (1976), Varma (1981), Cook (1996), Gupta (2001) and Sardesai and Yadav (2004). The assessment of macrophytes habitat status is presented with K Dominance curve (Lambshead et al. 1983) by using BioDiversity professional Software (Version 2).

Results and Discussion

Present investigation was done from four reservoirs of Shivaji University Campus during period of 2012 to 2013. In present study altogether 106macrophytes species were recorded out of which 73 species was recorded from R1,42 speciesfrom R2, 58 from R3 and 104 from R4. (Table No. 1).

The present macrophyte diversity broadly classified in four majorgroupsi.e Angiosperm, Pteridophyte, Bryophyte and Algae. Angiospermicmacrophyte diversity all over composed of 46 families, 74 genera and 84species. Pteridophyte diversity represents 3 families, 5 genera and 5 species. The diversity of Bryophytes includes 3 families, 4 genera and 4 species. While Algal diversity shows 8 family, 10 genera and 13 species. (Table No.2)

The percent contribution of observed macrophyte diversity is summarised in fig. 1. and Table No.2. R1 having percent contribution as an angiosperms 82.19%, pteridophyte 5.47%, bryophyte 5.47% and algae 6.34%. R2 shows angiosperms 88.37%, pteridophyte2.32%, bryophytes and algae 4.65%. In R3 it is observed that the percent contribution of macrophyte is angiosperm as 86.44%, pteridophyte 3.38%, bryophytes and algae 5.08%. R4 presenting percent contribution of macrophyte in range of angiosperm 79.80%, pteridophyte 2.88%, bryophytes 3.84% and algae 12.5%.

Macrophyte are also classified on the basis of their habitat (Keddy, 2000). The macrophyte are classified as marginal, submerged, floating and emergent. In R1 marginal (58), submerged (8) and emergent (7) species are present. Macrophyte habitat status of R2 shows macrophyte species as marginal (36), submerged (3) and emergent (4). According to R3 macrophyte diversity is observed as marginal (48), submerged (6) and emergent (5). In case of R4 marginal (68), submerged (23), floating (3) and emergent (10) macrophyte species are noticed. (Table No.3)

For more detailed study of macrophyte habitat from shivaji university campus, k dominance curve method is used. According to the macrophyte habitat all four reservoirs were observed and total species of marginal, submerged, floating and emergent habitat macrophyte were studied and by using this data K dominance curve are plotted. K dominance curve of R1, R2 andR3 shows three curves which represents three habitats of macrophytes i.e marginal, submerged and emergent, while K dominance curve of Rajaram reservoir shows four curves which represents four habitats of macrophyte i.e marginal, submerged, floating and emergent. (Fig.2)

Thus according to survey R4 having highest macrophyte diversity followed by R1 and R3 while very lowest macrophyte diversity shown by R2. The angiosperm macrophyte species have more contribution to all four reservoirs than pteridophyte, bryophyte and algae. Algae shows more contribution only in R4 than all other three reservoirs. Pteridophyte and bryophyte species are very less in all four reservoirs. From the study of macrophyte habitat it is clear that, the macrophyte species which have marginal habitat are more in all four reservoirs while submerged and emergent habitat macrophyte species are present more in R1 and R4 and very less present in R2 and R3. The floating type of macrophyte habitat is present only in R4 and absent in all other three reservoirs.

Table No. 1: Macrophytes recorded during study period from three reservoirs of Shivaji University campus. (Year 2012 to 2013)

Sr. No.	Name of Species	Family	Habit	Habitat status	Name of Reservoirs			
					R1	R2	R3	R4
	Angiosperms							
1.	*Indigofera linifolia* (L.f.) Retz. var. linifolia	Fabaceae	Herb	Marginal	+	+	+	+
2.	*Exacum pedunculatum* L.	Gentianaceae	Herb	Marginal	+	-	+	+
3.	*Trichodesma inaequale* Edgew.	Boraginaceae	Herb	Marginal	+	+	-	+
4.	*Linum mysorense* Heyne ex. Benth	Linaceae	Herb	Marginal	+	+	+	+
5.	*Spermacoce pusilla* Wall	Rubiaceae	Herb	Marginal	+	+	+	+
6.	*Mollugo pentaphylla* var. pentaphylla	Molluginaceae	Herb	Marginal	+	+	-	+
7.	*Arthraxon lanceolatus* (Roxb.) Hochst.	Poaceae	Herb	Marginal	+	+	+	+
8.	*Lavandula bipinnata* (Roth) O. Kuntze	Lamiaceae	Herb	Marginal	-	+	-	+
9.	*Crotalaria hebecarpa* (DC.) Rudd	Fabaceae	Herb	Marginal	+	-	+	+
10.	*Hedyotis corymbosa* (L.)Lam.	Rubiaceae	Herb	Marginal	+	-	-	+
11.	*Sesamum laciniatum* Klein ex. Willd.	*Pedaliaceae*	Herb	Marginal	+	-	+	+
12.	*Cassia mimosoides* L.	Caesalpiniaceae	Herb	Marginal	+	+	+	+
13.	*Cassia tora* L.	Caesalpiniaceae	Herb	Marginal	+	-	+	+
14.	*Indigofera linifolia* (L.f.) Retz.var. *campbellii*	Fabaceae	Herb	Marginal	+	+	+	+
15.	*Neanotis tubulosa (G.Don) Mabb.*	Rubiaceae	Herb	Marginal	-	-	-	+
16.	*Crotalaria medicaginea* Lamk. Var. *medicaginea*	Fabaceae	Herb	Marginal	+	-	+	+
17.	*Habenaria marginata* Coleb. Var. *marginata*	Orchidaceae	Herb	Marginal	+	-	+	+
18.	*Cyathocline purpurea* (Buch-Ham. Ex D.Don)O.Ktze var. *Purpurea*	Asteraceae	Herb	Marginal	+	-	+	+
19.	*Acalypha hispida* Burm.f.	Euphorbiaceae	Shrub	Marginal	+	-	-	+
20.	*Stemodia viscosa* Roxb.	Scrophulariaceae	Herb	Marginal	+	+	+	+
21.	*Cyanotis tuberosa* (Roxb.) J.A. & J.H. Schult.	Commelinaceae	Herb	Marginal	+	+	+	+

22.	*Cyanotis fasciculata* (Heyne ex Roth) J.A. & J.H. Schult.	Commelinaceae	Herb	Marginal	+	+	+	+
23.	*Cyanotis axillaris* (L.) D.Don	Commelinaceae	Herb	Marginal	+	+	+	+
24.	*Cyanotis cristata* (L.) D.Don	Commelinaceae	Herb	Marginal	+	+	+	+
25.	*Phyla nodiflora* (L.) Greene	Verbenaceae	Herb	Emergent	+	+	-	+
26.	*Argemone mexicana* L.	Papaveraceae	Herb	Marginal	+	+	+	+
27.	*Cleome viscosa* L.	Cleomaceae	Herb	Marginal	+	+	-	+
28.	*Cleome chelidonii* L.f.	Cleomaceae	Herb	Marginal	+	-	-	+
29.	*Portulaca oleracea* L.	Portulacaceae	Herb	Marginal	+	+	+	+
30.	*Tridax procumbens* L.	Asteraceae	Herb	Marginal	+	+	+	+
31.	*Ziziphus nummularia*	Rhamnaceae	Shrub	Marginal	+	+	+	+
32.	*Sesbania sesban* (L) Merr.	Fabaceae	Shrub	Marginal	+	+	+	+
33.	*Plumbago zeylanica* L.	Plumbaginaceae	Shrub	Marginal	-	+	-	+
34.	*Centaurium meyeri* (Bunge) Druce.	Gentianaceae	Herb	Marginal	+	+	+	+
35.	*Heliotropium indicum* L.	Boraginaceae	Herb	Marginal	+	-	+	+
36.	*Withania somnifera* (L.)	Solanaceae	Shrub	Marginal	+	-	-	+
37.	*Mecardonia procumbens* (Mill). Small.	Plantaginaceae	Herb	Marginal	+	-	+	+
38.	*Utricularia naikii* Yadav, Sardesai Gaikwad	Lentibulariaceae	Herb	Submerged	-	-	-	+
39.	*Sesamum Lanciniatum* Klein ex willd.	Pedaliaceae	Herb	Marginal	-	-	-	+
40.	*Boerhavia erecta* L.	Nyctaginaceae	Herb	Marginal	+	+	+	+
41.	*Achyranthes aspera* L. Var. aspera	Amaranthaceae	Shrub	Marginal	+	-	+	+
42.	*Alternanthera sessilis* (L.) R. Br.ex DC	Amaranthaceae	Shrub	Emergent	+	+	+	+
43.	*Euphorbia hirta* L.	Euphorbiaceae	Herb	Marginal	+	+	+	+
44.	*Euphorbia geniculata* Orteg.	Euphorbiaceae	Herb	Marginal	+	-	+	+
45.	*Pouzolzia pentandra* (Roxb.)Benn. Var pentandra	Utricaceae	Herb	Marginal	+	-	+	+
46.	*Typha angustifolia* L.	Typhaceae	Herb	Submerged	-	+	+	+
47.	*Coldenia procumbens* L.	Boraginaceae	Herb	Marginal	+	+	+	+
48.	*Rotala densiflora* (Roth ex R & S) Kohne	Lythraceae	Herb	Marginal	+	-	+	+
49.	*Nymphoides indicum* (L.) O. Ktze.	Menyanthaceae	Herb	Floating	-	-	-	+
50.	*Blyxa octandra* (Roxb.) Planch. ex Thw.	Hydrocharitaceae	Herb	Marginal	-	-	+	+

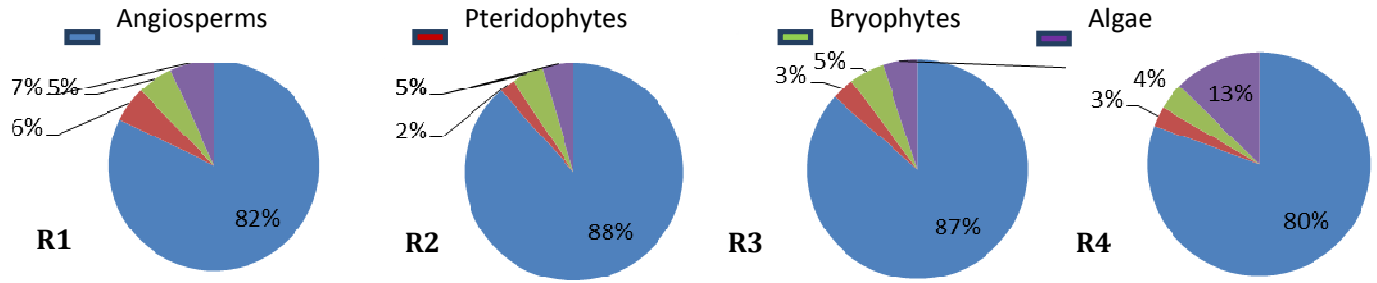
51.	*Ottelia alismoides (L.) Pers.*	Hydrocharitaceae	Herb	Submerged	-	-	-	+
52.	*Vetiveria zizanioides* (L.) Nash	Pooideae	Herb	Marginal	+	-	-	+
53.	*Potamogeton nodosus* Poir.	Potamogetonaceae	Herb	Submerged	-	-	+	+
54.	*Hydrilla verticillata* (L.f.) Royle	Hydrocharitaceae	Herb	Submerged	+	-	+	+
55.	*Najas Marina* L.	Najadaceae	Herb	Marginal	-	-	-	+
56.	*Oxalis corniculata* L. Var. corniculata	Oxalidaceae	Herb	Marginal	+	+	+	+
57.	*Commelina benghalensis* L.	Commelinaceae	Herb	Emergent	+	+	+	+
58.	*Ipomoea aquatica* Forssk.	Convolvulaceae	Herb	Emergent	+	+	-	+
59.	*Ludwigia octovalvis* (Jacq.) Raven subsp. Sessiliflora	Onagraceae	Herb	Marginal	+	-	-	+
60.	*Nymphoides hydrophylla* (Lour.) O. Ktze.	Menyanthaceae	Herb	Floating	-	-	-	+
61.	*Ceratophyllum demersum* L.	Ceratophyllaceae	Herb	Submerged	-	-	-	+
62.	*Vallisneria spiralis* L.	Hydrocharitaceae	Herb	Submerged	-	-	-	+
63.	*Cyperus rotundus* L. ssp. Rotundus	Cyperaceae	Herb	Emergent	+	+	+	+
64.	*Cymbopogon citratus* (DC.) Stapf.	Pooideae	Herb	Marginal	-	-	+	-
65.	*Cynodon dactylon* (L.) Pers.	Pooideae	Herb	Marginal	+	+	+	+
66.	*Amaranthus spinosus* Linn.	Amaranthaceae	Herb	Marginal	+	+	+	+
67.	*Ageratum conyzoides* L.	Asteraceae	Herb	Marginal	+	+	+	+
68.	*Parthenium hysterophorus* Linn.	Asteraceae	Herb	Marginal	+	+	+	+
69.	*Lantana camara* L. var. aculeata (L.) Moldenke	Verbenaceae	Shrub	Marginal	+	+	+	+
70.	*Lemna perpusilla* Torr.	Lemnaceae	Herb	Floating	-	-	-	+
71.	*Grangea maderaspatana* (L.) Poir.	Asteraceae	Herb	Marginal	+	-	+	+
72.	*Synedrella nodiflora* (L.) Gaertn	Asteraceae	Herb	Marginal	+	+	+	+
73.	*Centaurium meyeri* (Bunge) Druce.	Buddlejaceae	Herb	Marginal	-	-	-	+
74.	*Chloris barbata* Sw.	Pooideae	Herb	Marginal	-	-	-	+
75.	*Blumea obliqua*(L.) Druce.	Asteraceae	Herb	Marginal	+	-	-	+
76.	*Crotalaria juncea* L.	Fabaceae	Herb	Marginal	-	-	-	+
77.	*Sida acuta* Burm.f.	Malvaceae	Herb	Marginal	+	-	-	+
78.	*Phyllanthus reticulatus* Poir	Euphorbiaceae	Shrub	Emergent	+	-	+	+

79.	*Hemigraphis crenata* (Benth. Ex Hohen.) Bremek	Acanthaceae	Herb	Marginal	-	-	-	+
80.	*Tagetes erecta* L.	Asteraceae	Herb	Emergent	-	-	-	+
81.	*Cymbopogon martini* (Roxb.) Wats.	Pooideae	Herb	Emergent	-	-	-	+
82.	*Bergia ammannioides* Roxb. Ex Roth	Elatinaceae	Herb	Marginal	-	-	-	+
83.	*Chrozophora rottleri* (Geis.) Juss. Ex Spreng.	Euphorbiaceae	Herb	Emergent	-	-	-	+
84.	*Calotropis gigantean* (L.) R. Br.	Asclepiadaceae	Shrub	Emergent	+	-	+	+
	Pteridophytes							
85.	*Pteris vittata* L.	Pteridaceae	Shrub	Marginal	+	+	+	-
86.	*Adiantum philippense* L.	Pteridaceae	Shrub	Marginal	+	-	+	-
87.	*Azolla pinnata* R. Br.	Salvineaceae	Herb	Submerged	+	-	-	+
88.	*Salvinia Molesta* D.S. Mitch.	Salvineaceae	Herb	Submerged	-	-	-	+
89.	*Marsilea minuta* L.	Marsileaceae	Herb	Submerged	+	-	-	+
	Bryophytes							
90.	*Funaria hygrometrica* Hedw	Funariaceae	Herb (Moss)	Marginal	+	+	+	+
91.	*Cyathodium tuberosum*. Kash.	Targionaceae	Herb	Marginal	+	-	-	+
92.	*Anthoceros erectus* Kashyap	Anthocerotaceae	Herb (Moss)	Marginal	+	+	+	+
93.	*Targionia hypophylla* L.	Targioniaceae	Herb	Marginal	+	-	+	+
	Algae							
94.	*chara zeylanica* kl.ex.willd	Characeae	Herb	Submerged	+	-	+	+
95.	*Nitella furcatus* (Roxb.)	Characeae	Herb	Submerged	+	-	+	+
96.	*Oscillatoria brevis* Kutzing ex Gomant	Oscillatoriaceae	Herb	Submerged	-	-	-	+
97.	*Nostoc paludosum* Kutzing ex Bornet & Flahault	Nostocaceae	Herb	Submerged	-	-	-	+
98.	*Oscillatoria tenuis* C. Agardh ex Gomant	Oscillatoriaceae	Herb	Submerged	-	-	-	+
99.	*Spirullina nordstedtii*	Cyanophyceae	Herb	Submerged	+	+	-	+

100.	*Bulbochaete praereticulata* Joa	Oedogoniaceae	Herb	Submerged	-	-	-	+
101.	*Desmidium swartzii* C.Agardh ex Ralf	Desmidiaceae	Herb	Submerged	+	+	-	+
102.	*Mougeotia scalaris* Hassall	Zygnemataceae	Herb	Submerged	-	-	-	+
103.	*Spirogyra condensate* (Vauch.) Kuetz	Chlorophyceae	Herb	Submerged	-	-	-	+
104.	*Spirogyra crassa* (Kutzing) Kutzing	Zygnemataceae	Herb	Submerged	-	-	-	+
105.	*Spirogyra weberi Kützing*	Zygnemataceae	Herb	Submerged	+	-	+	+
106.	*Zygnema circumcarinatum Czurda*	Zygnemataceae	Herb	Submerged	-	-	-	+
	Total				**73**	**43**	**59**	**104**

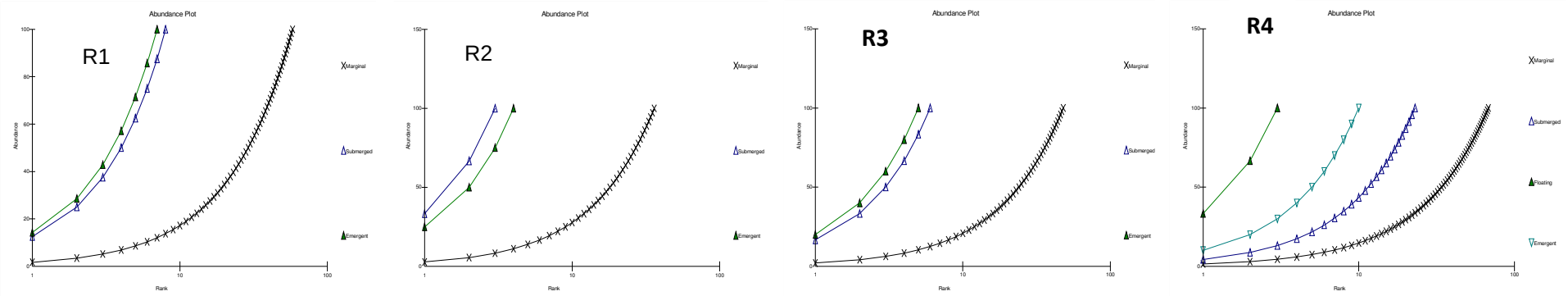
R 1: Reservoir behind Bhashabhavan,**R2:** Reservoir behind Music department**, R 3:** Lead garden Reservoir, **R 4**: Rajaram Reservoir

Fig 1: Macrophytes percent contribution of reservoirs from Shivaji university campus



R 1: Reservoir behind Bhashabhavan, **R 2:** Reservoir behind Music department**, R 3:** Lead garden Reservoir, **R 4:** Rajaram Reservoir

Fig 2: Habitat status of studied macrophytes from reservoires of Shivaji university campus by K dominance curve



R 1: Reservoir behind Bhashabhavan, **R 2:** Reservoir behind Music department**, R 3:** Lead garden Reservoir, **R 4:** Rajaram Reservoir

Table No. 2: Observed Plant groups and percent contribution of Macrophytes

Sr. No.	Plant group of Macrophyte	Name (Code) of Reservoir							
		R1		R2		R3		R4	
		TS	PC	TS	PC	TS	PC	TS	PC
1.	Angiosperms	60	82.19	38	88.37	51	86.44	83	79.80
2.	Pteridophytes	4	5.47	1	2.32	2	3.38	3	2.88
3.	Bryophytes	4	5.47	2	4.65	3	5.08	4	3.84
4.	Algae	5	6.84	2	4.65	3	5.08	13	12.5

R 1: Reservoir behind Bhashabhavan, **R 2:** Reservoir behind Music department**, R 3:** Lead garden Reservoir, **R 4:** Rajaram Reservoir TS: Total species PC: Percent contribution (%)

Table No. 3: Habitat Status of studied Macrophytes

Sr.No.	Habitat Status of Macrophyte	R1	R2	R3	R4
1.	Marginal	58	36	48	68
2.	Submerged	08	03	06	23
3.	Floating	00	00	00	3
4.	Emergent	07	04	05	10
	Total	**73**	**43**	**59**	**104**

R 1: Reservoir behind Bhashabhavan, **R 2:** Reservoir behind Music department**,**
R 3: Lead garden Reservoir, **R 4:** Rajaram Reservoir

Conclusion

From the present investigation it is concluded that the reservoirs of Shivaji university campus are clearly dominated by Angiosperms. The pteridophyte, bryophyteand algae are poor in distribution. The diverse type of macrophyte forms recorded from studying reservoirs indicates that, these reservoirs are very rich in plant diversity particularly in marginal and submerged species. Rajaram reservoir (R4) have great macrophyte diversity fallowed by Reservoir behind Bhashabhavan (R1), Lead garden Reservoir (R3) and Reservoir behind Music department (R1).

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