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Seasonal variations in diversity of aquatic macrophytes of Upper lake, Bhopal

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ABSTRACT

Macrophytes are used as biological indicators of the aquatic environment, allowing detection of ecosystem response to different stressors, i.e. pollution, eutrophication etc. These stressors lead to a reduction in macrophyte diversity and threaten the faunal diversity of aquatic ecosystems favouring the establishment of exotic species, at the expense of native species. To analyse the ecological status of a lake different diversity indexes (IVI, H' index) are used which describes the quality of natural areas. The present study was carried out in Behta village to determine the macrophyte species diversity (H' index) and importance value index (IVI) in three different seasons. A random sampling was done along several transect line carried out with the help of a 1 m^2 light plastic quadrate. During the whole study period, a total of 17 macrophyte species belonging to 12 families and 8 orders were found distributed in the lake. During our observation it has been noticed that out of 17 macrophyte species the *Eicchornia crassipes* (IVI=16.49) has the highest Importance value index in summer season while the highest Shannon-Wiener Index (H'=1.657) was observed during winter season. The diversity of species is not uniformly distributed and showed mosaic of low and high diversity patches. Therefore, this study highlights the loss of species richness and dominance of pollution-tolerant species showing that the western part of the lake is severely disturbed during the summer season.

Key words: *Bhoj Wetland, Macrophytes, Shannon-Wiener Index (H').*

Introduction

Aquatic macrophytes are one of the most abundant life forms on the earth and its diversity leads to a richness of life and beauty to the lakes. Macrophytes are hydrophytes of freshwater which can be easily seen with the naked eye and are normally found growing in or on the surface of water (Gecheva *et al.*, 2013). They provide shelter and food for small animals, release oxygen during photosynthesis and are reliable indicators of ecosystem health (Schneider, 2007). Aquatic plants integrate physical, chemical, and biological features of an ecosystem so their abundance and distribution are affected by variations in the environmental conditions and nutrient status of lake (Ciecierska and Kolada, 2014). The Upper Lake is a hotspot of biodiversity and lifeline of the Bhopal city, Madhya Pradesh, India. It is one of the most heavily used and exploited water body for sustainability and well-being, thus facing a great threat (Biswal, 2019). Unethical human activities near lake have changed the nutrient dynamics, favouring the growth of invasive species of macrophytes at the cost of native species, thus losing

biodiversity (Sharma and Singh, 2017). As a result, about 120 floral species of Upper lake are endangered and need conservation measures (Biswal, 2019). There are mainly two factors, i.e. Importance value index (IVI) and Shannon-Wiener Index (H') which determine the ecological status of lakes and their native biodiversity (Mandal and Joshi, 2014). IVI is a quantitative parameter that shows ecological importance of a species in a given ecosystem and it was determined according to (Curtis and Mcintosh, 1950). However, the H' Index is a helpful index that considers both the number of species as well as evenness of the species, under the influence of anthropogenic activities (Ghosh and Biswas, 2015) and it was estimated by using the formula given by Shannon and Weiner, 1963. Thus, in this study we tried to evaluate the effect of climate changes together with anthropogenic activities on the macrophyte biodiversity as it forms the basis for conservation planning of the lake.

Study Area

Bhopal is known as city of lakes and Upper lake is one of them. The present study was conducted on the western fringe of Upper Lake i.e. Behta village in Bhopal. It is located at 23º13'-23°16' N latitude and 77°18'-77°24' E longitude, surrounded by human settlements and agricultural fields with growth of macrophytes on the Western side.

Materials and Methods

The assessment of the various quantitative characters was carried out through line transect method, using a square of 1 m^2. A total number of 20 quadrats were studied by adopting the methodology of (Ambasht, 1970) at the sampling site during each season i.e. summer (SUM)-June 2018, monsoon (MON)-September 2018, and winter (WIN)-January 2019. The macrophytes were recognized with the help of standard literature by Adoni (1985).

Importance Value Index (IVI) / 300 = Relative density (R.D.) + Relative frequency (R.F.) + Relative abundance (R.A.)

$$H' = -\sum_{i=1}^{S}(pi) * (\log 10\ pi)$$

where, S = Number of species, pi = proportion of individuals of a given species

Results

During the study, overall 17 species of macrophytes belonging to 12 families were observed throughout at the shore of Behta village and some of them are shown in Figure 3. In terms of the overall ecological importance of macrophytes, the IVI results showed that the species with high importance values differ with different season (Table 2). The IVI of the *Eichhornia* crassipes (16.49 and 12.65) was the most dominant in summer followed by *Alternanthera philoxeroids* (9.62) in the monsoons and *Ceratophyllum demersum* (16.12, 8.7, 20.49) in winter. Consequently, the lowest IVI were observed for

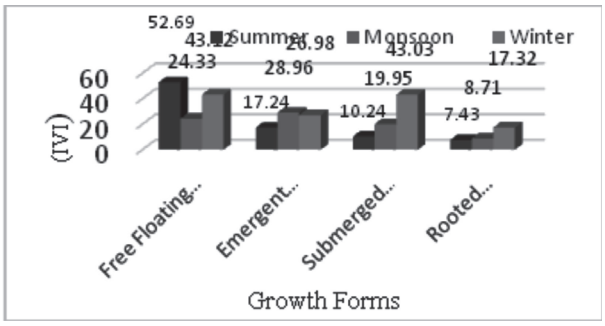

Fig. 1. Seasonal Variation in IVI of macrophytes dwelling in the Behta village

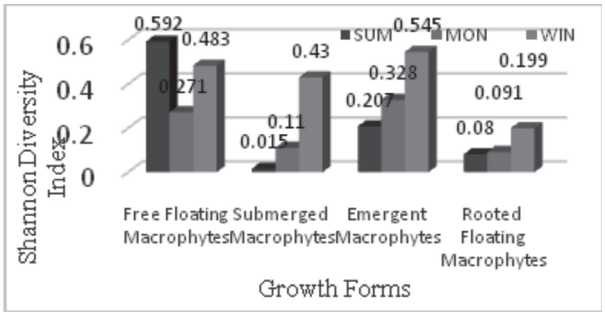

Fig. 2. Seasonal Variation in Shannon Index of macrophytes in the Behta village

Table 1. Seasonal variations inH'index of macrophytes in Behta village

Growth form of species	Shannon Weiner Index (H')			
	SUM	MON	WIN	Average
Free Floating	0.592	0.271	0.483	1.345
Submerged	0.015	0.11	0.43	0.555
Emergent	0.207	0.328	0.545	1.08
Rooted Floating	0.08	0.091	0.199	0.369
Total Community Value	0.894	0.799	1.657	3.35

Trapa natans (2.93) in summer season. The annual average values IVI of free-floating type were observed to be most dominant (36.35), followed by the submerged (29.43), emergents (23.06), and rooted floating type (11.15) macrophytes. The computation of Shannon-Wiener's index of macrophytes revealed that the species diversity was highest for the free-floating species (1.345) followed by the emergent (1.080), submerged (0.555) and rooted floating type (0.066) respectively (Table 1). The species diversity for the entire community was observed high in the Winter season (1.657), followed by Summer (0.894) and lowest in the Monsoon (0.799) respectively.

Discussion

The western fringe has lesser number of species and large number of individuals which causes low species richness and vice- versa. The low species richness may be attributed to low water level with slow speed of water, increased turbidity and high levels of humic substances, low pH, anoxic conditions and high anthropogenic activities (Ondiba *et al.,* 2018; Svitok *et al.,* 2016). Small differences in the values of species richness of macrophytes species within the site reveals that it has more homogeneous population. The evenness of water hyacinth was exceptionally high in site because the number of adult individuals of the species is extremely greater than the other species which increases the competition with other species for resources. Seasonal fluctuations in lake vegetation are mainly dependent upon hydrological changes, morphology of the bottom and sediment quality, so the conditions of growth for different species of macrophytes varies (Lacoul and Freedman, 2006). Chambers *et al.,* (2008) also concluded that macrophyte diversity for the tropics is higher than that of temperate regions. The value of diversity index (H') for macrophyte lies between (0.79 -1.65), similar to the values reported by earlier studies (Biswas and Ghosh, 2015) (0.86-2.30).

Conclusion

The present study reveals that the Behta village of

Table 2. Seasonal Variation inIVI of Macrophytesin Behta village

S. No.	Species of Macrophyte categorized by growth forms	IVI			
		SUM	MON	WIN	Average
I	Free Floating				
1	*Eichhornia crassipes*	16.49	10.19	12.67	13.45
2	*Spirodella polyrhiza*	15.45	3.98	6.05	8.49
3	*Wolfia globosa*	7.65	5.44	7.91	7
4	*Pistia*	4.82		2.71	3.76
5	*Azolla*	3.24		2.71	2.97
6	*Aponogeton natans*	5.31		4.76	4.88
	Total	**52.65**	**19.61**	**36.81**	**36.35**
II	Submerged				
1	*Ceratophyllum demersum*	16.12	8.7	20.49	15.10
2	*Ottelia alismoides*		4.08	4.82	4.45
3	*Hydrilla*	4.19		7.26	5.725
4	*P crispus*		7.13	8.28	7.705
5	*P lucens*			7.22	7.22
	Total	**20.31**	**19.91**	**48.07**	**29.43**
III	Emergent				
1	*Tripascum dactyloides*	6.87	3.65	8.54	6.35
2	*Colacasia esculenta*		7.62		13.62
3	*Isoetes coramandelina*		4.05	7.12	5.585
4	*Alternanthera philoxeroids*	11.32	7.64	10.37	9.77
	Total	**18.19**	**24.96**	**26.03**	**23.06**
VI	Rooted Floating				
1	*Nymphaeoids nouchali*		5.78	7.34	6.56
2	*Trapa natans*	2.93	7.43	9.98	6.78
	Total	2.93	13.21	17.32	11.15
	Grand Total	98.45	77.69	123.86	300

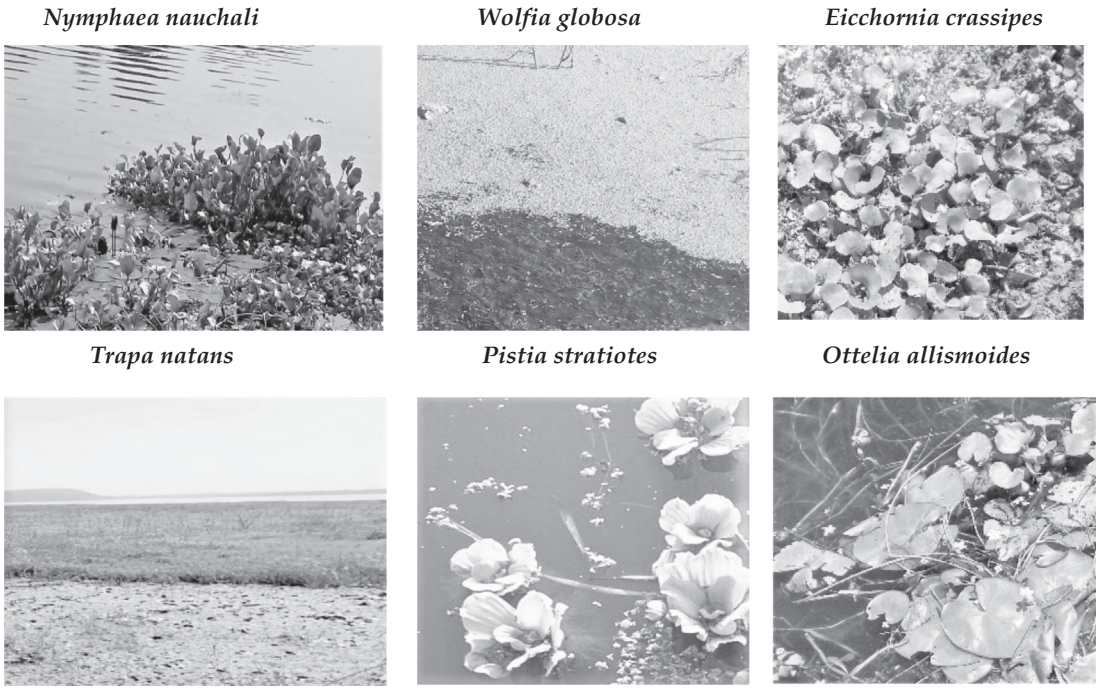

Fig. 3. Macrophytes of Upper Lake

the Upper lake was heavily disturbed in summer's, thus negatively effecting the overall health of lake ecosystem. So, it is very important to conserve the natural ecosystems that are deteriorating at an alarming rate otherwise the remnants will significantly lose their ability to sustain the present biological diversity.

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