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Current status of macrophyte diversity and distribution in Ghunghuta dam of Surguja (CG) India

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Abstract
The current research focuses on the documenting of aquatic macrophytes from Ghunghuta dam. Macrophytic survey was conducted in dam for a period of two years and recorded the presence of 17 macrophytic species belonging to 14 families. Among various ecological groups, rooted-floating type with 7 species showed qualitative dominance over emergent (04 species), and submerged and free floating species (03 species each). The computation of different diversity indices of macrophytes revealed that the highest values for the Shannon index, Simpson diversity index and Margalef diversity index were exhibited by Site-S2, Site-S1 and Site-S6 respectively.

Keywords: Diversity indices, macrophytes, ghunghuta dam, sites

Introduction

Macrophytes, in their various forms, are the most important biotic constituents of a lake environment. Because of their ability to integrate environmental changes over a few years and reflect the cumulative impact of multiple disturbances, macrophytes are regarded as effective indicators of the ecological state of water bodies (Tremp, 1995) [1]. They develop distinctive spatial patterns (Hutchinson, 1975 and Spence, 1982) [2-3] that frequently serve as a transitional boundary between open water and reed swamp habitats. Macrophytes participate in a number of feedback processes that help to keep the water clean even when nutrient levels are rather high (Moss, 1990) [4]. Furthermore, macrophytes have been shown to influence lake nutrient status, bottom material resuspension, and water turbidity (James and Barko, 1990; Horppilla and Nurminen, 2001) [5-6]. Aquatic plants and their communities may also be good indicators of changes occurring in lakes as a result of human-caused acidification and eutrophication (Roelofs, 1983; Lehman and Lachavanne, 1999) [7-8].

Macrophytes are an important component of lake ecosystems that support a variety of food chains in the water body. The macrophytes determine the general physiognomy of the ecosystem, showing the degree of pollution, and are thus responsible for the biogeochemical cycling of nutrients (Wetzel, 1975) [9]. Macrophytes contribute a significant portion of primary production in shallow lakes and wetlands, and hence play an important role in shaping the structure and function of these ecosystems. Expanding urbanization and unregulated population are to blame for the deterioration of these water bodies by affecting the limnological profile, which in turn affects the dominating components of the water body-macrophytes. Despite the fact that the wetlands of Kashmir have been studied for limnology and anthropogenic influence (Khan, 2001 and Parray *et al.*, 2008) [10-11], very little information on the quantitative examination of macrophytes is available. As a result, the current study was done to evaluate the community structure of macrophytes inhabiting Ghunghuta dam (CG) India.

Study area

The Ghunghutta reservoir is located in Surguja district (22 °94N latitude & 83°164E Longitude) of northern Chhattisgarh in India. Ghunghutta is a medium irrigation project which was constructed in 2002 across the river Ghunghutta which is a tributary of Rehar Sub basin Sone in the Ganga basin. The Dam is 14km. from the district head quarter Ambikapur. The Dam is 242.20 meter long and 31.50 meter high.

The live storage capacity of the reservoir is 62.05 MCM. Mainly reservoir water is used for irrigation but it is also utilized for pisciculture practices.

The Dam has typical rural environment which is enriched with the growth of variety of flora and fauna. The impact of anthropogenic pressure on the reservoir seems quite high and hence a constant monitoring of this water body is highly essential. A number of limnological studies were carried out on manmade reservoirs in India but there is a lack of baseline data on limnological characteristics of Ghunghutta reservoir Surguja which is used for irrigation and pisciculture activities. Therefore the present study was undertaken.

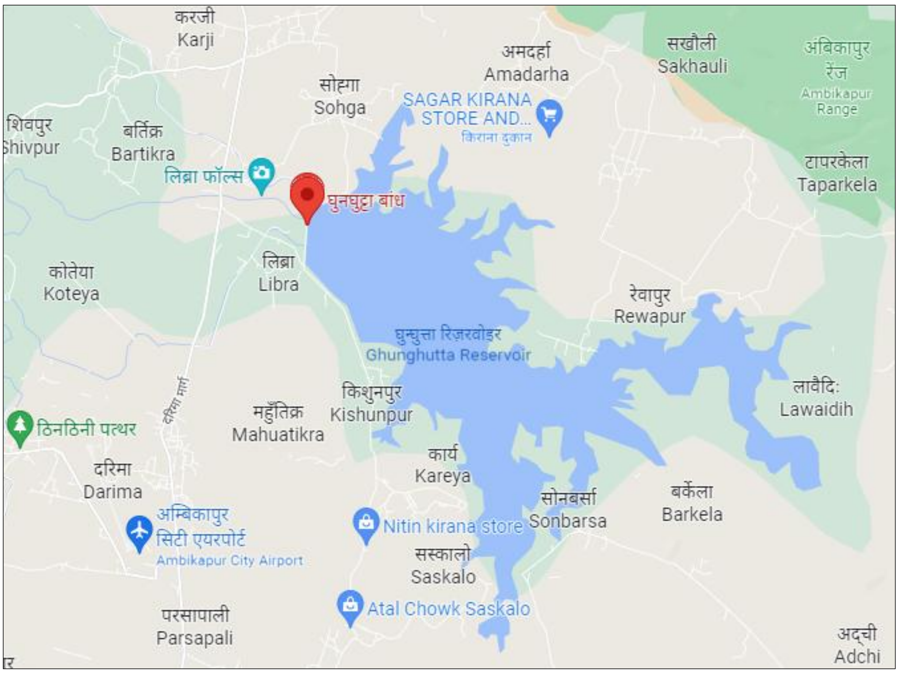

Fig 1: Map depicting different sampling locations in Ghunghuta dam.

Material and Methods

Several locations were chosen for the current macrophytic investigation because of apparent variations in topography, soil conditions, floral features, and human influences. Using the Random Quadrat Method, the macrophyte community characteristics were calculated on a seasonal basis during a two-year period (Misra, 1986) [12]. At each of the selected sites, 1m^2 quadrats were laid out at random. The macrophytes in each quadrat were separated species by species, and the number of individuals in each species was counted to determine various phytosociological characteristics (Misra, 1986) [12]. Standard literature (Biswas and Calder, 1954; Ward and Whipple, 1959; Adoni *et al.*, 1985; Cook, 1996) [13-16] and taxonomic expertise were used to identify the macrophytes. The phytosociological parameters such as frequency, density, and dominance were estimated in accordance with Curtis (1956), Philips (1959) [17-18]. The Importance Value Index of a species in the community provides an indication of relative importance of the species as comparison to other species (Curtis, 1956) [17] and is calculated by adding the relative density, relative frequency, and relative dominance. The species diversity of aquatic macrophytes was determined using the following formulas:

Shannon and Weiner diversity index (H) calculated using the Shannon and Weiner formula (1948) [19].

$$H' = -\sum_{i=1}^{i=s}\left(\frac{ni}{N}\right) log_e\left(\frac{ni}{N}\right)$$

H'= Index of species diversity
ni= Density of one species
N= Density of all species
e= Base of natural logarithm $log_e\left(\frac{ni}{N}\right) = 2.303\ log_{10}\left(\frac{ni}{N}\right)$
$\sum_{i=1}^{i=s}\left(\frac{ni}{N}\right)$ = Addition of the expression for the values of i = 1 to = s

Simpson's Diversity Index (D)

It provides higher weightage to dominant species in the sample and decreases as diversity increases and was computed as:

$$D = 1 - \sum_{i=1}^{s}(pi)^2$$

Where, "pi" is the proportion of individuals in the "ith" taxon of the community and "s" is the total number of taxa in the community (Simpson, 1949) [20].

Margalef Diversity Index (1958)

The Margalef diversity index (d) was calculated as:

$$d = \frac{(S-1)}{In\ N}$$

Where d =Margalef diversity index
S = Number of species
N = Total number of individuals in the sample

Evenness

Evenness is a measure of the relative abundance of the various species that contribute to an area's richness. The following formula was used to calculate the evenness:

J' = $H'/H'max$

Where: J' = Evenness index

H' = the observed value of Shannon index

H'_{max} = 1nS

S =Total number of species

Results and Discussion

During the two-year research period, seventeen macrophytic species from 14 families were identified. Table 1 shows the frequency range, relative frequency, density, relative density, abundance, relative abundance, and important value index.

Table 1: Macrophytic community features of Ghunghuta dam.

Species name	Density	Freq	Abundance	RD	RF	RA	IVI
	Emergents						
Typha angustata	16	27.8	19.2	1.97	6.49	2.16	10.62
Phragmites australis	1.9	27.8	2.5	0.23	6.49	0.28	7
Phragmites communis	0.88	16.7	2.28	0.1	3.9	0.26	4.26
Polygonium barbatum	3.83	22.2	5.75	0.47	5.19	0.64	6.3
Submerged							
Hydrilla verticillata	12.38	22.2	18.58	1.52	5.19	2.09	8.8
Ceretophylum demersum	46.39	22.2	69.58	5.71	5.19	7.84	18.74
Myriophylum spicatum	17.22	22.2	25.83	2.11	5.19	2.91	10.21
	Rooted floating leaved type						
Nelumbo nucifera	5.77	27.8	6.93	0.71	6.49	0.78	7.98
Trapa natans	12.22	33.33	12.22	1.5	7.78	1.37	10.65
Nymphaea alba	4	27.8	4.8	0.49	6.49	0.54	7.52
Nymphoides peltatum	18.88	22.2	28.33	2.32	5.19	3.19	10.7
Hydrocharis dubia	34.88	27.8	41.86	4.29	6.49	4.71	15.49
Potomegeton natans	5.5	22.2	8.25	0.67	5.19	0.92	6.78
Euryale ferox	0.16	5.6	3	0.017	1.3	0.33	1.647
	Free floating						
Azolla	469.88	33.33	469.88	57.84	7.78	52.96	118.58
Salvinia	30.88	33.33	30.88	3.8	7.78	3.48	15.06
Lemna	137.33	33.33	137.33	16.9	7.78	15.48	40.16

Among the 17 macrophyte species identified during the current investigation, 07 were rooted floating type, 4 were emergents, 3 each were submerged and free floating (Fig. 2). Poaceae, Hydrocharitaceae, and Nymphaceae showed dominance in the lake (02 species each), followed by Polygonaceae, Menyanthaceae, Nelumbonaceae, Typhaceae, Potamogetonaceae, Salviniaceae, Trapaceae, Azollaceae, Ceratophyllaceae, Haloragaceae, and Lemnaceae (01 species each). An overall macrophytic investigation revealed that the rooted floating leaved type (07 species) was dominant, followed by emergents (04 species), submerged and free floating leaved types (03 species each).

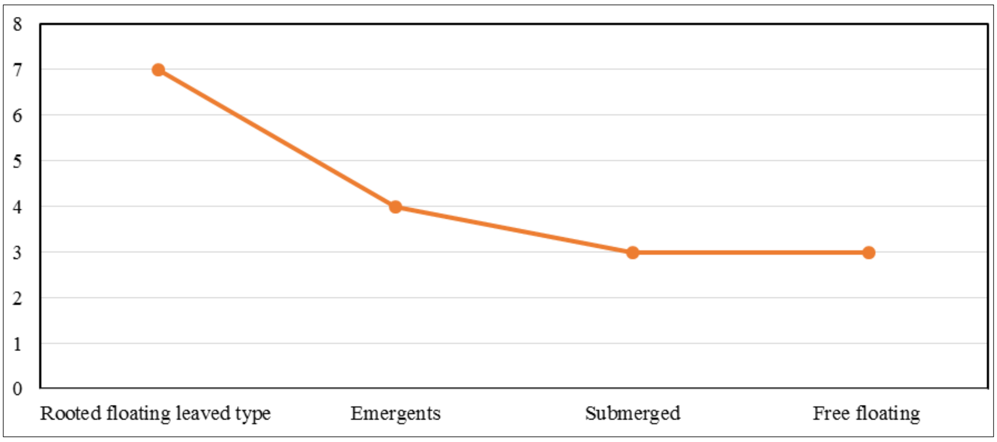

Fig 2: Percentile share of the macrophytes inhabiting Ghunghuta dam.

The study of Table 1 demonstrates that the maximum overall frequency was exhibited by *Azolla, Salvinia, Lemna and Trapa natans*, (33.33% each) and the least was shown by *Euryale ferox* (5.6%). *Azolla* sp. showed highest overall dominance in terms of density, frequency, abundance and IVI. *Typha angustata* and *Phragmites australis* were the dominant species among emergents in terms of frequency of occurrence recording frequency values of 27.8 each followed by *Polygonium barbatum* with a value of 22.2. *Trapa natans* recorded highest frequency value of 33.33 followed by *Nympheae alba, Nelumbo nucifera* and *Hydrocharis dubia* with a frequency value of 27.8 each among rooted floating-leaf types, while as *Ceratophyllum demersum*, *Hydrilla verticillata and Myriophyllum spicatum* showed same frequency 0f of 22.2 among the submerged. The three free floating species i.e., *Salvinia natans, Azolla* sp. and *Lemna* sp. depicted mean frequency values of 33.33 each.

In general, the maximum value for importance value index (IVI) was obtained for *Azolla* sp. (118.58), *Lemna* (40.16) and *Ceretophyllum demersum* (18.74), while as the least was obtained for *Euryale ferox* (1.64) followed by *Phragmites communis* with a value of (4.26). During the present study a total of 17 macrophytic species were recorded from the Ghunghuta dam. However, Maqbool and Khan (2013) reported 15 macrophytic species belonging to 10 families; Siraj *et al.,* (2018) observed 12 macrophytic species, while as Abubakar and Kundangar (2008). Thus, increasing macrophyte vegetation shows that lake water is obtaining nutrients, which aids in the abundant growth of macrophytes. The main source of plant nutrients is obviously the sewage, waste water, and animal dung used by the locals for drying on the outskirts of Ghunghuta dam, as well as detergents used for washing clothing directly within the region. The inflow of_animal dung helps to enhance nutrients, which promotes the growth of aquatic vegetation.

The *Azolla* sp. which is an indicator of organic enrichment, was the most dominant species in terms of density, frequency abundance and recorded highest IVI from the Ghunghuta dam. The present dominance of *Azolla* sp. can be attributed to its invasive tendency as well as its affinity for highly eutrophic and stagnant water.

Ceretophyllum demersum and *Myriophyllum spicatum* were found to be the most dominant submerged species during the research period. The increased growth of *Ceretophyllum* and *Myriophyllum* in the lake might be attributed to shallow depth, increased transparency of the waters, enrichment of lake sediments, and greater calcium levels.

Among the rooted floating leaved species, *Hydrocharis dubia* showed highest dominance in terms of mean density, abundance and importance value index and *T. natans* showed maximum frequency. *Euryale ferox* showed least dominance in terms of density, frequency and abundance and was recorded only at Site-S6 from the Ghunghuta dam. The reason for this is that local boatmen destroy this plant species in its initial vegetative stage at shallower depths, fearing that the thorny petioles of the plant at a later stage of growth would make extracting commercially useful rhizomes of *Nelumbo nucifera* hard and may be also due to environmental deterioration of the lake due to accelerated eutrophication.

The significant coverage of the *Typha angustata* and *P. australis* in the lake are indicative of its highly productive status (Hutchinson, 1975) [2].

The calculation of diversity indices of macrophytes indicated that the maximum values for the Shannon-Weiner's index, Simpson diversity index and Margalef diversity index were exhibited by Site-S2, Site-S1 and Site-S6 respectively, which may be due to the fact these sites are located near human habitations and receive discharges rich in nutrients from domestic sewage. Maximum species diversity recorded for these sites support the earlier observation that the water bodies influenced by domestic sewage effluents are most conducive to luxuriant growth of macrophytes (Tripathi and Pandey, 1990) [21]. The low values at Site-S4 may be due to the fact that this site is least polluted and supported comparatively low diversity and density of macrophytes during both the year of study. The results of evenness index indicated that Ghunghuta dam has a higher equal representation of species at Site-S4 and has lower representation or highest unequal representation at Site-S2 and Site-S1.

Table 2: Macrophyte diversity indices

Sites	Shannon_H	Simpson_1-D	Evenness_e^H/S	Margalef
S1	1.638	0.6655	0.3216	2.139
S2	1.689	0.6938	0.3383	2.088
S3	1.01	0.4812	0.305	1.336
S4	0.8692	0.4514	0.5963	0.6487
S5	1.558	0.6096	0.3167	2.098
S6	1.448	0.5782	0.2503	2.266

Conclusion

Based on the foregoing discussion, it is obvious that macrophyte proliferation is accelerating in Ghunghuta dam. Thus, increasing macrophyte vegetation shows that lake water is receiving nutrients, which aids in the abundant growth of macrophytes. Domestic sewage, animal dung used by the locals for drying in the marginal peripheries of Ghunghuta dam, and detergents used for washing clothes directly within the region are undoubtedly the main sources of plant nutrients. Besides, the dominance nature of *Azolla* sp. in terms of density, frequency abundance and highest IVI thus poses a serious threat to the lake. *Euryale* ferox was only found at Site-S6, which might be attributed to increasing human interference at the other sites. The highest diversity indices values were exhibited by Site-S2, Site-S1and Site-S6 sites respectively. As a result, the study focuses on the immediate need to take effective measures for the conservation and restoration of the lake. Constant monitoring and development of appropriate management strategies are extremely important for lake protection and conservation in future.

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