Macrophyte diversity and trophic status of Sakhya Sagar Lake, Shivpuri, Madhya Pradesh, India.

Article *in* Annals of Plant Sciences · September 2018

DOI: 10.21746/aps.2018.7.8.6

3 authors, including:

Anand KUMAR Mishra
GOVERNMENT SMS PG COLLEGE SHIVPURI MP INDIA
4 PUBLICATIONS **9** CITATIONS
SEE PROFILE

Musadiq H Bhat
Botanical Survey of India
19 PUBLICATIONS **41** CITATIONS
SEE PROFILE

Annals of Plant Sciences 7.8 (2018) pp. 2398-2402

ANNALS OF PLANT SCIENCES
ISSN: 2287-688X
OPEN ACCESS
www.annalsofplantsciences.com

Research Article

Macrophyte diversity and trophic status of Sakhya Sagar Lake, Shivpuri, Madhya Pradesh, India.

Mohit Arya[1]*, Anand Kumar Mishra[2] and Musadiq Hussain Bhat[3]
[1]Department of Zoology, Govt. K.R.G.P.G. (Auto.) College, Gwalior (M.P.)-474001, India.
[2]Department of Zoology, Govt. S.M.S.P.G. College, Shivpuri (M.P.)-473551, India.
[3]School of Studies in Botany, Jiwaji University, Gwalior (M.P.)-474011, India.

Received: 07-04-2018; **Revised:** 12-06-2018; **Accepted:** 23-07-2018

Abstract: Aquatic habitats provide suitable environment for supporting survival of a diversity of aquatic life forms. The study was conducted in Sakhya Sagar Lake which is situated inside the Madhav National Park Shivpuri district of Madhya Pradesh. To assess the status and distribution of macrophytes, frequent trips were conducted in the study area. The plants were classified based on their habit and their presence was visually observed. A total of 16 plant species were recorded, of which 16 species, 5 species were sub-dominant, 6 species were common and 5 species were un-common. Among all the 16 plants 9 species are free floating, 4 species are submerged hydrophytes, 1 species is emergent type hydrophyte and 2 species are marginal hydrophytes. Aquatic macrophytes like *Nymphaea nouchali*, *Nelumbo nucifera, Trapa natans, Ipomoea aquatica, Vallisnaria spiralis, Potamogeton crispus*, and *Azolla pinnata* were recorded as the common plants of this lake. The trophic status and macrophyte diversity of Sakhya Sagar Lake has been discussed in the paper.

Keywords: Macrophytes, Diversity, Trophic status, Sakhya Sagar Lake, Shivpuri.

Introduction

Aquatic life of an ecosystem is dependent on hydrologic system and geological conditions. Living organisms in aquatic habitats are continuously fed by the nutrients leached from the soil in their close proximity. Rooted plants, marsh grasses and algae play an important role in food webs and trophic relationships between various organisms. In freshwater systems, macrophytes act as indicators of the eutrophication. Eutrophic water bodies are highly productive while oligotrophic water bodies are relatively unproductive and have small number of aquatic plants and nutrients. Productivity of aquatic organisms is dependent on physico-chemical features of water.

Lakes are important feature of the Earth which provide habitat to plants and animals, and also influence microclimate, enhance the aesthetic beauty of the landscape besides being the source of precious water. They are also used for drinking, irrigation, fishing and eco-toursim. One percent of the earth's surface is covered by various fresh water bodies including the lakes (Gleick, 1996) which support life of 7 % of estimated 1.8 million species (Balian *et al.,* 2008). Various types of macrophytes (free floating, emergent, submerged, etc. are common life forms of an aquatic ecosystem. Macrophytes play an important role in maintenance of the lake ecosystem. Macrophytes can be used as tool in the determination of pollution and nutrient level (Melzer, 1999), water quality and lake condition (Clayton & Edwards, 2006), trophic status (Palmer *et al.*, 1992). At margins these macrophytes checks and binds the incoming soil and raise the bed level, resulting in water capacity loss.

In India, Subramanyam (1962) and Cook (1996) published aquatic and wetland plant species of India. In Madhya Pradesh, Maheshwari (1960), Unni (1967), Choudhary & Upadhyay (2009) and Anand *et al.,* (2012) carried out systematic study of aquatic angiosperms. In the present paper, macrophyte diversity and trophic status of Sakhya Sagar Lake in Shivpuri district of Madhya Pradesh, India has been discussed.

Materials and Methods

Study Area

The present study was conducted in Sakhya Sagar Lake of Madhav National Park, Shivpuri during April 2015 to March 2017. The Madhav National Park is rich in aquatic ecosystem. The Sakhya Sagar Lake (Chand Patha) is a perennial freshwater lake, covering an area of about 309.01 hectares. It is situated 4 km. east to Shivpuri town. Geographically it lies between 25º 20´- 25º 38´ N latitude and 77º 38´-77 º 57´ E longitudes (Figure 1). The lake has rocky and mildly sloppy banks with marginal reed-weeds and varieties of aquatic vegetation. Its depth varies from place to place and its basin shows the presence of muram, clay, black soil and sandy loam. The soil of lake is sandy loam and well drained.

***Corresponding Author:**
Dr. Mohit Arya,
Department of Zoology, Govt. K.R.G.P.G. (Auto.) College,
Gwalior (M.P.)-474001, India.
E-mail: aryans.mohit@gmail.com

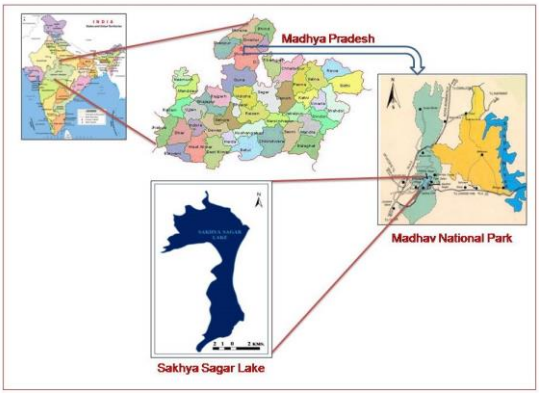

Figure 1. Location map of Sakhya Sagar Lake

Methodology

Hand picking and hook methods were used to collect the specimens of aquatic macrophytes of the lake. The collected specimens were identified with the aid of literature (Cook, 1996; Naskar, 1990; Fassette (1992). The classification was done as dominant, sub- dominant, common and uncommon on the basis of individuals of a species present in different sites and other selected areas in the lake.

Description of method in brief used to study the biological parameters viz., Water temperature (°C), Transparency (cm), Electrical conductivity (µS/cm), pH, Dissolved oxygen (mg/l), Free carbon dioxide (mg/l), Total alkalinity (mg/l), Total hardness (mg/l), Chlorides (mg/l), Calcium (mg/l), Nitrate (mg/l) and Phosphates (mg/l) (Table 4).

Results and Discussion

Macrophyte diversity

A total of 16 species of macrophytes are recorded in this study (Figure 2 and Table 2). Out of 16 species, 5 species were sub-dominant, 6 species were common and 5 species were un-common (Table 1). The floristic composition shows that the vegetation of hydrophytes in Sakhya Sagar Lake includes as many as 16 plants 9 species are free floating, 4 species are submerged hydrophytes, 1 species is emergent type and 2 species are marginal hydrophytes (Figure 3, Table 3). The dominant families are Nymphaeaceae, Hydrocharitaceae and Araceae (2 species each) Table 2).

Figure 2. A-View of lake, B- *Nymphoides cristata*, C- *Nymphaea nouchali,* D- *Ipomoea carnea,* E- *Ipomoea aquatica* F, *Azolla pinnata*

Table 1. Diversity of observed macrophytes in Sakhya Sagar Lake

Species	Dominant	Sub-dominant	Common	Un-common
Nelumbo nucifera		√		
Nymphaea nouchali				√
Nymphoides cristata.			√	
Trapa natans			√	
Ipomoea aquatica		√		
Lemna perpusilla				√
Azolla pinnata		√		
Pistia stratiotes				√
Eichhornia crassipes				√
Ceratophyllum demersum			√	
Hydrilla verticillata		√		
Vallisneria spiralis			√	
Potamogeton crispus		√		
Cyperus acticulatus				√
Ipomoea carnea			√	
Marsilea quadrifolia			√	

Table 2. Detailed description of Macrophytes in Sakhya Sagar Lake

Name of the Plant	Class	Family	Local Name	Description
Floating Hydrophytes				
Nelumbo nucifera Gaertn.	Dicot	Nymphaeaceae	Kamal	Native to Asia and flourishes from India to China usually found in Lakes, ponds and also cultivated for edible rhizomes. Its large pink or white flowers and leaf stalks rise above the water. Large, round leaves are covered with hairs. The stem is edible in India.
Nymphaea nouchali Burm.f.	Dicot	Nymphaeaceae	Neelkamal	It is a rhizomatous herb with submerged roots and stems. Parts of the leaves are submerged. Flower is usually violet blue in color. It is considered as an ayurvedic medicinal plant (*Ambal*). The dried plant material is used in India as animal forage.
Nymphoides cristata (Roxb.) Kuntze.	Dicot	Menyanthaceae	Jalrani / Kamudini	Annual herb with large floating stem, rooting at the nodes. Leaves floating, cordate at base, with dense brown glands on the lower surface. It is found in China, India and Pakistan.

Trapa natans L.	Dicot	Lythraceae	Singhara	This aquatic plant species has lax rosettes of triangular, coarsely toothed leaves floating on the surface with submerged leaf-stalks. Flowers are white in color. Fruits are top-shaped. It is mainly found in slow moving rivers, lakes, swamps, ponds.
Ipomoea aquatica Forssk.	Dicot	Convolvulaceae	Nali or Kalmi Sag	It is a semi-aquatic tropical soft glabrous herb often creeping on wet ground or floating in shallow waters mainly found in marshy areas. Flowers are white or pink with dark centre. It has many medicinal uses and is also are used for forage. Young shoots and leaves are used as vegetable.
Lemna perpusilla Torr.	Monocot	Araceae	Hari Kai	It is a small floating aquatic herb. Fronds are pale green in color. Seeds are minute and yellowish. Flowering occurs during April and May. It is found throughout the warmer regions of both the hemispheres.
Azolla pinnata R. Br.	Pteridophyte	Salviniaceae	Bhoori Kai	It is a floating herb with creeping and slender stem. Lateral branches are falsely dichotomous, with fibrous roots growing downwards. These plants are found floating in ponds, lakes and paddy fields. It is used to treat a large number of diseases. The whole plant is used as green manure and forage.
Pistia stratiotes L.	Monocot	Araceae	Jalkumbhi	It is an aquatic herb floating on the surface of the water. Roots hang inside water. It's thick floating leaves form a rosette and have no stem. Small flowers are present hidden in the middle of the plant amongst the leaves.
Eichhornia crassipes (Mart.) Solms	Monocot	Pontedericaceae	Jalkumbhi	It is a free-floating perennial aquatic plant with broad, thick, glossy, leaves. Leaves float above the water surface. An erect stalk supports a spike of 8-15 prominently attractive flowers, mostly lavender to pink in color.
Submerged Hydrophytes				
Ceratophyllum demersum L.	Dicot	Ceratophyllaceae	Khaja chhoti	It is a rootless, much branched, submerged, aquatic plant. Leaves are present in whorls. Flowers minute, solitary, axillary and unisexual.
Hydrilla verticillata (L.f.) Royle	Monocot	Hydrocharitaceae	Sewar or Khaja motipatti Jhangi, Kureli	It is an aquatic herb native to India, naturalized all over the world having off-white to yellowish rhizomes. The stems grow up to 1-2 m long. The leaves are arranged in whorls. The flowers are small. It reproduces vegetatively by fragmentation and by rhizomes and turions.
Vallisneria spiralis L.	Monocot	Hydrocharitaceae	Feeta ghas	It is an aquatic plant with narrow and linear leaves, pale-green to reddish in color. It is monoecious. In the wild, it can be found in tropical and sub-tropical regions worldwide. It is found in estuarine habitats, lakes, rivers, swamps, man-made reservoirs and irrigation channels.
Potamogeton crispus L.	Monocot	Potamogetonaceae	Potamogeton	*P. crispus* is a submersed perennial plant with slender, stems. The stems are rectangular with many branches. It bears branched rhizomes. The leaves are bright to dark green in color. The flowers are present as clusters of 3 – 5 whorls arranged in a spike. Fruit is smooth, containing small tuber-like swellings.
Emergent Hydrophytes				
Cyperus articulatus L.	Monocot	Cyperaceae	Motha	It is a perennial plant which grows upto 1-2 m. Stem is green or greyish green. Leaves are reduced, soft, yellowish-brown or often reddish. Flowering and fruiting occurs in months of March and April. It is mainly found in marshy areas
Marginal Hydrophytes				
Ipomoea carnea Jacq.	Dicot	Convolvulaceae	Besharam	It is a shrub which grows to 1-5 m high. The hindi name *besharam*, meaning shameless, refers to its extensive spreading. It has heart shaped leaves that are green in color. The plants bloom in clusters of pink flowers during spring and summer.
Marsilea quadrifolia L.	Fern	Marsileaceae	Chopatiya	It is an evergreen aquatic fern which grows in temperate, tropical and sub tropical climates. It grows up to 20 Cm. It usually grows in stagnant waters such as ponds, rice fields and ditches.

Table 3. Binomial, family and morpho-ecologic group of aquatic macrophytes.

Name of the Plant	Morpho-ecologic group
Nelumbo nucifera Gaertn.	Floating
Nymphaea nouchali Burm.f.	Floating
Nymphoides cristata (Roxb.)Kuntze	Floating
Trapa natans L.	Floating
Ipomoea aquatica Forssk.	Floating
Lemna perpusilla Torr.	Floating
Azolla pinnata R. Br.	Floating
Pistia stratiotes L.	Floating
Eichhornia crassipes (Mart.) Solms	Floating
Ceratophyllum demersum L.	Submerged
Hydrilla verticillata (L.f.)Royle	Submerged
Vallisneria spiralis L.	Submerged
Potamogeton crispus L.	Submerged
Cyperus articulatus L.	Emergent
Ipomoea carnea Jacq.	Marginal
Marsilea quadrifolia L.	Marginal

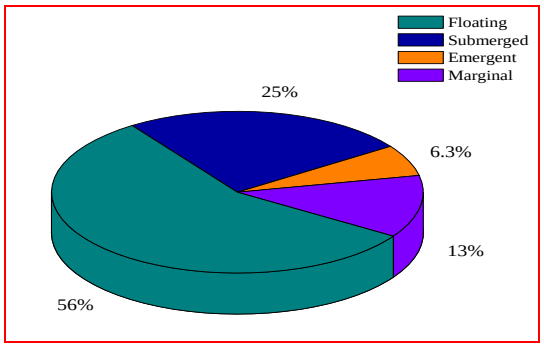

Figure 3. Distribution of macrophytes in Sakhya Sagar Lake

Submerged aquatic macrophytes contribute significantly to the productivity of the water body and provide suitable grounds for breeding, egg laying and rich oxygen and food supply for animal resources in an ecosystem (Pandit *et al.,* 1985; Kaushik *et al.,* 1991).

Trophic status

To study habitat utilization and trophic-relationship, the physico-chemical parameters of Sakhya Sagar Lake were studied along with the biological parameters (Table4). The higher amounts of TDS, BOD and COD values established the input of sewage in the lake which worsen the water quality and ultimately influences the wetland habitat. Nutrients and sediments entering the lake have increased algal blooms, reduced oxygen levels and declined fauna populations. The diagnostic features of Sakhya Sagar Lake are hydric soil with submerged, floating and amphibious vegetation which provide living place to aquatic fauna especially to resident and migratory birds. Water depth is an important factor which affects some column and bottom dweller fishes. Some waterfowl search for wetlands with open water. Water depth also determines vegetation type of aquatic ecosystem. Plants, vegetations and invertebrates in provide food for fauna species.

Table 4. Physico-chemical characteristics of water of Sakhya Sagar Lake

Parameter	Value	Trophic status	Reference
Water temperature (°C)	19.18 - 32.76	Meso-thermal	Lee *et al.*, (1981)
Transparency (cm)	81.75 - 123.75	Eutrophic	Lee *et al.*, (1981)
Electrical conductivity (µS/cm)	341.25 - 500	Eutrophic	Olsen (1950)
pH	7.28 - 8.23	Alkaline	Venkateswarlu (1983)
Dissolved oxygen (mg/l)	6.25 - 9.35	Good	Welch (1952)
Free carbon dioxide (mg/l)	0 - 2.33	Soft	Reid and Wood (1976)
Total alkalinity (mg/l)	77.5 - 123.75	Productive	Spence (1964)
Total hardness (mg/l)	160 - 210	Hard	Sawyer (1960)
Chlorides (mg/l)	130 - 273.75	Polluted	Unni (1983)
Calcium (mg/l)	10.28 - 27.30	Medium	Ohel (1934)
Nitrate (mg/l)	0.26 - 0.01	Eutrophic	Villenweider (1968)
Phosphates (mg/l)	4.05 - 7.63	Eutrophic	Lee *et al.*, (1981)
Overall trophic status:		**Eutrophic**	

During monsoon, wave currents and inflow of rain water acts as limiting factors for phytoplankton population. The water column of the lake gets extremely stratified to large extent in heavy rainfall with high turbidity in water, brought due to agricultural and surface runoff. Subsequently, the phytoplanktons gradually increase in post-monsoon. Advance studies on effects of pollutants, nutrient load, microphyte diversity are needed to conserve this lake and its invaluable biota in an well-organized approach.

Conclusion

This study illustrated the trophic status and provided a clear view about water quality in Sakhya Sagar Lake. The analysis of trophic state in wetland is a popular tool to assess sustainability of Madhav National park which can be used for the assessment of management. Study revealed that there was a direct relationship between trophic status and water quality in Sakhya Sagar Lake. The results showed that hydrophyte diversity is the main factor which control eutrophication. These revelations would provide us with a planning strategy for water quality management in this water body. Some measures should be implemented to improve water quality in Sakhya Sagar Lake as the trophic status exceeded the eutrophic level. Anthropogenic activities are increasing around Sakhya Sagar Lake. The present study revealed that hydrophytes which are economically and medicinally important are found in Sakhya Sagar Lake.

References

1. Anand K, Arjun P, Achuta NS. Aquatic Macrophyes of Betul District (M.P.). *Journal of Non-Timber Forest Products* 19.2 (2012):133-137.
2. Balian EV, Segers H, Leveque C, Martens K. The freshwater animal diversity assessment: an overview of the results. *Hydrobiologia* 595 (2008): 627-637.
3. Biswas K, Calder CC. Handbook of Common Water and Marsh Plants of India and Burma Rep. Bishen Singh Mahendra Pal Singh. Dehra Dun, 1984.
4. Choudhary M, Upadhyay R. A Contribution to aquatic Angiosperms flora of Hoshangabad, *Journal of economic and taxonomic botany* 33.1 (2009):155-161.
5. Clayton J, Edwards T. Aquatic plants as environmental indicators of ecological condition in New Zealand lakes. *Hydrobiologia* 570 (2006):147-151.
6. Cook CDK. Aquatic and wetland plants of India. Oxford University Press London, 1996.
7. Fassette NC. A manual of aquatic plants. Agro Botanical Publishers, Vyas Nagar, Bikaner, India (1992): 382.
8. Gleick PH. Water resources. In: S.H. Schneider eds. Encyclopaedia of Climate and Weather. Oxford University Press, New York, USA. (1996): 817-823.
9. Kaushik S, Agarkar MS, Saksena DN. Water quality and Periodicity of Phytoplanktonic Algae in Chambal Tal, Gwalior, Madhya Pradesh. *Bionature* 11.2 (1991): 87-94.
10. Lee GF, Jones RA, Rast W, Alternative approach to trophic status classification for water quality management. *Occasional paper* No. 66. Department of Civil and Environmental Engineering Program. Colorado, State University, for Collins, Colorado, 1981.
11. Maheshwari JK. The vegetation of Marshes, Swamps and rivers sides in Khandwa district (M.P.). *Journal of the Bombay Natural History Society* 57 (1960): 371-387.Melzer A. Aquatic macrophytes as tool for lake management. *Hydrobiologia* 395 (1999):181-190.
12. Naskar KR. Aquatic and semi-aquatic plants of the lower Ganga Delta. Daya Publishing House, New Delhi, (1990): 408.
13. Ohel W. Chemische unde Physikalische untersuchungen norddeut-scherseen. *Archiv fur Hydrobiologie* 26 (1934):386-464.
14. Olsen, SIGURD. Aquatic plants and hydrospheric factors. *Svensk Bot. Tidskr* 44.1 (1950): 1-44.
15. Palmer MAS, Bell SL, Butterfield I. A botanical classification of standing water in Britain: applications for conservation and monitoring. *Aquatic Conservation: Marine and Freshwater Ecosystems* 2 (1992):125-143.
16. Pandit AK, Pandit SN, Kaul V. Ecological relations between invertebrates and submerged macrophytes in two Himalayan lakes. *Pollution Research* 4 (1985): 53-58.
17. Reid GK, Wood RD. Ecology of Inland Waters and Estuaries. D. Van Nostrand Company 450 west 33rd street, New York (1976): 485.
18. Sawyer CH. Chemical for sanitary Engineer. McGraw Hill Book Co., New York, 1960.
19. Spence DHN. The macrophytes vegetation of lochs, swamps and associated fens. The vegetation of Scotland (Ed.: J.H. Burnett), Edinburgh (1964): 306-425.
20. Subramanyam K. Aquatic Angiosperms CSIR, New Delhi, India, 1962.
21. Unni KS. Comparative water chemistry of a plankton dominated and macrophytes dominated lake in Chhindwara, M.P. *Proceedings of the National Academy of Sciences, India* 53.B (1983): 81-88.
22. Unni KS. Studies on the vegetation of ponds, swamps and river-banks in Raipur. M.P. *Journal of the Bombay Natural History Society* 64 (1967): 95-102
23. Vankateswarlu V. Taxonomy and ecology of algae in the river Mossi, Hydrabad, India. II. Bacillariophyceae. In: Biliotheca Phycologica. (Ed.: J. Cramer) 66 (1983): 1-41.
24. Villenweider RA. Scientific fundamentals of the eutrophication of the lakes and flowing waters with particular reference to nitrogen and phosphorus as factors in eutrophication. OECD, Directorate of Scientific Affairs, Paris, DAS/CIS/ 68 (1968): 27.
25. Welch PS. Limnology. McGraw Hill Book. Co., New York, 1952.

Cite this article as:

Mohit Arya, Anand Kumar Mishra and Musadiq Hussain Bhat. Macrophyte diversity and trophic status of Sakhya Sagar Lake, Shivpuri, Madhya Pradesh, India. *Annals of Plant Sciences 7.8 (2018) pp. 2398-2402.*

http://dx.doi.org/10.21746/aps.2018.7.8.6

Source of support: Nil.
Conflict of interest: Nil.