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Trophic Status Assessment of Gomtisagar Lake of Jhalawar District using Phytoplanktons as Biomonitors

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Abstract

In order to assess the trophic status of Gomtisagar, a polluted perennial freshwater lake influenced by various anthropogenic activities, a survey of algal flora present in the shallow margins was conducted at distinct places seasonally. In all, 91 algal species belonging to Cyanophyceae (26), Chlorophyceae (40), Centric Diatoms (01), Pennate Diatoms (15) and Euglenophyceae (09) were identified. The Nygaard's Trophic State Indices were calculated and the values of indices for various classes when compared with the ranges assigned for various eutrophication levels showed varied eutrophication states in respect to different classes of algae. The CQ is a very sensitive and useful index of organic pollution, also indicative of highly eutrophic nature of this lake. Therefore, algal taxa have been used for biomonitoring of eutrophication and to assess the quality of water.

Keywords: Nygaard's Trophic State Indices, Biomonitoring, Eutrophication, Algae.

Introduction

Unplanned urbanization, rapid industrialization and indiscriminate use of artificial chemicals in agriculture are causing heavy and varied pollution in aquatic environments leading to deterioration of quality and depletion of aquatic biota (Yeole and Patil, 2005). Chemical analysis of water provides a good indication of the chemical quality of the aquatic systems, but do not necessarily reflect the ecological state of the system (Karr *et.al*., 2000). Biological assessment is a useful alternative for assessing the ecological quality of aquatic ecosystems, since biological communities integrate the environmental effects of water chemistry, in addition to the physical and geomorphological characteristics of rivers and lakes (Stevenson and Pan, 1999; Dora *et.al*., 2010).

Review of Literature

Phytoplanktons are an ecologically important group in most aquatic ecosystems but are nevertheless often ignored as appropriate indicators of aquatic ecosystem changes (Sharma and Shaily, 2011). However, because of their nutritional needs and their trophic position at the base of aquatic food web, phytoplankton indicators can provide relatively unique information concerning ecosystem conditions compared to commonly used animal indicators (Omar and Maznah, 2010). Various workers have identified many algae as indicators of particular type of pollution (Palmer, 1969). However, due to multifold pressure of pollutants from various sources on urban water bodies, algal diversity increases and under such conditions instead of using individual algae as an indicator of pollution, whole community is considered to assess the water quality (Patrick, 1965). On the basis of number of algal species belonging to various groups, Nygaard (1949) has devised an index to assess the eutrophication state of lakes. Various researchers have employed Nygaard's phytoplankton indices (Myxophycean Index, Chlorophycean Index, Diatom Index, Euglenophycean Index and Compound Coefficient Index) reliably and extensively to study the trophic status of different water bodies in the past (Gunale and Balakrishnan, 1981; Sharma and Sharma, 1991; Mishra *et.al*., 2001 and Sharan and Rekha, 2010). However, no serious studies have been

carried out on the ecological and trophic status of this water body except studies made by Singh (1979) and Sharma *et.al*. (1988) on the aquatic marshland plants of Jhalawar district. Accordingly, this study focuses on the results of biomonitoring of this urban polluted lake using Nygaard's Indices as biomonitoring is a reliable and economical means of water quality monitoring (Kohlmann *et.al*., 2018 and Pham, 2020). Phytoplankton's small size and ability to provide strong response to environmental changes are being routinely used for biomonitoring especially for trophic state of the water (Allende *et.al*., 2019 and Wu *et.al*., 2017). In the present study Nygaard's Indices were used to assess the degree of eutrophication in terms of trophic state of the water body.

Objectives

The phytoplanktonic community is considered as a major component of aquatic biota that often exhibits dramatic changes in response to different types of pollution. Phytoplanktonic abundance in a water body also reflects its ecological state. Hence, diversity of phytoplanktonic component in the aquatic ecosystem serves as a reliable index for biomonitoring of pollution load. The aim of the present study is to determine the diversity of phytoplanktonic flora and also to determine the water quality of Gomtisagar lake using algae as bioindicators.

Materials and Methods

Study Area

Jhalawar is situated in the Hadoti region of south- eastern part of Rajasthan at the edge of Malwa Plateau. It lies between 23^{o} 45' and 24^{o} 52' N Latitude and 75^{o} 27' and 76^{o} 56' E Longitudes on Kalisindh river which flows northwards through the centre of the district.

Jhalawar district is characterized by many shallow perennials and temporary man-made water bodies viz. Kadila, Mansarovar, Gomtisagar, Krishansagar, Khandia, Ganwari and Dhanwara pond.

This study was conducted at Gomtisagar, a prominent perennial freshwater lake which has been identified as one of the threatened lakes of this region. The lake when full has an area of 600 acres with maximum water level upto 1054 ft. Its gross storage capacity is 70 mcft. This lake is severely affected by housing colonies and human settlements. At least half of the total margin length of this lake is affected by agricultural practices. Sewage waste discharge from housing colonies, cloth washing and bathing activities, washing of automobiles and addition of Kota stone slurry from stone factories makes it a highly polluted lake.

Phytoplankton Identification

Algal samples were collected in acid washed plastic tubes and preserved in 5% formalin. The samples were identified with the help of standard references (Prescott, 1951; Desikachary, 1959; Randhawa, 1959; Philipose, 1967 and Gonzalves, 1981)

Nygaard Trophic State Indices

Nygaard (1949) has devised an index to assess eutrophication state of lakes. The algal samples were identified upto species level and then grouped into various classes to calculate Nygaard's five indices as described by Gunale and Balakrishnan (1981). Generally, Cyanophyta, Euglenophyta, Diatoms and members of Chlorococcales are resistant to higher nutrient levels and thus are found more commonly in eutrophic waters while Desmids and many Pennate Diatoms are sensitive to nutrients and found in oligotrophic waters (Patrick, 1965; Palmer, 1969; Gunale and Balakrishnan, 1981).

Results and Discussion

In the present study total 91 algal species were identified belonging to Cyanophyceae (26), Chlorophyceae (40), Centric Diatoms (01), Pennate Diatoms (15) and Euglenophyceae (09). Chlorophyceae was reported as a most dominant group in the water body. Van Den Hoeck *et.al.* (1995) also reported Chlorophyceae as a large and important group of freshwater algae. Members like *Chlorella vulgaris, Schizomeris and Stigeoclonium tenue* showed a wide range of tolerance to various pollutants. Rai (1978), Rai and Kumar (1979), Gunale and Balakrishnan (1979) have also shown these species as indicators of eutrophication. Dominance of Chlorococcales and Desmidiales indicating highly eutrophicated state of water body. Presence of Cyanophycean members like *Oscillatoria, Microcystis aeruginosa and Arthrospira* in the lake water show their tolerance to high degree of pollution as also noted by Palmer (1957) and Brook (1965). Taylor *et.al*. (1981) stated that *Microcystis* is an indicator of pollution. Diatoms and Euglenophyceae are present in a low numbers in the water body.

Values of Nygaard's Trophic State Indices presented in table 1 indicates that Diatoms and Euglenophytes are the least sensitive as their index values are 0.06 and 0.225, respectively. For Chlorophycean and Cyanophycean comparatively higher values of indices were calculated i.e., 1.75 and 3.25, respectively. The CQ which has the highest value on the other hand is a very sensitive and useful index of organic pollution. The values of indices for various classes when compared with the ranges assigned for various eutrophication levels showed varied eutrophication state in respect to different classes of algae. On account of higher number of species belonging to Cyanophyceae (26) and Chlorophyceae (only

Chlorococcales and Desmideae) (22), the lake is eutrophic, while on the other hand low number of species belonging to Diatoms (16) and Euglenophyceae (09) it is oligotrophic. The value of CQ is > 6 i.e. 8.12 which is indicative of highly eutrophic nature of this lake. The results were in accordance with earlier reports (Taylor *et.al*, 1977; Williams *et.al.*, 1977; Gunale and Balakrishnan, 1982 and Sharma and Sharma, 1991). Therefore, on the basis of ratios of indicator planktonic algal groups present in water, Nygaard's Indices could be used as reliable biomonitoring tool for monitoring trophic status of an urban water body influenced by various anthropogenic activities.

Table 1 Nygaard's Trophic State Indices of Gomtisagar Lake of Jhalawar District.

Index	Calculation	Range of index for		Trophic Index
		Oligotrophic	Eutrophic	
Myxophycean	$= \frac{\text{Myxophyceae}}{\text{Desmideae}}$	0.0—0.4	0.4—3.0	3.25
Chlorophycean	$= \frac{\text{Chlorococcales}}{\text{Desmideae}}$	0.0—0.7	0.7—9.0	1.75
Diatom	$= \frac{\text{Centric Diatoms}}{\text{Pennate Diatoms}}$	0.0—0.3	0.0—1.75	0.06
Euglenophycean	$= \frac{\text{Euglenophyta}}{\text{Myxophyceae} + \text{Chlorococcales}}$	0.0—0.2	0.0—1.0	0.225
Compound	$= \frac{\text{Centric Diatoms} + \text{Euglenophyta}}{\text{Desmideae}}$	0.0—1.0	1.2—2.5	1.25
Compound Quotient (CQ)	$= \frac{\text{Myxophyceae} + \text{Chlorococcales} + \text{Centric Diatoms} + \text{Euglenophyta}}{\text{Desmideae}}$	<2	>6	8.12

Conclusion

It is concluded from the study that composition of phytoplankton communities is greatly influenced by various anthropogenic activities in the surrounding land areas and the algae may serve as good indicator of these activities and they can be used as a potent criterion for biomonitoring of eutrophication. Present study also indicates that Gomtisagar lake has become highly eutrophic and this condition may lead to further deterioration of this precious water body.

References

1. *Allende, L., Fontanarrosa, M. S., Murno, A. and Sinistro, R. (2019) Phytoplankton functional group classifications as a tool for biomonitoring shallow Lakes: a case study. Knowl. Manag. Aquat. Ecol., 420; 5-18. DOI: 10.1051/kmae/2018044*
2. *Brook, A.J. (1965) Planktonic LD has indicators of lake types with a special reference to Desmidiaceae. Limnol. Oceanorg. 10: 403-411.*
3. *Desikachary T. V. (1959) Cyanophyta p. 686. Indian Council of Agricultural Research, New Delhi, India.*
4. *Dora, L. S., Maiti S. K., Tiwary R. K. and Anshumali, A. (2010) Algae as indicator of river water pollution. A Review. The Bioscan 2, 413–22.*
5. *Gonzalves, E. A. (1981) Oedogoniales, I.C.A.R., New Delhi, 757 pp.*
6. *Gunale, V. R. and Balakrishnan, M.S. (1979) Schizomeris leibleinii Kuetz. As an indicator of eutrophication. Biovigyanam 5(2): 171-172.*
7. *Gunale, V. R. and Balakrishnan, M.S. (1981) Biomonitoring of eutrophication in the Pavana, Mula & Mutha rivers flowing through Poona. Indian J. Environ. Hlth. 23, 316–22.*
8. *Karr, J. R., Allen, J.D. and Benke, A. C. (2000) River Conservation in the United States and Canada. In: Boon, P J; Davies, B R; Petts, G.E. (eds.) Global perspectives on River Conservation. Science, Policy and Practice. Wiley, New York. 3–39 pp.*
9. *Kohlmann, B., Arroyo, A., Macchi, P. A. and Palma, R. (2018). Biodiversity and biomonitoring indices. Integrated Analytical Approaches for Pesticide Management., Academic Press. 83-106 pp.*
10. *Mishra S. M., Pania S., Bajpal A. and Bajpai A. K. (2001) Assessment of trophic status by using Nygaard's index with special references to Bhoj wetland. Poll. Res. 20, 147–53.*
11. *Nygaard, G (1949) Hydrobiological studies on some Danish ponds and lakes II. The quotient hypothesis and some new or little known phytoplankton organisms. Dat. Kurge. Danske. Vid. Sel. Biol. Skr. 7: 1-293.*

12. *Omar W. and Maznah W. (2010) Perspectives on the use of algae as biological indicators for monitoring and protecting aquatic environments with special reference to Malaysian freshwater ecosystems. Trop. Life Sci. Res. 21, 51–67.*
13. *Palmer, C.M. (1957) Algae as biological indicator of pollution. Proceedings of the Seminar on Biological Problems in Water Pollution, 1956. U.S. Department of Health Education and Welfare: 60-69.*
14. *Palmer, C M (1969) A composite rating of algae Tolerating organic pollution. Phyco. L 5 : 78-82.*
15. *Patrick, R. (1965) Algae as indicator of pollution. In biological problems in water pollution. 3rd Seminar Bot. A. Tuft. Sanitory Eng. Centre Cincinati Ohio. 223-232 pp.*
16. *Pham, T. (2020). Using Benthic Diatoms as a Bioindicator to Assess Rural-urban River Conditions in Tropical Area: A Case Study in the Sai Gon River, Vietnam. Poll., 6(2); 387-398. DOI: 10.22059/poll.2020.292996.716*
17. *Philipose, M.T. (1967) Chlorococcales. Monographs on algae. I.C.A.R. Publication, New Delhi.*
18. *Prescott, G. W. A. (1951) Algae of the western Great lakes area. Cranbrook Institute of Science. Bulletin No. 31. 946 pp.*
19. *Rai, L.C. (1978) Ecological studies of algal communities of the Ganges River at Varanasi. Indian J. Ecol. 5 (1): 1-6.*
20. *Rai, L.C. and Kumar, H.D. (1979) Studies on some algae of polluted habitats. In Recent Researches in Plant Sciences, Kalyani Publishers, New Delhi, 12-18 pp.*
21. *Randhawa, M. S. (1959) Zygnemaceae. Indian Council of Agricultural Research, New Delhi.*
22. *Sharan L. and Rekha S. (2010) Biomonitoring of a freshwater habitat of Ranchi (Hatia Dam) on the basis of Nygaard's indices. The Bioscan. 5, 495–9.*
23. *Sharma N. K. and Shaily, B. (2011) An assessment of seasonal variation in phytoplankton community of Mahi River (India). Geneconserve 10, 154–64.*
24. *Sharma, N.K., Shringi, O.P. and Tyagi, B. (1988) additions to aquatic and marshland flora of Jhalawar district, J.Indian Bot. Soc. 66 : 455-156.*
25. *Sharma, R. and Sharma, K.C. (1991) A note on trophic state of Anasagar lake, Ajmer. Geobios new Reports 10: 158-159.*
26. *Singh, V. (1979) A study of aquatic and marshland plants of Jhalawar district. J. Bombay Nat. Hist.Soc. 75: 312-332.*
27. *Stevenson, R. J. and Pan, Y. (1999) Assessing Environmental conditions in Rivers and Streams using diatoms. In: Stoermer, E. F. and Smol, J. P. (eds.) The Diatoms: Applications for the environmental and earth sciences. Cambridge University Press, Cambridge. 11–40 pp.*
28. *Taylor, W.D., Hiatt, S.C., Higert, J.W., Lambou, V. W., Morris, F. A., Thomas, R.W., Morris, M.K. and Williams, L. R. (1977) Distribution of phytoplankton in Florida Lakes. US. EPA. National Eutrophication Survey Working Paper No. 679. Iii + 113 pp.*
29. *Taylor, W.D., Williams, L.R. and Horn, S.L. (1981) Phytoplankton water quality relationship in U.S. Lakes. Part VIII. Algae associated with or responsible, for water quality problems. Research and Development EPA- 600/53, 80-100.*
30. *Van Den Hoeck, C., Mann, D.G. and Jahns, H. M. (1995) Algae: An Introduction to Phycology. Cambridge University Press, Cambridge.*
31. *Williams, L. R., Taylor, W.D., Hiatt, F.A., Hern, S.C., Hilgert, J. W., Lambou, V.W., Morris, F.A., Thomas, R.W. and Morris, M.M.K. (1977) Distribution of phytoplankton in Mississippi Lakes. EPA-600/3-77-101. Ecol. Res. Ser (WP No. 685), 22 pp.*
32. *Wu, N., Dong, X., Liu, Y., Wang, C., Baattrup-Pedersen, A. and Riis, T. (2017) Using river microalgae as indicators for freshwater biomonitoring: Review of published research and future directions. Ecol. Indic., 81; 124-131. DOI: 10.1016/j.ecolind.2017.05.066.*
33. *Yeole, S.M. and Patil, G.P. (2005) Physico-chemical status of Yedshi lake in relation to water pollution. J. Aqua. Biol., 20: 41-45.*