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Species diversity of Cyanobacteria in a freshwater river under thermal effect in Rajasthan, India

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Abstract

Cyanoabacteria form the important component of phytoplanktons which are affected first when encountered with any kind of change in water. Aquatic cyanobacteria being at first trophic level are the first to be affected when water is used for cooling purpose by a power plant. This present work is an attempt to study the diversity of freshwater Cyanobacteria under the effect of thermal power station using a diversity index.

Cyanobacteria are the most primitive photosynthetic prokaryotic algae that were dominant during Precambrian period[30]. These are the most successful organisms that are exploiting extreme of habitats for billions of years since their existence[10]. Cyanobacteria play important role in ecosystem. Algae and blue-green algae form the important component of phytoplanktons which are the primary producers in an aquatic ecosystem. Cyanobacteria form the primary level of trophic level in an aquatic ecosystem. Most of the organic carbon contribution available in the aquatic food web is done by phytoplanktons. The growth of cyanobacteria is affected by the environment they are living in[30].

Thermal power plants use a source of water for cooling purpose. During 'once-through' cooling process the cooling water gets heated by some degrees of temperature and is discharged into the source of water which rises the temperature of ambient water and create thermal plume[5,14]. Chambal river is the freshwater river which is used as coolant by a thermal power plant of Rajasthan. The discharge of heated water back into the source causes various effects on the aquatic ecosystem[24,28].

Elaborative amount of work has been done on effects of thermal power plants on aquatic organisms throughout the world by many workers[8,11,21,24,26].

Chambal river has been the subject of study for its water quality and algal diversity by many workers in India[3,4,12,13]. The effect of thermal power plant on the diversity of cyanobacteria has been studied by Choubisa

and Dubey[6,7]. The present investigation provides a little insight of the species diversity of Cyanobacteria in a freshwater river under the thermal effect with the help of a diversity index.

The study is conducted on Cyanobacteria of a freshwater river of Rajasthan-Chambal river. Chambal river is one of the major tributaries of Yamuna river that originates from Janapao Hills of Vindhya range in south of Mhow town of Madhya Pradesh. After flowing for a time in a northerly direction through Madhya Pradesh (M.P.), it enters in Rajasthan at Chaurasigarh Fort where it flows in north – east direction. It again flows through M.P. before joining the Yamuna river in Uttar Pradesh. The river flows through Chittorgarh, Kota and Dholpur districts of Rajasthan[16]. The centre of the study is Kota city of Rajasthan. Kota Thermal Power Station, the first coal based super thermal power plant of Rajasthan, is located on the bank of Chambal river in the heart of Kota city being in operation since 1983. It has seven units of operation and uses 1180 cusecs of Chambal river water as a coolant during its operation[15].

Three sampling sites were selected on Chambal river for the present investigation. Station 1 (SN-1) was selected at Akelgarh in upstream of Chambal river, Station 2 (SN-2) at Kota Barrage near the thermal power plant and Station 3 (SN-3) was selected in the downstream of river almost 5 km distant from the power station.

To study the species diversity of cyanobacteria the surface water samples were collected in polyethylene bottles from the selected sampling stations during the summer season of 2018. The water samples collected for cyanobacteria were concentrated and also preserved using Lugol's solution. The Cyanobacteria were examined with the help of a trinocular research Metzer-M microscope at 100X and 400X. Quantitative study of cyanobacteria was done using a haemocytometer and camera was used for microphotography. The observation and identification of cyanobacteria was done with the help of monograph and standard keys[2,9,18,19,25].

Shannon-Weaver Index of diversity was calculated by the following formula to calculate the diversity of collected water samples:

$$H = 1 - \sum_{i=1}^{s} (p_i)^2 (\log 2\, p_i)$$ where H is index of species diversity, s is the number of species and p_i is the proportion of total sample belonging to the i^{th} species[1].

The highest number of cyanobacteria per mL was calculated at SN-2 and lowest at SN-3. 9 species of cyanobacteria have been reported at the upstream station SN-1, 20 species at station SN-2 while 12 species at downstream station SN-3 in summer season during the study period in previous work by the authors at selected stations of study[7]. Heat tolerant cyanobacteria *Merismopedia, Planktothrix* and *Synechococcus* were found to be dominant at SN-2.

Shannon Weaver Index (H) depicts the diversity of cyanobacteria of selected stretch of freshwater Chambal river. Higher the value of Shannon Weaver Index more will be the diversity of cyanobacteria at any site. The lowest diversity index (H) was calculated

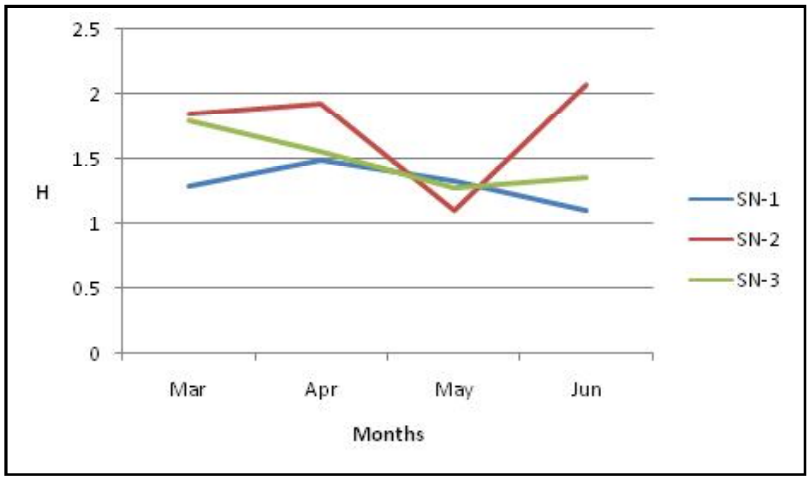

Figure 1. Shannon Weaver Diversity Index at three stations in summer season

at Station SN-1 with value of 1.31 and highest at SN-2 with 1.74 while Station SN-3 was observed with diversity index of 1.50 during the study period.

As station SN-2 is situated close to the point of thermal discharge from the power station, the temperature of water was raised and found to be higher than other two stations selected. Heat tolerant cyanobacteria *Merismopedia, Planktothrix* and *Synechococcus* were found to be dominant at SN-2 in previous work by the authors[7]. The high temperature favours the proliferation of cyanobacterial community among phytoplanktons[27,29]. The studies by Konopka and Brock[20] and Welch and Lindell[29] have indicated that rise in temperature due to discharge from power plants favours the growth of cyanobacteria.

The higher value of 'H' at SN-2 near the thermal power station indicates that the high temperature environment created from the heated water discharged from the coastal thermal power station is favourable for the growth of cyanobacteria.

The present observation of higher diversity of cyanobacteria in freshwater under the once-through cooling system thermal influence was found to be in contradiction to the results of Kim *et al.*[17]; Nwankwo *et al.*[23] and Nashaat *et al.*[22] which indicate loss of biodiversity of phytoplanktons under the influence of thermal discharge. But their research work was done on marine waters and the present research work has been conducted on freshwater.

Though not much work has been attempted on thermal influence of power plants on cyanobacteria specifically but the results obtained for the present study on freshwater are found to be in coincidence with the findings of Lo *et al.*[21] where a higher diversity of phytoplanktons was reported under thermal effect.

The present study reveals the difference in diversity index of cyanobacteria at three sites of river studied under influence of thermal power plant. The highest diversity of cyanobacteria was observed and calculated for SN-2 during the investigation. The therrmal tolerant cyanobacteria like *Oscillatoria* and *Synechococcus* were found dominant at SN-2. Some species of *Aphanocapsa*, *Gloeocapsa*, *Cylindrospermopsis, Lyngbya, Synechococcus, Synechocystis* were found restricted to SN-2. It can be concluded that the high temperature water discharged from the thermal power station is favouring the growth of cyanobacteria.

References :

1. Aery, N.C. (2010). Manual of environmental analysis. Ane Books Pvt Ltd., New Delhi.
2. Bellinger, E.G. and D.C. Sigee (2010). Freshwater Algae: Identification, Enumeration and Use as Bioindicators. Wiley Blackwell, UK.
3. Bhatnagar, M. and N. Bhardwaj (2013a). *Journal of Experimental Biology & Agricultural Sciences, 1*(2S): 131-138.
4. Bhatnagar, M., and N. Bhardwaj (2013b). *Nature Environment and Pollution Technology 12*(3): 547-549.
5. Cairns, Jr. J. (1969). *Chesapeake Science*, *10* (3&4): 177-185.
6. Choubisa, L and A. Dubey (2020). *Journal of Phytological Research, 33*(2): 165-169.
7. Choubisa, L and A. Dubey (2021). *International Journal of Botany Studies, 6*(4): 9-11.
8. Clark, J.R. (1969). *Scientific American*, *220*(3): 19-27.
9. Desikachary T.V. (1959). Cyanophyta, Monograph on blue green algae. ICAR, New Delhi.
10. Dodds, WK., and M.R. Whiles (2011). Freshwater ecology: concepts and environmental applications of limnology. Academic press.
11. Feng, J., F. Wang, and S. Xie (2011). *Acta Ecologica Sinica*, *31*(6): 310-316.
12. Gaur, K.S., V. Sharma, M.S. Sharma, R. Modi and B.K. Verma (2014). *World Journal of Environmental Biosciences*, *3*(1): 19-33.
13. Gupta, N., S.M. Nafees, M.K. Jain and S. Kalpana (2011). *Rasayan Journal of Chemistry*, *4:* 686-692.
14. Hill, C.T. (1972). *Boston College Environmental Affairs Law Review*, *2*(2): 406-420.
15. http://energy.rajasthan.gov.in/rvunl
16. https://www.waterdatabase.com/rivers/chambal-river/
17. Kim, Y.S., H.G. Choi and K.W. Nam (2008). *Journal of Environmental Biology*, *29*(4): 449-499.
18. Komárek J, J. Kaštovský, J. Mareš, and J.R. Johansen (2014). *Preslia*, *86:* 295-335.
19. Komárek J. and J. Komárková (2003). *Czech Phycology, Olomouc*, *3:* l-30.
20. Konopka, A. and T.D. Brock (1978). *Applied and Environmental Microbiology*, *36*(4): 572-576.
21. Lo, W.T., P.K. Hsu, T.H. Fang, J.H. Hu, and H.Y. Hsieh (2016). *Terrestrial, Atmospheric and Oceanic Sciences*, *27*(1): 107-120.
22. Nashaat, M.R., K.A. Merhoon, S.K. Salman, E.K. Abbas and E.H. Ali (2019). IOP Con. Series: *Journal of Physics*: Conf. Series 1234 (2019) 012064.
23. Nwankwo, D.I., L.O. Chukwu, G.

Osiegbu, E. Igho-Okor and O. Abiola (2014). *Journal of Environment and Ecology*, *5*(1): 61-78.
24. Poornima, E.H., M. Rajadurai, T.S. Rao, B. Anupkumar, R. Rajamohan, S.V. Narasimhan, V.N.R. Rao and V.P. Venugopalan (2005). *Journal of Thermal biology*, *30*(4): 307-316.
25. Prescott, G.W. (1954). How to know the Freshwater Algae. Brown Company Publishers, Dubuque, Iowa.
26. Ramchandra, T.V., S.P. Bhat, D.M. Mahapatra and G. Krishnadas (2012). *Indian Journal of Environmental Protection*, *32*(9): 705-718.
27. Schabhüttl, S., P. Hingsamer, G. Weigelhofer, T. Hein, A. Weigert and M. Striebel (2013). *Oecologia*, *171*(2): 527-536.
28. Snoeijs, P.J.M. and I.C. Prentice (1989). *Hydrobiologia*, *184*(1-2): 99-123.
29. Welch, E.B. and T. Lindell (1992). Ecological Effects of Wastewater- Applied Limnology and Pollutant Effects. Cambridge University Press.
30. Whitton, B.A. (2012). Ecology of cyanobacteria II: their diversity in space and time. Springer Science & Business Media.