

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

Leena Choubisa, Anuradha Dubey*

Research Scholar, Assistant Professor, Department of Botany, School of Science and Technology Vardhman Mahaveer Open University, Kota, Rajasthan, India

Abstract

Cyanobacteria are prokaryotic blue-green algae that explore variety of habitats. Various forms of cyanobacteria occur in diverse habitats of Rajasthan. Many workers have explored the freshwater cyanobacteria of Rajasthan. Diversity of cyanobacteria under thermal stress has been reported for the first time. Total 23 species of cyanobacteria were observed during the present study period. Few species have reported for the first time in the freshwater river.

Keywords: freshwater river, diversity, cyanobacteria

Introduction

Cyanobacteria, also known as blue-green algae, are the most primitive, thallophytic, autotrophic and prokaryotic algae. The study of microfossils and carbon isotopic data are evident of their dominance during Precambrian period (Lee, 2008; Whitton, 2012) [12, 21]. They show morphological diversity and may occur in variety of morphological forms. Their size ranges from 1 μm in diameter to several 100 μm (Dodds and Whiles, 2011) [4]. These blue-green algae are the only phototrophic prokaryotes which can evolve oxygen by photosynthesis (Whitton, 2012) [21]. They form an important component of blooms along with other algal groups. Cyanobacteria are the most successful organisms that can exploit every possible extreme of habitats since their existence (Dodds and Whiles, 2011) [4]. Their growth is affected by light, temperature and nutrients. Some of the members have the capacity of nitrogen fixation. (Lee, 2008; Moss, 2010) [12, 13].

Rajasthan, a land of desert, is the largest state of the Indian sub-continent. It owns some rivers like Luni, Banas, Chambal, Mahi, Parwati, Mez, Parwan etc. Rajasthan is rich in aquatic flora and fauna with its lakes and rivers. A coal-based thermal power plant is operational on the bank of Chambal river and its water is used as coolant during generation of electricity during once-through cooling system (<http://energy.rajasthan.gov.in/rvunl>). Chambal river is the only perennial freshwater river of desert land of Rajasthan in India. Many workers have studied the water quality and algal diversity of Chambal river for many years (Saksena *et al.*, 2008; Tiwari and Singh, 2008; Gupta *et al.*, 2011; Bhatnagar and Bhardwaj, 2013; Gaur *et al.*, 2014; Jain *et al.*, 2015; Yadav *et al.*, 2014; Grover *et al.*, 2017) [18, 19, 7, 2, 5, 8, 22, 17]. The present research was conducted with the aim to study the diversity of cyanobacteria in a freshwater river which is under the thermal influence from a coastal thermal power plant.

Materials and Methods

Study Area

The study is conducted in Kota city of Rajasthan which is located in south eastern part of Rajasthan. The freshwater Chambal river originates from Janapao Hills of Vindhya range in south of Mhow town of Madhya Pradesh state and it

covers 225 km across Rajasthan state during its course (<https://www.waterdatabase.com/rivers/chambal-river/>).

Kota Thermal Power Station popularly known as KTPS is located on the bank of Chambal river in the centre of Kota city. It is the coal based super thermal power plant of Rajasthan for generation of electricity with total installed capacity of 1240 MW. It is operational since 1983 (<http://energy.rajasthan.gov.in/rvunl>).

Sampling:

Three sampling sites were selected on the stretch of Chambal River in Kota city for the present study. First station (Stn.1) was selected at the point of entrance of Chambal river in the city near Akelgarh. The second station (Stn.2) was selected near the thermal power plant situated near Kota Barrage and third station was selected in the downstream at the Shiv temple (Stn.3) (Figure 1, 2 & 3). Sampling was done by simple random probability sampling method.



Fig 1: Sampling site Stn.1



Fig 2: Sampling site Stn.2



Fig 3: Sampling site Stn.3

Experimental Work

For the study of cyanobacterial diversity under thermal effect the surface water samples were collected from selected three sampling stations in the morning time during the summer season from March 2018 to June 2018. The collected samples were studied with the preparation of fresh mounts in laboratory and were also fixed and preserved using Lugol's solution for detailed examination. Metzger trinocular digital research microscope (Model METZ-5000 DTM) was used for the observation of planktonic cyanobacteria at 100X and 400X along with microphotography. The enumeration of cyanobacteria was done using a haemocytometer. Identification of cyanobacteria was done with the help of available monograph and relevant literature (Prescott, 1954; Desikachary, 1959; Anagnostidis and Komárek 1988; Komárek and Komárková, 2003; Komárek *et al.*, 2014) [15, 3, 1, 9, 10].

Results and Discussion

The cyanobacterial diversity of freshwater Chambal river was studied during the summer season in 2018. Total 13 genera with 23 species were observed in Chambal river at selected stations during the summer season (Table 1).

Majority of work on the effect of thermal effluents on aquatic flora and fauna has been documented by some workers mainly in southern part of India (Krishnakumar, 1991; Poornima *et al.*, 2005; Vinitha *et al.*, 2010) [11, 14, 20]. But these researches have been performed on marine waters.

Few workers have studied the algal diversity of freshwater Chambal river in Rajasthan in reference of pollution status and its water quality without taking into account the effect of thermal discharge from a thermal power plant. In a study on Chambal river water Gaur *et al.* (2014) [5] have reported few taxa of cyanobacteria like *Oscillatoria*, *Microcystis*, *Phormidium*, *Nostoc* and *Anabaena*. Bhatnagar and

Bhardwaj (2013) [2] have reported total 13 genera and 21 species of cyanobacteria during their one year study. In the studies done on algal diversity of Chambal River, cyanobacteria like *Merismopedia*, *Oscillatoria* and *Microcystis* have been observed of more common occurrence by the workers.

9 species were observed at upstream station Stn.1, 20 species at second station Stn.2 while 12 species of cyanobacteria were observed at downstream station Stn.3. Station Stn.2 was found rich in cyanobacterial species among the three sites selected for study. As the station Stn.2 is under the influence of thermal effect from discharge of thermal power station this is the possible reason for species richness at this station. Thermal tolerant genera like *Merismopedia*, *Planktothrix* and *Synechococcus* were found to be of more common occurrence at Stn.2. *Anabaena*, *Aphanocapsa*, *Chroococcus*, *Merismopedia*, *Oscillatoria*, *Planktothrix* and *Spirulina* were observed at upstream stations during the study period. On the other hand cyanobacterial taxa like *Cylindrospermopsis*, *Gloeocapsa*, *Lyngbya*, *Synechococcus* and *Synechocystis* were found to be localized at Stn. 2 only. As the river water is used as coolant by the thermal power plant, the heated water is discharged into the river. Hence there is effect of thermal discharge from the thermal power plant which is making the river water rich in cyanobacterial diversity particularly at station Stn.2.

The thermal effect from the thermal power plant was not observed at stations Stn.1 and Stn.3. *Microcystis* was found to be dominant at station Stn.3. All the four species of *Microcystis* observed during the study period were present at this station in summer season. The station Stn.3 is situated at the downstream of the river and is more affected with human interference which is main cause of organic pollution at this station.

This is the reason for more occurrence of bloom forming cyanobacteria at station Stn.3. The station Stn.3 is not affected by anthropogenic activities and any kind of pollution. So the lowest number of cyanobacterial species was observed at this site situated at the upstream of the freshwater river.

Conclusion

As the Stn.1 is located at the upstream of Chambal river and is minimally polluted site, so it was observed with the lowest species of cyanobacteria while Stn.3 is a downstream site with moderate presence of cyanobacterial species. On the other hand, Stn.2 is mostly under the thermal influence from a nearby thermal power plant as it receives the thermal discharge which is probably the reason for highest species diversity of cyanobacteria.

Table 1: Occurrence of Cyanobacteria in Chambal River during summer season

Cyanobacteria	Stn.1	Stn.2	Stn.3
<i>Anabaena</i> sp.	+	+	-
<i>Aphanocapsa grevillei</i> (Hass.) Rabenh.	+	+	-
<i>Aphanocapsa littoralis</i> Hansgirg	-	+	-
<i>Chroococcus</i> sp.	+	+	+
<i>Chroococcus dispersus</i> (v. Keissler) Lemm.	+	+	-
<i>Chroococcus minor</i> (Kütz.) Näg.	-	+	+
<i>Cylindrospermopsis</i> sp. Seenaya & Subba Raju	-	+	-
<i>Gloeocapsa</i> sp.	-	+	-
<i>Gloeocapsa punctata</i> Näg.	-	+	-

<i>Lyngbya</i> sp.	-	+	-
<i>Merismopedia elegans</i> A. Br.	+	+	+
<i>Merismopedia minima</i> Beck	-	+	+
<i>Microcystis aeruginosa</i> Kutz.	-	+	+
<i>Microcystis flos-aquae</i> (Wittr.) Kirchner	-	-	+
<i>Microcystis smithii</i> Komarek et Anagnostidis	-	-	+
<i>Microcystis wesenbergii</i> (Komarek) Komarek in Kondrateva	-	+	+
<i>Oscillatoria subbrevis</i> Schmidle	+	+	+
<i>Oscillatoria tenuis</i> Ag. ex Gomont	-	+	+
<i>Oscillatoria chlorina</i> Kütz. ex Gomont	+	-	+
<i>Planktothrix</i> sp. Anagnostidis & Komárek	+	+	+
<i>Spirulina laxissima</i> forma <i>major</i> f. nov. West, G.S.	+	+	-
<i>Synechococcus</i> sp.	-	+	-
<i>Synechocystis</i> sp.	-	+	-
(+ present - absent)			

References

- Anagnostidis K, Komárek J. Modern approach to the classification system of the cyanophytes 3-Oscillatoriales. *Archiv für Hydrobiologie*, Supplement 80, Algological Studies, 1988:50-53:327-472.
- Bhatnagar M, Bhardwaj N. Biodiversity of algal flora in River Chambal at Kota, Rajasthan. *Nature Environment and Pollution Technology*, 2013:12(3):547-549.
- Desikachary TV. Cyanophyta, Monograph on blue green algae. ICAR, New Delhi, 1959.
- Dodds WK, Whiles MR. Freshwater ecology: Concepts and Environmental Applications of Limnology. Academic press, USA, 2011.
- Gaur KS, Sharma V, Sharma MS, Modi R, Verma BK. Water quality assessment in relation to trophic status of the Rana Pratap Sagar Dam and the Chambal river (Rajasthan) India. *World Journal of Environmental Biosciences*, 2014:3(1):19-33.
- Grover S, Shrivastava P, Verma J, Khan AS. Eco-Taxonomical Studies on Diatoms from the Chambal River (Central India). *Plant Archives*, 2017:17(2):1517-1532.
- Gupta N, Nafees SM, Jain MK, Kalpana S. Physico-Chemical assessment of water quality of river Chambal in Kota city area of Rajasthan State (India). *Rasayan Journal of Chemistry*, 2011:4:686-692.
- Jain A, Jain S, Nagar N, Kachhawah P, Devra V. Correlation Analysis of Physico-chemical Parameters and Water Quality of Chambal River. A Case Study of Kota City. *International Journal of Engineering Research & Technology*, ETWQQM -2014 Conference Proceedings, 2015:3(3):1-4.
- Komárek J, Komárková J. Phenotype diversity of the cyanoprokaryotic genus *Cylindrospermopsis* (Nostocales); review 2002. *Czech Phycology*, Olomouc, 2003:3:1-30.
- Komárek J, Kaštovský J, Mareš J, Johansen JR. Taxonomic classification of cyanoprokaryotes (cyanobacterial genera) 2014, using a polyphasic approach. *Preslia*, 2014:86:295-335.
- Krishnakumar V, Sastry J, Swamy GN. Implication of thermal discharges into the Sea- A Review. *Indian Journal of Environmental Protection*, 1991:11(7):525-527.
- Lee RE. *Phycology*, Cambridge University Press, New York, 2008.
- Moss B. *Ecology of fresh waters: A View for the Twenty-First Century*. Wiley-Blackwell, UK, 2010.
- Poornima EH, Rajadurai M, Rao TS, Anupkumar B, Rajamohan R, Narasimhan SV, Rao VNR, Venugopalan VP. Impact of thermal discharge from a tropical coastal power plant on phytoplankton. *Journal of Thermal biology*, 2005:30(4):307-316.
- Prescott GW. *How to know the Freshwater Algae*. Brown Company Publishers, Dubuque, Iowa, 1954.
- Retrieved from <http://energy.rajasthan.gov.in/rvunl>
- Retrieved from <https://www.waterdatabase.com/rivers/chambal-river/>
- Saksena DN, Garg RK, Rao RJ. Water quality and pollution status of Chambal river in National Chambal sanctuary, Madhya Pradesh. *Journal of Environmental Biology*, 2008:29(5):701-710.
- Tiwari PS, Singh MK. Physico-chemical study of Chambal river water in Dholpur (Rajasthan). *Current World Environment*, 2008:3(2):289-292.
- Vinitha E, Veeramani P, Venugopalan VP. Chlorination for power plant biofouling control: potential impact on entrained phytoplankton. *International Journal of Environmental Studies*, 2010:67(4):515-530.
- Whitton BA. *Ecology of cyanobacteria II: their diversity in space and time*. Springer Science & Business Media, 2012.
- Yadav NS, Sharma MP, Kumar A, Pani S. Water quality assessment of Chambal river in National Chambal Sanctuary of Madhya Pradesh. *Environmental Sustainability: Concepts, Principles, Evidences and Innovations*, 2014:75(6):24-35.