



## **CYANOBACTERIAL BIODIVERSITY OF CHAMBAL RIVER IN RAJASTHAN**

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Chambal river is the only perennial river of Rajasthan which is used for drinking, irrigation and power generation. The river hosts excellent flora and fauna of which freshwater flora is of much importance because of its basic position in the food chain. Only few research reports are available on cyanobacteria of Chambal River in Rajasthan. In present scenario some more documentation of cyanobacterial biodiversity is required for further research.

**Keywords:** Bioassessment; biodiversity; cyanobacteria; phytoplanktons.

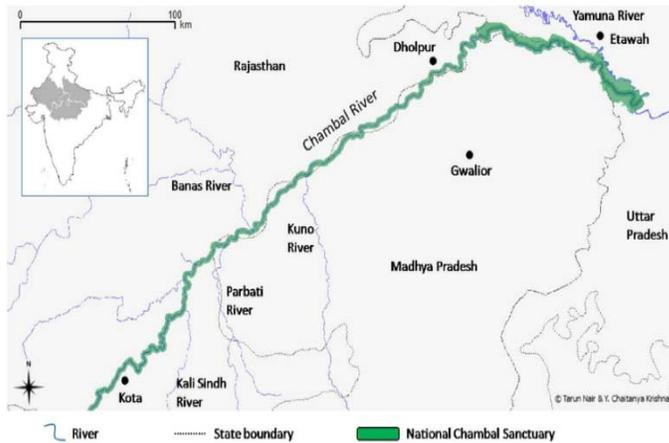
### **Introduction**

Rajasthan is a land of desert with very small area covered by rivers. Chambal river, a tributary of Yamuna River, is the only perennial river that originates at Mhow near Janapav temple in Madhya Pradesh. Flowing in a northerly direction through M.P., it enters Rajasthan at Chaurasigarh Fort where it flow in north – east direction<sup>1</sup>. It again flows through M.P. before joining the Yamuna river in U.P. Chambal river forms various deep picturesque gorges during its course that add scenic beauty to it. In stretch of 96 km in Rajasthan, it flows through Chittorgarh, Kota and Dholpur districts. The river water is used for industrial purpose, drinking, recreational activities, electricity generation and irrigation through four dams - Gandhi Sagar Dam, Rana Pratap Sagar Dam, Jawahar Sagar Dam and Kota Barrage constructed on it during its long course (Fig. 1 & 2)<sup>2</sup>. The river has derived its name from 'Charmanayavati' and with religious beliefs

holds a sacred position for the people of Kota with a holy name 'Maa Charmanayavati'<sup>2</sup> (Fig3)<sup>2</sup>. Besides being the lifeline of Kota city, Chambal River is also rich in aquatic flora and fauna including the mugger and gharial.

Due to use of its water for industrial purpose and colonization on its bank, the river gets the industrial effluents and sewage water discharged into it. Most of the research work has been targeted on water pollution and water quality of Chambal River. But a very stray literature is available on phytoplankton diversity of Chambal River, hence this paper is an attempt to review the works done on cyanobacterial biodiversity of Chambal river.

**Cyanobacteria-** Cyanobacteria are the most primitive, cosmopolitan, thallophytic, photosynthetic, prokaryotic organisms, classified under phylum alga which came into existence almost 3.5 billion years ago.



**Fig. 1** Course of Chambal River



**Fig. 2** Various dams constructed on Chambal river



**Fig. 3** Chambal River

The evidence of their origin can be traced through carbon isotopic data and study of microfossils which states their dominance during Precambrian period<sup>3,4</sup>. These are the most successful organisms that are in existence for billions of years and are still exploiting every possible extreme of habitats<sup>5</sup>. Cyanobacterial cells contain chlorophyll- a, beta carotene, c-phycocyanin, allophycocyanin and c-phycoerythrin with membrane bound nucleus and plastids lacking (prokaryotic cell structure). Motile reproductive cells are

never found in their life cycle<sup>6</sup>. They show morphological diversity and may occur in variety of morphological forms. They can be unicellular like *Synechocystis*, can occur in form of trichome (chain of cells) like *Oscillatoria*, or filament ( chain of cells enclosed in a gelatinous sheath) like *Phormidium* which can be branched as in *Scytonema* or colonial as in *Merismopedia*, *Microcystis*<sup>4</sup>. They are also known as ‘blue-green algae’ because of the bluish green colour imparted by dominant phycocyanin pigment to them<sup>7</sup>.

Because of their cosmopolitan nature, cyanobacteria are found in variety of habitats from freshwater to marine, planktonic to benthic, acidic to alkaline, hot water to soil, desert to snow<sup>7</sup>. Cyanobacteria like *Synechococcus* are even able to grow at temperature up to 73°C -74°C<sup>8,4</sup>.

### Unique in its Kind

Cyanobacteria possess some characteristic features that make them unique<sup>4,9,10,3</sup>.

- a) They are the only oxygenic phototrophic prokaryotes which can perform oxygen evolving photosynthesis through photosynthetic pigments diffused in the entire cytoplasm (chloroplasts being absent). They play a key role in global carbon cycles through assimilation of carbon and oxygenic photosynthesis. Their chief reserve food is cyanophycean starch.
- b) They are closely related to bacteria in evolution. Their cell wall is similar to Gram negative bacteria containing amino sugars and amino acids. Cell wall is enveloped with mucilaginous sheath secreted by cell membrane in some genera.
- c) They are the only algae that can fix atmospheric dinitrogen. This function can be attributed to specialized thick walled cells called 'heterocysts' provided with nodular thickenings present in some of the genera which provide anoxygenic environment for the action of nitrogenase enzyme, eg. *Nostoc*, *Anabaena*, *Aphanizomenon*, *Gloeotricha*.
- d) They have a capacity to form symbiotic association with a variety of eukaryotic organisms including plants and also with non photosynthetic organisms like fungi (in form of lichens), sponges, ascidians and corals. These associations can be best exemplified by *Nostoc* - *Sphagnum*

(bryophyte), *Anabaena azollae* - *Azolla* (pteridophyte), *Nostoc* - *Cycas* (gymnosperm), *Nostoc* - *Gunnera* (angiosperm), *Nostoc* & *Anabaena* - rice fields and even with other group of algae 'diatoms'.

Central vacuole is absent in cells but to planktonic forms buoyancy is provided by pseudovacuoles comprised of gas vesicles hence making them float that can result in formation of surface blooms. Bloom forming cyanobacteria can discolour the entire water body and release a variety of toxins which may be neurotoxins, hepatotoxins or cytotoxins detrimental to human health and fishes hence making the water unpotable. Major bloom forming taxa are *Anabaena*, *Microcystis* and *Aphanizomenon*, others being *Oscillatoria* and *Spirulina*<sup>11,9,12</sup>.

### Importance

Cyanobacteria play important role in ecosystem and have multiple uses in the biotechnology. These are the first oxygenic photosynthetic organisms that made today's aerobic environment to live in by releasing oxygen. Cyanobacteria like *Nostoc commune*, *Spirulina*, *Arthrospira*, *Aphanizomenon* can be used as nutrient source, health supplement and as animal feed. Being a rich source of protein and vitamin B<sub>12</sub>, *Spirulina* tablets are commonly being sold in market. *Arthrospira* extracts can be used in cosmetics due to moisturizing effects. They are also used in sewage disposal and wastewater treatment by the supply of oxygen required by bacteria for oxidative breakdown as done by *Nostoc*, *Scenedesmus*, *Anabaena*. Because of their nitrogen fixing capacity, *Aulosira fertilissima*, *Nostoc*, *Anabaena doliolum* are excellent biofertilizers thereby playing role in increasing the soil fertility. Cyanobacteria may be used for production

of secondary metabolites and bioenergy production<sup>12,3</sup>.

Free floating, unattached photosynthetic micro-organisms are together known as phytoplanktons. Their growth is affected by temperature, light and nutrients<sup>13,14</sup>. In an aquatic ecosystem phytoplanktons are the primary producers, the estimate of which can be used as water quality indicator<sup>15</sup>. Being easily available, cheap in use, more convincing and informative, algae are used as bioindicators<sup>16</sup>. Changes in water quality of aquatic system can be studied through bioassessment<sup>14</sup>. Most of the contribution to organic carbon made available to in the aquatic food web is done by phytoplanktons as they play a key role in global carbon cycle through assimilation of carbon and oxygenic photosynthesis<sup>3</sup>.

Generally, an alga maintains dissolved oxygen (DO) and aerobic environment of water body through photosynthesis necessary for bacterial decomposition of organic matter and respiration of aquatic fauna<sup>13</sup>. DO values of 4.3 – 14.59 mg/L have been reported in Chambal river by many workers<sup>17, 18, 19, 20</sup>.

### **Cyanobacterial Biodiversity**

Biodiversity, also known as biological diversity, can be defined as variation among species and habitats of living organisms be it at gene level; species level or at ecosystem level. Three types of biodiversity are known –  $\alpha$  diversity (local),  $\beta$  diversity (turnover) and  $\gamma$  diversity (regional). In general  $\alpha$  diversity is the diversity of life forms within a habitat<sup>21</sup>. Some workers have studied the cyanobacterial biodiversity of Chambal River in past years along with its water quality.

**Table 1.** Cyanobacterial Biodiversity of Chambal River in Rajasthan

S. No.	Name of Genera & Species
1.	<i>Anabaena sp.</i>
2.	<i>Aphanocapsa sp.</i>
3.	<i>Arthrospira sp.</i>
4.	<i>Calothrix sp.</i>
5.	<i>Chroococcus turgidis</i>
6.	<i>C. disperses</i>
7.	<i>Gloeocapsa sp.</i>
8.	<i>Lyngbya sp.</i>
9.	<i>Merismopedia tenuissima</i>
10.	<i>M. glauca</i>
11.	<i>M. elegans</i>
12.	<i>Microcystis aeruginosa</i>
13.	<i>M. lamelliformis</i>
14.	<i>M. robusta</i>
15.	<i>Nostoc sp.</i>
16.	<i>Oscillatoria proboscida</i>
17.	<i>O. princeps</i>
18.	<i>O. tenuis</i>
19.	<i>Phormidium sp.</i>
20.	<i>Spirulina major</i>
21.	<i>S. sublitissima</i>

Bhatnagar and Bhardwaj (2013 b)<sup>17</sup> reported total 13 genera and 21 species of cyanobacteria during their study. Genera that were very common are *Merismopedia*, *Oscillatoria* and *Microcystis*. In an another study conducted by Bhatnagar and Bhardwaj (2013 a)<sup>22</sup> at Kota Barrage constructed on Chambal river, total 10 genera and 18 species were reported by them both in upstream and downstream of the river. According to authors, cyanobacteria showed dominance during summer season. They also investigated *Microcystis aeruginosa* and *Oscillatoria sp.* in downstream of river as pollution tolerant genera.

Cyanobacterial diversity was also studied at Rana Pratap Sagar Dam and Chambal river by Gaur *et al.* (2014)<sup>18</sup>. They reported 5 genera- *Oscillatoria sp.*, *Microcystis sp.*, *Phormidium sp.*, *Nostoc sp.*, *Anabaena sp.* of common occurrence.

On the basis of research work done by these authors, all the reported genera and species of cyanobacteria are enlisted in table 1.

A wide variety of taxa of cyanobacteria have been reported in Chambal River. On the basis of the available literature studied 21 species of 13 different genera are known to occur in such an elaborate freshwater river system of Rajasthan. These versatile photosynthesizers are important economically and may be utilized for SCP, biofuel production etc. There is a requirement of their further documentation to be used commercially. With the rising effects of global warming and temperature changes, there is a possible risk of loss of biodiversity. Therefore, there is a need to study cyanobacterial flora of Chambal River and protect the cyanobacterial biodiversity in the present scenario.

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