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Diversity of Microorganisms Found in Fresh Water Lakes in Rajasthan

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ABSTRACT: Twenty three cyanobacterial strains were isolated from alkaline water samples of three aquatic sites (Anasagar, Pushkar lake) from Rajasthan. Microscopic examination showed one colonial, nine heterocystous and the remaining non-heterocystous filamentous forms. Genera wise distribution showed abundance of *Nostoc*, *Phormidium* and *Plectonema* followed by *Anabaena* and *Westiellopsis*. *Microcystis* and *Oscillatoria* were least abundant. *Nostoc* and *Phormidium* showed highest abundance in terms of CFU/mL followed by *Anabaena* and *Plectonema*. Pigments (chlorophyll, carotenoids and phycobilins) and N assimilatory enzymes (nitrate reductase and glutamine synthetase) differed significantly amongst the identified cyanobacterial strains. Biodiversity of microalgae and cyanobacteria from different freshwater bodies of Rajasthan (India) was studied. There were 26 green algae belonging to 16 genera, 9 morphotypes of diatoms and 48 morphotypes of 13 cyanobacterial genera. Indicating that generic diversity was high in green algae but morphotypic diversity in cyanobacteria. The diversity of phytoplankton in the lake Jaisamand of Rajasthan (India). Results depict that phytoplankton was contributed by six major groups which comprised total 85 species. Out of which 13 belongs to Myxophyceae, 5 to Euglenophyceae, 38 to Chlorophyceae, 3 to Xanthophyceae, 1 to Cryptophyceae and 23 to Bacillariophyceae. Thus, Bacillariophyceae and Chlorophyceae turned up as the dominant groups in terms of density. In mawatha lake of Jaipur, Rajasthan, 19 genera viz. *Stephanodiscus*, *Coscinodiscus*, *Cyclotella*, *Gomphonema*, *Melosira*, *Navicula*, *Hantzschia*, *Eunotia*, *Rhopalopodia*, *Cocconeis*, *Amphora*, *Synedra*, *Diatoma*, *Surirella*, *Fragillaria*, *Anomoeneis*, *Nitzschia*, *Diadesmis* and *Pinnularia* were found.

KEYWORDS: Rajasthan, lakes, microorganisms, bacteria, algae, diatoms, strains

I. INTRODUCTION

As a basic research tool, the micro-organisms, mainly the algal and cyanobacterial flora are nature's unique gift to mankind, as they possess several innate properties that make them ideal organisms with potential for multifaceted biotechnological applications. They show wide ecological tolerance and they occur in almost every conceivable habitat on earth [3]. They are found as planktonic forms in both freshwater and marine ecosystems and also as gelatinous mat like growth on shaded soil, rocks, mud, wood and some living organisms. They produce the compounds responsible for 'earthy' odours we detect in soil and some bodies of water. Active research in the field of algal biotechnology has opened up vast opportunities for eliminating human sufferings.[2] In short, these organisms have gained significance as a source of wholesome food materials, fixed atmospheric nitrogen, natural sources of colourants, biolipstics, bioplastics, biofuels, and fine chemicals like proteins, lipids, pigments, enzymes, antioxidants, minerals and vitamins, polysaccharides, glycerol and many other novel biologically active compounds. The basic and fundamental requirement for initiating algal and cyanobacterial biotechnology is to first enumerate the available natural wealth and to understand their ecobiological properties. This work is the first of its kind, surveying a continuous stretch of the cyanobacterial and algal flora of some sacred ponds of Rajasthan.[1]

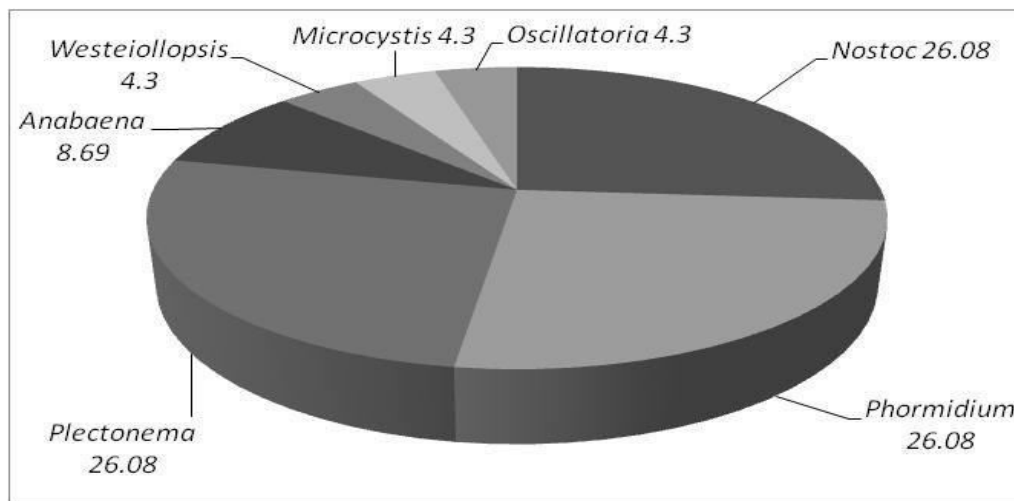


Fig.1. Algal species found in sacred lakes of Rajasthan

In case of Jodhpur, In all eighty four forms were observed in just twenty five samples that were collected from 7 water bodies. There were 26 green algae belonging to 16 genera, 9 morphotypes of diatoms and 48 morphotypes of 13 cyanobacterial genera.[4] Indicating that generic diversity was high in green algae but morphotypic diversity in cyanobacteria. Amongst green algae, a maximum of 5 morphotypes were that of *Scenedesmus*, followed by *Cosmarium* (3) while amongst cyanobacteria *Oscillatoria* (8), *Chroococcus* (6) and *Lyngbya* (5) had more representatives than *Phormidium*, *Nostoc* and *Gloeocapsa* that showed 4 morphotypes each. The most frequent genera were *Scenedesmus* > *Oscillatoria* > *Chroococcus* > *Gloeocapsa*, *Phormidium* > *Chlorococcum* > *Cosmarium* > *Chlorella* and *Plectonema*.



Fig.1b. Blue green algae in Rajasthan lake

II. OBSERVATIONS

The phytoplankton are the important components of aquatic ecosystem and contributing to the bulk of total primary productivity by producing organic matter which is the base of complex aquatic food webs. Further, the composition and abundance of phytoplankton can reflect the nutritional status and trophic condition of the water body within the stipulated period of time. Besides aquatic plants, [5] Phytoplankton is primary biological component from which the solar energy is transferred to higher organisms through various trophic levels of aquatic food chain. For these obvious reasons therefore, phytoplankton is often used to estimate the potential fish yields, productivity, water quality, energy flow, trophic status, and management measures, of any water body. Furthermore, the seasonal fluctuations and species composition of phytoplankton in any water body depend on levels of light, [7] temperature, nutrients, grazing pressure, onset of parasitic infections, extracellular metabolites of plants and animals with changing season during the year. [8] It was elucidated that study of plankton can be a very useful tool for the assessment of biotic potential thereby contributing to the overall assessment of basic nature and general economic potential of water body. The focus of the current study was to estimate the variability in phytoplankton throughout the year in terms of its distribution, abundance and diversity to assess the fishery potential of different lakes of Rajasthan. [6]

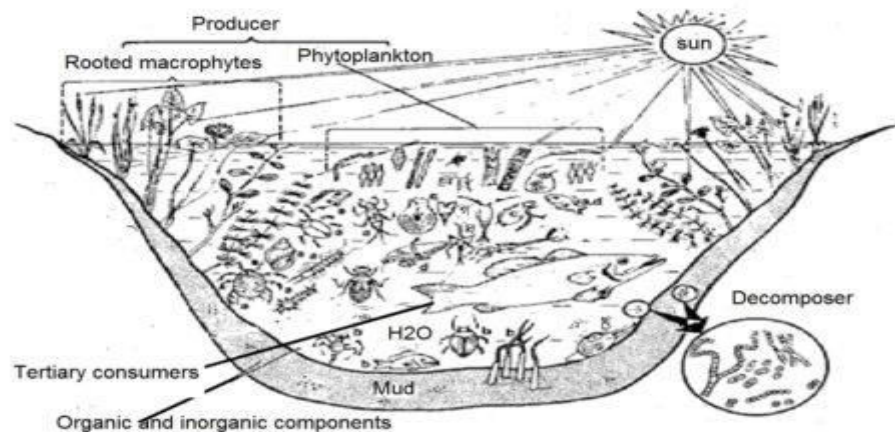


Fig. 1c. Biotic community of a lake

The planktonic flora in lakes of Rajasthan was contributed by six major groups i.e. Myxophyceae, Euglenophyceae, Chlorophyceae, Xanthophyceae, Cryptophyceae and Bacillariophyceae. These six groups comprises total 85 species in that 13 were from Myxophyceae, 5 from Euglenophyceae, 38 from Chlorophyceae, 3 from Xanthophyceae, 1 from Cryptophyceae and 23 belonged to Bacillariophyceae. [9] The lakes maintained fairly good population of phytoplankton which is providing opportunity for sustaining more fish biomass having broad based feeding habits for achieving high productivity [10].

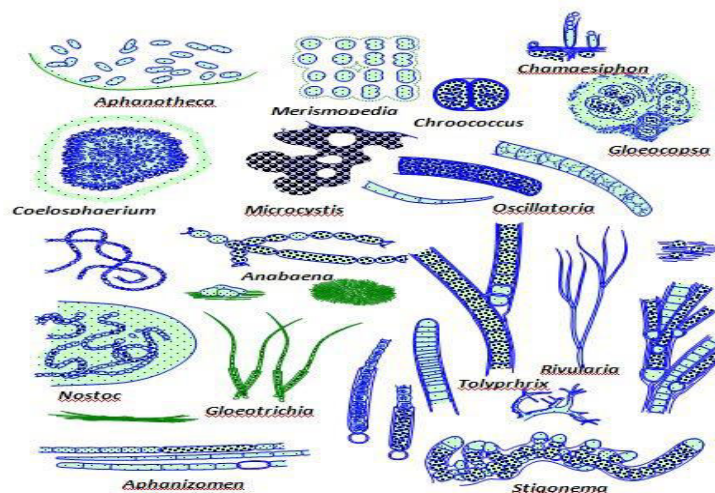


Fig.2. Freshwater microbial diversity from lakes in Rajasthan



Fig.3. Lake in Rajasthan

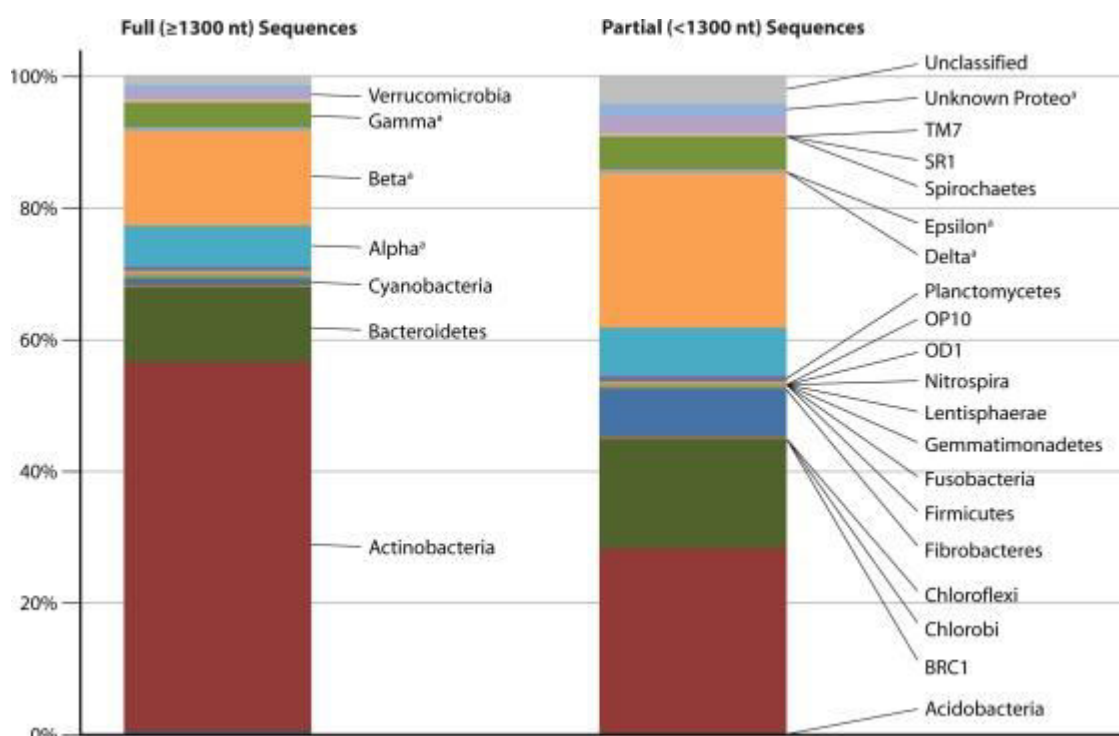


Fig.4. Bacterial species in freshwater lakes of Rajasthan

III. RESULTS

There are four major opportunistic pathogens in the Varthur lake series: *Legionella* spp. had the highest prevalence followed by total coliforms, mycobacterium spp. and Enterobacteriaceae. These are associated with increased rates of typhoid, dysentery, pneumonia, legionnaire's syndrome, cholera and bacterial meningitis in neighboring villages. [11] *Legionella* spp. has been found to cause Legionellosis, and is the leading water associated pathogen to cause pneumonia and even death in immunocompromised individuals with an increasing incidence. Dominant phyla included Proteobacteria (84%), Actinobacteria (8%), Firmicutes (7%), and Bacteroidetes (0.6%). The most prevalent class was Gammaproteobacteria (82%) followed by Coriobacteriia (7%), Bacilli (5%), and Clostridia (2%). Dominant orders included Pseudomonadales (81%), Coriobacteriales (7%), Lactobacillales (5%), and Clostridiales (2%). The family with the highest prevalence was Pseudomonadaceae (81%) followed by Coriobacteriaceae (7%), Lactobacillaceae (3%), and Streptococcaceae (1%). The most dominant genus was *Pseudomonas* (81%), followed by *Collinsella* (7%), *Lactobacillus* (3%), and *Streptococcus* (1%). [12]

The most abundant pathogenic species were *Pseudomonas alcaligenes*, *Campylobacter ureolyticus*, *Acinetobacter johnsonii*, *Campylobacter ureolyticus*, and *Veillonella dispar*. Other pathogenic species included *Acinetobacter lwoffii*, *Eggerthella lenta*, *Streptococcus anginosus*, *Haemophilus influenzae*, and *Enterococci* spp. [13] The one zoonotic bacterium was *Arcobacter cryaerophilus*. There were several human commensals found in each lake such as

Burkholderia glathei, *Bacteroides fragilis*, *Propionibacterium granulosum*, *Bacteroides acidifaciens*, and *Staphylococcus sciuri*. *B. fragilis* is an anaerobic organism commonly isolated.[14]

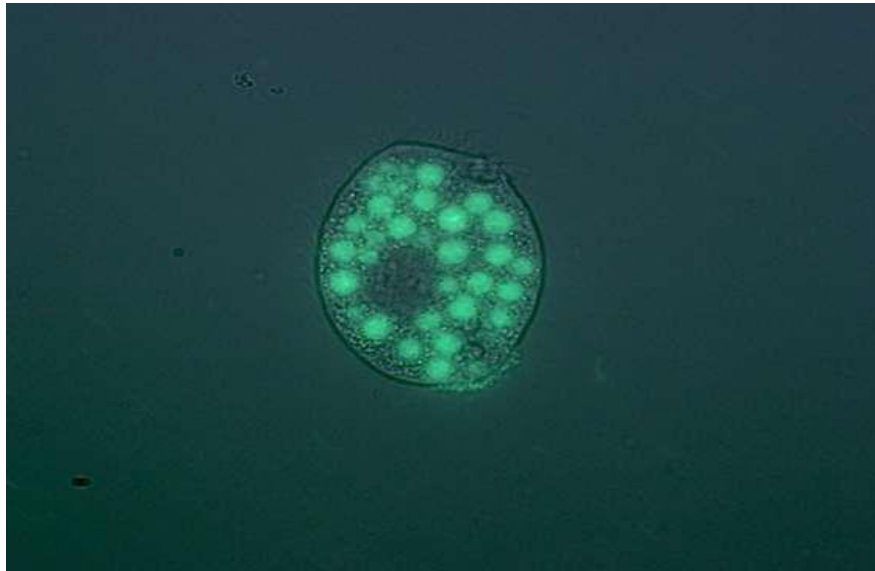


Fig.4b. Pathogenic bacteria in a lake

IV. DISCUSSION

Freshwater lakes are bodies of still, unsalted water surrounded by land. They are usually found in low lying areas and are fed from streams, rivers and runoff from the surrounding area. Freshwater bacteria are at the hub of biogeochemical cycles and control water quality in lakes. Despite this, little is known about the identity and ecology of functionally significant lake bacteria.[11] Molecular studies have identified many abundant lake bacteria, but there is a large variation in the taxonomic or phylogenetic breadths among the methods used for this exploration. Because of this, an inconsistent and overlapping naming structure has developed for freshwater bacteria, creating a significant obstacle to identifying coherent ecological traits among these groups. [4]

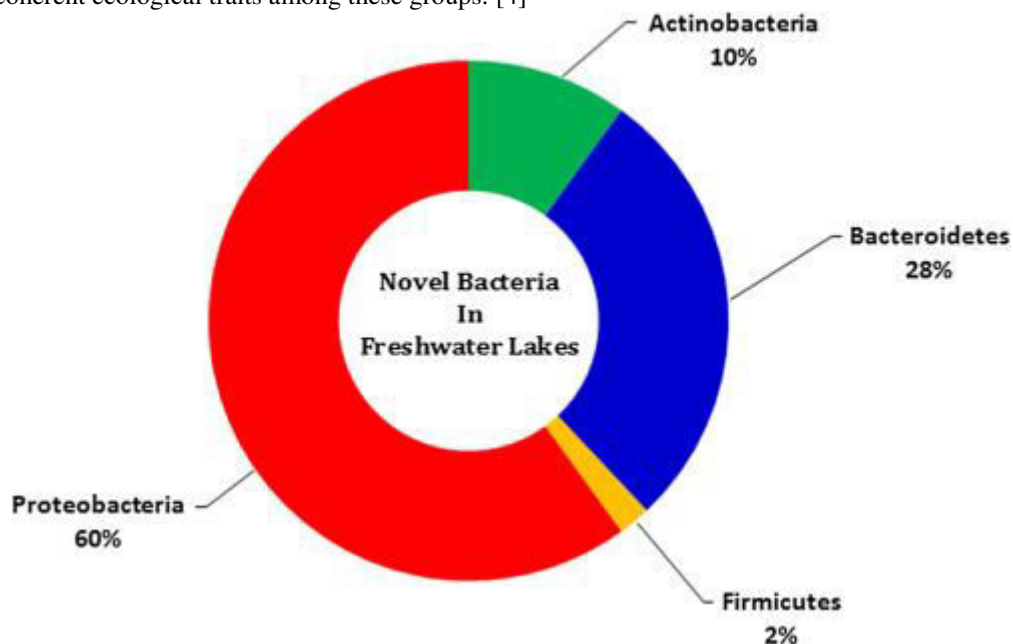


Fig.5. Novel bacteria in freshwater lakes of Rajasthan

Oxygen levels in the Rajasthan freshwater lakes are declining rapidly—faster than in the oceans—a trend driven largely by climate change that threatens freshwater biodiversity and drinking water quality. [8] The study published in Nature

found that oxygen levels in surveyed lakes across the Rajasthan areas have declined 5.5 percent at the surface and 18.6 percent in deep waters since 1980. Meanwhile, in a large subset of mostly nutrient-polluted lakes, surface oxygen levels increased as water temperatures crossed a threshold favoring cyanobacteria, which can create toxins when they flourish in the form of harmful algal blooms.[10]

"All complex life depends on oxygen. It's the support system for aquatic food webs. And when you start losing oxygen, you have the potential to lose species," said Kevin Rose, author and professor at Rensselaer Polytechnic Institute. "Lakes are losing oxygen 2.75-9.3 times faster than the oceans, a decline that will have impacts throughout the ecosystem."

Researchers analysed a combined total of over 45,000 dissolved oxygen and temperature profiles collected since 1941 from nearly 400 lakes around the globe. Most long-term records were collected in the temperate zone, which spans 23 to 66 degrees north and south latitude. In addition to biodiversity, the concentration of dissolved oxygen in aquatic ecosystems influences greenhouse gas emissions, nutrient biogeochemistry, and ultimately, human health.[11]

V. CONCLUSION

Freshwater is essential for our planet. Fresh water is vital for people, animals and microbes – it needs careful management because there's not always enough to go around.

Freshwater environments include rivers, lakes, wetlands, streams and underground aquifers. They store and clean the water that's crucial for people, animals and microbes.

Healthy freshwater environments supply water for drinking, growing crops, manufacturing, energy and transport. They also help to prevent erosion, dispose of waste and provide natural protection from flooding.

But we've been careless with this vital resource. Freshwater environments have been mismanaged, leading to pollution, drying rivers and damaged habitats. In the last century we've lost so many of the Rajasthan wildlife and microbes.

We believe it's possible to meet the freshwater needs of both people, wildlife and nature – if water is managed wisely. That's why we're working hard to help protect and manage freshwater resources in Rajasthan.[14]

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