

Seasonal Dynamics of Phytoplankton Diversity in Ranchi Lake: Indicators of Water Quality and Ecosystem Health

ABSTARCT

A British soldier named Colonel Onsely created Ranchi lake, which the locals call Bada Talab, as a freshwater environment. Evaluating phytoplankton diversity and its connection to water quality is the goal. The evaluation of phytoplankton which are mostly found in water bodies is the focus of this research. The majority of the phytoplanktonic species found in Bada Talab belong to the Chlorophyceae, Bascilariophyceae and Cyanophyceae groups and this assessment carried out at regular intervals. Thus it can be concluded that April 2023- June 2023 is the ideal time period for Cyanophyceae members to grow followed by January 2023- March 2023 for Chlorophyceae and January 2023-March 2023 for Bascilariophyceae. The most common species which are trustworthy markers of pollution and water quality were *Microcystis*, *Spirogyra*, *Nostoc*, *Oscillatoria*, *Scendesmus*, *Pinnularia* and *Volvox*. Certain genera such as *Microcystis* and *Spirogyra* are dominant and serve as indicators of pollution.

Keywords: Environment, Phytoplankton, Pollution, Nostoc

INTRODUCTION

The chemical formula of water is H_2O which is made up of three atoms i.e. two hydrogen atoms and one oxygen atom. Water is very essential for existence of life on earth for all living organisms. Plants largely depend on water for the process of photosynthesis. Light reaction requires water for electron transport and to generate ATP and NADPH which is the product of light reaction. Every organism needs water for sustaining its life; it is quite significant for proper functioning of body. Polluted water mainly affects the whole physiological process of our bodies. Excessive

growth of phytoplankton's causes death of other organism of the ecosystem called eutrophication. Pollution largely affect the relation between growth rate and each of these variable ^[5]. Biological parameters are generally used in assessing the quality of water body and pollution among different such parameters the algal flora has been used as an important tool in aquatic study ^[1]. Regular assessment of phytoplankton's species are generally essential for pure water bodies and for such balanced ecosystem.

An aquatic ecosystem is a type of ecosystem which are found under the water body. This includes communities of organism that interact with each other. Periodicity and species composition of different phytoplankton in regular interval is essential for assesing the quality of water and such taxonomic groups were found to be related with fluctuations of the physicochemical parameter of the ecosystem ^[2]. The two main types of aquatic ecosystem are basically marine ecosystem and fresh water ecosystem. In an any ecosystem there is a two component mainly biotic component and abiotic component. Biotic component includes autotrophic and heterotrophic organism. Autotrophic organism are mainly producers which are phytoplanktons, they mainly use solar energy to produce biomass from carbon. Heterotrophic organism are dependent on autotrophic organism directly or indirectly, after consuming or gaining energy these organism create their own biomass. Rajukumar and Ritakumari, (2004), Bai and Abraham,(2003) reported that species composition of phytoplankton communities differs and depends on the local climate, Soil and sewage like environmental factors which might be associated with differences among the species which depends upon the availability of nutrients and the degree of mixing or stratification ^[3]. Various phytoplanktonic species which are found in these water bodies in different depth as well as surface water bodies. Algae also act as Biological indicator. In both fresh water and marine research, phytoplankton pigment analysis is frequently employed ^[4]. Temperature is determining factor for phytoplankton size at both species as well as community level.

MATERIALS AND METHODS

The study was conducted in Ranchi lake also known as Bada Talab. Ranchi is an urban town in Jharkhand state, the river is located at lattitude 23.36 and longitude 85.31. Samples were taken from the lake in regular interval of one year from January

2023 to December 2023. Samples were collected in the morning between 7 am to 9 am using phytoplanktons net of 5 mironmeter mesh size. Each samples slide was made in triplicate. A sample drop was put on a sterile slide with a slip on top, and it was examined under a microscope. A 1000x magnification binocular light microscope (Olympus BH2) was used to identify and count the phytoplankton species. For each category, algae were graded accordingly to their presence (+) and absence (-) in the various water sources. Additionally, the quantity of a certain alga in the mount was recorded. Comparative morphology and description utilizing standard textbooks, guides and articles were used for identification (Tregouboff and Maurice, 1957; Compere, 1977; Nguetsop et al., 2007; Bellinger and Siegee. 2010). Algae were categorized using algaebase.org.

MAP OF RANCHI DISTRICT AND LOCATION OF BADA TALAB

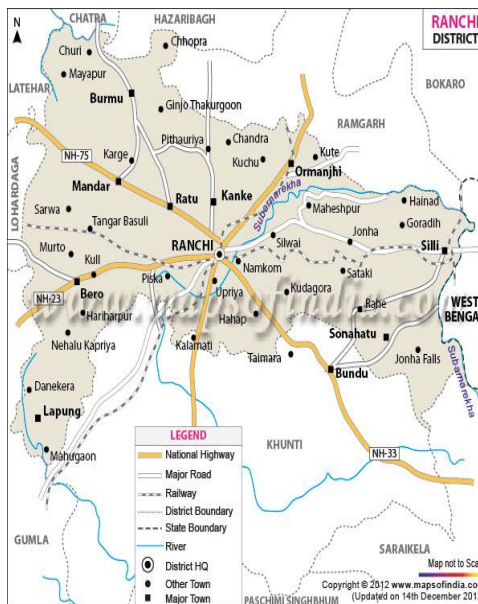


Fig.1: Map of Ranchi district

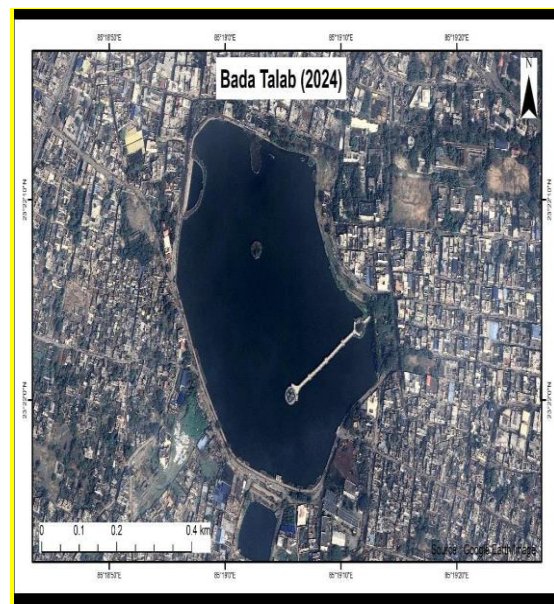


Fig.2: location of Bada Talab



Fig.3: Surface water collection



Fig.4: Under deep water collection

RESULTS & DISCUSSION

Water quality could be indicated by phytoplankton analysis, which count species and determines biomass ^[11]. After regular interval of assessment it is found that the phytoplanktonic species mainly found in bada talab are belong to class Cyanophyceae, Chlorophyceae and Bascilariophyceae. Water sample were collected from bada talab, sample were taken from surface water as shown in figure 3 and also from under deep water as shown in figure 4.

Among Cyanophyceae there is 4 genera were recorded namely *Oscillatoria sp*, *Nostoc sp*, *Microcystis sp*. and *Anabaena sp*. Among Chlorophyceae 5 genera were recorded namely *Scendesums sp.*, *Fristchella sp.*, *Volvox sp.*, *Chlorella sp*. and *Spirogyra sp*. Among Bascilariophyceae 7 genera were recorded namely *Gomphonema sp.*, *Navicula sp.*, *Pandorina sp.*, *Eunotia sp.*, *Eudorina sp.*, *Pinnularia sp*. and *Synedra sp*. Period from Jan 2023 to march 2023 total genera found in Cyanophyceae are 3 ie., *Oscillatoria.*, *Nostoc sp*. and *Anabaena sp*. In Chlorophyceae all the 5 genera were found namely *Scendesums sp*, *Fristchella sp*, *Volvox sp* , *Chlorella sp* and *Spirogyra sp*. In Bascilariophyceae all the 7 genera were found. Period from April 2023 to June 2023 all the four genera are found in Cyanophyceae, in Chlorophyceae 3 genera are present and in Bascilariophyceae 5 genera are found. Period from July 2023 to Sep 2023 there are 2 genera are recorded in Cyanophyceae, 3 genera in Chlorophyceae and 3 genera in Bascilariophyceae. Period from Oct 2023 to Dec 2023

there is 3 genera recorded in Cyanophyceae, 4 genera in Chlorophyceae and 4 genera in Bascilariophyceae.

Maximum number of genus in the class Cyanophyceae were observed during the period of April 2023 to June 2023 followed by Oct 2023 to Dec 2023, Jan to March 2023 and July to Sep 2023. Among Chlorophyceae maximum number of genus were observed during the period of Jan to March 2023 followed by Oct to Dec 2023, April to June 2023 and July to Sep 2023. Among Bascilariophyceae maximum number of genus were observed during the period of Jan to March 2023 followed by Oct to Dec 2023, April to June 2023 and July to Sep 2023. The distribution of various phytoplankton species indicates the characteristics of the water in which they live because they are habitat-specific ^{[12],[13]}. Phytoplankton have been used as biological indicators of water quality in ponds, lakes, and other aquatic ecosystems since the late 19th century ^[8]. For phytoplankton survival there is a major concern like ocean acidification, nutrient pollution, and global warming^[6]. Phytoplankton, despite constituting only about 1% of the total biomass of plants, perform roughly 50% of the Earth's photosynthetic carbon dioxide (CO₂) fixation and contribute to 50% of the planet's oxygen production ^[7]. Phytoplankton play a crucial role in estimating the primary production of aquatic ecosystems like ponds ^[9]. Study of phytoplankton is very much essential for primary productivity and it is very useful in assesment of fish yield and also carrying capacity of the pond ^[10]. Algae basically the autotrophs which occupies the first trophic level of an ecosystem and all others trophic level organism directly or indirectly depend upon them.

Table 1: Presence (+) and absence (-) of different genus in different period from jan to dec 2023.

Class	Order	Genus	Period from Jan to March 2023	Period from April to June 2023	Period from July to Sep 2023	Period from Oct to Dec 2023

Cyanophyceae	Nostocales	<i>Oscillatoria sp.</i>	+	+	-	+
Cyanophyceae	Nostocales	<i>Nostoc sp.</i>	+	+	+	+
Cyanophyceae	Chroococcales	<i>Microcystis sp.</i>	-	+	+	-
Cyanophyceae	Nostocales	<i>Anabaena sp.</i>	+	+	-	+
Chlorophyceae	Sphaeropleales	<i>Scendesums sp.</i>	+	-	-	+
Chlorophyceae	Chaetophorales	<i>Fristchella sp.</i>	+	+	+	+
Chlorophyceae	Chlamydomonadales	<i>Volvox sp.</i>	+	+	+	-
Chlorophyceae	Chlorellales	<i>Chlorella sp.</i>	+	-	+	+
Chlorophyceae	zygnematales	<i>Spirogyra sp.</i>	+	+	-	+
Bascilariophyceae	Cymbellales	<i>Gomphonema sp.</i>	+	+	-	+
Bascilariophyceae	Pennales	<i>Navicula sp.</i>	+	+	-	+
Bascilariophyceae	Cymbellales	<i>Cymbella sp.</i>	+	-	+	+
Bascilariophyceae	Eunotiales	<i>Eunotia sp.</i>	+	-	+	-
Bascilariophyceae	Bacillariales	<i>Nitzschia sp.</i>	+	+	-	+
Bascilariophyceae	Naviculales	<i>Pinnularia sp.</i>	+	+	-	-
Bascilariophyceae	Fragilariales	<i>Synedra sp.</i>	+	-	+	-

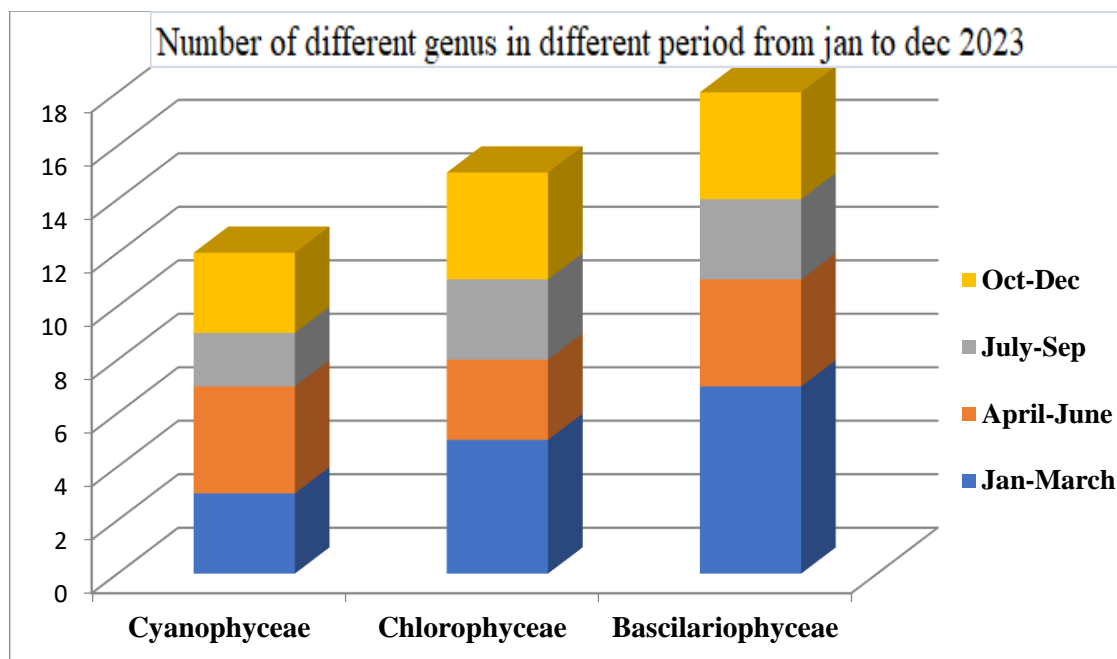


Fig 5:- Graphical representation of number of different genus in different period from Jan to Dec 2023.

CONCLUSION

From the above result and discussion, it can be concluded that the most favorable conditions for the growth of Cyanophyceae members are the period from April 2023 to June 2023, while for Chlorophyceae in Jan 2023 to March 2023 and for Bascilariophyceae in Jan 2023 to March 2023. The species of *Microcystis*, *Spirogyra*, *Nostoc*, *Oscillatoria*, *Scendesmus*, *Pinnularia* and *Volvox* were dominant, and this can be used as good indicator species of water quality and pollution. Human activity in Ranchi Lake water sources may be lowering the quality of water, putting the population at risk. The report suggests better management of the municipality's water sources and offers baseline data for future assessment. By documenting the seasonal variations of phytoplankton classes such as Cyanophyceae, Cholorophyceae and Bascialriophyceae in Ranchi Lake, this study aids in understanding the ecological dynamics of freshwater ecosystems. Additionally, it highlights the implications of pollution and eutrophication, contributing to water resource management strategies. The findings can serve as a benchmark for future studies in aquatic ecosystem conservation and environmental monitoring.

Disclaimer (Artificial intelligence)

There is NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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