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Diversity and Seasonal Fluctuation of Phytoplankton in Kot Dam, Jhunjhunu District, Rajasthan

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Abstract

Plankton communities serve as sensitive bioindicators of freshwater ecosystem health. The present study evaluates the phytoplankton diversity, composition, and seasonal dynamics of Kot Dam, Rajasthan, over two consecutive years (2021–22 and 2022–23). Quantitative analysis revealed the presence of six major phytoplankton classes, with Chlorophyceae and Bacillariophyceae collectively contributing over 60% of the total population. Seasonal trends indicated winter dominance of green algae and diatoms, summer proliferation of cyanobacteria, and monsoonal decline across all groups due to dilution and turbidity effects. Inter-annual comparison showed overall stability in total phytoplankton density, although a notable increase in Myxophyceae during the second year suggests rising nutrient enrichment and early eutrophication signals. Graphical tools and comparative analysis confirmed consistent community structure with emerging ecological stress. The study highlights the effectiveness of plankton-based assessment for monitoring reservoir health in semi-arid regions.

Keywords: *Phytoplankton diversity, seasonal variation, comparative analysis, Kot Dam, freshwater ecology, bioindicators.*

1. Introduction

Phytoplankton are microscopic, photosynthetic organisms containing chlorophyll that drift passively in aquatic environments due to their lightweight nature. They are termed plankton because they move primarily with water currents and tides (Fogg, G. E.,1991). Despite passive movement, phytoplankton play a fundamental role in aquatic ecosystems by transferring energy from lower trophic levels to higher ones, sustaining food webs and maintaining water quality. Major phytoplankton groups include algae, diatoms, and cyanobacteria, which act as primary producers forming the base of freshwater food chains (Suthers et al., 2019).

Phytoplankton contribute significantly to global biogeochemical cycles, producing nearly half of Earth's atmospheric oxygen and mitigating climate change by absorbing carbon dioxide (Basu and Mackey, 2018). Consequently, phytoplankton biomass and community composition are widely used to assess water quality and ecosystem health. In freshwater systems, plankton also contribute substantially to organic matter assimilation and nutrient cycling.

Excessive phytoplankton growth can create ecological and management problems. Certain groups, especially cyanobacteria, produce toxins harmful to fish and aquatic life (Banse, 1995). Due to rapid reproduction and short life cycles, plankton respond quickly to environmental change, making them sensitive ecological indicators (Ganai and Parveen, 2014). Elevated nitrogen and phosphorus levels stimulate harmful blooms and alter trophic status (Hamilton et al., 2008). Although several studies in India have examined phytoplankton diversity in reservoirs, systematic comparative data from Rajasthan, particularly long-term seasonal datasets, remain limited. The present research aims to bridge this gap by providing a comparative, data-driven assessment of plankton diversity across two consecutive years.

2. Materials and Methods

2.1 Study Area

The present study focuses on Kot Dam, located on the western fringe of the Aravalli range in Jhunjhunu district, Rajasthan, within the semi-arid Shekhawati region. The area is characterised by sandy, undulating terrain, extreme seasonal temperature variations, and monsoon-dominated rainfall. Kot Dam (27°39′N, 75°25′E), also known as Sarju Sagar Bandh, was constructed in 1923–24 for irrigation and water storage and now serves as the primary water source for the Shakambhari Conservation Reserve (Singodia and John, 2023). Despite limited macrophyte growth, the dam supports rich plankton diversity. The dam experiences three distinct seasons: summer (March–June), monsoon (July–October), and winter (November–February).

2.2 Sampling and Identification

Plankton samples were collected monthly from July 2021 to June 2023. Standard plankton nets and sedimentation techniques were used. Identification was carried out using standard taxonomic keys, and population density was expressed as organisms per litre (org/L).

2.3 Data Analysis and Scientific Tools

Plankton data were analysed to study seasonal and annual variations in community structure. Mean and standard deviation (Mean ± SD) were calculated to assess average abundance and variability. Percentage composition was used to determine the relative contribution of different plankton groups. Tabular analysis was carried out for easy comparison of plankton classes. Graphical tools such as line graphs, bar graphs, and pie charts were used to represent seasonal trends, class-wise comparison, and overall community structure.

3. Results

3.1 Phytoplankton Composition

The present study recorded six major phytoplankton classes in Kot Dam during 2021–2023, indicating diverse phytoplankton composition. Chlorophyceae dominated the community in both years, contributing 2522 org/L (38–40%) in 2021–22 and 2400 org/L in 2022–23, reflecting favourable freshwater conditions and high primary productivity. Bacillariophyceae ranked second, accounting for 1601 org/L (25%) in 2021–22 and 1539 org/L (25%) in 2022–23, suggesting relatively good water quality with adequate dissolved oxygen and alkaline pH. Together, these two groups contributed more than 60% of the total phytoplankton abundance.

Myxophyceae represented the third dominant group, showing an increase from 1428 org/L (23%) to 1535 org/L (25%), indicating rising nutrient enrichment and possible eutrophication trends. Dinophyceae contributed moderately (about 8%) in both years. Desmidiaceae and Xanthophyceae occurred in low densities, together contributing less than 5%, highlighting their sensitivity to environmental conditions and their usefulness as indicators of water quality changes.

Table 1. Overall density of phytoplankton classes in Kot Dam (2021–2023)

Class	2021–22 (org/L)	2022–23 (org/L)	Percentage Range
Chlorophyceae	2522	2400	38–40%
Bacillariophyceae	1601	1539	25%
Myxophyceae	1428	1535	23–25%
Dinophyceae	491	511	8%
Desmidiaceae	209	188	3%
Xanthophyceae	32	46	1%

3.2 Seasonal Dynamics

Inter-annual comparison of phytoplankton density reveals that the overall abundance remained nearly comparable during the two study years, with 6283 org/L recorded in 2021–22 and 6219 org/L in 2022–23, indicating general stability in phytoplankton productivity in Kot Dam. Despite this stability, a noticeable increase in the population of Myxophyceae during the second year suggests rising nutrient stress and the gradual onset of eutrophication tendencies within the reservoir

ecosystem. Seasonal trends further support this observation, as illustrated in Figure 1, which depicts the monthly variation of major phytoplankton groups during 2021–2023. The line graph shows pronounced seasonal periodicity, with Chlorophyceae and Bacillariophyceae exhibiting distinct population peaks during the winter months under favourable conditions such as lower temperature, higher dissolved oxygen, and stable water quality. In contrast, Myxophyceae and Dinophyceae dominate during the summer season, likely due to elevated temperatures and enhanced nutrient availability. A marked reduction in the density of all phytoplankton groups during the monsoon season reflects the combined effects of dilution from heavy rainfall, increased turbidity, and reduced light penetration.

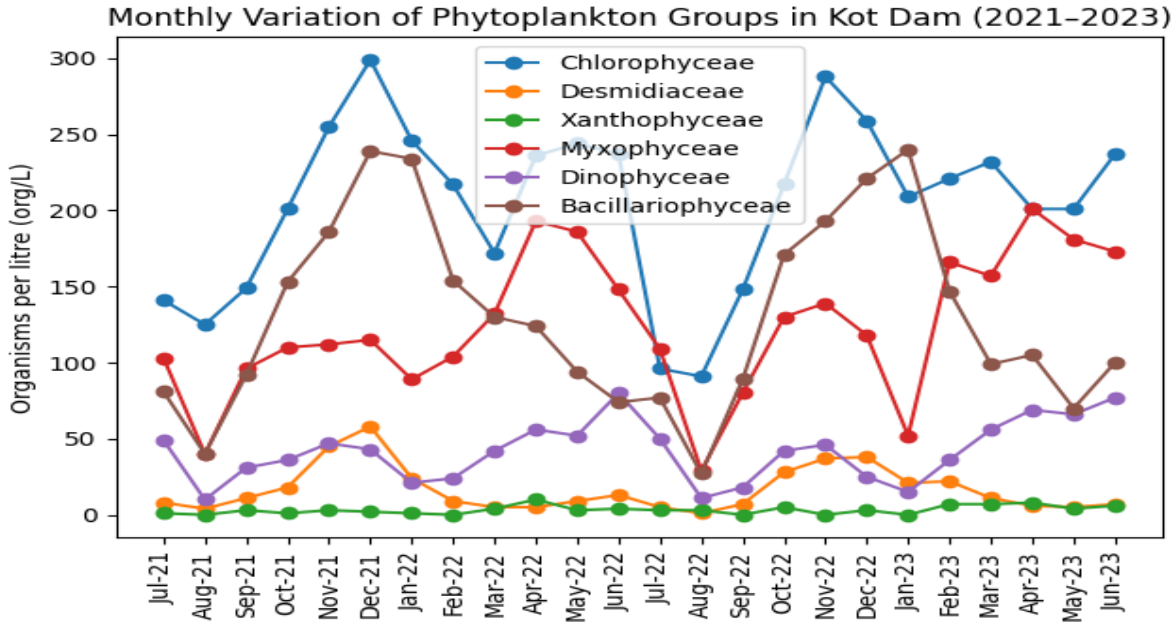

Figure 1. Seasonal variation of major phytoplankton groups (line graph)

Figure 2 presents the mean density of different phytoplankton groups (org/L) in Kot Dam through a bar graph, highlighting the comparative dominance structure of the phytoplankton community. The results indicate that Chlorophyceae constitute the most dominant group, followed by Bacillariophyceae and Myxophyceae. Dinophyceae show moderate abundance, whereas Desmidiaceae and Xanthophyceae contribute comparatively lower densities. The overall order of dominance observed is Chlorophyceae > Bacillariophyceae > Myxophyceae > Dinophyceae > Desmidiaceae > Xanthophyceae, reflecting the adaptive success of green algae and diatoms under prevailing environmental conditions in the reservoir.

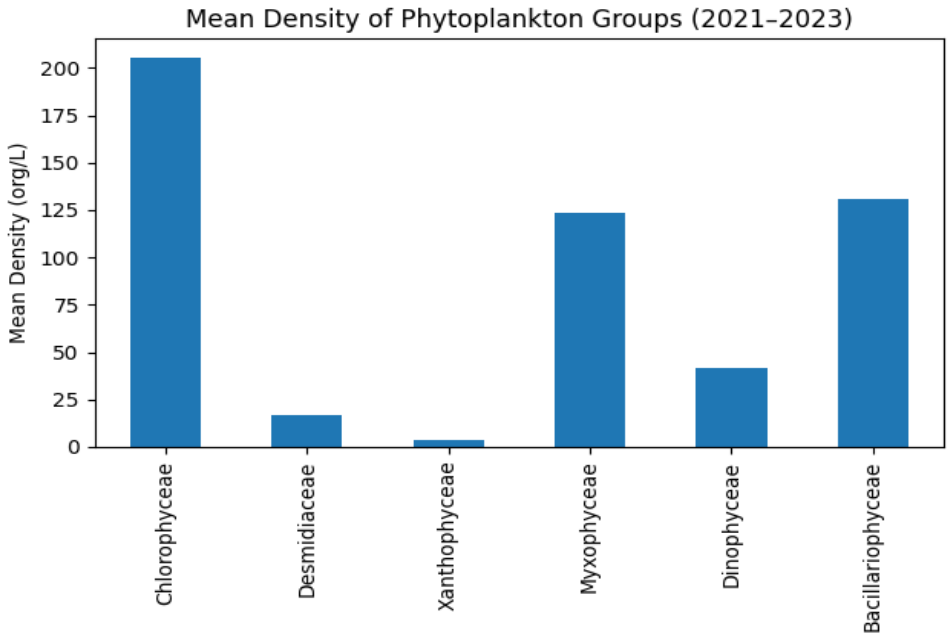

Figure 2. Comparative class-wise abundance between 2021–22 and 2022–23 (bar graph)

Figure 3 depicts the relative percentage contribution of different phytoplankton classes in Kot Dam using a pie chart, which confirms the overall stability of community structure across the study years. Chlorophyceae form the largest share of the phytoplankton community, contributing approximately 39%, followed by Bacillariophyceae at about 25% and Myxophyceae at nearly 24%. The remaining groups, including Dinophyceae, Desmidiaceae, and Xanthophyceae, together account for approximately 12% of the total phytoplankton population. This distribution indicates consistent dominance of green algae and diatoms, with a substantial contribution from cyanobacteria, reflecting the prevailing ecological conditions of the reservoir.

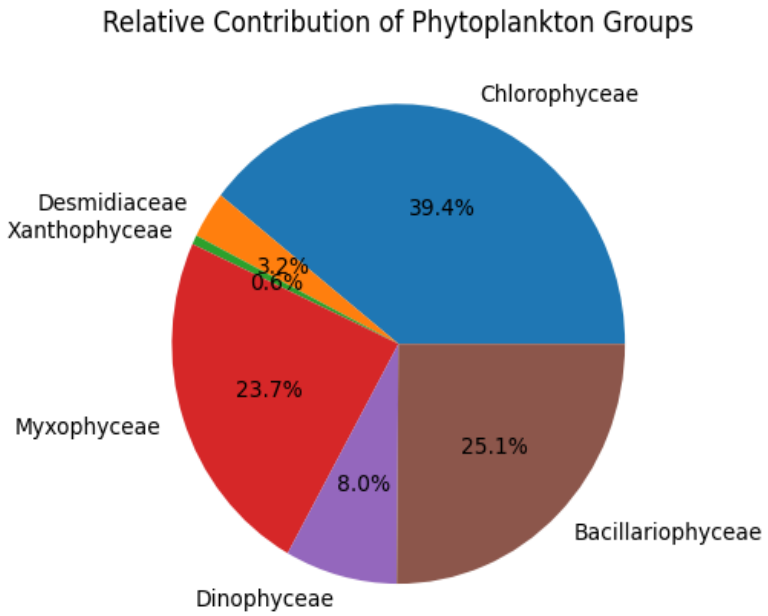

Figure 3. Percentage composition of phytoplankton communities (pie chart)

5. Discussion

The dominance of Chlorophyceae and Bacillariophyceae indicates relatively productive freshwater conditions, particularly during winter. The increased abundance of cyanobacteria during summer reflects nutrient enrichment and elevated temperatures, a trend commonly associated with eutrophication in tropical reservoirs. The low abundance of Desmidiaceae during summer and monsoon further supports water quality degradation during these seasons, as desmids are known indicators of clean, less polluted waters.

Comparative analysis across two years suggests ecological stability in overall plankton productivity but increasing dominance of pollution-tolerant groups. These patterns align with previous studies from Indian reservoirs and reinforce the utility of plankton-based assessment for reservoir management.

6. Conclusion

The present comparative study clearly demonstrates that plankton diversity and abundance in Kot Dam are strongly governed by seasonal and physicochemical factors. Winter supports maximum diversity and density, while summer and monsoon introduce ecological stress. The gradual increase in cyanobacterial dominance highlights the need for regular monitoring and nutrient management strategies. Plankton analysis proves to be an effective, low-cost scientific tool for assessing freshwater ecosystem health in semi-arid regions.

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