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Exploring the Dynamics of Phytoplankton in Khadakwasla Reservoir through Qualitative and Quantitative Analysis

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Abstract: Phytoplankton play a crucial role not only in primary production but also in nutrient cycling. Khadakwasla Reservoir serves as an important water source for the Pune City. By understanding the diversity and abundance of phytoplankton in this reservoir we can assess the ecological health and potential implications on water quality. The present study aimed to investigate the phytoplankton community in Khadakwasla Reservoir over a period of 21 months. Water samples were regularly collected on a monthly basis from four sampling stations across the reservoir. Qualitative and quantitative analysis of phytoplankton samples was done by using standard methods.

The observed variations in phytoplankton abundance and composition may be attributed to various factors including seasonal changes and anthropogenic activities in the catchment area. Observations indicate prevalence of Chlorophyceae as the dominant group, followed by Bacillariophyceae, Cyanophyceae, and Euglenophyceae. Thus, the dynamics of phytoplankton in Khadakwasla Reservoir is vital for effective water resource management and to assess potential implications for water quality and biodiversity.

Keywords: Phytoplankton, Khadakwasla Reservoir, Diversity, Abundance, Water quality, Aquatic ecosystems

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Introduction

Phytoplankton are the floating microscopic organisms, which serves as a primary food source for many aquatic living organisms and fish communities, is also an indicator of the wealthiest aquatic environment (Tiwari and Chauhan, 2006; Gokhale and Sharma, 2022; Sarker *et al.*, 2023). Their communities are usually quite diverse, with typically several dozens of species. They are an integral part of the aquatic ecosystem. They are microscopic, plant-like organisms that play a vital role in marine and freshwater environments. These tiny organisms are the initial crucial components of the food chain as they serve as primary producers, and are responsible for transfer of energy to higher level. They are also responsible for generating significant oxygen and

fixing carbon dioxide through photosynthesis. Additionally, they are also considered as bioindicators as their presence, size, biomass and number indicates the water quality and ecosystem's health. Thus, their study becomes important for understanding the overall ecological balance of a water body.

Khadakwasla reservoir is situated in the near vicinity of the cosmopolitan city Pune. It also serves as the major drinking water sources for the city. Increase in anthropogenic activities and environmental changes occurring in the region have raised concerns about the ecological health and water quality of this reservoir. As phytoplankton play a strategic role in assessing the overall health of an aquatic ecosystem, their qualitative and quantitative analysis becomes essential for effective management of the reservoir and its conservation efforts.

This study aimed to explore and analyse the phytoplankton community in Khadakwasla, understanding its composition, abundance, and distribution patterns. This study helped to address several important research questions, including—(i) What are the dominant phytoplankton species in Khadakwasla?, and (ii) What is the monthly variation in phytoplankton density?.

Materials and Methods

Study Area:

Khadakwasla reservoir is created by a dam built on river Mutha and it is located at a distance of about 20 km from Pune. Prestigious institutes of national repute like National Defence Academy (NDA) and Central Water and Power Research Station (CWPRS) are located near this reservoir

Details of Khadakwasla Dam:

(i) Impounds Mutha River, (ii) Locale Khadakwasla Village, Pune, Maharashtra India, (iii) Length 1939 m, (iv) Height 31.79 m, (v) Opening Year 1969, (vi) Dam Owner(s) Government of Maharashtra, (vii) Creates Khadakwasla Lake, (viii) Capacity 374 Million Cubic Meter, and (ix) Geographical Coordinates 18°26′30″N 73°46′5″E/18.44167°N 73.76806°E/ 18.44167; 73.76806.

It is seen that there has been an apparent similarity and uniformity in the physical appearance of water throughout the reservoir. Aquatic macro vegetation was observed to be remarkably scarce. Four sampling stations S-1, S-2, S-3, S-4 were selected at this reservoir. Samples were collected from all the three strata i.e., surface, middle and bottom layers of the water and the average of values obtained was used for analysis and study.

One litre water sample was collected in a bottle for estimation of phytoplankton from the reservoir. To preserve the phytoplankton for further analysis in the laboratory Lugol's solution was added to the bottle. It was then centrifuged in the laboratory for total sedimentation for quantitative and qualitative analysis of phytoplankton. Supernatant liquid was taken out with the help of pipette and the sample was concentrated up to 10 ml. as described by Wetzel and Likens (1979).

Qualitative analysis of phytoplankton:

For qualitative analysis of phytoplankton, keys given by Pennak (1953), Edmundson (1959), Ward and Whipple (1959), Needham and Needham (1962) and APHA (2012) were used as guiding principles for Identification of phytoplankton.

Quantitative analysis of phytoplankton:

Quantitative estimation of phytoplankton was done using the Drop count method. The abundance of phytoplankton was expressed as organisms/L by using following formula:

$$\text{Organisms/L.} = (N \times Y \times X) \div V$$

Where, N is number of organisms per drop; V is volume of original sample; X is total volume of the concentrated sample (ml) and Y is volume of one drop (ml).

Results and Discussion

For the qualitative analysis, count of various

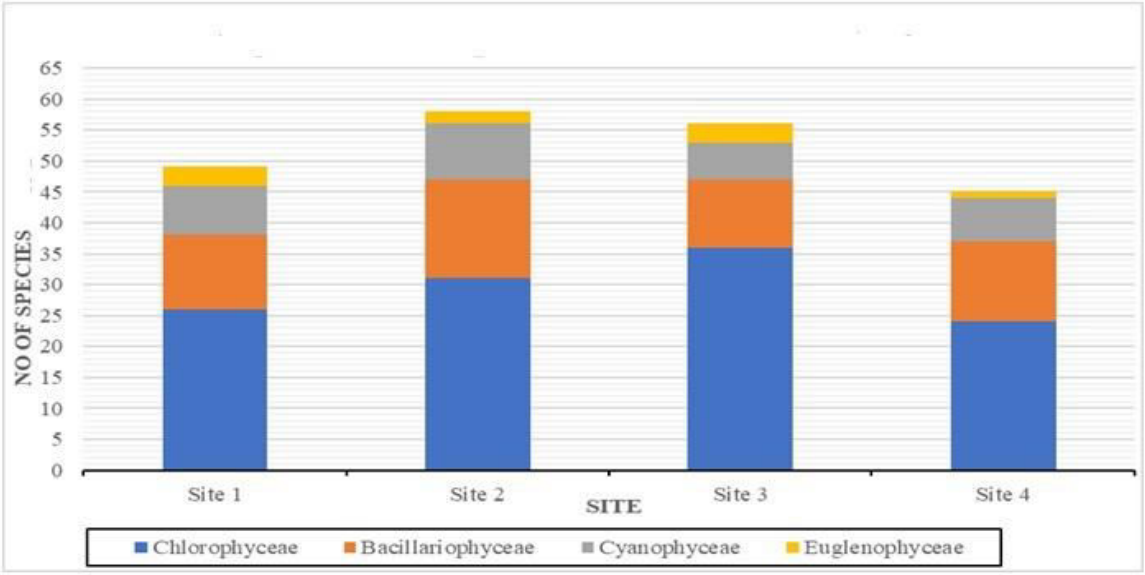

Fig. 1: Phytoplankton species recorded at various Sites.

species for phytoplankton was recorded at the four sampling stations at the beginning of study. For quantitative analysis, regular monthly sampling of the reservoir was conducted for twenty-one months at four selected sampling sites. Minimum and maximum values are discussed below to understand the trend of density of phytoplankton in the reservoir.

Qualitative Analysis:

During the period of study, the minimum number of chlorophyceae species recorded were 24 at S-4 and maximum was 36 at S-3. Minimum number of species of bacillariophyceae was 11 at S-3 and maximum was 16 at S-2. Number of species of cyanophyceae recorded at S-3 was 6 (minimum) and 9 species were recorded at site S-2, which was maximum. Number of species of euglenophyceae at S-4 was 1 which was minimum and at S-1 and S-3 it was recorded as 3, which was maximum.

Biological indicators are used for assessing the water quality because they react either positively or negatively to the changing parameter of water. Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae were represented by 26, 12, 8 and 3 species, respectively at S-1 sampling station and 31, 16, 9 and 2 species respectively at S-2 sampling station, 36, 11, 6 and 3 species at S-3 sampling station and 24, 13, 7 and 1 species, respectively at S-4 sampling station in Khadakwasla reservoir. Total number of species found at S-1, S-2, S-3 and S-4 sampling stations were 49, 58, 56 and 45, respectively (Fig. 1).

Quantitative Analysis:

During the study period the minimum number of phytoplankton recorded was 1000 organisms/L in December 2014 and maximum number was 3200 organisms/L in June 2013. At S-1 only 1100 organisms/L were found in December 2013 which were noted to be minimum and 3200 organisms/L was the maximum in June 2013. At S-2 the minimum number of phytoplankton was recorded in December 2013 and December 2014 and was 1200 organisms/L and the maximum number was 3100 organisms/L in June 2013. At S-3 the minimum reading recorded was 1000 organisms/L in December 2014 whereas the maximum was 2750 organisms/L in the months of May 2014. At S-4 only 1000 organisms/L were found in December 2014 which were noted to be minimum and 2850 organisms/L was the maximum in June 2013, May 2014 and June 2014. The range of phytoplankton remained between 1000 organisms/L to 3200 organisms/L. It shows the number of phytoplankton peaking in

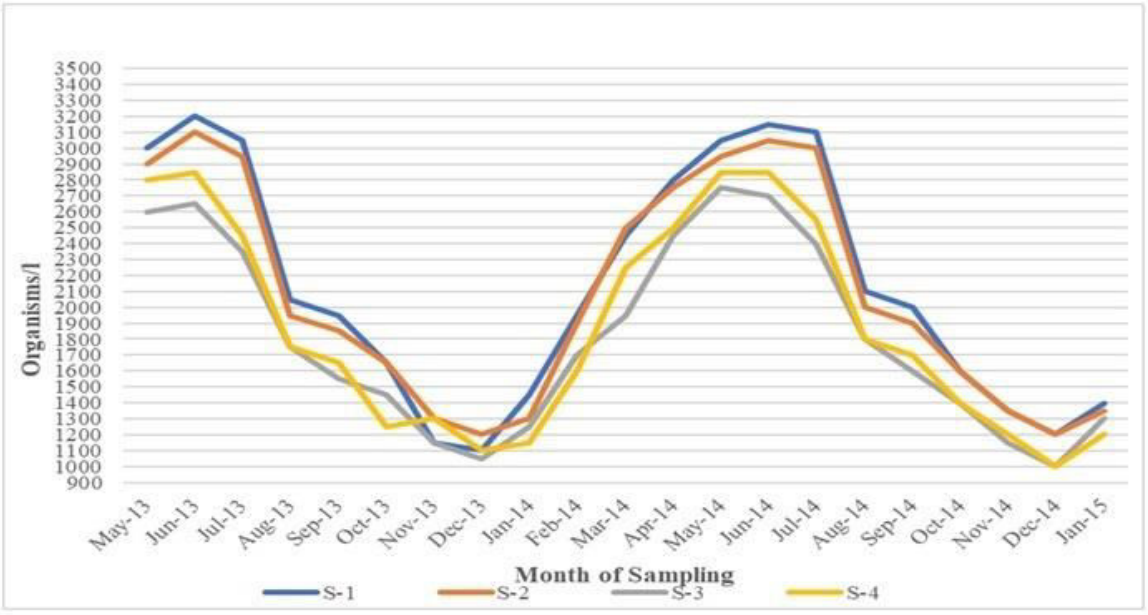

Fig. 2: Phytoplankton density during the study period.

the summer season as compared with the rest of the months.

Phytoplankton possess unique ability to fix inorganic carbon and build up organic matter through primary productivity which makes them a subject of prime importance. In the present study the total number of phytoplankton ranged from 1000 to 3200 org/Lin Khadakwasla reservoir. Qualitative analysis of phytoplankton density is represented in Figure 2.

In the current study, the levels of phytoplankton exhibit seasonal fluctuations. Welch (k1952) classified the lakes with high plankton abundance as eutrophic. The values of phytoplankton in Khadakwasla reservoir also indicate its eutrophic state, though to a lesser degree. High summer values of phytoplankton density were observed in the present study. During the summer season, the heightened temperature leads to increased decomposition rates, coupled with evaporation, elevated nutrient concentrations, and ample availability of nourishing substances through photosynthesis (Santhanam and Perumal, 2003) contributes to higher values of phytoplankton density. High summer values of phytoplankton were also observed by Vincent and Silvester (1979).

During the monsoon season, a reduction in phytoplankton density can be attributed to the influx of heavy floods and substantial freshwater inflow (Krishnamoorthy et al., 2007). These findings align with previous research by Wojciechowska *et al*. (2007), Chellappa *et al*. (2008), Laskar and Gupta (2009), Begum *et al*. (2010) and Tarakeshwar *et al*. (2011).

The pronounced peak in phytoplankton abundance during summer serves as an indicator that the dam water contains a substantial portion of the nutrients necessary for their growth. In the present study there is the prevalence of Chlorophyceae as the dominant group, followed by Bacillariophyceae, Cyanophyceae, and Euglenophyceae. These findings align with studies conducted by Tiwari and Chauhan (2006), Laskar and Gupta (2009), Adesalu (2010) and Kaparapu and Geddada (2013).

Conclusion

In conclusion, this study delved into a comprehensive investigation of the qualitative and quantitative aspects of phytoplankton in Khadakwasla reservoir. This study has identified

diversity and composition of phytoplankton populations in Khadakwasla reservoir over a period of 21 months. This understanding provides a foundation for understanding their ecological importance, particularly as primary producers at the base of aquatic food chains. This understanding has a potential to contribute to the ability to predict and manage the response of these organisms to changing conditions, including those influenced by human activities. The present study has relevance in the domains of conservation, fisheries management, and ecosystem health. They underscore the need for proactive measures to maintain balanced phytoplankton populations, recognizing their role in sustaining aquatic life and overall ecosystem stability.

In the present study the phytoplankton population ranged from 1000-3200 org/L was recorded during the study period. The quantitative analysis of phytoplankton indicates that the reservoir is slightly heading towards eutrophic state. However, the growth of this magnitude cannot be considered as the blooming condition, which may many times prove to be fatal to fish population. Similarly qualitative analysis of phytoplankton indicates that Khadakwasla reservoir has rich diversity of phytoplankton species.

Current study clearly indicates that there is sufficient evidence for further analysis into the intricate relationships between phytoplankton and their environments. Future investigations could delve deeper into the potential impacts of climate change, pollution, and other stressors on these vital organisms. By continuing to unravel the mysteries of phytoplankton dynamics, we pave the way for more effective conservation strategies, sustainable resource management, and a broader understanding of the delicate web of life that sustains our aquatic ecosystems.

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