ASSESSING PHYTOPLANKTON SPECIES DIVERSITY ACROSS FOUR FRESHWATER PONDS AND ITS ECOLOGICAL IMPLICATIONS

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Abstract

This study investigates the diversity of phytoplankton species in four different freshwater ponds located at Sirakol in South 24 Parganas district of West Bengal, with a focus on understanding the ecological implications of species distribution and diversity. Through microscopic analysis and quantitative assessments, the standing stock of various phytoplankton species was documented, revealing Pond 1 as the most diverse, followed by Ponds 3, 4, and 2. The Shannon-Wiener Diversity Index was employed to quantify species diversity, highlighting significant variations among the ponds. The results suggest that diverse phytoplankton communities contribute to ecosystem stability, and understanding these patterns can aid in the management of freshwater biodiversity and fish diversity in particular.

Keywords: *Phytoplankton, Aquatic Ecosystem*, *Shannon-Wiener Diversity Index*

1. Introduction

Phytoplankton, the microscopic autotrophic organisms found in aquatic ecosystems, form the foundation of the aquatic food web, contributing significantly to primary production and biogeochemical cycles. Their diversity and abundance are critical indicators of water quality and ecosystem health. Freshwater ponds, being dynamic ecosystems, host a variety of phytoplankton species whose distribution is influenced by factors such as nutrient availability, light penetration, and water temperature.

In this study, we aim to assess the species diversity of phytoplankton in four freshwater ponds at Sirakol located in the South 24 Parganas district of West Bengal. By comparing the diversity indices across these ponds, we can better understand the ecological dynamics at play and the potential implications for freshwater management. Phytoplankton is extremely important as natural food of fishes (Abd El-Hady, 2014; Abd El-Hady *et al*., 2016; Abd El-Karim M.S. & Mahmoud A.M.A. 2016; Hussian *et al*., 2016; Khudyi *et al*., 2016). Phytoplankton play numerous roles in ocean biogeochemical cycling (Devred *et al*., 2006; Fishwick *et al*., 2006; Aiken *et al*., 2007, 2008, 2009, Pal *et al*., 2017), and also to sustain fish diversity (Mitra, 2013; Mitra and Zaman, 2015; Mitra and Zaman, 2016; Mitra, 2018; Mitra and Zaman, 2021; Paul *et al.,* 2021, Mitra *et al.,* 2022; Mitra *et al.,* 2023). Phytoplankton and other floral community also play significant role in carbon sequestration (Mitra *et al.,* 2016; Pal *et al.,* 2016, 2018, 2018a, 2019, 2020, 2020a, 2021, 2022; Ahmed *et al.,* 2023).

2. Methodology

2.1 Study Area

The study was conducted in four freshwater ponds at Sirakol, designated as Pond 1, Pond 2, Pond 3, and Pond 4. These ponds vary in size, depth, and nutrient availability, providing a diverse range of habitats for phytoplankton communities.

2.2 Sampling and Analysis

Phytoplankton samples were collected from each pond using standard plankton nets and preserved in Lugol's solution. Microscopic examination was carried out to identify and quantify the different phytoplankton species. The standing stock of each species was documented in units of 10^5 cells per litre (Fig. 1).

Fig. 1. Collection of phytoplankton from the ponds

2.3 Diversity Index Calculation

The Shannon-Wiener Diversity Index (H') was employed to quantify the species diversity in each pond. This index is calculated using the formula:

$$H' = -\sum_{i=1}^{s} pi\ lnpi$$

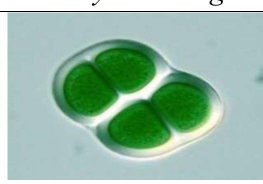
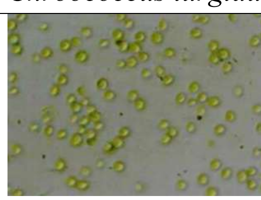
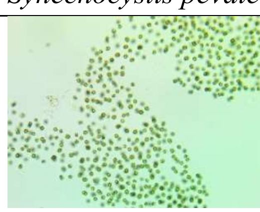
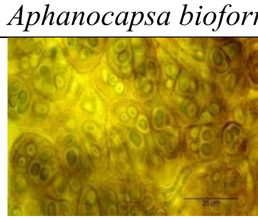
where pi is the proportion of the selected species relative to the total number of species. A higher H' value indicates greater species diversity.

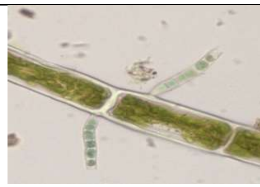
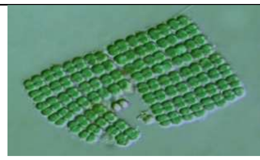
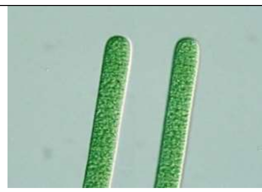
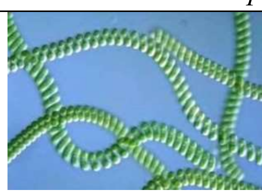
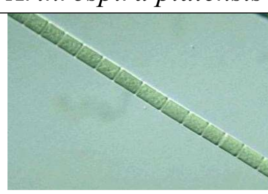
3. Results

3.1 Species Composition

A total of 11 phytoplankton species were identified across the four ponds. The standing stock (No. × 10^5/L) of each species in the respective ponds is presented in Table 1, and Fig 2.

Table 1. Standing stock of phytoplankton species with cell volume documented in the 4 ponds at Sirakol

Sl. No.	Microscopic view	Standing Stock (No. × 10^5/L)			
		Pond 1	Pond 2	Pond 3	Pond 4
1	 *Microcystis aeruginosa*	4.40	10.99	5.77	0
2	 *Chroococcus turgidus*	5.30	0.98	0	6.80
3	 *Synechocystis pevalekii*	2.85	0.61	4.17	7.30
4	 *Aphanocapsa bioformis*	3.05	2.93	4.83	1.89
5	 *Aphanotheceae pallida*	4.55	18.21	3.07	2.46

6	 *Stichosiphon sansibaricus*	1.55	1.10	2.63	7.10
7	 *Merismopedia elegans*	2.05	0	4.73	6.90
8	 *Oscillatoria curviceps*	9.25	2.91	10.97	6.98
9	 *Arthrospira platensis*	4.15	0	6.33	8.00
10	 *Oscillatoria amoena*	4.22	3.15	5.30	7.12
11	 *Lyngbya lutea*	5.50	9.71	7.07	6.70

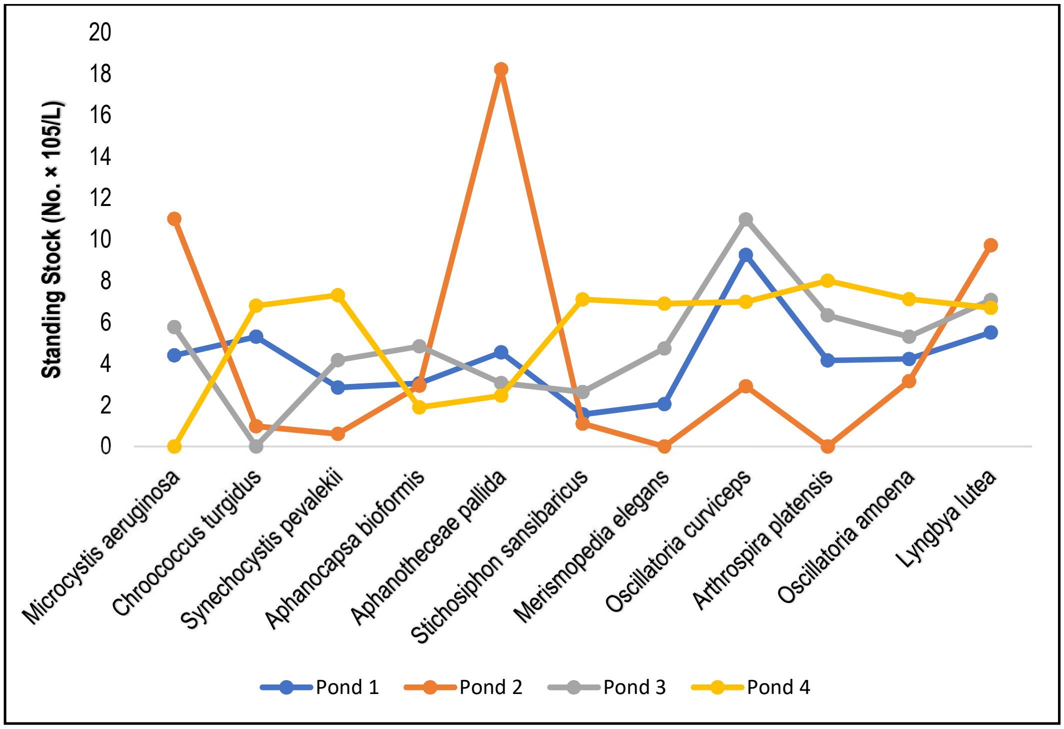


Fig 2. Standing stock of phytoplankton species in selected ponds at Sirakol

3.2 Diversity Indices

The Shannon-Wiener Diversity Index for each pond was calculated based on the species composition and their relative abundances (Table 2, and Fig. 3).

Table 2. Shannon-Wiener Diversity Index (H') of selected ponds

Pond	Shannon-Wiener Diversity Index (H')
Pond 1	2.296
Pond 2	1.731
Pond 3	2.226
Pond 4	2.235

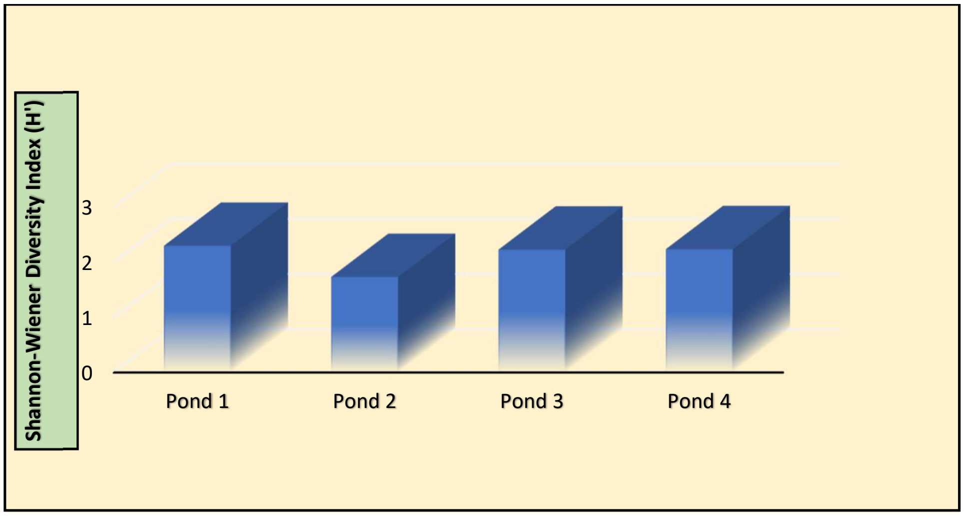


Fig 3. Shannon-Wiener Diversity Index (H') of phytoplankton species in the 4 selected ponds at Sirakol

Pond 1 exhibits the highest diversity, followed by Pond 4, Pond 3, and Pond 2. This variation reflects the ecological complexity and habitat conditions unique to each pond.

4. Discussion

The analysis reveals that Pond 1 exhibits the highest species diversity, as indicated by the Shannon-Wiener Index. This diversity is likely due to a balanced nutrient availability and favourable ecological conditions that support a wide range of phytoplankton species. Pond 2, with the lowest diversity index, might be experiencing conditions that favour the dominance of a few species, such as high nutrient loads leading to eutrophication.

Pond 3 and Pond 4 show intermediate levels of diversity, suggesting varying degrees of nutrient availability and habitat complexity. The presence of species like *Oscillatoria curviceps* and *Arthrospira platensis* in higher numbers across these ponds indicates a preference for the specific conditions prevalent in these water bodies.

Understanding the diversity of phytoplankton in freshwater ecosystems is crucial for maintaining ecological balance. High species diversity is often associated with greater resilience to environmental stressors and better ecosystem functioning. Therefore, efforts should be made to preserve and enhance phytoplankton diversity in freshwater habitats, especially in regions facing anthropogenic pressures.

The calculated diversity indices reveal that Pond 1 has the highest phytoplankton diversity among the four ponds studied. This high diversity is likely a result of balanced nutrient levels and favourable ecological conditions that support a wider variety of species. In contrast, Pond 2, which exhibits the lowest diversity, may be experiencing environmental stressors such as nutrient overload, which often leads to the dominance of a few species and reduced overall diversity.

Pond 3 and Pond 4 show intermediate levels of diversity, indicating moderate ecological stability. The presence of species like *Oscillatoria curviceps* and *Arthrospira platensis* in these ponds suggests that specific environmental conditions, such as light availability and nutrient concentrations, are influencing species distribution and abundance.

Understanding the diversity of phytoplankton is crucial for maintaining the health of aquatic ecosystems. High diversity is often associated with increased resilience to environmental changes and better overall ecosystem functioning. Therefore, preserving the diversity of phytoplankton communities is essential for the sustainable management of freshwater resources, particularly in areas facing anthropogenic pressures. Phytoplankton diversity is also closely related to the economic return from the waterbodies as they serve as the natural fish feed and promotes fish production.

5. Conclusion

This study underscores the importance of phytoplankton diversity in freshwater ecosystems. The findings suggest that Pond 1, with its high species diversity, serves as an ideal model for ecological balance and resilience. Conversely, the lower diversity observed in Pond 2 highlights the potential risks associated with environmental imbalances. These insights are valuable for developing conservation strategies aimed at protecting and enhancing the biodiversity of freshwater habitats.

This paper highlights the importance of phytoplankton diversity in maintaining the ecological health of freshwater ponds. Pond 1, with the highest species diversity, serves as a model for balanced ecosystem management. The findings underscore the need for targeted conservation efforts to protect these vital aquatic resources from degradation.

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