Uttar Pradesh Journal of Zoology

Volume 45, Issue 3, Page 124-138, 2024; Article no.UPJOZ.3177
ISSN: 0256-971X (P)

Investigating the Plankton Diversity and Physicochemical Properties in a Temple Pond in Tamil Nadu, India: Taxonomic Composition, Seasonal Variations, and Ecological Implications

Sangeetha M. [a], John Sundhar Kumar J. D. [b], Anitha T. S. [c] and Sivachandran R. [b++*]

[a] PG and Research, Department of Zoology, Poompuhar College, Melaiyur, Mayiladuthurai, Tamil Nadu, India.
[b] Department of Zoology, RKM Vivekananda College (Autonomous), Mylapore, Chennai, India.
[c] Department of Biochemistry and Molecular Biology, School of Life Sciences, Pondicherry University, Puducherry, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author SR and SM designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author SR and ATS managed the analyses of the study. Author JSK managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.56557/UPJOZ/2024/v45i33882

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://prh.mbimph.com/review-history/3177

Original Research Article

Received: 20/11/2023
Accepted: 27/01/2024
Published: 31/01/2024

[++] *Assistant Professor;*
**Corresponding author: Email: rsivachandran@rkmvc.ac.in;*

ABSTRACT

The present study explores the dynamics of phytoplankton and zooplankton in the Swetharanyeswarar temple pond located in the Mayiladuthurai district of Tamil Nadu, India. The study investigates species composition, diversity, and seasonal variations of these microscopic organisms, considering the ecological implications for the local food chain. Phytoplankton (Seven species), dominated by diatoms, cyanobacteria, and various other taxa, plays a fundamental role as primary producers, influencing nutrient cycling and climate patterns. The presence of *Microcystis* sp., associated with harmful algal blooms, emphasizes the need for monitoring and understanding its ecological implications. Zooplankton (13 species), including Rotifera, Copepods, and Calanoids, showcases a diverse community with distinct taxonomic members. The Rotifer community peaks in January, gradually declining, while Copepods exhibit notable diversity in April. Calanoids, represented by Macrocyclops albidus and Macrocyclops fuscus, display temporal fluctuations in diversity indices, indicating potential ecological changes influenced by environmental factors. The population of each zooplankton group is expressed as an average number of individuals per liter. Water quality parameters, crucial for understanding ecological dynamics, were meticulously measured in triplicates. Statistical analyses were conducted using Microsoft Excel to process and present the data as percentages.

The study establishes a connection between zooplankton dynamics and physicochemical parameters, highlighting correlations with turbidity, pH, and organic pollution indicators, as per the methods of APHA. Monthly variations in zooplankton populations reveal dynamic ecological patterns influenced by temperature and organic matter. The species richness index reflects a well-balanced distribution within the planktonic community, suggesting a healthy and resilient ecosystem in the Swetharanyeswarar temple pond. Statistical analysis involves expressing the zooplankton population as an average number of individuals per liter and presenting water quality parameters as percentages using Microsoft Excel. These findings underscore the importance of continued monitoring to decipher long-term trends and implement targeted strategies for maintaining water quality and ecosystem health. Overall, this research contributes valuable insights into the intricate relationships between phytoplankton, zooplankton, and environmental factors in a freshwater ecosystem, providing a foundation for informed fisheries management strategies and conservation efforts.

Keywords: Swetharanyeswarar temple; Tamil Nadu; phytoplankton; zooplankton; seasonal variations; ecological implications and taxonomic composition.

1. INTRODUCTION

Aquatic ecosystems, intricately woven by the interplay between phytoplankton and zooplankton, stand as pivotal contributors to water body productivity and health. The relationship between phytoplankton, the primary producers that utilize solar energy through photosynthesis, and zooplankton, which relies on these microscopic organisms for sustenance, forms the bedrock of aquatic food webs. This dynamic relationship has a profound impact on the dietary patterns of fish, throughout their life cycles, especially during crucial developmental stages like larval phases [1].

The significance of phytoplankton, encompassing a diverse array of microscopic algae and cyanobacteria, extends beyond their role as primary producers. They are key players in global biogeochemical cycles, particularly the carbon cycle, as they sequester carbon dioxide through photosynthesis, thereby influencing climate patterns. Additionally, phytoplankton contribute substantially to oxygen production, a vital component for the respiratory processes of aquatic organisms, thus influencing the overall oxygen balance in the ecosystem [2].

Zooplanktons play a crucial role in the transfer of energy at the secondary level in aquatic food webs, bridging the gap between autotrophs and heterotrophs [3]. Beyond their role in the complex balance of ecosystem components, zooplanktons serve as vital indicators of water quality and contamination, owing to their high sensitivity to environmental changes, Planktons, comprising a heterogeneous group of organisms, actively float and passively drift along the course of water currents in aquatic environments, making them invaluable indicators of environmental health [4].

In addition, the complex relationship between physicochemical properties and the planktonic community is of paramount significance in understanding and managing aquatic ecosystems. The physico-chemical properties of water, including its physical and chemical attributes, play a pivotal role in shaping the abundance, distribution, diversity, growth, reproduction, and movements of aquatic organisms [5]. Physical properties like temperature and turbidity impact the metabolic rates, growth, and reproductive patterns of planktonic organisms. Temperature variations affect phytoplankton's metabolic activity and photosynthetic rates, influencing the entire aquatic food web [6]. Turbidity, reflecting water clarity, is crucial for light penetration essential for phytoplankton photosynthesis. Changes in turbidity can disrupt the planktonic community balance, affecting the entire aquatic ecosystem [7].

Chemical properties, including pH, dissolved oxygen, and nutrient concentrations, are vital for planktonic organisms. pH fluctuations influence plankton sensitivity and distribution. Dissolved oxygen levels, crucial for aquatic organism survival, are influenced by various chemical factors, directly affecting zooplankton behavior and abundance [8]. Nutrient concentrations, especially nitrogen and phosphorus, are essential for phytoplankton growth. These nutrients shape phytoplankton composition and abundance, influencing zooplankton dynamics [9]. Understanding nutrient dynamics is crucial for assessing the overall health and productivity of the planktonic community.

In this context, our current research endeavors to enhance our comprehension of planktonic dynamics, specifically delving into the species composition and diversity of phytoplankton and zooplankton within the temple pond located in the Mayiladuthurai district of Tamil Nadu, India. The geographical coordinates (Latitude: 11.175829°, Longitude: 79.808487°) of this site accentuate its significance for exploration, offering valuable insights into the larger aquatic ecosystem and local biodiversity (Fig.1). Beyond mere taxonomic documentation, our study aspires to unveil the seasonal fluctuations in plankton abundance throughout the year, encompassing winter (January), pre-monsoon (February to March), and summer/monsoon (April to June) seasons. This temporal investigation assumes heightened importance as it not only enriches our understanding of the life cycles of these microscopic organisms but also holds implications for the intricacies of the local food chain, thereby contributing to informed fisheries management strategies. The anticipated findings not only contribute to scientific knowledge but also hold practical significance, with potential economic benefits, employment opportunities, and the overall equilibrium of the ecosystem at stake. By incorporating a species richness index, we aim to comprehensively assess the biodiversity and health of the ecosystem. Additionally, the geographical context of the Swetharanyeswarar Temple Pond adds another layer of importance to our research. The specific physicochemical properties of this water body, influenced by its location and surrounding environment, will directly impact the species composition and seasonal variations of plankton. Hence, our research aims to unravel these complexities and enhance our understanding of planktonic dynamics in this unique context.

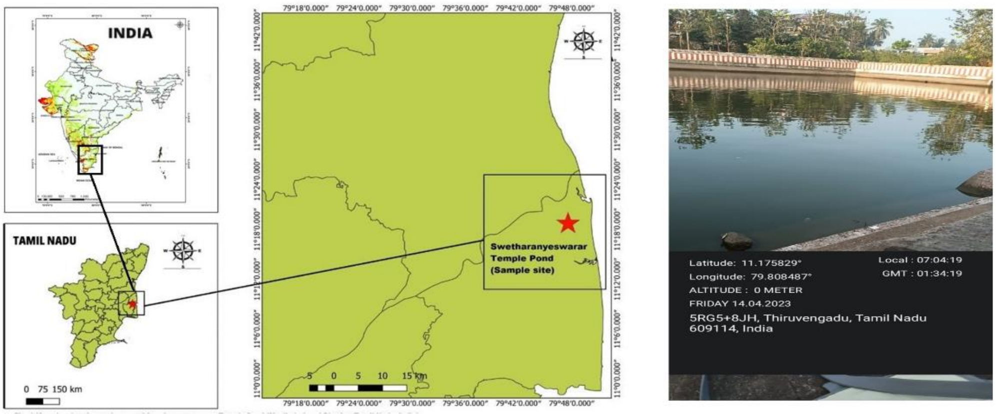


Fig. 1. Map showing the study area of Swetharanyeswarar Temple Pond, Mayiladuthurai district of Tamil Nadu, India

Furthermore, the significance of this relationship extends beyond ecological insights. The planktonic community serves as a vital indicator of the overall health of the aquatic environment. Changes in physicochemical properties can signal potential threats such as pollution, habitat degradation, or climate change, with cascading effects on the entire ecosystem, including fish populations and, consequently, fisheries. Thus, the interplay between physicochemical properties and the planktonic community is pivotal for deciphering the intricate dynamics of aquatic ecosystems, enriching scientific knowledge, and holding practical implications for informed and effective management strategies. Ultimately, our research aims to contribute towards a holistic understanding of these ecosystems, facilitating sustainable management and conservation efforts.

2. MATERIALS AND METHODS

2.1 Sampling Station and Sampling Design

Swetharanyeswarar temple is situated in the Mayiladuthurai district of Tamil Nadu, India (Latitude: 11.175829°, Longitude: 79.808487°). The pond's depth ranged from 5 to 6 feet. Sampling was conducted at 30-day intervals, spanning from January 2nd to June 10th, 2023. To enhance the precision of the results, three representative samples were collected during each sampling event (Fig.1).

2.2 Plankton Collection and Preservation

Plankton samples were systematically collected at monthly intervals, precisely at 6:30 am on each designated sampling day. This collection was facilitated using conical-shaped monofilament nylon net, commonly referred to as Plankton net. The plankton net featured a mesh size of 0.5 microns and a 30 cm diameter at the mouth. Sampling was conducted in various parts of the pond's pelagic water. The collection process involved passing water through the net, causing the plankton to accumulate at the lower end of the plankton net. Subsequently, the condensed plankton was carefully gathered into a glass test tube and securely fixed, following the protocol outlined by Welch [10]. Post-collection, the plankton materials were transferred into glass bottles and preserved utilizing a 30% formalin solution. Approximately 250 ml samples of plankton were treated with the formalin solution for preservation. Following preservation, the plankton samples were transported to the Unit of Aquaculture and Aquatic Toxicology at The New College, Royapettah, Chennai – 600 014.

2.3 Plankton Identification

Plankton cells were counted using a Sedgwick-Rafter cell counter under a light microscope. Identifying species requires expertise; therefore, a set of pencil and ink drawings depicting observed species was created on postcards to aid in organism recognition. Species identification followed the methods outlined by Todd [11] and Moniruzzaman [12].

2.3.1 Counting

The quantitative enumeration of zooplankton utilized a Sedgwick-Rafter (S-R) cell counter measuring 50 mm in length, 20 mm in width, and 1 mm in depth. Prior to filling the S-R cell with the sample, cover glasses were diagonally positioned across the cell, and samples were carefully transferred using a large bore pipette to prevent the formation of air bubbles in the cell covers. The S-R cell was allowed to settle for a minimum of 15 minutes to facilitate the settling of zooplankton. Subsequently, the plankton at the bottom of the S-R cell was enumerated using a compound microscope. The entire bottom slide area was meticulously examined by moving the mechanical stage.

For random sampling, three fields were examined for each sample, and the counts were averaged. The organisms counted were expressed as cells per liter (cells) of the sample. To achieve random counts, 20 cell counts in three slides were performed for each sample, and the averages were recorded. The number of plankton (Zooplankton) in the S-R cell was determined using the formula:

$$No./ml = \frac{\mathrm{C} \times 1000mm^3}{\mathrm{L} \times \mathrm{D} \times \mathrm{W} \times \mathrm{S}}$$

Where, *C* is the number of organisms counted, *L* is the length of each strip (S-R cell length) in mm, *D* is the depth of a strip (Whipple grid image width) in mm, *W* is the width of each stripe in mm, *S* is the number of strips counted. The number of cells per mm was then multiplied by a correction factor to adjust the number of organisms per liter, following the APHA (American Public Health Association) guidelines from 1998.

2.4 Diversity Assessment and Species Richness Index

2.4.1 Taxonomic identification

Phytoplankton and zooplankton taxa were meticulously identified using established taxonomic keys and microscopic examination. Enumeration of individual organisms was conducted to quantify the abundance of each identified taxon.

2.4.2 Diversity Indices calculation

Diversity indices were computed using the PAST software, available online, to assess the richness and evenness of the planktonic community. These indices included Taxa_S (total number of identified taxa), Individuals (count of planktonic organisms observed), Dominance_D (abundance of the dominant taxa), Simpson_1-D (Simpson diversity index), and Shannon_H (Shannon-Wiener diversity index). These indices collectively provided a comprehensive overview of the community structure.

2.5 Measurement of Physicochemical Parameters

Regular surface water samples were collected during the study period at regular interval. The surface water samples were collected in a precleaned polypropylene container for physical and chemical analysis. Samples were fixed with Manganese Sulphate and Alkaline iodide in 250 ml BOD bottles to analyze the dissolved oxygen in field. Water quality parameters analysis was performed at Wasser Chemicals & Systems Private Ltd, Chennai. These parameters encompassed appearance, pH, color, odor, turbidity, total dissolved solids (mg/l), total hardness as $CaCO_3$ (mg/l), calcium (mg/l), magnesium (mg/l), chlorides (mg/l), sulphates (mg/l), sodium (mg/l), potassium (mg/l), dissolved oxygen (DO) (mg/l), BOD and COD (mg/l). pH value at 25℃. Further, water parameters were analysed as per methods described in APHA (1998).

2.6 Statistical Analysis

The population of each group of zooplankton was expressed in average (number of individuals per litre). Water quality parameters were performed in triplicates and the data are shown as percentage using Microsoft Excel.

3. RESULTS AND DISCUSSION

The investigation conducted in the freshwater body of Swetharanyeswarar temple, Mayiladuthurai district, provides valuable insights into the phytoplankton and zooplankton dynamics, shedding light on their species composition, abundance, and monthly variations, In the course of our investigation, a total of seven phytoplankton species and thirteen zooplankton species were identified in the freshwater body of Swetharanyeswarar temple in the Mayiladuthurai district.

3.1 Phytoplankton Diversity

The analysis of phytoplankton in the Swetharanyeswarar temple pond revealed a diverse community comprising several taxa. Diatoms, cyanobacteria, *Melosira varians, Scenedesmus sp., Cerataulina sp., Coscinodiscus sp., and Microcystis sp*. were identified as significant constituents of the phytoplankton composition (Fig. 2).

Diatoms, known for their siliceous cell walls, contribute to the overall biodiversity of the phytoplankton community [13]. Cyanobacteria, a group of photosynthetic bacteria, play a crucial role in nutrient cycling and energy transfer within aquatic ecosystems [14]. The presence of *Melosira varians, Scenedesmus sp., Cerataulina sp., Coscinodiscus sp., and Microcystis sp*. further underscores the complexity and richness of the phytoplankton assemblage in the temple pond. The occurrence of *Microcystis sp*., a genus associated with harmful algal blooms, warrants attention due to its potential ecological implications [15]. Monitoring and understanding the factors influencing the abundance of *Microcystis sp*. are crucial for ensuring the health of the aquatic ecosystem, particularly in the context of water quality management.

The identified phytoplankton taxa contribute significantly to the temple pond's overall ecological dynamics, serving as primary producers and influencing nutrient cycling. The diversity observed in the phytoplankton community indicates a dynamic and balanced ecosystem. However, further investigation is needed to explore the seasonal variations and environmental factors influencing the abundance of these phytoplankton species.

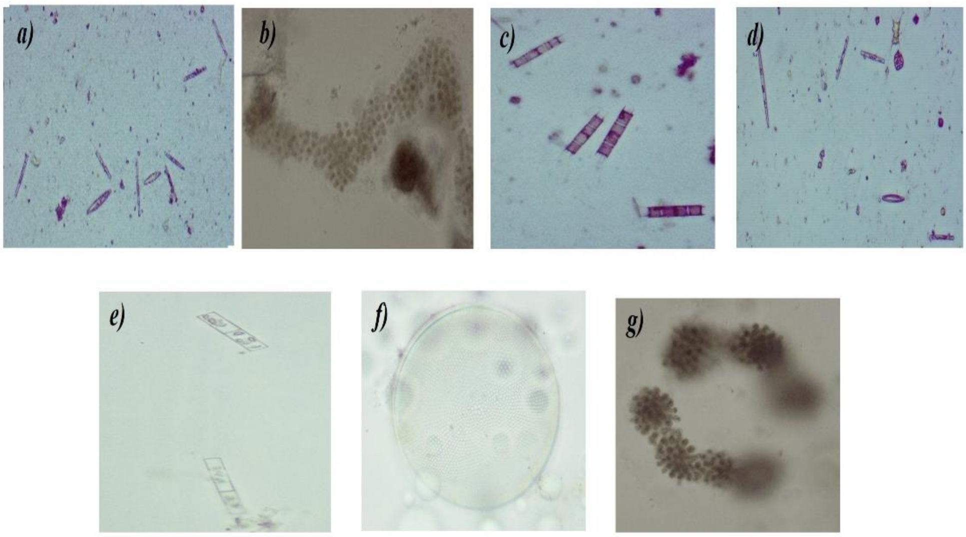


Fig. 2. Diverse Phytoplankton Community in Swetharanyeswarar Temple Pond, Mayiladuthurai district of Tamil Nadu, India. a) Diatoms; (b) Cyanobacteria; (c) *Melosira varians; (d) Scenedesmus sp; (e) Cerataulina sp.; (f) Coscinodiscus sp.; (g) Microcystis sp*

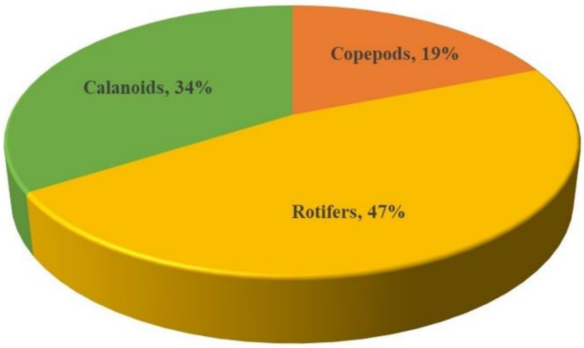


Fig. 3. Taxonomic Diversity of Zooplanktons in Swetharanyeswarar Temple Pond, Tamil Mayiladuthurai District, Tamil Nadu, India (January 2023 to June 2023)

3.2 Zooplankton Composition and Abundance

The zooplankton community in the Swetharanyeswarar temple pond displayed a rich diversity, encompassing five species of Rotifera, two species of Calanoids, and six species of Copepods (Fig.3).

Taxonomic identification within the Rotifera group in Swetharanyeswarar pond from January to June 2023 revealed specific members, including *Brachionus plicatilis* [16], *Brachionus forficula* [17], *Brachionus falcatus* [18], *Brachionus rubens* [19], and *Brachionus caudatus* [20], as illustrated in Fig 4. This detailed taxonomic insight adds precision to our understanding of the zooplankton community in the pond. *Brachionus plicatilis, Brachionus forficula, Brachionus falcatus, Brachionus rubens,* and *Brachionus caudatus* contribute distinctly to the overall diversity of Rotifers in Swetharanyeswarar pond.

Moving to the diversity indices presented in Table 1, the study indicates temporal variations in Rotifer species richness. The consistent presence of five Rotifer species (S) is observed throughout the study period. April emerges as a noteworthy month with a peak diversity index of 0.00109, indicating a substantial diversity of Rotifers. This aligns with a lower overall zooplankton count in April, suggesting a concentration of Rotifer species. March records a significant diversity index of 0.00043, while May and June exhibit intermediate diversity indices of 0.00057 and 0.00102, respectively. These fluctuations underscore the dynamic nature of Rotifer species richness in Swetharanyeswarar pond and emphasize the ecological complexity brought about by specific taxonomic members within the Rotifera group. Further research is warranted to elucidate the ecological roles and environmental factors influencing the observed temporal variations in the Rotifer community.

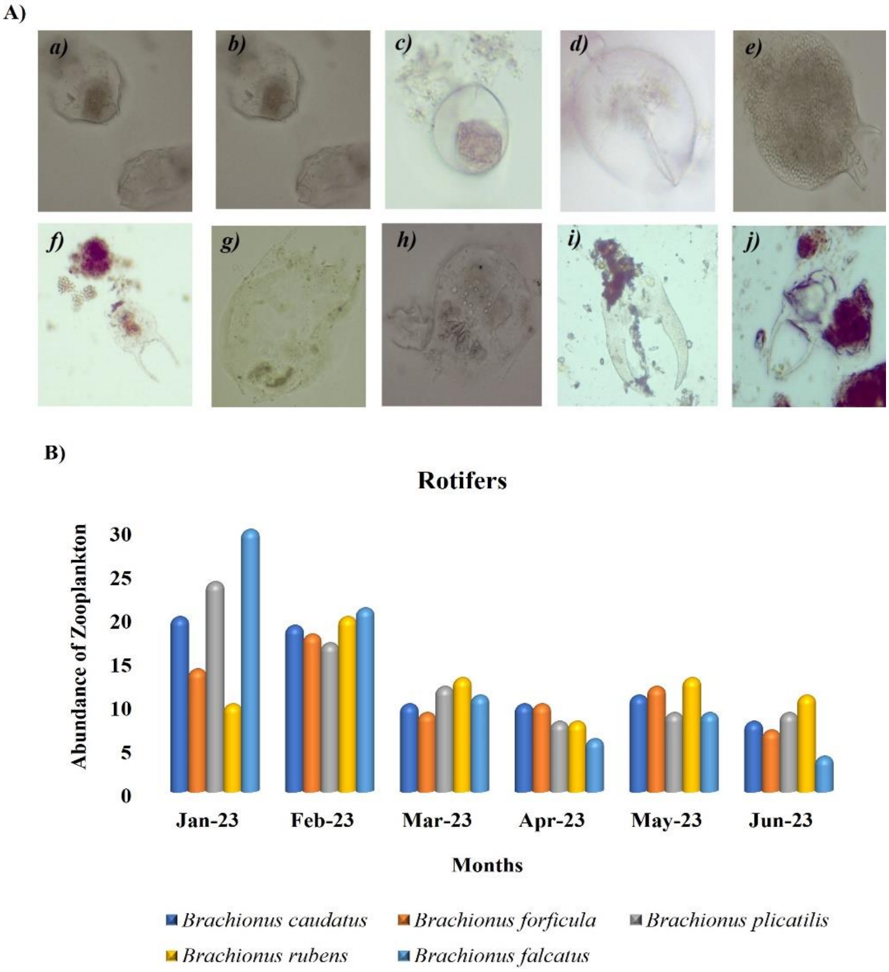


Fig. 4. (A) Zooplankton community with Rotifer species in Swetharanyeswarar temple, Mayiladuthurai district of Tamil Nadu: (a) Brachinous larval stage 1; (b) Brachinous larval stage 2; (c) Brachinous larval stage 3; (d) Brachinous larval stage 4; (e) *Brachionus caudatus* eating Zygnema; (f) *Brachionus forficula*; (g) *Brachionus plicatilis*, (h) *Brachionus rubens*; (i) *Brachionus falcatus*; (j) *Brachionus forficula.* (B) Monthly variation of Rotifera from Jan 2023 to June 2023

Table 1. Diversity indices of Zooplankton (Rotifers) in Swetharanyeswarar pond from January 2023 to June 2023

S.No	Month	Number of species (S)	Total number of Zooplankton (N)	Total number of individual species (n)	Diversity Index = S-1/1n N
1	January 2023	5	167	98	0.00024
2	February 2023	5	174	95	0.00024
3	March 2023	5	166	55	0.00043
4	April2023	5	87	42	0.00109
5	May 2023	5	129	54	0.00057
6	June 2023	5	100	39	0.00102

Additionally, the copepod category in this study revealed a diverse assembly featuring *Heliodiaptomus cinctus* [21], *Neodiaptomus strigilipes* [22], *Heliodiaptomus viduus* [23], *Heliodiaptomus alikunhii* [24], *Rhinediaptomus indicus* [25], and Heliodiaptomus *pulcher* [26], as illustrated in Fig 5. This diversity underscores the richness of copepod species inhabiting the studied aquatic ecosystem. Noteworthy species like *Heliodiaptomus cinctus, Neodiaptomus strigilipes,* and *Heliodiaptomus viduus* contribute significantly to the overall biodiversity. The presence of *Rhinediaptomus indicus* and *Heliodiaptomus pulcher* further enhances the variety within this copepod community, signifying its ecological significance in nutrient cycling and energy transfer within aquatic ecosystems.

Concurrently, the diversity indices of copepod zooplankton from January to June 2023, presented in Table 2, reveal temporal variations in species richness and diversity. With a constant number of species (S) at 6, April stands out with a diversity index peak of 0.0027, suggesting a notably diverse copepod community. This coincides with a lower total number of zooplankton observed in April, indicating a concentrated presence of copepod species. In contrast, March records the lowest diversity index of 0.00086, indicating a comparatively less diverse community. May and June show intermediate diversity indices (0.0013 and 0.0023, respectively). These fluctuations highlight potential ecological changes influencing copepod populations in Swetharanyeswarar pond. Further investigations into environmental factors, such as temperature and nutrient availability, could elucidate the underlying mechanisms driving these variations and contribute to a comprehensive understanding of copepod dynamics in this aquatic ecosystem, providing a foundation for future ecological studies and conservation efforts in the area.

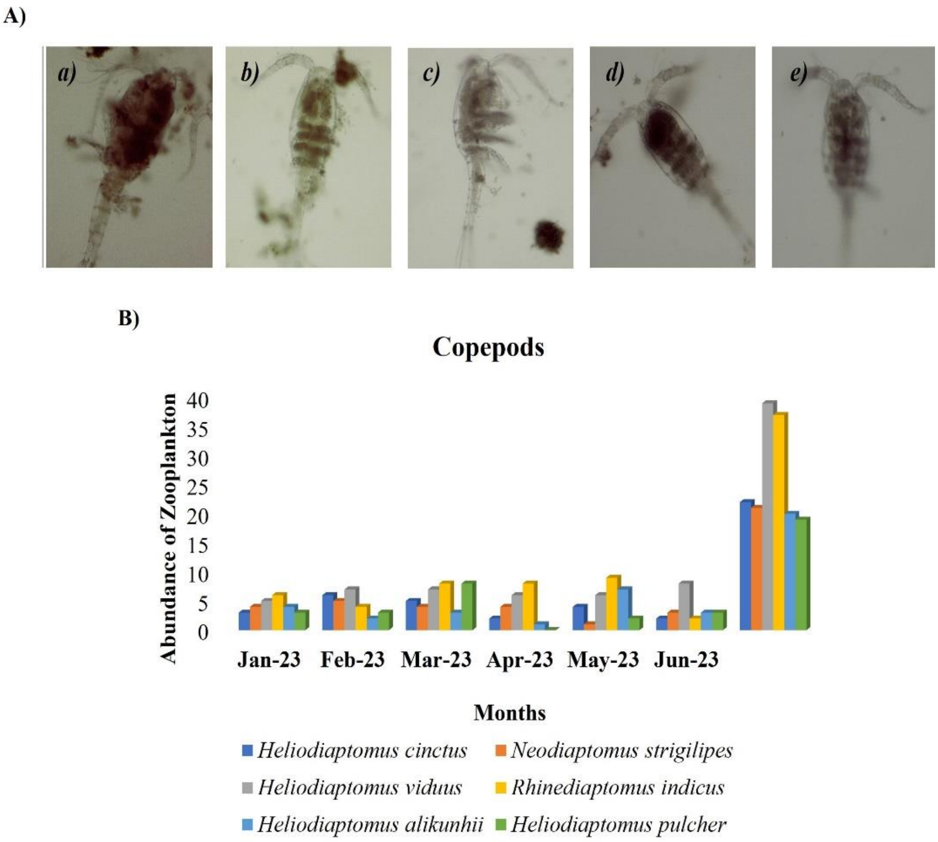


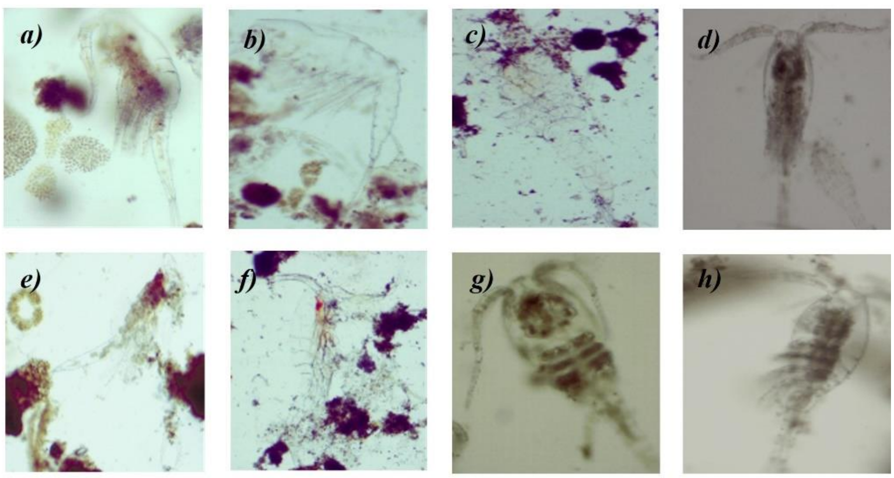
Fig. 5. (A) Zooplankton community with Copepod species in Swetharanyeswarar temple, Mayiladuthurai district of Tamil Nadu: ***(a) Heliodiaptomus cinctus; (b) Heliodiaptomus pulcher; (c) Heliodiaptomus viduus; (d) Rhinediaptomus indicus; (e) Neodiaptomus strigilipes and cyanobacteria; (f) Heliodiaptomus alikunhii; (g) Heliodiaptomus viduus female; (h) Neodiaptomus strigilipes*** **(B) Monthly variation of Copepod from Jan 2023 to June 2023**

Table 2. Diversity indices of Zooplankton (Copepods) in Swetharanyeswarar pond from January 2023 to June 2023

S.No	Month	Number of species (S)	Total number of Zooplankton (N)	Total number of individual species (n)	Diversity Index = S-1/1n N
1	January 2023	6	167	25	0.0011
2	February 2023	6	174	27	0.0010
3	March 2023	6	166	35	0.00086
4	April2023	6	87	21	0.0027
5	May 2023	6	129	29	0.0013
6	June 2023	6	100	21	0.0023

Calanoids, renowned for their crucial role in nutrient cycling and energy transfer, play a significant role in shaping the foundation of the aquatic food web. This study highlights the presence of various Calanoid species, such as *Macrocyclops albidus* [27] and *Macrocyclops fuscus* [28]. Their inclusion emphasizes the rich diversity within the zooplankton community, as illustrated in Fig. 6.

A)



B)

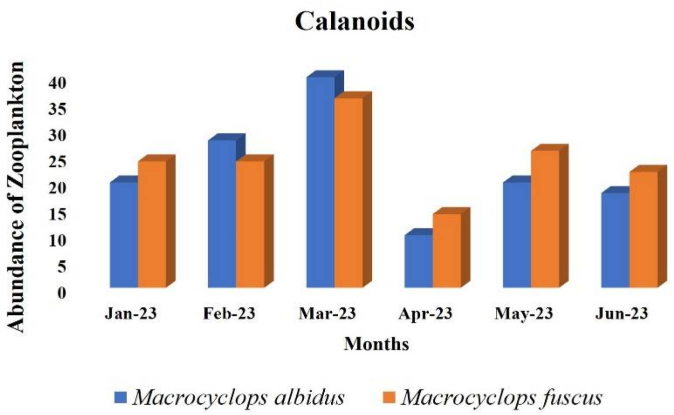


Fig. 6. (A) Zooplankton community with Calanoids, in Swetharanyeswarar temple, Mayiladuthurai district of Tamil Nadu:.(a) *Macrocyclops albidus*; (b) *Macrocyclops albidus* (1); (c) *Macrocyclops albidus* (2); (d) *Macrocyclops fuscus*; (e) *Macrocyclops fuscus* (1). (B) Monthly variation of Calanoids from Jan 2023 to June 2023

Interestingly, from the present study, the diversity indices of Calanoid zooplankton in Swetharanyeswarar pond exhibited temporal fluctuations from January to June 2023. The number of observed species remained constant at 2 throughout the study period. Notably, April recorded a peak diversity index of 0.00047, suggesting a more diverse Calanoid zooplankton community during that month. In contrast, March displayed a lower diversity index of 0.00007, indicating a decline in diversity compared to the preceding months. May and June showed intermediate values (0.00016 and 0.00025, respectively) (Table 3). These variations in diversity indices may be influenced by environmental factors, including temperature and nutrient availability. Further investigation into the specific ecological dynamics and environmental conditions contributing to these fluctuations is crucial for a comprehensive understanding of Calanoid zooplankton diversity in Swetharanyeswarar pond.

Thus, these findings affirm the crucial role of the zooplankton community in nutrient dynamics, serving as the primary link between primary producers and higher trophic levels within the Swetharanyeswarar temple pond. The insights derived from this taxonomic exploration align with the broader understanding of the indispensable contribution of zooplankton to maintaining ecological balance and sustaining the overall health of freshwater ecosystems.

3.3 Species Richness Index

Following the comprehensive impact of seasonal variations and physicochemical properties on its planktonic community, we were interested to perform species richness index to further elucidate the ecological dynamics within the pond. The investigation of the Swetharanyeswarar temple pond unveiled a highly diverse planktonic community encompassing 18 identified taxa and a substantial number of individuals. The calculated dominance index (D) revealed a low prevalence of specific taxa, indicating a well-balanced distribution within the community and a healthy ecosystem where no single species dominates excessively. Similarly, a notable Simpson diversity index (1-D) underscored the richness and diversity within the pond's planktonic community. This observation aligns with the moderate level of species richness and evenness indicated by the Shannon-Wiener index (H). These findings collectively suggest that the Swetharanyeswarar temple pond hosts a varied and ecologically balanced planktonic community. The coexistence of multiple taxa and the equitable distribution of individuals contribute significantly to the resilience and stability of the ecosystem. These results offer valuable insights into the pond's health, emphasizing the significance of maintaining such diversity for the overall well-being of freshwater ecosystems.

3.4 Seasonal Variations in Zooplankton Population Density and their Correlation with the Physicochemical Parameters

The present study also investigates the intricate relationship between zooplankton population dynamics, encompassing Rotifera, Copepods, and Calanoids, and the physicochemical parameters characterizing the Swetharanyeswarar Temple Pond from January to June 2023. In addition, this study also reveals how these factors shape the broader planktonic community, which includes Rotifera, Copepods, and Calanoids. The recorded monthly variations in zooplankton population density, as depicted in Table 4, unveil a dynamic temporal dimension, with all species exhibiting distinct morphologies. Monthly diversity of zooplankton (Rotifera, Copepods and Calanoids) population density recorded in from January 2023 to June 2023 month was recorded 823 org/ 1.8 liter of water (6 month × 300 ml). Rotifers were identified higher in January month of 98 organisms / 300ml of water sample. Rotifer abundance peaks in January 2023 (98 organisms per 300 ml of water), gradually diminishing in subsequent months (39 organisms per 300 ml of water sample in June 2023), aligning with the ecological patterns influenced by temperature and other organic matter [29]. The surge in Rotifer population during summer, attributed to decomposing vegetation, underscores the complex ecosystem interactions.

Further, examining the water analysis results (Table 5) revealed a clear correlation between zooplankton dynamics and physicochemical parameters, represented as percentage in Fig.7. One key aspect is the turbidity of the water, which refers to the cloudiness or haziness caused by suspended particles. The consistent turbid and unclear appearance of the water is reflected in the fluctuations observed in zooplankton abundance, as illustrated in Table 5. Turbidity levels, though within an acceptable range, can impact the penetration of light into the water. Light availability is essential for photosynthetic processes in phytoplankton, the primary producers at the base of the aquatic food web. Any variations in turbidity can influence the growth and distribution of phytoplankton, subsequently affecting the abundance and composition of zooplankton [30]. Furthermore, the pH values, another critical physicochemical parameter, also exhibit some degree of fluctuation within the narrow range of 5.7 to 6.5. These fluctuations may have implications for the sensitivity of Rotifers, as highlighted by the observed population dynamics. Different species within the planktonic community may have varying tolerances to pH levels, and even slight deviations can influence their abundance and diversity [31].

Notably, the presence of an unpleasant odour, coupled with elevated biochemical oxygen demand (BOD) and chemical oxygen demand (COD) levels, serves as an indicator of potential organic pollution in the water. These factors may have implications for zooplankton health, as reflected in the observed fluctuations in Copepod (21 organisms per 300 ml in April and June) and Calanoid populations (44 organisms per 300 ml of in January, increasing from February to March and decreasing from April to June). High levels of BOD and COD can lead to oxygen depletion in the water, affecting the aerobic conditions required for the survival of various planktonic species.

Table 3. Diversity indices of Zooplankton (Calanoids) in Swetharanyeswarar pond from January 2023 to June 2023

S.No	Month	Number of species (S)	Total number of Zooplankton (N)	Total number of individual species (n)	Diversity Index = S-1/1n N
1	January 2023	2	167	44	0.00013
2	February 2023	2	174	52	0.00011
3	March 2023	2	166	76	0.00007
4	April2023	2	87	24	0.00047
5	May 2023	2	129	46	0.00016
6	June 2023	2	100	40	0.00025

Table 4. Monthly diversity of Zooplankton in Swetharanyeswarar temple from January 2023 to June 2023

Sample month and date	Class / Order	No. of Zooplankton 100 ml of sample			Total
		Sample 1	Sample 2	Sample 3	
January (02.01.2023)	Rotifers	30	25	43	98
	Calanoids	12	15	17	44
	Copepods	9	6	10	25
February (03.02.2023)	Rotifers	26	35	34	95
	Calanoids	17	20	15	52
	Copepods	6	12	9	27
March (04.03.2023)	Rotifers	20	18	17	55
	Calanoids	25	23	28	76
	Copepods	10	12	13	35
April (05.04.2023)	Rotifers	15	14	13	42
	Calanoids	10	6	8	24
	Copepods	6	5	10	21
May (04.05.2023)	Rotifers	18	20	16	54
	Calanoids	10	21	15	46
	Copepods	8	9	12	29
June (10.06.2023)	Rotifers	12	11	16	39
	Calanoids	12	13	15	40
	Copepods	5	7	9	21
Grand Total					**823**

Table 5. Physicochemical analysis of water from Swetharanyeswarar temple from January 2023 to June 2023

Sl.No	Physicochemical Analysis	Unit	Results					
			Jan 2023	**Feb 2023**	**Mar 2023**	**April 2023**	**May 2023**	**June 2023**
1	Appearance: When Analyzed After Filtration		Turbid Clear	Turbid Clear	Turbid Clear	Turbid Clear	Turbid Clear	Turbid Clear
2	pH value at 25℃		5.9	5.7	5.9	6.0	6.4	6.5
3	Color	Hazen Unit	20.0	20.0	20.0	20.0	20.0	19.0
4	Odour		Disagreeable	Disagreeable	Disagreeable	Disagreeable	Disagreeable	
5	Turbidity	NTU	5.5	5.4	4.5	5.0	5.5	5.2
7	Total Dissolved Solids	mg/l	295	292	296	294	291	295
8	Total Hardness as $CaCO_3$	mg/l	112	107	109	125	120	110
9	Calcium as Ca	mg/l	21	20	18	21	21	22
10	Magnesium as Mg	mg/l	14	15	13	15	12	15
11	Chlorides as Cl	mg/l	103	102	101	103	102	103
12	Sulfates as SO_4	mg/l	1.50	1.45	1.55	1.47	1.52	1.49
13	Sodium as Na	mg/l	30.0	28.0	29.0	31.0	30.0	31.0
14	Potassium as K	mg/l	4.0	4.1	4.3	4.2	3.9	4.0
15	Dissolved oxygen	mg/l	4.5	4.2	4.2	5.0	5.5	6.0
16	BOD	mg/l	1000	1100	1100	1050	1050	1200
17	COD	mg/l	4500	4400	4400	4700	3000	3700

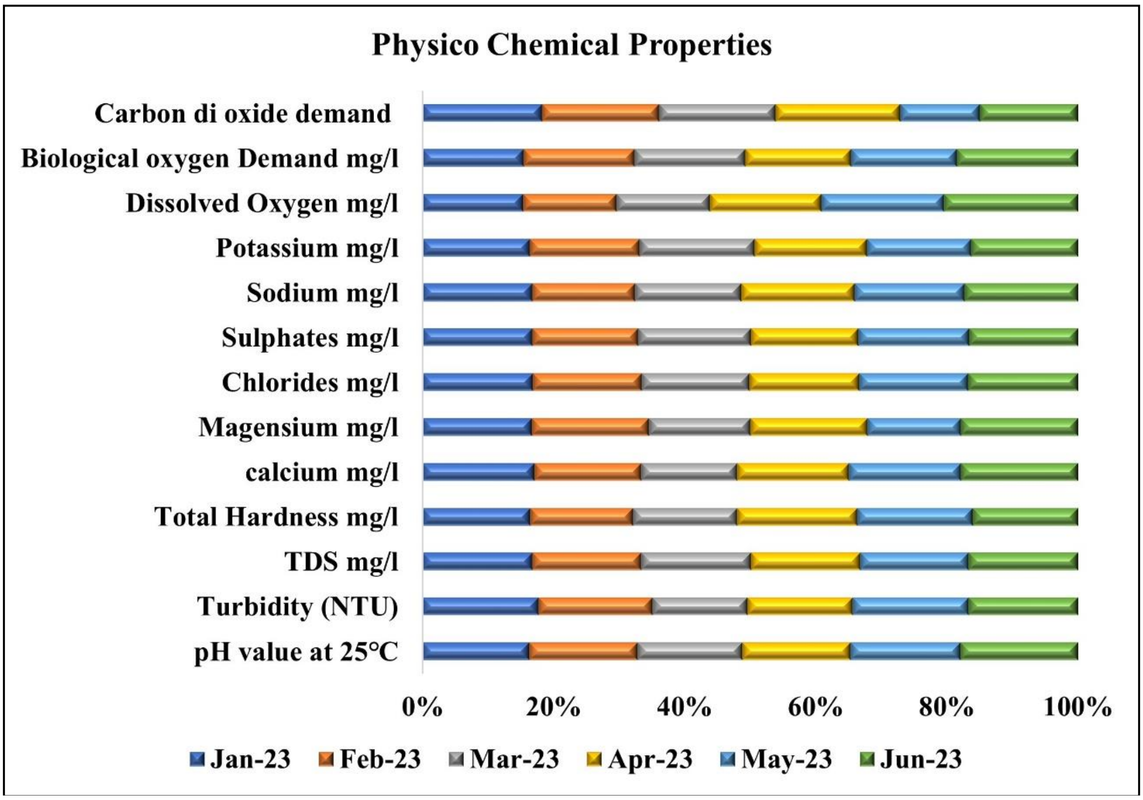


Fig. 7. Physico chemical parameters, represented as percentage of Swetharanyeswarar temple pond, Mayiladuthurai district, Tamil Nadu, India

Moreover, the levels of total dissolved solids (TDS) and major ions such as magnesium, calcium, sulfates, sodium, chlorides and potassium, remain relatively stable. The TDS values that have fallen within the permissible limits, indicates suitability of water for various uses. However, these stable parameters, along with dissolved oxygen levels, which are generally favorable but may show lower values during increased biological activity, contribute to the overall ecological conditions influencing the behavior and distribution of the zooplankton community.

Thus, the mixed composition of zooplankton species, ranging from mesotrophic to eutrophic, reflects the resilience of the ecosystem to varying physicochemical conditions. In corroboration with the earlier findings, various researchers have delved into the diversity of zooplankton, exploring the biodiversity of zooplankton [32], conducting investigations on the ecological variations of Rotifers [33], and scrutinizing the composition and population dynamics of phytoplankton, zooplankton, and productivity in association with seasonal changes in the physicochemical attributes of water [34]. The interplay between these parameters and the planktonic community dynamics underscores the complexity of the aquatic ecosystem. Hence, continued monitoring is very much crucial to decipher long-term trends and implement targeted strategies. Plans to address issues such as odours, reduce organic load, and enhance water treatment can contribute significantly to the maintaining the health and sustainability of the Swetharanyeswarar Temple Pond. In particular, this comprehensive understanding aligns with the guidelines set by the American Public Health Association (APHA) and emphasizes the importance of considering both biological and physicochemical aspects in aquatic ecosystem management [35].

4. CONCLUSION

In summary, the study of phytoplankton and zooplankton dynamics in the Swetharanyeswarar temple pond, Tamil Nadu, reveals a diverse ecosystem. Dominated by diatoms and cyanobacteria, the phytoplankton community, with the presence of *Microcystis sp*., plays a crucial role in nutrient cycling. The zooplankton community, including Rotifera, Copepods, and

Calanoids, exhibits distinct taxonomic members, with notable diversity observed in Rotifers in January and Copepods in April. Temporal fluctuations in Calanoids suggest potential ecological changes influenced by environmental factors. Correlations between zooplankton dynamics and physicochemical parameters highlight the intricate relationship between biological and environmental components, with monthly variations reflecting dynamic ecological patterns. The calculated species richness index indicates a well-balanced distribution within the planktonic community, signifying a healthy and resilient ecosystem in the Swetharanyeswarar temple pond. These insights contribute to our understanding of freshwater ecosystems, emphasizing the importance of continued monitoring and targeted strategies for maintaining water quality and ecosystem health. The study provides a comprehensive exploration of the relationships between phytoplankton, zooplankton, and their environment, offering valuable perspectives on aquatic ecosystem dynamics.

ACKNOWLEDGEMENTS

The authors would like to acknowledge Wasser Chemicals & Systems Pvt Ltd, Chennai, for their crucial role in conducting the physicochemical analysis of the water samples.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Trochine C, Risholt C, Schou MO, Lauridsen TL, Jacobsen L, Skov C, et al. Diet and food selection by fish larvae in turbid and clear water shallow temperate lakes. Sci Total Environ. 2022; 804:150050.
2. Naselli-Flores L, Padisák J. Ecosystem services provided by marine and freshwater phytoplankton. Hydrobiologia. 2023;850:2691–2706.
3. Fernández-Urruzola I, Bode A, Loick-Wilde N, Schneider W, Lindsay D, Escribano R. Trophic ecology of midwater zooplankton along a productivity gradient in the Southeast Pacific. Front Mar Sci. 2023;10
4. Liu H, Cheng W, Xiong P, Li H, Liu Z, Ai J, et al. Temporal variation of plankton and zoobenthos communities in a freshwater reservoir: Structure feature, construction mechanism, associated symbiosis and environmental response. Ecol Indic. 2023;154:110774.
5. M Mishra AP, Kumar S, Patra R, Kumar A, Sahu H, Chandra N, Pande CB, Alshehri F. Physicochemical Parameters of Water and Its Implications on Avifauna and Habitat Quality. Sustainability. 2023; 15(12):1-17.
6. Boscolo-Galazzo F, Crichton KA, Barker S, Pearson PN. Temperature dependency of metabolic rates in the upper ocean: A positive feedback to global climate change? Glob Planet Change. 2018; 170:201–12.
7. Nunes P, Roland F, Amado AM, Resende NS, Cardoso SJ. Responses of Phytoplanktonic Chlorophyll-a Composition to Inorganic Turbidity Caused by Mine Tailings. Front Environ Sci. 2022;9.
8. Espinosa-Díaz LF, Zapata-Rey YT, Ibarra-Gutierrez K, Bernal CA. Spatial and temporal changes of dissolved oxygen in waters of the Pajarales complex, Ciénaga Grande de Santa Marta: Two decades of monitoring. Sci Total Environ. 2021; 785:147203.
9. Barcelos e Ramos J, Schulz KG, Voss M, Narciso Á, Müller MN, Reis FV, et al. Nutrient-specific responses of a phytoplankton community: a case study of the North Atlantic Gyre, Azores. J Plankton Res. 2017;39(4):744–61.
10. Welch PS. Limnological methods. Philadelphia: Blakiston Co Philadelphia; 1948.
11. Todd CD, Laverack MS, Boxshall G. Coastal Marine Zooplankton: A Practical Manual for Students. Cambridge University Press.1996; 118.
12. Khondker M. Practical Limnology and Systematics of Freshwater Hydrophytes (A practical book written in Bangla for B. Sc. (Hons.) and M. S. classes); 1997.
13. Vincent F, Bowler C. Diatoms Are Selective Segregators in Global Ocean Planktonic Communities. mSystems. 2020; 5(1):e00444-19.
14. Lobus NV, Kulikovskiy MS. The Co-Evolution Aspects of the Biogeochemical Role of Phytoplankton in Aquatic Ecosystems: A Review. Biology. 2023; 12(1):92.
15. Chatterjee S, More M. Cyanobacterial Harmful Algal Bloom Toxin Microcystin and Increased Vibrio Occurrence as Climate-

Change-Induced Biological Co-Stressors: Exposure and Disease Outcomes via Their Interaction with Gut–Liver–Brain Axis. Toxins. 2023;15(4):289.
16. WoRMS - World Register of Marine Species - Brachionus Plicatilis Müller; 1786. Available:https://www.marinespecies.org/aphia.php?p=taxdetails&id=134982
17. Brachionus forficula Wierzejski; 1891. Available:https://www.gbif.org/species/4984093
18. Brachionus falcatus Zacharias; 1898. Available:https://www.gbif.org/species/4984079
19. Brachionus rubens Ehrenberg; 1838. Available:https://www.gbif.org/species/4984208
20. Australia A of L. Subspecies: Brachionus caudatus personatus. Available:https://bie.ala.org.au/species/https://biodiversity.org.au/afd/taxa/c201dd4f-3f12-4d7e-ba3b-a3363f967cc7
21. The World of Copepods – Heliodiaptomus cinctus Gurney; 1907. Available:https://www.marinespecies.org/copepoda/aphia.php?p=taxdetails&id=356668
22. The World of Copepods - Neodiaptomus strigilipes Gurney; 1907. Available:https://www.marinespecies.org/copepoda/aphia.php?p=taxdetails&id=353739
23. Heliodiaptomus viduus. Gurney; 1916. Available:https://www.gbif.org/species/4332331
24. Radhakrishna Y, Reddy YR. On the Validity of Zeylanodiaptomus Papillopedis Fernando & Hanek, 1976, and Heliodiaptomus Alikunhii Sehgal, 1960 (Copepoda). Crustaceana. 1977;32(1):87–8.
25. The World of Copepods - Rhinediaptomus indicus Kiefer, 1936. Available:https://www.marinespecies.org/copepoda/aphia.php?p=taxdetails&id=1419082
26. The World of Copepods - Heliodiaptomus pulcher orissaensis Sehgal; 1967. Available:https://www.marinespecies.org/copepoda/aphia.php?p=taxdetails&id=363376
27. Macrocyclops albidus; 2016
28. The World of Copepods - Macrocyclops fuscus Jurine; 1820. Available:https://www.marinespecies.org/copepoda/aphia.php?p=taxdetails&id=356814
29. Ji G, Wang X, Wang L. Planktonic Rotifers in a Subtropical Shallow Lake: Succession, Relationship to Environmental Factors, and Use as Bioindicators. The Scientific World Journal. 2013;2013:702942
30. Hintz NH, Schulze B, Wacker A, Striebel M. Ecological impacts of photosynthetic light harvesting in changing aquatic environments: A systematic literature map. Ecol Evol. 2022 Mar 22;12(3):e8753.
31. Paradox of the Plankton - an overview. Available:https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/paradox-of-the-plankton
32. Karmakar SR, Hossain MB, Sarker MM, Nur AAU, Habib A, Paray BA, et al. Diversity and Community Structure of Zooplankton in Homestead Ponds of a Tropical Coastal Area. Diversity. 2022;14(9):755.
33. González-Gutiérrez S, Sarma SSS, Nandini S. Seasonal Diversity and Morphometric Variations of Rotifers in Relation to Selected Environmental Variables from a Tropical High-Altitude Lake in Mexico. Diversity. 2023;15(8):942.
34. Sultana S, Khan S, Hena SM, et al. Seasonal dynamics of zooplankton in a eutrophic fish pond of Bangladesh in relation to environmental factors. J Aquac Mar Biol. 2023;12(2):129–136.
35. APHA (American Public Health Association) Standard methods for the examination of water and waste water. 18th Ed. APHA; Washington DC, USA; 1995.

Peer-review history:
The peer review history for this paper can be accessed here:
https://prh.mbimph.com/review-history/3177