

# Seasonal Dynamics and Diversity Analysis of Phytoplankton in Lakshmipuram Lake, Anakapalli Dist., Andhra Pradesh, India.

## Abstract

Phytoplankton play a vital role in aquatic ecosystems as primary producers, and their diversity serves as a key indicator of water quality and ecological health. The present study investigates the phytoplankton diversity of Lakshmipuram Lake, located in Anakapalli district of Andhra Pradesh, over a one-year period from January 2024 to December 2024. Phytoplankton samples were collected from three different sites across three seasons—pre-monsoon (March–May), monsoon (June–September), and post-monsoon (October–December)—using standard methods outlined in Standard Methods for the Examination of Water and Wastewater. Collections were conducted in the morning between 7:00 am and 9:00 am using a 5  $\mu\text{m}$  mesh phytoplankton net and preserved in 3% formaldehyde solution. The samples were examined under an optical microscope, and species identification was carried out using standard identification keys and reference guides.

A total of 29 genera belonging to three major classes—Chlorophyceae (15 genera), Cyanophyceae (8 genera), and Bacillariophyceae (6 genera)—were identified. Among these, Chlorophyceae was the dominant class, contributing 51.7% of the total genera; Cyanophyceae (27.6%) and Bacillariophyceae (20.7%). Seasonal variations revealed that phytoplankton abundance was highest during the pre-monsoon and lowest during the monsoon season. Diversity indices indicated moderate diversity and evenness across the lake. The Shannon-Wiener diversity index ranged from 1.0363 to 1.0483 with an average of 1.043, while the Evenness index (Pielou's  $J'$ ) ranged from 0.3077 to

0.3113 with an average of 0.310, showing a moderately stable and evenly distributed phytoplankton community.

The study concludes that Lakshmipuram Lake supports a diverse and moderately productive phytoplankton community, which varies significantly with seasonal changes. The findings provide valuable baseline data for future ecological assessments and contribute to the effective conservation and management of this freshwater ecosystem.

## Keywords

Phytoplankton Diversity; Abundance; Seasonal variation; Lakshmipuram Lake.

## 1. Introduction

Lakes are essential freshwater ecosystems that support diverse aquatic life. It provides significant water resources for household, commercial, and agricultural uses. Phytoplankton are microscopic autotrophic organisms that form the base of aquatic food webs and play a crucial role in biogeochemical cycles. They are particularly noteworthy due to their ability to serve as bioindicators that quickly respond to changes in environmental conditions (Mani & Sebastian, 2023). The Phytoplankton community on which the whole floodplain population depends is largely influenced by a number of physicochemical factors (Acharjee et al., 2021). Evaluating physico chemical parameters are generally used in assessing the quality of water bodies and pollution (Pratap et al., 2025). Regular assessment of phytoplankton's species is essential for pure water bodies and for such a balanced ecosystem (Verma et al., 2025). It is an efficient bio-indicator for water quality assessment and maximum production of phytoplanktons are obtained when Physio-chemical factors are at optimum level. Monitoring the plankton is important because some of the plankton can be an indicator for the healthy environment of the water body. pyhsico-chemical relationship with productivity in ecology (Effendi et al., 2016).

Lakshmipuram Lake is a vital water body used for domestic purposes and irrigation. This study was conducted to assess the phytoplankton diversity of Lakshmipuram Lake, Anakapalli Dist., Andhra Pradesh, India by analysing its species composition, abundance. Understanding the phytoplankton community structure will help in formulating appropriate conservation and management strategies.

## 2. Material and Methods

### 2.1 Study area

Lakshmipuram Lake is situated in the village of Lakshmipuram in the Anakapalli district, Andhra Pradesh, India. Its 650 acres with a capacity of 195 million cubic meters are

highly helpful to all the farmers in the nearby areas. Every year, about 1500 acres are successfully farmed beneath this lake. It is close to national highway 16 and has a road transit facility. Its average elevation is 30 meters above sea level, and its coordinates are 22.090N, 82.150E. The region has a tropical climate, with reported average temperature and humidity ranging from 24.2°C to 30°C and 61% respectively. The ichthyofaunal diversity of Lakshmipuram Lake found good potential with a variety of freshwater fish fauna (Pratap et al., 2025).

## 2.2 Sampling

The collection of plankton was done using standard methods outlined in Standard Methods for the Examination of Water and Wastewater. Water samples were collected from three different seasons, viz., pre-monsoon (March-May), monsoon (June-September), post-monsoon (October-December) at three different sites from the lake in a regular interval of one year from January 2024 to December 2024. Samples were collected in the morning between 7 am to 9 am using phytoplankton net of 5 micron mesh size and preserved in 3% formaldehyde solution.



**Image 1: A map of Lakshmipuram Lake, Lakshmipuram village, Anakapalli district, Andhra Pradesh, India. Image credits to Google Maps and BurningCompass.Com website.**

## 2.3 Data analysis

The sample was examined thoroughly under an optical microscope for taxonomic analysis. The systematic identification of phytoplankton up to the species level was carried out using standard keys, standard textbooks, guides such as Edmondson (1959), Schumacher and Raleigh (1973), Palmer (1980) and Prescott (2008). Three diversity indices were used to obtain estimation of species diversity, species richness and species evenness.

### A) Species Richness (S)

It gives the total number of species present in a sample.

### B) Shannon-Wiener Diversity Index (H')

$$H' = -\sum_{i=1}^s p_i \ln p_i$$

where:

$p_i$ :  $n_i/N$

$n_i$ : Number of individuals of species  $i$

$N$ : Total number of individuals of all species

This index accounts for both abundance and evenness.

### C) Pielou's Evenness Index (J')

$$J' = H' / \ln S$$

It measures how evenly individuals are distributed among species.



**Image 2: Sampling sites of Lakshmiapuram Lake, Anakapalli district, Andhra Pradesh, India.**

### 3. Results and Discussion

The present study analysed the phytoplankton diversity in Lakshmiapuram lake between January 2024 to December 2024. Microscopic examination of phytoplankton revealed that there were there classes consisting of 29 genera of phytoplankton belongs to Bacillariophyceae (6 genera), Chlorophyceae (15 genera) and Cyanophyceae (8 genera). List of species observed in the lake were given in Table 1.

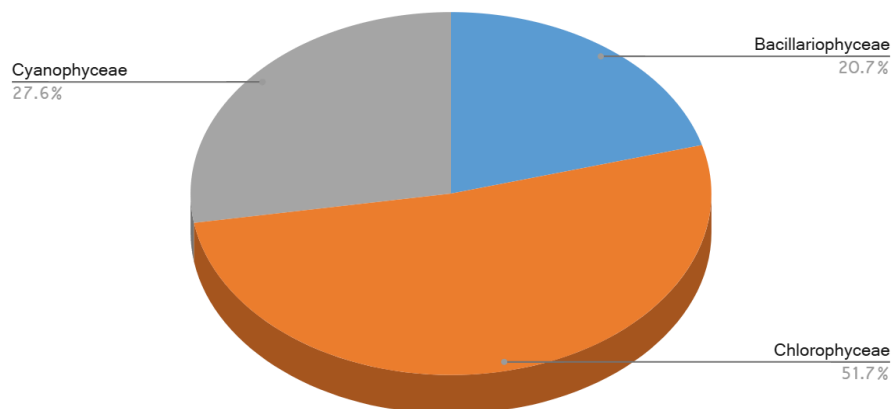
The species observed were: *Navicula sp.*, *Pinnularia sp.*, *Synendra sp.*, *Diatoma sp.*, *Cymbella sp.* and *Fragilaria sp.*, (Bacillariophyceae); *Volvox sp.*, *Eudorina sp.*, *Pandorina sp.*, *Chlamydomonas sp.*, *Cosmarium sp.*, *Spirogyra sp.*, *Closterium sp.*, *Spirogonium sp.*, *Scendesmus sp.*, *Ankistrodesmus sp.*, *Pediastrum sp.*, *Oocystis colonie sp.*, *Oedogonium sp.*, *Mougeotia sp.*, *Rhizoclonium sp.*, (Chlorophyceae); *Microcystis sp.*, *Chroococcus sp.*, *Oscillatoria sp.*, *Spirulina sp.*, *Nostoc sp.*, *Anabaena sp.*, *Rivularia sp.*, *Gloeotrichia sp.*, (Cyanophyceae).

**Table 1: Species Composition of Phytoplankton in Lakshmipuram Lake**

S. NO	Class	Order	Genera	
1	Bacillariophyceae	Diatoms	<i>Navicula sp.</i>	
2			<i>Pinnularia sp.</i>	
3			<i>Synendra sp.</i>	
4			<i>Diatoma sp.</i>	
5			<i>Cymbella sp.</i>	
6			<i>Fragilaria sp.</i>	
7	Chlorophyceae	Volvocales	<i>Volvox sp.</i>	
8			<i>Eudorina sp.</i>	
9			<i>Pandorina sp.</i>	
10			<i>Chlamydomonas sp.</i>	
11		Congugales	<i>Cosmariam sp.</i>	
12			<i>Spirogyra sp.</i>	
13			<i>Closterium sp.</i>	
14			<i>Spirogonium sp.</i>	
15		Chlorococcales	<i>Scendesmus sp.</i>	
16			<i>Ankistrodesmus sp.</i>	
17			<i>Pediastrum sp.</i>	
18			<i>Oocystis colonie sp.</i>	
19		Oedogoniales	<i>Oedogonium sp.</i>	
20			<i>Mougeotia sp.</i>	
21			<i>Rhizoclonium sp.</i>	
22		Cyanophyceae	Chroococcales	<i>Microcystis sp.</i>
23				<i>Chroococcus sp.</i>

24		Hormogoniales	<i>Oscillatoria sp.</i>
25			<i>Spirulina sp.</i>
26		Nostocales	<i>Nostoc sp.</i>
27			<i>Anabaena sp.</i>
28			<i>Rivularia sp.</i>
29			<i>Gloeotrichia sp.</i>

A number of previous year studies focused on phytoplankton diversity reported that there were 48 taxa phytoplankton belonging to Bacillariophyceae, Dinophyceae, Chlorophyceae and Cyanophyceae identified in Mahakam Delta, East Kalimantan (Effendi et al., 2016); a total of 42 genera of phytoplankton were observed and identified belongs to Chlorophyceae, Bacillariophyceae, and Myxophyceae in Kondakarla Lake, Andhra Pradesh (Vinay Sagar & Kameswara Rao, 2019); 36 taxa were identified in which 19 belonged to Chlorophyceae, 10 to Cyanophyceae, 6 to Bacillariophyceae and 1 to Euglenophyceae in Chatla Floodplain Lake, Assam (Acharjee et al., 2021); a total of 54 phytoplankton species include 38 diatoms, 9 dinoflagellates, 3 green algae, and 4 blue-green algae in Swarnamukhi River Estuary, Nellore, India (Ratnam et al., 2022); 58 species of microalgae belonging to 4 classes such as Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae in Kasipatnam Temple Stream, Kasipatnam, Anathagiri Mandal, Visakhapatnam (Dist), Andhra Pradesh, India (Padmaja Rani Ponnaganti, P. Rathna Kumar, & Mohan, 2023); a total of 39 species belonging to 5 taxonomic groups were identified: Chlorophyceae, Bacillariophyceae, Cyanophyceae, Euglenophyceae, and Xanthophyceae in Downstream Region of Meenachil River, Kerala (Mani and Sebastian 2023); a total of 39 species belonging to 5 taxonomic groups were identified: Chlorophyceae, Bacillariophyceae, Cyanophyceae, Euglenophyceae, and Xanthophyceae in Midstream Region of Meenachil River, Kerala (Mani and Sebastian 2023); a total of 50 genera of planktons were found belongs to Chlorophyta, Cyanophyta, and Bacillariophyta in Bornadi River Basin, Assam (Pathak et al., 2025); a total of 3 groups of phytoplankton were found such as Chlorophyceae, Cyanophyceae, and Bacillariophyceae in Devarjan Reservoir, Udgir (Nagpurne Vinay S. and Allapure R. B. 2025); a total of 3 groups of phytoplankton were found such as Cyanophyceae, Chlorophyceae, and Bacillariophyceae in Ranchi Lake (Verma and Nag 2025).



**Image 3: The genera percentage composition of phytoplankton diversity in Lakshmipuram Lake.**

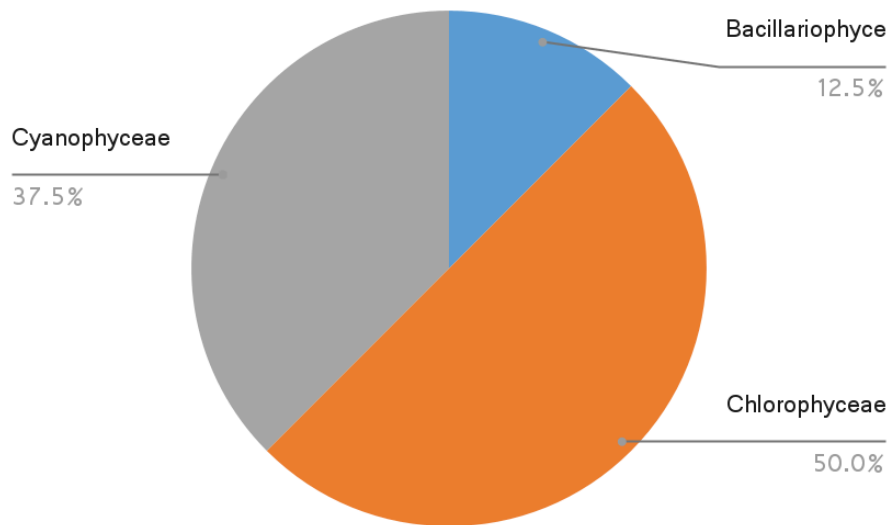
In this present study, the number and percentage composition of order and genera under different classes is shown in Table 2 and Images 3 & 4. Among three classes, the class Chlorophyceae has dominated with 4 orders and 15 genera contributing to 50% and 51.7% respectively followed by Cyanophyceae with 3 order and 8 genera contributing to 37.5% and 27.6% respectively and Bacillariophyceae with 1 order and 6 genera contributing to 12.5% and 20.7% respectively.

**Table 2: The number and percentage composition of order and genera under different classes.**

Sl. No	Class	Order	Genera	Order %	Family %
1	Bacillariophyceae	1	6	12.5	20.7
2	Chlorophyceae	4	15	50	51.7
3	Cyanophyceae	3	8	37.5	27.6

In this present investigation, the phytoplankton fluctuates seasonally and its productivity was high during pre-monsoon and low in monsoon (Table 3 and Image 5). Chlorophyceae is dominated in pre-monsoon (854) and least in monsoon (344) with a total of 1798 including post-monsoon contributing 43.17% of total phytoplanktons. Next followed by Cyanophyceae: pre-monsoon (729), monsoon (344) and post-monsoon (600) with a total of 1586 contributing 38.00%; Bacillariophyceae: pre-monsoon (382),

monsoon (154) and post-monsoon (247) with a total of 783 contributes to 18.80% of total phytoplanktons during the study period.

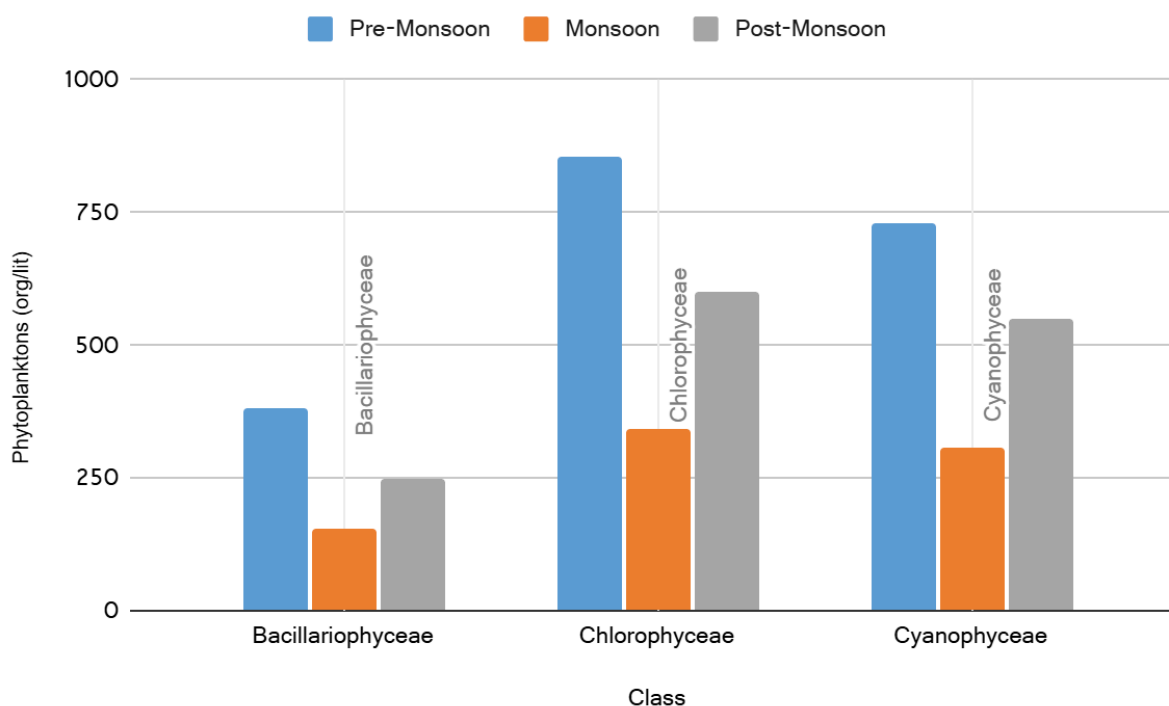


**Image 4: The order percentage composition of phytoplankton diversity in Lakshmipuram Lake.**

Similar observations are recorded in Riwada Reservoir, Visakhapatnam with a dominated phytoplankton high during pre-monsoon and low in monsoon (Kaprapu J. and Rao M. N. G. 2013); a study revealed that the pre-monsoon season had a higher abundance of phytoplankton with 39 species, while the monsoon season had only 27 species in Midstream Region of Meenachil River, Kerala (Mani and Sebastian 2023); Maximum growth of phytoplankton population was recorded in post-monsoon and minimum during monsoon period at freshwater wetlands of Birbhum district, West Bengal (Garai et al., 2022).

**Table 3: Total seasonal variations of phytoplanktons (orgs/liter) at Lakshmipuram Lake during Jan 2024 to Dec 2024.**

S. No	Class	Pre-Monsoon	Monsoon	Post-Monsoon	Total	Percentage %
1	Bacillariophyceae	382	154	247	783	18.80%
2	Chlorophyceae	854	344	600	1798	43.17%
3	Cyanophyceae	729	307	550	1586	38.00%



**Image 5: Graphical representation of seasonal variations of phytoplanktons (org/liter) at Lakshmipuram Lake during Jan 2024 to Dec 2024.**

Diversity indices results indicate that, among the three seasons pre-monsoon has highest diversity index ( $H' = 1.0483$ ) and highest evenness index ( $J' = 0.31131$ ); post-monsoon has highest species richness ( $S = 25$ ), lowest diversity ( $H' = 1.0363$ ) and lowest evenness ( $J' = 0.3077$ ); Monsoon has lowest species richness ( $S = 20$ ), ( $H' = 1.0473$ ), ( $J' = 0.3110$ ). The average ( $H' = 1.043$ ) shows that phytoplanktons exhibiting moderate diversity and ( $J' = 0.310$ ) shows moderate evenness in Lakshmipuram Lake.

**Table 4: Seasonal variations of phytoplanktons, biodiversity indices at Lakshmipuram Lake during Jan 2024 to Dec 2024.**

S. No	Diversity Index	Pre-Monsoon	Monsoon	Post-Monsoon	Average
1	Species Richness (S)	22	20	25	22.33
2	Shannon-Wiener diversity index ( $H'$ )	1.0483	1.0473	1.0363	1.043
3	Pielou's Evenness Index ( $J'$ )	0.31131	0.31102	0.30775	0.310

#### 4. Conclusion

The present study offers a comprehensive assessment of phytoplankton diversity and seasonal variations in Lakshmipuram Lake over the period of one year (January to December 2024). A total of 29 genera belonging to three major classes Chlorophyceae, Cyanophyceae, and Bacillariophyceae were recorded, with Chlorophyceae emerging as the dominant group both in terms of diversity and abundance. Seasonal analysis revealed that phytoplankton productivity peaked during the pre-monsoon, likely due to favorable physicochemical conditions, and declined during the monsoon season.

The study also demonstrates notable seasonal fluctuations in diversity indices, where pre-monsoon recorded the highest Shannon-Wiener diversity ( $H'=1.0483$ ) and evenness ( $J'=0.3113$ ), suggesting a more stable and balanced phytoplankton community during this period. Although post-monsoon had the highest species richness ( $S=25$ ), it showed lower diversity and evenness, indicating a less uniform distribution of taxa. On the whole, the average diversity ( $H'=1.043$ ) and evenness ( $J'=0.310$ ) reflect a moderate level of phytoplankton diversity and distribution uniformity in the lake ecosystem.

These findings highlight the ecological significance of Lakshmipuram Lake as a moderately productive freshwater body that supports diverse phytoplankton communities, which are vital for the lake's trophic structure and overall ecological functioning. The seasonal variations observed emphasize the need for continuous monitoring, especially in the context of climatic and anthropogenic pressures, to safeguard the lake's ecological balance and productivity.

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