Exploring Phytoplankton Diversity and Morphology in Shakkar Lake: A Case Study at Narnala Fort

Bharat R. Nagare

Assistant Professor
Department of Botany
Shri Shivaji Arts, Commerce and Science College
Akot Dist. Akola, Maharashtra.

Abstract- **Phytoplankton, as primary producers, is integral to the functioning of freshwater ecosystems, profoundly impacting aquatic food webs and water quality. This research investigates the phytoplankton diversity, morphology, and species composition in Shakkar Lake at Narnala Fort, shedding light on its ecosystem dynamics. Plankton samples were collected weekly from four designated sampling sites over a month-long period and preserved in a 5% formalin solution for microscopic analysis. The study identified phytoplankton belonging to the Cyanophyceae, Chlorophyceae, and Bacillariophyceae classes in Shakkar Lake. Within Cyanophyceae, four genera were observed: Anabaena, Nostoc, Microcystis, and Spirulina. Chlorophyceae exhibited three genera: Spirogyra, Cosmarium, and Zygnema, while Bacillariophyceae revealed three genera: Pinnularia, Cymbella, and Ulnaria. These findings provide valuable insights into the phytoplankton community structure of Shakkar Lake, enhancing our understanding of its ecological dynamics and contributing to broader research on freshwater ecosystems.**

Keywords: **Phytoplankton, Freshwater Ecosystems, Shakkar Lake, Narnala Fort, Diversity, Morphology, Species Composition, Cyanophyceae, Chlorophyceae, Bacillariophyceae.**

Introduction

The objective of the current research is to identify the various types of phytoplankton inhabiting Shakkar Lake and to investigate their morphology and diversity. Situated within the Narnala Fort, Shakkar Lake is positioned at coordinates 210 15′ N and 770 4′ E, near Akot, Akola District, Maharashtra, and is currently located within the Melghat Tiger Reserve. This lake serves as a crucial water source for the Maharashtra Jeevan Pradhikaran water supply office. Phytoplankton, being ubiquitous, unicellular, and microscopic, serves as the primary life forms in aquatic environments. They play a pivotal role as the primary producers in the aquatic food chain, thereby significantly contributing to the global fishery resource (Reynolds, 1987; Vajravelu et al., 2018; Boruah and Das, 2001). [1][2][3] Additionally, phytoplankton is fundamental in maintaining the equilibrium between living organisms and abiotic factors within aquatic ecosystems. The distribution of phytoplankton and their variations in different zones of a water body are influenced by various physico-chemical parameters of water. Research indicates that summer is the most conducive season for phytoplankton growth in freshwater lakes due to factors such as extended duration of light exposure, increased salinity, and pH levels (Chaturvedi et al., 1999).[4] Conversely, late summer and monsoon seasons witness a decrease in phytoplankton production due to factors like heavy rainfall, heightened turbidity, reduced salinity, temperature, and pH levels (Saravanakumar et al., 2008).[5] The study of plankton is an invaluable tool for assessing water quality in any water body, contributing significantly to the understanding of the lake's primary nature and overall economy (Pawar et al., 2006).[6]

Material and Method

Study area:

Location: Shakkar Lake is situated within the Narnala Fort, which is positioned in the Akot, Akola District, and Maharashtra, India.
Coordinates: Latitude 21° 15' N, Longitude 77° 4' E.
Closest City: Akot, which is approximately 18 km away from the lake.
Current Status: The area is now part of the Melghat Tiger Reserve.

Sampling:

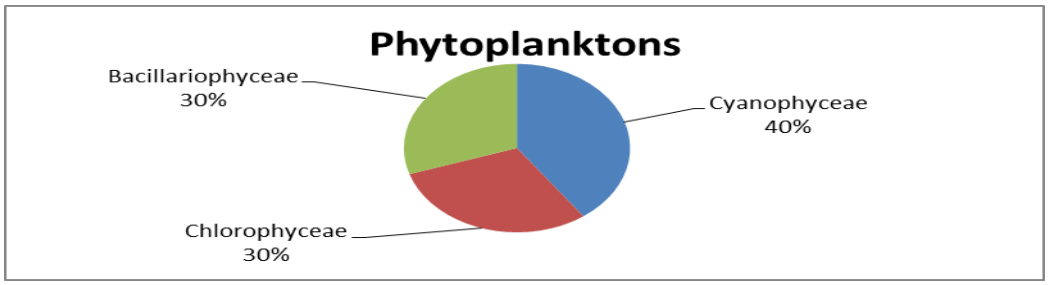
Sampling Period: Plankton samples were collected weekly for the duration of a month in March 2023.
Sampling Sites: Four sampling sites within the lake were selected for plankton sampling.

Sample Collection: Surface water samples, containing phytoplankton, were directly collected from each selected site of the lake.
Handling: Samples were carefully transferred to bottles without disturbance to preserve their integrity.
Transport: Collected samples were brought to the laboratory for further analysis.
Timing: Sampling was conducted during morning hours.

Shakkar Lake

Preservation and Identification of Phytoplankton Samples:
Preservation: Samples were preserved in a 5% formalin solution to maintain their structure for microscopic identification.
Microscopic Identification: Plankton slides were prepared from the preserved samples. Identification was performed using a Magnus digital binocular microscope equipped with a 5-megapixel camera.
Identification Resources: Various resources were utilized for identification, including:
Reference books specifically focused on plankton identification.
Journals and research papers relevant to plankton taxonomy and ecology.
Online resources such as Google Lens, likely used for image-based identification assistance.

Observation and Result



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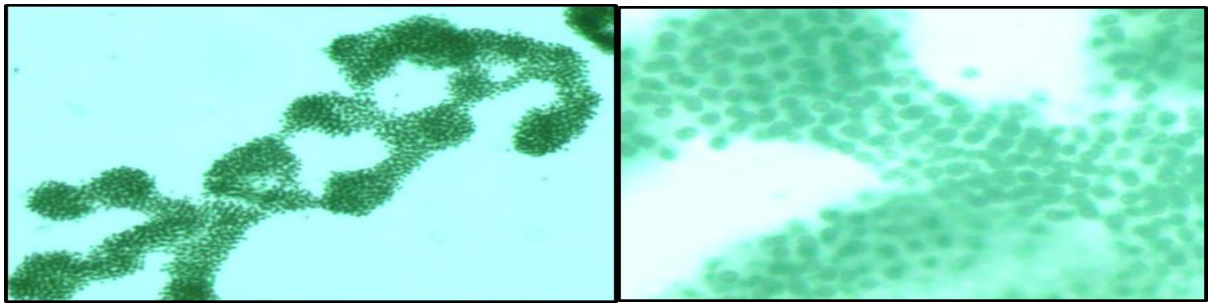
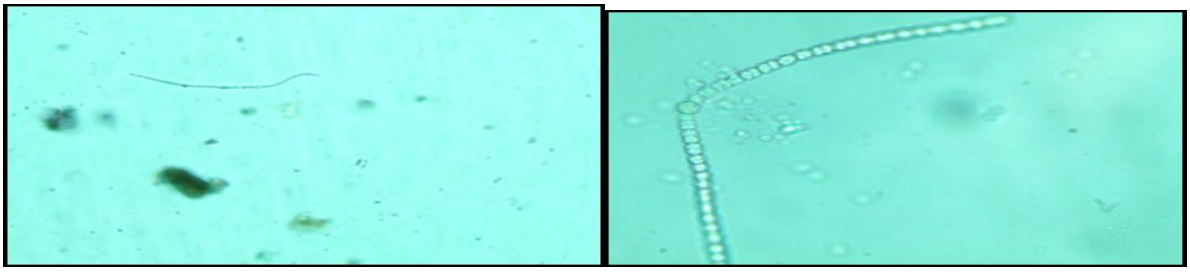


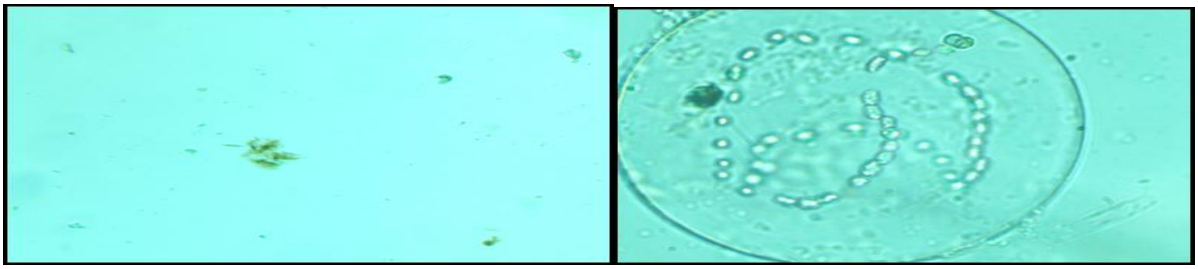
Microcystis

Spirulina

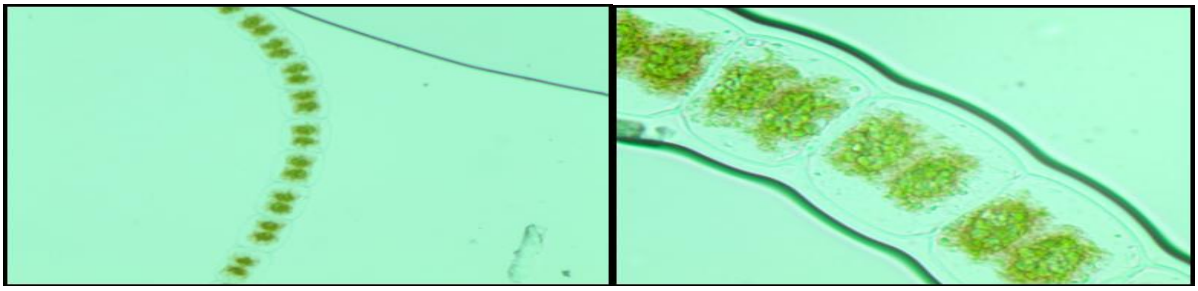
Spirogyra



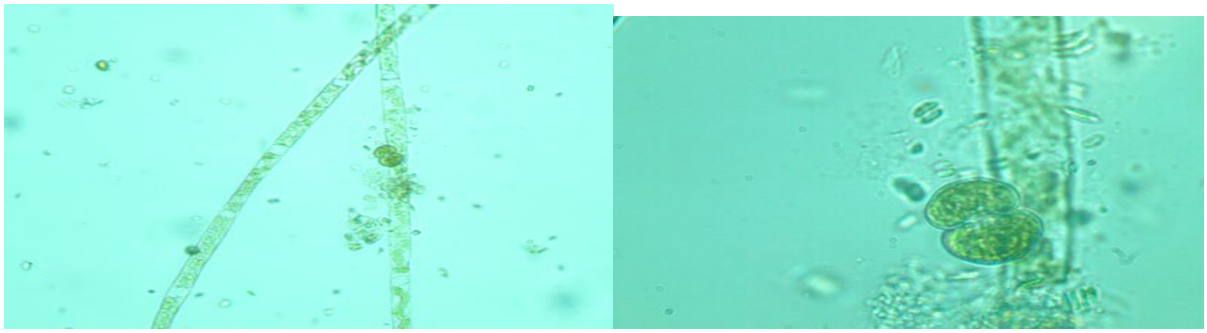
Anabaena



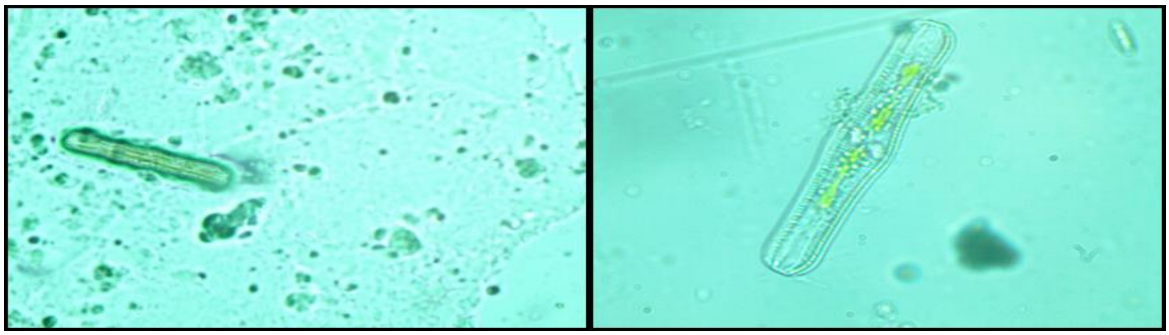
Nostoc



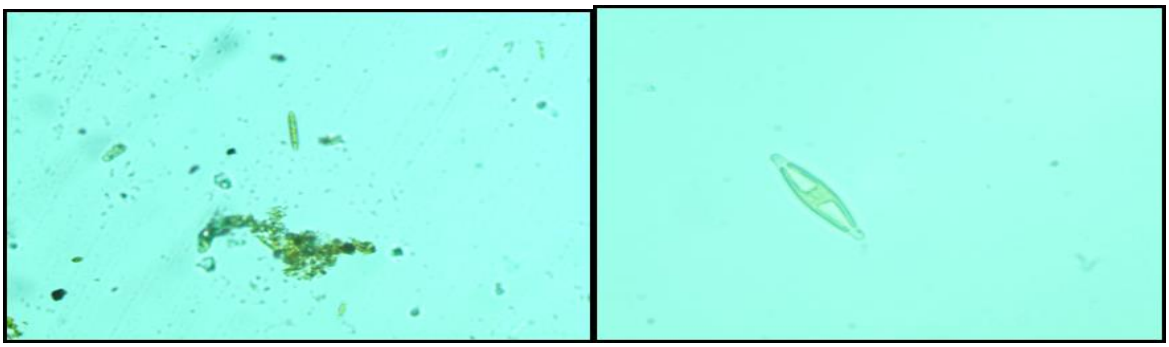
Zygnema



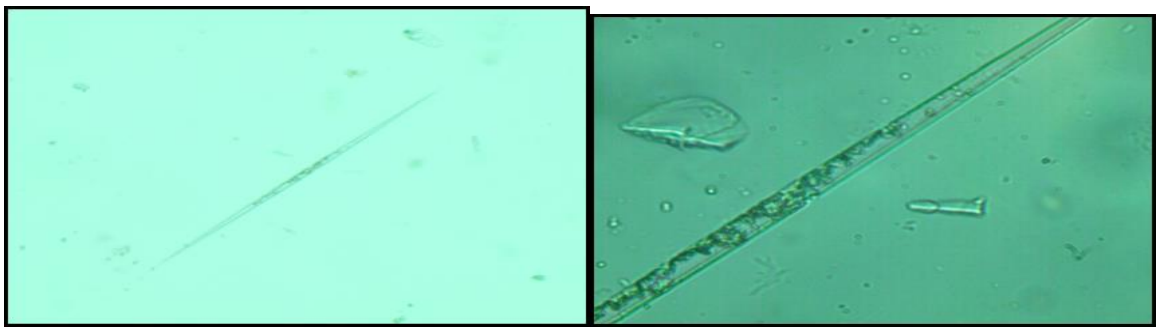
Cosmarium



Pinnularia



Cymbella



Ulnaria

Cyanophyceae Members

Microcystis

Microcystis is known for its small cells that contain gas-filled vesicles. Typically, these cells form colonies, which are visible to the naked eye and initially appear spherical. However, over time, these colonies lose their coherence and develop perforations or irregular shapes. The colonies are held together by a dense mucilage, which consists of various complex polysaccharide compounds such as xylose, mannose, glucose, fucose, galactose, rhamnose, and others (Rohrlack, Henning, & Kohl, 1999).

Spirulina

Spirulina is a multicellular and filamentous blue-green microalgae that forms symbiotic relationships with bacteria capable of nitrogen fixation from the air. It can exhibit rod or fragment shapes, with trichomes forming a regularly spirally curled cylinder. The individual cells within these trichomes can be delicate and challenging to distinguish, with sizes ranging from 1 to 8 µm in the periphery depending on the species. Spirulina is commonly found in both freshwater and brackish environments. Reproduction in Spirulina occurs exclusively through asexual means, primarily by double fission, as it does not engage in sexual reproduction..

Anabaena

Anabaena is a genus of nitrogen-fixing blue-green algae characterized by beadlike or barrel-like cells and interspersed enlarged spores known as heterocysts. These algae are commonly found as plankton in shallow water and on moist soil. There exist both solitary and colonial forms of Anabaena, with the colonial forms resembling those of a closely related genus, Nostoc. In temperate latitudes, particularly during the summer months, Anabaena may undergo prolific growth, leading to the formation of water blooms (Britannica, Editors of Encyclopaedia, 2016).

Nostoc

Nostoc is the most prevalent genus of cyanobacteria, widely distributed across various aquatic and terrestrial environments. These organisms have the ability to form colonies consisting of filaments made up of moniliform cells enveloped in a gelatinous sheath composed of polysaccharides. Additionally, Nostoc has the capability to establish symbiotic relationships within plant tissues, facilitating nitrogen fixation through specialized cells called heterocysts. The genus Nostoc encompasses numerous species exhibiting diverse morphologies, habitat distributions, and ecological functions (Fidor et al., 2019; Sand-Jensen, 2014).

Chlorophyceae Members

Spirogyra

Spirogyra is a genus of filamentous charophyte green algae belonging to the order Zygnematales. It derives its name from the helical or spiral arrangement of chloroplasts, which is a distinguishing feature of the genus. With over 400 species, Spirogyra is commonly found in freshwater habitats. Typically, Spirogyra measures between 10 to 100 µm in width and can grow to several centimeters in length. It is often observed as green slimy patches on the ground near ponds and other stagnant water bodies (Parmentier, 10).

Cosmarium

Cosmarium is a genus of freshwater organisms that belong to the Charophyta division, which is a group of green algae considered to be the ancestors of land plants (Embryophyta). Within this extensive genus, the cells display considerable variability. They are all constricted in the middle, giving them a characteristic bi-lobed appearance, with each half referred to as a semicell. The cells come in various shapes, and their cell walls may exhibit different textures, including smooth surfaces or ornamentation with spines, granules, scrobiculations (pits), or pores. Generally, Cosmarium cells are flattened in structure (Hall & McCourt, 2014).

Zygnema

Zygnema is a genus of freshwater filamentous thalloid algae, encompassing approximately 100 species. Among them is a terrestrial species known as Z. terrestre, which is identified in India. Zygnema typically grows as a free-floating mass of filaments, although young plants may attach to streambeds using a holdfast structure. These filaments form a tangled mat, ranging in color from yellow-green to bright green. Each filament consists of elongated barrel-shaped cells, with two star-shaped (stellate) chloroplasts arranged along the cell's axis (Guiry & Guiry, 2008).

Diatoms

Diatoms are single-celled organisms that exist either individually or in colonies, adopting various shapes such as ribbons,
fans, zigzags, or stars. These organisms exhibit a wide range of cell sizes, spanning from 2 to 200 micrometers in diameter (Hasle et al., 1996).

Pinnularia

Pinnularia are elongated elliptical unicellular organisms characterized by their unique cell structure. Their cell walls primarily consist of pectic substances supported by a rigid silica framework. Each cell is divided into two halves known as thecae, which overlap akin to a Petri dish and its cover. The larger outer valve is termed the Epitheca, while the smaller inner valve is referred to as the Hypotheca. A connecting band called a cingulum covers the margins of the two thecae, collectively forming a structure known as a frustule. Additionally, the entire cell is enveloped by a mucilaginous layer (Vashishta, Sinha, & Singh, 1960).

Cymbella

The cells of this organism exhibit a dorsiventral curvature, resembling the shape of an orange slice, ranging from slight to pronounced. They can exist either as colonial entities, forming branched mucilage stalks, or as individual cells. Within each cell, a single plastid contains two H-shaped plates that connect toward the dorsal side of the girdle, creating an enlarged bridge structure (Round et al., 1990).

Ulnaria

This organism is a pennate diatom, characterized by its elongated to needle-like shape when viewed from the valve, and appearing narrow and rectangular when viewed from the girdle. The valves are identical and lack a raphe, placing the genus within the category of araphid diatoms. Striae, or fine lines, are arranged in parallel rows, separated along the central axis of the cell by a thickened sternum. The central area of the valve lacks striae or may have very faint ones. While similar to Fragilaria, this organism does not form ribbons of cells joined side to side. Cells of this species are frequently attached to surfaces by one end. Furthermore, its chloroplasts are golden brown in color.

Result

The investigatory study conducted in Shakkar Lake has unveiled the presence of a diverse array of phytoplankton genera spanning different classes. The identified phytoplankton species in Shakkar Lake include *Anabaena, Nostoc, Microcystis, Spirulina, Spirogyra, Cosmarium, Zygnema, Pinnularia, Cymbella, and Ulnaria.* These findings highlight the rich biodiversity of phytoplankton in Shakkar Lake, underscoring the significance of further research to elucidate their ecological roles and dynamics within the lake ecosystem.

Conclusion

In conclusion, the phytoplankton community in Shakkar Lake at Narnala Fort comprises species belonging to the classes Cyanophyceae, Chlorophyceae, and Bacillariophyceae. Within Cyanophyceae, four genera were identified: *Anabaena, Nostoc, Microcystis, and Spirulina*. Chlorophyceae exhibited three genera: *Spirogyra, Cosmarium, and Zygnema*, while Bacillariophyceae revealed three genera: *Pinnularia, Cymbella, and Ulnaria*. These findings underscore the rich diversity of phytoplankton in Shakkar Lake and contribute to our understanding of its ecological dynamics. Further research is warranted to elucidate the interactions among these phytoplankton taxa and their impact on the lake's ecosystem health and functioning.

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