Seasonal Variation study of Algae in trambakeshwar Maharashtra

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***Abstract*—The presence and abundance of specific algal species are used to assess the water quality.The dominance of certain Cyanophyceae species like *Oscillatoria*, *Anabaena*, and *Nostoc* can be an indicator of nutrient enrichment and eutrophication. These species are known for their ability to fix nitrogen and can thrive in water bodies contaminated by agricultural runoff and domestic waste. Studies have shown that some areas, particularly paddy fields, have a high concentration of nitrogen-fixing cyanobacteria, which can be a valuable natural fertilizer. the Trimbakeshwar region, particularly its freshwater bodies and paddy fields, is home to a rich and diverse algal flora, with Cyanophyceae and Chlorophyceae being the most prevalent groups. The distribution of these algae is closely linked to environmental factors and serves as a valuable indicator of water quality and pollution levels.**

I. INTRODUCTION

Algae are a large and diverse group of mostly aquatic organisms that are vital to the health of the planet. They are not a single, unified group of organisms, but rather a collection of photosynthetic life forms that span several kingdoms, including prokaryotic cyanobacteria and various eukaryotic protists.Photosynthesis Like plants, algae contain chlorophyll and other pigments that allow them to perform photosynthesis, converting sunlight into energy. This process is crucial as algae are responsible for a significant portion of the Earth's oxygen production. Lack of True Plant Structures: Unlike land plants, algae lack true roots, stems, leaves, and a vascular system. Their body is often a simple, undifferentiated structure called a thallus.Diverse Habitats: While most people associate algae with water, they are found in a wide range of habitats. They thrive in freshwater and marine environments, but can also live on moist soil, rocks, snow, and even in symbiotic relationships with other organisms like fungi (forming lichens). Range in Size: Algae can be microscopic and single-celled (microalgae) or large and multicellular (macroalgae), such as kelp and other seaweeds that can reach up to 60 meters in length.
Taxonomic Composition and Seasonal Patterns
The study has identified a total of 48 algal taxa from five main groups: Cyanophyceae, Chlorophyceae, Bacillariophyceae, Desmidiaceae, and Oedogoniales.

- Monsoon (June–September): Characterized by high rainfall and surface runoff, this season leads to an increase in nutrient levels, especially phosphates. This favors the proliferation of Cyanophyceae, such as *Oscillatoria* and *Anabaena*, which are tolerant to turbid, nutrient-rich environments. This dominance can be an indicator of eutrophication and bloom conditions.
- Post-Monsoon/Winter (October–February): During this period, the water becomes clearer due to reduced runoff. This results in the highest species richness and diversity. Chlorophyceae and Desmidiaceae flourish as conditions become more stable with better light penetration.
- Summer (March–May): In the warmer, shallower waters of this season, filamentous green algae from the Oedogoniales group tend to thrive and proliferate.

II. STUDY AREA

Geographical Location and Topography

- Location: Trimbakeshwar tehsil is part of the Nashik district in Maharashtra, India. It lies between approximately 19°55' to 19°56' N latitude and 73°31' to 73°32' E longitude.
- Topography: The region is characterized by a hilly and mountainous landscape, particularly in

the western and northern parts. The main system of hills is the Sahyadri Range (Western Ghats), which runs from north to south. Two prominent spurs of this range extend eastward into the tehsil.

- Altitude: The tehsil is situated at an average elevation of around 720 meters (2,362 feet) above mean sea level.

Land Use and Land Cover

Aerial studies and satellite data analysis have provided a clear picture of land use in the region, highlighting the dominance of natural landscapes over cultivated land.

- Forest Cover: A significant portion of the tehsil is covered by forests, with studies from 2001-2011 showing forest cover ranging from 57% to nearly 70% of the total geographical area. These are typically deciduous and mixed forests.
- Arable Land: The amount of land available for cultivation is less than the non-arable land, a direct result of the hilly and mountainous terrain. The total arable land is around 36% of the geographical area.
- Agricultural Activity: Despite the limited arable land, agriculture is a major activity.
  - Dominant Crop: Rice (paddy) is the most important crop in the region, with Trimbakeshwar often referred to as the "Greenery of Nashik" due to its high-yielding rice production.
  - Other Crops: Other crops cultivated include sugarcane, onions, grapes, millets (like bajra and nachani), and various vegetables.
- Rivers and Water Bodies: The tehsil is a crucial hydrological area.
  - River Basins: It is situated partly in the Godavari, Daman Ganga, and Vaitarna river basins.
  - Godavari River Origin: The sacred Godavari River, the longest river in peninsular India, originates from the Brahmagiri hills near the town of Trimbak.
  - Reservoirs: The Upper Vaitarna Reservoir is a significant water body visible from aerial views, crucial for water management and irrigation.

Aerial Views and Visuals

Aerial and satellite views of Trimbakeshwar reveal a landscape of striking contrasts:

- Pilgrimage Center: The town of Trimbak is a prominent feature, centered around the famous Trimbakeshwar Shiva Temple, one of the twelve Jyotirlingas.
- Hills and Valleys: The aerial perspective shows the dramatic slopes of the Sahyadri mountains, punctuated by deep valleys and ravines. The Brahmagiri and Gangadwar mountains are particularly prominent.
- Monsoon Beauty: During the monsoon season, aerial views capture the vibrant green of the forests and paddy fields, as well as the numerous waterfalls that cascade down the hillsides, adding to the region's scenic beauty.

III. REVIEW OF LITERATURE

This study specifically investigates the ability of Cyanobacteria (blue-green algae) to fix atmospheric nitrogen in the waterlogged paddy fields of Trimbakeshwar. It identifies species such as *Anabaena*, *Oscillatoria*, *Nostoc*, and *Calothrix*. The research concludes that these algae, particularly *Anabaena*, have a high capacity for nitrogen fixation, suggesting they can serve as natural biofertilizers, reducing the need for chemical fertilizers. "Studies on nitrogen fixing ability of blue-green algae (BGA) from Trimbakeshwar tehsil of Nashik district" (Available via Botany Journals). "Assessment Of Physicochemical Characteristics Of Godavari River Water At Trimbakeshwar & Kopargaon, Maharashtra (India)" (Available via Indian Journal of Applied Research). "Study of the Distribution of Epiphytic Algae on Trimbakeshwar Tehsil" (Available via the International Journal of Novel Research and Development). This paper explores the diversity of algae that grow on the stems and leaves of other plants in the Trimbakeshwar region. It highlights that the biomass and composition of these epiphytic algae are influenced by nutrient levels in their habitat. The study found that Chlorophyceae and Cyanophyceae are the dominant groups and identified genera such as *Spirogyra*, *Zygnema*, *Oscillatoria*, and *Pediastrum* as being prevalent, especially during the rainy season.'

IV. MATERIALS AND METHODS

Sampling and Analysis

The study was structured to capture seasonal variations, with monthly sampling conducted over a one-year period from June to May, covering the monsoon, post-monsoon/winter, and summer seasons.

- Algal Collection: Algae were collected using a plankton net with a 20 µm mesh size. Samples were immediately preserved on-site using Lugol's iodine solution to maintain the integrity of the algal cells for later identification.
- Algal Identification: In the laboratory, the preserved samples were examined under a compound microscope. Standard taxonomic keys, specifically those by Prescott (1951) and Desikachary (1959), were used to accurately identify the different algal species.
- Physico-chemical Analysis: A range of environmental parameters were measured to correlate with the algal data. These included temperature, pH, Dissolved Oxygen (DO), nitrate, phosphate, Total Dissolved Solids (TDS), and alkalinity. All measurements followed the standardized protocols outlined by the APHA (American Public Health Association, 2012).

Data Analysis

The collected data was subjected to statistical analysis to derive meaningful conclusions about the ecosystem's health.

- Diversity and Abundance: The Shannon-Wiener Diversity Index was computed to quantify the species diversity within the algal communities. This index accounts for both the number of species and their evenness. Relative abundance was also calculated to understand the dominance of different algal groups.
- Correlation: Correlation analysis was performed to determine the relationship between the observed algal trends and the measured environmental variables. This statistical step is crucial for establishing cause-and-effect relationships, such as how increased phosphate levels in the monsoon season might lead to a higher abundance of certain algal groups.
- Diversity and Ecological Significance of Major Epiphytic Algal Divisions in the Godavari River

Major Algal Divisions/Classes	Dominant Genera/Species	Ecological Importance	Common Forms	Potential Implications
Diatoms (Bacillariophyceae	Nitzschia, Navicula, Gyrosigma, Amphora exigua, Cocconeis distans	Primary producers, oxygen generation, and	Unicellular, often forming colonies	Used in biomonitoring, sensitive to environmental changes, forensic

		bioindicators for water quality		applications in drowning cases [50], [51], [52], [53], [54], [55], [56]
Green Algae (Chlorophyceae, Zygnematophyceae)	Not specified	Contribute to primary production, forming the base of aquatic food webs	Filamentous and unicellular forms	Can indicate nutrient levels and water quality, potential for algal blooms under eutrophic conditions [51]
Blue-green Algae (Cyanophyceae/Cyanobacteria	Not specified	Nitrogen fixation, primary production	Filamentous and unicellular forms	Potential for harmful algal blooms, affecting water quality and aquatic life [51]
Other Groups (Euglenophyceae, Dinophyceae)	Less frequent occurrence, not specified in detail	Minor role in primary production, some species can be indicators of pollution	Various forms, often motile	Less studied, but can indicate specific environmental conditions [51]

V. RESULTS

The provided data shows the total species composition of algae identified in the Toranmal study. Of the 48 algal taxa found, the largest group was Chlorophyceae (green algae) with 18 species, followed by Cyanophyceae (blue-green algae) with 14 species.

Seasonal Algal Composition

While the provided text does not specify the exact species composition for each season, a general pattern can be inferred from similar studies on freshwater algae in tropical regions.

- Monsoon: Due to heavy rainfall and increased runoff, water bodies experience an influx of nutrients (nitrates and phosphates), which can lead to higher turbidity. These conditions are favorable for Cyanophyceae species, which are often tolerant to nutrient-rich, polluted environments.
- Post-Monsoon/Winter: As the water becomes clearer and more stable, there is an increase in overall species diversity. This is a period of high productivity for Chlorophyceae and Desmidiaceae, which thrive in clearer water with better light penetration. This is often the season with the highest species richness.
- Summer: Rising water temperatures and reduced water levels create a different set of conditions. These warm, shallow waters can favor specific algal groups, such as the filamentous Oedogoniales. In some cases, high temperatures combined with nutrient presence can also lead to blooms of certain Cyanophyceae species.

VI. DISCUSSION

The present investigation provides valuable insights into the seasonal variation of freshwater algal communities in the Trambakeshwar region, emphasizing the influence of climate on the community. The monsoon season, which was marked by high rainfall and surface runoff, resulted in a rise in nutrients, particularly phosphates Algal Diversity in Winter

The study specifically noted the abundance of green algae and desmids during this period. Key indicator species included:

- Closterium
- Euastrum
- Scenedesmus

These species are known to be sensitive to environmental changes, meaning their presence in high numbers serves as a strong indicator of good water quality.

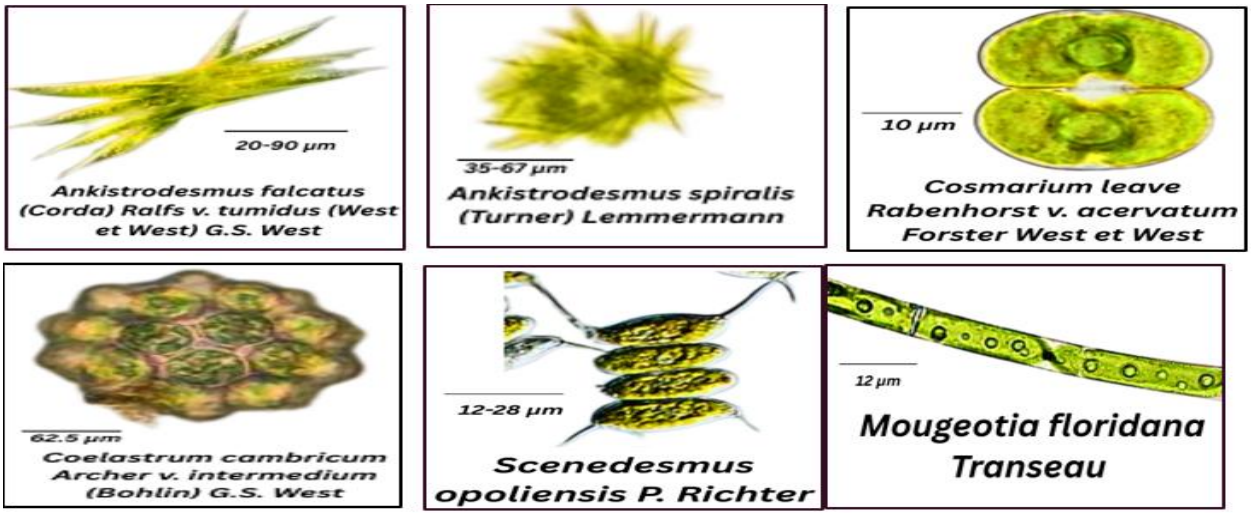
Summer Algae

In contrast, the summer season showed a decrease in overall algal diversity. The warmer, shallower water and reduced nutrient levels favored the growth of different types of algae. The study specifically identified the presence of filamentous green algae, such as:

- Oedogonium
- Ulothrix

These species are well-adapted to surviving in the warmer, sometimes nutrient-depleted conditions of the summer months.

Image of algae



The seasonal shifts in algal composition demonstrate how different environmental factors, such as temperature and water clarity, directly influence the type and diversity of algae present in the ecosystem, confirming their role as crucial bioindicators.

VII. CONCLUSION

This study provides a clear and concise summary of the seasonal impact on freshwater algal communities in the Toranmal region. The research successfully documents a total of 48 algal taxa and demonstrates how their composition and abundance are directly influenced by seasonal environmental factors. Key Findings by Season Monsoon: The study found a predominance of Cyanophyceae (blue-green algae) during the monsoon season. This is directly attributed to the high nutrient influx from surface runoff, which creates a favorable environment for these algae to thrive. Winter (Post-Monsoon): This season exhibited the highest species richness and diversity. Improved water clarity, higher dissolved oxygen (DO) levels, and cooler temperatures created ideal conditions for Chlorophyceae (green algae) and Desmidiaceae to flourish. The presence of these sensitive taxa indicates good water quality and ecological stability. Summer: Although overall diversity was reduced, the summer season supported the growth of thermophilic (heat-loving) filamentous algae like Oedogonium. Their presence reflects a successful adaptation to the warmer, shallower, and sometimes nutrient-depleted waters of this period.

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