

Diversity and Seasonal Variations of Plankton Communities in Adol Freshwater Reservoir of Borala (20°06'00 N 76°59'00"E), Malegaon Tehsil, District Washim (M.S.) India

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Abstract

Plankton communities are highly sensitive indicators of environmental changes in aquatic ecosystems. The present study was conducted to analyze the diversity and seasonal variation of plankton communities in Adol Freshwater Reservoir using observations over a period of two year. A total of 35 genera of phytoplankton and 8 genera of zooplankton were recorded. Among phytoplankton, Bacillariophyceae (83%) dominated, followed by Chlorophyceae (9%) and Cyanophyceae (8%). Zooplankton were mainly represented by Rotifera, Protozoa, and Copepoda. Seasonal variation showed maximum density during winter and minimum during monsoon. The Shannon-Wiener diversity index ranged from 1.75 to 2.61 for phytoplankton and 0.95 to 1.56 for zooplankton. Environmental factors such as temperature, dissolved oxygen, turbidity, and nutrient levels significantly influenced plankton diversity. The study concludes that the reservoir is moderately productive and ecologically stable.

Keywords : Diversity , Plankton communities, seasonal variation, Adol Freshwater Reservoir

1. Introduction

Freshwater ecosystems are biologically productive systems in which organisms interact continuously with their surrounding physical and chemical environment. The ecological characteristics of a reservoir are determined by several factors, including water temperature, light penetration, nutrient availability, rainfall, water level, dissolved substances and biological interactions. Reservoirs also have considerable ecological and socioeconomic importance because they provide water for irrigation, support fisheries, and sustain diverse aquatic communities. Understanding the biological characteristics of such water bodies is therefore essential for evaluating their productivity and ecological condition (Wetzel, 2001).

Plankton form an important biological component of freshwater ecosystems. These organisms inhabit the water column and are generally unable to maintain their position against prevailing water currents. Based on their nutritional characteristics, plankton are broadly divided into phytoplankton and zooplankton. Phytoplankton are mainly photosynthetic organisms that synthesize organic matter, whereas zooplankton comprise predominantly heterotrophic organisms that obtain energy by feeding on phytoplankton, bacteria, detrital particles and other microorganisms. Together, these communities play an essential role in energy transfer and nutrient cycling within aquatic food webs (Odum & Barrett, 2005; Wetzel, 2001).

Phytoplankton constitute the major microscopic primary producers of most freshwater ecosystems. Through photosynthesis, they utilize sunlight, carbon dioxide and inorganic nutrients to produce organic matter and release oxygen. Their productivity provides the basic energy source for numerous aquatic organisms. Freshwater phytoplankton include diverse taxonomic groups, among which green algae, diatoms, cyanobacteria and euglenoids are frequently encountered. The occurrence and abundance of these groups depend upon environmental conditions such as nutrient concentrations, temperature, light availability, water transparency, pH and mixing characteristics. Consequently, changes in phytoplankton communities can provide useful ecological information about the condition and productivity of a water body (Reynolds, 2006).

Zooplankton occupy an important intermediate position within aquatic food webs. They utilize phytoplankton and other suspended organic materials as food and subsequently become prey for fish and other aquatic organisms. Common freshwater zooplankton assemblages include

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members of Rotifera, Cladocera, Copepoda and Ostracoda. Differences in the abundance and composition of these groups are associated with variations in food resources, environmental conditions, predation and competition. Because of their relatively rapid response to environmental changes, zooplankton communities can also provide useful information concerning the biological characteristics of freshwater ecosystems (Pennak, 1989; Wetzel, 2001).

The plankton community of a reservoir is not static and may undergo considerable changes during different seasons. Environmental variables such as air and water temperature, precipitation, solar radiation, nutrient input, turbidity, water level and circulation influence plankton production and distribution. The seasonal availability of nutrients and changes in physical conditions can consequently alter the relative abundance of different planktonic groups. Investigating these seasonal patterns is therefore important for understanding the temporal dynamics and ecological functioning of freshwater ecosystems (Reynolds, 2006).

Assessment of plankton diversity has considerable significance in freshwater ecological studies. Species composition, abundance and seasonal distribution can be used to characterize the biological condition of a water body. Changes in plankton communities may be associated with nutrient enrichment, organic inputs, changes in trophic status and other environmental disturbances. In particular, shifts in phytoplankton and zooplankton assemblages can provide useful biological evidence for interpreting changes in water quality and ecosystem productivity. Standardized sampling and analytical procedures are therefore important for obtaining reliable information on aquatic biological communities (APHA, AWWA & WEF, 2017).

Reservoirs used for irrigation and fisheries are subject to continuous interactions between natural ecological processes and human activities. Changes in water level, nutrient inflow, catchment characteristics and fisheries-related activities can influence the availability of nutrients and consequently affect plankton production. Since plankton constitute an important food resource for many aquatic organisms, their diversity and abundance are also relevant to the biological productivity and fisheries potential of a reservoir.

The Adol Freshwater Reservoir situated at Borala, Malegaon, Washim District, Maharashtra, is an important local freshwater resource associated with irrigation and fisheries. However, information on the planktonic communities inhabiting this reservoir is comparatively limited. Documentation of its plankton diversity can provide useful baseline information for understanding the biological characteristics of the reservoir and for future ecological and fisheries investigations.

The present investigation was therefore undertaken to study the diversity, density and seasonal distribution of plankton in Adol Freshwater Reservoir. The study focuses on documenting the major planktonic groups occurring in the reservoir, assessing their abundance and examining variations in their occurrence during different seasons. The information generated through the study may contribute to the ecological characterization of the reservoir and provide baseline data useful for monitoring its biological productivity and fisheries resources.

2. Objectives Of The Study

The present investigation was undertaken with the following objectives:

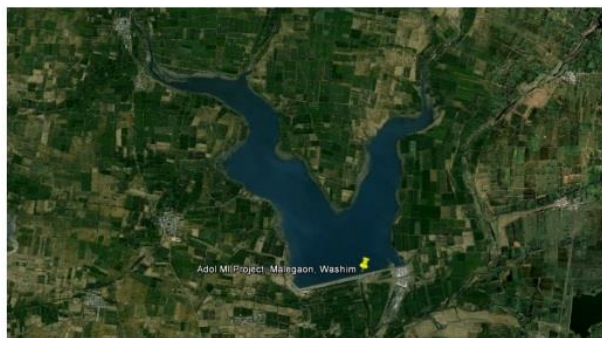
- To document the diversity and composition of phytoplankton and zooplankton communities occurring in the Adol Freshwater Reservoir.
- To determine seasonal fluctuations in plankton abundance and density during the study period.
- To examine the association between plankton communities and selected physico-chemical characteristics of the reservoir water.
- To assess the ecological condition of the reservoir based on plankton diversity, abundance, seasonal distribution, and relevant environmental parameters.

3. Materials And Methods

3.1 Study Area

The Adol Freshwater Reservoir is situated at Borala in Malegaon Tehsil of Washim District, Maharashtra, India. The reservoir serves as an important local freshwater resource and contributes to the surrounding agricultural activities and fisheries. The water body provides

suitable habitat for a variety of aquatic organisms, including planktonic communities, and therefore represents a suitable site for investigating plankton diversity, abundance, and seasonal variation.



3.2 Sampling Method

Plankton samples were collected from the Adol Freshwater Reservoir at monthly intervals for a period of 24 months to document seasonal and annual variations in the plankton community. Sampling was carried out using a plankton net having a mesh size of 25 μm , which was used to concentrate planktonic organisms from the reservoir water. The collected samples were transferred into clean, labelled sample containers and preserved immediately in 4% formalin solution to maintain the morphological characteristics of the organisms until laboratory examination.

3.3 Identification and Enumeration

In the laboratory, preserved plankton samples were examined under a compound microscope. The organisms were identified to the lowest practical taxonomic level using standard taxonomic keys and relevant plankton identification literature. The qualitative composition of the plankton community was recorded by noting the different taxa encountered during each sampling period. Quantitative estimation of plankton abundance was performed using a Sedgwick–Rafter counting chamber. A measured volume of the well-mixed sample was introduced into the chamber and the organisms were counted systematically under the microscope. The observations obtained from successive sampling periods were used to determine the abundance and seasonal distribution of phytoplankton and zooplankton in the reservoir.

3.4 Diversity Index

$$H = -\sum_{j=1}^S p_i \ln p_i$$

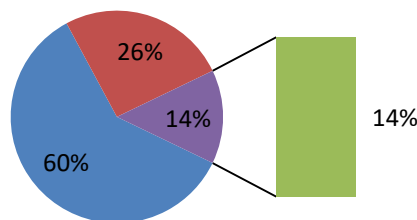
4. RESULTS

4.1 Phytoplankton Composition

Group	No. of Genera	Percentage
Bacillariophyceae	21	83%
Chlorophyceae	9	9%
Cyanophyceae	5	8%

4.1 Phytoplankton Composition

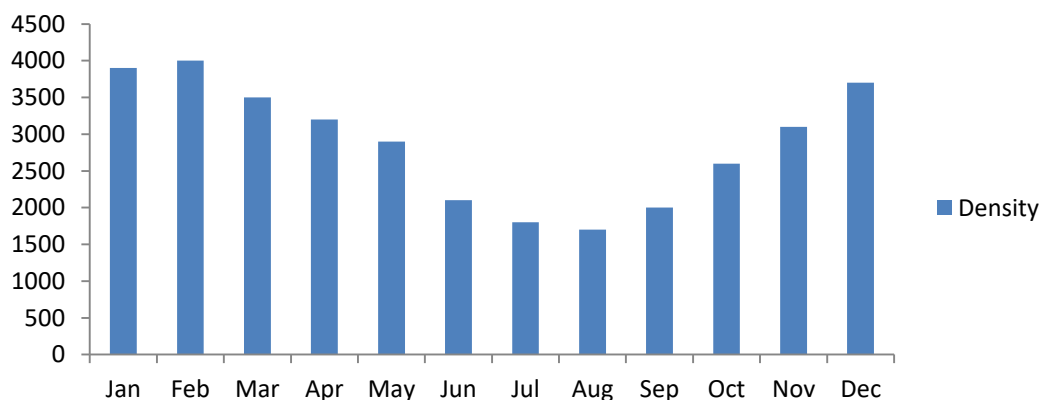
■ Bacillariophyceae ■ Chlorophyceae ■ Cyanophyceae



4.2 Monthly Phytoplankton Density (Units/L)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Density	3900	4000	3500	3200	2900	2100	1800	1700	2000	2600	3100	3700

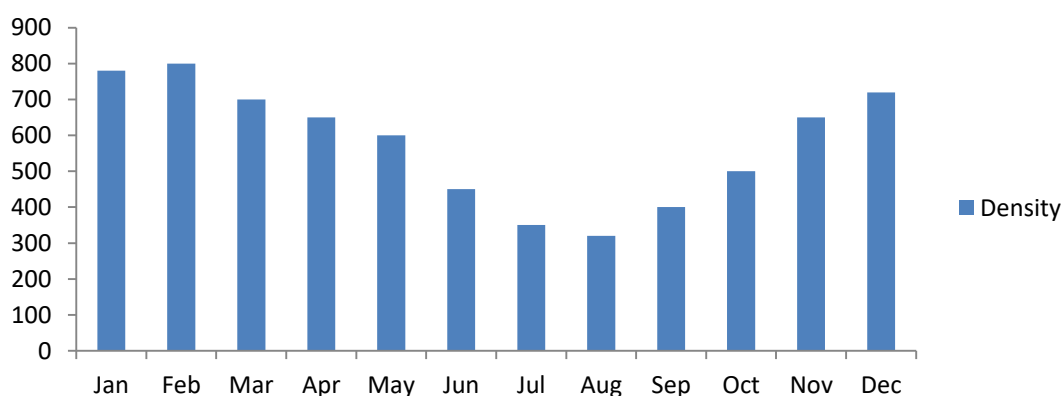
4.2 Monthly Phytoplankton Density (Units/L)



4.3 Zooplankton Density (Units/L)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Density	780	800	700	650	600	450	350	320	400	500	650	720

4.3 Zooplankton Density (Units/L)



4.4 Seasonal Summary

Season	Phytoplankton	Zooplankton
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Winter	Highest	Highest
Summer	Moderate	Moderate
Monsoon	Lowest	Lowest

4.5 Physico-Chemical Parameters

Parameter	Winter	Summer	Monsoon
Temperature (°C)	18	32	26
Dissolved Oxygen	8.5	6.2	5.8
Turbidity	Low	Medium	High
Nutrients	High	Moderate	Low

5. Discussion

The present investigation provides an overview of the planktonic community structure and its seasonal dynamics in the Adol Freshwater Reservoir, Borala, Malegaon, Washim District, Maharashtra. The observations demonstrate noticeable temporal changes in the abundance and composition of phytoplankton and zooplankton. Such changes are expected in freshwater reservoirs because plankton populations respond rapidly to fluctuations in temperature, rainfall, water transparency, nutrient availability, dissolved oxygen, water movement and biological interactions. The results obtained in the present study therefore provide useful information regarding the ecological functioning and biological productivity of the reservoir.

5.1 Phytoplankton composition and predominance of Bacillariophyceae

A major feature of the phytoplankton community was the pronounced contribution of Bacillariophyceae (diatoms), which represented approximately 83% of the recorded phytoplankton. The substantial occurrence of diatoms suggests that environmental conditions during the investigation provided suitable opportunities for their growth. Bacillariophyceae are important freshwater primary producers and frequently form a significant component of phytoplankton assemblages.

The successful development of diatoms is associated with several environmental characteristics, including nutrient availability, light conditions, temperature, water movement and dissolved silica. Their silica-based frustules are a characteristic structural feature, while their photosynthetic capacity enables them to contribute significantly to organic matter production in aquatic environments. The high proportion recorded in the present study may consequently reflect the prevailing combination of environmental conditions in the reservoir.

Although diatoms are frequently used in ecological assessment, their predominance should not be interpreted as conclusive evidence of a particular water-quality category. Different diatom species have different environmental tolerances, and some can occur under nutrient-enriched or disturbed conditions. Accordingly, the ecological significance of the observed 83% contribution of Bacillariophyceae should be considered together with the abundance of other phytoplankton groups and the measured physicochemical characteristics of the reservoir.

5.2 Seasonal dynamics of plankton

Marked seasonal differences were observed in the abundance and diversity of plankton. Among the seasons investigated, winter showed the highest plankton density and comparatively greater diversity, whereas monsoon exhibited the lowest abundance. Seasonal changes of this nature are primarily associated with differences in the physical and chemical environment of the reservoir. During winter, relatively stable hydrological conditions and improved water transparency may provide suitable conditions for phytoplankton development. Increased penetration of light into the water column can enhance photosynthetic activity, while appropriate nutrient availability can further support primary production. The development of phytoplankton provides food resources for zooplankton and may consequently contribute to an increase in the abundance of secondary consumers.

The comparatively greater diversity during winter may also be associated with reduced physical disturbance and relatively stable environmental conditions. When environmental fluctuations are less pronounced, different planktonic taxa may coexist and utilize available resources in different ways. Thus, the winter increase in abundance and diversity probably represents the

combined effect of several favourable ecological conditions rather than the influence of temperature alone.

5.3 Effect of monsoon conditions

The reduction in plankton abundance during the monsoon season can be related to the substantial hydrological changes produced by rainfall and surface runoff. Heavy precipitation can increase the inflow of water, suspended sediments and organic materials from the surrounding catchment. This process may considerably increase turbidity and consequently reduce the penetration of sunlight into the water column.

Reduced light availability can limit photosynthetic activity and influence phytoplankton production. In addition, strong inflow and water movement may physically redistribute or wash planktonic organisms from particular areas of the reservoir. The addition of large quantities of rainwater can also dilute existing plankton populations and modify nutrient concentrations.

The influence of monsoon rainfall on plankton is therefore complex. Runoff may introduce nutrients into the reservoir, but simultaneous dilution, turbidity and increased water movement can restrict the immediate development of plankton populations. The low density observed during monsoon in the present investigation may thus reflect the combined influence of these hydrological processes.

5.4 Zooplankton response to seasonal changes

Zooplankton exhibited seasonal fluctuations broadly comparable to those observed for phytoplankton, with higher abundance during winter and lower abundance during monsoon. This pattern may partly be explained by changes in food availability. Since many freshwater zooplankton feed directly on phytoplankton or microorganisms associated with suspended organic matter, variations in primary production can influence their population size.

The relatively greater phytoplankton availability during winter may have provided favourable feeding conditions for zooplankton. In contrast, reduced phytoplankton abundance during monsoon, together with increased turbidity and physical disturbance, may have limited zooplankton development.

However, zooplankton populations are regulated by several interacting factors. In addition to food availability, predation by fish, competition among zooplankton taxa, temperature, dissolved oxygen and habitat conditions may influence their distribution. Therefore, the similarity between phytoplankton and zooplankton seasonal patterns should be viewed as an ecological association rather than evidence that phytoplankton alone controls zooplankton abundance.

5.5 Significance of rotifer occurrence

The zooplankton assemblage included representatives of important freshwater groups such as Rotifera, Cladocera, Copepoda and Ostracoda. Rotifers formed a notable component of the community. Their occurrence in freshwater environments is widespread, and many species possess short reproductive cycles that allow their populations to respond rapidly to changes in environmental conditions and food resources.

The presence of a substantial rotifer component may indicate that the reservoir provides suitable conditions for organisms capable of exploiting relatively small food particles and microorganisms. Nevertheless, rotifer abundance by itself is insufficient to establish the trophic condition of the reservoir. Interpretation should preferably be based on species-level composition, seasonal abundance and associated environmental parameters.

Cladocerans and copepods are also ecologically important because they transfer energy from lower trophic components to larger aquatic organisms. Their occurrence contributes to the natural food base available to fish and other consumers and therefore has potential significance for the fisheries productivity of the reservoir.

5.6 Interpretation of Shannon–Wiener diversity

The calculated Shannon–Wiener diversity index showed seasonal differences in plankton community structure. The comparatively higher values recorded during winter indicate greater community heterogeneity, with several taxa contributing to the overall assemblage. Lower values during monsoon suggest a comparatively less diverse community during a period of greater environmental fluctuation.

A decrease in diversity may occur when environmental disturbance favours a limited number of tolerant organisms while restricting the growth of more sensitive taxa. Increased turbidity, hydrological instability and changes in nutrient availability during rainfall may therefore contribute to the observed seasonal decline.

It is important, however, to avoid assigning a universal ecological meaning to a particular Shannon–Wiener value. Diversity indices are affected by sampling effort, habitat characteristics, taxonomic resolution and the natural species pool of the ecosystem. Consequently, the values obtained in this study are most informative when used to compare seasonal patterns within the reservoir rather than applying a fixed numerical threshold to classify water quality.

5.7 Association with physicochemical characteristics

The distribution of plankton in the reservoir is closely related to variations in environmental conditions. Among the major factors, temperature, water transparency, turbidity, dissolved oxygen, pH and nutrient availability can substantially affect plankton growth and survival.

Temperature influences metabolic activity and reproductive processes in planktonic organisms. Light availability determines the potential for photosynthetic production, making transparency an important factor for phytoplankton. Turbidity can restrict light penetration and thereby modify the depth at which photosynthesis can occur. Dissolved oxygen is particularly relevant to zooplankton and other aerobic aquatic organisms.

Nutrients, especially nitrogen and phosphorus, are essential for phytoplankton production. Their availability can influence both total abundance and community composition. At the same time, excessive nutrient inputs may alter the competitive relationships among phytoplankton taxa and lead to substantial changes in community structure.

The seasonal patterns observed in the present investigation therefore appear to result from the combined influence of several physicochemical variables. More detailed statistical approaches, including correlation analysis and multivariate techniques, could provide additional information about the relative importance of individual environmental factors in controlling plankton distribution.

5.8 Ecological significance of plankton variation

The plankton community represents an important component of the reservoir ecosystem because it links primary production with higher trophic levels. Phytoplankton convert inorganic substances and solar energy into organic matter, while zooplankton consume primary producers and subsequently provide food for fish and other aquatic organisms.

The strong representation of Bacillariophyceae, seasonal variation in total plankton density and differences in community diversity indicate that the biological characteristics of the Adol Reservoir vary considerably throughout the year. These observations demonstrate why seasonal sampling is essential for meaningful ecological characterization.

The present findings can also serve as baseline information for subsequent studies. Long-term observations could reveal whether the seasonal patterns identified in the present investigation remain consistent or change in response to alterations in rainfall, land use, water abstraction, nutrient inputs and fisheries-related activities.

5.9 Implications for fisheries productivity

Plankton abundance has direct ecological significance for reservoir fisheries because many fish species depend on plankton during their early developmental stages, while several adult fishes also utilize zooplankton and phytoplankton either directly or indirectly. Consequently, seasonal variation in plankton availability may influence the natural food resources supporting fish populations.

The relatively high plankton abundance recorded during winter may represent a period of greater availability of natural food resources. Conversely, the reduced plankton concentration during monsoon may temporarily modify food-web interactions because of hydrological disturbance and reduced plankton stability.

Understanding these seasonal patterns can therefore complement fisheries investigations and may help explain seasonal differences in fish feeding conditions and biological productivity. Nevertheless, direct conclusions about fish production should be supported by independent fisheries observations rather than inferred solely from plankton abundance.

5.10 Environmental monitoring and management implications

The findings emphasize the importance of regular biological and physicochemical monitoring of the Adol Freshwater Reservoir. Plankton communities can respond rapidly to environmental changes and may therefore provide an effective component of an integrated reservoir-monitoring programme.

Periodic assessment of phytoplankton and zooplankton should ideally be accompanied by measurements of temperature, pH, dissolved oxygen, transparency, conductivity, turbidity and major nutrients. Such combined monitoring would make it possible to identify changes in ecological conditions at an early stage.

Protection of the reservoir catchment from excessive sediment and nutrient inputs is also important for maintaining ecological stability. Appropriate management of surrounding land-use activities, control of waste discharge and prevention of excessive nutrient loading can help minimize undesirable changes in plankton community structure.

5.11 Overall interpretation

Taken together, the results indicate that seasonal environmental variability plays an important role in shaping the plankton community of the Adol Freshwater Reservoir. The marked contribution of Bacillariophyceae, higher plankton density and diversity during winter, and lower abundance during monsoon collectively demonstrate substantial temporal variation in the reservoir's biological community.

The observed patterns should be interpreted using an integrated ecological approach. Neither the predominance of a single phytoplankton group nor an individual diversity-index value can independently establish the overall ecological condition of a freshwater reservoir. Rather, the most reliable interpretation emerges from the combined evaluation of plankton composition, population density, diversity indices and physicochemical characteristics.

The present study consequently provides useful baseline information on the planktonic resources of the Adol Freshwater Reservoir. Continued seasonal monitoring and expansion of future investigations to include nutrient dynamics, detailed species-level identification, statistical relationships and fisheries parameters would provide a more comprehensive understanding of the reservoir ecosystem and support its long-term ecological and fisheries management.

6. Significance Of The Study

- Helps in understanding freshwater ecosystem dynamics
- Useful for fisheries management
- Acts as a baseline for future ecological studies
- Helps in water quality assessment

7. Conclusion

The study reveals that Adol Freshwater Reservoir supports diverse plankton communities with clear seasonal variation. Winter season shows maximum productivity, while monsoon shows minimum due to unfavorable conditions.

The reservoir exhibits moderate ecological stability and good water quality. Continuous monitoring and management strategies are necessary to maintain ecological balance.

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