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Biodiversity and Seasonal Distribution of Zooplankton in Freshwater Systems

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Abstract- Freshwater ecosystems play an important role in maintaining ecological balance, supporting biodiversity, and providing essential resources for human activities. Zooplankton are microscopic aquatic organisms that occupy a central position in freshwater food chains and serve as reliable indicators of water quality and ecosystem health. The present study investigates the seasonal variation of zooplankton diversity and its relationship with physicochemical parameters in the Sathnala Project reservoir located in Adilabad district, Telangana. The study focuses on four major zooplankton groups namely Rotifera, Cladocera, Copepoda, and Ostracoda. Seasonal sampling was conducted during summer, monsoon, and winter periods to analyze species diversity, abundance, and distribution patterns. Physicochemical parameters such as temperature, pH, dissolved oxygen, turbidity, and nutrient concentration were also evaluated. The findings indicate that seasonal variations significantly influence zooplankton communities and water quality characteristics. Higher zooplankton abundance was observed during summer due to increased nutrient concentration and phytoplankton growth, whereas monsoon conditions resulted in reduced diversity because of dilution and increased turbidity. Winter showed moderate abundance with relatively stable ecological conditions. The study confirms that zooplankton communities are effective bioindicators for freshwater ecosystem assessment and water quality monitoring. The research contributes important baseline data for ecological studies and sustainable management of freshwater resources in Telangana.

Keywords: Zooplankton Diversity, Freshwater Ecology, Seasonal Variation, Water Quality, Sathnala Reservoir, Bioindicators, Physicochemical Parameters.

I. INTRODUCTION

Freshwater ecosystems are important natural resources that support biodiversity, ecological stability, fisheries, agriculture, and domestic water supply. Lakes, ponds, rivers, and reservoirs provide essential ecosystem services while maintaining environmental balance. Among the biological communities present in freshwater systems, zooplankton occupy a critical position because they act as primary consumers linking phytoplankton to higher trophic levels such as fish and aquatic animals.

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Zooplankton communities mainly consist of Rotifera, Cladocera, Copepoda, and Ostracoda. These organisms are highly sensitive to environmental changes including temperature, dissolved oxygen, pH, turbidity, and nutrient concentration. Because of their rapid response to ecological disturbances, zooplankton are widely used as biological indicators for monitoring freshwater ecosystem health and water quality.

Seasonal variation is one of the most important factors influencing zooplankton diversity and abundance. In tropical regions like Telangana, environmental conditions change considerably during summer, monsoon, and winter seasons. These seasonal changes directly affect water chemistry, nutrient availability, phytoplankton growth, and zooplankton population dynamics. Human activities such as agricultural runoff, domestic sewage discharge, and pollution further alter freshwater ecosystems and influence zooplankton communities.

The Sathnala Project reservoir located in Adilabad district of Telangana is an important freshwater resource used for irrigation, fisheries, and domestic purposes. Despite its ecological and economic importance, limited scientific studies have been conducted regarding zooplankton diversity and seasonal ecological variation in this reservoir. Therefore, the present study aims to analyze seasonal changes in zooplankton populations and evaluate their relationship with physicochemical parameters of water quality.

II. LITERATURE REVIEW

Zooplankton are considered important ecological indicators in freshwater ecosystems because of their sensitivity to environmental fluctuations. Previous studies have demonstrated that water temperature, dissolved oxygen, pH, nutrient concentration, and turbidity significantly affect zooplankton abundance and diversity. High species diversity generally indicates healthy and stable aquatic ecosystems, while reduced diversity suggests environmental stress or pollution.

Recent studies from 2019 to 2023 emphasized the role of seasonal variation in controlling zooplankton population dynamics. Researchers reported that summer seasons usually support higher zooplankton abundance because increased temperature and evaporation enhance nutrient concentration and phytoplankton productivity. Monsoon seasons often reduce zooplankton density due to dilution effects, high turbidity, and increased water flow. Winter conditions generally support moderate abundance with improved species diversity because of stable environmental conditions.

Several researchers have identified Rotifera as dominant organisms in nutrient-rich waters due to their rapid reproduction and adaptability. Cladocerans function as efficient filter feeders that regulate phytoplankton populations, while copepods are highly sensitive to ecological disturbances and serve as indicators of environmental quality. Ostracods are associated with sediment conditions and provide information regarding bottom-water characteristics.

Many freshwater ecological studies have focused on large reservoirs and lakes, whereas regional freshwater systems in Telangana remain insufficiently explored. Existing literature indicates a lack of integrated ecological studies combining zooplankton diversity with physicochemical analysis in local freshwater reservoirs such as the Sathnala Project.

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III. OBJECTIVES OF THE STUDY

The major objectives of the present study are:

1. To identify and classify major zooplankton groups in the Sathnala reservoir.
2. To analyze seasonal variation in zooplankton diversity and abundance.
3. To evaluate physicochemical parameters influencing zooplankton communities.
4. To study the relationship between water quality and zooplankton population dynamics.
5. To assess the ecological health of the reservoir using zooplankton as bioindicators.

IV. MATERIALS AND METHODS

Study Area

The Sathnala Project reservoir is located in Adilabad district of Telangana. The reservoir serves multiple purposes including irrigation, fisheries, and domestic water supply. The region experiences tropical climatic conditions characterized by summer, monsoon, and winter seasons.

Sample Collection

Zooplankton samples were collected during different seasons using plankton nets from selected sampling stations within the reservoir. Seasonal sampling was conducted over one year to evaluate variation in population dynamics.

Identification of Zooplankton

Collected zooplankton samples were preserved and examined under microscopes for identification and classification. Major groups identified included:

- Rotifera
- Cladocera
- Copepoda
- Ostracoda

Species diversity and abundance were analyzed using standard ecological methods.

Physicochemical Analysis

Water samples were analyzed for important physicochemical parameters including:

- Water temperature
- pH
- Dissolved oxygen
- Turbidity
- Nutrient concentration
- Transparency

Ecological indices such as Shannon-Weiner diversity index and Simpson's index were used for diversity assessment.

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V. RESULTS AND DISCUSSION

Seasonal Variation in Zooplankton Diversity

The study revealed significant seasonal variation in zooplankton abundance and diversity. Summer season showed the highest zooplankton density due to elevated temperature and nutrient concentration. Increased phytoplankton growth during summer provided abundant food resources for zooplankton communities. Rotifera dominated during this season because of their rapid reproductive capacity and adaptability to nutrient-rich conditions.

During monsoon season, zooplankton diversity and abundance declined considerably. Heavy rainfall increased water volume and turbidity, reducing light penetration and phytoplankton productivity. Dilution of nutrients and strong water currents also affected zooplankton survival and distribution.

Winter season exhibited moderate zooplankton abundance with comparatively higher species diversity. Stable environmental conditions, balanced nutrient availability, and improved water transparency supported ecological stability during this period.

Physicochemical Parameters

Water temperature varied significantly across seasons and strongly influenced zooplankton population dynamics. Higher temperatures during summer accelerated metabolic activity and reproduction in zooplankton species.

Dissolved oxygen levels fluctuated seasonally and showed positive relationships with species diversity. Adequate oxygen concentration supported higher survival rates and ecological stability. pH values remained slightly alkaline, which favored freshwater zooplankton growth.

Turbidity increased during monsoon because of runoff and suspended particles, negatively affecting phytoplankton growth and zooplankton abundance. Nutrient levels such as nitrates and phosphates influenced phytoplankton productivity, indirectly affecting zooplankton populations.

Zooplankton as Bioindicators

The study confirmed that zooplankton are effective bioindicators of freshwater ecosystem health. Variations in species diversity and abundance reflected changes in water quality and ecological conditions. Dominance of pollution-tolerant species indicated nutrient enrichment and ecological disturbance in certain periods.

High species diversity during stable environmental conditions indicated healthy ecosystem functioning, whereas reduced diversity during disturbed conditions suggested ecological stress. The findings support the use of zooplankton communities for environmental monitoring and sustainable freshwater management.

VI. ECOLOGICAL IMPORTANCE OF ZOOPLANKTON

Zooplankton perform important ecological functions in freshwater ecosystems. They act as intermediate links between phytoplankton and fish in aquatic food chains. By grazing on phytoplankton, zooplankton regulate algal growth and maintain ecological balance.

Zooplankton also contribute to nutrient cycling through feeding and excretion processes. These activities recycle nitrogen and phosphorus within aquatic ecosystems and support primary productivity. Any disturbance in zooplankton communities may affect fish populations, biodiversity, and overall ecosystem stability.

VII. IMPACT OF HUMAN ACTIVITIES

Human activities significantly influence freshwater ecosystems and zooplankton dynamics. Agricultural runoff introduces fertilizers and chemicals into reservoirs, increasing nutrient concentration and causing eutrophication. Domestic sewage and industrial wastes also affect water quality and ecological balance. The Sathnala reservoir experiences pressure from agricultural and domestic activities. Excess nutrient input can initially increase zooplankton abundance through enhanced phytoplankton growth, but prolonged pollution reduces dissolved oxygen and negatively affects sensitive species. Monitoring zooplankton communities therefore provides valuable information regarding anthropogenic impacts on freshwater systems.

VIII. CONCLUSION

The present study analyzed seasonal variation in zooplankton diversity and its relationship with physicochemical parameters in the Sathnala Project reservoir, Telangana. The findings revealed that seasonal environmental changes significantly influence zooplankton abundance, diversity, and community structure.

Summer season supported maximum zooplankton density due to increased nutrient concentration and phytoplankton productivity, whereas monsoon season reduced abundance because of dilution and turbidity effects. Winter conditions favored moderate abundance and higher species diversity due to ecological stability.

The study demonstrated that physicochemical parameters such as temperature, dissolved oxygen, pH, turbidity, and nutrient concentration strongly affect zooplankton population dynamics. Zooplankton communities were confirmed as reliable bioindicators of water quality and freshwater ecosystem health. The research provides important baseline ecological data for the Sathnala reservoir and contributes to freshwater ecological studies in Telangana. The findings are useful for environmental monitoring, fisheries management, biodiversity conservation, and sustainable management of freshwater resources.

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