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DIVERSITY OF ZOOPLANKTON IN HIRVA LAKE, UMRED, MAHARASHTRA, INDIA

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ABSTRACT:

Freshwater ecosystems serve as important habitats for a wide range of aquatic flora and fauna. Zooplankton constitute a diverse assemblage of microscopic organisms that play a vital role in aquatic food webs by transferring energy from primary producers to higher trophic levels, including fish and other aquatic predators. By feeding primarily on phytoplankton, bacteria, and detritus, zooplankton play a significant role in nutrient cycling and energy flow within aquatic ecosystems. The present study investigates the seasonal variation and diversity of zooplankton in Hirva Lake, Umred, District Nagpur, Maharashtra, India, over an annual cycle. Zooplankton samples were collected monthly from five selected sampling sites (S1, S2, S3, S4, and S5) representing different seasonal conditions, summer, monsoon, and winter and were analysed using standard limnological methods. The study highlights the ecological significance of zooplankton communities as effective bioindicators of water quality and trophic status in Hirva Lake. During the study period, zooplankton species belonging mainly to Rotifera, Cladocera, and Copepoda were recorded. Among these groups, Rotifera emerged as the dominant component, followed by Copepoda and Cladocera, indicating their high adaptive capability to fluctuating environmental conditions.

Keywords:- Freshwater Ecosystem, Seasonal Variation, Zooplankton, Bioindicator, Hirva Lake.

INTRODUCTION:

Freshwater lakes are among the most productive and valuable ecosystems on the Earth, providing essential ecological, economic, and social services. Although they occupy a small fraction of the Earth's surface, lakes support a disproportionately high level of biodiversity, particularly fish, invertebrates, plankton, and aquatic plants (Wetzel, 2001; Mitsch and Gosselink, 2015). Lakes play a crucial role in regulating hydrological cycles, nutrient retention, and carbon sequestration, while also serving as important sources of drinking water, fisheries, irrigation, and recreation (Dodds and Whiles, 2020). Moreover, lakes act as sensitive indicators of environmental change, responding rapidly to anthropogenic pressures such as eutrophication, pollution, climate change, and habitat modification (Carpenter et al. 2011).

Freshwater zooplankton are widely recognised as effective bioindicators of freshwater ecosystem health because of their short life cycles, rapid population responses, and sensitivity to changes in water quality, nutrient status, and pollution. Variations in zooplankton community composition, abundance, and diversity often reflect alterations in trophic status, eutrophication, and toxic contamination in aquatic systems (Lampert and Sommer, 2007; Jakhar, 2013; Ismail and Adman, 2016). For instance, dominance of rotifers and small-bodied cladocerans is commonly associated with eutrophic and polluted waters, whereas diverse copepod and large cladoceran populations indicate relatively unpolluted conditions (Jeppesen et al. 2011). Moreover, zooplankton quickly accumulate contaminants such as pesticides and heavy metals, making them useful indicators of chemical stress in lakes and reservoirs (Attayde

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and Bozelli, 1998). Therefore, monitoring zooplankton assemblages provides a reliable and cost-effective tool for assessing ecological status and environmental changes in freshwater ecosystems.

Zooplanktons are a fundamental component of freshwater lake ecosystems, forming a critical link between primary producers (phytoplankton) and higher trophic levels such as fish. They play an important role as food for aquatic fauna (Gharpure and Bhatkulkar, 2015). By grazing on phytoplankton, zooplankton regulate algal biomass, improve water clarity, and influence nutrient cycling within lakes (Lampert and Sommer, 2007). They facilitate the transfer of energy and essential nutrients from lower to higher trophic levels, thereby sustaining fish production and overall ecosystem productivity (Allan and Castillo, 2007). Additionally, zooplankton communities respond quickly to changes in water quality, making them reliable bioindicators of trophic status, pollution, and ecological health in freshwater lakes (Jeppesen et al. 2011). Any alteration in zooplankton abundance or composition can significantly disrupt lake food webs and ecosystem stability.

Zooplankton play a crucial role in aquatic ecosystems by acting as a key link between primary producers (phytoplankton) and higher trophic levels such as fish and other aquatic organisms. They efficiently transfer energy and nutrients from microscopic algae to fish larvae and planktivorous fishes, thereby supporting fisheries productivity and food web stability. Many freshwater and marine fish species depend heavily on zooplankton during their early life stages, making zooplankton essential for successful fish recruitment and long-term population sustainability (Letcher et al. 2015).

In addition to their trophic role, zooplankton contribute significantly to nutrient cycling and biogeochemical processes. Through grazing, excretion, and vertical migration, they regulate phytoplankton biomass, recycle nutrients such as nitrogen and phosphorus, and influence carbon fluxes in aquatic systems, including the biological carbon pump in oceans (Steinberg and Landry, 2017). Zooplankton communities are also highly sensitive to environmental changes, such as eutrophication, pollution, temperature fluctuations, and climate change, making them reliable bioindicators of water quality and ecosystem health (Allan and Castillo, 2007; Jeppesen et al. 2011). Thus, zooplankton are integral to maintaining ecological balance, productivity, and resilience of both freshwater and marine ecosystems.

Hirva Lake is a principal freshwater body located in Umred tahsil of Nagpur district, Maharashtra, India, approximately 47 km south of the Nagpur district headquarters. The lake covers a total area of 6.91 hectares and has a catchment area of 0.0691 km². As one of the notable freshwater resources in the region, Hirva Lake contributes significantly to the local ecosystem and supports diverse aquatic life. Zooplankton diversity, abundance, and tolerance levels are widely recognised as effective indicators of water quality deterioration caused by pollution and eutrophication, largely driven by anthropogenic activities. In view of the ecological importance of zooplankton, the present study investigates the seasonal variation and diversity of zooplankton in Hirva Lake.

MATERIALS AND METHODS

Sampling Site

The present investigation was conducted in Hirva Lake, located at Mangalwari Peth near Adarsh Mahavidyalaya, Umred, District Nagpur, Maharashtra, India. Geographically, the lake is situated at 20°51′14″ N latitude and 79°19′29″ E longitude (Fig. 1). Sampling sites were selected based on the representativeness, accessibility, and ecological heterogeneity of the study area. A total of five sampling sites were established for zooplankton analysis: S1 (East), S2 (West), S3 (North), S4 (South), and S5 (Central).

Fig. 1: Satellite image of Hirva Lake

Collection of Zooplankton

Monthly water samples were collected during the morning hours (07:00–08:00 h) from January 2023 to December 2023 for the analysis of zooplankton populations. At each sampling site, 50 L of water was filtered through a plankton net with a mesh size of 56 µm to concentrate the zooplankton, and the filtrate was collected in a bottle attached to the net. The concentrated samples were preserved in 4% formalin. Monthly samples collected from the five sampling sites (S1, S2, S3, S4, and S5) were properly labelled and stored at room temperature until further analysis.

Analysis of Zooplankton

Analyses of zooplankton were carried out following standard procedures prescribed by the American Public Health Association (APHA, 1976). For quantitative estimation, preserved samples were thoroughly homogenized, and subsamples were withdrawn using a wide-mouthed pipette. Zooplankton enumeration was performed using a Sedgwick–Rafter counting cell under a compound microscope. The numerical abundance of zooplankton was expressed as individuals per litre of water filtered. Zooplankton organisms were identified up to the lowest possible taxonomic level based on morphological characteristics observed under the microscope, using standard taxonomic keys and reference literature, particularly Ward and Whipple (1959), Needham and Needham (1972), Adoni (1985), and Battish (1992). Species diversity of zooplankton was assessed using the Shannon–Wiener Diversity Index (SWDI) (Shannon, 1948)

RESULTS & DISCUSSION

The zooplankton analysis of Hirva Lake revealed a rich and diverse community structure, indicating the lake's ecological status. Zooplankton were represented mainly by Rotifera, Cladocera, Copepoda, and Ostracoda during the study period. The present study recorded 17 zooplankton species across all sampling sites in Hirva Lake (Table 1). The study was conducted during the period January 2023 to December 2023. The annual analysis revealed that Copepoda and Ostracoda were equally dominant, each contributing approximately 31% of the total zooplankton population. Cladocerans constituted about 20%, while rotifers accounted for nearly 18% of the total zooplankton community.

The site-wise distribution of zooplankton revealed distinct variations in community structure. At sampling site S1, copepods were the most abundant group, followed by cladocerans and rotifers. At sampling site S2, copepods, ostracods, and cladocerans showed comparatively higher abundance, whereas rotifers were less represented. Site S3 was characterised by a clear dominance of copepods over ostracods, cladocerans, and rotifers. In contrast, sampling site S4 exhibited the dominance of ostracods, followed by cladocerans and rotifers. At sampling site S5, copepods again emerged as the most abundant group, exceeding the populations of ostracods, cladocerans, and rotifers. Overall, all five sampling sites exhibited considerable zooplankton diversity and marked spatial variation in community composition, reflecting differences in local environmental conditions within the lake ecosystem.

Table 1: Zooplankton species recorded from all sampling sites of Hirva Lake during the study period.

Sr. No.	Name of Species	Sampling Sites				
		S1	S2	S3	S4	S5
Group I – Copepoda						
1	*Cyclops sp.*	+	+	+	-	+
2	*Nauplius sp.*	-	+	+	+	+
3	*Microcyclops sp.*	+	-	-	-	+
4	*Diaptomus*	+	+	+	-	-
5	*Helidiaptomus*	+	-	-	-	+
Group II - Ostracoda						
6	*Cypris sp.*	+	-	+	+	+
7	*Pseudocandona sp.*	+	+	_	_	_
8	*Limnocythere sp.*	+	+	_	_	_
9	*Eucypris sp.*	-	+	-	-	+
10	*Paracandona sp.*	-	+	-	+	-
Group III – Cladocera						
11	*Moina macrocopa*	+	+	+	-	-
12	*Moina micrura*	-	+	-	-	+
13	*Macrothrix elegans*	+	-	+	+	+
14	*Sida crystalline*					
Group IV – *Rotifers*						
15	*Brachionus calyciflorus*	+	-	+	-	+
16	*Keratella tropicana*	-	+	-	+	-
17	*Brachionus rubens*	+	-	+	+	+
	Total	11	10	09	08	11

(‘ +’ = Present ; ‘–’ = Absent)

Zooplankton communities play a pivotal role in freshwater ecosystems by regulating phytoplankton populations through grazing pressure and facilitating the transfer of energy to higher trophic levels, including fish (Wetzel, 2001). Zooplankton are the primary consumers of aquatic ecosystems (Dede, 2024). In the present context, variations in zooplankton abundance, diversity, and composition reflect changes in physicochemical conditions and trophic status of the water body. Similar observations have been reported by Wetzel (2001) and Allan and Castillo (2007), who emphasised the sensitivity of zooplankton assemblages to environmental fluctuations.

The dominance of Rotifera in many freshwater systems is often associated with nutrient enrichment and eutrophic conditions due to their rapid reproductive rates and tolerance to environmental stress (Sládeček, 1983; Ismail and Adnan, 2016; Sharma and Sharma, 2018). Conversely, the presence and abundance of Cladocera and Copepoda generally indicate relatively stable and moderately productive waters, as these groups are more sensitive to pollution and require better water quality (Jayabhaye and Madlapure, 2006; Jeppesen et al. 2011; Błędzki and Rybak, 2016). Shifts in the relative abundance of these groups, therefore, serve as reliable indicators of ecological health.

Seasonal fluctuations in zooplankton density are commonly influenced by physicochemical factors, such as temperature, dissolved oxygen, turbidity, and nutrient availability, as well as anthropogenic stressors like pollution and eutrophication (Siddiqui et al. 2025). Higher zooplankton abundance during warmer months may be attributed to increased phytoplankton production and favourable thermal conditions that enhance metabolic and reproductive rates (Lampert and Sommer, 2007). In contrast, reduced diversity during adverse conditions may result from habitat disturbance, reduced dissolved oxygen, or increased pollutants, as reported in earlier freshwater studies (Dodson et al. 2010).

Zooplankton diversity and community composition serve as effective bioindicators for monitoring freshwater ecosystem health and assessing the impact of environmental stressors. Furthermore, anthropogenic activities such as agricultural runoff, urban effluents, and pesticide inputs can significantly alter zooplankton community structure by selectively eliminating sensitive taxa and promoting tolerant species (Hanazato, 2001 and Witeska et al. 2022). Such alterations may disrupt trophic interactions and ultimately affect fish productivity and ecosystem stability. In the present study, the diversity of zooplankton in Hirva Lake may be altered due to municipal waste and runoff from the residential colony. Overall, the observed zooplankton patterns highlight the need for continuous monitoring, as shifts in community structure can serve as early warning indicators of ecological degradation and provide a scientific basis for conservation and management strategies in freshwater ecosystems.

CONCLUSIONS

In Hirva Lake, plankton diversity was found to be appreciably high, with zooplankton occurring in good abundance. Seasonal fluctuations in zooplankton abundance and diversity were evident, with maximum diversity observed during the winter season, followed by the monsoon and summer. The Shannon–Wiener diversity index revealed moderate to high diversity values, suggesting that the lake exhibits mesotrophic to eutrophic characteristics. Seasonal changes influenced variations in zooplankton distribution, driven by changes in physicochemical factors and nutrient availability. Regular monitoring of zooplankton diversity is essential for assessing ecosystem health and for the sustainable management and conservation of the Hirva Lake.

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