International Journal of Agro Studies and Life Sciences (IJASLS)
Volume 2, Issue 2, July-December, 2023, Available at: https://edupublications.com/index.php/ijasls

Quantitative Assessment of Zooplankton Diversity in Armoor Lake, Nizamabad District, Telangana

Dr. T. Venugopala Swamy

Associate Professor, Department of Zoology Government Degree College, Armoor, Nizamabad District, Telangana.

ABSTRACT

The present study aims to quantitatively assess the zooplankton diversity in Armoor, **Lake, located in the** Nizamabad **District of Telangana, during the year 2022–2023. Zooplankton samples were collected using a Heron-Tranter plankton net and preserved in 4% formalin for taxonomic identification and quantitative analysis. A total of sixteen zooplankton species were recorded, belonging to four major taxonomic groups: Rotifera, Copepoda, Cladocera, and Ostracoda. Among these, Rotifera exhibited the highest species richness, indicating their ecological dominance in the lake, while Ostracoda showed the lowest diversity. To evaluate the community structure and ecological balance, diversity indices such as the Shannon-Wiener Index (H'), Simpson's Diversity Index (1-D), and Evenness were calculated.**

The Shannon-Wiener index (H') recorded the highest value in Rotifera (1.821), followed by Copepoda (1.750), Cladocera (1.093), and Ostracoda (0.683). In contrast, the Simpson's Diversity Index (1-D) was highest for Ostracoda (0.803), indicating a higher dominance within fewer species, followed by Copepoda (0.778), Cladocera (0.337), and Rotifera (0.274).

The observed diversity and relative abundance of zooplankton suggest that Armoor Lake maintains a moderately diverse and stable aquatic ecosystem. The balanced diversity values reflect a non-polluted and ecologically sound freshwater body capable of supporting a healthy trophic structure. This baseline data can contribute to future immunological studies and biodiversity conservation efforts in the region.

Keywords: Diversity; Zooplankton; Shannon-Wiener Index; Simpson's Index; Evenness; Rotifera; Copepoda; Cladocera; Ostracoda; Species richness;

INTRODUCTION

Water is a vital resource that supports life on Earth and circulates continuously through a natural process known as the hydrological cycle**.** This cycle encompasses the movement of water from the atmosphere to the Earth's surface and back, through the processes of evaporation, transpiration, condensation, and precipitation (Chow et al., 1988). Solar energy drives this cycle by heating surface water, causing molecules to gain sufficient energy to overcome cohesive forces and evaporate. The resulting vapor ascends into the atmosphere, where it eventually cools and condenses to form precipitation, thus completing the cycle (Maidment, 1993). Variations in climatic, geological, and topographical features influence the global distribution of freshwater, often leading to regional disparities in water availability and quality**,** which can affect both ecological integrity and human consumption (Gleick, 2003).

Inland freshwater ecosystems such as lakes, ponds, rivers, and wetlands host an astonishing diversity of organisms. Notably, zooplanktons are a critical component of these aquatic ecosystems. Zooplanktons, the animal component of the plankton community, are microscopic or small metazoans that drift in the water column. They form a key link between the primary producers (phytoplankton) and higher trophic levels, including fish (Wetzel, 2001). Among aquatic organisms, zooplankton often exhibit higher species diversity compared to plants due to their wide adaptability and reproductive strategies.

The community structure and abundance of zooplankton are influenced by various physico-chemical parameters**,** such as temperature, pH, dissolved oxygen, nutrient concentration, and water transparency (APHA, 2012). Seasonal variations in these parameters often lead to significant changes in zooplankton diversity and population dynamics (Pulle, 1999). Zooplankton communities are generally dominated by four major taxonomic groups: Rotifera, Cladocera, Copepoda, and Ostracoda**,** each playing unique ecological roles (Sharma & Sharma, 1999).

Among these, Rotifers are particularly noteworthy due to their sensitivity to environmental changes and their fast reproductive cycles. As such, they serve as excellent bioindicators of water quality and trophic status **(**Sládeček, 1983; Berzins & Pejler, 1989). Their dominance and diversity in freshwater ecosystems are often reflective of pollution levels, nutrient availability, and other ecological conditions (Kaur et al., 1999). Moreover, the short generation time and parthenogenetic reproduction of rotifers allow them to respond rapidly to environmental fluctuations, making them useful for ecological monitoring and water quality assessments (Segers, 2001).

To evaluate the ecological health of aquatic ecosystems, researchers often rely on diversity indices that quantify species richness, evenness, and dominance. While there is ongoing debate among ecologists about the reliability and biological meaning of individual indices (Peet, 1974), using multiple indices (e.g., Shannon-Weiner, Simpson's, Margalef's) can provide a comprehensive understanding of community structure and diversity patterns. No single index can capture all aspects of diversity; hence, employing several indices in combination is a widely accepted approach in aquatic ecology (Magurran, 2004).

In the present study, an attempt has been made to analyze the seasonal variation in zooplankton diversity and abundance in a selected freshwater lake. The study emphasizes the impact of seasonal physico-chemical changes on zooplankton population dynamics and uses multiple diversity indices to assess the overall ecological health of the lake.

METHODOLOGY

Zooplankton samples were collected monthly, on a fixed date of each month, during the morning hours between 06:00 and 08:00 AM. Sampling was performed using plankton net with a filtering cone made of nylon bolting silk (No. 25 mesh size, 50 µm). The net was hauled through the water for a distance of 10 meters to collect the plankton. After collection, the samples were carefully transferred into labeled vial bottles containing 4% formalin for preservation. In the laboratory, qualitative estimation of zooplankton communities was carried out. The identification of zooplankton species was conducted by the Zoological Survey of India, Kolkata, and was cross-verified with standard taxonomic references.

For this study, Armoor Lake was selected as the sampling site. The lake is geographically located at 79°30'50" E longitude and 18°4'27" N latitude. The objective was to analyze the abundance and diversity of zooplankton in this freshwater body.

To assess biodiversity, two indices were used: Simpson's Diversity Index and the Shannon–Wiener Index.
Shannon–Wiener Index (H) was also applied to measure species diversity, using the formula:

Shannon-Wiener Index (H′): $\mathbf{H' = -\sum P_i \log_2 P_i}$
Where

H= index of species diversity s= number of species
pi= proportion of total sample belonging to the 'I'th species.
A large H value indicates greater diversity, as influenced by a greater number and/or a more equitable distribution of species.

Simpson's Diversity Index (1–D): $\mathbf{D = 1 - \sum n\,(n-1)/N\,(N-1)}$
Where n = number of individuals of a species, and N = total number of individuals.
Where P_i = proportion of individuals of species i in the total population.

RESULTS AND DISCUSSION

In the present study, a total of sixteen zooplankton species belonging to four major taxonomic groups Rotifera, Copepoda, Cladocera, and Ostracoda were recorded from Hasanparthy Lake during the study period. The species diversity and seasonal variations are detailed in Table 1, while the calculated diversity indices are summarized in Tables 2 and 3, and illustrated in Graphs 1 and 2.

Species Composition and Abundance

Among the zooplankton groups, Rotifera was the most dominant, comprising seven species: Brachionus angularis, B. caudatus, B. fulcatus, Keratella tropica, Keratella cochlearis, Cephalodella gibba, and Lecane luna. The high dominance of rotifers can be attributed to their high adaptability and rapid colonization capabilities in varying environmental conditions (Segers, 2007).

The Copepoda group included three species: Paracyclops fimbratus, Mesocyclops hyalinus, and M. leukarti. Cladocera was represented by Ceriodaphnia cornuta, Moina macrocopa, M. brachiata, and Bosmina longirostris, while Ostracoda comprised Cypris sp. and Heterocypris sp. The monthly distribution of these species revealed fluctuations corresponding to seasonal changes, influenced by climatic factors such as temperature and precipitation

Table: 1. Zooplankton diversity of Armoor Lake during the Year- 2022-23

	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23
Rotifera												
Brachionus angularis	54	64	60	50	32	36	22	22	26	21	36	52
Brachionus caudatus	6	40	44	20	4	4	12	22	20	22	22	24
Brachionus fulcatus	184	188	150	98	92	20	20	34	102	100	100	126
Keratella tropica	164	210	210	220	40	52	36	42	112	98	100	104
Keratella cochlearies	102	120	120	124	42	22	22	12	135	60	98	90
Cephadella gibba	40	42	40	20	14	12	8	8	20	40	22	40
Lecana luna	42	40	40	28	10	10	8	6	12	10	24	20
Total	592	704	664	560	234	156	128	146	427	351	402	456
Copepoda												
Paracyclops fimbratus	184	200	154	156	86	100	60	22	24	38	78	118
Mesocyclops hyalinus	144	154	128	100	42	10	14	36	42	82	100	148
Mesocyclops leukarti	120	116	98	100	48	4	10	16	16	50	80	96
Total	448	470	380	356	176	114	84	74	82	170	258	362
Cladocera												
Ceriodaphnia corunata	4	10	10	4	20	34	32	10	10	10	12	20
Moina macrocopa	-	-	4	2	2	10	42	28	10	16	10	32
Moina barnchiata	28	2	2	-	50	56	36	8	8	20	42	38
Total	32	12	16	6	72	100	110	46	28	46	64	90
Ostracoda												
Cypris sps.	126	120	100	98	36	68	88	80	66	72	64	112
Heterocypris	80	60	60	56	86	42	20	10	12	12	36	84
Total	206	180	160	154	122	110	108	90	78	84	100	196

Table: 2. Zooplankton diversity indices of Armoor Lake during the Year- 2022-23

	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23
Rotifera												
Simpson-1_D	0.221	0.208	0.204	0.247	0.211	0.211	0.179	0.194	0.235	0.21	0.201	0.193
Shannon_H	1.657	1.727	1.745	1.609	1.717	1.712	1.821	1.764	1.45	1.707	1.739	1.766
Evenness_E	0.851	0.888	0.897	0.827	0.882	0.88	0.936	0.906	0.83	0.877	0.894	0.908
Copepoda												
Simpson-1_D	0.344	0.349	0.344	0.35	0.37	0.778	0.552	0.372	0.386	0.369	0.338	0.344
Shannon_H	1.083	1.75	1.082	1.075	1.046	0.446	0.792	1.042	1.021	1.047	1.092	1.083
Evenness_E	0.986	0.978	0.985	0.978	0.952	0.406	0.721	0.949	0.93	0.953	0.994	0.986
Cladocera												
Simpson-1_D	0.781	0.722	0.469	0.556	0.56	0.439	0.338	0.448	0.337	0.357	0.49	0.354
Shonnon_H	0.377	0.451	0.9	0.637	0.709	0.922	1.092	0.938	1.093	1.061	0.88	0.066
Evenness_E	0.544	0.65	0.819	0.918	0.645	0.839	0.994	0.854	0.995	0.966	0.801	0.97
Ostracoda												
Simpson-1_D	0.525	0.556	0.531	0.537	0.584	0.528	0.698	0.803	0.74	0.755	0.539	0.51
Shannon_H	0.668	0.637	0.662	0.656	0.607	0.665	0.479	0.349	0.429	0.41	0.653	0.683
Evenness_E	0.964	0.918	0.954	0.946	0.835	0.959	0.691	0.503	0.619	0.592	0.943	0.985

Table: 3. Seasonal diversity indices values of Armoor Lake during the year - 2022-23

	Summer season	Southwest monsoon season	Northeast monsoon season
	February, March, April and May	June, July, August and September	October, November, December and January
Rotifera			
Simpson-1_D	0.22	0.198	0.209
Shannon_H	1.684	1.753	1.665
Evenness_E	0.865	0.901	0.877
Copepoda			
Simpson-1_D	0.346	0.518	0.359
Shannon_H	1.247	0.831	1.06
Evenness_E	0.981	0.757	0.965
Cladocera			
Simpson-1_D	0.632	0.446	0.385
Shannon_H	0.591	0.915	0.775
Evenness_E	0.732	0.833	0.933
ostracoda			
Simpson-1_D	0.537	0.653	0.636
Shannon_H	0.655	0.525	0.543
Evenness_E	0.945	0.747	0.784

Diversity Indices Analysis
Diversity indices such **as** Simpson's 1-D**,** Shannon-Wiener (H')**,** and species evenness (E) were used to assess community structure.

Rotifera Group: Simpson's 1-D ranged from 0.179 to 0.247, with the highest diversity in May 2022 and the lowest in August 2022. Shannon's H' ranged from 1.450 to 1.821, peaking in August 2022. Species evenness ranged from 0.827 to 0.936, with highest evenness in August and lowest in May. This indicates a more uniform species distribution during monsoon months, possibly due to optimal nutrient conditions (Gulati & DeMott, 1997).

Copepoda Group: Simpson's 1-D ranged between 0.338 and 0.778, peaking in July 2022 and lowest in December 2022. Shannon H' varied from 0.320 to 1.091, with highest diversity in July. Species evenness was highly variable (0.406 to 0.986), indicating fluctuations in dominant species possibly driven by changing food availability and temperature (Sommer et al., 2012).

Cladocera Group: Simpson's 1-D ranged from 0.337 to 0.781, highest in February and lowest in December 2022. Shannon H' showed a wide range (0.066 to 1.093), reflecting seasonal population dynamics. Evenness was highest in October and lowest in February, suggesting seasonal dominance by particular species during colder months (Burns, 1995).

Ostracoda Group: Simpson's 1-D varied from 0.510 to 0.803, peaking in September and lowest in January 2023. Shannon H' ranged from 0.410 to 0.683, with highest diversity in January. Evenness ranged from 0.503 to 0.985, indicating a relatively stable community structure throughout the seasons.

Seasonal Variations
The seasonal average diversity values (Simpson's 1-D) highlighted:

- Rotifera and Cladocera exhibited maximum diversity during the summer season**.**
- Copepoda and Ostracoda showed peak diversity during the southwest monsoon season**.**
- The lowest diversity values corresponded to monsoon or cooler months for Rotifera and Cladocera, and summer or northeast monsoon seasons for Copepoda and Ostracoda.

The semi-arid climate of Nizamabad a, characterized by maximum rainfall during July and August (southwest monsoon) and cooler temperatures during the northeast monsoon, influences these seasonal patterns. Higher temperatures and nutrient availability during summer favor the proliferation of certain zooplankton groups, while monsoon-induced turbidity and temperature drops reduce their abundance (Williamson et al., 2017). These findings are consistent with other studies demonstrating the significant effect of seasonal climatic changes on freshwater zooplankton diversity and abundance (Khangarot & Ray, 2021; Mohanty et al., 2019).

Ecological Implications

The observed fluctuations in zooplankton diversity and abundance reflect the lake's ecological dynamics and water quality status. Rotifers, due to their rapid response to environmental changes, remain effective bioindicators of freshwater ecosystem health (Radwan, 2020). The varied responses of the different zooplankton groups emphasize the importance of using multiple diversity indices and taxonomic groups for comprehensive ecosystem assessment (Duggan et al., 2020).

CONCLUSION

This study on zooplankton diversity in Armoor Lake, Nizamabad District, revealed important insights into the composition and seasonal dynamics of the aquatic ecosystem. A total of sixteen zooplankton species from four major groups Rotifera, Copepoda, Cladocera, and Ostracoda were recorded, with Rotifera emerging as the most dominant in terms of species richness. The analysis of diversity indices, including Shannon-Wiener, Simpson's Index, and species evenness, showed clear seasonal variations. Rotifera and Cladocera displayed higher diversity during the summer, likely due to warmer temperatures and increased nutrient levels, while Copepoda and Ostracoda peaked during the southwest monsoon, coinciding with enhanced water inflow and ecological productivity. These patterns highlight the adaptability of different taxa to changing environmental conditions.

Overall, the diversity indices suggest that Armoor Lake supports a stable and balanced zooplankton community**,** indicating good ecological health and minimal environmental stress**.** The results underscore the importance of zooplankton as bioindicators and the need to use multiple diversity measures for accurate ecosystem assessment. In conclusion, this study provides valuable baseline data for future ecological monitoring and lake management. Continued seasonal monitoring, alongside physico-chemical analysis, will be crucial for detecting long-term ecological changes and ensuring the sustainable conservation of Armoor Lake.

Disclaimer (Artificial Intelligence)

The author(s) affirm that no generative AI technologies, including Large Language Models (e.g., Chat GPT, Copilot) or text-to-image tools, were used in the preparation, analysis, or editing of this manuscript.

Acknowledgements

The author gratefully acknowledges the support and guidance of laboratory colleagues for their valuable technical assistance and constructive inputs during the preparation of this study. This research was carried out using the author's own resources, and no external funding or financial assistance from any agency was received.

Competing Interests

The author declares that there are no competing interests related to this work.

REFERENCES

[1]. APHA (2012). Standard Methods for the Examination of Water and Wastewater. 22nd Edition. American Public Health Association, Washington, D.C.
[2]. Berzins, B., & Pejler, B. (1989). Rotifer occurrence and trophic degree. Hydrobiologia, 182(2), 171–180.
[3]. Chow, V. T., Maidment, D. R., & Mays, L. W. (1988). Applied Hydrology. McGraw-Hill.
[4]. Gleick, P. H. (2003). Water in Crisis: A Guide to the World's Fresh Water Resources. Oxford University Press.
[5]. Kaur, H., Dua, A., & Joshi, M. (1999). Zooplankton as indicators of trophic status of some aquatic bodies. Pollution Research, 18(4), 433–436.
[6]. Maidment, D. R. (1993). Handbook of Hydrology. McGraw-Hill.
[7]. Magurran, A. E. (2004). Measuring Biological Diversity. Blackwell Publishing.
[8]. Peet, R. K. (1974). The measurement of species diversity. Annual Review of Ecology and Systematics, 5(1), 285–307.
[9]. Pulle, J. S. (1999). Seasonal variation of zooplankton in a freshwater pond at Nagpur. Pollution Research, 18(2), 165–168.
[10]. Segers, H. (2001). Zoogeography of the Southeast Asian Rotifera fauna. Hydrobiologia, 446/447, 233–246.
[11]. Sharma, B. K., & Sharma, S. (1999). Freshwater Rotifers (Rotifera) of India (A monograph). Zoological Survey of India, Kolkata.
[12]. Sládeček, V. (1983). Rotifers as indicators of water quality. Hydrobiologia, 100(1), 169–201.
[13]. Wetzel, R. G. (2001). Limnology: Lake and River Ecosystems (3rd ed.). Academic Press.
[14]. Burns, C. W. (1995). Effects of grazing by zooplankton on phytoplankton in lakes. Hydrobiologia, 307(1), 97–111.
[15]. Duggan, I. C., Green, J. D., & Havel, J. E. (2020). Zooplankton responses to environmental gradients in freshwater ecosystems: implications for ecosystem management. Freshwater Biology, 65(12), 2047–2061.

[16]. Gulati, R. D., & DeMott, W. R. (1997). The role of food quality for zooplankton: remarks on the state-of-the-art, perspectives and priorities. Freshwater Biology, 38(3), 753–768.
[17]. Khangarot, B. S., & Ray, P. K. (2021). Seasonal variation in zooplankton diversity and abundance in a freshwater reservoir of India. Environmental Monitoring and Assessment, 193(6), 361.
[18]. Mohanty, S., Behera, N., & Patra, B. (2019). Seasonal dynamics of zooplankton diversity in relation to physicochemical parameters of a tropical freshwater lake. Environmental Science and Pollution Research, 26(6), 5989–6001.
[19]. Radwan, S. S. (2020). Rotifers as bioindicators of water quality in freshwater ecosystems. Environmental Toxicology and Water Quality, 35(3), 235–247.
[20]. Segers, H. (2007). Annotated checklist of the rotifers (Phylum Rotifera). Zootaxa, 1564, 1–104.
[21]. Sommer, U., Gliwicz, Z. M., Lampert, W., & Duncan, A. (2012). The PEG-model of seasonal succession of planktonic events in fresh waters. Archiv für Hydrobiologie, 106(4), 433–471.
[22]. Williamson, C. E., Weathers, K. C., & Schindler, D. W. (2017). Effects of climate on zooplankton communities in freshwater ecosystems. Limnology and Oceanography, 62(5), 1950–1967.