SEASONAL OCCURRENCE OF ZOOPLANKTON SPECIES IN INYA LAKE WITH EMPHASIS ON ROTIFER SPECIES

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Abstract

The present study investigated the occurrence and abundance of zooplankton in Inya Lake, Kamayut Township, Yangon, from June 2023 to May 2024. The zooplanktons were collected monthly from the five study sites in Inya Lake; Site I (Approximately 90 m from the Restaurants), Site II (Approximately 240 m from Kan Thar Yar hospital), Site III (Approximately 500 m from Sailing and Rowing Club), Site IV (Approximately 120 m from U.S Embassy) and Site V (Approximately 240 m from Mya Kyune Thar Golf club). They were immediately preserved in 5% formalin after collection and identified based on their morphology and morphometric measurements. The results revealed that a total of 37 species of zooplankton comprising 24 species of rotifers belonging to 8 families and 10 genera, Cladocerans 8 species belonging to 4 families and 6 genera and Copepods 5 species, 4 families and 4 genera were recorded. The collected rotifers were identified and categorized into three sizes: large, small, and super small, based on their body length. The most abundant rotifer species were of small size. Among them, *Brachionus calyciflorus* was the most abundantly occurring species in the freshwater environment. The findings confirm that Inya Lake supports a diverse zooplankton community whose seasonal peaks (wet and cold seasons) and species composition are characteristic of productive freshwater bodies.

Keywords : Inya Lake, Zooplankton, seasonal occurrence, abundance

Introduction

Inya Lake offers essential services to the residents of Yangon. Efforts are now underway to conserve and protect the lake through a biological equilibrium approach to potentially utilize its water during unforeseen emergencies. The lake was originally constructed in 1885 to supplement the water supply to Kandawgyi Lake, which at the time was the primary water source for Yangon (Kalaya-Htun, 2005). Today, Inya Lake is a popular recreational spot for locals and tourists, offering boating, fishing, and relaxation. In addition to its recreational value, the lake plays an important role in the city's ecosystem, regulating temperature and acting as a buffer against flooding during the monsoon season. The food chain is a system in which organisms derive energy from their environment and pass it. Phytoplankton, as primary producers, form the base of the food chain (Treece, 2000). In the lake's ecosystem, zooplankton species, which form the second level of the food chain, are crucial food sources for various invertebrates and fish. Copepods, cladocerans, and rotifers are the main groups of zooplankton found in Inya Lake (Aung Kyaw Zaw, 2017). However, Inya Lake faces threats from pollution and human activities, making it important to balance conservation efforts with the needs of a growing city.

Zooplankton, which are small drifting organisms moved by water currents, play a crucial role in freshwater and marine ecosystems. They are the primary food source for many aquatic

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animals in both flowing and still-water ecosystems, transferring energy from algae to higher trophic levels like fish (Sebastian *et al*., 2014). Zooplankton, particularly rotifers, are vital in maintaining the ecological balance of freshwater systems like Inya Lake. They play a critical role in the food chain between primary producers and higher-level consumers.

Understanding the seasonal dynamics of zooplankton populations is important for ecological conservation and practical applications such as aquaculture. While Inya Lake supports a variety of zooplankton species, the impact of seasonal environmental changes on these populations remains understudied. Zooplankton are highly sensitive to environmental changes and serve as excellent indicators of water quality due to their short life cycles, allowing them to respond rapidly to changes in water conditions. They play a key role in indicating eutrophication status and overall productivity of freshwater bodies.

Among the zooplankton species, rotifers are well known due to their value in aquaculture. Particularly, rotifers are of interest due to their potential as live feed in aquaculture, especially in the early developmental stages of fish larvae. The present study focused on identifying the dominant zooplankton species in different areas of Inya Lake by seasons, with a particular emphasis on domestic rotifer species suitable for aquaculture. The aim was to study the occurrence of zooplankton species and the abundance of native rotifer species in Inya Lake to assess potential candidates for live food production.

Materials and Methods

Sampling site and the study period

The five different sites were selected as the sampling sites for water collection in Inya Lake. There were Site I (Approximately 90 m from the Restaurants by the lake's banks), Site II (Approximately 240 m from Kan Thar Yar hospital), Site III (Approximately 500 m from Sailing and Rowing Club), Site IV (Approximately 120 m from U.S Embassy) and Site V (Approximately 240 m from Mya Kyune Thar Golf club) Fig.(1).

Figure. 1. Map of the Study Area (Source: Google)

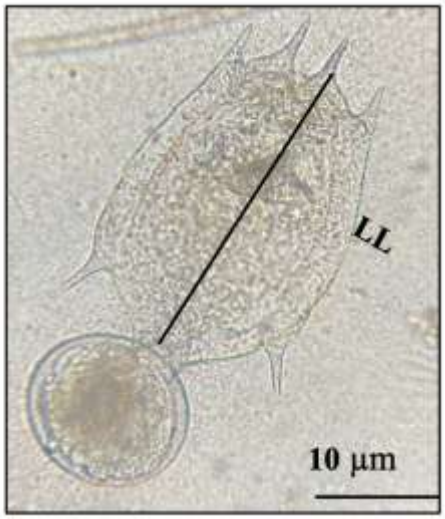
Collection of zooplankton in Inya Lake

Zooplankton were monthly collected from five study sites of Inya Lake. The collection was done between 6:00 – 9:00 am in a morning at approximately 0.5-1 m depth of water. A plankton net with a mesh size of 50 µm and a diameter of 40 cm was used to collect the zooplankton (Plate 1). The plankton samples were collected by filtering 30 mL of water through the plankton net. After collection, the plankton samples were filtered into the plastic bottles. Collection samples of 30 mL were mixed and preserved in 0.04 mL of 5% formalin in the plastic bottles. The preserved plankton specimens were examined under an inverted microscope (Olympus CKX 41). Identification of the zooplankton was followed according to Witty (2004), Shiel (1995), and Islam *et al*. (2022).

Classification of rotifer species

The collected rotifers were identified under an inverted microscope. Totally 100 individuals of each identified rotifer species were measured (Lavens and Sorgeloos, 1996). Based on the Lorica Length, the rotifers were classified as Large type (L-type) (lorica length ranging from 130 to 340 µm), Small type (S-type) (lorica length ranging from 100 to 210 µm), and Super small type (SS-type) (lorica length ranging from > 100 µm) (Plate 2).

Plate 1. Drifting water through the plankton net.



LL - Lorica Length

Plate 2. *Brachionus calyciflorus* (Palls, 1766)

Water quality analysis

The physico-chemical parameters Dissolved Oxygen (DO), Ammonia, Total Dissolved Solids (TDS), and pH of water samples collected from each study site were monthly recorded using the Test kit.

Data calculation

Species richness, abundance, and species diversity indices were calculated as follows:

(a) Species richness = Number of recorded species in the study area.
(b) Abundance = Number of individuals in study sites.
(c) Shannon-Weiner index of Diversity (1949)

$$H' = -\sum_{i=1}^{s}(P_i)\ (log_2 P_i)$$

$$P_i = S/N$$

H´ = Shannon-Weiner index of species diversity
S = Number of individuals of each species in the sample
N = Total number of individuals of all species in the sample
Pi = Proportion of individuals belonging to species

(d) Pielou's Evenness or Equitability (Pielou's, 1966).

$$J = \frac{H'}{log2S}$$

H´ = Shannon Weiner index
S = Total number of species
J = Distribution of individuals among species

Results

Occurrence and abundance of zooplankton species in Inya Lake

The 37 zooplankton species were recorded from five study sites (Plates 3) under three major groups of zooplankton: Rotifers, Cladocerans, and Copepods in the study lake (Table 1).

Rotifers belonged to two classes, two orders, and eight families: Brachionidae, Testudinellidae, Philodinidae, Lecanidae, Synchaetidae, Asplanchnidae, Trichocercidae, and Conochilidae. The family Brachionidae had the highest abundance, with 6,012 individuals. The second most abundant family was Testudinellidae, comprising 3,056 individuals, followed by Asplanchnidae with 1,499 individuals. Synchaetidae accounted for 243 individuals, Conochilidae for 123 individuals, Trichocercidae for 107 individuals, Philodinidae for 72 individuals, and Lecanidae for just one individual.

Cladocerans belonged to one class, three orders, and four families: Daphniidae, Moinidae, Sididae, and Chydoridae. The family Daphniidae had the highest number of individuals, with 2,338 recorded. Moinidae followed with 2,244 individuals, while Chydoridae and Sididae had 50 and 67 individuals, respectively.

Copepods belonged to three classes, three orders, and four families: Cyclopidae, Calanidae, Harpacticidae, and Centropagidae. Cyclopidae was the most abundant, with 12,855

individuals, followed by Calanidae with 2,483 individuals. Harpacticidae and Centropagidae were the least abundant, with 39 and 12 individuals, respectively.

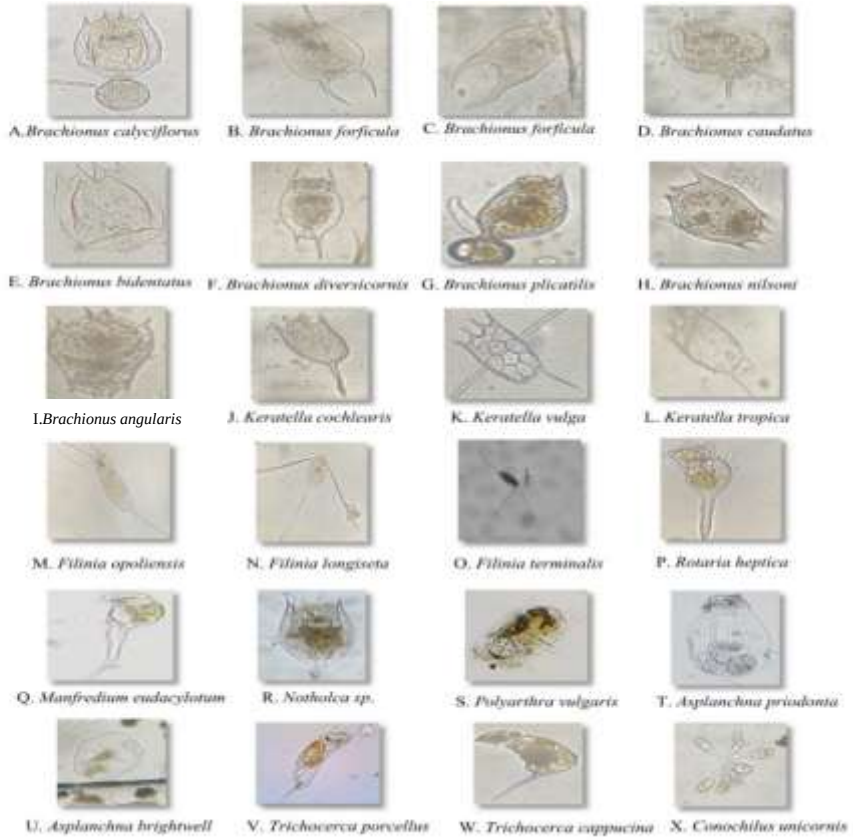


Plate 3. Recorded zooplankton species in Inya Lake (40×)

Table 1. Abundance of zooplankton in Inya Lake from June 2023 to May 2024

Phylum	Order	Family	Site I	Site II	Site III	Site IV	Site V
Rotifera	Ploima	Brachionidae	919	1298	1129	1256	1410
		Testudinellidae	537	613	525	652	729
		Philonidae	3	21	23	13	12
		Lecanidae	-	-	-	-	1
		Synchaetidae	58	48	43	47	47
		Asplanchnidae	283	365	351	245	255
		Trichocercidae	32	10	12	28	25
	Flosculariaceae	Conochilidae	67	36	4	9	7
Cladocerans	Anomopeda	Daphniidae	532	553	487	427	339
	Cladocera	Moinidae	554	549	474	351	316
		Sididae	20	4	11	3	12
	Diplostraca	Chydoridae	14	15	16	17	5
Copepods	Cyclopoida	Cyclopidae	2708	2898	2404	2243	2602
	Calanoida	Calanidae	675	566	422	420	400
		Centropagidae	7	5	-	-	-
	Harpacticoida	Harpacticidae	5	12	22	-	-
Total			6414	6993	5923	5711	6160

Monthly occurrence of zooplankton species in Inya Lake

At site I, the abundance of rotifer species reached its peak in January 2024, with the lowest abundance observed in June 2023. Cladocerans observed with a peak in October 2023, with their lowest levels also recorded in June 2023, whereas copepods peaked in August 2023 and reached their minimum in April 2024.

At Site II, rotifer species peaked in February 2024, with a minimum abundance in June 2023. A peak of cladocerans was found in August 2023, and the lowest abundance was in June 2023. Copepods peaked in August 2023 and reached their lowest abundance in April 2024. Rotifers also reached their peak abundance in February 2024, with the lowest levels in June 2023 at site III. Cladocerans peaked in October 2023 and showed their lowest abundance in June 2023, while copepods peaked in August 2023 and a minimum in April 2024.

At Site IV, the peak abundance of rotifer species occurred in February 2024, with the lowest abundance recorded in May 2024. Cladocerans reached a peak in November 2023 and were at their lowest in June 2023. Copepods peaked in July 2023 and displayed their minimum abundance in April 2024.

At Site V, rotifers reached their peak abundance in February 2024, with the lowest levels recorded in May 2024. Cladocerans peaked in November 2023, with their minimum abundance observed in July 2023. Copepods exhibited the highest abundance in June 2023 and reached their lowest levels in April 2024, as shown in Fig. 1.

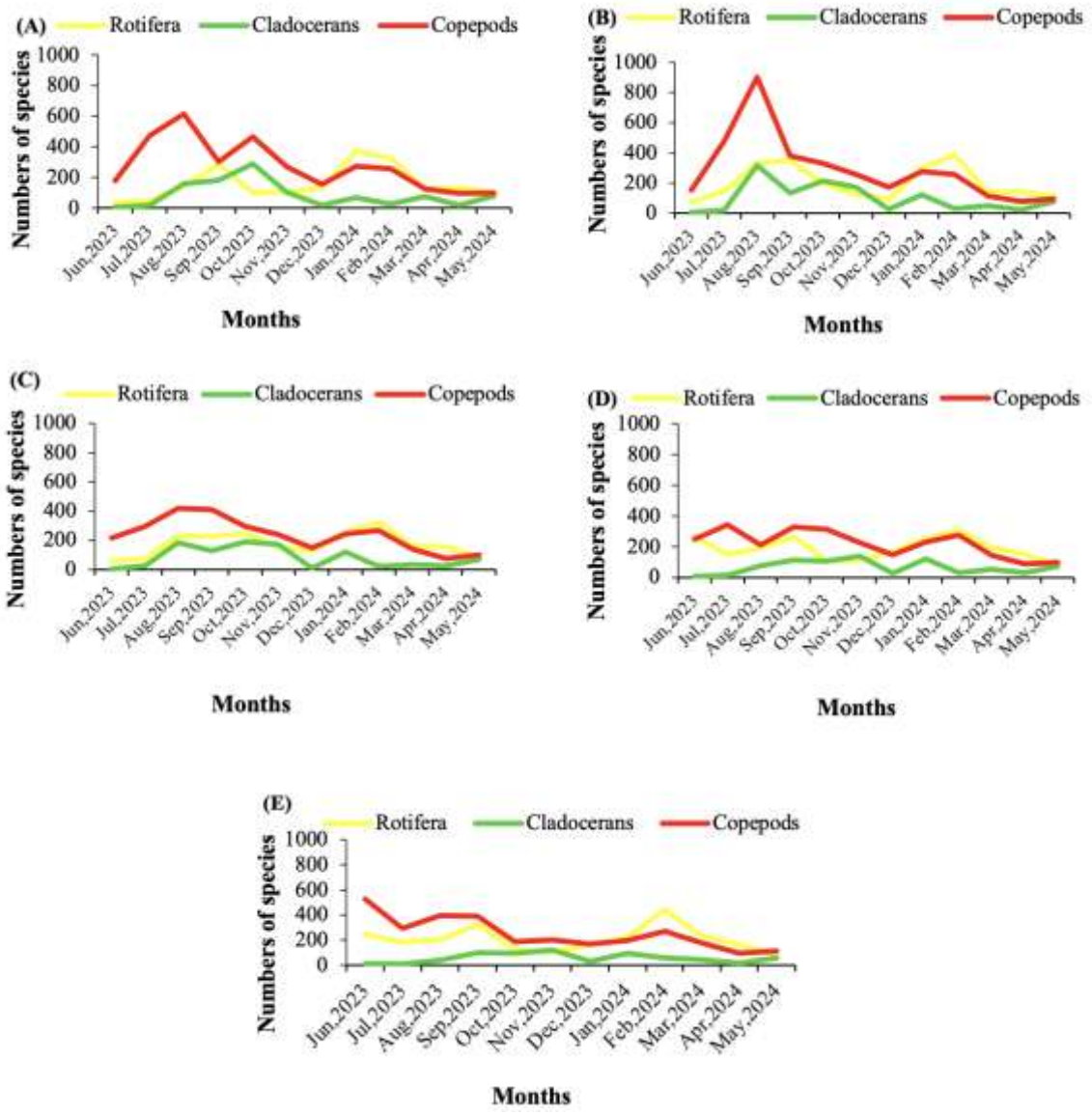


Figure. 1. Abundance of zooplankton species in five study sites during the study period (A)Site I, (B) Site II, (C) Site III, (D) Site IV and (E) SiteV

Species richness, population, diversity, and evenness of zooplankton species

The analysis of diversity indices across the five study sites reveals notable variation in species composition and distribution. Species richness was highest at Site III (32 species) and lowest at Site V (26 species), indicating slight differences in the number of species present. Abundance peaked at Site II (6993 individuals), while Site IV recorded the lowest count (5711), suggesting differences in population density. The Shannon-Weiner diversity index (H') was relatively consistent across sites, ranging narrowly from 2.419 (Site V) to 2.499 (Site III), reflecting a moderate and fairly uniform level of species diversity. Evenness values were also closely aligned, with Sites IV and V showing slightly higher evenness (0.741 and 0.743, respectively), indicating a more equitable distribution of individuals among species in those locations. Overall, while species counts and abundance varied, diversity and evenness remained fairly stable across all sites in Table 2.

Table 2. Comparison of species richness, diversity indices and evenness of zooplankton in five study sites.

No	Diversity indices	Site I	Site II	Site III	Site IV	Site V
1	Species Richness	29	31	32	28	26
2	Population	6414	6993	5923	5711	6160
3	Shannon-Weiner index (H')	2.43	2.464	2.499	2.468	2.419
4	Evenness (E)	0.722	0.718	0.721	0.741	0.743

Size classes of identified rotifers

In the present work, to select the possible zooplankton species for livefood production, rotifer species were categorized into three size classes: large (L), small (S), and super small (SS), based on lorica Length (Table 3). Four species were classified as large rotifers, including *Rotaria heptica* (608±130.11µm), *Notholca* sp. (250±353.55µm), *Asplanchna priodonta* (416±282.84µm), and *Asplanchna brightwell* (341±176.78µm). Twelve species were categorized as small rotifers, with *Brachionus calyciflorus* (200±70.71µm) and *B. falcatus* (115±21.21µm) being the most abundant. Other notable small species included *Keratella cochlearis* (90±42.43µm), *Filinia opoliensis* (110±70.71µm), and *Polyarthra vulgaris* (108±59.40µm). The super small rotifer group comprised eight species, with *Keratella vulga* (90±14.14µm) and *K. tropica* (83.5±23.33µm). Among the recorded rotifer species, *Brachionus calyciflorus* was the most abundant, which was classified as "S" size rotifer.

Table 3. Recorded rotifer species with the respective "Lorica Length" in Inya Lake during the study period

Sr. no	Species	Lorica Length (µm)	Remark	Numbers of recorded individuals during study period in all study sites
1	*Brachionus calyciflorus*	(200±70.71)	S	2,572
2	*Brachionus falcatus*	(115±21.21)	S	2,079
3	*Brachionus forficula*	(98±25.46)	S	977
4	*Brachionus caudatus*	(150±70.71)	S	79
5	*Brachionus bidentatus*	(91±35.36)	S	8
6	*Brachionus diversicornis*	(150±70.71)	S	264

Sr. no	Species	Lorica Length (µm)	Remark	Numbers of recorded individuals during study period in all study sites
7	*Brachionus plicatilis*	(174.5±58.69)	S	10
8	*Brachionus nilsoni*	(116.5±47.38)	S	8
9	*Brachionus angularis*	(75±21.21)	SS	14
10	*Keratella cochlearis*	(90±42.43)	S	1,086
11	*Keratella valga*	(90±14.14)	SS	691
12	*Keratella tropica*	(83.5±23.33)	SS	743
13	*Filinia opoliensis*	(110±70.71)	S	501
14	*Filinia longiseta*	(41.5±58.69)	SS	2
15	*Filinia terminalis*	(91.5±12.02)	SS	33
16	*Rotaria heptica*	(608±130.11)	L	72
17	*Manfredium eudacylotum*	(107.5±152.03)	S	1
18	*Notholca* sp.	(250±353.55)	L	1
19	*Polyarthra vulgaris*	(108±59.40)	S	243
20	*Asplanchna priodonta*	(416±282.84)	L	1,044
21	*Asplanchna brightwell*	(341±176.78)	L	455
22	*Trichocerca porcellus*	(58±35.36)	SS	55
23	*Trichocerca capucina*	(58±35.36)	SS	52
24	*Conochilus unicornis*	(52.5±24.75)	SS	123

Discussion

The structure of the zooplankton community in Inya Lake was studied through monthly surveys over a year. The result revealed 37 zooplankton species belonging to three groups: rotifers, cladocerans, and copepods. Among these rotifers was the most dominant group, followed by cladocerans and copepods. Specifically, 24 species of rotifers from 8 families and 10 genera were recorded. There were also 8 species of cladocerans from 4 families and 6 genera, and 5 species of copepods from 4 families and 4 genera. The family Brachionidae was the most dominant and diverse among the rotifers throughout the study period. These species are commonly found in eutrophic waters (Berzins and Pejler, 1989; Sampaio and Slopez, 2000). This pattern is common in lakes, ponds, reservoirs, and rivers (Neves *et al.*, 2003).

In different study sites, 15 families in Site I, and Site II, 14 families in Site III and Site V, and 13 families in Site IV.

In Site I, 7 families of rotifers, 4 families of cladocera, and 4 families of copepods were recorded. In Site II, 7 families of rotifers, 4 families of cladocera, and 4 families of copepods were recorded. In Site III, 7 families of rotifers, 4 families of cladocera, and 3 families of copepods were recorded. In Site IV, 7 families of rotifers, 4 families of cladocera, and 2 families of copepods were recorded. In Site V, 8 families of rotifers, 4 families of cladocera, and 2 families of copepods were recorded. Thus, the result noted that rotifers were the dominant species at all study sites. Similarly, Aung Kyaw Zaw (2017) observed three groups of zooplankton rotifers, cladocerans, and copepods. The rotifers were the dominant group, showing 65% in Inya Lake and 71% in Kandawgyi Lake.

The highest diversity was observed in August and September 2023, and the lowest in April 2024. Aung Kyaw Zaw (2017) reported that the more number of zooplankton species were observed in the wet season, followed by the cool season and the dry season. Chandraseker (1996) showed that the water temperature, turbidity and transparency, and dissolved oxygen were favorable for rotifer population. Also, Sukumaran and Das (2001) studied plankton abundance with the physico-chemical features of Manchribele reservoir in Bangalore, India. They reported that high chloride content and optimal temperature were favorable for zooplankton in different seasons. The low population was encountered in the hot season (April and May). Among them, the population density of rotifers is high in the cold season and less in summer. In cold seasons with low temperature and normal DO content, some factors influence the growth, reproduction, and mortality of zooplankton, such as depth, pH, nutrients, sunlight, and temperature (Gyllstrom and Hansson, 2004). The present study observed that the copepods (cyclopoid, calanoids) contributed the highest abundance and biomass of the three major groups almost every month in Inya Lake, which was similar to the result from Perez *et al*. (2008) and Papa and Zafaralla (2011). They are found to be dominant in oligotrophic lakes.

In the present study, three groups of zooplankton-rotifers, cladocerans, and copepods were analyzed, focusing on the 24 rotifer species identified based on lorical Length (Lavens and Sorgeloos, 1996), classified into three size categories: Large, Small, and Super Small.

Among the Large-sized rotifers (608±130.11µm), four species were recorded, including one species from the Brachionidae family, one from Philodinidae, and two from Asplanchnidae. In the Small-sized group (200±70.71µm), twelve species were identified, including eight from Brachionidae, two from Testudinellidae, one from Lecanidae, and one from Synchaetidae. In the Super Small-sized group (83.5±23.33µm), eight species were recorded, consisting of one from Brachionidae, four from Testudinellidae, two from Trichocercidae, and one from Conochilidae.

In this study, *Asplanchna priodonta* (Asplanchnidae) was the most frequently recorded species among the Large-sized group. In the Small-sized group, *Branchionus calyciflorus* (Brachionidae) had the highest number of individuals, while *Keratella tropica* (Testudinellidae) was the most abundant species in the Super Small-sized group, respectively. This study highlights the variation in size and abundance of rotifers across the study sites, offering important insights into the composition of rotifer communities.

Conclusion

The present study documented the species composition and seasonal variation of zooplankton in Inya Lake. Totally 37 zooplankton species of 16 families under seven orders across six classes, were recorded. The highest seasonal variation occurred during the wet season, while the lowest was observed in the hot season. The family Brachionidae showed a peak in abundance during the cold season. The greatest number of individuals was found in August and September, with the lowest in April. A notable abundance of the small-sized species *Brachionus calyciflorus* was recorded at Site V. These findings suggest that the nutrient availability, habitat conditions, and overall environmental quality of Inya Lake remain favorable for supporting zooplankton populations. Further studies are necessary to understand the community structure and ecological dynamics of the zooplankton in Inya Lake.

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References

Aung Kyaw Zaw, 2017. *Comparison of Diversity and Abundance of Zooplankton in Inya Lake and Kandawgyi Lake, Yangon Region*. *Ph.D Dissertation*, Department of Zoology, University of Yangon.

Berzins, B. and Pejler, B. 1989. Rotifer occurrence in relation to temperature. Hydrobiologia, 175: 223- 231.

Chandrasekhar SVA. 1996. Zooplankton studies on KeoladeoGhana National Park, Bharatpur, Rajasthan, withspecial reference to Rotifera and Cladocera. Rec ZoolSurv India,2010:110(1):93-101.7.

Gyllstrom, M., Hansson, L.A. 2004. *Dormancy in freshwater Zooplankton: Induction, termination and the importance of benthic-pelagic coupling*. *Aquatic Sciences* 66 (3): 274-295

Islam, M. S., Azadi, M. A., Nasiruddin, M., Islam, M. T. 2022. Checklist of Zooplankton of the Halda River, Chattogram, Bangladesh. *J Biores Manag*. 9 (1): 110-122

Kalaya-Htun. 2005. *Limnology of Inya Lake* (In Part) *M.Res*. Thesis. Arts and Science University, Yangon.

Lavens, P., Sorgeloos, P. 1996. *Manual on the production and use of live food for aquaculture.* FAO Fisheries Technical Paper. No. 361: 295

Neves, I.F., Recha, O., Roche, K. F. and Pinto, A., 2003. Zooplankton community structure of two marginal lakes of the river Cuiaba (Mato Grosso, Brazil) with analysis of Rotifera and Cladocera diversity. *Brazilian Journal of Biology* 63: 1-20.

Papa, R.D.S., Zafaralla, M.T. 2011. The composition, diversity and community dynamics of limnetic zooplankton in a tropical caldera lake (lake taal, philippines), *The raffles bulletin of zoology*. 59 (1): 1-7

Perez, T., Enriquez, E.E., Guerrero, R.D. III, Simon, D. and Schiemer, F. 2008. Catchment characteristics, hydrology, limnology and socio-economic features of Lake Taal, Philippines. In: Schiemer, F., Simon, D. U.S. Amarasinghe and Moreau, J. (ed.), Aquatic ecosystems and development: comparative Asian perspectives. Biology of inland waters series. Backhuys Publishers Leiden, The Netherlands. 63–80

Sampaio, E-V. SLOPEZ, C.M. 2000. *Zooplankton community composition and some Limnological aspects of an oxbow Lakes of the Paraopeba River, Sao Francisco River Basin, Minas Gerais, Brazil. Braz, Arch*. Biol. Technol, 43: 285-293

Sebastian, J., K., Sadanand, M. and Yamakanamardi, S. M. (2014). Seasonal variations in the abundance of zooplankton groups in relation with physico- chemical parameters content. Aquatic Microbial Ecology Laboratory, Department of Studies in Zoology, University of Mysore, India. Cladocerans and Copepods from Australian Inland Waters: Identification Guide Series No.3 151

Shiel RJ, 1995. A Guide to Identification of Rotifers, Cladocerans and Copepods from Australian Inland Water. Co-operative Research Centre for Freshwater Ecology, Murry-Darling Freshwater Research Centre, Ellis Street, Thurgoona.144pp.

Smirnova, T.S., Smirnova, T.S. 1982. Zooplankton. In: Petrova N. A. (ed.), Anthropogenic eutrophication of Lake Ladoga. Nauka, Leningrad, pp. 173–180

Sukumaran, P.K. and Das, A.K. (2001). Distribution of plankton in some freshwater reservoirs of Karnataka. Journal of the Inland Fisheries Society of India, 33: 29-36.

Treece, G.D. 2000. "*Zooplankton Culture*", Texas Grant College Program, Bryan, Texas, 901-905

Witty, L.M. 2004. *Practical Guide to Identifying Freshwater Crustacean Zooplankton, 2nd edition, CooperativeFreshwater Ecology,* Pg.161