ZOOPLANKTON DIVERSITY IN RELATION TO WATER QUALITY IN TAUNGTHAMAN LAKE

Eindra Htoo Kyaw[1], Win Maw Oo[2]

Abstract

Study on zooplankton diversity in relation to water quality of Taungthaman Lake was carried out from July 2014 to February 2015. A total of 29 species of zooplankton comprising 21 species of rotifer, 6 species of cladocera and 2 species of copepod were recorded. In the present study, the highest species richness of rotifer was observed as compare to cladocera and copepod population in Taungthaman Lake. Among the zooplankton groups, *Mesocyclops leckurti* was the dominant species and *Microcyclops* sp. was sub-dominant. Temperature was little effect on the zooplankton population. The pH of the lake water was influence on the zooplankton population and Dissolved Oxygen concentrations seem to be limiting factor on the zooplankton population in Taungthaman Lake.

Key words: Rotifera, Cladocera, Copepoda

Introduction

Zooplankton are microorganisms that float freely in the surface water column of water bodies, these are important food material for fish and invertebrate predators.

Zooplankton also plays a very important role in the food chain as they are in the second trophic level as primary consumer and also as contributors to the next trophic level. Both the qualitative and quantitative abundance of plankton in a fish pond are of great importance in managing

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the successful aquaculture operation, as they vary from location to location and pond to pond within the same location even within similar ecological conditions (Koli & Muley, 2012).

Water is an important source for living organisms on the earth. Day by day exploitation of human population water resources are polluted due to increased domestic sewage water, increased industrial, urbanization and agricultural activity. Water bodies contain large number of chemical substances. Physico-chemical characteristics of water body play a significant role in composition, distribution and abundance of aquatic organisms in the lake. The water quality assessment and planktonic study are very important to determine the nature of the lake. Lakes are most essential water bodies in rural area contributing to drinking water, agricultural practices, aquaculture, ground water charging, and sustainable development of flora and fauna (Sivalingam *et al*., 2013).

Increased supply of nutrients due to anthropogenic activities (sewage, industrial effluents, fertilizer run off from agricultural fields) changes the lake ecosystem causing eutrophication. Lakes with low supply of nutrients are called oligotrophic, while those with high nutrients are called eutrophic. Continuous eutrophication results from autotrophic production of internal organic matter by primary producers (photosynthetic plants and algae) from nutrients available in the lake, derived either from external sources (anthropogenic activity in the catchment) or internal recycling (decay of organic matter and dissolution from bottom sediments).

In many shallow lakes, eutrophication may be manifested in macrophytic growth rather than phytoplankton. Efficient utilization of nutrients depends on several factors, which define the growth condition and hence the resultant biomass production at the primary producer level. Grazing of phytoplankton by zooplankton (secondary producer) and predation by fish (tertiary consumers) represent carbon transfer system of the lake (Welch, 1948).

Taungthaman Lake is one of the important producer for food fish in Upper Myanmar. It is well known for the number of fishes caught each year and small prawns support to local consumption of Mandalay environs. In the lake, three groups of zooplankton namely, Rotifera, Cladocera and Copepoda formed the dominant faunal groups.

Zooplankton plays an important role in indicating the water quality, eutrophication status and productivity of a freshwater body (Mikschi, 1989).

Thus in order to find out the status of a freshwater body it is necessary to observe seasonal diversity and abundance of zooplankton.

Therefore, the aims of the present study were to examine the species diversity and to evaluate the abundance of zooplankton in relation to measure water quality parameters of Taungthaman Lake.

Materials and Methods

Study Area

Taungthaman Lake is located in the Amarapura township between 21° 53' N to 21° 54' N latitude and 96° 03' E to 96° 05' E longitude (Fig-1).During the rainy season, the water body of the lake is approximately 607 ha and is about 324 ha during hot season.

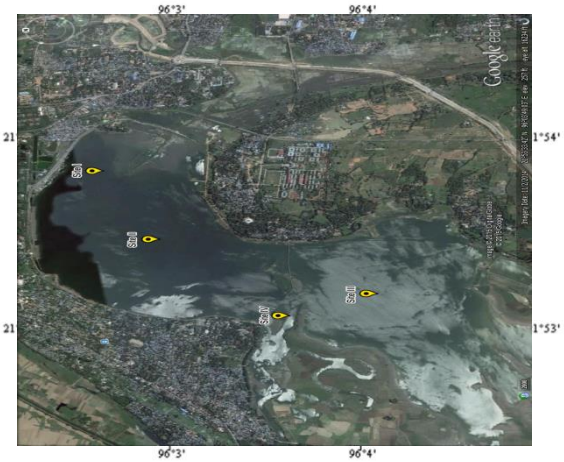


Fig 1. Location of the sampling sites in Taungthaman Lake, (Source from Goggle)

Taungthaman Lake was a large flood plain transformed into a permanent lake by the construction of water control gates.

During the rainy season, the main body of the lake received water from the Ayeyawady river, through channel in the west. Water flows into the lake through Yekyi bauk Chaung and to a lesser extent from the Myit Nge River through the Let koke pin Chaung. Waste water from Payandaw Chaung also flowed into the north–east of Taungthaman Lake.

Collection of Sample

Zooplankton samples were collected monthly form four different sites of Taungthaman Lake. Sampling was made between 8:00 am to 10:00 am. Site I is near inlet of waste water from Payandaw Chaung. Site II is northern part of the U Pein's bridge and Site III is southern part of the U Pein's bridge. Site IV is at the connection of lake with river mouth.

The plankton samples were collected by plankton nylon net with a mouth diameter of 12 cm and 50 µm mesh size. The plankton samples were hauled vertically from the surface water column.

Preservation and Identification

The final volume of the filtered sample 150 ml, which was transferred to another 150 ml plastic bottle and labeled mentioning the time, date and place of sampling . The samples collected in 150 ml plastic bottles were preserved by adding 5 ml of 4% formaldehyde solution. The quantitative analyses of plankton populations were done by counting the numbers in each species. The samples were identified under a compound microscope with magnification of 4x10, 10x10 and 10 x 40. For species identification, the following references were used; Edmonson (1966), Pennak (1989), Shiel (1995), Witty (2004) and Segers (2007).

The specimens were measured by using calibrated eye–pieces micrometer. Microphotographs were taken with cannon digital camera attached to compound microscope.

Water Quality Parameters

Various types of water quality parameters such as water depth, water temperature, pH, Dissolved Oxygen (DO) concentrations and Biological Oxygen Demand (BOD) were measured to relationship among measured parameters. Water samples were collected from four sampling sites and transported to laboratory of Water Supply and Sanitation Department, Mandalay City Development Council for analysis.

Water temperature and Water depth were recorded immediately at study site. Water temperatures of the studied areas were measured by mercury thermometer.

Analysis of Data

Shannon-weiner diversity is commonly used to species diversity in a community.Shannon's index accounts for abundance and evenness of the species present.

Shannon-weiner Diversity index (1949)

$$H' = -\sum_{i=1}^{s} pi \, ln pi$$

$$Pi = \frac{n_i}{N}$$

Where, Pi = The proportion of species i relative to the total number of Species

n_i = The number of individual of i species of the sample

N = The total number of individuals in the sample

A large H value indicates greater diversity, as influenced by a greater number and/ or a more equitable distribution of species.

Shannon s equitability (E_H) can be calculated by dividing H by H_{max}

$$E_H = \frac{H}{Hmax}$$

Where E_H = evenness index

H' = The Shannon Weiner index

H_{max} = log S

S = the number of species

Equitability assumes a value between 0 and 1 with 1 being complete eveness.

The species richness of zooplankton were calculated by Margalef (1969)

$$R = \frac{(s-1)}{ln N}$$

R = Margalef's Species Richness Index

S = The number of Species

N = The total number of Species individuals

The Index of Dominance (ID) represents the percentage of abundance contributed by two most abundant species and calculated according to formula by Menhinick (1964).

$$ID = 100 \times \frac{Y_1 + Y_2}{Y}$$

Y_1 = most abundant species

Y_2 = second abundant species

Y = total abundance of all species

Results

A total of 29 species of zooplankton comprising 21 species of rotifer, 6 species of cladocera and 2 species of copepoda were recorded in the present investigation. (Table.1)

The percentage composition of zooplankton in Taungthaman Lake, rotifer constituted (46.55%) of the total zooplankton and the cladocera constituted (8.31%) and the copepod constituted (45.14%)(Figure.2).

Variation in population density of different zooplankton groups in four sampling sites from Taungthaman Lake during the present study was shown in Fig 3.

Comparison have been made among the sampling sites during the period of study showed that the highest population density of Rotifer was observed at site I in August; that of Cladocera at site III in August and site IV in September and Copepoda at site IV in October.

Diversity indices of zooplankton in Taungthaman Lake

Diversity indices of different zooplankton groups in four sampling sites from Taungthaman Lake during July 2014 to February 2015 was presented in Table.2.

Shannon -weiner diversity index (H)

Shannon-Weiner diversity index (H') of rotifer ranged from (0.47-2.2). The highest diversity was recorded at site II in August and lowest at site IV in November. The cladocera diversity index (H') ranged from (0.00-1.27). The highest diversity was recorded at site II in October and lowest at site II in November. The copepod diversity index (H') ranged from (0.00-0.71). The highest diversity was recorded at site IV in February and lowest at site I in August.

Evenness diversity index (E_H)

The rotifer evenness diversity index (E_H) ranged from (0.47-2.19). The highest diversity was recorded at site II in November and lowest at site IV in November. The Cladocera evenness diversity index (E_H) ranged from (0.00-2.3). The highest diversity were recorded at site I in December, site III in October and site IV in November and lowest at site II in November. The copepod evenness diversity index (E_H) ranged from (0.00-2.3). The highest diversity was recorded at site I in October, site II in July, August, October and lowest at site I in August and site III in December.

Zooplankton richness

Species richness of rotifer ranged from (0.81-3.46). It was highest at site I in November and lowest at site I in February. Species richness of cladocera ranged from (0.00-1.82). The highest richness value was recorded at site I in December and February and lowest value at site II in November. Species richness of copepod ranged from (0.00-0.51). The species richness values of copepod were not different throughout the study period.

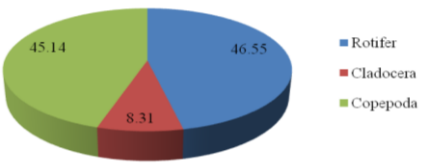


Figure 2. Percentage composition of zooplankton in Taungthaman Lake

Table .2 Diversity indices of four sampling sites from Taungthaman Lake

A. Diversity index in Site I

Month	Rotifer			Cladocera			Copepod		
	H'	R	E_H	H'	R	E_H	H'	R	E_H
July	1.413	1.55	1.36	0.56	0.48	1.87	0.68	0.51	2.26
August	1.625	2.00	1.42	0.53	0.46	1.76	0.00	0.00	0.00
September	1.425	2.89	1.32	1.03	0.75	1.71	0.61	0.25	2.01
October	1.808	2.61	1.50	1.08	0.43	2.26	0.69	0.15	2.30
November	2.168	3.46	2.08	0.71	1.00	1.18	0.68	0.32	2.25
December	1.388	1.91	1.45	1.10	1.82	2.30	0.60	0.38	1.99
January	1.752	1.94	1.62	0.65	0.73	1.08	0.47	0.16	1.55
February	0.956	0.81	1.37	1.10	1.82	2.30	0.33	0.29	1.08

Index of Dominance(ID)=46.40%

B. Diversity index in Site II

Month	Rotifer			Cladocera			Copepod		
	H'	R	E_H	H'	R	E_H	H'	R	E_H
July	2.106	1.77	2.11	1.01	0.80	2.12	0.69	0.25	2.30
August	2.204	1.94	2.12	0.97	0.80	2.03	0.69	0.24	2.28
September	2.004	3.17	1.80	1.02	0.74	2.14	0.61	0.25	2.01
October	1.144	1.94	1.27	1.27	0.84	2.11	0.69	0.17	2.30
November	1.847	2.27	2.19	0.00	0.00	0.00	0.47	0.42	1.58
December	1.313	2.00	1.22	1.04	0.96	2.18	0.68	0.26	2.26
January	1.253	1.27	1.39	0.53	0.25	1.77	0.51	0.16	1.68
February	1.100	1.24	1.23	0.62	0.26	2.04	0.55	0.19	1.82

Index of Dominance(ID)=48.80%

C. Diversity index in Site III

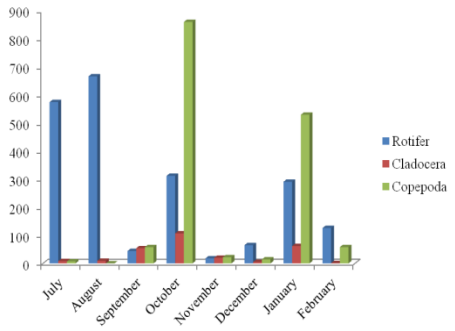
Month	Rotifer			Cladocera			Copepod		
	H'	R	E_H	H'	R	E_H	H'	R	E_H
July	1.609	2.21	1.40	1.01	0.65	1.68	0.60	0.17	2.00
August	1.411	1.57	1.41	0.41	0.21	1.37	0.49	0.17	1.62
September	1.890	1.88	1.98	1.08	0.75	1.79	0.69	0.44	1.45
October	1.110	1.62	1.23	1.08	0.96	2.27	0.68	0.22	2.27
November	1.903	2.39	1.90	1.24	0.93	2.07	0.67	0.24	2.24
December	1.610	1.91	1.45	1.09	0.68	1.82	0.00	0.00	0.00
January	1.583	1.04	2.03	0.34	0.22	1.12	0.59	0.18	1.94
February	1.089	1.16	1.29	0.45	0.35	1.50	0.62	0.17	2.06

Index of Dominance(ID)=42.42%

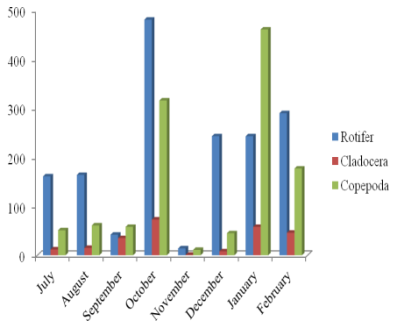
D. Diversity index in Site IV

Month	Rotifer			Cladocera			Copepod		
	H'	R	E_H	H'	R	E_H	H'	R	E_H
July	2.010	1.54	2.11	0.43	0.55	0.89	0.58	0.21	1.93
August	1.450	1.17	1.72	0.46	0.51	0.97	0.56	0.20	1.87
September	1.212	2.07	1.21	0.48	0.64	0.08	0.67	0.18	2.23
October	0.688	1.31	0.72	0.86	0.70	1.42	0.69	0.14	2.28
November	0.474	1.66	0.47	0.69	0.72	2.30	0.67	0.27	2.23
December	1.584	1.39	1.58	0.63	0.79	1.05	0.69	0.17	2.30
January	0.910	1.61	1.01	0.58	0.53	1.22	0.49	0.16	1.64
February	0.907	1.32	0.95	1.92	0.40	6.39	0.71	0.17	2.35

Index of Dominance(ID)=57.80%



Site-I



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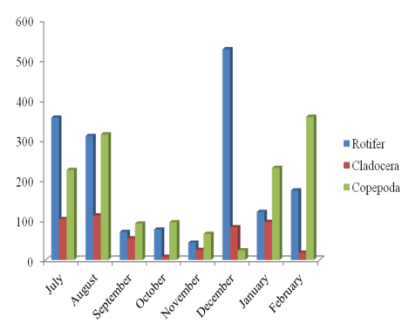
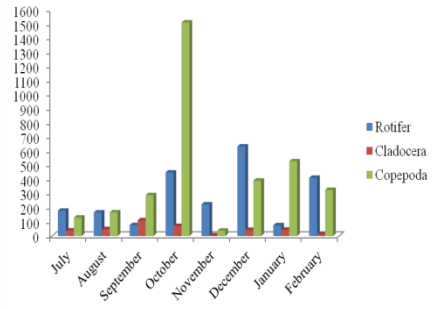
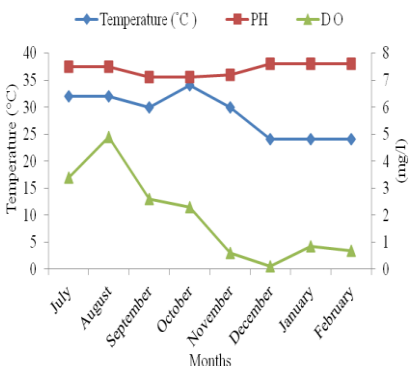


Site-III

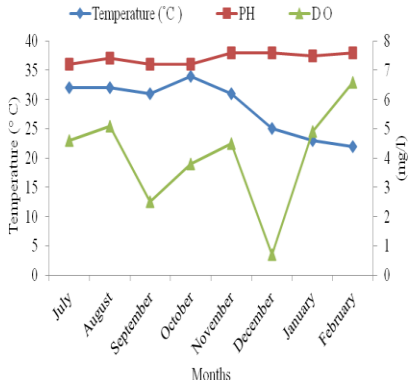


Site-IV

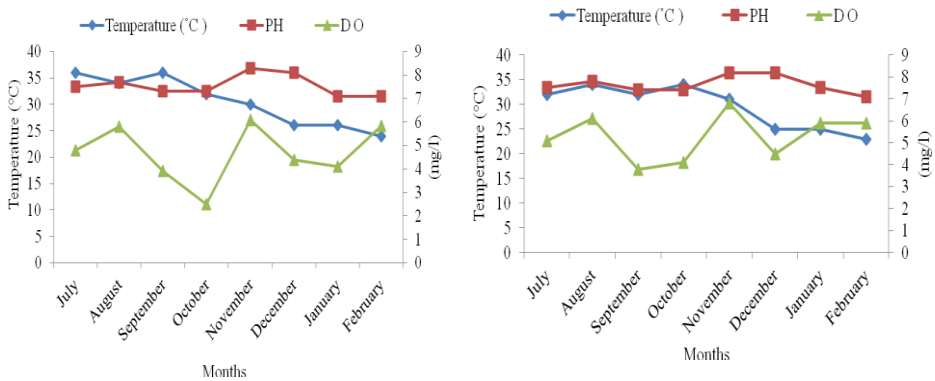
Figure 3. Variation in population density of different zooplankton groups in four sampling sites from Taungthaman Lake



Site-I



Site-II



Site-III Site-IV

Figure 4. Comparison of water temperature, pH and Dissolved Oxygen concentration at four sampling sites from Taungthaman Lake

Discussion

In the present investigation, a total of 29 species of freshwater zooplankton were collected and studied lasted from July 2014 to February 2015 at four sampling sites from Taungthaman Lake.

The species composition of the different zooplankton showed that the rotifer has more species composition than other zooplankton group.

In the present study, based on the number of species and relative abundance (the number of individuals per litre) rotifers were also dominant group in Taungthaman Lake. Rotifer constituted (46.55%) of total zooplankton. Copepoda was the second group in abundance and constituted (45.14%) of total zooplankton and Cladocera constituted (8.31%).

Among the zooplankton groups, *Mesocyclops leckurti* was found to be dominant species constituted (25.54%) of the total zooplankton and *Microcyclops* sp. was found to be sub dominant species constituted (19.96%) of the total zooplankton throughout the study period.

Diversity indices provide more important information about community composition than simply species richness (i.e, the number of species present) and typically measured as the relative abundance (No. of individuals per litre) of different species in a community. Shannon – Weiner diversity index is commonly used to characterize species diversity.

In the present study, rotifer species showed high diversity index value at site II in August and lowest value at site IV in November. Cladocera species showed high diversity index value at site II in October and lowest value at site II in November Copepoda species showed high diversity index value at site IV in February and lowest value at site I in August.

The highest species richness of rotifer was occurred at site I in November and lowest at site I in February. The highest species richness of cladocera was occurred at site I in December and February and lowest at site II in November. The species richness values of copepods were not different throughout the study period.

According to Shannon-Weiner diversity index, the value of diversity index (H') increases both when the number of species increases and when evenness increases. The highest species richness of rotifer was observed as compare to cladocera and copepod population in Taungthaman Lake during the present study.

Quantitative analysis during the period of study showed that the family Brachionidae exhibit maximum diversity of species. The genus *Brachionus* is dominant among other rotifer species.

According to Sladecek (1983), the genus *Brachionus* is in the index of eutrophic waters and its abundance is considered as a biological indicator of eutrophication. So, the abundance of *Brachionus* species in cold season suggested that the Taungthaman Lake has reached the eutrophic stage in the present study.

In the present investigation, the highest population density of rotifer was observed at site I. In this site, the water temperature ranged from (24°C-34°C), the value of pH ranged from (7.1-7.6) and Dissolved Oxygen concentrations (DO) ranged from (0.01 mg/l-4.9 mg/l).

The highest population density of cladocera was observed at site III and site IV in rainy season. The highest population density of copepod was observed at site IV in October. In this site, water temperature ranged

from (23°C-34°C), Dissolved Oxygen concentration (DO) ranged from (3.8 mg/l-6.8 mg/l) and the value of pH ranged from (7.1-8.2)(Figure.4).

During the present study, a distinct fluctuation of zooplankton population in different months as well as seasons were observed.

Temperature is one of the essential and changeable environmental factors, since of influence the growth and distribution of flora and fauna. (Hashemzadeh and Venkataramana, 2012)

In Taungthaman Lake, water temperature ranged from (22˚C-36°C). Water temperature was maximum (36°C) in rainy season and minimum (22˚C) in cold season. The variation in water temperature may be due to different time of collection and the influence of season. So, the present study suggested that the water temperature was little effect on the zooplankton population in Taungthaman Lake.

The pH of the Taungthaman lake range from (7.1-8.3) throughout the study period .This indicated the pH of the Taungthaman is alkaline. Islam *et al*. (1974) reported that the absence of *Brachionus* from acidic waters, while George (1964) reported that the absence of *Brachionus* from water above pH 8.5. Lower pH value below 5 is regardless as adversive to the aquatic organisms. So, the pH of the lake water was influence on the zooplankton population.

Dissolved Oxygen is important parameters in water quality assessment and it is reflect on biotic factors of the water. The value of DO ranged between
(0.01 mg/l-6.8 mg/l). It was maximum (6.8 mg/l) at site IV in November and minimum (0.01 mg/l) at site I in December during the study period. This may be due to difference in water temperature. In high temperature, the solubility of oxygen is lowered and also the organic substances are degraded. Concentration of Dissolved Oxygen (DO) is inversely proportional to temperature at a given time.

In Taungthaman Lake, the spatial distribution of zooplankton corresponds with Dissolved Oxygen concentrations (DO).The highest population of rotifer was observed at site I. This area was affected by the influx of waste water from Payandaw Chaung into the northeast of Taungthaman Lake. This area has less oxygen concentrations than other sampling sites.

The highest population of cladocera was observed at site III and site IV and the highest population of copepod was observed at site IV. Site III and site IV area were located where the lake has connection with the river inflowing water from the Ayeyawady river during rainy season brings in freshwater which replaces the “old” waters. This area shows more oxygen concentrations than other sampling sites.

The present study showed that the rotiferan community can survive in low Dissolved Oxygen concentrations and cladocerans and copepods community has high oxygen requirements.

There it can be concluded that Dissolved Oxygen concentration (DO) seem to be limiting factor on the zooplankton population.

Index of dominance (ID) represents the percentage abundance of zooplankton population. The highest index of dominance (ID) was occurred in site IV (57.80%) than the other sampling sites. This may due to site IV was at the connection of lake with river mouth, flowing water from the Ayeyarwady river during rainy season .This area was more oxygen concentration than the other sampling sites.

Ostozic (2000) reported that the zooplankton community and composition and structure are affected by eutrophication, these communities can also be used as an indicator of changing trophic status of an aquatic ecosystem.

Therefore, it is concluded that among the various zooplankton composition, rotifer constitute high species richness and abundance were observed during the period of study. The result suggested that the Taungthaman Lake has reached the eutrophic stage in cold season.

Thus increase in number of zooplankton was accordance with dissolve oxygen of its habitat. The study also showed that zooplankton species survive in the neutral condition.

Table-1 .List of zooplankton species from Taungthaman Lake

Class	Order	Family	Species
Monogononta	Ploimida	Asplanchnidae	*Asplanchna herricki* de Gueme,1888
			Asplanchna priodonta Gosse,1850
		Brachionidae	*Anuraeopsis fissa* Gosse,1851
			Brachionus angularis Gosse, 1851
			Brachionus budapestinensis Daday,1885
			Brachionus calyciflorus Pallas, 1776
			Brachionus caudatus Barrois & Daday, 1894
			*Brachionus diversicornis (*Daday, 1883)
			Brachionus falcatus Zacharias, 1898
			Brachionus forficula Wierzejski 1891
			Brachionus quadridentata Hermann, 1783
			Brachionus rubens Ehrenberg, 1838
			*Keratella tropica (*Apstein, 1907)
			Plationus patulus (Müller, 1786)
			Platyias quadricornis (Ehrenberg, 1832)
	Floscularíceae	Lecanidae	*Lecane luna* (Müller, 1776)
		Synchaetidae	*Polyarthra vulgaris* Carlin, 1934
		Trichocercidae	*Trichocerca* sp.
		Hexathridae	*Hexathra mira (*Hudson, 1781)
		Filiniidae	*Filinia longiseta (*Ehrenberg, 1834)
			*Filinia terminalis (*Plate,1886)
Branchiopoda	Cladocera	Sididae	*Diaphanosoma leuchtenbergianum* Fisher,1850
		Moinidae	*Moina micrura* Kurz, 1874
		Daphnidae	*Ceriodaphnia rigaudi* Richard, 1894
		Bosminidae	*Bosmina longirostris* Muller, 1776
		Chydoridae	*Kurzia latissima* (Kurz) 1874
			Leydigia acanthocercoides (Fisher)1854
Copepoda	Cyclopoida	Cyclopidae	*Microcyclops* sp.
			Mesocyclops leckurti Calaus, 1857

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