Global Veterinaria 15 (1): 24-30, 2015
ISSN 1992-6197

DOI: 10.5829/idosi.gv.2015.15.01.95330

An Investigation on Biomass, Density and Percentage of Occurrence of Zooplankton from Manchar Lake, Province Sindh, Pakistan

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Abstract: Present study deals with the assessment of biomass, density and percentage of occurrence of zooplankton from Manchar Lake, Province Sindh, Pakistanduring two years study period ranging from August 2011 to July 2013. Collection of zooplankton samples were made in selected six stations including Danister, GulshahPir, Mudiput, Central point Aroni, Garkno and Jarang by using planktonic net with mesh size 55 µm. The obtained results of the present study revealed that great variation in the biomass of zooplankton among the different seasons of year asmaximum biomass was reported in the month of summer (monsoon) season where as lowest values were noted in the months of winter season. In addition, Rotifer population density during whole study period was found to be rich as compared to cladocerans and copepods which might be because rotifers have great capability to tolerate large fluctuations in the water parameters. Furthermore, water quality parameters like temperature, TDS, Salinity, total hardness showed positive impact on the density and diversity of zooplanktons, except dissolve oxygen (DO) that revealed negative impact on rotifers, cladocerans and copepods populations.

Key words: Zooplankton · Biomass · Density and percentage of occurrence · Manchar Lake

INTRODUCTION

Planktons are microscopic organisms that drift or float on the mercy of water waves. These organisms inhibit almost all water bodies including oceans, rivers, lakes and ponds. Plankton mainly includes two major groups of zooplankton and phytoplankton. Both groups have the ability to survive due to their characteristic in a medium with less shelter and food deficient.Zooplankton and many other micro invertebrates also depend upon phytoplankton for their survival. Physicochemical parameters (i.e., temperature, salinity, light and pH), availability of food, invertebrate predation and toxic elements can also influence on zooplankton population. Zooplanktons are main source of food for other aquatic organisms and play an important role in determining of pollution in water and the state of eutrophication [1]. Infantand Reihl [2] reported that planktons are excellent indicator of nutrition in aquatic medium. Seasonal changes, both in species composition and biomass of zooplankton can alter the population of phytoplankton. Zooplankton differs in contribution to biomass and total abundance depending on predation by zooplanktivorous fishes [3]. Zooplankton distribution, composition and movement are also affected by physical and chemical characteristics of the ecosystem [4]. In lakes, diverse differences between the community dynamics, composition of littoral and limnetic zooplankton may occur which require separate assessments [5]. Therefore, present study was conducted on biomass, density and percentage of the occurrence of zooplankton populations in the Manchar Lake of province Sindh in order to observe the impact of water quality on the abundance and density of zooplanktons which are commonly used as important food resources for the aquatic organisms and particularly fish fauna of lake.

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MATERIALS AND METHODS

Samples Collection and Identification: Zooplankton was collected from Manchar Lake for the period of two years that extends from August 2011 to July 2013 fromthe following six stations:

Station 1=Danister, Station 2= GulshahPir, Station 3= Mudiput, Station 4= Central point Aroni, Station 5= Garkno and Station 6= Jarangby using planktonic net with mesh size 55 µm.For qualitative analysis, Kemmerer's bottle (1.2 liter) was used in the present study. Whereas, for quantitative analysis, six liters of water sample was collected by using Kemmerer's water sampler drawn at a depth of almost 24 cm and filtered through the net. The samples of zooplankton were then immediately transferred into the plastic jars and preserved in 4% formalinsolution and brought into the laboratory for further analysis. Then the taxonomic identifications of all samples were made by using binocular microscope (Nikon Eclipse E 200) at 40X and 100X magnifications. Counting was made with the help of Sedgwick-Rafter counting chamber. The zooplanktons were identified by keys and illustrations provided by Battish [6], Mizuno and Takahashi [7] and Segers [8].

Estimation of Dry Weight Biomass: All samples were rinsed with distilled water and then placed on pre-weighed and pre-dried Petri dish at 60°C for 48 hours in aluminum boats, cooled in a desiccator and then weighed on a microbalance (Chyo MJ-3000 Japan). Zooplankton dry weight was estimated by using the keys followed by Michaloudi [9].

Diversity Index: Shannon-weiner (H) was calculated as by using equation 1 followed by Shannon-Wiener [10] as follows;

Shannon-Wiener Diversity Index

$$H = -\Sigma piln\,(pi) \quad (1)$$

where 'H' is diversity index, 'Ln' is natural logarithm;'i' is index number for each species, 'pi'is the number of individuals within species.

RESULTS AND DISCUSSION

In the present study, biomass, density and diversity index of zooplanktons found in Manchar Lake for the period of two years that extends from August 2011-July 2013 from six stations i.e., Station 1 (Danister), Station 2 (GulshahPir), Station 3 (Mudiput), Station 4 (Central point Aroni), Station 5 (Garkno) and Station 6 (Jarang) were calculated and presented in the Tables 1(a &b), 2 (a &b), to 3 and Figures 1a to 1c, respectively. The zooplanktons recorded in the present study include rotifers, cladocerans and copepods.

Zooplankton Biomass (Dry Weight): In the present investigation, zooplankton biomass showed variationsbetween two years of study period. During the first year study period that extends from August 2011 to July 2012, the lowest dry weight that is 10.2 mg/l was recorded at station 1 in the month of December 2011, while maximum biomass that is 51.2 mg/l was recorded in the month of March 2012 at station 1. The mean values of zooplankton biomass between two years study period was ranged from 26.98 mg/l (January 2012) to 44.03 mg/l (June 2012), as shown in Table 1a, respectively.

Whereas, during the second year study period that extends from August 2012 to July 2013, the maximum biomass that is 42.9 mg/l was recorded in the month of May 2013 at station1, while minimum biomass was 12.6mg/l recorded in January 2013 at station 4. Whereas mean values during two years study period were ranged from 21.35mg/l to 35.35 mg/l, respectively (Table 1b).

Density of Zooplankton: In the present study, the density of zooplanktons during two years study period from August 2011toJuly 2013 was54663/liter water sample as shown in Table 2a, respectively. During the first year study period that extends from August 2011 to July 2012, the density of zooplankton was 29958/liter, while in second period of study from August 2012 to July 2013 was 24705/liter (Table 2a). During the two years study periods, among the other zooplankton populations in Manchar Lake, rotifers shows highest density or found to be most abundant (67.96%) as compared to cladocerans (29.14%) and copepods 2.89% in the total catch samples, respectively. In additions, variations were also reported in the number of individuals/liter of these zooplanktons population during the two years study period. In general, zooplanktons populations were more abundant per liter of sample during the first year study period as compare to the second. Rotifer population density during whole study period was found to be rich during first year study period that is 2281/liter recorded in the month of June and the lowest in the second year study period that is 643/liter in the month of January as shown in Table 2b, respectively. Cladoceran highest population density was 1062/liter recorded in the month of July during first year

Table 1a: Monthly fluctuation of Zooplankton biomass (dry weight in mg/l) at six stations of Manchar Lake from August 2011 to July 2012

Months	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Mean±S.D
Year 2011							
August	34.1	42.7	24.2	26.5	44.2	35.7	34.57±8.16
September	42.6	39.1	27.9	32.8	29.3	26.1	32.97±6.58
October	33.4	29.4	33.2	31.4	19.7	29.6	29.45±5.07
November	38.3	38.4	26.3	29.4	18.3	25.3	29.33±7.87
December	10.2*	22.4	27.4	38.4	34.2	39.5	28.68±11.18
Year 2012							
January	30.2	29.1	34.5	19.5	22.4	26.2	*26.98±5.46
February	31.5	26.5	20.4	16.5	33.9	33.7	27.08±7.30
March	51.2**	39.1	26.7	33.2	23.1	26.2	33.25±10.51
April	39.3	47.5	40.4	25.8	33.7	39.3	37.67±7.29
May	39.5	38.5	45.6	40.7	47.2	42.8	42.38±3.46
June	48.6	41.7	44.5	44.6	37.5	47.3	44.03±4.00**
July	47.8	44.3	36.5	39.7	44.7	46.9	43.32±4.37

Note: S.D=standard deviation; * shows minimum value; ** shows maximum value.

Table 1b: Monthly fluctuation of Zooplankton biomass (dry weight in mg/l) at six stations of Manchar Lake from August 2012 to July 2013

Months	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Mean±S.D
Year 2012							
August	35.2	22.8	38.2	39.4	33.6	23.8	32.17±7.18
September	33.8	41.6	29.5	16.9	30.2	15.7	27.95±10.0
October	28.2	19.7	21.3	17.3	28.5	35.9	25.15±6.96
November	26.9	31.2	18.5	21.4	26.2	16.4	23.43±5.62
December	29.3	31.6	24.1	19.9	15.5	29.5	24.98±6.31
Year 2013							
January	20.3	30.5	27.9	12.6*	21.2	15.6	21.35±6.89**
February	31.1	26.5	15.9	31.2	19.7	22.3	24.45±6.23
March	35.8	25.8	31.3	19.7	24.1	22.9	26.60±5.91
April	39.3	36.9	28.5	15.8	24.4	29.7	29.10±8.54
May	42.9**	38.4	39.6	19.6	27.9	22.8	31.87±9.72
June	40.3	41.7	37.8	33.2	24.4	20.4	32.97±8.77
July	39.4	35.8	42.1	38.8	34.1	21.9	35.35±7.16***

Note: S.D=standard deviation; * shows minimum value; ** shows maximum value

Table 2a: Density of zooplanktons per liter from Manchar Lake during the two years study period August 2011toJuly 2013

Zooplanktons	August 2011 to July 2012	%	August 2012 to July 2013	%	Total	%
Rotifers	21027	70.2	16123	65.3	37150	67.96**
Cladocerans	8108	27.1	7821	31.7	15929	29.14
Copepods	823	2.7	761	3.1	1584	2.89*
	29958	100.0	24705	100		
			Grand Total (N)=		54663	99.99

Note: * shows minimum value; ** shows maximum value

Table 2b: Quantitative seasonal variation in frequency of occurrence of zooplankton in MancharLake from August 2011toJuly 2013

	Rotifers				Cladocerans				Copepods			
Months	August 2011 to July 2012	%	August 2012 to July 2013	%	August 2011 to July 2012	%	August 2012 to July 2013	%	August 2011 to July 2012	%	August 2012 to July 2013	%
August	1811	8.61	1658	10.28	944	11.64	1058	13.53	114**	13.85	98	12.88
September	1694	8.06	1330	8.25	723	8.92	845	10.80	89	10.81	69	9.07
October	1466	6.97	1022	6.34	511	6.30	591	7.56	53	6.44	52	6.83
November	1408	6.70	886	5.50	379	4.67	257	3.29	42	5.10	31	4.07
December	1444	6.87	855	5.30	335	4.13	340	4.35	35	4.25	27	3.55
January	1301	6.19	643*	3.99	344	4.24	256	3.27	26	3.16	14*	1.84
February	1426	6.78	914	5.67	308	3.80	240*	3.07	21	2.55	24	3.15
March	2010	9.56	1465	9.09	670	8.26	656	8.39	56	6.80	41	5.39
April	2057	9.78	1703	10.56	945	11.66	690	8.82	72	8.75	69	9.07
May	2040	9.70	1822	11.30	994	12.26	864	11.05	112	13.61	95	12.48
June	2281**	10.85	1818	11.28	893	11.01	1019	13.03	100	12.15	104	13.67
July	2089	9.93	2007	12.45	1062**	13.10	1005	12.85	103	12.52	137	18.00
Total	21027	100	16123	100	8108	100	7821	100	823	100	761	100

Note: * shows minimum value; ** shows maximum value

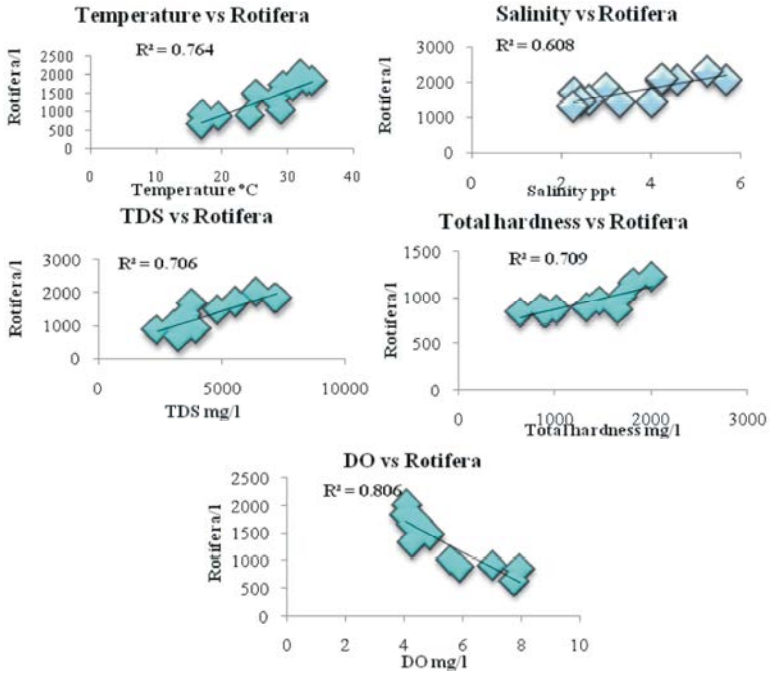

Fig. 1a: Showing Regression coefficient (R^2) of Rotifera and water parameters of Manchar Lake

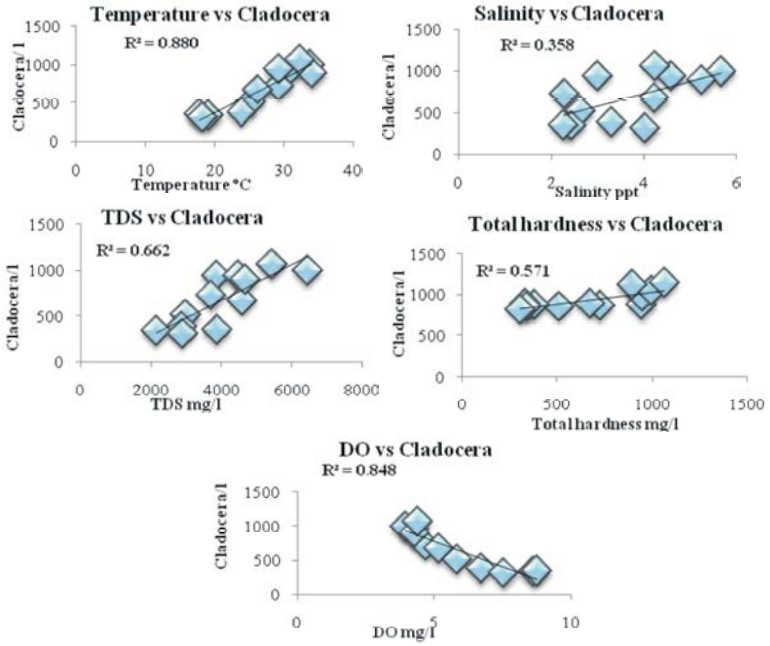

Fig. 1b: Showing Regression coefficient (R^2)of Cladoceraand water parameters of Manchar Lake

study period and the lowest was 240/liter recorded in February during second year study period. However, were less frequent in total zooplankton populations and showed highest population density of 114 /liter in August during first year of study period and lowest population that is 14 /literwas recorded in the month January of second study period as shown in Table 2b, respectively.

Frequency of the Occurrence of Zooplankton: During the first year study period that extends from August 2011 to July 2012, frequency of the occurrence of zooplankton showed a great variation throughout the year. Both rotifers and cladocerans were found to be more frequent or abndant in the month of July, while copepod populationswere found to berich in the month of August

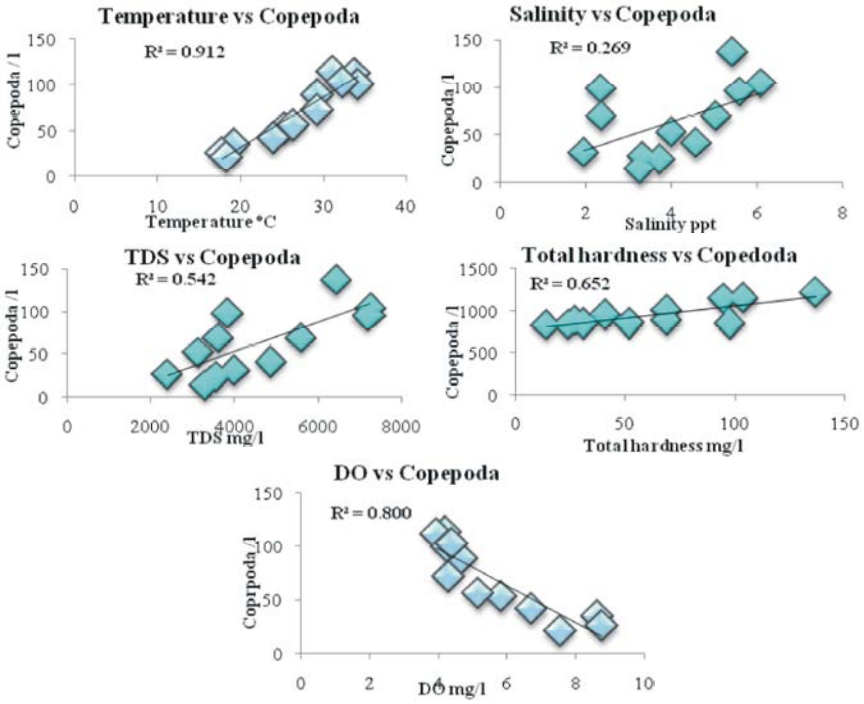

Fig. 1c: Showing Regression coefficient (R^2)of Copepoda and water parameters of Manchar Lake

among the other zooplankton populationsas shown in Table 2b, respectively. In addition, the minimum frequency of occurrence recoded for rotifers was 6.19 % in the month of January, whereas for cladocerans was 3.80 % and copepod was 2.55 % during February, respectively.

During the second year study period that extends from August 2012 to July 2013, maximum frequency of occurrence for rotifers was 12.45 % and for copepods was 18.0% in month of July, whereas for Cladocerawas 13.53 % in August, as shown in Table 2b respectively. On the other hand, minimum frequency of occurrence recorded for rotifers was 3.99 % and copepods was 1.84 % in the month of January, whereas cladocera showed 3.07 % in the month of February, respectively.

Diversity Index of Zooplankton: The impact of water parameters such as temperature, salinity, total dissolve solids (TDS), total hardness and dissolve oxygen (DO) on density and diversity of zooplankton populations were noted and presented in Tables 3 and Figures 1a-1c, respectively. The results of the present study revealed that water parameters like temperature, salinity, total dissolve solids (TDS), total hardness showed positive impacts on density and diversity of rotifer population, however negative correlation was reported with DO for the two years study period that extends from August 2011 to July 2013 as shown in Figure 1a, respectively. The Shannon-Weiner diversity index calculation revealed that rotifers were the most diverse group ranging from 1.770 to 1.772 during the whole two years study period as shown in Table 3, respectively.

In present study, positive correlation of cladocerans was observed with water parameters i.e., temperature, salinity, TDSand total hardness, while strong negative correlation was noted with dissolve oxygen (DO) was reported for the two years period as shown in Figure 1b, respectively. The diversity index calculation for cladocera was ranging from 1.753 to 1.788 for the two years study period (Table 3).

During the two years study period, copepods also showed positive correlation with water parameters like temperature, salinity, TDS and total hardness; whereas negative correlation with dissolve oxygen (DO) was seen for the two years study period as shown in Figures 1a-1c, respectively. Calculation of Shannon-Weiner diversity index revealed that copepodes was more diverse in first year as compared to second year of study period ranged from 0.784 to 0.676, as shown in Table 3, respectively.

In the present study, rotifers were found to be more abundant and dominant as compare to other zooplankton populations, because rotifershave more capability to tolerate extreme temperature. Therefore, Galkovskaya [11] stated that very high temperature can increase rapidly the growth of rotifers; hence, the density of rotifer is

Table 3: Diversity Index of zooplankton from August 2011 to July 2013

	Rotifers		Cladocerans		Copepods	
Months	8/2011 to 7/2012	8/2012 to 7/2013	8/2011 to 7/2012	8/2012 to 7/2013	8/2011 to 7/2012	8/ 2012 to 7/2013
August	1.766	1.795	1.782	1.747	0.843	0.838
September	1.797	1.792	1.789	1.754	0.801	0.761
October	1.767	1.644	1.791	1.747	0.828	0.572
November	1.777	1.77	1.759	1.773	0.846	0.694
December	1.671	1.792	1.785	1.802	0.804	0.62
January	1.754	1.795	1.693	1.743	0.52	0.429
February	1.768	1.735	1.682	1.817	0.652	0.594
March	1.799	1.776	1.769	1.863	0.803	0.697
April	1.766	1.799	1.789	1.839	0.841	0.597
May	1.798	1.791	1.717	1.805	0.859	0.741
June	1.793	1.793	1.755	1.838	0.79	0.799
July	1.79	1.786	1.723	1.729	0.817	0.772
Average	1.770	1.772	1.773	1.788	0.784	0.676

controlled by water temperature [12]. In present study, the highest density of rotifer was recorded during summer season (June and July) and low density in winter season (January), which was in agreement with Stephen *et al*. [13]. Population density of rotifers also show positive correlation with other water parameters like salinity, TDS and total hardness, which was in accordance with the finding ofSulehria and Malik [14].

Oxygen is very vital component for all aquatic organisms; therefore, the population of zooplankton is influenced by level of oxygen (DO) in water [15]. In the present study, negative correlation with dissolve oxygen (DO) was reported for rotifers, cladocerans and copepods were in agreement withSulehria and Malik [14]. High salinity value or low pH can decrease quantity and diversity of rotifers as reported by Horn and Goldman [16]. Large numbers of rotifers with high species richness in tropical rivers, lakes and reservoirs was reported by Borges and Pedrozo [17]. Shannon-Weiner diversity indexes (H-) of rotifer ranged from 1.770 to 1.772 more or less weresimilar with findings of Thirupathaiah *et al*. [18].

During the whole study periods, the populations of cladocerans were found to be rich in July, but found to be rare in month of February. Cladocerans are considered filter feeders that depends upon phytoplankton, therefore highest populations of cladoceranwas reported from March to August, while lower populations was noted from September to February indicating that they prefer warm water more than cold water in Manchar Lake. Opposite findings are reported by Watkar and Barbate [19] from River Kolar. Iqbal and Kazmi [20] reported 15 species of Cladocera from Hub Dam. *Cyclops* showed high population in summer with two peaks one in May and other in July. Present findings are also supported by Mahar [21], as low number of cyclopoids was observed in winter, while higher population was reported in summer. Watkar and Barbate [19] found that freshwater copepods occur in all kinds of aquatic environment and play a key role in environmental pyramids.

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