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Diversity and its Indices in Zooplankton with Physico-Chemical Properties of Mula Dam Water Ahmednagar, Maharashtra, India

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ABSTRACT

In the present investigation five diversity indices as Shannon-Weaver diversity index, Simpson's diversity index, Index of Dominance, Index of Evenness & Species richness were evaluated in zooplankton from Mula dam. A total of 23 species of zooplankton belonging protozoa, rotifer, cladocera, copepoda & decapoda were recorded. It showed seasonal variation & density as summer > winter > rainy. They were in order: rotifer (46%), cladocera (17%), copepoda (16%), decapoda (13%), & protozoan (8%). The water samples were analyzed for various parameters.

Key words: Zooplankton, water parameters, diversity indices, Mula dam.

INTRODUCTION

Zooplanktons are often common denizens of the ecosystem and they have been considered as an indicator species of inhabited area/body. Some workers showed that abundance, density, diversity and community structure in zooplanktons [21,5,14,23,15]. Population of zooplankton is sensitive indicators of aquatic ecosystem. One of the major priorities of conserving zooplankton in monitoring their population to find methods with diversity indices is useful for long term survival. Hence, diversity and its indices are incorporated in the present study.

There is no in-depth analysis in the structure and dynamic of the zooplankton community in the study area, which is fundamental as primary producer for the management and the assessment of the water body. The aims of the present study were to determine the zooplankton species composition, abundance and diversity to delineate its pattern and to reference their basic ecological frame during study in reservoir.

This present study was conducted in rural habitat, in three seasons: rainy, winter and summer during 2008-10. Mula dam is the study area located 19°20' to 19°35' N latitude & 74°25' to 74°36' E longitude. The dam was artificially built across the Mula River in 1971 and contains natural water and capacity of dam is 21 TMC. It experiences an average rain fall 58 cm. Maximum depth being 67.97 m. The reservoir bottom is composed of detritus-mud layer in the littoral zone. The physiographic of basin is semi agricultural & semi-arid with cultivated top soil bank.

MATERIALS AND METHODS

Collection of samples: Water samples were collected bimonthly from the reservoir, during the early hours (7 to 9 am) during January 2008 to December 2010. The plankton samples were collected by filtering 50 liters of water through standard planktonic net (45µ) and the concentration samples were preserved in 5% formalin in 100 ml vial.

Biological identification: They were identified with the help of standard literature up to generic level. For identification of rotifer work [22,7] were consulted. Copepod were identified with the help of key provided [3,8]. Cladocera were identified with the help of key provided [17,13]. The quantitative analysis of organism was carried out using Sedwick-Rafter counter [Table 1].

Physico-chemical analysis: The pH and temperature of water samples were recorded on the spot with the help of pen (pen) pH meter and thermometer respectively. The analysis of filtered water samples was carried out for the parameters, as Electrical Conductivity [EC], Total Dissolved Solids [TDS], Total Hardness [TH], Major Constituents [cationic- Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K) and anionic- Chloride (Cl), Total Alkalinity (TA), Sulphates (SO₄), Minor Constituents [Phosphate (PO₄) and Nitrate (NO₃)], indicator parameter [Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)]. The samples were done according to standard methods [2].

Diversity indices analysis: To evaluate the diversity indices of zooplankton species were calculated by respective formula/equation as Shannon-Weaver Diversity Index [16], Simpson Diversity Index [18], Species Richness [10], Index of Evenness with Shannon index and Index of Dominance [4] were used. These indices were used to obtain the estimation of species diversity index, species richness & species evenness using respectively equations/formulae. All individual species indices were also evaluated. The indices were evaluated at individual species level (Table 2).

RESULTS AND DISCUSSION

The data presented in Table 1 revealed that the record of 23 taxa in Mula dam reservoir: 5 protozoan (18%), 8 rotifer (46%), 4 cladocera (17%), 3 copepoda (16%) & 3 decapoda (13%) Rotifer was the highest in all categories. The season wise dominance was in order as 47% summer > 39% winter and > 24 rainy. The water body presents common conditions, high insulation, and relative high temperature & reflects stability period.

The Shannon- Weaver diversity index (S-WDI) ranged from 0.089 to 0.32 bits ind⁻¹ (Table 2). It indicates conditions of intermittent surface distribution where, certain zooplankton species have better environmental conditions to reach higher individual numbers. In the study when the numbers of species were relatively higher & constant, the S-WDI values remain 0 to 1 bits ind⁻¹ in overall species. The zooplankton abundance decline due to connection with redistribution of number of individuals in a water body or less possibilities to stay in the euphotic zone where photosynthesis occurred. The alteration between high & low densities shows that phytoplankton is related to hydrographic factors [19]. Dash [6] reported that the high value of S-WDI, the greater is the plankton diversity. Low value of S-WDI was recorded in *Stenator* sp. (protozoa). This report gain supports [9,1]. They noticed that the S-WDI to be suitable indicator for water quality assessment.

During ecological sampling Simpson's Diversity Index (SDI) in measuring distributed area, found total 23 species in five groups of zooplankton. The SDI number of species per liter was 0.117 [*Balantidium* sp.] to 1.43 bits ind⁻¹ (*Cristulata* sp.). The SDI remains in between 0.117 to 1.43 bits ind⁻¹. In the study Index of Dominance (ID) was found to be maximum (100%) in *Brancionous* sp. and *Cristaluta* sp. (rotifer) & minimum (20.69%) in *Balantidium* sp. (protozoa). The percent ID varies species to species and group of zooplankton because their number is varied in population.

The species, Species Richness (SR) index was found to be high as 1.29 bits ind⁻¹ in *Cristaluta* sp. [rotifer]. Mostly rotifer species revealed higher values of SR. The lowest as 0.19 bits ind⁻¹ value noticed from three species of protozoa as *Balantidium*, *Creatium* & *Rugipe* sp.. Rajagopal [15] focused SR index on zooplankton and reported similar pattern of study but the SR values varies. It might be due to limnological & geographical condition of water.

Water sample temperature ranged from 21.9 °C in winter to 26.9 °C in summer. The decrease in water temperature was from summer, rainy and winter allows well mixing of water column. The pH ranged from neutral (7.2) during rainy to alkaline (7.9) during the winter, with maximum value of 8.2 in summer. The reduced buffering capacity of this system total alkalinity (58.6 ppm) allows strong changes in pH [11]. High and low values of DO & pH are associated with pulses and decrements of plankton, respecting zooplankton.

The concentration of dissolved oxygen (DO) fluctuation between 4.2 ppm in summer and 6.9 ppm in winter. Relatively low concentration of DO detected in October to January may be due overturn, when the mixing goes deeper to anoxic area. Thus the oxygen is redistributed in water which provokes in the upper layer of the water.

Electric conductivity (EC) ranged from 71 to 128 µmho cm⁻¹. This ionic concentration can be ranged as being intermediate. According [20] classification, it belong to class-I as <600 µmho cm⁻¹. Chemical oxygen demand (COD) values were ranged from 20.3 to 33.3 ppm, with maximums value during rainy and minimum in summer. It coincided with a period of low zooplankton densities.

Table 1. Showing population density of zooplankton from Mula dam reservoir

Zooplankton	Rainy				Winter				Summer			
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Protozoa												
1. <i>Arcella</i> sp	+			+	+		+	+	+	+		+
2. <i>Balantidium</i> sp.		+	+		+		+	+	+		+	+
3. <i>Ceratium</i> sp.	+		+	+	+	+		+		+	+	
4. <i>Rugipe</i> sp.			+	+	+	+	+		+	+	+	+
5. <i>Stentor</i> sp.	+	+		+	+	+		+	+		+	+
Rotifer												
1. <i>Brancionous</i> sp.	+	+	+			+	+	+	+	+	+	
2. <i>Cristaluta</i> sp.	+	+	+	+	+	+		+	+	+	+	+
3. <i>Cupelopagis</i> sp.	+	+	+			+	+	+		+	+	
4. <i>Rotaria</i> sp.	+	+		+	+	+	+	+	+	+		+
5. <i>Testudinella</i> sp.	+	+		+	+	+	+	+	+		+	+
6. <i>Keratella</i> sp.	+	+	+	+	+	+			+	+	+	+
7. <i>Trichoreca</i> sp.	+	+		+	+	+	+	+	+	+		+
8. <i>Lecane</i> sp.	+	+	+		+	+	+			+	+	
Cladocera												
1. <i>Alona</i> sp.		+	+	+	+		+	+	+	+	+	+
2. <i>Chydorus</i> sp.	+	+	+	+	+	+		+	+	+	+	
3. <i>Daphnia</i> sp.	+		+	+		+	+	+	+		+	+
4. <i>Monia</i> sp.	+	+	+	+	+	+		+	+	+	+	+
Copapoda												
1. <i>Eucyclope</i> sp.		+	+	+	+	+		+	+	+	+	+
2. <i>Mesocyclopes</i> sp.	+	+	+	+	+		+	+		+	+	+
3. <i>Naupilus</i> sp.	+	+	+	+		+	+	+	+		+	
Decapoda												
1. <i>Zoea</i> Larva	+		+	+	+	+	+		+	+		+
2. <i>Cardona</i> sp	+	+		+	+	+		+	+	+	+	+
3. <i>Cyclocypria</i> sp.	+	+	+		+		+	+		+	+	+

Number of organisms / liter of water.

Table 2. Diversity indices of zooplankton from Mula dam reservoir.

Zooplankton	S-WDI	SDI	SR	IE	ID
<i>Arcella</i> sp.	0.06	0.19	0.20	0.042	23.28
<i>Balantidium</i> sp.	0.06	0.117	0.19	0.042	20.69
<i>Ceratium</i> sp.	0.06	0.17	0.19	0.042	23.28
<i>Rugipe</i> sp.	0.32	0.18	0.19	0.22	82.46
<i>Stentor</i> sp.	0.089	0.33	0.32	0.062	670.25
<i>Brancionous</i> sp.	0.22	1.20	1.09	0.15	100.82
<i>Cristaluta</i> sp.	0.075	1.43	1.29	0.052	100.84
<i>Cupelopagis</i> sp.	0.24	1.38	1.24	0.17	90.53
<i>Rotaria</i> sp.	0.22	0.85	1.11	0.15	82.89
<i>Testiudinella</i> sp.	0.07	1.29	1.17	0.049	87.97
<i>Keratella</i> sp.	0.23	1.31	1.18	0.16	88.00
<i>Trichoreca</i> sp.	0.19	0.95	0.87	0.13	87.82
<i>Lecane</i> sp.	0.15	0.93	0.86	0.13	41.41
<i>Alona</i> sp.	0.15	0.68	0.63	0.10	59.43
<i>Chydorus</i> sp.	0.16	0.69	0.64	0.10	56.89
<i>Daphnia</i> sp.	0.16	0.73	0.67	0.111	59.46
<i>Monia</i> sp.	0.18	0.76	0.68	0.111	69.82
<i>Eucyclope</i> sp.	0.18	1.06	0.97	0.14	75.05
<i>Mesocyclopes</i> sp.	0.18	0.90	0.83	0.13	64.69
<i>Naupilus</i> sp.	0.16	0.91	0.84	0.13	72.48
Zoea Larva	0.12	0.71	0.71	0.111	56.94
<i>Cardona</i> sp.	0.15	0.93	0.86	0.13	75.00
<i>Cyclocypria</i> sp.	0.14	0.50	0.47	0.084	48.92

S-WDI = Shannon -Weiner's diversity index

SDI = Simpson's diversity index

SR = Index Species Richness

IE = Index of Evenness

ID = Index of Dominance

Nitrates were detected in low concentration (<1 ppm) during study period with minimum value in rainy [0.58 ppm] and reaching maximum in summer (0.95 ppm). Orthophosphate were highest 1.22 ppm in summer and lowest value 0.58 ppm during rainy. The magnitude of N and P values in study indicate that distributed a nutrient overload of anthropogenic activities. Based of PO₄ concentration the water body could be classified as mesoeutrophic water body [12].

From the aforesaid data it could be made out that the availability of water, safe habitat and food sources for zooplankton in reservoir are important for the occurrence which reflects diversity indices. As water quality are the important habitat characteristics that influences the distribution indices of zooplankton. The proper & regular maintenance of dam would be further increase the plankton population. The result of the study helps to conserve the organisms which are useful in aquaculture due to food web in reservoir.

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