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MONITORING WATER BODY: SEASONAL VARIATIONS IN DENSITY AND SPECIES RICHNESS OF CLADOCERANS OF YASHWANT LAKE, TORANMAL (M.S.) INDIA.

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Short Profile

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ABSTRACT:

The density of Cladocerans was maximum in summer, while it was minimum in post-monsoon. Maximum species richness of Cladocerans was recorded in summer and Minimum species richness was recorded in winter at Yashwant lake Toranmal. The Cladocerans community structure depends on a variety of environmental factors that include biotic, such as predation or competition, as well as various abiotic factors. The density and species richness of cladocerans shows significant seasonal variations at all the three stations namely YLA, YLB and YLC of Toranmal. The Pearson correlation was also calculated by keeping cladocerans as dependent variable and other biotic and abiotic factors as independent variables.

KEYWORDS

zooplankton, seasonal variation, Cladocerans, Toranmal.

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INTRODUCTION

Zooplanktons are minute heterotrophic organisms in water bodies that are present at various depths in their own niches in every type of aquatic environment. Zooplanktons form an important link in the dynamic ecosystems of estuaries, bays, rivers and lakes. By their heterotrophic activity zooplankton transport the organic material of primary and secondary production. The study of fresh water fauna especially zooplankton, even if of a particular area, is extensive and complicated due to environmental, physical, chemical and geographic variations involving ecological, extrinsic and intrinsic factors (Majagi and Vijaykumar,2009).

Cladocerans (water fleas) are primary freshwater small sized (0.2 – 6 mm) brachiopod crustaceans inhabiting pelagic, littoral and benthic zones. The cladocera are found in all sorts of fresh waters with higher densities in lotic than lentic systems. The shallow weedy backwater of lake, where water level is fairly permanent, harbour a great variety of species than does any other kind of locality. Here, they also act as the link in the food chain. Most of them are herbivorous, feeding on phytoplankton and in turn, are preyed upon by certain invertebrates and fish, thus, involved in the transfer of energy from primary producers to secondary and tertiary consumers within the aquatic food web (Dodson and Frey, 2001). They inhabit diverse habitats and are at a time exposed to great variety of harsh and extreme environmental conditions.

A high diversity of cladocerans can be found in the littoral zone of stagnant waters, as well as temporary water bodies. Cladocerans especially Daphnia are important model organisms in both basic and applied research, (Venkataraman, 1990, Yousuf, et al., 1983, Rane, 2002). The Canonical Correspondence Analysis of cladocerans and environmental variation in the cladoceran species has shown strong positive correlation between size of cladocerans and vegetation cover (Dagmar et al., 2006). These authors have concluded that the presence of fish seems to play a minor role in shaping species richness in Donana wetlands. Cladoceran actively select their food, with preference for large particles, and are unselective filter feeders (Claes et al., 2004). It has been reported that the life history strategies of tropical and temperate cladoceran taxa differ in response to several abiotic (temperature, light and oxygen saturation percentage) and biotic factors (predation and inter and intra-specific competition).

The water fleas (the cladocerans) are important component of the fauna of freshwaters; particularly significant in the food web of stagnant waters (Forro et al., 2007). Most species are filter feeders and usually reproduce by cylindrical parthenogenesis. Thus their population mainly dominated by females. However, sexually produced diapausing eggs are common and resistant to desiccation and other unfavorable conditions, and may even survive passage through the digestive track of birds (Figuerola et al., 2003). Thus, birds are important propagules for their passive dispersal. Cladocerans have also gained certain economic importance as they are widely used in aquaculture and these large filter feeding planktonic species have an indirect economic impact as important fish food or phytoplankton controlling group.

MATERIAL AND METHODS

Yashwant Lake is located on Toranmal Plateau, one of the important plateaus in mid-Western Satpura Mountains. This plateau forms a table land on the summit, covering about 41 Sq.Km. area at

1155 meter altitude (AMSL) extending between 21o 54´ North to 21o 61´ latitude and 74o 26´ to 74o 34´ East longitude. It is situated 140 Km. North of Dhule, and 90 Kms East of Nandurbar, the district capitals of Maharashtra. Toranmal plateau is a quantum part of Satpura Mountains forming the cultural transition with its trijunctional location between Maharashtra, Madhya Pradesh and Gujarat State of India. Yashwant lake has a perimeter of 2.75 Km. and spreads in 39 hectares. It was constructed during British period by damming the dip gorge.

The Cladocerans along the periphery of Yashwant Lake were collected during each biweekly visit at the three stations namely YLA, YLB and YLC. Slandered method was used for qualitative and quantitative analysis of cladocerans (Edmondson, 1963, Battish,1992, Rane,2002).Hence, species richness of cladocerans is considered as number of species observed per visit.

The data of the two years (from December-2006 to November-2008) was pooled and separated for three months and analyzed for seasonal variations, with respect to winter (December, January, February), Summer (March, April, May), Monsoon (June, July, August) and Post-monsoon (September, October, November). Further, the Mean, Standard Error of Mean (SEM) and One-Way ANOVA with No post test for various parameters for four seasons was performed. The correlation between the abiotic factors and the cladoceran density was calculated. The Pearson correlation was calculated by keeping cladoceran as dependent variable while biotic and abiotic factors as independent variables.

Google satellite image of Yashwant lake

RESULTS

Seasonal variations in the density and species richness of Cladocerans for two years of investigations are presented in Table.1 ten genera of cladocera (11 species) were recorded from Yashwant Lake. Maximum density of cladocerans were also recorded in summer with 742.8 ± 13.63 ind./L., 853.3 ± 24.59 ind./L and 886.7 ± 12.59 ind./L at YLA, YLB and YLC respectively (Table.1). The densities lowered in monsoon and ranged from 675 ± 29 ind./L at YLA, 713.3 ± 34.9 ind./L at the YLB and

826.9 ± 8.43 ind./L at YLC. Minimum densities were recorded during post-monsoon with 459.8 ± 26.17 ind./L , 570 ± 30 ind./L and 600 ± 34.25 ind./L at YLA, YLB and YLC respectively. In winter the densities increased nonsignificantly to 535 ± 50.93 ind./L, 653.3 ± 60.81 ind./L and 663.3 ± 58.06 ind./L at the three stations respectively.

Maximum species richness of Cladocerans were observed in summer with marginal variations among the three stations. 11.3 ± 0.42 species were observed at YLA, 7.83 ± 0.3 at YLB and 8.6 ± 0.21species at YLC (Table.1). In monsoon, it ranged from 7.3 to 11.6 with 11.67 ± 0.3 at YLA, 6.83 ± 0.47 at YLB and 7.33 ± 0.21 at YLC. Minimum species richness were recorded in post-monsoon which varied from 7.83 ± 0.74 at YLA to 5 ± 0.25 species at YLB and 5.33 ± 0.21 at YLC respectively. The species richness increased in winter and reached to 8.66 ± 0.21, 6.5 ± 0.22 and 7.33 ± 0.33 at YLA, YLB and YLC respectively.

Table: 1 Seasonal Variations in density (No. of individuals /Litre) and species richness of Cladocera at YLA, YLB and YLC of Yashwant Lake during November 2006 to December 2008

Parameters	Stations with F value	Winter	Summer	Monsoon	Postmonsoon
Cladocera density	YLA $F_{3\ 20}$ 15.30	535 ± 50.93	742.8 ± 13.63	675.3 ± 29.7	459.8 ±26.17
	YLB $F_{3\ 20}$ 8.87	653.3 ± 0.81	853.3 ± 24.59	713.3 ± 4.90	570 ± 30
	YLC $F_{3\ 20}$ 15.23	663.3 ± 8.06	886.7 ± 12.29	826.7 ± 8.43	600 ±34.25
Cladocera Species richness	YLA $F_{3\ 20}$ 21.67	8.66 ± 0.21	11.33 ± 0.42	11.67 ± 0.3	7.83 ± 0.74
	YLB $F_{3\ 20}$ 12.55	6.500 ± .223	7.833 ± 0.30	6.833 ± 0.47	5.00 ± 0.25
	YLC $F_{3\ 20}$ 30.91	7.333 ± .333	8.667 ± 0.21	7.333 ± 0.21	5.33 ± 0.21

Table: 2 Pearson correlation of Cyanophyceae density with Biotic and Abiotic parameters of Yashwant Lake during December 2006 to November 2008

Sr. No.	Parameter	YLA	YLB	YLC
1	Ambient Temperature AT)	.668**	.483*	.750**
2	Water Temperature (WT)	.707**	.518**	.769**
3	Water Cover (WC)	-.822**	-.765**	-.799**
4	Total Solids (TS)	.640**	.540**	.667**
5	Total Suspended Solids (TSS)	-.039	-.075	-.026
6	Total Dissolved Solids (TDS)	.855**	.836**	.875**

7	Transparency	-.226	.073	-.303
8	Acidity	.826**	.763**	.909**
9	Alkalinity	.760**	.690**	.867**
10	Carbon Dioxide (CO_2)	.633**	.504*	.707**
11	Dissolved Oxygen (DO)	-.414*	-.419*	-.474*
12	Chloride	.861**	.797**	.904**
13	Total Hardness (TH)	.222	.454*	.352
14	pH	.721**	.632**	.792**
15	NO_2^-	.425*	.047	.309
16	NO_3^-	-.07	-.37	-.225
17	PO_4^{-3}	.527**	.219	.565**
18	Total Density Of Zooplankton (TDZ)	.919**	.885**	.936**
19	Total Density Of Phytoplankton (TDP)	.782**	.727**	.810**
20	Total Density of Mollusc (TDM)	-.234	-.428*	-.223
21	Total Density of Birds (TDB)	-.525**	-.308	-.581**

** The pearson correlation is significant at the 0.01 level (two tailed)
*The pearson correlation is significant at the 0.05 level (two tailed)

DISCUSSION

Zooplankton play a functionally important role in aquatic systems by consuming phytoplankton and bacteria and then releasing nutrients back in the ecosystem or by serving as prey for transferring nutrients to higher trophic levels (Hillbricht, 1977). The Zooplankton community compositions in shallow water systems are not only influenced by predation (Donald et al., 2001; Hampton and Gilbert, 2001) but also by, water chemistry and hydrology (Moss, 1994). Of the hydrology, the hydroperiod and water cover are the major physical factors responsible for formation of the various ecological communities (Shurin, 2000). According to Pennak (1946) and Bonecker and Lansac-Toha (1996) plankton are abundant during the slow water current, while rise in water brings about a sharp decline in their density. In the present study, at the higher altitudinal lake in the semi arid-zone of Maharashtra, India, the water level and the resultant water cover have proven to be the important factors in regulating the density of the plankton.

Cladocerans show seasonal fluctuations (Kaushik and Sharma 1994; Sharma and Sharma 2009) the maximum density of Cladocera was also recorded in summer and minimum in post-monsoon that can be correlated with water level/ cover. It has been reported that the density and biomass of Cladocerans is primarily determined by food supply (Wright, 1954; Singh, 2000).With rising temperature in summer the food supply in the form of algae, detritus and bacteria is available which

leads to an increase in Cladocerans population. In addition the overwintering adults or resting eggs of Cladoceran also become active as the temperature increases resulting in faster rate of moulting and brood production with increase in food supply that can results in rise in the number of eggs per brood (Wetzel, 2001). Quadri and Yousuf (1978) have also reported that the temperature is the primary factor affecting the occurrence and distribution of Cladocerans. In present study the Cladoceran density is significantly positively correlated with total density of phytoplankton and water temperatures as well as water cover. The minimum population of Cladoceran in post-monsoon may be attributed to the dilution factor.

The seasonal succession of the Cladocera is quite variable, both among species and within a species that live in different lake conditions. Some species are perennial and overwinter in low population densities as adults (parthenogenetic females) rather than as resting eggs (Wetzel, 2001).

Cladocerans constitute important links in limnetic as well as benthic food chains eg. Daphnia and Moina., while Diaphanosoma, Chydorus, etc. are indicators of eutrophication (Mahajan, 1981). The most frequent cladocerans at YL were Diaphanosoma species, Ceriodaphnia cornuta and Moina micrura. In littoral zone, the members of family Chydoridae represented major component. These organisms are usually associated with macrophytes, periphyton or sediment (Wisniewski-Santos et al., 2002). Of these the Cydorus species was frequently recorded at station YLB and station YLC where the macrophytes are maximum in numbers but rarely at station YLA with rocky bottom.

The effect of temperature on Cladocerans has implication from the viewpoint of species distribution, body size and abundance (Stockwell and Johannsson, 1997). Most temperate water bodies contain Cladoceran genera like Daphnia and Basmina among herbivore taxa and Leptodora and Cercopagic among predatory taxa (Dumont and Negrea, 2002). In contrast tropical water bodies typically contain genera Moina, Ceriodaphnia, Macrothrix and Diaphanosoma all of which are predominantly herbivorous taxa (Dodson and Frey, 2001). These four genera of tropics were also recorded in the Yashwant lake (Annexture) the higher altitude lake.

The other parameters of the present study showed that the reservoir is of a better quality although there is a need of continuous monitoring to maintain quality of the water. The results indicate that the maximum number of genera occurred during summer than in post-monsoon. Among Cladoceran zooplanktonic population in general, low population of perennial species and a near absence of aestival species in winter are common. In present investigation moderate species richness is recorded in winter. Cladoceran density is also positively correlated at the level of 0.01 with various physicochemical parameters except AT (atmospheric temperature), NO2-, TH (Total Hardness) and Transparency and correlated variously with biotic component at the three stations with respect to their microhabitats according to substratum, vegetation and anthropopressures.

CONCLUSION

The study of Cladocerans in Yashwant Lake revealed that maximum species richness of Cladocerans was in summer while minimum in winter probably higher temperature of summer favouring the growth of cladocerans. Since the surface water temperature fluctuations in Yashwant lake varied from 18.38 ± 0.15˚C to 22.2 ± 0.37˚C. In today's modern world, tourism is fast growing field and Toranmal area is one of the most favoured centre, So for conservation point of view this aquatic ecosystem can be change from tourism to ecotourism.

Annexture-I

Cladocerans of Yashwant Lake observed at Toranmal in Satpura ranges during December 2006 to November 2008

A.Cladocera
Phylum – Arthropoda
Class – Crustacea (Pennant, 1777)
Order – Cladocera (Latreille, 1829)
Family – Sididae (Baird, 1850)
Genus – Diaphanosoma (Fischer, 1850)
1.Diphanosoma sarsi (Richard, 1895)
Family – Daphniidae (Straus, 1820)
Genus – Ceriodaphnia (Dana, 1853)
2.Ceridaphnia cornuta (Sars, 1888)
Genus – Simocephalus (Schodler, 1858)
3.Simocephalus vetalus (O. F. Muller, 1776)
Family – Moinidae (Goulden, 1968)
Genus – Moina (Baird, 1850)
4.Moina micrura (Kurz., 1874)
5.Moina brachiata
Family – Bosminidae (Norman and Brady, 1867)
Genus – Bosmina (Baird, 1843)
6.Bosmina spp.
Family – Macrothricidae (Norman and Brady, 1867)
Genus – Macrothrix
7.Microthrix spinosa (King, 1853)
Family – Chydoridae (Stebbing, 1902)
Sub-Family – Chydorinae
Genus – Chydorus (Leach, 1843)
8.Chydorus spp.
Sub-Family – Aloninae (Frey, 1967)
Genus – Alona (Baird, 1850)
9.Alona rectangula (Sars, 1862)
Genus – Acroperus (Baird, 1843)
10.Acroperus harpae (Baird, 1834)
Genus – Indialona (Petkovaski, 1966)
11 Indialona ganpati (Petkovaski, 1966)

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