SEASONAL VARIATIONS OF ZOOPLANKTON COMMUNITY IN TWO SACRED TEMPLE TANKS OF PONDA, GOA, INDIA.

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ABSTRACT

Zooplankton are good indicators of the changes in water quality, because they are strongly affected by environmental conditions and respond quickly to changes in water quality. Hence, qualitative and quantitative studies of zooplankton are of great importance. In the present study, qualitative and quantitative studies of zooplankton in two sacred temple tanks of Goa were carried out for one annual cycle. (Dec. 2009 to Nov. 2010). Present investigations revealed that, 17 species of Zooplankton belonging to four major groups i.e., Calanoid (six sps.), Cladoceran (five sps.), Rotifera (four sps.) and Cyclopoid (two sps.), were present. Densities as well as diversity of zooplankton were higher at Site-1than Site-2. Among zooplankton, Copepod group was dominant at both the sites throughout the study period. Density of zooplankton during different seasons at two sites was as follows: Site 1: Winter season >Summer season > Rainy season and Site 2: Summer season > Rainy season > Winter season.

Key words: Density, Diversity, Seasonal abundance, Temple tank, Zooplankton.

INTRODUCTION

The requirement of water in all lives, from microorganisms to man, is a serious problem today, because most of the water resources have reached to point of crises due to unplanned urbanisation and industrialisation. In India, natural ponds are estimated to have an area of about 0.72 million hectares, most of these ponds are found in the vicinity of villages, places of religious worship and other human inhabitation (Gulati and Schultz, 1980).They are important part of human civilisation, meeting many crucial needs for life on earth such as drinking water, protein roduction, water purification, energy, fodder production, food storage, recreation, research, education, sinks and climate stabilizers (Vaishali and Madhuri, 2004).

The aquatic ecosystem covers a vast area and the organisms occurring in this area are under the influence of its physicochemical parameters. The natural and artificial contaminants affecting the physiochemical properties of water impart an indirect effect on the stability of the interacting biological resources, apart from degrading the environmental conditions (Miller and Miller, 2007).

The physic-chemical methods are used to detect effects of pollution on the water quality but changes in the trophic conditions in water are reflected in the biotic community structures as shown by occurrence, diversity and abundance pattern of species. (Cairns, 1979).

Zooplankton are major trophic link in food chain and being heterotrophic organisms, play a key role in cycling of organic materials in aquatic ecosystems.

According to Ahmad (1996), Murugan *et.al.*, (1998) and Dadhich and Saxena (1999) reported that, zooplankton plays an integral role and serve as bio-indicators and it is a well suited tool for understanding water pollution.

The knowledge of their abundance, species diversity and special distribution is important in understanding trophodynamics and trophic progression of water bodies.

Although a number of studies have been carried out on ecological conditions of freshwater bodies in various parts of India (Michael, 1969; Rama and Bhati, 1982; Rana 1991; Sinha and Islam, 2002; Singh *et. al.*, 2002), in Goa, the ecological studies of freshwater body is very scanty and on freshwater bodies of smaller dimensions such as temple tanks is almost nil. Therefore, in present investigations, attempts were made to study the zooplankton species richness, diversity, seasonal abundance and zooplankton composition of two sacred temple tanks of Ponda taluka in Goa.

MATERIALS AND METHODS

The study was conducted for a period of one year from Nov. 2009 to Oct. 2010 on two sacred temple tanks viz; site 1 (Shri Ramnath temple tank, Ramnathi Ponda). Shri Ramnath temple, which has completed 450 years of its existence is dedicated to Lord Shiva, is situated at about 26km away from Panaji, Goa, on Panaji-Belgaum National highway, has a beautiful temple tank with clear water. History says that, the temple was shifted to the present site in the 16th century to prevent its destruction by the then Portuguese authorities.

Site-2 (Shri Manguesh temple tank, Mangeshim Ponda) is located at Mangeshim in Priol, Ponda taluka, is about 22 km from Panaji the capital of the state of Goa. This 400-year-old temple is also dedicated to Shiva stands out with its simple and yet exquisitely elegant structure. The temple has a magnificent water tank, which is believe to be the oldest part of the temple. Zooplankton samples were collected from these two temple tanks, between 0800hrs and 1100hrs on monthly basis for one year.

Samples were collected by filtering about 20lt of water through plankton net of mesh size 45 micron. Filtrate was collected in 200ml bottle and 4% formalin was added to preserve the sample for further studies in laboratory. The concentrate was examined under microscope and zooplankton were counted using Sedgwick Rafter plankton counting cell according to Welch (1948). Further these zooplankton were identified using standard literature (Battish, 1992; Edmondson, 1965, 1992; Dhanapathi, 2000).

RESULTS AND DISCUSSION

Copepods

Freshwater copepods constitute one of the major zooplankton communities occurring in all types of water bodies and ranging from free living to parasitic forms. They serve as food to several fishes and play major role in ecological food pyramids. Copepods were recorded more at Site-1 than Site-2. Throughout the study period, copepods, which includes calanoids, cyclopoids and nauplii were found to be most dominant group occupying the top first position in total zooplankton community at both the sites (Fig. 3). Season wise abundance of copepods at site 1 was as follows:

Winter season >Summer season > Rainy season

And at site 2 was as follows:

Summer season > Rainy season >Winter season

Copepods (Table-6) were represented by six species of calanoids and two species of cyclopoids.

Rotifers

The Rotifers also called as rotaria or wheel animalcules are group of small, usually microscopic pseudocoelomate animals, which have been variously regarded as separate phylum. The rotifers have attracted much attention of limnologists because of their wide distribution in water they frequently occur.

Higher abundance of rotifers is seen at Site-2 as compared to Site-1. Species like *B. calciflorus* and *K. tropica* are often observed during study period at both sites. According to Noguira (2001) and Sampaio *et. al.*, (2002), *B. Calciflorus* acts as indicator of eutrophication. Rotifers were represented by *K. tropica, B. falcatus, B. budapestinensis, B. calciflorus* (Table-6).

Cladocerans

Cladocerance popularly called as "water fleas" prefers to live in deep water and constitute a major item of food chain and energy transformation. Higher abundance of cladocerance is seen at Site-2. The cladocerans are represented by *Moina micrura, Diaptomus excisum, Bosmina destessi, Moinodaphnia macleygi* and *Ceriodaphnia cornuta* (Table-3).Korovchinsky (2000) reported that, pelagic cladocerans of large lakes in the eastern hemisphere were mainly composed of *Ceriodaphnia, Bosmina, Moina, Diaphanosoma* and *Daphnia*. First three genera have a great significance in terms of occurrence in our study sites. They are also common genera in temperate and tropical water bodies (Arcifa, 1984; Gulati, 1990; Pinto-Coelho *et al.*, 2005; Patalas, 1972).

Further, in present investigations, it was observed that, the zooplankton mainly comprises copepods, cladocerans and rotifers. Copepods are the largest contributors in terms of density (78.70%) and diversity at both sites followed by cladocera (11.79%) and rotifers (9.52%) at Site-1, and rotifer (30.56%) and cladocera (4.61%) at Site-2. (Fig-3)

Tropical and temperate limnological comparative studies have demonstrated that oligotrophic systems are dominated by copepods, whereas more eutrophic systems are dominated by rotifers and cladocerans (Guevara *et. al.*, 2009). Nevertheless, the work by Pinto-Coelho *et. al.* (2005) established that cladocerans and cyclopoids are associated to the more eutrophic lakes and reservoirs, which support greater crustacean abundances in most latitudes.

In this study the seasonal abundance (no/l.) of zooplankton groups was in the following increasing order throughout study period through all the seasons (Tab.3 and 4).

Site 1: Copepoda > Cladocera > Rotifera.

Site 2: Copepoda > Rotifera > Cladocera.

Abundance of zooplankton (no/l) season wise at these sites was as follows:

Site 1 (Fig. 1, Tab. 3): Winter season >Summer season > Rainy season

The population falls during monsoon, due to dilution effect. The population again rises to a higher level in winter, as a result of favourable environmental conditions. Normally, the monsoon is associated with lower population densities due to its dilution effect and decrease in photosynthetic activity by primary producers. Similar results have been shown by Edmondson (1965), Baker (1979), Bais and Agrawal (1993), Salve and Hiware (2010) and Ude *et.al.*,(2011). This is in consonance with Mitsch and Gosselink (2000), who reported that, the biodiversity of ecosystem depends upon and is determined by their hydrological characteristics and to a great extent on nutrient status.

Site 2 (Fig. 2, Tab. 4) Summer season > Rainy season > Winter season

The summer population maxima of zooplankton especially copepods, were co-related with higher temperatures, lower transparency and high standing crop of primary producers leading to greater availability of food (Priolkar and Pai, 2010). Similar results have been reported by Ganpati (1943), Ramakrishna and

Sarkar (1982), Bhati and Rana (1987), Kumar and Datta (1994), Salve and Hiware (2010), Joshi (2011) and Jadhav *et.al.*, (2012).

For tropical and subtropical reservoirs, densities of zooplankton are regulated by rain intensity, phyto-plankton productivity, wind action and predation (Nogueira *et al*. 1999; Roldan and Ruýz 2001). However, it was not possible to quantify the impact of predators on the zooplankton in this study, as we do not have reliable investigations about the influence of planktivorous fish.

Density and diversity (13 species at Site-1 and 10 species at Site-2) of zooplankton was more at Site-1 than to Site-2 (Fig-3, Tab 5). Welch (1952) reported that, the diversity and density or distribution of plankton isaffected mainly by wind flow, inflowing streams, dilution, qualitative variation of water, physico-chemical alteration of water, depth of water, current plankton swarms and action of predators and diurnal migration of plankton. Thus the study has determined that, abundance of zooplankton has been governed by the cumulative effect of physico-chemical and biological variables.

Thus, from the present studes we can conclude that, the diversity and density of zooplanktons from both the sites (Site-1 and Site-2) exhibited by four major groups (Rotifera, Cladocera, Calanoid and Cyclopoid) with 17 species, showed seasonal variability in density due to different parameters which has impact on them. Site-1 is more productive in comparison with Site-2 in relation for having higher density and diversity, which is probably attributed to availability of more food. Copepod is a dominant group at both the sites. Seasonal abundance is seen more during winter season at site-1 and during summer at site-2 due to favourable growth conditions.

Table 1: Population density of zooplankton (org/lit) at Shri Ramnath temple tank, Ramnathi, Ponda (Site-1)

MONTH	CALANOIDS		CYCLOPOIDS		ROTIFERS		CLADOCERA		NAUPLII	
	Density	%	Density	%	Density	%	Density	%	Density	%
DEC 09	167.65	64.13	13.90	4.50	42.70	13.85	54.00	17.52	29.95	9.72
JAN 10	25.80	27.83	3.60	3.88	16.20	17.48	9.90	10.68	37.20	40.13
FEB 10	29.25	31.60	4.35	4.70	1.45	2.55	6.25	6.75	51.25	55.38
MAR 10	27.80	30.41	1.80	1.96	2.80	3.06	14.50	15.86	44.50	48.68
APR 10	6.40	16.16	4.40	11.11	5.40	13.63	6.40	16.16	17.00	42.92
MAY 10	39.70	57.57	0	---	3.65	5.29	4.40	6.38	21.2o	30.74
JUN 10	0.30	21.42	0.10	7.14	0	---	0.40	28.57	0.60	42.85
JUL 10	0.05	0.81	0	---	0	---	0	---	6.10	99.18
AUG 10	0.40	53.33	0	----	0	----	0	---	0.35	46.66
SEP 10	2.25	47.36	0		0		0		2.50	52.63
OCT 10	18.40	32.85	0.80	1.42	0		0.20	0.35	36.6	65.35
NOV 10	22.50	50.33	1.20	2.68	0		0		21.00	46.97

Table 2: Population density of zooplankton (org / lit) at Shri Manguesh temple tank, Mangeshim, Ponda (Site-2).

MONTH	CALANOIDS		CYCLOPOIDS		ROTIFERS		CLADOCERA		NAUPLII	
	Density	%	Density	%	Density	%	Density	%	Density	%
Dec-09	10.00	26.07	2.85	7.43	20.60	53.71	0.20	0.52	4.70	12.25
Jan-10	10.05	47.40	1.90	8.96	2.85	13.44	1.05	4.95	5.35	25.23
Feb-10	2.10	7.15	0.60	2.04	5.50	18.73	0.75	2.55	20.40	69.50
Mar-10	12.60	40.71	7.35	23.74	0.75	2.42	0.50	1.61	9.75	31.50
Apr-10	6.95	21.35	2.95	9.06	14.95	45.92	1.50	4.60	6.20	19.04
May-10	62.15	71.31	0.60	0.68	1.25	1.43	0.15	0.17	23.00	26.39
Jun-10	3.30	10.96	5.40	17.94	4.40	14.61	9.00	29.90	8.00	26.57
Jul-10	1.05	2.54	0	---	6.10	14.76	2.80	6.77	31.35	75.90
Aug-10	0.35	1.12	2.50	8.03	12.00	38.58	1.25	4.01	15.00	48.23
Sep-10	1.60	4.02	0.50	1.25	33.25	83.64	1.25	3.14	3.15	7.92
Oct-10	2.00	44.44	0.15	3.33	0.65	14.44	0.15	3.33	1.55	34.44
Nov-10	4.00	7.22	2.75	4.96	33.00	59.62	1.80	3.25	13.80	24.93

Table.3: Season wise population density of zooplankton (org / lit) at Shri Ramnath temple tank- Ramnathi Ponda (Site-1).

Site 1	calanoids	Cyclopoids	Rotifers	Cladocera	Nauplii	total
Summer	25.79	2.64	3.33	7.82	33.49	73.07
Rainy	0.75	0.02	0	0.1	2.39	3.26
Winter	58.59	4.88	15.98	16.02	31.19	126.66
Average	28.38	2.51	6.44	7.98	22.36	

Table 4: Season wise population density of zooplankton (org / lit) at Shri Manguesh temple tank, Mangeshim, Ponda (Site-2).

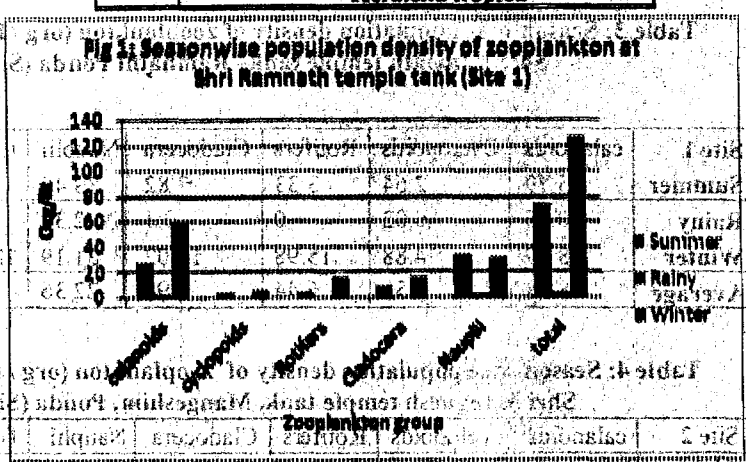
Site 2	calanoids	cyclopoids	Rotifers	Cladocera	Nauplii	Total
Summer	20.95	2.88	5.61	0.73	14.84	45.01
Rainy	1.58	2.10	13.94	3.58	14.38	35.58
Winter	6.63	1.91	14.23	0.80	6.35	29.92
Average	9.72	2.30	11.26	1.70	11.86	

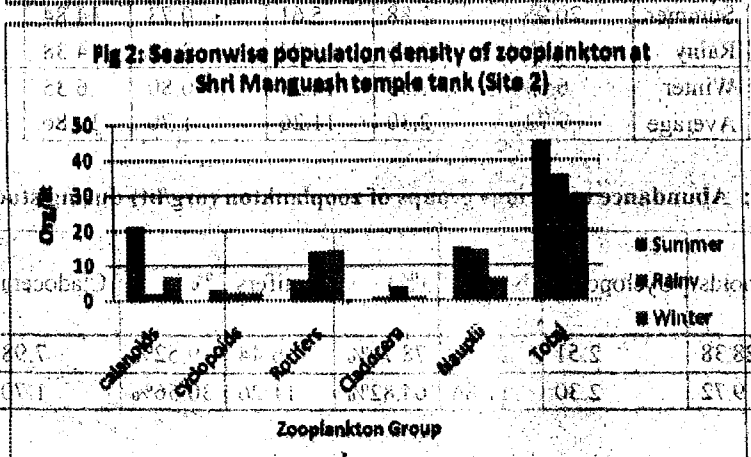
Table 5: Abundance of various groups of zooplankton (org/lit) during study period.

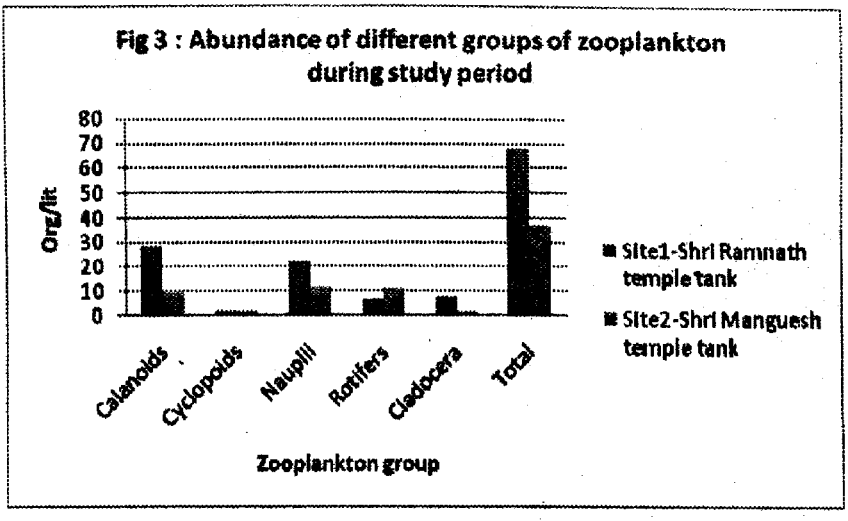
Sites	Calanoids	Cyclopoids	Nauplii	(%)	Rotifers	%	Cladocera	%	Total
Site1	28.38	2.51	22.36	78.70%	6.44	9.52%	7.98	11.79%	67.67
Site2	9.72	2.30	11.86	64.82%	11.26	30.56%	1.70	4.61%	36.84

Table 6: Zooplankton diversity from two temple tanks at Ponda, Goa, during Study period

Sr. no	Zooplankton	Species
1	Calanoid	Diaptomus saltinus
		Diaptomus floridanus
		Heliodiaptomus vidus
		Heliodiaptomus cinctus
		Eurytemora volvox
		Paradiaptomus greeni
2	Cyclopoid	Procyclops poppei
		Mesocyclops hyalinus
3	Cladocera	Bosmina deitessi
		Moina micrura
		Diaptomus excisum
		Moinodaphnia macleayi
		Ceriodaphnia comuta
4	Rotifers	Brachionus budapestinensis
		Brachionus calciflorus
		Brachionus falcatus
		Keratella tropica







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