INTERNATIONAL JOURNAL OF ENVIRONMENT
Volume-3, Issue-1, Dec-Feb 2013/14 ISSN 2091-2854
Received:6 January *Revised:15 January* *Accepted:21 January*

OCCURRENCE OF ZOOPLANKTONS AT SACRED PALUSTRINE HABITAT, CENTRAL GUJARAT, INDIA, WITH CONSERVATION AND MANAGEMENT STRATEGIES

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Abstract

The aim of the present study was to represent the zooplankton composition of Sacred Palustrine Habitat (SPH), Anand District, Central Gujarat, India. Collections of zooplanktons were carried out at three permanent sampling stations at fortnight intervals over one year period covering three consecutive seasons from June 2012 to May 2013. The zooplankton population was represented by a total of 29 genera and 31 species bestowed by 12 species of Ciliophora, followed by Rhizopoda (6), Zooflagellata (5), Rotifera (4), Cladocera (2), Copepoda and Ostracoda (1) each. Of the total 31 species of zooplanktons, nine species were abundant, 11 were common, and 12 were rare. The present paper discusses the population profile of zooplanktons in waters of SPH with suggested conservation and management strategies.

Key words: Zooplanktons, Occurrence, Sacred palustrine habitat, Central Gujarat

Introduction

Freshwater habitat has played an imperative role for human civilization imparting massive ecological usefulness for livelihood in all the continents of the world (Junk, 2002). Globally, wetlands are characterized by a large number of ecological niches which harbour a significant percentage of world's biological diversity and are amongst the most productive ecosystems comparable to rainforests and coral reefs (Thomas and Deviprasad, 2007). Zooplanktons community is an important link in the transformation of energy from producers to consumers due to their large density, drifting nature, high group or species diversity and different tolerance to the stress factors. This plankton group is cosmopolitan in nature, which inhabits all freshwater habitats of the world (Jalilzadeh *et al.*, 2008). Monitoring of zooplankton communities is needed to predicatively model the ecosystem (Deborah and Condon, 2009). The zooplanktons are known not only to form an integral part of the lentic community but also contribute significantly to the biological productivity of the lentic

ecosystem (Wetzel, 2001). The diversity of zooplankton is one of the most important ecological parameter which is an intermediate linkage between phytoplankton and fish; plays a key role in cycling of organic materials in an aquatic ecosystem. Discharge of anthropogenic wastes and surface run-off cause deleterious effect on flora and fauna and other aquatic organisms (Sah *et al*., 2000).

Zooplankton communities are typically diverse and occur almost in all lakes and ponds, which are highly sensitive to environmental variations. Due to short life cycle, these communities often respond quickly to environmental changes (Sharma *et al.*, 2007). Cultural eutrophication, siltation, predation, and habitat destruction excise drastic impacts on zooplankton community structure (Wanganeo, 2007). As a major element in aquatic biota, zooplankton community often exhibits dramatic changes in response to the changes in the physico-chemical properties of aquatic environment. Hence, zooplankton fauna or zooplankton association can be used as useful means for the assessment of water pollution (Dar and Dar, 2009).

According to Ferrar (2002), the primary productivity of freshwater ecosystem fluctuates with changes in environmental factors and grazing by zooplanktons. Low zooplankton populations usually have rapidly multiplied phytoplankton population (Trivedi *et al*., 2003). Hakanson *et al*. (2003) attributed this to food availability and avoidance of predators. Zooplanktons are globally recognized as pollution indicator organisms in the aquatic environment (Sunkad and Patil, 2004). George (1966), Krishnamurthy and Visvesvara (1966), Sreenivasan (1967) and Michael (1968) worked thoroughly on the ecology of zooplankton population from different waters of India. Some of the works which have been done in Bangladesh include those of Das and Bhuiyan (1974), Islam and Mendes (1976), Khan *et al*., (1978), Bhuiyan and Nesa (1998 a,b) and Bhuiyan *et al*. (1997). Islam *et al*., (2000) studied ecology and seasonal abundance of some zooplankton of a pond in Rajshahi Tehsil.

In Gujarat, although some information is available on the zooplankton community of aquatic ecosystem, studies are sparse and restricted to mere short-term taxonomic observations of lentic environment without scanty ground-truth quantitative analysis. Several studies have been carried out on different aspects of lentic ecosystems too. The floral and faunal diversity of aquatic ecosystem including major industrial development pressures on mangroves and coastal ecosystems of Gujarat wad observed by Oswin (2004). Nirmal Kumar *et al.* (2005, 2008) explored physico-chemical characteristics of water, sediments and diversity of aquatic macrophytes in lentic ecosystem. Temporal and spatial variations with reference to community composition of zooplankton had been studied by Soni (2007) for two community reservoirs (Pariyej and Kanewal), Central Gujarat, for a yearlong study period. Influence of water quality on composition and seasonal abundance of phytoplankton community in Thol wetland of Gujarat was studied by Nirmal Kumar *et al.* (2011). Rawal and Pandit (2010) evaluated the quality of surface water devastating due to rapid industrialization, population growth and urbanization of Ahmedabad city. The goal of the present paper is to investigate the zooplankton occurrence at Sacred Palustrine Habitat (SPH), District Anand, Central Gujarat, India, for three consecutive seasons from June 2012 to May 2013, at three selected study sites, along with conservation and management strategies for preserving the prevailing and surviving biota of the region.

Materials and Methods

Study Area

Sacred Palustrine Habitat (SPH), District Anand, Central Gujarat, India, is located between 22.59^0 N and 72.87^0 E, with an average elevation of 37 meters (~111 feet) above MSL. Temperature ranges from lowest 12 ^{0}C (peak winter) to highest 36 ^{0}C (peak summer). According to 2001 census, the human population of the region is around 10,024 with an average literacy rate of 74%. It is the most worshiped holy place of Lord Swaminarayana, and has also become the source of sacredness for the inhabitants from not only Gujarat State but from all over India (Fig. 1).

Figure 1. Holistic view of Sacred Palustrine Habitat (SPH), Central Gujarat, India

Sampling

Collections of zooplanktons were carried out at three permanent sampling stations at fortnight intervals for three consecutive seasons over one year time period (June 2012 to May 2013). The nylon net (20µ mesh-size) was used for collection of zooplanktons. Plankton net of conical shape and reducing cone (having filtering area three times larger than the area of the mouth) with the bottle at its end was preferred (Downing and Rigler, 1984). Zooplanktons were collected precisely from each sampling site using plankton net towing into open water three times (horizontally, vertically and obliquely). Later, the samples were transferred to air-tight plastic bottles, carefully labelled, and preserved immediately on-site using 4% formaldehyde. Systematic identification of zooplanktons was done using light compound binocular microscope (Almicro), referring various monographs, books and other published literature such as Tonapi (1980), Pennak (1994), Edmondson (1998), and Battish (2000). After an accurate identification of each individual from genus to species level, all the samples were preserved in plankton laboratory for comparative studies with other samples as a future reference. The occurrence status of all the taxa were determined on the basis of the number of samples in which a given taxon occurred in relation to the total number of samples collected.

For this, the following categories were determined: Abundant (A): > 80%; Common (C): 10-70%, and Rare (R): <10%. (Reckendorfer *et al*., 1999)

Results and Discussion

The population structure of zooplanktons in water of SPH was represented by a total of 31 species belongs to 29 genera representing 7 classes. Of which, 11 genera (37.93%) were represented by Ciliophora, followed by 6 (20.68%) genera of Rhizopoda, 5 (17.24%) genera of Zooflagellata, 3 (10.34%) genera of Rotifera, and 2 (6.89%) genera of Cladocera, while Copepoda and Ostracoda representing with 1 (2.77%) genera each (Table 1). The peak gradient of diversity of zooplanktons could be due to habitat heterogeneity, influenced by favouring surface water quality for sustenance of planktons (Soni and Thomas, 2013a; Soni and Thomas, 2013b; Soni and Thomas, 2013c; Soni *et al*., 2013).

The supremacy of zooplanktons was reflected by the occurrence of members of Class Ciliophora 12 species (38.70%), followed by 6 species (19.35%) of Rhizopoda, 5 species (16.12%) of Zooflagellata, and 4 species (12.90%) of Rotifera, 2 species (6.45%) of Cladocera and only 1 species (3.22%) of Copepoda and Ostracoda each. These results clearly depict the importance and dominance of Ciliophora, Zooflagellata and Rhizopoda in the aquatic ecosystem of SPH (Howaida *et al.*, 2007). The finding obtained in the present study was in congruence with the findings of Soni and Thomas (2013).

Table 1. Zooplanktons recorded at Sacred Palustrine Habitat (SPH)

Class	**Genera**	**Species**	**Genera:Species**
Zooflagellata	5	5	1.10
Rhizopoda	6	6	1.10
Ciliophora	11	12	1.09
Rotifera	3	4	1.33
Copepoda	1	1	1.10
Cladocera	2	2	1.10
Ostracoda	1	1	1.10
Total (7 Classes)	**29**	**31**	**4.14:4.42**

Among the recorded species (31), the most copious species belongs to class Ciliophora *viz*. *Coleps hirtus* Muller, *Paramecium Aurelia* Her., *Paramecium bursaria* Ehr., *Vorticella campanula* Ehr., which exhibited its occurrence throughout the study period at all study sites, whereas the common species among them were *Chilophrya utahensis* (Pack) Kahl and *Stentor coeruleus* Ehrenberg, while the other species of the class were noted rarely. The supremacy of members of Ciliophora amongst the other classes of zooplanktons substantiates the previous work of Nirmal Kumar *et al.* (2011).

Of the listed classes, Zooflagellata, Rhizopoda and Rotifera formed the second most dominant group of zooplanktons. The dominant taxa amongst these classes of zooplanktons were *Bodo caudatus* Dujardin, *Amoeba proteus* L., and *Thecamooeba verrucosa* Ehrenberg. On the contrary, species such as *Actinomonas mirabilis* Kent, *Bodopsis godboldi* Lackey, *Mastigamoeba replans* Stokes, *Trimastigamoeba sp.* Whitmore, *Arcella megastoma*

Penardand, and *Difflugia oblongata* Ehrenberg, were observed as common, and the remaining species were reported as sporadic.

Of the documented species (3) of Cladocera, *Daphnia lumholtzi* G.O. Sars dominated the other members of the class, whereas *Oxyurella singalensis* Daday noted as common. Contrastingly, class Copepoda and Ostracoda was represented by only single species *viz. Cyclops sp.* and *Cypris pubera* O.F. Muller, respectively, which could be the resultant impact of negligible extent of anthropogenic pollution at SPH.

The reported taxa (29 genera, 31 species) of zooplanktons at SPH can be depicted by a ratio 1:4.14:4.42 (Family: Genera: Species) (Table 1), noticeably indicates remarkably the peak species richness (11 Genera, 12 Species) of zooplanktons belonging to Class Ciliophora, with a ratio 1:09 (Genera: Species), followed by Rhizopoda and Zooflagellata members (6 Genera, 6 Species) and (5 Genera, 5 Species) with a Genera: Species ratio (1:1), respectively. Besides, class Rotifera was ruled with 3 genera and 4 species (Genera: Species ratio - 1:33), and the least recorded taxa were represented by members of Class Cladocera with 2 genera 2 species (1:1), while Copepoda and Ostracoda with 1 genera and species each (Genera: Species ratio - 1:1).

Table 2 denotes the site-wise description of reported classes of zooplanktons. Sites V1 and V3 showed the existence of all the documented classes (7) of zooplanktons. Highest numbers of genera (29) of zooplanktons were recorded in water of Site 1 and the least number of genera (18) was observed at Site 3, whereas the water of Site 2 exhibited the intermediate number of zooplanktons genera (26).

Table 2. Status of Zooplanktons at Sacred Palustrine Habitat (SPH)

Zooplanktons	**V1**	**V2**	**V3**
Class	7	6	7
Genera	29	26	18
Species	31	28	19
A	9	9	9
C	7	8	8
R	8	2	2

V1, V2, V3= Sampling stations;
A-Abundant, C-Common, R-Rare

Similarly, in congruence with the observed genera, the maximum number of species was noticed at Site 1, following Site 2 and the least species richness was reported at Site 3. With respect to the status, 9 species of zooplanktons were found abundant in the water of all the sampling stations, whereas 8 species were classified as common at Site 2 and 3 each, and the least (7) at Site 1. During the study period, some zooplanktons species appeared only during one or two months and thus were categorized as rare species. Highest number (8) of such species was seen at Site 1 and the least (2) at site 2 and 3 each, respectively (Figures 2, 3).

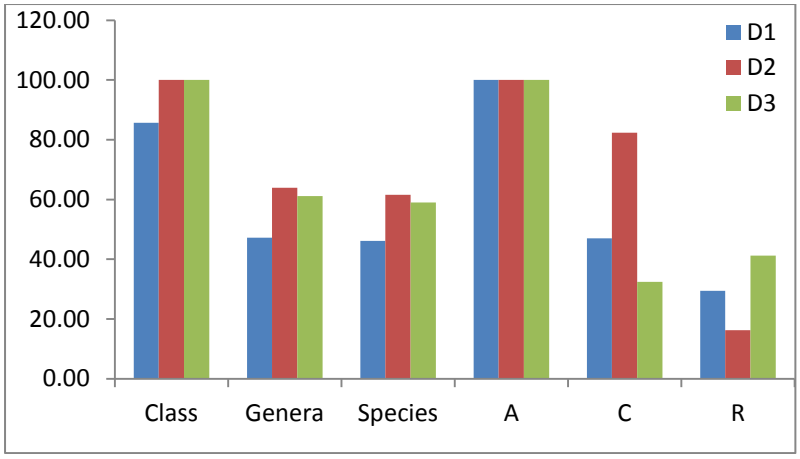

Figure 2. Percent Distribution of Zooplanktons at Sacred Palustrine Habitat (SPH)

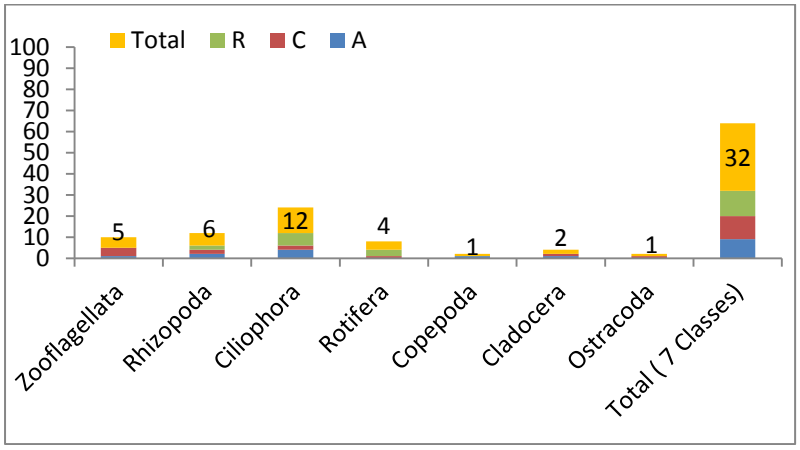

Figure 3. Occurrence and Status of reported Classes at Sacred Palustrine Habitat

The present investigation clearly revealed that a total of 29 genera and 31 species were recorded at Sacred Palustrine Habitat (SPH) throughout the tenure of the investigation period. The ratio of Family: Genera: Species revealed that for each family, 4 genera and 4 species of zooplanktons were present. Among the recorded classes of zooplanktons, Ciliophora occurred as the most dominant taxa accounted for 11 genera (37.93%), followed by 6 (20.68%) genera of Rhizopoda, 5 (17.24%) genera of Zooflagellata, 3 (10.34%) genera of Rotifera, and 2 (6.89%) genera of Cladocera, while Copepoda and Ostracoda representing only 1 (2.77%) genus each (Table 1). The site-wise approach at SPH showed the prolific occurrence of all the documented classes (7) of zooplanktons at Sites 1 and 3, whereas Site 1 as recorded with only 6 classes. The steep gradient of zooplanktons species was observed at all the study sites (Site 1, 2 and 3) reflected by the persistence of members of class Ciliophora. On the contrary, no any member of class Ostracoda was noted in the water of Sites 2 (Annexure 1).

Annexure 1. Zooplanktons recorded at Sacred Palustrine Habitat (SPH), Central Gujarat, India (June 2012 to May 2013)

Class	Species	V1	V2	V3	Status
Zooflagellata	*Actinomonas mirabilis* Kent	+		+	C
	Bodo caudatus Dujardin	+	+	+	A
	Bodopsis godboldi Lackey	+	+		C
	Mastigamoeba replans Stokes		+	+	C
	Trimastigamoeba sp. Whitmore	+	+		C
	Species	**4**	**4**	**3**	
Rhizopoda	*Actinophrys sol* Ehr.	+			R
	Amoeba proteus L.	+	+	+	A
	Arcella megastoma Penard		+	+	C
	Difflugia oblongata Ehrenberg	+	+		C
	Pyxidicula scutella Playfair	+			R
	Thecamooeba verrucosa Ehrenberg	+	+	+	A
	Species	**5**	**4**	**3**	
Ciliophora	*Campanella umbellaria* Linnaeus		+		R
	Chilodonella uncinata Ehrenberg	+			R
	Chilophrya utahensis (Pack) Kahl		+	+	C
	Coleps hirtus Muller	+	+	+	A
	Keronopsis muscorum Kahl	+			R
	Paramecium aAurelia Ehr.	+	+	+	A
	Paramecium bursaria Ehr.	+	+	+	A
	Placus luciae Kahl		+		R
	Podophrya bengalensis Ghosh	+			R
	Spasmostoma viride Kahl			+	R
	Stentor coeruleus Ehrenberg	+		+	C
	Vorticella campanula Ehr.	+	+	+	A
	Species	**8**	**7**	**7**	
Rotifera	*Brachionus caudatus* Pallas			+	R
	Chydorus ciliates Poggenpol		+	+	C
	Mytilina ventralis Ehrenberg	+			R
	Species	**2**	**1**	**2**	
Copepoda	*Cyclops sp.*	+	+	+	A
	Species	**1**	**1**	**1**	
Cladocera	*Daphnia lumholtzi* G.O. Sars	+	+	+	A
	Oxyurella singalensis Daday	+		+	C
	Species	**2**	**1**	**2**	
Ostracoda	*Cypris pubera* O.F. Muller	+		+	C
	Species	**1**	**0**	**1**	
	Total Species	**23**	**18**	**19**	

V1, V2, V3 = Sampling stations; A = Abundant, C = Common, R = Rare

Conclusion

The dilemma that is presented by the depleting zooplanktons is essentially how it is possible for a number of species to coexist in a relatively isotropic or shapeless environment all competing for the same sorts of resources especially when the habitat is shrewdly impacted by anthropogenic pressures which on the whole adversely affects the biodiversity and the ecology. Looking into its future insight, it is now high time to manage, conserve, and

restore the ecosystem in proper, well-monitored way. Different conservation and management strategies that can be adopted to maintain the vitality and vivacity of the aquatic body are suggested as follows:

- Improve spawning and rearing of available fish diversity to form an interlinking chain among higher level consumers in trophic pyramids for sustainable networking of food-chains and food-webs.
- Manage the optimum level of anthropogenic nutrients for augmenting the food availability to the prevailing biota therein.
- Restore and enhance the habitat for providing a flourishing niche to wildlife and plant species.
- Restrain the occurrence of toxic contaminants invading the ecosystem by reducing the anthropogenic activities.
- Rule-out the superfluous invasion of non-native aquatic plant species for an equal share of aquatic food resources.
- Lessen the undesirable effects of commercial and recreational activities to improve the richness in biotic diversity.
- Identify the nutrient sources and understand their broad ecological effects on the ecosystem.

Acknowledgements

We are thankful to Dr. C.L Patel, Chairman, Charutar Vidya Mandal (CVM), Dr. V.S. Patel, Director, Sophisticated Instrumentation Centre for Applied Research and Technology (SICART), Dr. P.M. Udani, Director, Institute of Science & Technology for Advanced Studies & Research (ISTAR), and Dr. Nirmal Kumar, J.I., Head, Department of Environmental Science and Technology (DEST), Vallabh Vidyanagar, Gujarat, India, for providing necessary infrastructure, and logistic facilities throughout the tenure of the research work.

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