

ZOOPLANKTON COMMUNITY STRUCTURE IN RELATION TO PHYSICAL CHEMICAL FACTORS OF VEERANAM LAKE WATER

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ABSTRACT – This paper investigates the effect of important physico-chemical factors of Veeranam lake water on the species-wise distribution of Zooplankton community structure in Veeranam lake, Tamil Nadu during the period 2002, 2003 and 2004. Zooplankton in the Veeranam lake consists of 45 Taxa, out of which 5 belonging to Rhizopoda, 7 Ciliata, 1 Zooflagellata, 14 Rotifera, 10 Cladocera, 6 Copipoda and 2 Ostracoda. Significant variations were noted with regard to the species-wise distribution of zooplankton community. The overall trend in the distribution of zooplankton species indicated that among the seven major groups recorded, highest number are from Rotifera, followed by Cladocera and Ciliata. Among the three years of the study period, highest mean values were recorded during 2002 for water depth (4.68 m), total dissolved solids (359.17 mg/l), electrical conductivity (503.10 mho/sec), dissolved oxygen (11.91 mg/l), pH (8.01), phenolphthalein alkalinity (5.93 mg/l), calcium (34.74 mg/l), manganese (0.07 mg/l), chloride (54.62 mg/l), fluoride (0.30 mg/l), and sulphate (23.36 mg/l), while the mean values of total alkalinity (152.40 mg/l), magnesium (15.06 mg/l), and phosphate (0.29 mg/l) were highest during 2003 and the mean values of remaining variables viz., water temperature (28.81°C), atmospheric temperature (30.18°C), turbidity (8.81 NTU), total hardness (126.00 mg/l), iron (0.18 mg/l), free ammonia (6.69 mg/l) and nitrite (1.27 mg/l) and nitrate (0.21 mg/l) were highest during 2004. Further it is observed that these variations in the levels of physico-chemical factors of Veeranam lake water determines the availability and distribution of different zooplankton community in the lake.

Key words : Zooplankton, Veeranam lake, physical factors, water temperature, Rotifera, Cladocera.

INTRODUCTION

The name plankton comes from the Greek word 'planktos' which means 'wanderer' or 'drifter'. Zooplankton are a wide range of both unicellular and multicellular organisms. Most of the zooplankton are 'heterotrophs' that is they obtain energy from organic compounds, such as algae or other zooplankton while some of them such as the dinoflagellates, may also be fully or partially photosynthetic which are gaining energy from sunlight. As a result, they are found in surface waters where food resources are abundant. The processing of phytoplankton and food resources, by way of their consumption, these zooplankton play a vital role in aquatic food webs, as a controlling factor and as by being resource for consumers on higher trophic levels for many animals besides as a channel for packing organic material in the biological pump Thurman (1997). The significant role of these plankton species in various levels of maintenance of aquatic ecosystems were identified throughout the world. Apart from other direct role they play in well functioning of fresh water ecosystem, their distribution, also indicates the pollution level of that particular ecosystem and it indirectly plays a major role in inviting various rare

migratory birds to that area. Veeranam lake is one such freshwater wetland ecosystem which supports to a maximum of about fifty two water bird species belonging to various ecological categories. Water quality features of wetlands such as water depth, temperature (surface water & atmospheric) turbidity, total dissolved solids, electrical conductivity, dissolved oxygen, pH, phenolphthalein alkalinity, total alkalinity, total hardness, calcium, magnesium, iron, manganese, free ammonia, nitrite, nitrate, chloride, fluoride, sulphate and phosphate were reported to directly influence the availability and distribution of microfaunal community of that particular ecosystem and that in turn effects upon the macrofauna composition especially the water bird population characteristics such as species richness, diversity and density (Murphy *et al* 1984). Inclusions of hydrology in wetland habitat evaluation had considerable merits because levels of primary productivity in the aquatic systems and their trophic structure and total biomass throughout the aquatic food web are mediated via a host of interacting physical and chemical factors (Hutchinson 1957 and Wetzel 1975) and hence this attempt was made to investigate the effect of physico-chemical factors of lake water on the distribution

of zooplankton community with the following objectives.

- To document different Zooplankton species of the lake.
- To assess the zooplankton community structure in relation to physic-chemical parameters of lake water.

MATERIALS AND METHODS

Study Period : Data were collected from April 2002 to February 2004 so as to cover four seasons *viz.*, Pre-monsoon (August and September), Monsoon (October - December) Post-monsoon (January – March) and Summer (April-July) of two successive years.

Study Area : The Veeranam lake is situated ($11^{\circ} 15^{\circ}$ N and $11^{\circ} 25^{\circ}$ N; $79^{\circ} 30^{\circ}$ E & $79^{\circ} 35^{\circ}$ E) in Cuddalore District, TamilNnadu, Southern India about 25 km West of the Temple town Chidambaram (Fig.1.). It is situated about 30 km inland from the Bay of Bengal. This lake was dug by the Chola King Paranthaga during the 9th Century A.D. The lake is about 16 km length and 8 km width with the water holding area of about 15 km² and capacity of 930 million cu.ft. There are 34 sluices in the lake through which about 40,000 acres of two taluks *viz.*, Chidambaram and Kattumannarkoil are getting irrigation. The lake receives water from the river “Vadavar” and also from the “Sengal Stream”. The Veeranam lake has to depend often on the release of water from the Mettur Dam and Grand Anaicut. The lake area offers a wide variety of micro habitats which provide suitable substrates for a variety of water birds. The Veeranam lake and its watershed are situated in the rain shadow regions of Southwest Monsoon (June – August) and receive Northeast monsoon (September – December) only. The climate is tropical. Hot weather prevails in the months of March to June, and the Maximum temperature varies from 30° C to 38° C.

Regions & Stations of the Lake : Based on the depth contour, four regions (I,II,III and IV) were demarcated in the lake artificially by imaginary boundaries. Three sampling stations were located randomly in each region and plankton samples were taken from each.

Region I : This region is characterized by thick aquatic vegetation dominated by *Ipomea aquatica*, *Cyperus* sp. and *Acacia* sp. This is nearer to the Vadavar inlet of the lake. Cattle grazing is a major disturbance in this region. It extends from Lalpettai to Nathamalai and is about 5 Km in extent.

Region II : This is a region of open, deep water habitat. On its western side patches of *Cyperus* sp. Predominate. This extends from Nathamalai to Kandakumaran and is of about 2.5 Km in extent.

Region III : This is the deepest open water habitat of the lake. This extends from Kandakumaran to Koolapadi and is of about 3.0 Km in extent.

Region IV : This region is characterized by shallow open water. This extends from Koolapadi to Vazhakollai and is of about 1.0 Km in extent.

Collection and analysis of zooplankton : The plankton were collected by a plankton net (upper aperture 22 cm; depth 34 cm; lower aperture 6 cm). They were collected in all the regions by dragging the net for 0.9 meters at each sampling site. The plankton collected were stored in 4% formalin for identification. They were identified through light microscope with the help of Ward and Whipple (1959), Adoni *et al.* (1985) and Battish (1992).

Analysis of physico-chemical factors of water :

Water depth : A pole marked in centimeter scale was used to obtain depths of water columns at 12 different stations and the average depth at each region was calculated (Murphy *et al.* 1984).

Surface Water and Atmospheric Temperature : Surface water temperature was measured at 8.00 a.m. with a LCD - portable digital multi-thermometer with external sensor probe in all the three stations 0.1 m below the water level and 0.1 m above the water column for atmospheric temperature (Danell & Sjoberg 1982) with 0.1 °C accuracy.

Standard methods described by Trivedi *et al* (1987), Trivedi and Goel (1986) & Murphy *et al* (1984), were followed for assessing the levels of turbidity, total dissolved solids, electrical conductivity, dissolved oxygen, pH, phenolphthalein alkalinity, total alkalinity, total hardness, calcium, magnesium, iron-total, manganese, free ammonia, nitrite, nitrate, chloride, fluoride, sulphate and phosphate.

RESULTS

Distribution of zooplankton species : Distribution of zooplankton species belonging to different taxa were given in table – 1, and number of individual species in each taxa and its percent distribution of these taxa were given in figs. 2 & 3. Zooplankton in the Veeranam lake consists of 45 Taxa, out of which 5 belonging to Rhizopoda, 7 Ciliata, 1 Zooflagellata, 14 Rotifera, 10 Cladocera, 6 Copipoda and 2 Ostracoda. Significant notable variations were found with regard to species-wise distribution of zooplankton community. Overall trend in the distribution of zooplankton species indicated that among the seven major groups recorded, highest number and percent distribution are from Rotifera, followed by Cladocera and Ciliata.

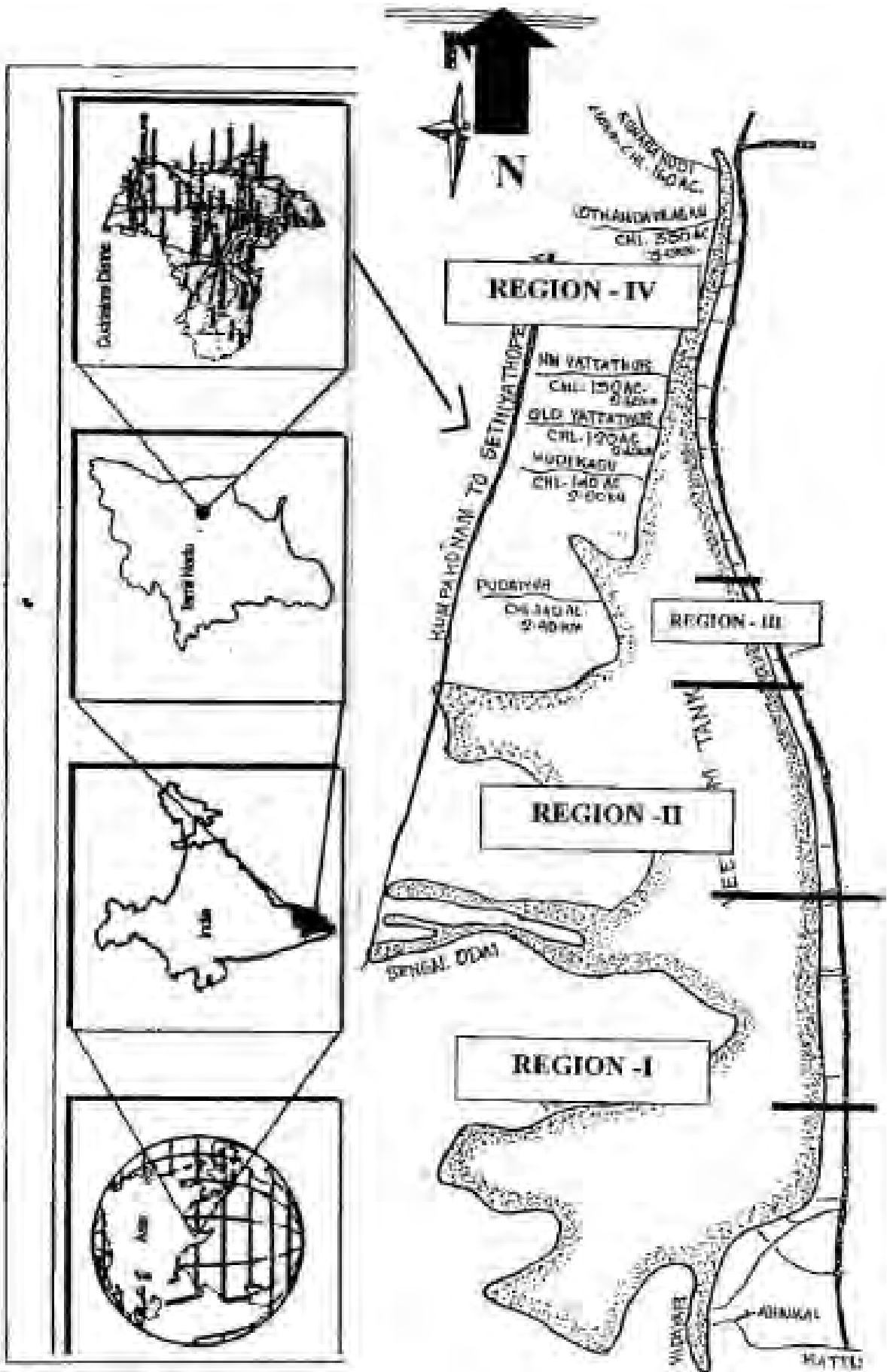


Fig. 1 : Sketch map of the Veeranam lake and its irrigation channels.

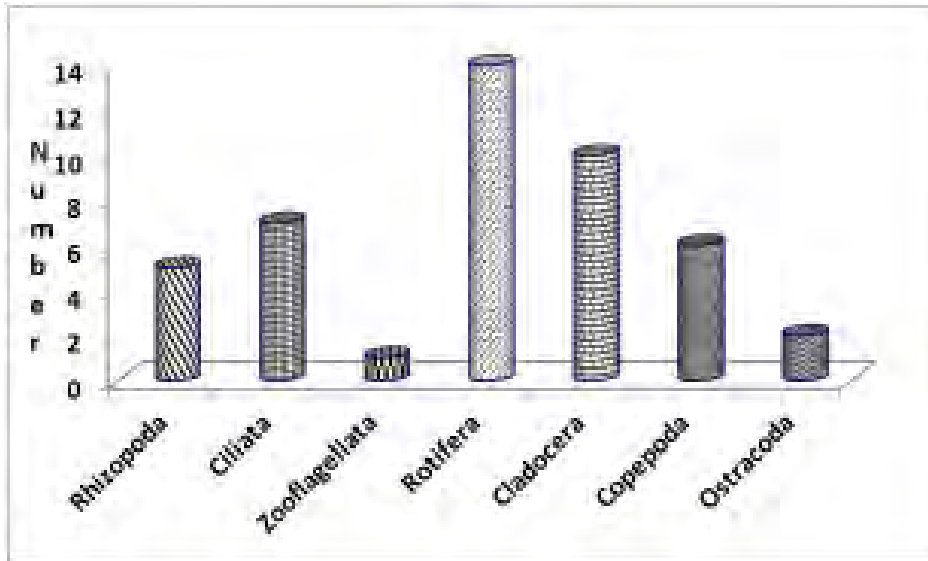


Fig. 2 : Zooplankton (number of species from different taxa) recorded in Veeranam lake during the study period.

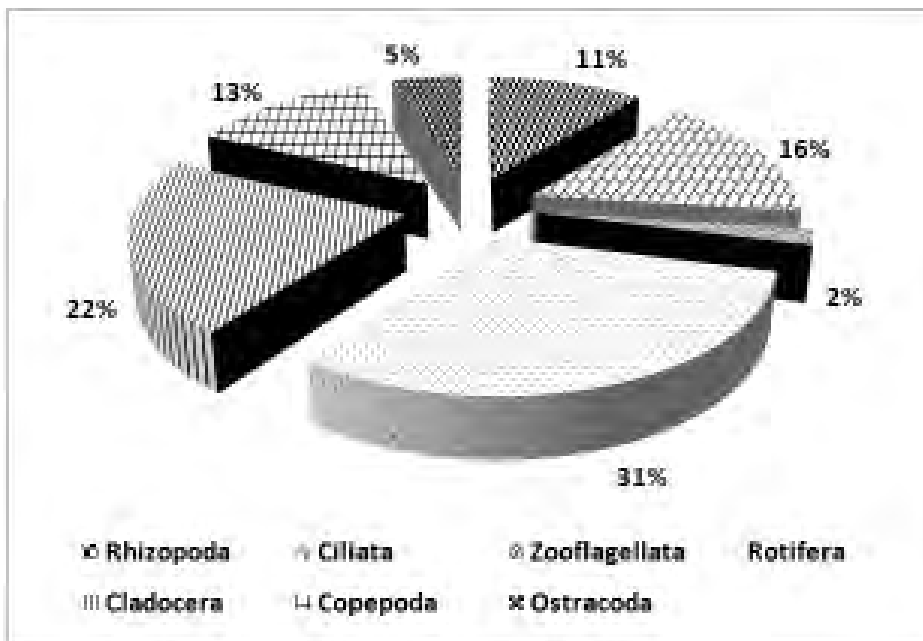


Fig. 3 : Percent distribution of zooplankton (percent species from different taxa) recorded in Veeranam lake during the study period.

Physico-Chemical factors of Veeranam lake water :

Variations in the Physico-chemical features of water in the Veeranam lake during different years of the study period are given in table 2 & fig. 4. Water depths ranged between 2.6 – 9.0 (m) during 2002 2.0 – 4.8 (m) during 2003 and 2.0 – 4.7 (m) during 2004, water temperature between 24-36 °C during 2002, 25-30 °C during 2003 and 26-32°C during 2004, atmospheric temperature between 24-36°C during 2002, 24-29°C during 2003, and

27-34°C during 2004, turbidity between 1-195 (NTU) during 2002, 2-20 NTU during 2003 and 3-24 NTU during 2004, Total Dissolved Solids between 273-573 mg/l during 2002, 292-382 mg/l during 2003 and 298-363 mg/l during 2004, electrical conductivity between 390-779 mho/sec during 2002, 417-546 mho/sec during 2003, and 425-518 mho/sec during 2004, Dissolved Oxygen between 5.34-18.25 mg/l during 2002, 1.68-15.44 mg/l during 2003 and 5.62 – 16.85 mg/l during 2004, pH between 7.3-9.5 during 2002, 7.2-8.4 during 2003 and 7.3-8.9 during 2004,

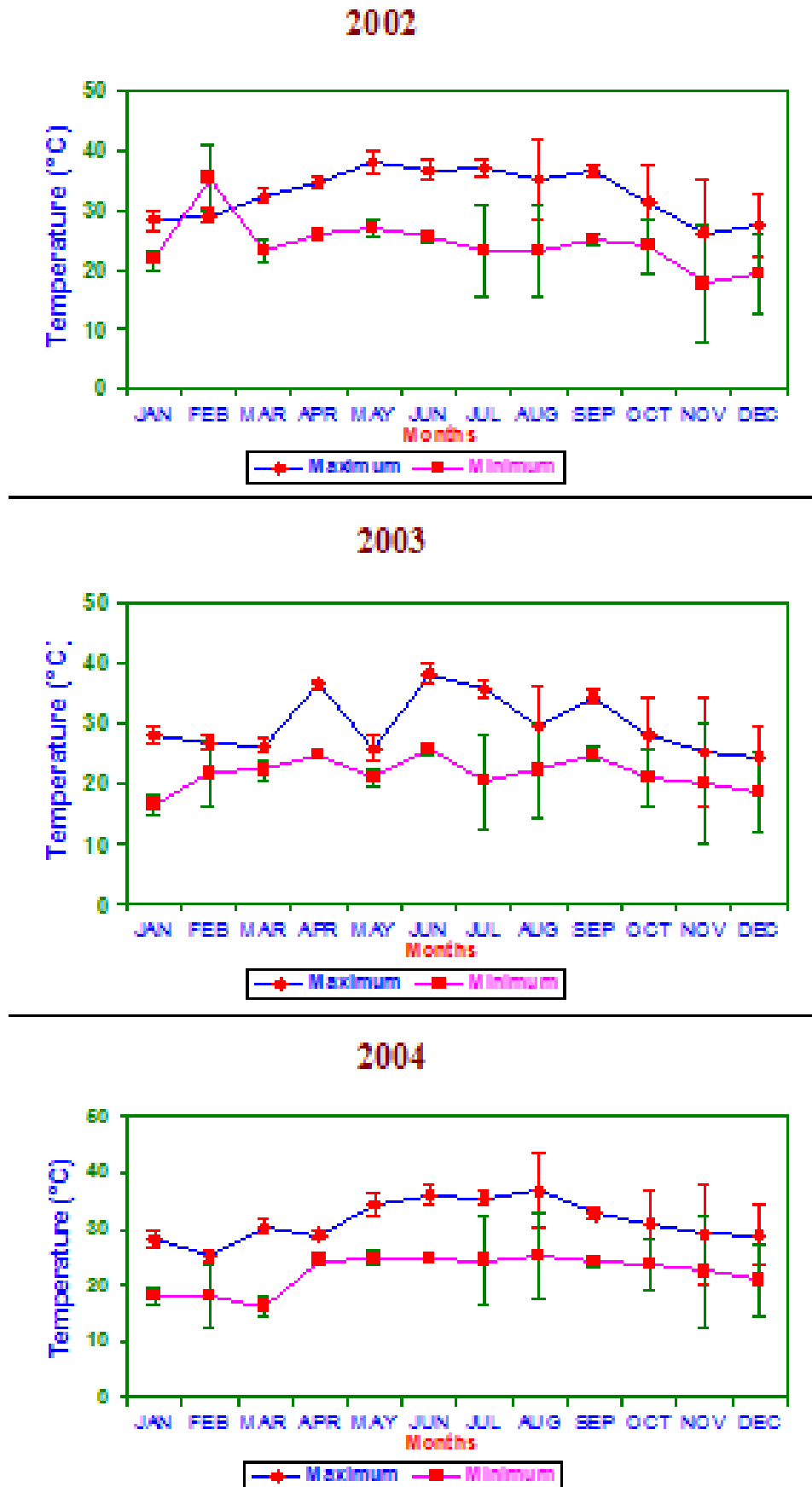


Fig. 4 : Monthly mean maximum and minimum temperatures (°C) at the study area during 2002-2004. Bars represent X ± 1S.D.

phenolphthalein alkalinity between 0.36 mg/l during 2002, 0.6 mg/l during 2003 and nil during 2004, total alkalinity between 92-198 mg/l during 2002, 136 -174 mg/l during 2003 and 130 -160 mg/l during 2004, total hardness between 35-184 mg/l during 2002, 102- 144 mg/l during 2003 and 110-158 mg/l during 2004, calcium between 16-121 mg/l during 2002, 21-29 mg/l during 2003 and 20-29 mg/l during 2004, magnesium between 0-18 mg/l during 2002, 12-19 mg/l during 2003 and 11-18 mg/l during 2004, Iron between 0-6.7 mg/l during 2002, 0-0.6 mg/l during 2003 and 0- 1.25 mg/l during 2004, manganese 0-2 mg/l during 2002, 0-0.15 mg/l during 2003 and nil during 2004, free ammonia between 0-8.4 mg/l during 2002, 0.07-49 mg/l during 2003 and 0.39-65 during 2004, nitrite between 0.42 mg/l during 2002, 0-0.29 mg/l during 2003 and 0-

0.14 mg/l during 2004, nitrate between 0-4 mg/l during 2002, 0-2 mg/l during 2003 and 0-3 mg/l during 2004, chloride between 36-141 mg/l during 2002, 30-52 during 2003 and 42-56 mg/l during 2004, Fluoride between 0.10-0.80 mg/l during 2002, 0.10-0.20 mg/l during 2003, and 0.10-0.20 mg/l during 2004, sulphate between 5-185 mg/l during 2002, 9-32 mg/l during 2003 and 11-16 mg/l during 2004 and phosphate between 0-0.78 mg/l during 2002, 0.04-1.40 mg/l during 2003 and 0.03- 0.32 mg/l during 2004. Among the three years of the study period, highest mean values were recorded during 2002 for water depth, total dissolved solids, electrical conductivity, dissolved oxygen, pH, phenolphthalein alkalinity, calcium, manganese, chloride, fluoride, and sulphate, while the mean values of total alkalinity, magnesium, nitrite and phosphate

Table. 1. List of different species of Zooplankton recorded in Veeranam lake during different years of the study period.

S.No	PROTOZOA	ROTIFERA	CRUSTACEANS
	Rhizopoda		Cladocera
1	<i>Amoeba</i> sp.	<i>Heteromeyenia</i> sp.	<i>Daphnia</i> sp.
2	<i>Diffflugia</i> sp.	<i>Ephydatia</i> sp.	
3	<i>Hyalosphenia</i> sp.	<i>Brachionus</i> sp.	<i>Moina</i> sp.
4	<i>Pelomyxa</i> sp.	<i>Keratella</i> sp.	<i>Holopedium</i> sp.
5	<i>Platoum</i> sp.	<i>Monostyla</i> sp.	<i>Ceriodaphnia</i> sp.
6		<i>Notholca</i> sp.	<i>Bosmina</i> sp.
	Ciliata		
7	<i>Flexiphyllum</i> sp.	<i>Asplanchna</i> sp.	<i>Diaphanosoma</i> sp.
8	<i>Lacrymaria</i> sp.	<i>Kellicottia</i> sp.	<i>Chydorus</i> sp.
9	<i>Mesodinium</i> sp.	<i>Lacane</i> sp.	<i>Eurycercus</i> sp.
10	<i>Enchelys</i> sp.	<i>Pompholyx</i> sp.	<i>Macrothrix</i> sp.
11	<i>Hastatella</i> sp.	<i>Platyias</i> sp.	<i>Simocephalus</i> sp.
12	<i>Stylonychia</i> sp.	<i>Ploesoma</i> sp.	Copepoda
13	<i>Euplotes</i> sp.	<i>Rattulus</i> sp.	<i>Cyclops</i> sp.
	Zooflagellata		
14	<i>Mallomonas</i> sp.	<i>Trichocerca</i> sp.	<i>Mesocyclops</i> sp.
15			<i>Diaptomus</i> sp.
16			<i>Calanus</i> sp.
17			<i>Eucalanus</i> sp.
18			<i>Pseudodiaptomus</i> sp.
			Ostracoda
19			<i>Cypris</i> sp.
20			<i>Notodromas</i> sp.

were highest during 2003 and the mean values of remaining variables viz., water temperature, atmospheric temperature, turbidity, total hardness, iron, free ammonia and nitrite were highest during 2004.

DISCUSSION

Distribution of zooplankton species : Zooplankton are a vital component of freshwater food webs. Specific species of zooplankton are strictly restricted by variations in the salinity and temperature; while other species can withstand wide temperature and salinity gradients (Thurman 1997). Generally the rate of photosynthesis increases with the raising of temperature up to a maximum and then diminishes rapidly with further rise of temperature (Tait 1980). Moore (1981) had stated that temperature may be limiting the development of all major zooplanktonic groups. The water temperature had also been reported to play an important role in controlling the occurrence and abundance of algal diversity (Nazneen 1980). The metabolism, physiology and behaviour of aquatic organisms are directly related to the temperature of the aquatic environment (Wetzel and Likens 1979). Group formation or patchiness in zooplankton community is also influenced by many physical and biological factors. The physical factors that affect the distribution of zooplankton community in an aquatic environment includes the mixing of waters in a specific point, water depth, temperature (both surface water and atmospheric temperature), turbidity and the dissolved

accumulated levels of total dissolved solids (Lalli and Parsons (1993).

Physic-chemical factors of Veeranam lake water :

Water depth is identified as the important physical factor which could influence the availability and distribution of different zooplankton species (Dwivedi and Pandey 2002). Temperature found to be the major influencing ecological (physical) factor in the distribution and regulation of various zooplankton species. Large number of ecological processes in the fresh water bodies are influenced by temperature (Sathe *et al* 2001). A significant direct relationship of temperature with productivity had been established by several authors (Vasisht and Sharma 1975, Eloranata and Saliminer 1984, Verma and Mohanty 1994).

Highly fluctuating levels of turbidity was noted during different years of the study period and Singh and Desai (1980) stated that the effect of turbidity could influence the primary productivity. Higher levels of dissolved solids have been observed to increase phytoplanktonic growth (Bhatt and Negi (1985). Mittal *et al* (1990) had stated that functioning of an ecosystem and its ability to support life forms depends to a greater extent on the physical characteristics of water. These hydrological features were regarded as the important physical factors that could influence the diversity of micro fauna composition especially the zooplankton distribution. Dissolved oxygen is found to be the influencing factor in regulating metabolic processes of aquatic organisms besides indicating the

Table 2 : Variations in the Physico-Chemical factors of Veeranam lake water during different years of the study period (Data pooled across all stations and months; values are X ± ISD (range)).

S. No.	VARIAB LES **	YEAR			S. No.	VARIAB LES **	YEAR		
		2002	2003	2004			2002	2003	2004
1	WD	4.68 ± 1.588 (2.6 – 9.0)	4.006 ± 0.729 (2.0 – 4.8)	3.96 ± 0.998 (2.0 – 4.7)	12	CA	34.74 ± 14.533 (16.0 – 121.0)	23.73 ± 2.251 (21.0 – 29.0)	24.45 ± 2.423 (20.0 – 29.0)
2	WT	28.12 ± 2.835 (24.0 – 36.0)	27.46 ± 1.457 (25.0 – 30.0)	28.81 ± 1.940 (26.0 – 32.0)	13	MG	9.93 ± 3.675 (0 – 18.0)	15.06 ± 2.404 (12.0 – 19.0)	14.46 ± 2.162 (11.0 – 18.0)
3	AT	29.32 ± 2.736 (24.0 – 36.0)	26.33 ± 1.915 (24.0 – 29.0)	30.18 ± 2.639 (27.0 – 34.0)	14	I	0.15 ± 0.876 (0 – 6.7)	0.09 ± 0.171 (0 – 0.6)	0.18 ± 0.372 (0 – 1.25)
4	T	5.95 ± 25.389 (1.0 – 195.0)	5.53 ± 4.882 (2.0 – 20.0)	8.81 ± 6.306 (3.0 – 24.0)	15	MN	0.07 ± 0.368 (0 – 2.00)	0.01 ± 0.046 (0 – 0.15)	0 (0)
5	TDS	359.17 ± 64.4 (273 - 573)	332.27 ± 23.60 (292 - 382)	337.27 ± 23.08 (298 - 363)	16	FR. AM	0.37 ± 1.228 (0 – 8.4)	4.029 ± 1.457 (0.07 – 49.0)	6.69 ± 1.341 (0.39 – 65.0)
6	EC	503.10 ± 71.51 (390 - 779)	474.87 ± 33.90 (417 - 546)	481.36 ± 32.91 (425 - 518)	17	NI	0.01 ± 0.068 (0 – 0.42)	0.042 ± 0.088 (0 – 0.29)	0.21 ± 0.049 (0 – 0.14)
7	DO	11.91 ± 3.820 (5.34 – 18.25)	8.14 ± 3.556 (1.68 – 15.44)	9.75 ± 4.266 (5.62 – 16.85)	18	NIT	0.24 ± 0.575 (0 – 4.0)	0.69 ± 0.601 (0 – 2.0)	1.27 ± 1.103 (0 – 3.0)
8	pH	8.01 ± 0.839 (7.30 – 9.50)	7.60 ± 0.359 (7.20 – 8.40)	7.53 ± 0.229 (7.30 – 8.90)	19	CH	54.62 ± 12.938 (36.0 – 141.0)	40.13 ± 7.269 (30.0 – 52.0)	47.63 ± 4.178 (42.0 – 56.0)
9	PHE. ALK	5.93 ± 10.198 (0.0 – 36.0)	1.06 ± 4.131 (0.0 - 16)	0 (0)	20	FL	0.30 ± 0.157 (0.10 – 0.80)	0.11 ± 0.035 (0.10 – 0.20)	0.13 ± 0.050 (0.10 – 0.20)
10	TOT. ALK	150.12 ± 19.73 (92.0 – 198.0)	152.40 ± 11.64 (136.0 – 174.0)	143.27 ± 9.22 (130.0 – 160.0)	21	SU	23.36 ± 23.057 (5.0 – 185.0)	14.60 ± 6.490 (9.0 – 32.0)	14.54 ± 1.508 (11.0 – 16.0)
11	TOT. HA	124.05 ± 27.45 (35.0 – 184.0)	122.40 ± 13.05 (102.0 – 144.0)	126.00 ± 12.87 (110.0 – 158.0)	22	PHO	0.05 ± 0.141 (0 – 0.78)	0.29 ± 0.323 (0.04 – 1.40)	0.18 ± 0.088 (0.03 – 0.32)

** Water depth(m), Water temperature(°C), Atmospheric temperature (°C), Turbidity(NTU), Total Dissolved Solids (mg/l), Electrical Conductivity(mho/sec), Dissolved Oxygen(mg/l), pH, Phenolphthalein Alkalinity (mg/l), Total Alkalinity (mg/l), Total hardness (mg/l), Calcium (mg/l), Magnesium (mg/l), Iron-total (mg/l), Manganese (mg/l), Free Ammonia (mg/l), Nitrite (mg/l), Nitrate (mg/l), Chloride (mg/l), Fluoride (mg/l), Sulphate (mg/l) and Phosphate (mg/l).

pollution status of the water body. pH is an indicator of overall productivity and pH of fresh water body is an important environmental and ecological factor that determine its faunal composition (Sathe *et al.* 2001). High amount of ammonia is mainly due to anaerobic decomposition of bottom organic matter. According to Bruce (1958) high value of free ammonia is a sign of pollution. Levels of nitrites and other nutrients were reported to be the important variables that influenced the avifaunal characteristics in the shores of the Islands of Gulf of Mannar (Divakaran 2000). Nitrate is an important factor for controlling the occurrence and abundance of phytoplankton (Dwivedi and Pandey 2002), as it is an important source of nitrogen for phytoplankton. Sulphate is regarded an important mineral substance for phytoplankton and algal growth (Dwivedi and Pandey 2002). Hydrological features of the wetlands such electrical conductivity (McNicol and Wayland 1992), hardness (Murphy *et al.* 1984), alkalinity (McNicol and Wayland 1992), salinity (Barr 1986), chloride (Wetzel 1975), iron (APHA 1995), phosphate (Welch *et al.* 1978) and fluoride (IPCS 2005) were regarded as the factors that could influence water bird species richness, diversity and density through regulating the distribution of micro organisms, floral and macrofaunal composition of wetland ecosystems.

Thus, it can be concluded that variations in the physico-chemical factors of Veeranam water determines the distribution and diversity of zooplankton community structure in Veeranam lake during the study period.

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