Journal of Environmental & Analytical Toxicology

Thirunavukkarasu et al., J Environ Anal Toxicol 2013, 4:1
DOI: 10.4172/2161-0525.1000200

Research Article Open Access

Zooplankton Composition and Community Structure of Kottakudi and Nari Backwaters, South East of Tamil Nadu

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Abstract

Zooplankton plays an important role to study the faunal bio-diversity of aquatic ecosystems. It is occurrence and distribution influences the fishery potentials. The fishes mostly breed in areas where the planktonic organisms are plenty so that their young ones could get sufficient food for survival and growth. The zooplankton composition during the study period includes the members of Foraminifera, Rotatoria, Calanoida, Cyclopoida, Harpacticoidea, Doliolida, Appendicularia, Decapoda, Sagittoida, Amphipoda, Coelentrata, Pteropoda, Cladocera and larval forms. In station I, about 88 species of zooplankton were recorded. In station II, about 92 species of zooplankton were recorded. The zooplankton population densities were ranged from 23,150 to 80,890 org/l in station I and 23,197 to 80,691org/l in station II. The Shannon - Wiener's diversity index (H') values were ranged from 4,505 bits/ind. to 5,915 in station I and 4,590 bits/ind. to 5,928bits/ind. in station II. The Simpson richness was ranged from 0.662 to 0.995 in station I and 0.665 to 0.998 in station II. The Pielou's evenness (J') was ranged from 0.590 to 0.952 in station I and 0.513to 0.952 in station II respectively.

Keywords: Zooplankton; Composition; Kottakudi; Nari backwaters; Research background

Introduction

Zooplanktons are the small, floating and weakly swimming animals found in various water bodies including coastal waters. Together with the phytoplankton and the bacterio-plankton, they constitute the plankton community. They assume a great ecological significance in the ecosystem as they play a vital role in food web of the food chain, nutrient recycling and transfer of organic matter from primary producers to secondary consumers like fishes [1-3]. Zooplankton help determines the quantum of fish stock and the failure of fishery resources is attributed to the reduced copepod population [4]. Hence, the zooplankton communities, based on their quality and species diversity, are used for assessing the productivity of fishery resources, fertility and health status of the ecosystem. Marine zooplankton comprises a large variety of different organisms with some ten thousands of species of mero-plankton. Their sizes range from tiny flagellates to giant jellyfish. The growth rate, productivity and species diversity of zooplankton in tropical waters especially in coastal waters is high. The zooplankton community is represented by heterogeneous groups of organisms of varying size and belonging to different phyla of animal kingdom. Over 70% of total zooplankton of coastal waters was constituted by primitive crustaceans belonging to the order, 'Copepoda' of the phylum, 'Arthropoda'. The order-Copepoda comprised of three sub-orders viz; Calanoida, Cyclopoida and Harpacticoida [2]. Any study concern with ecological community structure is dependent on accurate information on the distribution and abundance of the species making up the community [5].

Zooplankton is an inseparable part of the aquatic ecosystem, and it fulfills a great variety of important function as secondary producers. To species diversity indices of zooplankton communities are used to evaluate the quality of water. Hence, zooplankton can be used as an indicator of sorority. In addition, species diversity, abundance and biomass of zooplankton determine production of fish in the ecosystem [6]. In the present investigation an attempt has been made to investigate the species composition, population density and structure of zooplankton from Kottakudi and Nari backwaters.

Materials and Methods

Zooplankton samples were collected in monthly intervals from the stations I- Kottakudi and station II- Nari backwaters for a period of two years from January 2010 to December 2011. The samples were collected by horizontal towing of plankton net (0.35m mouth diameter), made up of bolting silk (Cloth No.10; mesh size 158μm) for twenty minutes at one knot speed. These samples were preserved in new polythene container with 5% neutralized formalin and used for qualitative analysis. For the quantitative analysis of zooplankton a known quantity of water (1000 liters) was filtered through a bag-net of same mesh size and the numerical plankton analysis was carried out using a binocular microscope. The zooplanktons were qualitatively identified using the standard works of Davis [7], Kasturirangan [8], Newell and Newell [9], Deboyd L Smith [10], Wimpenny [11], Todd [12], Perumal et al. [13]. The isolated zooplanktons were subjected to species composition and population density. The statistical analysis such as species diversity was calculated using diversity (H') Index [14]; species richness was calculated by following Simpson Index (D') formula and species evenness was calculated using the formula proposed by Pielous [15] as Pielou's Evenness (J') Index.

The Two way ANOVA test was employed to find out the variations in physico-chemical parameters, population density, species diversity, species richness and species evenness in relation to stations and

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Received November 26, 2013; **Accepted** December 16, 2013; **Published** December 18, 2013

Citation: Thirunavukkarasu K, Soundarapandian P, Varadharajan D, Gunalan B (2013) Zooplankton Composition and Community Structure of Kottakudi and Nari Backwaters, South East of Tamil Nadu. J Environ Anal Toxicol 4: 200. doi: 10.4172/2161-0525.1000200

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months. Pearson-correlation coefficient analysis was performed between physico-chemical parameters and population density, species diversity, species richness and species evenness for both the stations.

Results

Species composition

The zooplankton composition during the study period includes the members of Foraminifera, Rotatoria, Calanoida, Cyclopoida, Harpacticoidea, Doliolida, Appendicularia, Decapoda, Sagittoida, Amphipoda, Coelentrata, Pteropoda, Cladocera and larval forms. In station I, about 88 species of zooplankton were recorded which includes 16 species of Foraminifera, 2 species of Rotatoria, 28 species of Calanoida, 6 species of Harpacticoidea, 6 species of Cyclopoida, 2 species of Doliolida, 2 species of Appendicularia, 1 species of Decapoda, 2 species of Sagittoida, 1 species of Amphipoda, 3 species of Coelentrata, 1 species of Pteropoda, 2 species of Cladocera and 16 species of larval forms. In station II, about 92 species of zooplankton were recorded which includes 17 species of Foraminifera, 2 species of Rotatoria, 31 species of Calanoida, 6 species of Harpacticoidea, 6 species of Cyclopoida, 2 species of Doliolida, 2 species of Appendicularia, 1 species of Decapoda, 2 species of Sagittoida, 1 species of Amphipoda, 3 species of Coelentrata, 1 species of Pteropoda, 2 species of Cladocera and 16 species of larval forms (Table 1).

S. No.	Name of the species	Station I		Station II	
		2010	2011	2010	2011
	Foraminifera				
	Globigerina rubescense	+	+	+	+
	G. bulloides	+	+	+	+
	G. opima	+	+	+	+
	Tintinnopsis cylindrica	+	+	+	+
	T. beroidea	+	+	+	+
	T. butschi	+	+	+	+
	T. tocantinensis	+	+	+	+
	T. tubulosa	+	+	+	+
	T. minuta	-	-	+	+
	T. brindle	+	+	+	+
	T. mortensenii	+	+	+	+
	Eutintinnus tennuis	+	+	+	+
	Dictyocysta seshaiyai	+	+	+	+
	Codonellopsis ostenfeldii	+	+	+	+
	Favella philipensis	+	+	+	+
	F. brevis	+	+	+	+
	Rhabdonella lohmanni	+	+	+	+
	Rotatoria				
	Brachionus calyciflorus	+	+	+	+
	B. plicatilis	+	+	+	+
	Calanoida				
	Calanus sp.	+	+	+	+
	Nannocalanus minor	+	+	+	+
	Canthocalanus pauper	+	+	+	+
	Eucalanus elongatus	+	+	+	+
	E. monachus	-	-	+	-
	Calanopia minor	+	+	+	+
	Metacalanus aurivilli	+	+	+	+
	Paracalanus parvus	+	+	+	+
	Acrocalanus gibber	+	+	+	+
	A. gracilis	+	+	+	+
	Centropages tenuiremis	+	+	+	+
	C. furcatus	+	+	+	+
	Pseudodiaptomus aurivilli	+	+	+	+
	P. serricaudatus	+	+	+	+
	Labidocera pavo	+	+	+	+
	L. acuta	-	-	+	-
	L. pectinata	+	+	+	+
	L. minuta	+	+	+	+
	Pontella sp.	+	+	+	+
	Pontella danae	+	+	+	+
	P. securifer	+	+	+	+
	Pontellopsis herdmani	+	+	+	+
	Acartia spinicauda	+	+	+	+
	A. southwelli	+	+	+	+
	A. erythraea	+	+	+	+
	A. danae	-	-	+	-
	A. centrura	+	+	+	+
	Tortanus barbatus	+	+	+	+
	Temora turbinata	+	+	+	+
	T. stylifera	+	+	+	+
	T. discaudata	+	+	+	+
	Harpacticoidea				
	Clytemnestra scutellata	+	+	+	+
	Euterpina acutifrons	+	+	+	+
	Microsetella rosea	+	+	+	+
	M. norvegica	+	+	+	+
	Macrosetella gracilis	+	+	+	+
	Metis jousseamei	+	+	+	+
	Cyclopoida				
	Oithona rigida	+	+	+	+
	O. brevicornis	+	+	+	+
	O. similis	+	+	+	+
	Oncaea venusta	+	+	+	+
	Corycaeus catus	+	+	+	+
	C. danae	+	+	+	+
	Doliolida				
	Doliolum coioides	+	+	+	+
	Salpa fusiformis	+	+	+	+
	Appendicularia				
	Oikopleura parva	+	+	+	+
	O. dioica	+	+	+	+
	Decapoda				

	Lucifer hanseni	+	+	+	+
	Sagittoida				
	Sagitta enflata	+	+	+	+
	S.bipunctata	+	+	+	+
	Amphipoda				
	Amphithoe sp.	+	+	+	+
	Coelentrata				
	Diphyes sp.	+	+	+	+
	Obelia sp.	+	+	+	+
	Aurelia sp.	+	+	+	+
	Pteropoda				
	Creseis sp.	+	+	+	+
	Cladocera				
	Penilia sp.	+	+	+	+
	Evadne sp.	+	+	+	+
	Larval forms				
	Mysis larvae	+	+	+	+
	Crustacean nauplius	+	+	+	+
	Copepod naupliius	+	+	+	+
	Barnacle nauplius	+	+	+	+
	Shrimp zoea	+	+	+	+
	Crab zoea	+	+	+	+
	Euphasid zoea	+	+	+	+
	Hydrozoan larvae	+	+	+	+
	Acanthomentron	+	+	+	+
	Gastropod veliger	+	+	+	+
	Bivalve veliger	+	+	+	+
	Polychaete larvae	+	+	+	+
	Cyphonautes larvae	+	+	+	+
	Ophiopluteus larvae	+	+	+	+
	Fish larvae	+	+	+	+
	Fish egg	+	+	+	+
Total		88	88	92	89

+ Present - Absent

Table 1: Check list of zooplankton species recorded from January 2010 to December 2011.

Population density

The zooplankton population densities ranged from 23,150 to 80,890 org/l in station I and 23,197 to 80,691org/l in station II. Minimum zooplankton population densities were recorded in the month of December (2010) and maximum in the month of June (2011) in station I. In station II, the zooplankton population densities were recorded minimum in the month of December (2010) and maximum in the month of June (2011) (Table 2). The population density showed significant variation between two stations (Table 3). Population density showed positive correlation with temperature, salinity and pH and showed negative correlation with rainfall in station I. Population density is positively correlated with temperature and negatively correlated with rainfall in station II (Tables 7 and 8).

Shannon-Wiener's diversity (H')

The Shannon-Wiener's diversity index (H') values were ranged from 4,505 bits/ind. to 5,915 in station I and 4,590 bits/ind. to 5,928 bits/ind. in station II. Minimum zooplankton diversity was recorded in the month of December (2010) and maximum in the month of June (2011) in station I. In station II, the zooplankton diversity was recorded minimum in the month of December (2010) and maximum in the month of June (2011) (Table 4). The zooplankton diversity did not show significant variation between two stations (Table 3).

Seasons	Months	2010		2011	
		Station I	Station II	Station I	Station II
Post monsoon	January	50,980	50,195	50,290	50,315
	February	60,890	60,610	60,520	60,490
	March	70,639	70,410	70,390	70,410
Summer	April	78,191	78,210	78,119	78,290
	May	80,380	80,399	80,400	80,490
	June	80,890	80,630	80,730	80,691
Pre monsoon	July	41,150	41,610	41,992	41,680
	August	32,690	32,715	32,638	32,415
	September	31,198	31,215	31,128	31,125
Monsoon	October	29,630	29,515	29,390	29,398
	November	27,615	27,390	27,615	27,415
	December	23,150	23,197	23,397	23,210

Table 2: Monthly variations of zooplankton population density (org/l) from January 2010 to December 2011.

Source of Variation	SS	df	MS	F	F crit	P
Population density						
Stations	27484020	1	27484020	22.64096	4.844336	<0.05
Months	1.04E+10	11	9.44E+08	777.774	2.81793	<0.05
Error	13352978	11	1213907			
Total	1.04E+10	23				
Species diversity						
Stations	0.135	1	0.135	0.690219	4.844336	NS
Months	3.471962	11	0.315633	1.613748	2.81793	NS
Error	2.15149	11	0.19559			
Total	5.758452	23				
Species richness						
Stations	0.00329	1	0.00329	0.983397	4.844336	NS
Months	0.034409	11	0.003128	0.934994	2.81793	NS
Error	0.036801	11	0.003346			
Total	0.074501	23				
Species evenness						
Stations	0.00608	1	0.00608	1.186272	4.844336	NS
Months	0.059654	11	0.005423	1.05807	2.81793	NS
Error	0.05638	11	0.005125			
Total	0.122114	23				

NS – Non significant

Table 3: Results of Two-way ANOVA for the zooplankton composition.

Simpson richness

The Simpson richness was ranged from 0.662 to 0.995 in station I and 0.665 to 0.998 in station II. The minimum species richness was recorded in the month of December (2010) and maximum in the month of June (2011) in station I. In station II, species richness was recorded minimum in the month of December (2010) and maximum in the month of June (2011) (Table 5). The species richness did not show significant variation between two stations (Table 3).

Pielou's evenness (J')

The Pielou's evenness (J') was ranged from 0.590 to 0.952 in station I and 0.513to 0.952 in station II. Minimum species evenness

Seasons	Months	2010		2011	
		Station I	Station II	Station I	Station II
Post monsoon	January	4,690	4,686	4,690	4,678
	February	4,725	4,718	4,760	4,742
	March	4,970	4,975	4,918	4,913
Summer	April	5,138	5,297	5,190	5,239
	May	5,390	5,495	5,697	5,498
	June	5,580	5,610	5,915	5,928
Pre monsoon	July	5,310	5,298	5,330	5,335
	August	5,190	5,112	5,113	5,213
	September	4,900	4,910	4,913	4,912
Monsoon	October	4,811	4,805	4,802	4,886
	November	4,590	4,610	4,603	4,615
	December	4,505	4,590	4,573	4,613

Table 4: Monthly variations of zooplankton population diversity (bits/ind) from January 2010 to December 2011.

Seasons	Months	2010		2011	
		Station I	Station II	Station I	Station II
Post monsoon	January	0.715	0.718	0.716	0.719
	February	0.892	0.894	0.895	0.892
	March	0.796	0.782	0.789	0.788
Summer	April	0.815	0.812	0.825	0.824
	May	0.948	0.945	0.952	0.952
	June	0.993	0.992	0.995	0.998
Pre monsoon	July	0.890	0.891	0.893	0.895
	August	0.873	0.875	0.860	0.872
	September	0.851	0.850	0.849	0.842
Monsoon	October	0.825	0.823	0.816	0.812
	November	0.793	0.795	0.796	0.798
	December	0.662	0.665	0.663	0.667

Table 5: Monthly variations of species richness from January 2010 to December 2011.

was recorded in the month of December (2010) and maximum in the month of May (2011) in station I (Table 6). In station II, species evenness was recorded minimum in the month of December (2011) and maximum in the month of May (2011). The species evenness did not show significant variation between two stations (Table 3).

Discussion

Zooplankton in the present study consisted of a total of 88 (2010 & 2011) forms in station I and 92 & 89 forms (2010 & 2011) in station II including larvae. The order of abundance of various groups are Pteropoda < Decapoda < Amphipoda < Doliolida < Cladocera < Sagittoida < Rotatoria < Appendicularia < Coelentrata < Harpacticoidea < Cyclopoida < Larval forms < Foraminifera < Calanoida. Almost similar pattern of abundance was reported in Parangipettai coastal waters [16]. Population density of zooplankton was low during monsoon season due to the hydrographically washable environmental condition. The monsoon flow cause great depletion of zooplankton population density. Padmavathi and Goswami [17], Ananthan [18], Bhunia and Choudhury [19] had stated that the heavy rain changed the salinity, temperature and other environmental variable which in turn decreased the zooplankton density. Further, the higher population densities of zooplankton observed during summer were coincided with the peak of phytoplankton density. It is supported from the earlier observations of Govindasamy and Kannan [20] and Godhantaraman [21] from Parangipettai and Pitchavaram mangrove areas and Jegadeesan [22] in Coleroon estuary and Murugan and Ayyakkannu [23] from Uppanar

Seasons	Months	2010		2011	
		Station I	Station II	Station I	Station II
Post monsoon	January	0.715	0.718	0.716	0.719
	February	0.892	0.894	0.895	0.892
	March	0.796	0.782	0.789	0.788
Summer	April	0.815	0.812	0.825	0.824
	May	0.948	0.945	0.952	0.952
	June	0.932	0.939	0.930	0.934
Pre monsoon	July	0.928	0.927	0.916	0.915
	August	0.893	0.892	0.898	0.893
	September	0.812	0.813	0.815	0.819
Monsoon	October	0.789	0.786	0.782	0.780
	November	0.615	0.618	0.613	0.620
	December	0.590	0.591	0.596	0.513

Table 6: Monthly variations of species evenness from January 2010 to December 2011.

backwater. Further, higher population density with more number of copepod species were also observed by Rajagopalan [24].

The higher zooplankton density was recorded during summer season, which might be due to stable environmental conditions. It prevailed during the season, and great neritic element presence from adjacent sea could also be contributed to the maximum density of zooplankton. Further, salinity is the key factor influencing zooplankton distribution and abundance in Goa waters [17]. Abundance of various zooplanktons in the coastal areas was being fluctuated in accordance with salinity regime. Among the various groups, calanoida formed a predominant group with a total number of 31 species. Also *Acrocalanus gibber, A. gracilis and Paracalanus parvus* were common forms found in both the stations, which might be due to their ability to adapt to the prevailing environmental conditions and also because of the continuous breeding behaviors of the species. Similar opinion was earlier given by Sampathkumar and Kannan [25], Sarkar et al. [26] Srinivasan and Santhanam [27], Kowenberg [28], Neelam Ramaiah and Vijayalakshmi Nair [29] and Biji [30].

There was a gradual increase in population density with the abundance of larval forms during summer, when optimal salinity was noticed. During monsoon season, the population density was comparatively low than in summer. This was due to the northeast monsoonal effect when heavy fresh water run-off caused a decline in population density. A recovery phase was noticed from March (post-monsoon) onwards. From these observations, it can be obvious that the summer season is favorable for macro-zooplankton production for both the stations of the present study. This was supported by the work of Srikrishnadhas, Sundaraj et al. [31] from Porto-Novo waters. The zooplankton plays a key role in the dynamics of aquatic ecosystems as their grazing limits in the standing crop of phytoplankton. Phytoplankton-zooplankton sequence forms the classical food chain in the aquatic environment. The zooplankton (secondary) production is significant as they occupy the second tropic tier between the phytoplankton (primary producer) and tertiary (carnivore production) tiers.

In the present study, copepods formed the dominant group in macro-zooplankton, both in species composition and richness. It constituted 80 to 90% of total macro-zooplankton population was well supported by Magdy and Nasser [32], who recorded 75% in the Gulf of Aqaba, Red Sea, Egypt. Raghavan et al. [33] reported that copepods were predominant in macro-zooplankton population in the Arabian Sea. The copepods dominance in zooplankton were showed

Parameters	Ra.fa.	Temp	Salin.	pH	DO	NO_2	NO_3	NH_4	IP	SiO_3	Pop. Den.
Ra.fa.	1										
T	-0.226	1									
Salin.	-0.879**	0.493	1								
pH	-0.715*	0.611	0.838*	1							
DO	-0.372	0.693*	0.476	0.603*	1						
NO_2	0.561*	-0.725**	-0.625*	-0.739**	-0.950	1					
NO_3	0.427	-0.727**	-0.492*	-0.674**	-0.934	0.973	1				
NH_3	0.616**	-0.622**	-0.622**	-0.755**	-0.879	0.965	0.948	1			
IP	0.525*	-0.812	-0.610*	-0.799**	-0.891	0.957	0.947	0.910	1		
SiO_3	0.663**	-0.619**	-0.693**	-0.711	-0.921	0.953	0.908	0.922	0.899	1	
Pop. Den.	-0.579**	0.571**	0.671**	0.640**	0.822	-0.807	-0.683	-0.734	-0.723	-0.844	1

*Correlation is significant at 5% level (P<0.05)
**Correlation is significant at 1% level (P<0.01)

Table 7: Correlation (r) values between physico-chemical parameters, biological parameters and zooplanktons for station-I.

Parameters	Ra.fa.	T	Salin.	pH	DO	NO_4	NO_3	NH_4	IP	SiO_3	Pop. Den.
Ra.fa.	1										
T	-0.542	1									
Salin.	-0.766*	0.798*	1								
pH	-0.808**	0.720*	0.970**	1							
DO	-0.350	0.780**	0.639*	0.541	1						
NO_2	0.582*	-0.858	-0.724**	-0.679**	-0.930	1					
NO_3	0.428	-0.872	-0.638**	-0.579*	-0.925	0.962	1				
NH_4	0.616**	-0.844	-0.729**	-0.701**	-0.862	0.968	0.949	1			
IP	0.525**	-0.952	-0.706**	-0.642**	-0.849	0.930	0.945	0.910	1		
SiO_3	0.679**	-0.873	-0.804	-0.738	-0.906	0.959	0.908	0.923	0.908	1	
Pop. Den.	-0.576**	0.665**	0.759	0.695	0.826	-0.821	-0.704	-0.749	-0.732	-0.848	1

*Correlation is significant at 5% level (P<0.05)
** Correlation is significant at 1% level (P<0.01)

Table 8: Correlation (r) values between physico-chemical parameters, biological parameters and zooplanktons for station-II.

in the central west coast of India, Vijayalakshmi et al. [34] in near shore waters of zooplankton in a coastal upwelling in New Zealand central waters [35]. The dominance of copepods, among different other macro-zooplankton groups, in most of the places including the present study suggests that copepods probably show successful adaptation to any type of aquatic environment than any other group of zooplankton. Understanding of copepods fauna is, therefore, important for management and protection of biological resources in the coastal waters. The diverse marine plankton has been influenced by the long and short term (geological, climatic, hydrological) natural and anthropogenic processes [36]. Investigation on the species composition, population density and community structure of the zooplankton is necessary to assess the potential fishery resource of any given area [37]. Marine copepods are natural feed, which can act as alternatives or supplements to *Artemia* nauplii [38-41]. Copepods were found to be numerically abundant throughout the study period at both the stations. Similar copepods abundance was also recorded earlier by Sreekumaran et al. [42] in western Bay of Bengal, Abidi et al. [43] from Akarpati (Navapur) coastal water, Gajbhiye and Desai [44] in polluted and unpolluted regions of Bombay waters, Anbazhagan [45] in Kodiakarai waters and Vijayakumar and Sarma [46] from Visakhapatnam harbor water.

The abundance of this group steadily increased in both the stations from November to May with raising trend of salinity. With the onset of southwest monsoon (July -October), salinity dropped and the population density also declined [1,19]. The important factors that controlled the distribution of calanoida were rainfall and salinity as suggested by Bijoy and Abdul [47], Neelam Ramaiah et al. [48]. Calanoida are the primary consumers of phytoplankton and principal food prey of larval and juvenile fishes, making up the base of pelagic food chains [49]. Calanoida dominated in the zooplankton community in abundance throughout the year, forming 30-35% of total zooplankton composition [50]. In the present study also calanoids were the dominant copepods for both the stations followed by cyclopoids and harpacticoids. Tintinoids showed a wide range of salinity tolerance and they have recorded high during summer might be due to influence of neritic waters. These results are in agreement with the previous findings of Chandran and Damodara et al. [51,52] from Vellar estuary and Jegadeesan [22] from Coleroon estuary. The meroplankton organisms such as bivalve veliger, gastropod veliger and copepod nauplii were commonly available for both the station. It is already reported in Point Calimere coastal waters Sundharesan [53]. The fish were also found to be common for both the stations indicated that the coastal ecosystem serves as breeding and nursery grounds for a variety of fish. These findings are agreement with the reports of Chandrasekaran and Natarajan [54].

Maximum species diversity of zooplankton was recorded during the month of June of summer season for both the stations. The high values of zooplankton species diversity were found to be associated with the high zooplankton density that also indicated the stable high salinity and phytoplankton density. The low species diversity was observed during monsoon season could be attributed to heavy rainfall influx and low salinity. Rajkumar [21] Govindasamy and Kannan [40] have obtained similar values from Pitchavaram mangroves. The maximum evenness values were recorded during summer season and the minimum values during monsoon season. Similar observations were already made by Neelam Ramaiah andVijayalakshmi Nair [29] from Vellar estuary and from Uppanar estuary by Murugan and Ayyakkannu [23]. In general, species diversity index coincide with species richness and diversity index with increasing richness of species. During monsoon season, the freshwater flow played a key role in altering the estuary environment and resulted in reduction of species, thereby decreasing the diversity index. The results of Analysis of Variance (ANOVA) for the difference in zooplankton distribution between the stations are significant at 0.05% level. The results of the present study showed that a combination of factors influence the zooplankton distribution and abundance in estuary. Among the various factors examined, abrupt change in salinity caused by rainfall can be considered as the most important water quality parameter which affects zooplankton abundance as reported previously by many workers Watanabe et al. [38], Rajkumar [39-41]. The results of the present study showed that a combination of factors influence the zooplankton distribution and abundance in estuary. Among the various factors examined, abrupt change in salinity caused by rainfall can be considered as the most important water quality parameter which affects zooplankton abundance.

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