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Short Note

Zooplankton Diversity in Vallarpadam, India: Influence of Hydrochemistry, Season and Semi Diel Cycle

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Abstract: Statistical analysis of data concerning the zooplankton standing crop influenced by the hydrochemical characters and season over semi diel cycle were presented. A dendrogram for hierarchical classification of multivariate cluster analysis showed a succession of two clusters. Copepod varieties form a single cluster apart from the other zooplankton group indicated a positive correlation expressed by a low distance cluster scale combination. The chemical factors, especially salinity and nutrient composition, showed significant correlation sustaining the zooplankton standing crop.

Key words: Zooplankton diversity, hydrochemistry, correlation, cluster analysis, Vallarpadam.

Introduction

Zooplankton groups are a biological indicator of water quality, eutrophication and pollution levels by the abundance and absence of some particular varieties and an important source of food chain (Sibel, 2006). Estuaries are considered as the lively water bodies in the coastal area because of the constant supply of nutrients from rivers and other land-based discharges, which form the natural media for the phytoplankton proliferation (Madhu et al., 2007). Various types of trophic relationship between the phytoplankton and zooplankton have been established in estuarine systems (Tan et al., 2004). A recent study conducted in the Cochin estuarine system envisaged that the zooplankton grazing, especially micro type, plays a significant role over the primary producers (Jyotibabu et al., 2006). Vallarpadam is a small island located in the Cochin estuarine system. Even though many research works have been carried out in the Cochin estuarine system relating to the plankton diversity and distribution, an attempt has not been initiated at Vallarpadam transect regarding the zooplankton standing crop. In the present paper we examine the zooplankton abundance in relation to hydrology, season and community structure based on their interrelationship using statistical tools in the Vallarpadam region of Cochin estuarine system.

Materials and Methods

The sampling point at Vallarpadam (Latitude 9° 58′ 47″ N and Longitude 76° 15′ 38″ E) selected for the present study is a small island situated in the Cochin estuarine system (Figure 1). It is a major pilgrimage centre and in the recent past the Vallarpadam International Container Transshipment Terminal, that helps to improve the container handling facilities, was commissioned.

Water samples were analyzed for various physico-chemical characteristics. Physical parameters such as

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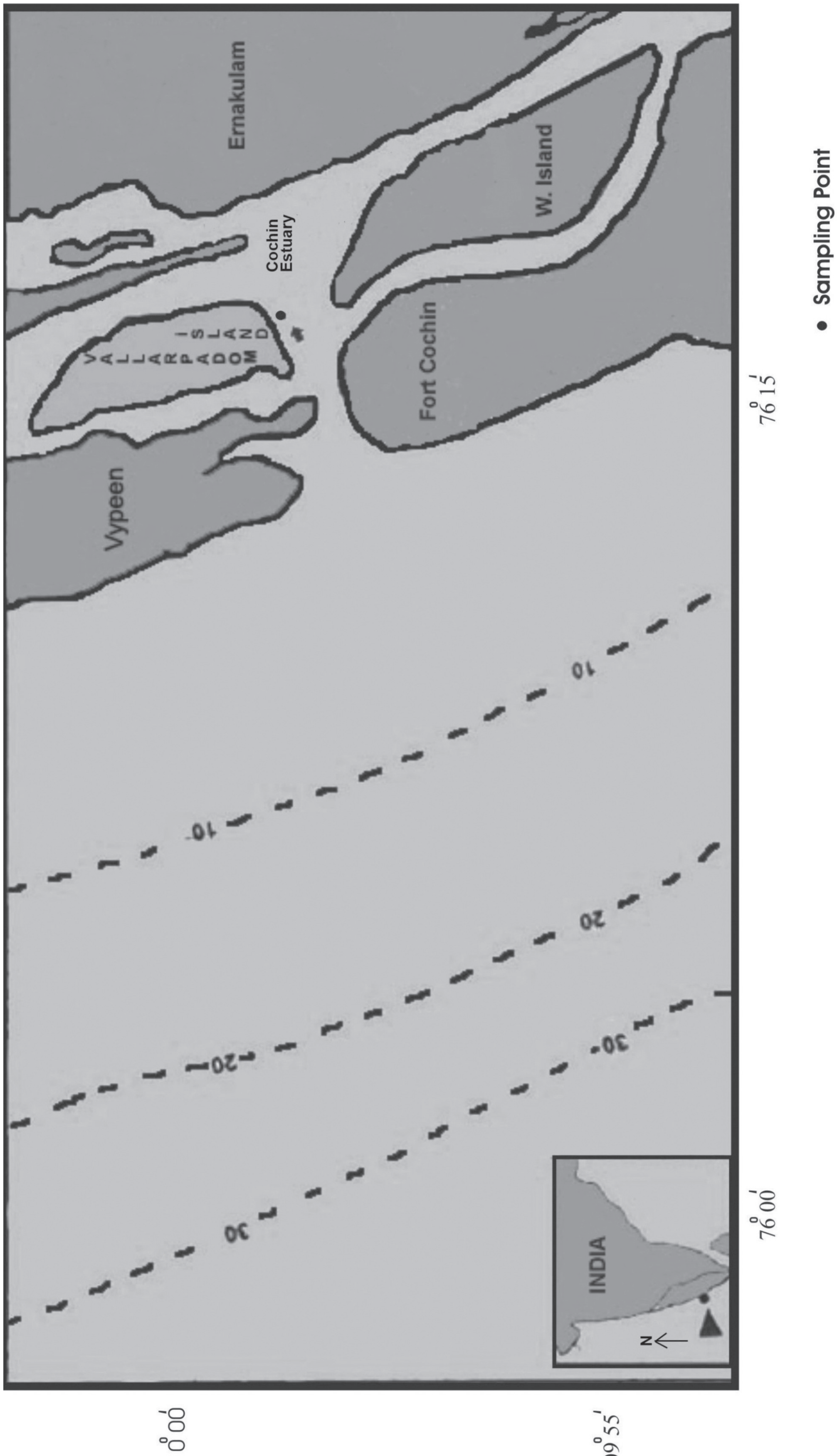

Figure 1: Map showing the sampling point at Vallarpadam.

transparency, temperature, salinity, pH and dissolved oxygen were measured in situ. The samples for inorganic phosphate, nitrate, nitrite, total nitrogen, total phosphorous, ammonia and silicate were kept frozen until analysis in the laboratory. Chemical parameters were analyzed by the methods of seawater analysis (Grasshoff et al., 1999). The zooplankton collection was done by horizontal hauling using a Bongo net (mouth diameter 40 cm, mesh size 55 µm) equipped with a calibrated flowmeter. The net was operated from the deck of a fishing boat for 10 minutes at a speed of two knots/hour. Concentrated zooplankton was preserved in 4.0% formaldehyde and seawater solution. Zooplankton was identified group wise according to UNESCO (1968), Omori and Ikeda, (1984) and Goswami (2004) using an inverted microscope (Ceti).

The Pearson correlation was performed to find out the significant correlation among hydrochemical factors and zooplankton groups. A dendrogram for hierarchical classification was used to assess the potential relationship between the zooplankton groups. All the statistical analysis was carried out using SPSS (Statistical Package for Social Science).

Results

The correlation existed between zooplankton groups and hydrological characteristics at Vallarpadam according to the Pearson correlation matrix as displayed in Table 1. The significant correlation between cladocerans and salinity (0.01 level) and their insignificant correlation towards total suspended solids suggests that the saline water having less total suspended solids intrusion into the estuary enhances the population. The poor correlation for brachyuran larvae with dissolved oxygen indicates their capability to thrive in waters having stumpy oxygen concentration. The correlation of copepods and brachyuran larvae with salinity was highly significant confined to their entrance into the estuarine system along with the marine water during high tide. Throughout the study copepods exhibited an insignificant correlation with nutrients pointing out their grazing habit over phytoplankton that exploit nutrients for their intensification. The negative correlation of ichthyoplankton especially fish larvae between temperature, transparency, total suspended solids and nitrate emphasized the unlimited outcome of physical factors that act as an irritant in their feeding regime and growth that revealed their identity as planktivorous. The strong affinity of hyperiids towards salinity categorizes them under hyper saline variety. The correlation of tintinnids with transparency, temperature, total suspended solids and biological oxygen demand indicated that these factors are essential for their proliferation.

The dendrogram revealed the occurrence of two clusters for zooplankton standing crop at Vallarpadam (Figure 2). All the zooplankton groups recorded from the sampling point showed a better community interaction, which was found exceptional for copepods. This implied that the copepods are depending massively on the estuary for feeding purpose alone and back to sea routed by tidal influence but the other zooplankton groups showed their representation as a part of the estuarine micro fauna.

Discussion

The present results of the statistical correlations observed between the zooplankton group and hydrochemical parameters in the Vallarpadam transect bring out the large input of nutrients into the Cochin estuary irrespective of seasons. Several studies have been conducted in this estuarine system from 1970's onwards to find out the major factor that forms the key cause for this prevailing eutrophication. Overall the studies concluded that the rapid urbanization and industrialization prevailing in the Cochin metropolitan city discharged untreated or partially treated wastes into the six major rivers entering the estuary enhancing the nutrient concentration (Unnithan et al., 1975; Madhu et al., 2007). A well-balanced community structure of zooplankton dominated by copepods, ichthyoplankton (fish eggs, fish larvae), larval forms of crustaceans, polychaetes and tintinnids was observed. The increase in copepod population can be discussed with the grazing habit over phytoplankton found common in tropical estuaries (Tan et al., 2004). In the present finding saline water intrusion supported a significant abundance in zooplankton especially copepods and cladocerans that showed high correlation towards salinity. The mass entry of marine zooplankton to the Cochin estuarine system for feeding purpose from the adjoining Arabian Sea was well documented (Madhupratap, 1987). The high representation of fish larvae assumes that the estuarine system with high biological production, provide an ideal breeding ground for many commercially important fish species (Quasim, 2003).

The dendrogram cluster model plotted explains the community structure between the zooplankton groups at Vallarpadam. Copepods showed a difference as an opportunistic invader for feed and also expressed a competition-based attitude towards other resident groups.

Table 1: Correlation coefficients between the abundance of major zooplankton groups and physico-chemical parameters at Vallarpadam

	Sl.No	1	2	3	4	5	6	7	8	9	10	11	12	15	17	18	20	21	22	23	24	25	26	28	29	31
Transparency	1	1																								
Temperature	2	0.372	1																							
Salinity	3	3.191	-0.162	1																						
pH	4	0.313	0.396	0.265	1																					
Total suspended solids	5	.641*	0.464	-.826(**)	-0.255	1																				
Dissoled oxygen	6	0.473	-0.115	-.790(**)	-0.451	.703(*)	1																			
BOD	7	0.03	-.663(*)	-0.352	-0.539	-0.029	0.427	1																		
Nitrite	8	.917**	0.599	-.635(*)	0.461	.666(*)	0.287	-0.315	1																	
Nitrate	9	.856**	0.267	-.934(**)	-0.027	.835(**)	.714(*)	0.211	.767(**)	1																
Ammonia	10	.818**	0.031	-0.609	0.427	0.377	0.329	0.143	.748(*)	.768(**)	1															
Silicate	11	0.081	-0.337	-0.536	-.655(*)	0.422	0.469	0.629	-0.07	0.503	0.226	1														
Inorganic phosphate	12	-0.225	-0.441	-0.33	-.859(**)	0.304	0.527	.665(*)	-0.378	0.236	-0.156	.881(**)	1													
Total phosphorous	13	0.34	-0.429	-.670(*)	-0.484	0.415	.777(**)	.786(**)	0.076	.638(*)	0.411	.776(**)	.749(*)													
Total nitrogen	14	.886(**)	0.168	-.930(**)	0.018	.772(**)	.717(*)	0.244	.767(**)	.987(**)	.830(**)	0.467	0.185													
Brachyuran larvae	15	-0.388	-0.185	0.631	0.407	-0.611	-.717(*)	-0.068	-0.35	-0.535	-0.121	-0.207	-0.279	1												
Chaetognaths	16	-0.236	-0.136	0.295	0.176	-0.376	-0.496	-0.08	-0.133	-0.126	0.135	0.268	0.058	0.279												
Cladocerans	17	-0.551	-0.104	.656(*)	0.161	-.638(*)	-0.39	-0.062	-0.462	-0.572	-0.411	-0.374	-0.127	0.053	1											
Copepods	18	0	-0.403	.875(**)	-0.02	-.762(*)	-0.598	-0.219	-.736(*)	-.869(**)	-0.581	-0.312	-0.105	0.387	0.593	1										
Cumacea	19	-0.361	-0.257	0.6	0.298	-0.519	-.663(*)	-0.345	-0.174	-0.53	-0.034	-0.33	-0.413	0.476	0.152	.701(*)										
Euphasids	20	-0.444	0.103	0.17	-0.467	0.019	-0.023	0.102	-0.375	-0.275	-0.545	0.015	0.265	-0.275	0.376	0.309	1									
Fish eggs	21	0.465	-0.137	-0.25	0.391	-0.179	-0.011	0.157	0.351	0.329	.651(*)	0.043	-0.243	-0.152	0.142	-0.187	-0.466	1								
Fish larvae	22	-.662(*)	-.674(*)	0.547	-0.29	-.646(*)	-0.191	0.22	-.707(*)	-0.595	-0.462	0.023	0.282	0.101	0.611	.648(*)	0	0.084	1							
Gastropod larvae	23	0.278	0.299	0.053	0.605	-0.007	-0.034	-0.319	0.272	-0.01	0.165	-0.605	-0.63	0.344	-0.27	-0.197	-0.32	-0.179	-0.504	1						
Nauplii	24	-0.358	0.093	0.396	0.21	-0.241	-0.17	-0.074	-0.366	-0.352	-0.344	-0.274	-0.11	0.574	0.064	0.147	0.033	-0.535	-0.132	.651(*)	1					
Zoea	25	0.463	0.188	-0.34	0.177	0.021	0.028	-0.034	0.291	0.15	0.192	-0.293	-0.457	-0.145	-0.377	-0.334	-0.219	0.351	-0.401	0.4	-0.108	1				
Anomuran	26	-0.48	0.035	0.3	-0.31	-0.208	-0.086	0.091	-0.414	-0.344	-0.517	-0.086	0.192	-0.34	.748(*)	0.404	.863(**)	-0.135	0.312	-0.466	-0.092	-0.292	1			
Hyperiids	27	-0.463	-0.034	.642(*)	0.328	-0.554	-0.394	-0.12	-0.447	-0.555	-0.42	-0.388	-0.184	0.626	0.433	0.297	-0.212	-0.248	0.356	0.382	.758(*)	-0.263	-0.042			
Lucifer	28	-0.431	-0.133	0.278	-0.31	-0.288	-0.235	-0.159	-0.414	-0.379	-0.517	0.087	0.192	-0.024	0.184	0.319	-0.183	0.039	0.625	-0.466	-0.195	-0.014	0.024	1		
Polychaetes	29	0.032	-0.169	-0.282	-0.446	0.171	0.335	0.014	-0.083	0.107	-0.17	0.263	0.304	-0.365	-0.318	-0.133	-0.378	0.072	0.312	-0.252	-0.293	0.272	-0.307	.764(*)	1	
Siphonophores	30	0.371	0.059	-0.076	0.422	-0.336	-0.155	0.035	0.225	0.004	0.256	-0.44	-0.556	-0.129	0.232	-0.143	-0.23	.734(*)	0	0.163	-0.277	.725(*)	0.031	0.031	0.043	
Appendicularians	31	-0.42	-0.026	0.198	-0.398	-0.101	-0.157	-0.126	-0.434	-0.343	-0.614	0.141	0.268	0.17	-0.161	0.147	-0.166	-0.373	0.33	-0.152	0.196	0.029	-0.199	.833(**)	.722(*)	1
Mysis	32	-0.279	0.204	-0.022	-0.442	0.146	0.143	0.137	-0.259	-0.086	-0.429	0.059	0.272	-0.421	0.317	0.124	.953(**)	-0.35	-0.136	-0.251	0.051	-0.07	.839(**)	-0.223	-0.312	-0.202
Tintinnids	33	.641(*)	.666(*)	-0.609	0.129	.650(*)	0.446	-0.352	.665(*)	0.563	0.273	-0.191	-0.293	-.646(*)	-0.377	-0.572	0.034	0.09	-.694(*)	0.337	-0.154	0.587	-0.068	-0.23	0.17	-0.176
Crescus	34	-0.342	-0.043	0.07	-0.497	-0.01	-0.088	-0.113	-0.354	-0.239	-0.538	0.24	0.321	-0.017	-0.208	0.122	-0.13	-0.251	0.333	-0.332	-0.066	0.089	-0.156	.885(**)	.821(**)	.960(**)

** Correlation is significant at the 0.01 level (2-tailed).* Correlation is significant at the 0.05 level (2-tailed).

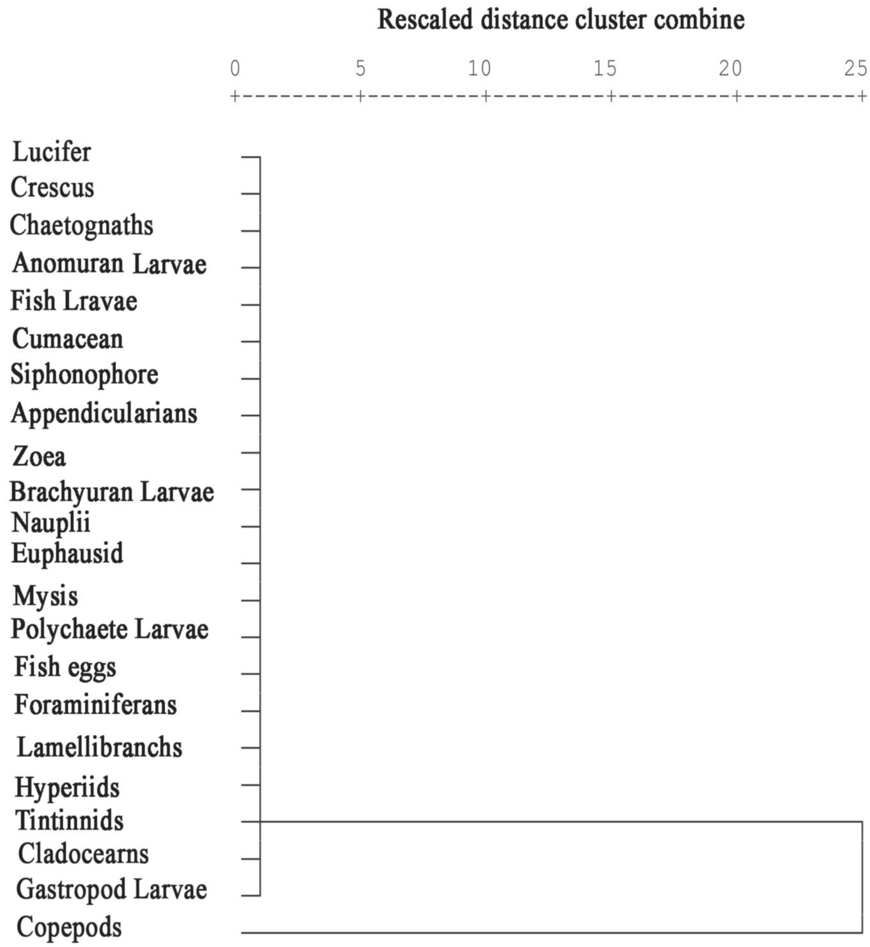

Figure 2: Dendrogram for hierarchical clustering of Zooplankton standing crop in Vallarpadam.

Cluster analysis is defined as an indicative of the degree of similarity in species composition either between stations or at the same station over time (Ismael and Dorgham, 2003).

We conclude, based on our recent findings, that the engineering modifications, periodic dredging activities and the inflow of pollutants to the Cochin estuarine system has not yet affected the biological productivity of the estuarine waters surrounding the Vallarpadam transect. Recently dredging activities and engineering modifications are going on in connection with the commencement of International Container Transshipment Terminal. The existing zooplankton groups can be considered as the indicators of water quality, pollution and eutrophication at this region.

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