Journal of Ecosystem & Ecography

Varadharajan and Soundarapandian, J Ecosys Ecograph 2013, 3:4
DOI: 10.4172/2157-7625.1000135

Research Article Open Access

Distribution and Abundance of Zooplankton Along Tamil Nadu Coastal Waters, India

Varadharajan D* and Soundarapandian P

Faculty of Marine Sciences, Centre of Advanced Study in Marine Biology, Annamalai University, Tamil Nadu, India

Abstract

Zooplanktons have a limited ability to control their fine-scale distribution in the water column, but they are also at the mercy of oceanic currents and water movements. The distribution and abundance of zooplanktons are strongly influenced by many factors. The present study consists of 26 species at three different stations. In this study, maximum of these species are found in station-3, i.e., Pichavaram, than the other 2 stations. The species recorded in the present study belongs to families: Foraminifera (9), Calanoida (6), Cyclopoida (4), Appendicularia (4) Hydroida(1), Rotatoria(1) and Sagittoida(1). The zooplankton production gradually decreases with increasing depth, where the offshore stations yield less abundance than the coastal waters stations.

Keywords: Zooplankton; Diversity; Abundance; Physico-chemical; Research special

Introduction

Zooplanktons are tiny animals found in all aquatic ecosystems, particularly the pelagic and littoral zones in the ocean. They are one of the primary consumers of the ocean and grazes on the phytoplankton. They themselves are an important food source for large animals [1] and are important in the remineralization and transport of nutrients [2] which is very important in the conservation of modern oceanic food webs [3,4]. Marine ecosystem of the estuaries and lagoon are among the most productive and zooplankton rich in the world [5]. High zooplankton biomass and productivity are related to the input of energy and matter from mangrove forests, which are the most common coastal vegetations in the tropics [6]. The species diversity and abundance of the community structure of the zooplankton is necessary to assess the potential fishery resource of a place [7]. Zooplankton provides an important food source for larval vertebrates and invertebrates in natural waters and in aquaculture ponds. It has been reported that in many countries the failure of fishing is attributed to the reduced zooplankton [4,5]. Zooplankton species distribution shows wide spatio temporal variations due to the different hydrographical factors on individual species. They also serve as good indicators of water quality as per the previous studies on zooplankton of Indian coastal environment [3,4,8-10]. The present study identifies the diversity and abundance of zooplankton in relation to physico-chemical parameters.

Materials and Methods

The distributions of zooplankton were investigated in three stations. The three stations were (Station-1) Poombukar, (Station-2) Pazhayar and (Station-3) Pichavaram at Tamil nadu, south east coast of India. The study was conducted from January 2011 to June 2011. Zooplankton samples were collected at monthly intervals from the surface waters of the study area. In all the three stations, samples were collected by horizontal towing of plankton net (0.35m mouth diameter) made of bolting silk (No.10, mesh size 158μm) for half an hour. These samples were preserved in 5% formalin [11] and used for qualitative analysis. Zooplankton standing stock was resolute by a counting method. The major taxonomic groups of zooplankton were determined under the light microscope with a magnification of 10x10. Samples were analyzed for determination of zooplankton diversity and abundance [12] and standard works of [13,14]. The species evenness, richness, diversity and index were calculated by using computer statistical software package,'ECOSTAT'. Physico-Chemical parameters such as temperature, salinity, pH, dissolved oxygen, biological oxygen demand and nutrients were analyzed by standard methods [15].

Results

The zooplankton recorded in the present study consisted of 26 species at three stations during the January 2011 to June 2011. The maximum species are recorded in station-3, compared to other stations (Table1). The zooplanktons recorded in the present study belongs to families: Foraminifera (9), Calanoida (6), Cyclopoida (4), Appendicularia (4) Hydroida(1), Rotatoria(1) and Sagittoida(1) (Table1).

The data analysis in Margalef's species richness (*d'*), Shannon-Weiner diversity function (*H'*), Pielou's evenness (*J'*) and Simpson's dominance (*1-λ'*) was used to reflect the underlying changes in physical and chemical properties of zooplankton species. The species richness and diversity of zooplankton at three sampling stations were determined using Pielous evenness which was highest at the station-3 (0.9278) and lowest at the station-1 (0.8741). Both Margalef's diversity and richness were highest at the stations 3 (5.5669 and 6.8421) and lowest at the station-1 (5.1710 and 6.4731). Both Shannon and Simpson indices were highest at the stations 3 (5.6875 and 0.9434) and lowest at the station1 (5.2481 and 0.9214) (Table 2).

Atmospheric temperature (°C)

The high atmospheric temperature was recorded 32°C in month of June at station-3 and the low atmospheric temperature was recorded 27.5°C in March month at station-1 (Table 3-5).

Water temperature (°C)

The high water temperature was recorded 32.5°C in month of June

***Corresponding author:** Varadharajan D, Faculty of Marine Sciences, Centre of Advanced Study in Marine Biology, Annamalai University, Tamil Nadu, India; E-mail: heartvaradhan@gmail.com

Received July 15, 2013; **Accepted** September 05, 2013; **Published** September 07, 2013

Citation: Varadharajan D, Soundarapandian P (2013) Distribution and Abundance of Zooplankton Along Tamil Nadu Coastal Waters, India. J Ecosys Ecograph 3: 135. doi: 10.4172/2157-7625.1000135

at station-3 and the low water temperature was recorded as 26.0°C in the month of March at station-1(Table 3-5).

S.No	Foraminifera	Station-1	Station-2	Station-3
1	*Globigerina rubescence*	-	+	+
2	*G.bulloides*	+	-	+
3	*G.opima*	+	+	+
4	*Tintinnopsis bermudensis*	+	+	+
5	*T.butschlii*	+	+	-
6	*T .cylindrica*	+	+	+
7	*T.rubulosa*	+	+	+
8	*T.mortensenii*	+	+	+
9	*Eutintinnus tenuis*	+	+	+
	Hydroida			
1	*Obelia* sp	+	+	+
	Rotatoria			
3	*Brachionus plicatilis*	+	-	+
	Calanoida			
1	*Rhincalanus* sp	+	+	+
3	*Metacalanus* sp	+	+	+
4	*Eucalanus* sp	+	+	+
5	*Acartia danae*	+	+	+
6	*Acartia* sp	-	-	+
	Cyclopoida			
1	*Oithona rigida*	+	+	+
2	*Euterpina acutifrons*	+	-	+
3	*Microsetella* sp	+	+	+
4	*Macrosetella* sp	+	+	+
	Sagittoida			
1	*Sagitta* sp	+	+	+
	Appendicularia			
1	Copepod nauplii	+	+	+
2	Shrimp zoea	+	+	+
3	Crab zoea	+	+	+
4	Fish larvae	+	+	+
	Total	**23**	**21**	**24**

(Denotes presence +, Denotes absent -)

Table 1: Checklist of zooplankton species recorded from three stations.

	Station1	Station2	Station3
Pielou's evenness J	0.8741	0.919	0.9278
Shannon -wienner's diversity(H)	5.2481	5.5353	5.6875
Margalef's(D)iversity index	5.171	5.2755	5.5669
Margalef's(D) Species Richness(SR)	6.4731	6.6124	6.8421
Simpson's Index(D)	0.9214	0.932	0.9434

Table 2: Zooplankton evenness, diversity, richness and index.

Salinity (‰)

The maximum salinity was recorded 35**(‰)** in the month May at station-3 and minimum was recorded 29.5 **(‰)** in the month of March at station-2 (Table 3-5).

pH

The maximum pH was recorded 8.2 in the month May at station-3 and minimum was recorded 7.8 in the month of June at station-3 (Table 3-5).

Dissolved oxygen (mg/l)

The maximum dissolved oxygen was recorded 4.87 mg/l in the month January at station-3 and minimum was recorded 0.279 mg/l in the month of June at station-1 (Table 3-5).

Biological oxygen demand (mg/l)

The maximum BOD was recorded 3.129 mg/l in the month March at station-2 and minimum was recorded 0.183 mg/l in the month of May at station-1 (Table 3-5).

Chemical oxygen demand (mg/l)

The maximum COD was recorded 0.951 mg/l in the month March at station-3 and minimum was recorded 0.209 mg/l in the month of May at station-2 (Table 3-5).

Nutrients

Ammonia (µM): The maximum ammonia was recorded 2.213 µM in the month January (station-3) and minimum was recorded 1.018 µM in the month of May (station-1) (Table 3-5).

Total nitrogen (µM): The maximum total nitrogen was recorded 22.36 µM in the month June (station-3) and minimum was recorded 10.56 µM in the month of April (station-1) (Table 3-5).

Total phosphorous (µM): The maximum total phosphorous was recorded 2.356 µM in the month February (station-3) and minimum was recorded 0.361µM in the month of May (station-2) (Table 3-5).

Reactive silicate (µM): The maximum reactive silicate was recorded 3.245 µM in the month March (station-3) and minimum was recorded 1.023 µM in the month of June (station-1) (Table 3-5).

Discussion

Marine zooplankton functions at many levels in ocean food webs, as consumers, producers and prey. Ranging in size from microns to centimeters and meters, they are also major contributors to elemental cycling and vertical fluxes. The zooplankton production gradually decreases with increasing depth, where the offshore stations yield less abundance then the coastal waters [3-5]. The high rate of zooplankton productions influences enrichment of organic matter and plays a vital

Parameters / Month	AT (°C)	WT (°C)	Salinity (‰)	pH	DO (mg/l)	BOD (mg/l)	COD (mg/l)	µM			
								NH_4	TN	TP	SiO_3
January	29.5	30.5	32.5	8	2.95	0.152	0.231	2.125	14.21	1.074	2.147
February	28	29.5	32	8.1	2.89	0.516	0.272	1.173	12.45	2.147	2.236
March	27.5	26	32.5	8.1	2.01	1.214	0.23	0.914	12.72	1.215	2.114
April	31	32	34	8	0.512	2.325	0.276	1.056	13.56	0.751	2.125
May	30	31	34.5	8.1	0.434	2.234	0.183	1.018	19.23	0.369	2.136
June	30.5	29.5	33.5	7.9	0.279	3.061	0.592	1.536	15.08	2.174	1.023

Table 3: Water quality parameters in Poombukar during from January 2011 to June 2011.

Parameters / Month	AT (°C)	WT (°C)	Salinity (‰)	pH	DO (mg/l)	BOD (mg/l)	COD (mg/l)	µM			
								NH_4	TN	TP	SiO_3
January	30	30.5	31.5	8.1	1.73	0.128	0.217	2.032	13.61	2.032	2.174
February	28.5	29	31	8	2.51	0.651	0.252	1.093	14.82	2.041	2.062
March	29	28.5	29.5	8.1	2.9	3.129	0.306	0.145	15.73	1.632	2.142
April	31	31	34.5	8	0.715	2.315	0.228	1.631	16.51	0.418	2.113
May	30	32	34	8.1	0.326	2.062	0.209	2.084	19.26	0.361	2.105
June	30.5	31.5	32.5	8	0.281	3.175	0.412	1.561	12.39	2.032	1.871

Table 4: Water quality parameters in Pazhayar during from January 2011 to June 2011.

Parameters / Month	AT (°C)	WT (°C)	Salinity (‰)	pH	DO (mg/l)	BOD (mg/l)	COD (mg/l)	µM			
								NH_4	TN	TP	SiO_3
January	31	31.5	32.5	8.1	4.87	0.198	0.259	2.213	13.18	2.047	2.418
February	29.5	30.5	31.5	8.1	3.09	0.673	0.267	1.147	18.93	2.356	2.514
March	30	31	32	8	3.81	1.547	0.951	1.892	12.91	1.732	3.245
April	30.5	31.5	34.5	8.1	0.963	2.632	0.263	1.245	21.54	0.514	2.148
May	32	32.5	35	8.2	0.487	2.487	0.384	2.092	20.82	0.621	2.169
June	31.5	31	33.5	7.8	0.362	3.015	0.568	1.634	18.36	2.179	1.923

Table 5: Water quality parameters in Pichavaram during from January 2011 to June 2011.

role in secondary and tertiary productions, represented by young instars of fishes. The survival of the young of herbivorous finfish and shellfishes such as tilapia, sardinella and mud crabs and shrimps may depend on the availability of abundant littoral zooplankton and benthos aided by omnivory and high ecological efficiencies [16,17]. Planktonic fish larvae prey on zooplankton and occasionally phytoplankton. Several families of finfish and shellfishes consume zooplankton wholly or partly in various stages of their life histories. There are thus crucial to achieving high finfish and shellfish yields in the tropics even if their role seems to be mainly through the young stages of fishes [5].

In the present study abundance and distribution zooplankton was found to dependent on water quality and coexisting biotic communities at given point of time. The temperature and plankton productivity are positively correlated. The variation of productivity is related to variation in temperature. Similar findings were reported by [3-5]. Temperature is an important factor which regulated the biogeochemical activities in the aquatic environment. Water temperature influences aquatic weeds, algal blooms [3] and surrounding air temperature [3,4]. The metabolic and physiological activities and life process such as feeding, reproduction, movements and distribution of aquatic organisms are greatly influenced by water temperature. Hydrogen ion concentration (pH) in surface waters remained alkaline throughout the study period at all the stations with maximum value during in the month of May and the minimum during in the month of March (Table 3-5). The high pH recorded might be due to the influence of seawater penetration and high biological activity [18] and due to the occurrence of high photosynthetic activity [19]. The salinity acts as a major ecological factor in the distribution of living organisms and its variation caused by dilution and evaporation is most likely to influence the faunal distribution of the coastal ecosystems [20]. Presently, there were no such wide salinity variations, which observed between two stations between the months. The structure of associations of the zooplankton is indirectly linked with salinity, because the stability of the niches is controlled by its distribution. The distribution of various species undulates up and down the estuary depending on the salinity variations.

Biological oxygen demand of the study area have been increased from one station to another station with increasing distance from discharge point, the temperature is decreased, however oxygen level is increased with distance. It shows that temperature is affecting the dissolved oxygen level in water [21]. This may be due to several factors, the rise in temperature, increased biological activity, respiration of organisms and the increased rate of decomposition of organic matter. [10] has also reported similar pattern of monthly variations in BOD in the Arasalar and Cauvery estuaries. Chemical Oxygen Demand (COD) determines the oxygen required for chemical oxidation of organic matter with the help of strong chemical oxidant. In the present investigation maximum COD was recorded in the month March (station-3) and minimum was recorded in the month of May (station-2) were observed during the study month respectively due to low rainfall and increase in salinity, temperature, phytoplankton productivity and microbial utilization of oxygen at the time of decomposition. Nutrients are considered as one of the most important parameters in the marine environment by influencing the growth, reproduction and metabolic activities of living beings. Nutrients, more importantly the ammonia and silicate have emerged as the main factors controlling the phytoplankton growth reported by [22]. Distribution of nutrients is mainly based on the season, tidal conditions and freshwater flow from land source. In India, many studies on physico-chemical and biological water quality parameters and abundance of zooplankton have been carried out [3,4,23,24].

In the present study the most dominant copepod species were *Acartia* sp and *Eucalanus* sp. In general, copepod species flourished at different month of the year [13]. Cyclopoida was represented by *Oithona* sp. *Microsetella* sp and *Macrosetella* sp. The distribution of some *Acartia* species is known to be affected by temperature and salinity regimes [25,26]. Numerical abundance of copepods was also recorded by different coastal system of India [24,27]. Foraminiferans are key group and sensitive to environmental changes and they act as bioindicators of the ecosystem [28]. *Globigerina rubescence, G.opima*, *Tintinnopsis cylindrica, T. rubulosa* and *Eutintinnus tenuis* has revealed these species are dominant, others subdominant and still others rare. Zooplankton community is highly sensitive to environmental variation. As a result, change in their diversity and species abundance or community composition can provide important indications of environmental change or disturbance, hence, they are of ecological importance. Further the important factors that controlled the distribution of zooplanktons were rainfall, river discharge and salinity as opined by [29]. Since the monthly variations of zooplankton are

related to a variety of environmental factors in aquatic environments [3,4] the approach adopted in the present investigation, namely to relate temporal changes in diversity to temporal changes in environmental conditions, resulted in the development of a better understanding of the nature of interactions between the zooplankton community and its environment in the different coast.

References

1. Day JW, Hall CAS, Kemp WM, Yanez-Arancibia A (1989) Estuarine Ecology. John Wiley and Sons, New York, USA.
2. Harris E (1959) The nitrogen cycle in Long Island Sound. Bull Bingham Oceanogr Collect 17: 31-42.
3. Perumal P, Sampathkumar P, Karuppasamy PK (1999) Studies on the bloom forming species of phytoplankton in the Vellar estuary, southeast coast of India. Ind J Mar Sci 28: 400-403.
4. Rajasegar M, Srinivasan M, Rajaram R (2000) Phytoplankton diversity associated with the shrimp farm development in Vellar estuary, south India. Seaweed Res. Utiln 22: 125-131.
5. Robertson AI, Blabber SJM (1992) Plankton, Epibenthos and Fish Communities. Tropical Mangrove Ecosystems, American Geophysical Union, Washington, DC, USA 173-224.
6. Lugo AE, Snedaker SC (1974) The ecology of mangroves. Ann Rev Ecol Syst 5: 39-46.
7. Varadharajan D, Soundarapandian P, Dinakaran GK, Vijakumar G (2009) Crab Fishery Resources from Arukkattuthurai to Aiyammpattinam, South East Coast of India. Curr Res J Biol Sci 1: 118-122.
8. Tiwari LR, Nair VR (1993) Zooplankton composition in Dharamtar creek adjoining Bombay harbour. Indian J Mar Sci 22: 63-69.
9. Sivaswamy SN (1990) Plankton in relation to coastal pollution at Ennore, Madras coast. Indian J Mar Sci 19:115-119.
10. Saraswathi R (1983) Hydrobiology of two estuarine systems (Arasalar and Kaveri) of the southeast coast of India with special reference to plankton. Ph.D. Thesis, Annamalai University, India.
11. Parsons TR, Yoshiaki M, Carol ML (1984) A Manual of chemical and biological methods for seawater analysis. Pergamon Press, Oxford, England.
12. David VPC, Rowena GW, Joanna Hugues DC, Christopher PG, David BR (2003) Guide to the coastal and surface zooplankton of the south-western Indian Ocean. Marine Biological Association of the United Kingdom, Plymouth (UK).
13. Kasthuriranagn LR (1963) Key to the identification of the common pelagic copepods of Indian coastal waters. CSLS publication, Canada.
14. Wickstead J (1962) Plankton from the East African Area of the Indian Ocean. Nature 196: 1224-1225.
15. Strickland JDH, Parsons TR (1972) A practical handbook of seawater analysis. Bull Fish Res Bd, Canada.
16. Varadharajan D, Soundarapandian P, Gunalan B, Babu R (2010) Seasonal abundance of macrobenthic composition and diversity along the South East coast of India. Eur J Applied Sci 2: 1-5.
17. Manoharan J, Varadharajan D, Thilagavathi B, Priyadharsini S (2011) Biodiversity and abundance of benthos along the South East Coast of India. Pel Res Lib Advan Applied Sci Res 2: 554-562.
18. Das J, Das SN, Sahoo RK (1997) Semidiurnal variation of some physico-chemical parameters in the Mahanadi estuary, East coast of India. Ind J Mar Sci 26: 323-326.
19. Padmavathi G, Goswami SC (1996) Zooplankton ecology in the Mandovi-Zuari estuarine system of Goa, West coast of India. Indian J Mar Sci 25: 268-273.
20. Chandrasekaran VS (2000) Relationship between plankton and finfish and shellfish juveniles in Pichavaram mangrove waterways, Southeast coast of India. Seaweed Res Utiln 22: 199-207.
21. Maruthanayagam C, Subramanian P (1999) Biochemical variation of zooplankton population. J Mar Biol Ass India 41: 111-115.
22. Gannon JE, Stemberger RS (1978) Zooplankton especially crustaceans and rotifers as indicators of water quality. Trans Am Micros Soc 971: 16-35.
23. Reddy AN, Reddeppa Reddi K (1994) Seasonal distributions of foraminifera in the Araniar river estuary of Pulicat, South east coast of India. Indian J Mar Sci 23:39-42.
24. Gothandaraman N (2001) Seasonal variations in taxonomic composition, abundance and food web relationship of microzooplankton in estuarine and mangrove waters, Parangipettai region, Southeast coast of India. Ind J Mar Sci 30: 151-160.
25. Cervetto G, Gaudy R, Pagano M (1999) Influence of salinity on the distribution of Acartia tonsa (Copepoda: Calanoida). J Exp Mar Biol Ecol 239: 33-45.
26. Gaudy R, Cervetto G, Pagano M (2000) Comparison of the metabolism of *Acartia clause* and *A. tonsa*: influence of temperature and salinity. J Exp Mar Biol Ecol 247: 51-65.
27. Jegadeesan P (1986) Studies on the environmental inventory of the marine zone of Coleroon estuary and inshore waters of Pazhayar, Southeast coast of India. Ph.D. Thesis, Annamalai University, India.
28. Gandhi MS, Rajamanickam GV (1997) Siltation in the Palk Strait inference by benthic foraminifera. Fifth Scientific Tamil Conference, Annamalai University, India.
29. Bijoy Nandan S, Abdul Azis PK (1994) Organic matter of sediments from the retting and the non-retting areas of Kadinamkulam estuary, Southeast coast of India. Ind J Mar Sci 25: 25-28.