ISSN 1996-3351

Asian Journal of Biological Sciences

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Asian Journal of Biological Sciences 4 (1): 25-34, 2011
ISSN 1996-3351 / DOI: 10.3923/ajbs.2011.25.34

Hydrobiological Investigations in Ayyampattinam Coast (Southeast Coast of India) with Special Reference to Zooplankton

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ABSTRACT

An investigation was made on the influence of physico-chemical parameters on zooplankton composition of Ayyampatinam coastal region situated in southeast coast of India (Lat. 09°54' N: Long. 79°08' E). Quantitative and qualitative analysis of zooplankton besides physico-chemical parameters were carried out from October 2007 to September 2008. 45 species of zooplankton were recorded, Copepoda formed the major fraction (44%) followed by other metazoans (25%), decapodal larval forms (15%), Ciliats (8%), Foraminiferans (3%), Hydromedusae (2%), Decapoda (2%) and Appendicularians (1%). Higher values of zooplankton density and species diversity were found during premonsoon and summer seasons. The seasonal distribution and abundance of zooplankton are discussed in relation to hydrographical parameters.

Key words: Hydrographical parameters, nutrient analysis, zooplankton diversity, copepods

INTRODUCTION

Zooplankton is the primary consumers of the oceans and grazes on the phytoplankton. They themselves are an important food source for large animals. Basking sharks, whales, fish and some species of rays rely on zooplankton for their food supply. Most fishes and prawns during their critical phase receive their nourishment by feeding on copepods Zooplankton provides an important food source for larval fish and shrimp in natural waters and in aquaculture ponds. It has been reported that in many countries the failure of fishery was attributed to the reduced zooplankton especially copepod population (Stottrup, 2000). Success of aquaculture of fin and shell fishes depend upon the availability of live-feed organisms like copepod. Studies on zooplankton communities, especially copepods are very important in assessing the health of coastal ecosystems (Ramaiah and Nair, 1997). Most of the planktonic organisms are restricted in the neritic zone due to abundance of nutrients, light and favorable physico-chemical variables like water temperature, dissolved oxygen, salinity and pH etc. Information on species diversity, richness, evenness and dominance evaluation on the biological components of the ecosystem is essential to understand detrimental changes in environs (Krishnamoorthy and Subramanian, 1999; Ashok Prabu *et al*., 2005). Species composition and seasonal variation in zooplankton abundance has been studied in other regions of Indian coastal waters (Gopinathan *et al*., 2001; Ashok Prabu *et al*., 2005; Mathivanan *et al*., 2007). Phytoplankton initiates the marine food chain, by serving as food to primary consumers like zooplankton, shellfish and finfish (Saravanakumar *et al*., 2008). Since, zooplankton are at the base of the marine ecosystems, understanding their properties and the relationships between them will allow us to detect and avoid a potential crash in the ecosystem (Conway, 2005). Ayyampattinam coast is a fishery landing place. Present investigation was made on the spatial and temporal changes of zooplankton from Ayyampattinam region in relation to hydrography.

MATERIALS AND METHODS

The Ayyampattinam coast (Fig. 1) is situated 45 km North of Thondi and it is a fishing hamlet (Lat. 09°54' N: Long. 79°08' E). Rainfall data collected from October 2007 to September 2008 and were obtained the local meteorological unit (Govt. of India) located at Manamelkudi, Southeast coast of India. Temperature was measured using a standard Centigrade Thermometer. Salinity was estimated with the help of a hand refracto meter (ATAGO) and pH by using a ELICO Grip pH meter.

Water samples were collected in one liter clean polythene bottle at the monthly interval at Oct. 2007 to Sep. 2008. Samples were kept in an ice box and immediately transported to the laboratory. Initially water samples were filtered through the Millipore filter system to remove the plankton and debris. Filtered seawater was used for analysis of nutrients like inorganic nitrate, nitrite, inorganic phosphate, reactive silicate and ammonia by the standard method of Stickland and Parsons (1972).

The zooplankton samples were collected through Indian ocean standard net (dia= 0.36 m; mesh size 158 µM; cloth No. 10) during the full moon day of the Oct. 2007 to Sep. 2008. For the quantitative analysis 500 L of water were filtered through conical plankton net made up of bolting silk having the same mesh size of the net. Zooplankton samples were preserved in 5% neutralized formalin and used for quantitative analysis. Zooplankton were identified using the standard works

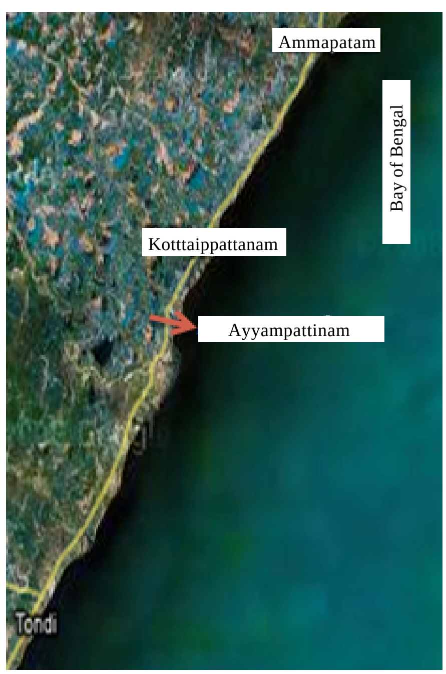

Fig. 1: Study area

of Kasturirangan (1963), Newell and Newell (1977), Smith (1977), Wimpenny (1966), Todd and Laverack (1991) and Perumal *et al.* (1998).

Biodiversity indices were calculated following the standard formulae of Shannon and Weaver (1949) diversity index (H'), Gleason (1922) richness (D); Pielou (1966) evenness. Pearson correlation co- efficient (r) values calculated to understand the relationships between distribution, diversity of zooplankton and hydrographical features.

RESULTS AND DISCUSSION

The total rainfall recorded was 1708.1 mm at Ayyampattinam. The remarkable variations were noticed in salinity and temperature patterns. The surface water temperature varied from 25.5 to 33.4°C and the salinity varied from 23 to 35 ppt (Fig. 2), whereas, only limited variations were observed in pH and Do distribution. The pH values fluctuated between 7.8 and 8.2 and the Do (mL L^{-1}) from 3.6 to 5.2 (Fig. 2). Nitrates values (µg L^{-1}) ranged between 3.21 and 6.34 (Fig. 2), Nitrites (µg L^{-1}) varied from 0.74 to 0.896 (Fig. 2). Phosphates (µg L^{-1}) ranged between 0.22 and 1.16 (Fig. 2). The ranges of reactive silicate (µg L^{-1}) were: 24.85-61.92 (Fig. 2). The concentrations of ammonia (µg L^{-1}) ranges were: 0.05-0.32 (Fig. 2).

Totally 45 zooplankton were identified at Ayyampattinam coastal region, which comprised of Foraminifera (2 species), Copepoda (24 species), Decapoda (1 species), Appendicularia (1 species), Chaetognatha (1 species), Hydromedusae (1 species), Ciliata (6 species), Cladocera (1 species) and Larvae (8) (Table 1). Presently recorded zooplankton consisted of 45 forms including 8 larvae. The descending order of abundance of the various groups of zooplankton is as follows: Copepoda> Larvae>Ciliata>Cladocera>Chaetognatha>Foraminifera>Decapoda.

The ranges of population densities (Org L^{-1}) of zooplankton were: 3300-20262. During the study period the individual species of *Oithona brevicornis* were dominant. The maximum density of zooplankton was recorded during premonsoon period. In copepod population, calanoida is the most dominant and it contains 15 species. The species diversity ranged from 3.75 to 4.62; species richness varied between 0.91 and 0.94; species evenness ranged from 0.92 to 0.97 (Fig. 3).

Physico-chemical variables in the marine environment are subjected to wide temporal variations. Rainfall is the most important cyclic phenomenon in tropical countries as it brings about important changes in the physical and chemical characteristics of the coastal environment. The rainfall in India is largely influenced by two monsoons viz., Southeast monsoon on the West coast and Northeast monsoon on the east coast (Perumal, 1993). The salinity acts as a limiting factor in the distribution of living organisms and its variation caused by dilution and evaporation is most likely to influence the fauna in the coastal ecosystems (Balasubramanian and Kannan, 2005; Sridhar *et al.*, 2006).

Presently, the salinity was found to be high during summer season and low during the monsoon season. Generally, its seasonal variation is attributed to factors like removal of CO_2 by photosynthesis through bicarbonate degradation, dilution of seawater by freshwater influx, low primary productivity, reduction of salinity and temperature and decomposition of organic matter (Karuppasamy and Perumal, 2000; Rajasegar, 2003; Paramasivam and Kannan, 2005). The recorded higher values (34.0%) could be attributed to the low amount of rainfall, higher rate of evaporation and also due to neritic water dominance, as reported by earlier workers in other areas (Govindasamy *et al.*, 2000; Rajasegar, 2003). The minimum salinity recorded during the monsoon season and the maximum was recorded during summer season as reported earlier by Sundaramanickam *et al.* (2008).

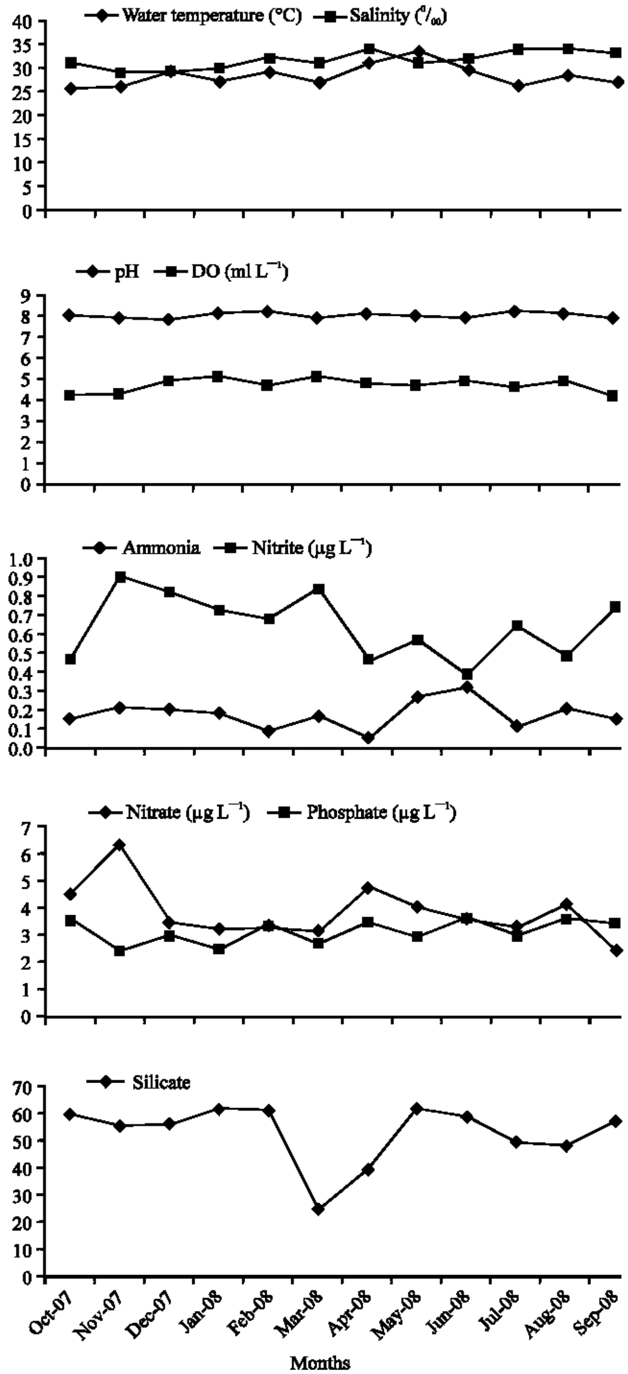

Fig. 2: Temporal variations of temperature, salinity, pH, dissolved oxygen, ammonia, nitrite, nitrate, phosphate and silicate in Ayyampattinam coast, south east coast of India

The recorded high Summer pH might be due to the influence of seawater inundation and biological activity and due to the presence of high photosynthetic organisms (Das *et al*., 1997; Santhanam, 1998). The observed high monsoonal values might be due to the cumulative effect of higher wind velocity coupled with heavy rainfall and the resultant freshwater mixing (Das *et al*.,

Table 1: List of zooplankton of the ayyampattinam area

Name of the species	Relative abundance
Copepoda-calanoida	
Acartia spinicauda	M
Acartia danae	R
Acartia erythrea	R
Acrocalanus gibber	R
Acrocalanus gracilis	M
Centropages furcatus	M
Eucalanus elongatus	M
Euchaeta marina	R
Nanocalanus minor	R
Paracalanus parvus	M
Pontella danae	R
Pseudodiaptomus serricaudatus	R
Temora turbinata	M
Temora stylifera	M
Temora discaudata	R
Cyclopoida	
Corycaeus catus	R
Corycaeus danae	R
Oncaea venusta	R
Oithona rigida	D
Oithona brevicornis	D
Oithona similis	R
Herpacticoida	
Euterpina acutifrons	M
Microsetella norvegica	M
Macrosetella gracilis	R
Decapoda	
Lucifer hanseni	M
Appendicularia	
Oikopleura parva	R
Chaetognatha	
Sagitta enflata	R
Hydromedusae	
Obelia sp.	R
Ciliata	
Favella brevis	R
Favella philippiensis	M
Tintinnopsis butchi	R
Tintinnopsis beroea	R
Tintinnopsis cylindrica	R
Tintinnopsis tocantinensis	M
Cladocera	
Penilia sp.	R
Foraminifera	
Globigerina bulloides	R
Globigerina opima	M
Larval forms	
Mysis larva	M

Table 1: Continued

Name of the species	Relative abundance
Polychaete larvae	M
Crab zoea	M
Fish eggs	D
Copepod nauplii	D
Bivalve veliger	M
Gastropod veliger	M
Shrimp	M

D: Dominant, M: Moderate, R: Rare

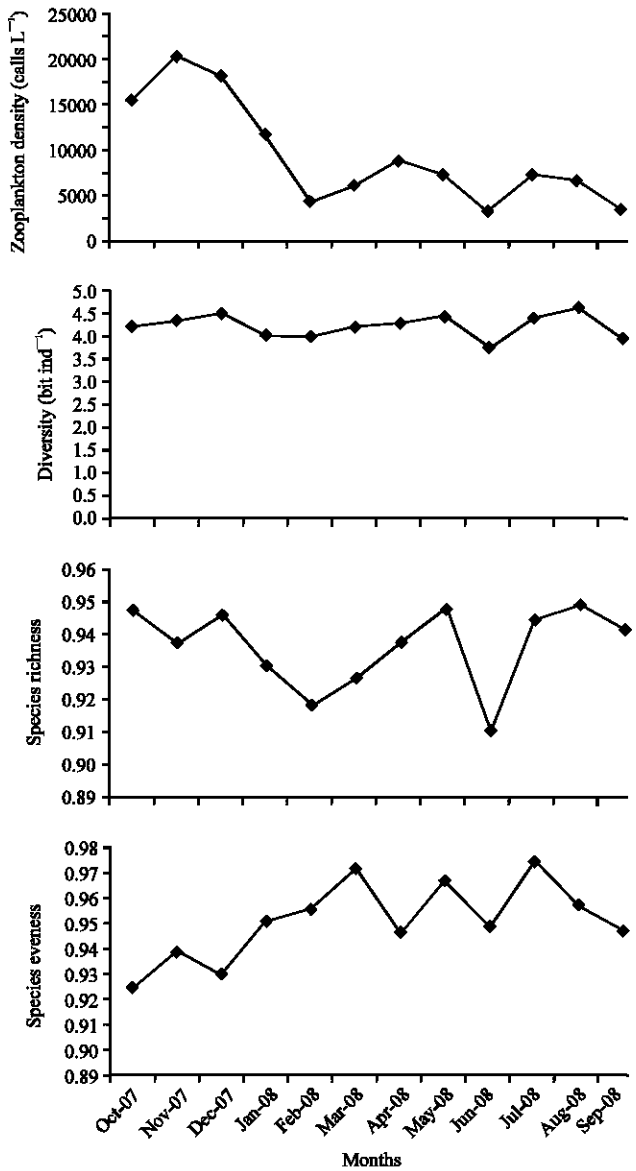

Fig. 3: Seasonal variations of zooplankton population density, diversity, richnness and eveness

1997). Mitra *et al.* (1990) have mainly attributed seasonal variation of dissolved oxygen to freshwater flow and terrigenous impact of sediments.

Nutrients are considered as one of the most important parameters in the estuarine environment influencing growth, reproduction and metabolic activities of living beings. Distribution of nutrients is mainly based on the season, tidal conditions and freshwater flow from land source. Presently recorded high monsoonal values could be mainly due to the organic materials received from the catchment area during ebb tide (Das *et al.*, 1997). The increased nitrates level was due to fresh water inflow, mangrove leaves (litter fall) decomposition and terrestrial run-off during the monsoon season (Karuppasamy and Perumal, 2000; Santhanam and Perumal, 2003). The recorded low values of nitrate may be due to its utilization by phytoplankton as evidenced by high photosynthetic activity and also due to the neritic water dominance, which contained only negligible amount of nitrate (Govindasamy *et al.*, 2000).

The recorded earlier Summer nitrite values could be due to the increased phytoplankton excretion, oxidation of ammonia and reduction of nitrate and by recycling of nitrogen and also due to bacterial decomposition of planktonic detritus present in the environment (Govindasamy *et al.*, 2000). The recorded low nitrite values during summer season may be due to less freshwater inflow and high salinity (Mani and Krishnamurthy, 1989; Murugan and Ayyakkannu, 1991).

The recorded high concentration of inorganic phosphates during monsoon season might possibly be due to intrusion of upwelling seawater into the creek, which in turn increased the level of phosphate (Nair *et al.*, 1984). Low Summer values could be attributed to the limited flow of freshwater, high salinity and utilization of phosphate by phytoplankton (Senthilkumar *et al.*, 2002). The variation may also be due to the processes like adsorption and desorption of phosphates and buffering action of sediment under varying environmental conditions (Rajasegar, 2003).

The recorded high concentration of inorganic silicate content was higher than the other nutrients (NO_3, NO_2 and PO_4) and higher value was noticed during monsoonal season when the salinity was very low and this may be due to heavy influx of fresh water (Anbhazhagan, 1988). The low value of silicate recorded during post-monsoonal season could be attributed to uptake of silicates by phytoplankton for their biological activity (Mishra *et al.*, 1993). Higher concentration of ammonia was observed during monsoon season could be partially due to the death and subsequent decomposition of phytoplankton and also due to the excretion of ammonia by planktonic organisms (Segar and Hariharan, 1989).

High density of zooplankton recorded in Summer season might be due to the stable salinity and high phytoplankton population density. The abundance of zooplankton during Summer season was also reported by Srinivasan and Santhanam (1991) in pullavazhi backwaters, Karuppasamy and perumal (2000) in the Pichavaram mangroves, Madhu *et al.* (2007) in Cochin backwaters. The recorded high densities might be due to the relatively stable environment condition, which prevailed during those seasons and great neritic elements presence from the adjacent sea could have also contributed to the maximum density of zooplankton. Further, salinity is the key factor influencing the distribution and abundance of zooplankton (Padmavati and Goswami, 1996).

The copepod population densities were high and *Acartia* sp., was dominated in sub-order calanoids and that of *Oithona* sp., among cyclopoid was noticed, the abundance of *Oithona* sp., was mainly due to its high reproductive capacity. Similar findings were earlier reported by Santhanam and Perumal (2003). Many copepod species disappear during monsoon and species composition also changed, since they are mostly stenohaline (Eswari and Ramanibai, 2004). During monsoon period heavy flood changed the salinity and temperature and due to this environmental variation the zooplankton population density also decreased. Similar observation was earlier made by Padmavati and Goswami (1996). The important factors which controlled the distribution of copepods were rainfall, river discharge and decreased phytoplankton abundance due to increased turbidity (Bijoy Nandan and Abdul Azis, 1994). The meroplanktonic organisms such as veligers of bivalves and gastropod, copepod nauplii and barnacle nauplii and that of the most common species of copepods *Acartia spinicauda, A, danae, A, erytharea, A. southwelli, Paracalanus parvus, Oithona brevicornis, O. similis, O. rigida* were commonly found in Ayyampattinam region.

The observed maximum premonsoonal species diversity may be due to the high zooplankton density that also indicated the stable high salinity values and phytoplankton density. The low species diversity was observed monsoon season, which could be attributed to heavy freshwater influx and low salinity (Prasad, 2003). This is supported by the obtained statistically significant values between diversity and density (r = 0.65). Maximum species richness was recorded during premonsoon season. During premonsoon season, population density of zooplankton also increased with increasing species richness (Santhanam and Perumal, 2003).

Population density, species diversity and species richness values were high during premonsoon along with high values of evenness index, suggesting the equal distribution of species during this season (Karuppasamy and Perumal, 2000). The statistical correlation values of evenness showed positive correlation with species richness and species diversity. The results of Analysis of Variance (ANOVA) for the difference in zooplankton distribution between the stations are significant at 0.05% level.

In the present investigation, the increase or decrease of salinity in the water column exerts either a direct or an indirect effect in the appearance or disappearance of some forms and replacement by others. The indirect effect might be due to the scarcity of food caused by the fluctuations of salinity in the waters ultimately affecting the population abundance of zooplankton.

The collected information is a base line data on the zooplankton distribution and abundance with reference to hydrography and this would form a useful tool for further ecological assessment at Ayyampattinam coast.

ACKNOWLEDGMENTS

The authors are grateful to the Prof. T. Balasubramanian, Director, Faculty of Marine Science and CAS in Marine Biology, Annamalai University, Parangipettai, Tamil Nadu and India for providing the requisite facilities and to the authorities of Sethusamudram Ship Channel Project for providing fellowship to the first author.

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