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Population density of two copepods in relation to hydrographic parameters in Parangipettai coastal waters, southeast coast of India

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Abstract

An investigation was carried out on the spatio-temporal variations of the calanoid copepod, *Acartia spinicauda* and the cyclopod copepod *Oithona similis* in relation to hydrography along Parangipettai coast, southeast coast of India during October 2002 - September 2003 covering 3 stations. The minimum and maximum values of atmospheric and surface water temperatures (°C), salinity (‰), pH and dissolved oxygen (ml l^{-1}) were: 28.5-35.0; 28.7-34.2; 14.5-35.7; 7.4-8.6 and 3.0-7.2 respectively. The ranges (µM) of nitrate, nitrite, phosphate and silicate were 7.9-52.9; 0.6-9.6; 0.5-7.5 and 8.2-140.5 respectively. The density (No/l) of nauplii and adults of *A. spinicauda* and *O. similis,* in the surface water samples were 7-29,000; 92-54,000 and 9-20,000; 86-46,000 respectively. The population density was more in the estuary than in the estuarine mouth and sea. When compared to *O. similis,* the density of *A. spinicauda* was found to be more throughout the year, and it may be due to the calanoid copepod's continuous breeding, high reproductive capacity and ability to adapt to the widely changing environmental conditions.

Keywords: Parangipettai, copepods, *Acartia spinicauda*, *Oithona similis,* density

Introduction

Tropical aquatic ecosystems are the most productive areas with rich zooplankton population (Robertson and Blabber, 1992). Information on species diversity, richness, evenness and dominance evaluation on the biological components of the ecosystems is essential to understand the changes in the environment (Krishnamoorthy and Subramanian, 1999). The rate of zooplankton production can be used as a tool to estimate the exploitable fish stock of an area (Stottrup, 2000).

Copepods are the important grazers of phytoplankton and microzooplankton and thus they form a major trophic link to many predatory invertebrates and fish (Atkinson, 1996). They are found distributed extensively in the water medium and sometimes account for 80 to 90% of the total zooplankton population. Most fish and prawn species depend on copepods at early stages of their life cycle and some even feed exclusively on copepods.

Some studies were carried out on the species composition and seasonal distribution of copepods in the other regions of Indian coastal waters (Goswami, 1982; Sarkar *et al*., 1986; Padmavathi and Goswami, 1996; Sujatha Mishra and Panigrahy, 1996; Ramaiah and Nair, 1997; Madhupratap, 1999; Santhanam and Perumal, 2003). An investigation was carried out on the spatio-temporal patterns of population density of two copepods *vis-a-vis* hydrography from Parangipettai coastal waters.

Material and methods

Vellar estuary (11°29’ N lat. 79°46’E long.) is situated near Parangipettai on the southeast coast of India (Fig. 1). For the present investigation three stations were chosen. Station 1 is in Bay of Bengal, where the depth is about 5 m, with sandy bottom and the mean salinity was 33‰. It is away from the Vellar estuarine mouth by 3 km. The Vellar estuarine mouth is station 2 and the depth is 2.5 m with

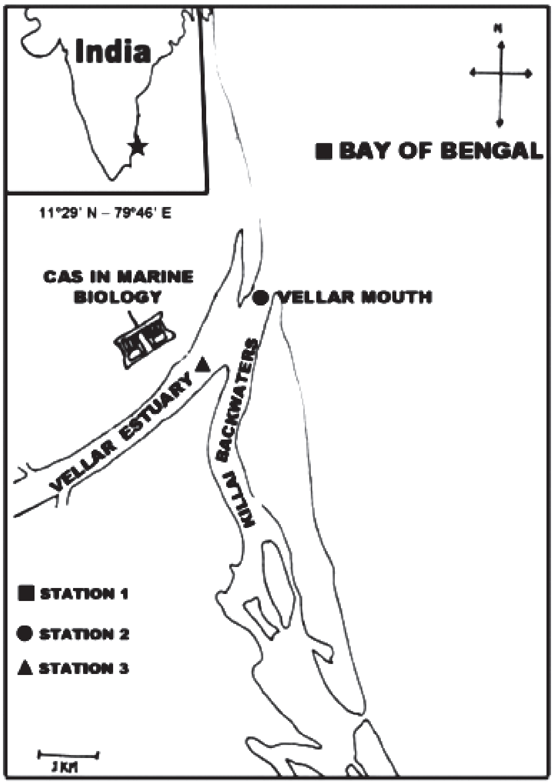

Fig. 1. Map showing location of sampling sites

muddy-sand bottom. Station-3 is 1.5 km from station 2 and located opposite to the Marine Biological Station in Parangipettai. The depth is 2.5 m with muddy bottom and the mean salinity of both the stations was 20‰.

Fortnightly surface water and copepod samples were collected from October 2002 to September 2003. Rainfall data were obtained from the Meteorological Unit of Govt. of India, located at Marine Biological Station, Parangipettai. Data on temperature, salinity, dissolved oxygen and pH were collected from morning to noon. Atmospheric and surface water temperatures were measured using standard mercury-filled centigrade thermometer. Salinity was estimated with the help of a hand refractometer (Atago, Japan) and pH was measured using Elico pH meter (Model LC-120). Dissolved oxygen was estimated by the modified Winkler's method following Strickland and Parsons (1972). For the analysis of nutrients, surface water samples were collected in clean polythene bottles and kept in an ice box and transported immediately to the laboratory for analysis. The water samples were filtered using a Millipore filtering system (MFS) and analyzed for dissolved inorganic phosphate, nitrate, nitrite and reactive silicate by adopting the standard methods described by Strickland and Parsons (1972).

Copepod samples were collected from the study areas by horizontal towing of a zooplankton net (0.35m mouth diameter), made of bolting silk cloth (No 10: mesh size 158 mm) for twenty minutes. The samples were preserved in 5% neutralized formalin and used for qualitative analysis. The copepods were identified following Kasturirangan (1963). For the quantitative analysis of copepods, 500 l of natural water was filtered through a bag net (158 µm aperture size) and from this collected/ concentrated samples, numerical plankton analyses were carried out using a binocular microscope. Simple correlation was made for the statistical interpretation of the physico-chemical parameters and copepod density.

Results and discussion

Rainfall: A total rainfall of 1059 mm was recorded from October, 2005 to September, 2006. It varied from 10mm to 362mm and rain did not occur during the months of January - April, June and July (Fig. 2). In the present study, the peak values of rainfall were recorded during the monsoon month of October. Maruthanayagam and Subramanian (1999) have also reported the bulk of rainfall during the northeast monsoon season along the southeast coast of India.

Temperature: Atmospheric and surface water temperatures varied from 28.5°C to 35.0°C and from 28.7°C to 34.2°C respectively (Fig. 2). The surface water temperature showed an increasing trend from December to April. Generally, surface water temperature is influenced by the intensity of solar radiation, evaporation, freshwater influx and cooling and mix up with ebb and flow from adjoining neritic waters. The water temperature during October was low because of strong land sea

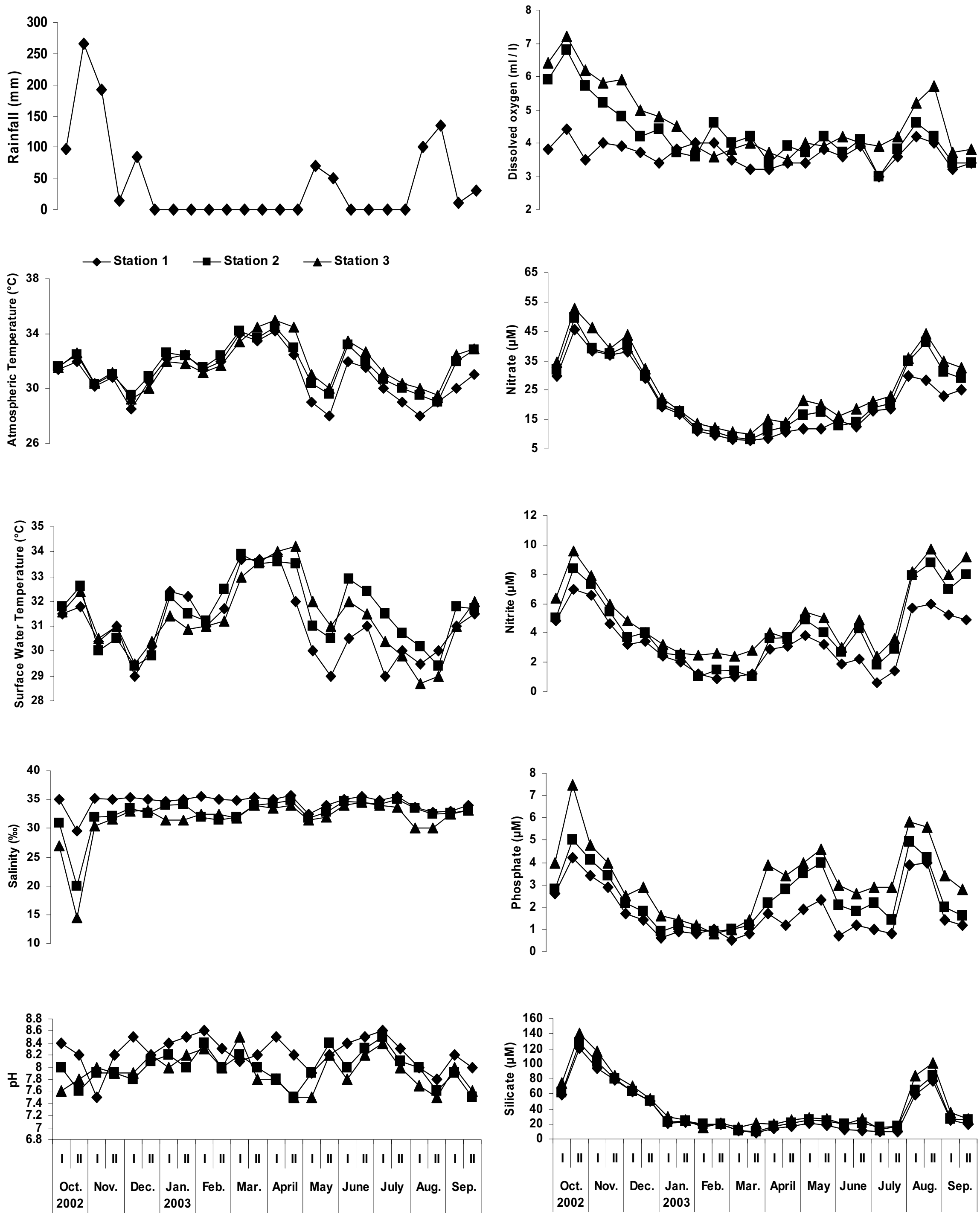

Fig. 2. Hydrographic parameters of Parangipettai coastal waters during October 2002 - September 2003

breeze and precipitation and the recorded high value during summer could be attributed to high solar radiation (Govindasamy *et al*., 2000; Senthilkumar *et al*., 2002; Santhanam and Perumal, 2003).

Salinity: The salinity was found to be high during summer and low during monsoon at all the stations (Fig. 2). The higher values (35.7‰) 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 (Gowda *et al.,* 2001; Rajasegar, 2003). During the monsoon season, the rainfall and the freshwater inflow from the land reduced the salinity (14.5‰). Statistical analysis revealed highly significant negative correlation of salinity with rainfall.

pH: Hydrogen ion concentration (pH) in the surface waters remained alkaline throughout the study period at all the stations with maximum (8.6) during summer and minimum (7.4) during monsoon (Fig. 2). Generally, seasonal fluctuations in pH 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 (Paramasivam and Kannan, 2005). The recorded high premonsoon and summer pH might be due to the influence of seawater penetration and high biological activity (Govindasamy *et al*., 2000) and due to the occurrence of high photosynthetic activity (Sridhar *et al*., 2006).

Dissolved oxygen: It varied from 3.0 to 7.2 ml l^{-1} (Fig. 2). It is well known that temperature and salinity affect the dissolution of oxygen (Govindasamy *et al*., 2000). In the present investigation, higher values of dissolved oxygen were recorded during monsoon months at all the stations. 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 (Rajasegar, 2003). Seasonal dissolved oxygen concentration showed an inverse trend with temperature and salinity. Dissolved oxygen was observed to be low during postmonsoon and summer seasons, which could be due to the gradual saline water incursion and increasing temperature (Govindasamy *et al*., 2000).

Nutrients: The recorded highest nitrate value (52.9 µM) during monsoon season could be due to the organic materials received from the catchment area during ebb tide (Santhanam and Perumal, 2003; Ashok Prabu *et al*., 2005) (Fig. 2). Another possible way of nitrate entry is through oxidation of ammonia form of nitrogen to nitrite formation (Rajasegar, 2003). The low values (7.9 µM) during the nonmonsoon period may be due to its utilization by phytoplankton as evidenced by high photosynthetic activity and also due to the neritic water dominance, which has only negligible amount of nitrate (Govindasamy *et al*., 2000; Rajaram *et al*., 2005). Further, significant inverse relationship between rainfall and nutrients indicated that freshwater flow constituted the main source of the nutrients in the estuaries.

The higher nitrite concentration during monsoon season (9.6µM) 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 (Govindasamy *et al*., 2000). Further, the denitrification and air-sea interaction exchange of chemicals are also responsible for the increased concentration (Rajasegar, 2003) (Fig. 2). The low nitrite concentration (0.6µM) during postmonsoon seasons may be due to less freshwater inflow and high salinity (Murugan and Ayyakkannu, 1991).

The observed high monsoonal phosphate value (7.5µM) might be due to the regeneration and release of total phosphorus from the bottom mud into the water column by turbulence and mixing (Chandran and Ramamoorthi, 1984) (Fig. 2). Moreover, the bulk of weatherings of rocks soluble alkali metal phosphates (in the upstream area) are carried into the estuaries (Govindasamy *et al*., 2000). The addition of super phosphates applied in the agricultural fields as fertilizers and alkyl phosphates used in households as detergents can be other sources of inorganic phosphates during the season (Senthilkumar *et al*., 2002). The postmonsoonal low value (0.5µM) could be attributed to the limited flow of freshwater, high salinity and utilization of phosphate by phytoplankton (Senthilkumar *et al.,* 2002; Rajasegar, 2003). 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 silicate content was higher than that of the other nutrients and the higher concentration (140.5µM) during monsoon may be due to heavy inflow of fresh water derived from land drainage carrying silicate leached out from rocks. Further, due to the turbulent nature of water, the silicate from the bottom sediment might have been exchanged with overlying water (Govindasamy *et al*., 2000; Rajasegar, 2003) (Fig. 2). The removal of silicates by adsorption and co-precipitation of soluble silicate silicon with humic compounds and iron might also be responsible for the increased value (Rajasegar, 2003). The observed low postmonsoonal values (8.2 µM) could be attributed to the uptake of silicates by phytoplankton (Sujatha Mishra *et al*., 1993; Ramakrishnan *et al.,* 1999).

Population density: The population density (No/l) of nauplii and adults of *A. spinicauda* varied from 7 to 29,000 and 92 to 54,000 respectively in the three stations (Fig. 3); in the case of *O. similis,* the respective density ranges were: 9 – 20,000 and 86 – 46,000 (Fig. 3). When compared to the previous study on *O. rigida* from Parangipettai coastal waters (Kumar, 1993), the present density values of the two copepods are higher.

The nauplii and adult copepods showed considerable spatio-temporal variations in relation to the prevailing environmental conditions. The surface water temperature, salinity and pH were positively correlated with copepod density. But negative correlation was obtained between copepod density and rainfall, dissolved oxygen and nutrients at all the stations. The observed high summer population density of copepods in the estuary and sea was due to higher salinity and phytoplankton density (Santhanam and Perumal, 2003; Ashok Prabu *et al*., 2005). Salinity showed positive

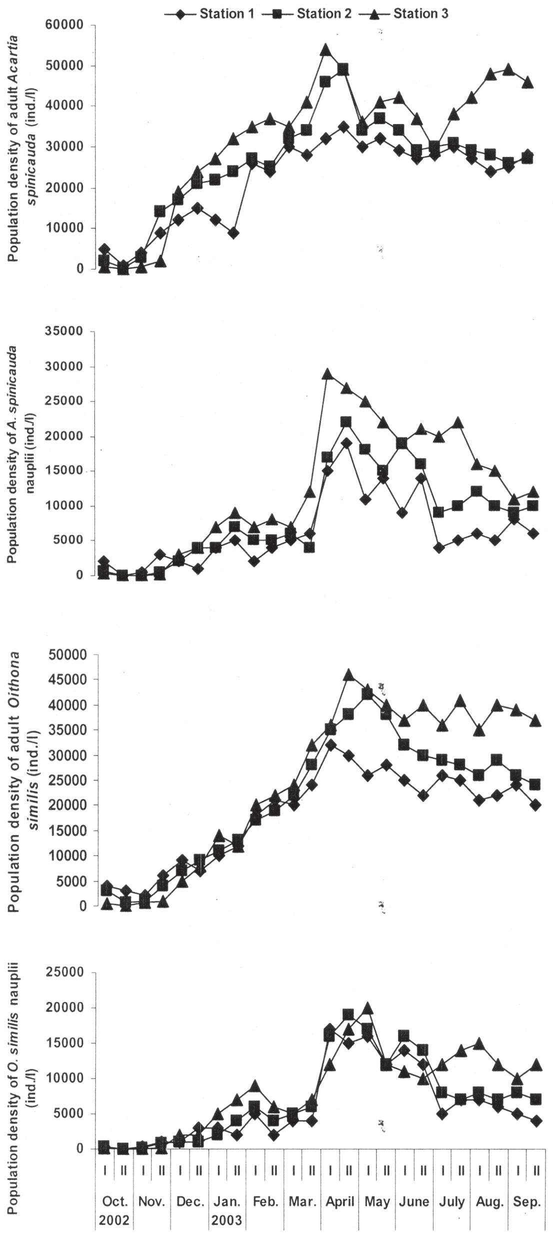

Fig. 3. Density of adults and nauplii of *Acartia spinicauda* and *Oithona similis* in Parangipettai coastal waters

correlation with population density of *A. spinicauda* and *O. similis* at station 1 (r = 0.2244; r = 0.1350), station 2 (r = 0.6086; r = 0.4698) and at station 3 (r = 0.5650; r =0.4891). The recorded low population density of nauplii and adults during the monsoon was due to the heavy input of freshwater as reported earlier by Santhanam and Perumal (2003) in Vellar estuary. The recorded highest population density (Numbers/l) (*A. spinicauda* 54,000 and *O. similis* 46,000) in the estuary could be related to the organic matter input from the catchment areas (Santhanam and Perumal, 2003). The high density of *A. spinicauda* could be ascribed to its continuous high breeding capability besides its general adaptability to the prevailing environmental conditions.

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