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Seasonal distribution of pelagic tunicates with influence of the environmental parameters in the Parangipettai, southeast coast of India

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ABSTRACT

Pelagic tunicates are the major components of herbivorous zooplankton biomass in the upper layers of warm seas and are able to colonize when the conditions are suitable and they grow faster rate than other zooplankton. The distribution and abundance of pelagic tunicates were studied in relation to physicochemical parameter variables during April 2008 to March 2010 in Parangipettai coastal waters of Bay of Bengal. Totally, 15 species of pelagic tunicates were identified during the study period. The pelagic tunicate density was high during February 09 and low during November 08. Most of the species observed during premonsoon and postmonsoon season. Generally, salps were the most abundant groups than the doliolids and appendicularians. Salpafusiformiswas more abundant species in all seasons than the other species of tunicates. The distribution and abundance of pelagic tunicate were showed significant (P<0.01) positively correlated with temperature and salinity during the study periods.

Key words: *Salpafusiformis*, pelagic tunicate, environmental parameters, diversity indices, correlation coefficient, Parangipettai coastal water

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INTRODUCTION

Marine gelatinous organisms are commonly called ‘gelatinous zooplankton’, avoiding taxonomic terminology, but importance evolutionary characters such as planktonic life history, a transparent structure and fragile body mostly composed of soft bodies consist of at least 95% water content. Gelatinous macroplankton constitute an important part of the plankton in oceanic and coastal waters during various times of the year (Aldredge and Madin,1982). Gelatinous zooplankton are a taxonomically diverse group that includes Cnidaria, Ctenophores, colonial Siphonophores, heteropods, pteropods and pelagic tunicates.

Pelagic tunicates are an important part of the oceanic and coastal waters and are widely distributed throughout the world’s oceans. They are important component of the pelagic food web (Kremer and Madin 1992; Deibel, 1998, Madin and Deibel, 1998) and are receiving an increasing attention recently due to their ecological, evolutionary and biogeochemical importance (Andersen, 1998; Boero*et al*., 2008). They have complex life cycles with obligatory alternation of asexual and sexual generations (Bone, 1998), and are adapted to respond quickly to biological and physical dynamics (Capitanio*et al*., 2005; Deibel and Pafenhöffer, 2009; Li *et al*., 2010) and found in dense populations occur during the spring phytoplankton bloom (Gorsky*et al*., 1991; Drits*et al*., 1992; Menard et al., 1994) or in productive shelf and coastal waters (Zeldis*et al*., 1995;VanSoest, 1998).

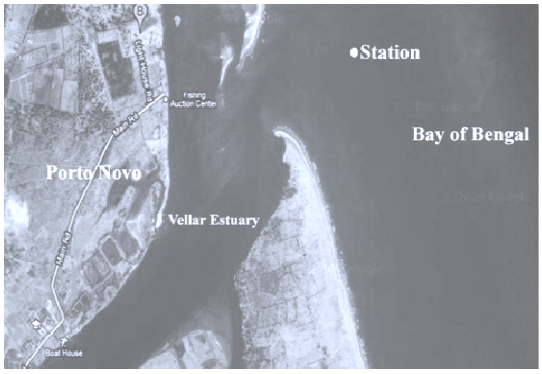
Pelagic tunicates are small changes to high degree sensitivity in temperature, salinity, food, and ocean currents are generally considered to be the major factors and thaliacea tend to congregate in the areas of high abundances of nano- and ultra-plankton (Nakamura,1998; Cristian and Madin, 2004). They occur mostly in the epiplanktonic zone of the Indian Ocean. Most doliolids and salps appear to be abundant close to the increasing concentrations of chlorophyll a (Chl a) in the northern part of the Levantine Sea (Weikert and Godeaux, 2008), in the Japan Sea (Iguchi and Kidokoro,2006) and in the northern Arabian Sea (Naqvi*et al*.,2002). Thaliceans occur regularly inupwelling waters,rich in nutrients and phytoplankton and are transported (Paffenhöfer et al.,1995; Deibel and Pafenhöffer, 2009). Even though there are several works available on the distribution and seasonal variation of pelagic tunicates from other regions. Similar recent studies from Indian waters are very scanty except some earlier reports (Ganapati and Bhavanarayana, 1958; Nagabhushanam, 1961; Krishnamurthy, 1967; Bhavanarayana and Ganapati, 1971 and 1972; Bhavanarayana, 1974). The goal of this study was to reveal species composition and abundance distribution of pelagic tunicate in the Parangipettai coastal waters and discuss the influence of environmental factors on their distribution and assemblage.

MATERIALS AND METHODS

Study area

In the present study were contacted during April 2008 to March 2010. The topography of the Parangipettai is situated along (Latitude 11º30. 42N, Longitude 079º47. 05E) the southeast coast of India (**Fig. 1**) and it has a unique potential for marine and brackish water resources, being endowed with various aquatic biotopes viz., neritic, estuarine, backwaters and mangroves. There is not polluted, receiving only the land drainage through the Vellar estuary.

Figure 1.Sampling sites of Parangipettai coastal water.



Sampling

Zooplankton samples were carried out from April 2008 to March 2010 in Parangipettai coastal waters. Surface samples were collected by using zooplankton nets (mouth diameter 60 cm) made up of bolting silk cloths (Mesh size - 200µm) towed for 10 minutes. The collected samples were preserved in 4% neutralized formalin for the species identification. Environmental parameters like temperature, salinity and dissolved oxygen were measured by using standard methods. Densities of water column were presented as number of individuals per cubic meter(unit: inds./m^3).

Statistical analysis

Diversity indices and Pearson correlation analysis was applied to find the distribution of pelagic tunicate in relation to environmental variables by using PRIMER 6 (Plymouth Routine in Marine Environmental Research, Clarke and Gorley, 2001).

Species abundance

The estimated abundance (density) for the different groups was represented as no. m^{-3}. The abundance and relative abundance of each group was calculated using the formula:

$$\text{Abundance} = \frac{\text{No. of individuals of the particular taxa}}{Volume\ of\ water\ filter\ (v)}$$

= No. of particular taxa in the unit volume (no. m^{-3})

$$\text{Relative abundance} = \frac{\text{No. of specimens in the particular taxa}}{\text{Total no. of organisms x 100}}$$

= Percentage of particular taxa (%)

Species diversity (Shannon and Weaver, 1963)

(a) Species richness-the number of different species in a particular area (Margalef, 1968)

$$D = \frac{S - 1}{\log N}$$

(b) Species evenness–the relative abundance with which each species are represented in an area (Heips, 1974)

$$E = [(H(S)\text{-}1)]/(S\text{-}1)$$

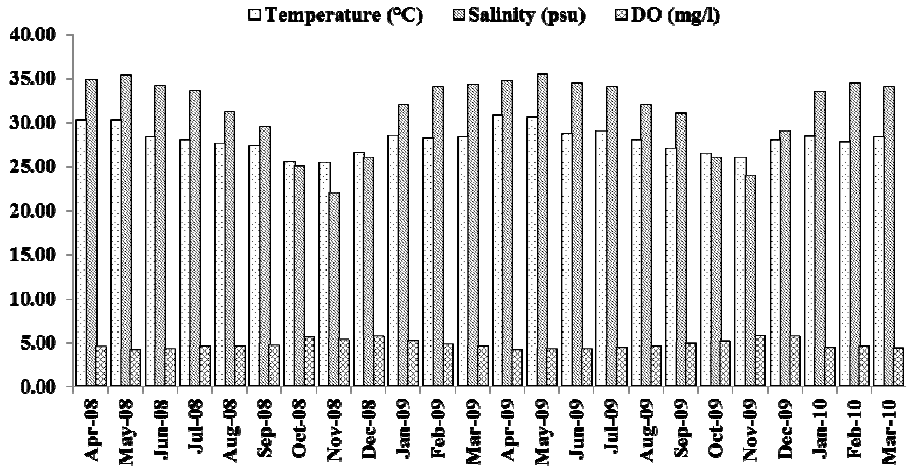
(c) Species diversity–this index takes into account the number of species and the evenness of the species.

$$H(S) = -\sum[P(\log_2 P)]$$

RESULTS AND DISCUSSION

The environmental parameters are given in Fig. 2. The surface water temperature was ranged from 25.43°C to 30.81°C, with maximum was recorded in Apr 2009 and the minimum was in November 2008. The temperature was fallen from April (30.56°C) to November (27°C) periods and further, there was an increase from December (27°C) to March (31°C). The range of salinity was about 22 to 35.40psu. The minimum level of salinity was reported during November 2008 and maximum in May 2009. The salinity decreasing trend was observed from April (35) to November (22) and it was increased from December (26) to March (34.30). The concentration of DO was about 4.10 to 5.70mg/l, with lowest value was recorded during April 2009 and higher value was during November 2009.

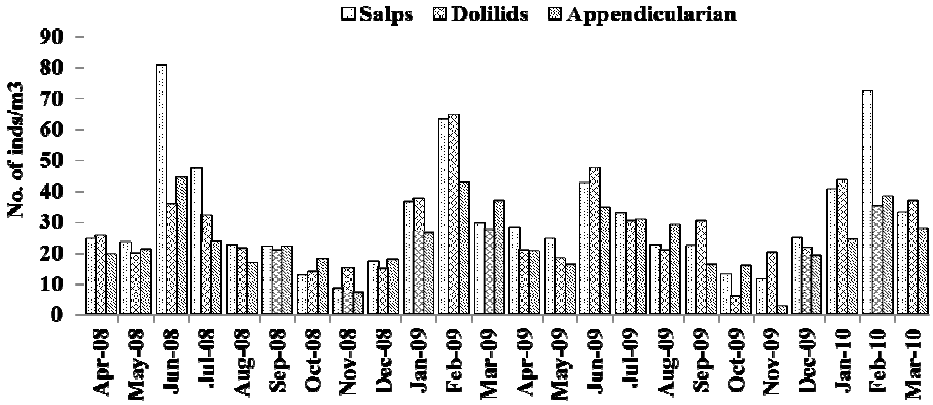
Figure 2. Monthly variation of Environmental parameters



Community structure

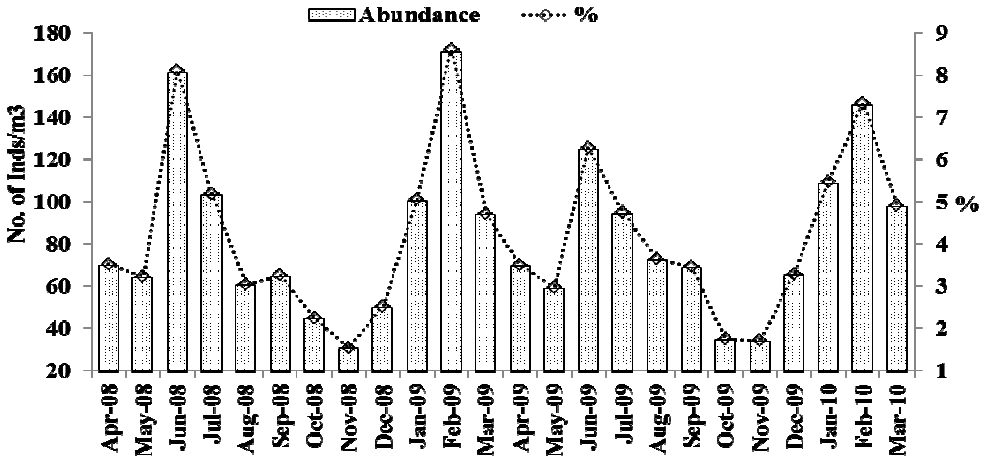
A total of fifteen species of pelagic tunicates including six species of salps, five species of doliolids and four species of appendicularians were found in the samples. The highest number of taxa was identified during January, February, March and June (more than 12), whereas during August, October and November it was less than 7 (**Figure 3**).

Figure 3. Number of taxa collected during the study periods of April 2008 to March 2010.



Population density of pelagic tunicates ranged from 30.39 to 170.93inds/m^3. Highest species density was in February 2009 and lowest in November 2008. The two peaks of pelagic tunicates abundance were observed during the study period. One of the peak (161.14inds/m^3) was during June 2008 and second peak (170.93inds/m^3) was during February 2009. The percentage composition of pelagic tunicates was ranged from 1.52 to 8.59% and in the maximum was in February 09 and minimum was in November 08 (**Figure 4**).

Figure 4. Abundance and percentage composition of pelagic tunicates



The percentage of pelagic tunicates were ranged from 28.70 to 38.09% including salps (38.09%), doliolids (33.20%) and appendicularians (28.70%) (**Figure5**). The abundance of the pelagic tunicates including salps were ranged from 8.23 to 80.79inds/m^3, doliolids from 5.78 to 64.88inds/m^3 and appendicularian from 2.54 to 44.44inds/m^3 (**Figure 6**). In the overall observation, *S. fusiformis* was the most dominated species than the *D. gegenbauri*, (**Figure 7**).

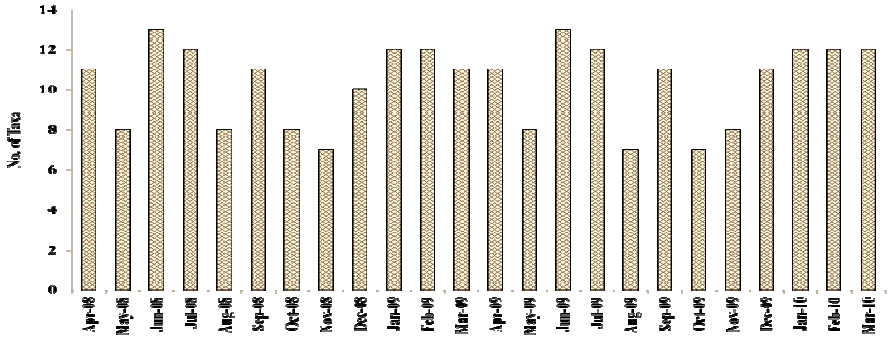


Figure 5.Abundance and percentage composition of Group of pelagic tunicates.

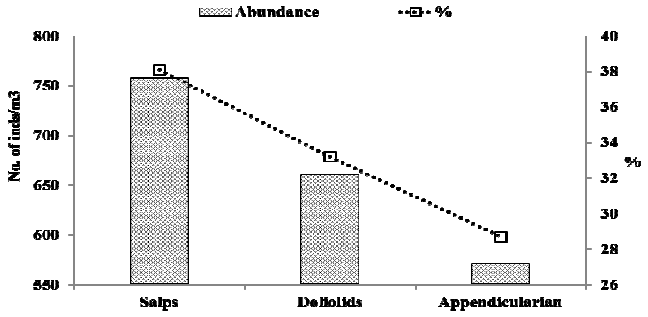


Figure 6.Monthly abundance of the salps, doliolids and appendicularians.

The diversity indices fluctuated from 1.72 to 2.39 bits/individuals and high species diversity was recorded during July 2009 at those where 12 species of pelagic tunicates with low species density (88.79inds/m^3) and the low values of species diversity were recorded in Nov-09, with 6 species and low density (41.14inds/m^3). Species evenness was ranged from 0.87 to 0.99. The highest species evenness was recorded during September 2009 and lowest during June 2009, with high taxa (7) and low density (84.93inds/m^3) of the species abundance. Species richness was observed and the range was from 0.84 to 0.918, with high richness in April 2009 and low during Nov-08 (**Figure 8**).

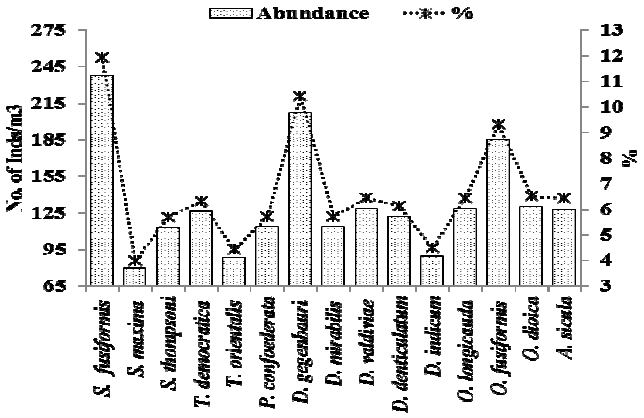


Figure 7. Species wise percentage composition of the pelagic tunicate.

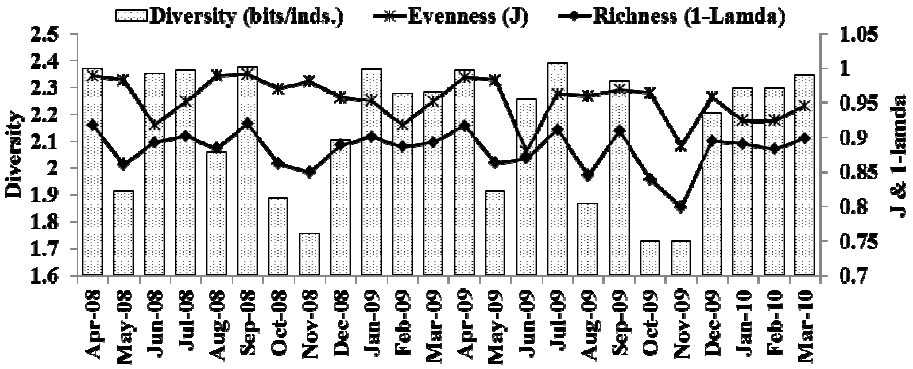


Figure 8.Diversity index of pelagic tunicate.

Correlation coefficient

Correlation analysis was clearly indicated the distribution of pelagic tunicate was highly influenced by environmental parameters (**Table 1**). Temperature was positively correlated with salinity, salps, doliolids and appendicularians at P<0.01 value. Salinity was also positively correlated with all the groups. Temperature and salinity was negatively correlated with dissolved oxygen. DO was negatively correlated with species distribution and environmental parameters.

Table 1.Correlation coefficient of environmental parameters and abundance of pelagic tunicates during the study periods

	Temperature	Salinity	DO	Salps	Doliolids	Appendicularian
Temperature	1					
Salinity	0.858	1				
DO	-0.805	-0.856	1			
Salps	0.2353	0.5993	-0.443	1		
Doliolids	0.2573	0.5520	-0.345	0.734	1	
Appendicularian	0.315	0.6571	-0.499	0.842	0.699	1

In Parangipettai coastal water, the hydrographical condition records are available for several years, but distribution data of the pelagic tunicates are very less (Krishnamurthy 1962) and he discussed only six species. Distribution of the pelagic tunicates in the Bay of Bengal and Indian Ocean are very sparse and only a few studies have been reported (Ganapati and Bhavanarayana, 1958; Bhavanarayana and Ganapati, 1971; Bhavanarayana, 1974). The present study is the first time report to describe the species composition and distribution of pelagic tunicates with influence of environmental parameters in the Parangipettai coastal waters.

The lowering of temperature observed during monsoon season was due to the general cooling of the atmosphere and strong land sea breeze and precipitation. The increase in temperature is due to the reversal of the current direction from north-south to south-north bringing in warm oceanic waters from the equatorial region of the Indian Ocean and could be attributed to high solar radiation (Das *etal*., 1997; Karuppasamy and Perumal, 2000;Govindasamy*et al*., 2000; Senthilkumar*et al*., 2002; Santhanam and Perumal, 2003; *Reddi et al*., 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 ecosystem (Kouwenbery, 1994; Chandra Mohan and Sreenivas, 1998; Balasubramanian and Kannan, 2005; and Sridhar et al., 2006) and it is also influenced by the higher temperature as is evident from the present study. The higher values of salinity (35psu) could be attributed to the low amount of rainfall, higher rate of evaporation and neritic water dominance and the decline in salinity is due to the strong south-western current bringing in large quantities of fresh water (Govindasamy*et al*., 2000; Gowda*et al*., 2001; Rajasegar, 2003).

The higher values of dissolved oxygen were recorded during monsoon season. 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*., 1997). It is well known that the temperature and salinity affect the dissolution of

oxygen (Vijayakumar*et al*., 2000; Saravanakumar*et al*., 2007). The recorded highest nutrients value during monsoon season could be mainly due to the organic materials received from the catchment area during ebb tide (Karuppasamy and Perumal, 2000;Santhanam and Perumal, 2003). Temperature and salinity is the main hydrographical parameter which could be attributed to the plankton diversity and distribution (Padmavathiand Goswami, 1996; Ramaiah and Nair, 1997).

Pelagic tunicates are ocean wide distribution and majority of these pelagic tunicates are confined to the epiplanktonic zone. Distribution of pelagic tunicates is influenced by the seasonal changes in the water movement and their associated temperature and salinity structure. The abundance of pelagic tunicates in this study was similar to previous studies (Bhavanarayana and Ganapati, 1971; Bhavanarayana, 1974) in the western part of the Bay of Bengal. The surface water temperature seems to be the only environmental factor significantly influences the distribution of pelagic tunicates (Nair and Krishna Iyer 1974).

The pelagic tunicate fauna was rich during February and June coinciding with the period of pronounced upwelling of the subsurface waters. Semi-annually reversing monsoon winds determine the pattern of surface currents which inturn affect the distribution of plankton. This reversal in the pattern of circulation may result in the shifting of the high density area of these pelagic tunicates from the head of the Bay towards the south-east part and west coast of India. Environmental factors which significantly influences the distribution of pelagic tunicates. The abundance of pelagic tunicate in the study was similar to the previous study done in the different parts of the world oceans have been made earlier workers Licandro*et al*., (2006) in the northern South China Sea and also by Tsuda&Nemoto (1992).

CONCLUSION

Our results clearly showed that the seasonally different of distribution and abundance of pelagic tunicate Most pelagic tunicate species in this study showed seasonal changes in abundance and perhaps alternation of generation during the year and speculate, based on the low pelagic tunicate abundance and chlorophyll *a* concentration in this study area, that these distribution patterns might be food-limited and reproduction related. The two peaks of pelagic tunicates abundance were observed during February (winter season) and June (Southwest monsoon season). Furthermore, significant correlations between pelagic tunicate abundance and water temperature and salinity could have been influenced by hydrographic conditions.

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