International Journal of Fisheries and Aquatic Research
ISSN: 2456-7248
Impact Factor: RJIF 5.44
www.fishjournals.com
Volume 3; Issue 2; April 2018; Page No. 35-40

Study of plankton community structure and physico-chemical parameters of Kayalpattinam coastal waters of Tuticorin coast, Southeast coast of India

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Abstract
The diversity and distribution of phytoplankton, zooplankton community structures were observed in relation to environmental parameters in the coastal waters of the Kayalpattinam coast, Southeast coast of India during February-March 2015. The physico-chemical parameters such as surface water temperature, TDS, Salinity, pH, Dissolved Oxygen, Conductivity were analyzed. The above values were 28.50±1.80ºC, 30.93±1.46 (mg/l), 34.0±0.50ppt, 8.33±0.51, 7.09±0.68 (mg/ml), 11.63±0.71 (µs/cm), respectively. A total of 11 phytoplankton species and 17 zooplankton species were recorded and a total number of populations of phytoplankton and zooplankton species recorded were 87 and 122 respectively. Among the phytoplankton, the maximum percentages were covered by *Coscinodiscus gigas* (39.08%) followed by *C.excentericus* (28.74%), *Oscillatoria* (6.9%), *Biddulphia mobilensis* (4.6%) and *Leptocylindrus danicus* (4.6%). Similarly, the zooplankton population was dominated by species such as *Copepod nauplii* (29.51%), *Oikopleuro dioica* (28.69%), *Oithona brevicornis* (9.84%) *Centrophages furgatus* (5.74%). Both qualitative and quantitative abundance of phytoplankton and zooplankton communities in this coastal ecosystem are presented and discussed.

Keywords: phytoplankton, zooplankton, water quality, Kayalpattinam coast, South east coast

Introduction
Phytoplankton are the basic stratum serving as a food for primary consumers like zooplankton, shellfish and finfish larvae (Saravanakumar *et al.,* 2008[16]; Mathivanan *et al.,* 2007 [9]; Sridhar *et al.,* 2006 [17]. Biomass and productivity of phytoplankton in different regions and zones are important factors in regulating the production of organism at higher tropic-levels. Phytoplankton species distribution shows wide spatial-temporal variations due to the differential effect of hydrographical factors on individual species and serving as good indicators of water quality and pollution (Gouda and Panigrahy, 1996) [5]. According to Saravanakumar *et al.,* (2007) [15] and Robertson and Blabber (1992) [13] tropical ecosystems are one of the most productive ecosystems with rich zooplankton population. The species diversity, richness, evenness and dominance have been determined by biological components of aquatic ecosystem which is essential to regulate the aquatic environments (Krishnamoorthy and Subramanian, 1999) [7]. Zooplankton is important food source for larval fish and shrimp in natural waters and aquaculture ponds. In many countries the failure of fisheries activities was often attributed to the reduced zooplankton population especially copepod population (Stottrup, 2000) [19]. In India, various authors have reported the species composition and seasonal variation of phytoplankton and zooplankton abundance from different regions of Indian coastal waters (Saravanakumar *et al.,* 2008 [16]; Mathivanan *et al.,* 2007 [9]; Sridhar *et al.,* 2006 [17]; Thillai Rajasekar *et al.,* 2005 [20]; Geetha Madhav and Kondalarao, 2004 [3]; Godhantaraman, 2001 [4]; Rajasegar *et al.,* 2000 [12]; Krishnamoorthy and Subramanian, 1999) [7]. Present study was done with the observation on species composition and community structure of plankton from inshore waters of Kayalpattinam coast in relation to surface water temperature, TDS, Salinity, pH, Dissolved oxygen and Conductivity. This study was first attempt in this region.

Material and Methods
Description of Study Area
Kayalpattinam coast is situated in Gulf of Mannar is a main fish landing Centre which approximately 150-200 mechanized boats are in operation daily. It is located near Tiruchendur coast of Tuticorin district. The detailed study area is given in Fig.1.The survey and sample collection were conducted during the month of February to March 2015. The entire village sewage and effluent was found to get discharged in this region (Fig 3). This station is contaminated by the fishing related activities like washing, processing of fishes and other organic items, dumping of by catch items etc. The wastages of industrial, household, hospitals, fish wastes have been discharged in addition to the dead and decaying animals. Water and plankton sampling was done from two sites marked at N 08º 35.461' E 078º 09.431' and N 08º 35.501' E 078º 09.553'. The collected water samples were analyzed by using portable water sample analyzer.

Fig 1: Map showing the study area

1a Sewage mixing in the coastal waters

1b Sewage and fishing waste discharging point

1c Fishing activities at Kayalpattinam coast

1d Plankton collection(towing of plankton net by using outboard engine boat)

Fig 2

Sample Collection and Analysis

Surface plankton sample collections were done for both qualitative and quantitative analysis of the plankton populations. The qualitative analysis of plankton was done after standard plankton net made of No.30 (mesh aperture 41 µm) bolting silk was towed for 15minutes using a mechanized boat maintaining the speed of 1 knot/hour. The quantitative analysis was done with surface plankton collections made by filtering 500 liters of seawater using a graduated bucket and hand net made of the same bolting silk cloth in all the stations of study. The collected plankton samples were analyzed in the laboratory for their species composition and biomass in terms of density. An inverted microscope was used for the observation of the species composition and density. Identification of the phytoplankton and zooplankton was done using standard keys of Santhanam *et al.,* (1987) [14]; Kasturirangan (1963) [6]. The quantitative estimation of plankton was done following the method of Srinivasan and Santhanam (1998) [18]. The plankton samples were made up to a known volume and a sub sample of 1ml was taken in a Sedgwick- Rafter counting cell which was subsequently transferred to a microscope provided with a stage for

counting. The density of phytoplankton was expressed as cells/m^3 and zooplankton densities were expressed as individuals/ m^3 of water. Two counting were made and the average was recorded for each plankton sample.

Results

The parameters such as surface water temperature, TDS, Salinity, pH, Dissolved Oxygen, Conductivity were 28.50±1.80ºC, 30.93±1.46 (mg/l), 34.0±0.50ppt, 8.33±0.51, 7.09±0.68 (mg/ml), 11.63±0.71 (µs/cm) respectively (Fig.3). A total of 11 phytoplankton species and 17 zooplankton species were recorded (Table 1). The phytoplankton species were *Biddulphia mobilensis*, *Biddulphia sinensis*, *Coscinodiscus excentericus*, *Coscinodiscus gigas*, *Leptocylindrus danicus*, *Rhizosolenia* sp, *Navicula* sp, *Pleurosigma angulatum*, *Climascophenia elongate*, Peridinium depressum and *Oscillatoria* sp. In the samples of phytoplankton, the dominance was observed to be by *Coscinodiscus gigas* 39.08%, followed by *Coscinodiscus excentericus* (28.74%), *Oscillatoria* sp (6.9%), *Biddulphia mobilensis* (4.6%), *Leptocylindrus danicus* (4.6%). Similarly, in the zooplankton samples *Copepod nauplii* (29.51%), *Oikopleuro dioica* (28.69%), *Oithona brevicornis* (9.84%) *Centrophages furgatus* (5.74%) were recorded (Fig.4).The phytoplankton groups such as Bacillariophyceae, Dinophyceae and Cyanophyceae were evaluated as percentage composition is the population and among this, the dominant phytoplankton group was Bacillariophyceae (81.6%) followed by Dinophyceae (11.5%) and least was Cyanophyceae (6.9%) (Fig.5, Table.1). The zooplankton species were *Favella philippensis*, *Tintinnopsis cylindica*, *Globigerina* sp, *Acartia danae*, *Centrophagus furgatus*, *Microsetella rosea*, *Oithona brevicornis*, *Chaetognatha*, *Sagitta* sp, *Oikopleuro dioica*, *Balanus nauplius*, *Bivalve veliger*, *Cirripede nauplii*, *Copepod nauplius*, Fish egg, Gastropod veliger, *Lepas nauplius* and Polychaete larvae. In zooplankton samples, *Copepod nauplius* (29.51%), *Oikopleuro dioica* (28.69%), *Oithona brevicornis* (9.84%) and *Centrophagus furgatus* (5.74%) were present. Bivalve and gastropod veliger were found to be 4.10%, *Favella philippensis*, *Globigerina* sp and *Sagitta* sp were present up to 2.46%. *Tintinnopsis cylindica*, *Microsetella rosea*, *Cirripede nauplii*, Fish egg and Polychaete larvae were present upto 1.64%. *Acartia danae*, *Balanus nauplius* and *Lepas nauplius* were present upto 0.84%. (Fig.6, Table.2). The dominant zooplankton group was meroplankton (44.25%), second dominant was chordate (28.69%) and followed by copepod (18.04%), tintinnida (4.1%) and 2.46% was covered by foraminifera and chaetognatha. (Fig.7). The phytoplankton density was 87000 cells/m^3 and zooplankton density was 122000 individuals/m^3. The percentage contribution of each group of phyto and zooplankton was in the order as given below:

Phytoplankton: *Bacillariophyceae* > *Dinophyceae* > *Cyanophyceae*;

Zooplankton: *Meroplankton* > *Chordata* > *Copepod* > *Tintinnida* > *Chaetognatha* > *Foraminifera*.

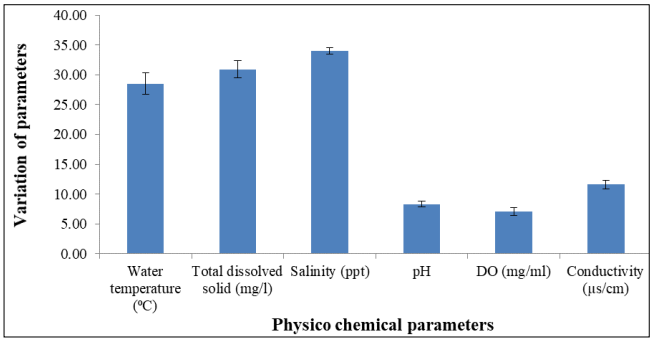

Fig 3: Physico- chemical parameters of Kayalpattinam coast.

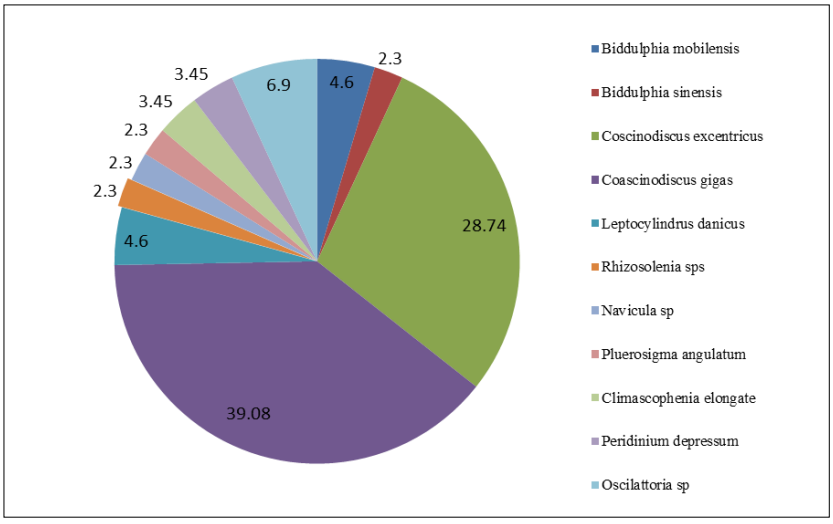

Fig 4: Percentage composition of phytoplankton species at Kayalpattinam coast

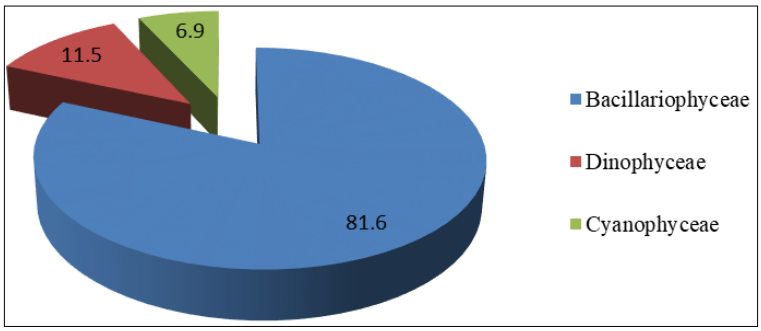

Fig 5: Percentage compositions of Phytoplankton groups

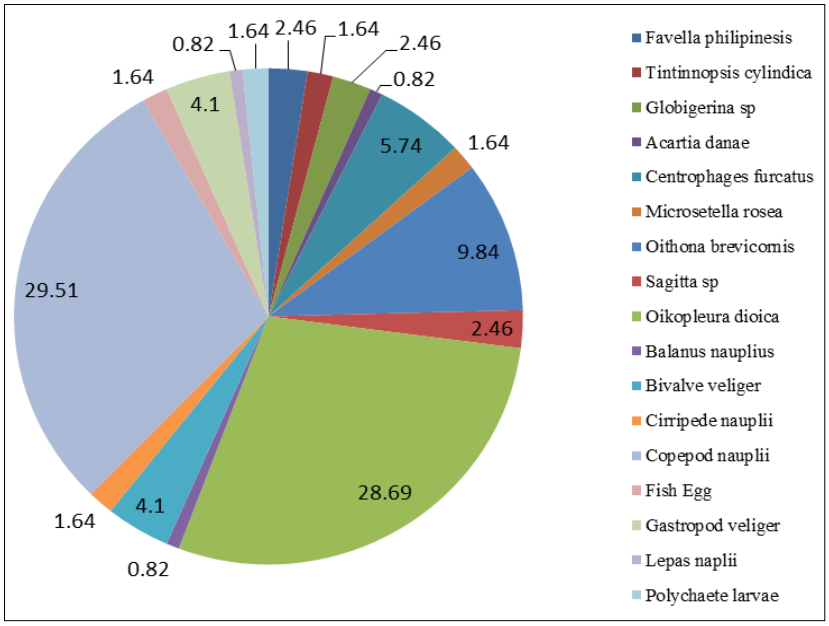

Fig 6: Percentage composition of Zooplankton species at Kayalpattinam coast

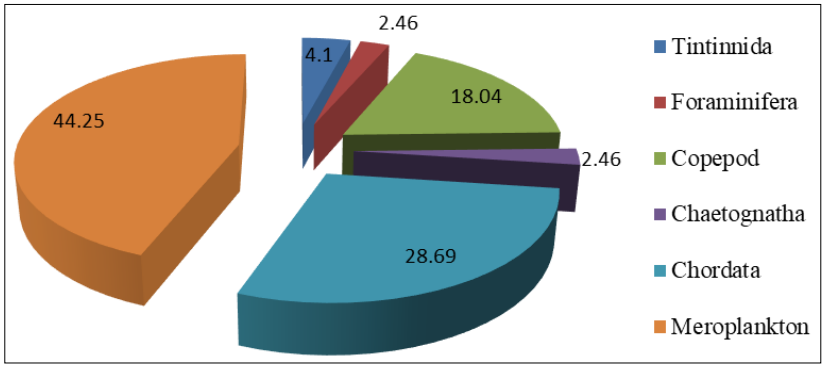

Fig 6: Percentage composition of Zooplankton groups

Table 1: Distribution and abundance of Phytoplankton species in Kayalpattinam Coast

Sl. No	Phytoplankton species	Abundance	Total no. of. Individual species	Percentage of individual species
	Centrales			
1.	*Biddulphia mobilensis*	+	4	4.60
2.	*Biddulphia sinensis*	+	2	2.30
3.	*Coscinodiscus excentricus*	+	25	28.74
4.	*Coascinodiscus gigas*	+	34	39.08
5.	*Leptocylindrus danicus*	+	4	4.60
6.	*Rhizosolenia* sp	+	2	2.30
	Pennales			

7.	*Navicula* sp	+	2	2.30
8.	*Pluerosigma angulatum*	+	2	2.30
9.	*Climascophenia elongate*	+	3	3.45
10.	*Peridinium depressum*	+	3	3.45
	Cyanophyceae			
11.	*Oscilattoria* sp	+	6	6.90
Number of species appeared		11	87	100

Table 2: Distribution and abundance of Zooplankton species in Kayalpattinam Coast

Sl.No.	Zooplankton Name	Abundance	Total No. of. Individual species	Percentage of Individual species
	Tintinnida			
1.	*Favella philipinesis*	+	3	2.46
2.	*Tintinnopsis cylindica*	+	2	1.64
	Foramnifera			
3.	*Globigerina* sp	+	3	2.46
	Copepod			
4.	*Acartia danae*	+	1	0.82
5.	*Centrophages furcatus*	+	7	5.74
6.	*Microsetella rosea*	+	2	1.64
7.	*Oithona brevicornis*	+	12	9.84
	Chaetognatha			
8.	*Sagitta* sp	+	3	2.46
	Chordata			
9.	*Oikopleura dioica*	+	35	28.69
	Meroplankton			
10.	*Balanus nauplius*	+	1	0.82
11.	*Bivalve veliger*	+	5	4.10
12.	*Cirripede nauplii*	+	2	1.64
13.	*Copepod nauplii*	+	36	29.51
14.	Fish Egg	+	2	1.64
15.	*Gastropod veliger*	+	5	4.10
16.	*Lepas nauplii*	+	1	0.82
17.	*Polychaete larvae*	+	2	1.64
Number of species appeared		17	122	100

Discussion

Plankton density and species composition are largely depending on the basic water quality parameters. The salinity acts as a determining factor in the distribution of living organisms, and its variation caused by dilution and evaporation which influence the fauna of the intertidal zone. Sridhar *et al.,* (2006) [17].The relationship of water parameters is indicated through the high population of zooplankton compared to phytoplankton species. Generally, fluctuations in pH values during different seasons of the year are attributed to factors like removal of CO_2 by photosynthesis through bi-carbonate degradation, dilution of seawater by freshwater influx, reduction of salinity and temperature and decomposition of organic matter. During this preliminary study, surface water temperature, salinity, pH and dissolved oxygen were found to be limiting factors in the distribution of zooplankton populations. Compared to phytoplankton, the zooplankton species were dominant due to their intake feeding an phytoplankton populations. Similar observation was type of study was carried out for the zooplankton and phytoplankton species by Achuthankutty *et al.,* (1980) [1]. A similar to the present observation, copepod contribution of 79.6%, and 87.2% to the total zooplankton population was observed by Gagbhiye *et al.,* (1991) [2] from Bombay coastal waters, Varghese and Krishnan (2009) [21] from Cochin backwaters, Kerala and Padmavati *et al.,* (2008) [11] from Bay of Bengal. Copepods were the only single and most dominant group occurring throughout the study period. The dominance of copepods among the zooplankton groups was recorded by several researchers (Nair and Azis, 1987 [10]; Madhu *et al.*, 2007) [8]. Since copepods are dominant they can tolerate wide fluctuations in environmental conditions and breed throughout the year. A similar observation was also made by Srinivasan and Santhanam (1998) [18] and recorded a total of 12 species of copepods in sewage polluted waters along Tuticorin coast. Meroplanktonic organisms such as *Balanus nauplii*, *bivalve veliger*, *cirripede nauplii*, crab zoea, fish egg, fish larvae, gastropod veliger, nauplius of *Acetes indicus*, Polychaete larvae and prawn mysis were also recorded in the domestic and fisheries waste discharge towards coastal waters of Kayalpattinam coast.

Conclusion

The present study also reflects the impacts of domestic and fisheries wastes on the plankton species. This study also suggested that meroplankton, chordata and copepod groups could be dominant due to the availability of fisheries wastes as food sources. Phytoplankton were lowest category due to the high level of contamination occurred in the sea water. Phytoplankton species mainly decreased by lesser

photosynthetic activity due to seawater contamination. The continuous monitoring is important for the sustainable plankton population in the polluted marine environments.

Acknowledgements
The authors are grateful to the Department of Marine Science, Bharathidasan University, Tiruchirapalli and Directorate of Sustainable Aquaculture, Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Soorakkottai, Thanjavur for providing facilities and encouragement.

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