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Seasonal Variation of Physico-Chemical Characteristics in Point Calimere Coastal Waters (South East Coast of India)

P. Damotharan, N. Vengadesh Perumal, M. Arumugam, S. Vijayalakshmi and T. Balasubramanian

CAS in Marine Biology, Annamalai University, Parangipettai-608 502, India

Abstract: The results of an investigation carried out during September 2006 to August 2007 on hydrography. The present study was attempted on the physic chemical variability of the Kodiakkarai (Point Calimere) (Southeast coast of India) is reported. Air and surface water temperatures varied from 23.5 to 28.2°C and from 24 to 29.5°C respectively. Salinity values varied from 26 to 35‰ and the pH ranged between 7.8 and 8.3. Variation in dissolved oxygen content was from 3.15 to 5.24 ml/l. The ranges of inorganic nutrients (µM) viz. nitrate, nitrite, phosphate, silicate and ammonia were: 3.54-7.05; 0.28-0.98; 0.26-2.82; 19.96-53.39 and 0.02-0.85 respectively. Distribution of nutrients has exhibited considerable seasonal and spatial variation.

Key words: Physico-chemical · Temperature · Salinity · pH · Dissolved oxygen in Kodiakkarai

INTRODUCTION

The rapid industrialrialization and aquaculture practices along the river system and the coastal areas have brought considerable decline in the water quality of brackish waters and the estuaries. Coastal zones and estuaries impartment ecological systems and resource for a verity of uses. Such areas are subjected to variety of socio-economic drivers. Producing increased pressures and impact, this can lead to environmental stress or even affect public health [1-3]. With the sudden increase of population and rapid economic development, these areas are facing many ecological problems. Such problems have been assigned mostly to an excess of nutrient, associated with industrial and municipal wastewater [4] forestry and agriculture [5]. The subsenguent increase in nutrient loads produces an ecological impact over biological communities [6] associated mostly with eutrophication processes [7, 8]

The hydrobiological study is a pre-requisite in any aquatic system for the assessment of its potentialities and to understand the realities between its different trophic levels and food webs. Further, the environmental condition such as topography, water movement, salinity, oxygen, temperature and nutrient characterizing particular water mass also determine the composition of its biota. Thus, the nature and distribution of the physical and chemical characteristics of the water body. In Indian estuaries and seas the physical-chemical characteristics had been carried out by many workers [9-12].

The present study discusses spatial distribution of water column temperature, salinity, dissolved oxygen, surface nutrient (silicate and nitrate) and pH in the Indian Ocean sector of the southern ocean. Attempt has also been made to identify the signature of the various mechanisms of nutrient transport and its relation to the water column characteristics of the southwestern Indian Ocean. The possible influence, if any, of waters conman characteristics on the plankton foraminiferal abundance is also explored.

MATERIALS AND METHODS

Surface water samples were collected at monthly interval from the stations 1 and 2 for a period of one year from September 2006 to August 2007, for the estimation of various physico-chemical parameters.

Rainfall data were obtained from the meteorological unit (Govt. of India.) located at Vedaranyam. Temperature was measured using a standard centigrade thermometer. Salinity was estimated

Corresponding Author: P. Damotharan, CAS in Marine Biology Annamalai University, Parangipettai-608 502, India.
E-mail: damotharanp@gmail.com.

with the help of a refractometer (Atago, Japan) and pH was measured using ELICO Grip pH meter. Dissolved oxygen was estimated by the modified Winkler's method [13] and is expressed as ml/l.

For the analysis of nutrients, surface water samples were collected in clean polyethylene bottles, kept immediately in an icebox and transported to the laboratory. The collected water samples were filtered by using a Millipore filtering system and analysed for dissolved inorganic nitrate, nitrite, phosphate and reactive silicate adopting the standard procedures described by [13] and are expressed in µM.

RESULTS

Monthly variations in meteorological and physico-chemical parameters viz. rainfall, air and surface temperature, salinity, pH, dissolved oxygen, inorganic phosphate, nitrite, reactive silicate and ammonia in waters were recorded for a period of one year from September 2006 to August 2007.

Rainfall: Total rainfall of 2026 mm was recorded from September, 2006 to August, 2007. Monthly rainfall (mm) varied from 15.75 to 746.75 during the study period. No rainfall was recorded during the months of January and March. The maximum rainfall (746.75 mm) was recorded during the north-east monsoon (November 2006) and minimum (15.75) during the month of June, 2007 (Fig. 2).

Temperature: During the study period air temperature varied from 23.5°C to 28.2°C.The minimum was recorded during monsoon season (December, 2006) at station 2 and maximum during the summer season (May, 2007) at station 1 In general, the station showed similar seasonal changes. (Fig. 4). The surface water temperatures varied from 24°C to 29.5°C, The minimum surface water temperature was recorded during monsoon season (December, 2006) at station 2 and maximum was recorded during the summer season (May, 2007) at station 1(Fig. 3). In general, all the station showed similar seasonal changes.

Salinity, Ph and Dissolved Oxygen: Salinity range was varied from 26 to 35 respectively. The two stations showed similar seasonal pattern in salinity distribution and registering low salinity the minimum salinity (26) during the monsoon season in station 1.

Fig. 1: Map showing the study area

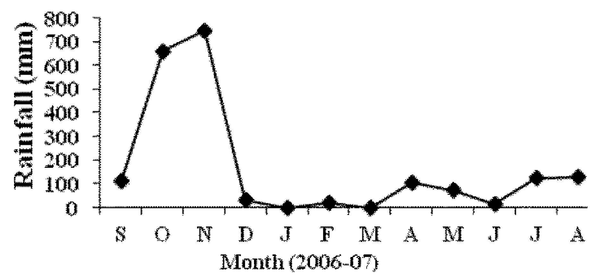

Fig. 2: Rainfall recorded during 2006 to 2007 in the study area

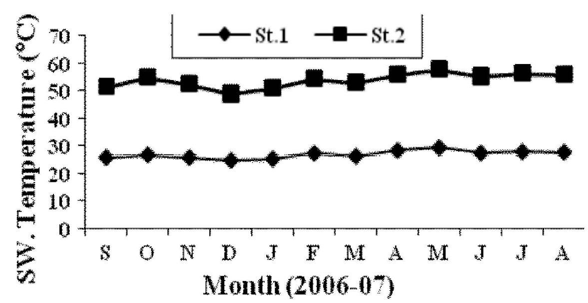

Fig. 3: Seasonal changes in surface water temperature during 2006 to 2007 at stations 1 and 2

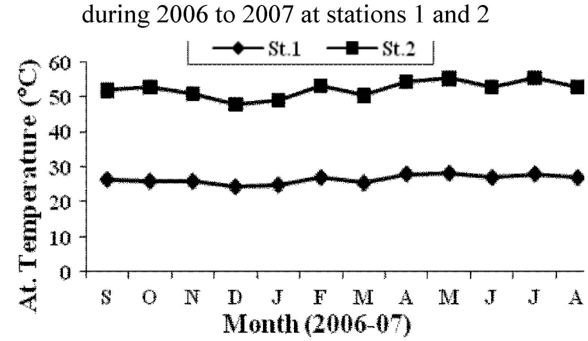

Fig. 4: Seasonal variation in atmospheric temperature during 2006 to 2007 at stations 1 and 2

The maximum salinity (35) was observed during the summer season station 2. (Fig.5). seasonal fluctuations in the pH of the water varied from 7.8 to 8.3 the minimum

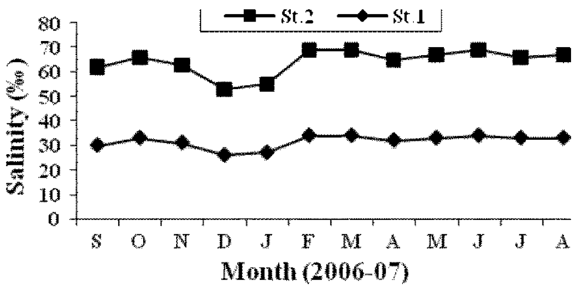

Fig. 5: Seasonal changes in salinity during 2006 to 2007 at stations 1 and 2

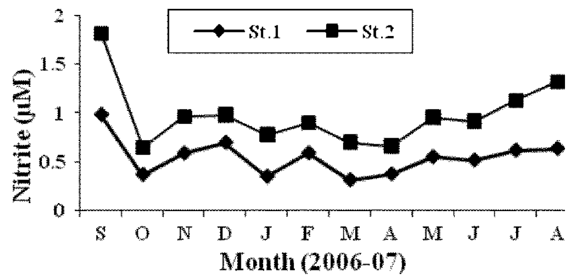

Fig. 8: Seasonal changes nitrite during 2006 to 2007 at stations 1 and 2

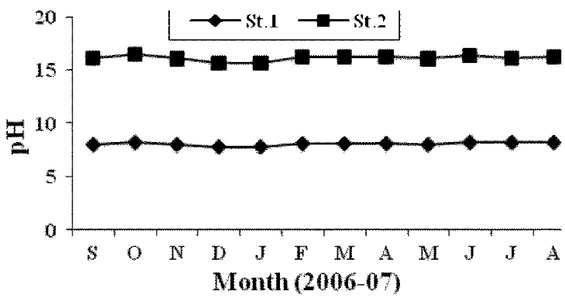

Fig. 6: Seasonal changes in pH during 2006 to 2007 at stations 1 and 2

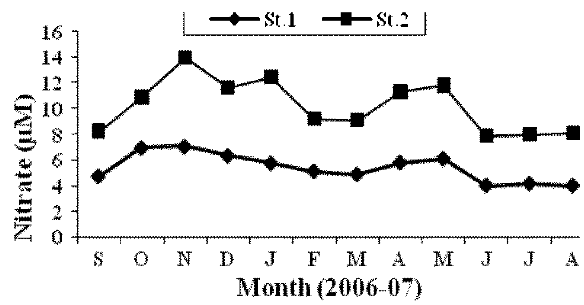

Fig. 9: Seasonal changes in nitrate during 2006 to 2007 at stations 1 and 2

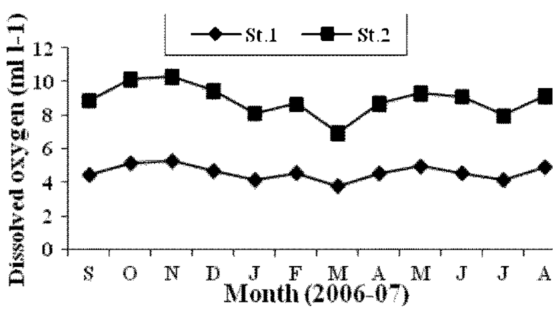

Fig. 7: Seasonal changes in dissolved oxygen during 2006 to 2007 at stations 1 and 2

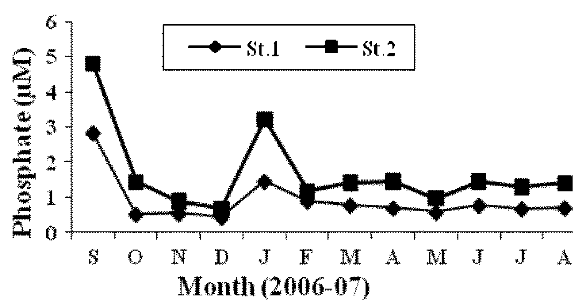

Fig. 10: Seasonal changes phosphate during 2006 to 2007 at stations 1 and 2

pH (7.8) during the monsoon seasons in station 1. The maximum pH (8.3) was observed during the summer season 2. pH followed the trend similar to that of salinity (Fig. 6). Dissolved oxygen concentration was varied from 3.15to 5.24 mg/l respectively. The minimum value was recorded during the summer season station2 and the maximum values during monsoon season at station 1 (Fig. 7).

Nitrite, Silicate, Inorganic Phosphate and Ammonia: The nitrite concentration was varied from 0.28 to 0.98 µM respectively. The minimum nitrite values were recorded during the monsoon season in station 2 and the maximum values were recorded during pre monsoon season at the stations 2 (Fig.8). The recorded highest nitrate value during monsoon season. The recorded highest nitrates value (7.05µM) during monsoon season could be mainly due to the organic materials received from the catchment area during ebb tide. The increased nitrates level was due to fresh water inflow and terrestrial run-off during the monsoon season. Another possible way of nitrates entry is through oxidation of ammonia form of nitrogen to nitrite formation. The recorded low values (3.54µM) during non-monsoon period (Fig. 9). Silicate values was ranged from 19.96 to 53.32 µM concentration it also shows the similar trend like nitrite minimum was recorded during summer in station 1. And the maximum values were recorded during monsoon season at stations 2 (Fig.11). Inorganic phosphate concentration was varied from 0.2 to 2.8 µM Minimum value was recorded during the monsoon season

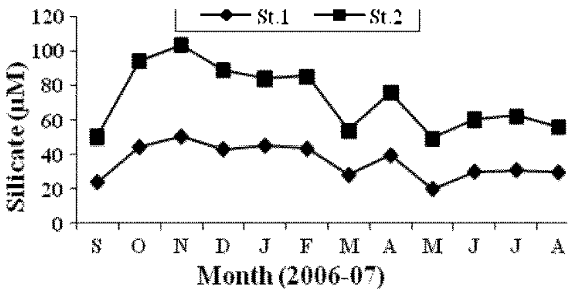

Fig. 11: Seasonal changes in silicate during 2006 to 2007 at stations 1 and 2

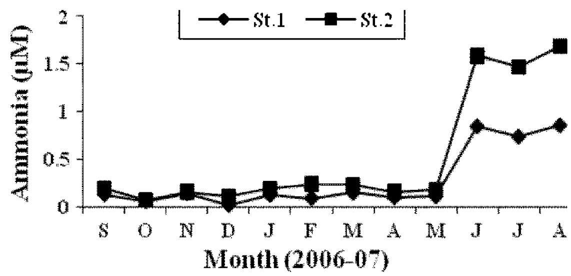

Fig. 12: Seasonal variation in ammonia during 2006 to 2007 at stations 1 and 2

and the maximum value during pre monsoon season at both stations (Fig. 10). Ammonia level was varied from 0.016 to 85 μM. The minimum values were recorded during the monsoon season station and the maximum values during the pre monsoon season at the both stations (Fig. 11).

DISCUSSION

The physic-chemical variable of the present study areas are subjected to wide spatial temporal variation. Rainfall is the most important cyclic phenomenon in tropical countries as it brings important changes in the hydrographical characteristics of the marine and estuarine environments. In the present study, the peak values of rainfall were recorded during the monsoon month of November. The rainfall in India is largely influenced by two monsoons viz. southwest monsoon on the west coast, northern and northeastern India and by the northeast monsoon on the southeast coast [14]. On the other hand tidal rhythm, water current and evaporation in summer produced only little variation in those parameters or mostly stable in the absence of rainfall. [15] Have also reported the occurrence of bulk of rainfall during northeast monsoon season along the southeast coast of India.

The surface water temperature showed an increasing trend from December to May. 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 December was low because of strong land sea breeze and precipitation and the recorded high summer value could be attributed to high solar radiation [8, 16, 17]. The observed spatial variation in temperature could be due to the viable intensity of prevailing streams and the resulting mixing of water [19]. Statistical analysis showed a positive correlation (r=0.925 at station 1 and r=0.914 at station 2) between air and surface water temperatures for both stations.

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 faunal distribution of the coastal ecosystems [20]. Presently, wide salinity variations were observed between two stations and during different seasons. Generally, changes in the salinity in the brackishwater habitats such as estuaries, backwaters and mangroves are due to the influx of freshwater from land run off, caused by monsoon or by tidal variations. This is presently evidenced by the positive correlation (r=-0.075 at station 1 and r=-0.009 at station 2) obtained between salinity and rainfall. Further, salinity is also influenced by the higher temperature as is evident from the obtained significant positive correlation with temperature. The salinity was found to be high during summer season and low during the monsoon season at both the stations. The recorded higher values 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 [10, 12]. During the monsoon season, the rainfall and the freshwater inflow from the land in turn moderately reduced the salinity, as reported by [21] in the Bay of Bengal and coastal waters of Kalpakkam by [11].

Hydrogen ion concentration (pH) in surface waters remained alkaline throughout the study period at all the stations with maximum value during the monsoon season and the minimum during monsoon and post monsoon seasons. Generally, fluctuations in pH values during different seasons of the year 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 besides decomposition of organic materials as stated by [12]. The recorded high summer pH might be due to the influence of seawater penetration and high biological activity [16] and due to the occurrence of high photosynthetic activity [22].

It is well known that the temperature and salinity affect the dissolution of oxygen [23]. In the present investigation, higher values of dissolved oxygen were recorded during monsoon months at all the stations. Season-wise observation of dissolved oxygen showed an inverse trend against temperature and salinity. 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 [16, 21].

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. The recorded highest nitrate value during monsoon season could be mainly due to the organic materials received from the catchment areas during ebb tide [16]. The increased nitrates level was due to fresh water inflow and terrestrial run-off during the monsoon season [18]. Another possible way of nitrates entry is through oxidation of ammonia form of nitrogen to nitrite formation [12]. The recorded low values during non-monsoon period 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 [16, 17, 24].

The recorded higher nitrite values during pre monsoon season could be due to the increased planktonic organisms 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 [17]. Further, the denitrification and air-sea interaction exchange of chemicals are also responsible for this increased value [25]. The recorded low nitrite value during monsoon season may be due to less freshwater inflow and high salinity [26].

The recorded high concentration of inorganic phosphates during pre monsoon season might possibly be due to intrusion of upwelling seawater into the creek, which in turn increased the level of phosphate [27]. Further, regeneration and release of total phosphorus from bottom mud into the water column by turbulence and mixing is also attributed to the recorded higher monsoonal values [25]. The recorded low monsoonal phosphate values could be attributed to the high utilization of phosphate by phytoplankton [12]. The variation may also be due to the processes like adsorption and desorption of phosphate and buffering action of sediment under varying environmental conditions [17]. Moreover, the weatherings of rocks soluble alkali metal phosphate, the bulk of which are carried into the estuaries are also responsible for the recorded higher values [10].

The silicate content was higher than the other nutrients (NO_3, NO_2 and PO_4) and the recorded high monsoonal values may be due to heavy inflow of monsoonal freshwater 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 [12, 29. The dissolution of particulate silicon carried by the river, the removal of soluble silicates by adsorption and co-precipitation of soluble silicon with humic compounds and iron [12] are some of the processes which might have caused the depletion of silicate during summer season. The recorded low summer values could also be attributed to uptake of silicates by phytoplankton for their biological activity [30, 31].

Higher concentration of ammonia was observed during the pre-monsoon season in both the stations. Lower concentration of ammonia was observed during the monsoon season in both stations. The recorded higher concentration could be partially due to the death and subsequent decomposition of phytoplankton and also due to the excretion of ammonia by planktonic organisms as opined [32].

CONCLUSION

The physico-chemical status of the coastal waters of the point Calimere, using this methodology, is good in general.

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REFERENCES

1. Cave, R., R.L. Ledoux, K.T. Jickells, J.E. Andrews and H. Davies, 2003. The Humber catchment and its Costal areas: From UK to European Perspectives. Sci. Total Environ, 314-316: 31-52.

2. Belzunce, M.J., O. Solaun, V. Valencia and V. Perez, 2004. Contaminants in Estuarine and Coastal waters. In: Oceanography and Marine Environment of the Basque Country, Borja, A. and M. Collins (Eds). Elsevier Oceanography series, Vol. 70. Amsterdam, pp: 33-51.
3. Sundaramanickam. A., T. Sivakumar, R. Kumaran, V. Ammaiappan and R. Velappan, 2008. A Comparative study of Physico- Chemical Investigation Along parangipettai and Cuddalure Coast. J. Envi. Sci. and Technol., 1(1): 1-10.
4. Balls, P.W., 1992. Nutrient behavior in two contrasting Scottish estuaries, The Forth and Tay. Oceanol. Acta, 15: 261-277.
5. Bell, P.R.F., 1991. Status of eutrophication in the great Barrier Reef Lagoon. Pollut. Bull., 23: 89-93.
6. Karlson, K., R. Rosenberg and E. Bonsdorff, 2002. Temporal and spatial large-scale effects of eutrophication and oxygen deficiency on benthic fauna in Scandinavian and Baltic waters. A review. Oceanogr. Mar. Bio. Ann. Rew., 40: 427-489
7. Wang, P.F., J. Martin and G. Morrison, 1999. Water quality and eutrophication un Tampa Bay, Florida. East. Coast. Shelf. Sci., 49: 1-20.
8. Hanninen, J., I. Vuorinen, H. Helminen, T. Kirkkala and Lehtila, 2000. Trends and gradients in nutrient concentrations and loading in the archipielago sea, Northern Baltic, in 1997. East. Coast. Shelf Sci., 50: 153-171.
9. Ramaraju, V.S., V.V. Sarma, T.V. Narasimha Rao and Vijayakumar, 1987. Variation of physic-chemical characteristics with tide in Visakhapatnam harbor waters, East coast of India. Indian J. Mar. Sci., 16: 218-222.
10. Gowda, G., T.R.C. Gupta, K.M. Rajesh, H. Gowda, C. Lingadhal and A.M. Ramesh, 2001. Seasonal distribution of phytoplankton in Nethravathi estuary, Mangalore. J. mar. biol. Ass. India, 43(1and2): 31-40.
11. Satpathy, K.K., 1996. Seasonal distribution of nutrients in the coastal waters of Kalpakkam, East coast of India. Indian J. Mar. Sci., 25: 221-224.
12. Rajasegar, M., 2003. Physico-chemical characteristics of the Vellar estuary in relation to shrimp farming. J. Environ. Biol., 24(1): 95-101.
13. Strickland, J.D.H. and T.R. Parsons, 1972. A practical hand book of seawater analysis. Bull. Krish. Res. Bd. Canada, pp: 167: 310
14. Perumal. P., 1993. The influence of meteorological phenomena on the ecosystems of a tropical region, Southeast coast of India. A case study. Ciencias Marinas, 19(3): 343-351.
15. Maruthanayagam, C. and P. Subramanian, 1999. Biochemical variation of zooplankton population. J. Mar. Biol. Ass. India, 41(1and2): 111-115.
16. Das, J., S.N. Das and R.K. Sahoo, 1997. Semidiurnal variation of some physico-chemical parameters in the Mahanadi estuary, East coast of India. Indian J. Mar. Sci., 26: 323-326.
17. Govindasamy, C., L. Kannan and Jayapaul Azariah, 2000. Seasonal variation in physico-chemical properties and primary production in the coastal water biotopes of Coromandel Coast, India. J. Environ. Biol., 21(1): 1-7.
18. Santhanam, P. and P. Perumal, 2003. Diversity of zooplankton in Parangipettai coastal waters, Southeast coast of India. J. mar. biol. Ass. India, 45(2): 144-151.
19. Reddi, K.R., N. Jayaraju, I. Suriyakumar and K. Sreenivas, 1993. Tidal fluctuation in relation to certain physico-chemical parameters in Swarnamukhi river estuary, East coast of India. Indian J. Mar. Sci., 22: 232-234.
20. Chandramohan, P. and N. Sreenivas, 1998. Diel variations in zooplankton populations in mangrove ecosystem at Gaderu canal, Southeast coast of India. Indian J. Mar. Sci., 27: 486-488.
21. Mitra, A., K.C. Patra and R.C. Panigrahy, 1990. Seasonal variations of some hydrographical parameters in a tidal creek opening in to the Bay of Bengal. Mahasagar-Bull. Natl. Inst. Oceanogr., 23(1): 55-62.
22. Subramanian, B. and A. Mahadevan, 1999. Seasonal and diurnal variations of hydro biological characters of coastal waters of Chennai (Madras) Bay of Bengal. Indian J. Mar. Sci., 28: 429-433.
23. Vijayakumar, S., K.M. Rajan, R. Mridula Mendon and Hariharan, 2000. Seasonal distribution and behaviuor of nutrients with reference to tidal rhythm in the Mulki estuary, coast of India Southwest. J. Mar. Boil. Ass. India, 42: 21-23.
24. Rajashree Gouda and R.C. Panigrahy, 1996. Ecology of phytoplankton in coastal waters off Gopalpur, East coast of India. Indian J. Mar. Sci., 2: 13-18.
25. Choudhury, S.B. and R.C. Panigrahy, 1991. Seasonal distribution and behaviour of nutrients in the creek and coastal waters of Gopalpur, East coast of India. Mahasagar-Bull. Natl. Inst. Oceanogr., 24(2): 81-88.

26. Murugan, A. and K. Ayyakannu, 1991. Ecology of Uppanar backwaters, Cuddalore. II. nutrients. Mahasagar-Bull. Natl. Inst. Oceanogr., 24(2): 103-108.
27. Nair R. Vijayalakshmi, Asha Jyothi Krishnamurthy and S.N. Gajbhiye, 1999. Tropic structure and levels of selected metals in the zooplankton community of Thane-Bassein creek, Bombay. Indian J. Mar. Sci., 28: 173-183.
28. Chandran, R. and K. Ramamoorthi, 1984. Hydrobiological studies in the gradient zone of the Vellar estuary. I. Physico-chemical parameters. Mahasagar-Bulletin of the National Institute of Oceanog., 17: 69-78.
29. Govindasamy, C. and L. Kannan, 1996. Ecology of rotifers of Pichavaram mangroves, Southeast coast of India. Indian Hydrobiol., 1: 69-76.
30. Sujatha Mishra, D. Panda and R.C. Panigrahy, 1993. Physico-chemical characteristics of the Bahuda estuary (Orissa), East coast of India. Indian J. Mar. Sci., 22: 75-77.
31. Ramakrishnan, R.P. Perumal and P. Santhanam, 1999. Spatio-temporal variations of hydrographical features in the Pichavaram mangroves and Mohi aqua farm, Southeast coast of India. Intl. Sem. Appl. Hydrogeochem, Annamalai University, India, pp: 197-203.
32. Segar, K. and V. Hariharan. 1989. Seasonal distribution of nitrate, nitrite, ammonia and plankton in effluent discharge area of Mangalore, West coast of India. Indian J. Mar. Sci., 18: 170-173.