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Physico-chemical parameters and Ichthyofauna diversity of Arasalar Estuary in Southeast coast of India

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Physico-chemical changes may have the tendency to accumulate in the various organs of estuarine organisms, especially fish which may in turn enter into the human metabolism through consumption causing serious hazards. Hence, the present study was carried out to determine the physic-chemical characteristics of water and Ichthyofauna in Arasalar Estuary in Southeast coast of India for the period of one year from September 2012 to August 2013. The environmental parameters such as, temperature, pH, salinity, dissolved oxygen (DO), silicate, nitrate and phosphate were observed at the Department of Zoology, Rajah Serfoji Government College, Thanjavur, Tamil Nadu, India. During the period of study, air temperature varied from 28.8 to 35°C. The surface water temperature also varied from 25 to 31.5°C. The monthly mean values of hydrogen ion concentration of water varied from 7.1 to 8.2. The salinity of water varied from 5.5 to 34%. Dissolved oxygen in Arasalar estuary varied from 3.5 to 7.2 mg/l. The total phosphorus varied from 0.29 to 2.15 µg/l. The nitrate varied from 0.47 to 3.75 µg/l. The silicate content varied from 28.25 to 198.74 µg/l. Totally, 866 fishes were collected belonging to 4 orders and 5 families. *Mystusgulio* was found to be the dominant species (25.40%) in the study area.

Key words: Arasalar estuary, physico-chemical parameters, ichthyofauna diversity.

INTRODUCTION

Estuaries have very high potential for fishery development in the wild, therefore, are considered as the potential source for feeding, spawning and nursery ground for most of the finfishes and shellfishes. The faunal distribution and productivity of estuary depend on various physico-chemical factors such as temperature, pH, salinity, DO and micro nutrients such as nitrate, phosphate and silicate. Several investigations have been carried out on the physico-chemical features of southeast Indian estuaries and Uppanar estuary (Nedumaran et al., 2011). The fluctuation of physico-chemical characters in estuarine environment has a profound influence on the occurrence of the juveniles of fish stocks. The fish communities of the Australian estuary have been investigated (Loneragon et al., 1986; Blaber et al., 1989; Morton, 1989; Moyle et al., 1986). The Arasalar Estuary is located on

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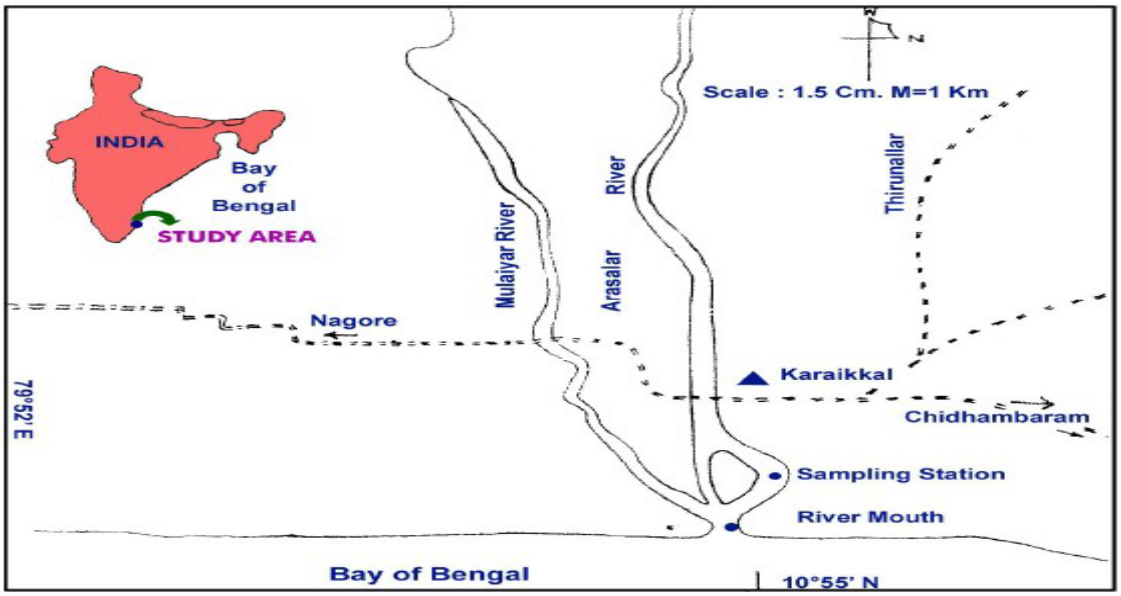

Figure 1. Study area map.

eastern side, 100 km away from Rajah Serfoji Government College, Thanjavur, Tamil Nadu, India. It is assumed that the combination of anthropogenic activities and the discharge of domestic sewage into the estuary might influence the biodiversity of the estuarine system. The water quality and biological diversity of this estuarine area are deteriorating, mainly due to rapid increase in human settlement, industrialization and sanitation (Ragothaman and Patil, 1995). Few work has been published on the physico-chemical characteristics in relation to ichthyofaunal diversity in Arasalar Estuary, hence the present study was conducted to study the physico-chemical parameters and distribution of ichthyofauna in the Arasalar Estuary, southeast coast of India.

MATERIALS AND METHODS

Study area

Arasalar Estuary is situated at Karaikal (Lat. 10° 55'; N and Long.79° 52'E) of the Bay of Bengal, southeast coast of India (Figure 1). In the present investigation, monthly samplings were carried out from September 2012 to August 2013.

Analysis of physico-chemical parameters

Water and air temperature was measured using a standard Celsius thermometer with the accuracy of ± 0.5°C. The pH of water was recorded in the field by using Elico pH meter (model – LI-120). The Mohr-Knudsen titration procedure and Winkler's method was followed for salinity and dissolved oxygen quantification, respectively (Strickland and Parsons, 1972). For analysis of nutrients, surface water samples were collected in clean polyethylene bottles and kept in an ice box and transported immediately to the laboratory. The water samples were filtered using a Millipore filtering system and analyzed for total phosphorus, nitrate and silicate by adopting the standard methods described by Strickland and Parsons (1972).

Collection and identification of fin fishes from Arasalar Estuary

In order to estimate the fishery potential, a cast net measuring 2.5 m length, with a mesh size varying from 7 mm at the base and 15 mm at the apex was employed for the collection of fish throughout the period of study. The net was hauled ten times during every collection at each sampling site. The collected specimens were identified up to species level. The fin fishes were identified by using the description and key given by Day (1889a, b) and Nelson (1976).

RESULTS

Physico-chemical parameters

Monthly variation in meteorological and physico-chemical parameters namely: the correlation coefficient (r) values between the environmental parameters like air and surface water temperature, pH, salinity, dissolved oxygen, phosphate; nitrate and silicate content in Arasalar estuarine water were recorded for a period of one year from September 2012 to August 2013 (Table 1). The north east monsoon in Tamil Nadu brings very heavy rain during the October, November and December months. The pattern of rainfall facilitates the divisions of the year into post monsoon (January - March) summer

Table 1. Correlation coefficient (r) values between the environmental parameters.

Parameters	At. temp.	W. temp.	pH	Salinity	DO	Silicate	Phosphorous	Nitrate
At. temp.	1							
W. temp.	0.7618	1						
pH	0.8244	0.7918	1					
Salinity	0.8396	0.714	0.88582	1				
DO	-0.608	-0.721	-0.6831	-0.6439	1			
Silicate	-0.745	-0.639	-0.7843	-0.9036	0.8024	1		
phosphorous	-0.647	-0.781	-0.6643	-0.7924	0.765	0.8457	1	
Nitrate	-0.827	-0.786	-0.8295	-0.9144	0.8518	0.9042	0.8356368	1

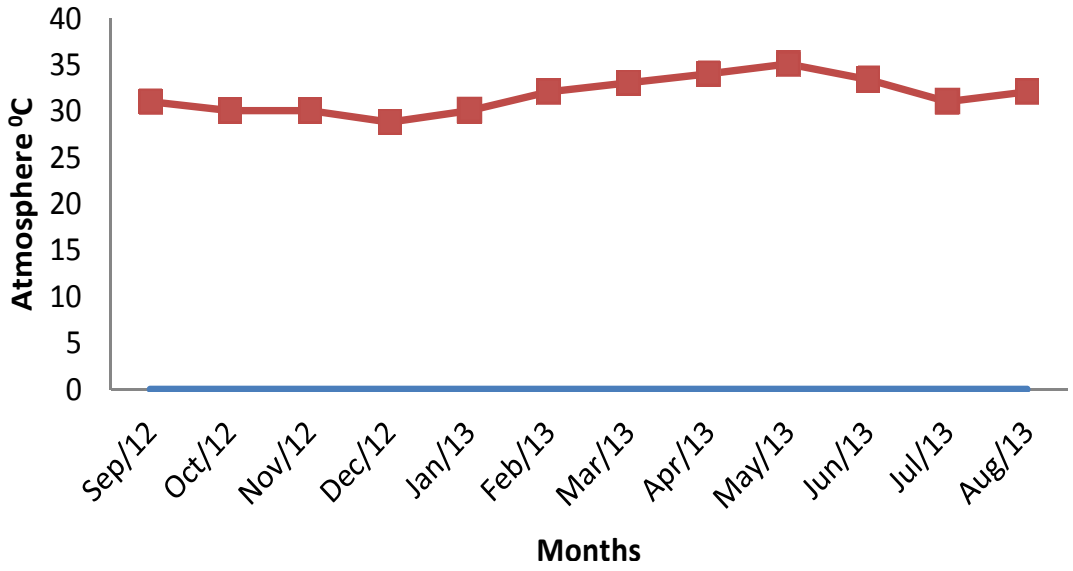

Figure 2. Monthly variations of Atmospheric temperature during September 2012 to August 2013.

(April – June), pre monsoon (July – September) and monsoon (October – December). During the study period, air temperature varied from 28.8 to 35°C, the minimum was recorded during monsoon season (December 2012) and maximum during the summer season (May 2013) (Figure 2). The surface water temperature varied from 25 to 31.5°C. The minimum surface water temperature was recorded during monsoon season (November 2012) and maximum was recorded during the summer season (May 2013) (Figure 3). The monthly mean values of hydrogen ion concentration of water varied from 7.1 to 8.2. Maximum values of pH were observed in the summer season (May 2013) and minimum values were recorded in the monsoon seasons (December 2012) (Figure 4). The salinity in Arasalar estuary varied from 5.5 to 34%. Minimum salinity (5.5% was recorded during monsoon (November 2012) and was slowly built up during post monsoon, and attained maximum value (34%) during summer seasons (May 2013) (Figure 5). Dissolved oxygen in Arasalar estuary ranged from 3.5 to 7.2 ml/l, while the minimum DO was recorded during the month of June, 2013, maximum value occurred in the month of November (2012) (Figure 6). For dissolved phosphorus, the monthly values recorded in Arasalar estuary ranged from 0.29 to 2.15 µg/l. The total phosphorus was minimum in the month of June, 2012 and maximum during the month of November, 2012 (Figure 7). The nitrate varied from 0.49 to 3.75 µg/l. Minimum was recorded during the month of June, 2013 and the maximum during the month of October, 2012 (Figure 8). The monthly variation of silicate recorded in Arasalar estuary varied from 28.25 to 98.94 µg/l. Minimum silicate was recorded during the month of May, 2013 and maximum during the month of November, 2012 (Figure 9).

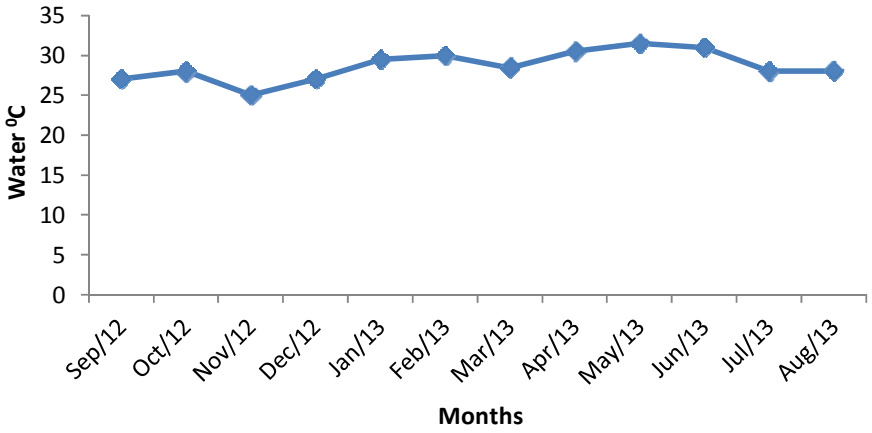

Figure 3. Monthly variations of Water temperature during September 2012 to August 2013.

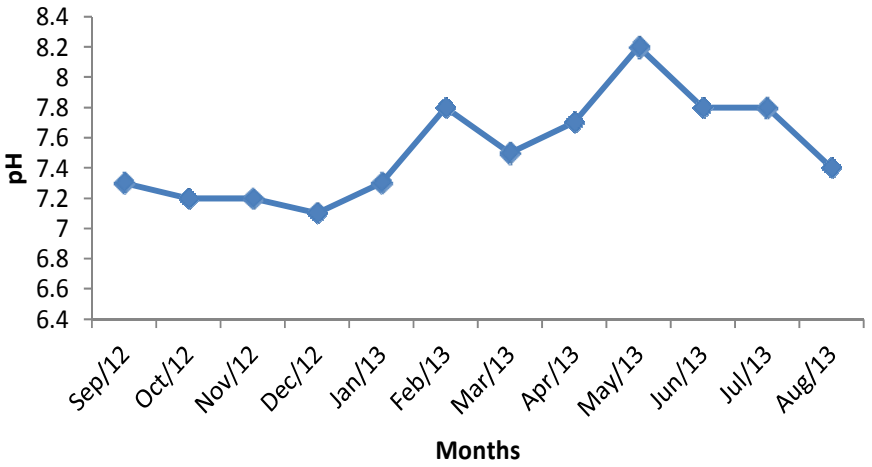

Figure 4. Monthly variations of pH during September 2012 to August 2013.

Ichthyofauna diversity of Arasalar Estuary

A total of 866 fishes were collected, they belong to 4 orders and 5 families in the study area (Figure 10). *Mystus gulio* accounted for about 25.40% and *Liza parsia* was the second dominating fish contributing 21.94% of the total. *Mugil cephalus* occupied the third rank with 20.20%. *Sillago sihama* with 17.89% *Chanos* with 6.69% and *Oreochromis mossambicus* with 7.85% ranking fourth, fifth and sixth species.

DISCUSSION

The monthly variations in meteorological and physico-chemical parameters such as, rainfall, air and surface water temperature, pH, salinity, dissolved oxygen, phosphate, nitrate and silicate contents in Arasalar estuarine waters were recorded for a period of one year from September 2012 to August 2013. The surface water temperature largely depends on the intensity of solar radiation, evaporation, freshwater influx, cooling and mixing due to currents and tidal flow. Surface water temperature also showed a similar trend of monthly variation as that of air temperature and the high values were reported during the summer season (May, 2013) and lower values during the monsoon season (December, 2012). The gradual increase in water temperature from monsoon to summer is directly related to atmospheric conduction and radiation. Similar findings were reported by Thangaraj (1984).During the study period, air temperature varied from 28.8 to 35°C. The minimum was recorded during monsoon season

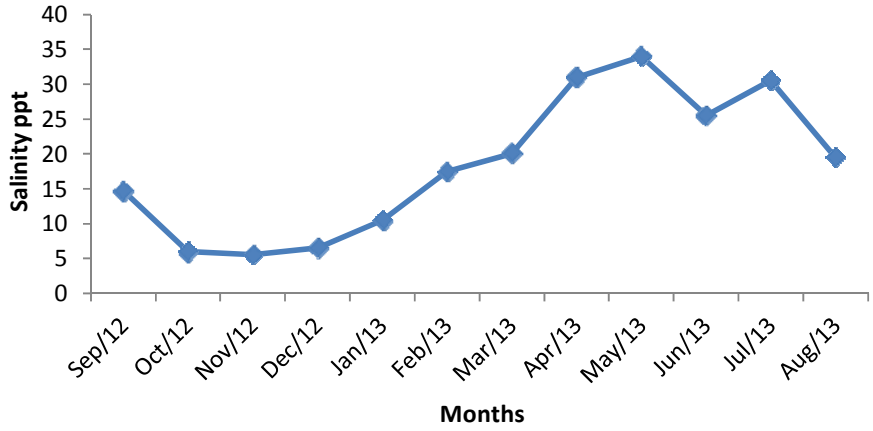

Figure 5. Monthly variations of Salinity during September 2012 to August 2013.

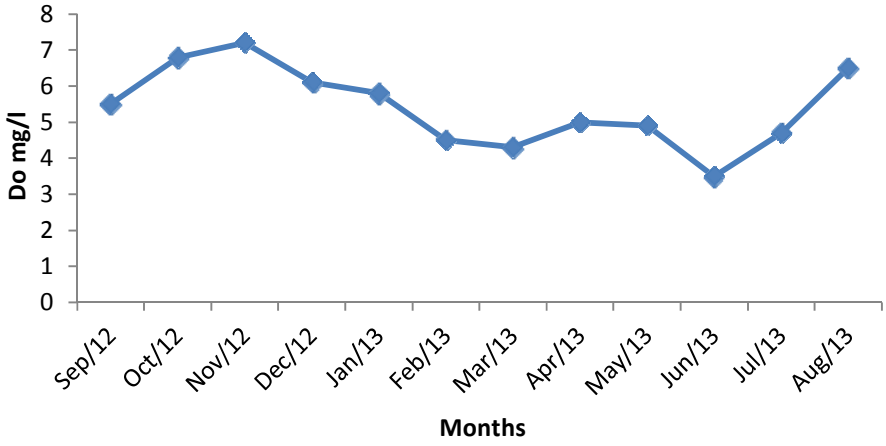

Figure 6. Monthly variations of Dissolved oxygen during September 2012 to August 2013.

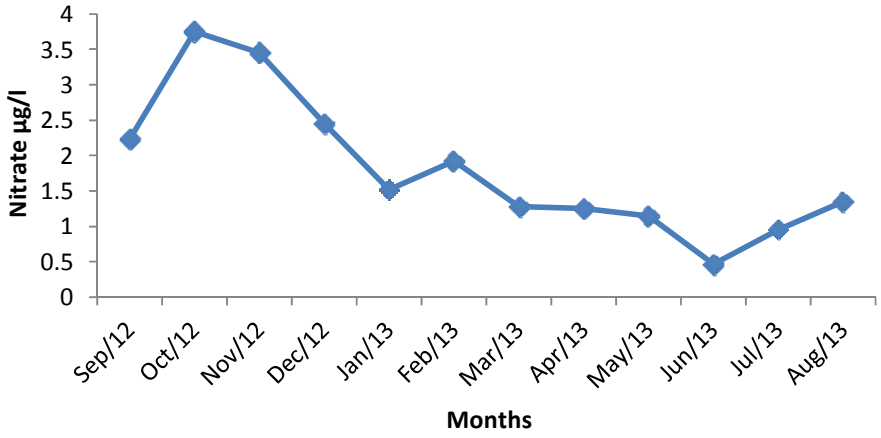

Figure 8. Monthly variations of Atmospheric temperature during September 2012 to August 2013.

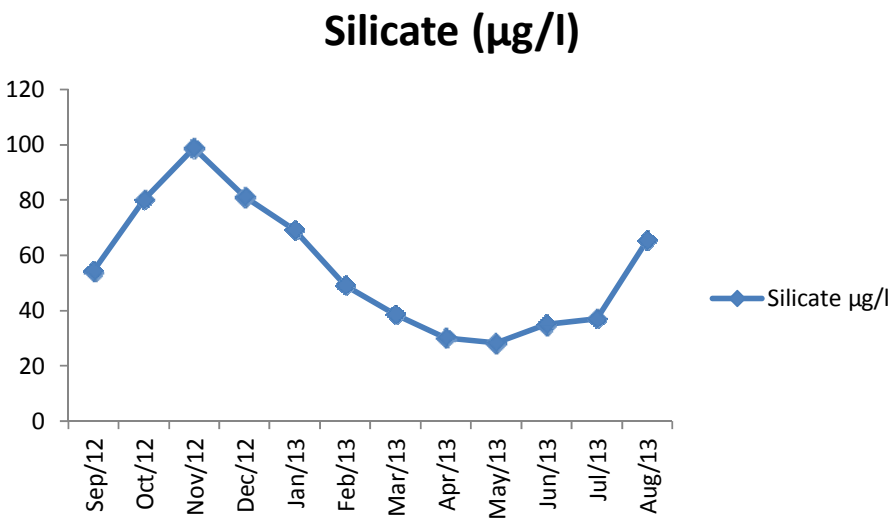

Figure 9. Monthly variations of Silicate during September 2012 to August 2013.

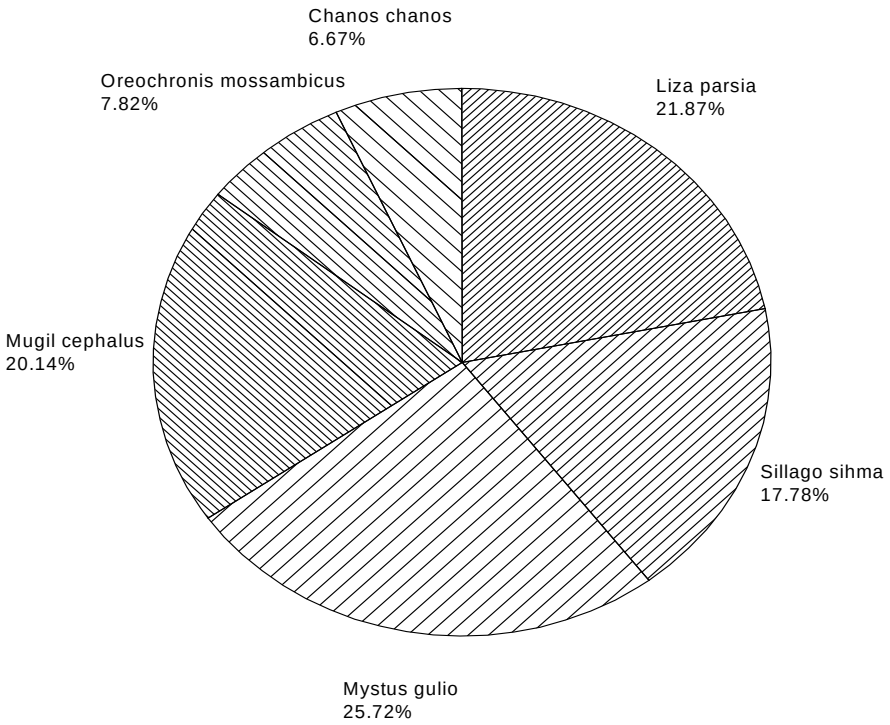

Figure 10. Diversity of Ichthyofauna in Arasalar Estuary during September 2012 to August 2013.

(December, 2012) and maximum during the summer season (May, 2013). Dissolved oxygen is one of the most important parameters, which reflects the physical and biological processes of water. The dissolved oxygen content depends upon the photosynthetic activities, monsoonal floods and the turbulence caused by winds (Nedumaran et al., 2011). In the present study, the dissolved oxygen concentration was low during summer and high during monsoon period. During 2012, the dissolved oxygen concentration was low as compared to

2013, which may perhaps be due to low rainfall recorded during that period. The trend noticed in the present study is in accordance with the findings of hydrology and heavy metals (Rajasegar, 2003). The seasonal variation of salinity in Arasalar estuary is graphically represented in Figure 3. A marked seasonal change in salinity was observed throughout the study period. Minimum salinity was recorded during monsoon (December, 2012) and increased slowly during post monsoon, and attained maximum value during summer seasons (May, 2013). Salinity acts as a prime factor among the most important environmental parameters in the distributions of living organisms (Chandra Mohan and Sreevanivas, 1998). The salinity variation in the exchange of ions and nutrients is because of the tidal flow and is low during the monsoon season in the Arasalar estuary. The present study is in conformity with the earlier reports from Vellar estuary (Palpandi, 2011; Singbal, 1976) Uppanar backwaters (Murugan and Ayyakannu, 1991; Soundarapandian et al., 2009). The monthly mean values of hydrogen ion concentration of water varied from 7.1 to 8.2. Maximum values of pH were observed in the summer season (May, 2013) and minimum values were recorded in the monsoon seasons (December, 2012). The minimum values of pH during monsoon in the study area may be controlled by the influence of freshwater discharge, rainfall and the decomposition of organic matter as stated by Ragothaman and Patil (1995) and Upandhayay (1998). The photosynthetic activity may cause high pH, because of bicarbonate degradation by carbonic anhydrase associated with photosynthesis (Rajkumar et al., 2009). In the present study, the total phosphorus and nitrate were found to be higher during monsoon periods and decreased slowly from summer on wards. High concentration of total phosphorus during monsoon season is due to heavy rainfall, decomposition of particulate organic matter, industrial effluents and from the agricultural discharges from the adjacent lands there are serious omissions. Such monsoonal maximum and summer minimum in the total phosphorus concentration was also reported from Vellar estuary (Chandran and Ramamoorthi, 1984).

The peak values of silicate observed during monsoon may be attributed to the heavy fresh water influx and land run off which carries silt and other silicon deposits from upper to reach the river. Observations similar to the present study were reported earlier (Qasim et al., 1969; Ansari and Rajagopal, 1974) in Cochin back waters (Nair et al., 1983), Ashtamudi estuary (Praba Devi, 1986) and Coleroon estuary. The silicate concentration also showed negative relationship (r=-0.9036) with salinity, which was also noted earlier in Vellar estuary (Chandran and Ramamoorthi, 1984; Thangaraj, 1984) and in Kerala backwaters (Sarala Devi et al., 1983). The diversity is an important tool to study a variety of species in a particular area and to evaluate the abundance of individuals within each species (Ramaiyan et al., 1986). In the present study, totally 866 fishes belonging to only five species was observed in the study area which may be due to the stable environmental condition at the study area. Similarly, high diversities were observed by Morton (1989) in the Cochin waters and in the Vellar estuary (Chandran, 1982), and they attributed this is to the stable environmental condition. The diversity values observed in the present study were comparable to the results of Shanmugam (1985) and Chandrasekaran (1986) in Vellar estuary. The conclusion of the present study is that physico-chemical parameters influence the Ichthyofaunal diversity and Arasalar estuary are not extremely pollutant but at the same time there is possibility of gradual addition of heavy metals in due course. It reveals that the estuarine environment is largely influenced by the annual cycle of monsoon.

Conflict of Interests

The authors have not declared any conflict of interests.

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