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STUDIES ON PHYSICOCHEMICAL PARAMETERS OF WATER FROM RAJAKKAMANGALAM ESTUARY OF SOUTHWEST COAST OF INDIA

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ABSTRACT

The monthly and seasonal variations of physico chemical parameters were studied during January 2015 to December 2015 in Rajakkamangalam estuary (Latitude: 8° 114'N; Longitude: 77° 38'E) of southwest coast of India. The atmospheric and water temperature ranged from 29.0^{0}C to 34.8 ^{0}C and 27 ^{0}C to 33.4^{0}C. The pH ranged from 5.82 to 8.12. Salinity fluctuated between 0 to 12 ppt. The dissolved oxygen ranged between 0.56 ml/l to 5.60 ml/l. The CO_2 ranged between 0 to 12.2 ppm. The value of BOD ranged from 0.28 ml/l to 3.08 ml/l. EC shows irregular pattern of distribution. TDS ranged between 80 mgl $^{-1}$ to 355 mgl $^{-1}$. The values of nitrite and nitrate ranged from 0.35µg/l to 3.10 µg/l and 18.12µg/l to 30.75µg/l. The seasonal variation revealed that atmospheric temperature, water temperature, pH, dissolved oxygen, BOD, EC, nitrite and nitrate were more in northeast monsoon season and low in non monsoon season.

KEYWORDS: *Seasonal variation, physicochemical parameters, water, nutrients.*

INTRODUCTION

An estuary may be formed by conjunction of one or more river or stream that opens to the sea. These are vital aquatic ecosystems that are transition between terrestrial and aquatic system, where significant change in the physico-chemical properties and biological processes were observed due to the mixing of fresh and marine waters (Patterson and Ayyakkannu, 1991; Bardarudeen *et al*., 1996; Senthilkumar *et al*., 2002; Prasanna and Ranjan, 2010). Estuaries and mangroves are highly potential for fishery development in the aquatic environment and are considered as the potential source for feeding, spawning and nursery ground for most of the fin fishes and shell fishes. Estuaries are fragile habitats, experiencing declining water quality and eutrophication. Anthropogenic inputs associated with agriculture, aquaculture, urbanization, coastal development and industrial expansion are a primary cause for the decline in the quality of natural habitats in these sensitive waters (Bijoy Nandan and Abdul Azis 1994; James L Pinckney *et al.,* 2001). Estuaries receive substantial amount of nutrients as well as anthropogenic wastes from land and transferred toward inshore seas; estuaries also receive nutrients and organic matter from wetlands (Odum and Heald, 1972; Robertson *et al.,* 1992).

Rivers play a major role in assimilation or carrying off of municipal and industrial wastewater and runoff from agricultural land, the former constitutes the constant polluting source whereas the latter is a seasonal phenomenon. Physico chemical properties of the water gets varied season wise and in addition, anthropogenic activities such as agriculture, urbanization, domestic sewage in the catchment area result in the deterioration of water quality (Verma *et al.,* 2012). Ecological studies are very important in marine environment for determining the challenges of water quality and for the general evaluation of the area. Physical and chemical parameters such as atmospheric temperature, water temperature, dissolved oxygen, salinity, pH, nitrite, nitrate, phosphate and sediment total organic carbon, nitrogen, and phosphorus etc. play a pivotal role in an aquatic system (Balasubramanian and Kannan, 2005). The nature and distribution of the flora and fauna in an estuary are mainly controlled by the fluctuation in the physical and chemical characteristics of the water. Moreover, hydrological study is the pre requisite for the assessment of potentialities and to understand the realities between tropic levels and food webs (Murugan and Ayyakkannu, 1991). The amount of rainfall in a particular area predicts the rate of inflow, which plays a major role in nutrient concentration (Kasza, 1993).

Estuaries and harbour adjacent sites are often subjected to environmental disturbances from various sources such as domestic sewage outfall, pesticides, heavy metals and petroleum hydrocarbons (Ansari *et al.,* 1994). Hydrogen sulphide produced during coconut husk retting processes is the major pollutant of water bodies of the estuarine area (Gopakumar and Kuttyamma, 1999). The environmental conditions such as topography, water movement and stratification, salinity, oxygen, temperature and various nutrients characterizing particular water mass determine the composition of its biota. Good quality of water resources depend on large number of physico chemical parameters and the magnitude and source of pollution load and to assess that monitoring of these parameters is essential (Reddi *et al.*, 1993). Several reports are available on the physico-chemical features of Indian estuaries (Rajasegar, 2003; Balasubramanian and Kannan, 2005; Ajithkumar *et al.,* 2006; Asha and Diwakar, 2007; Ashok Prabu *et al.,* 2008; Saravanakumar *et al.,* 2008; Gowda *et al.,* 2009; Gadhia *et al.,* 2012; Pravat Ranjan Dixit *et al.,* 2013; Arumugam and Sugirtha P. Kumar, 2014; Uma Maheswara Rao *et al.,* 2015; Sobha Rani, 2016). The current study was undertaken to assess the present status of water quality in Rajakkamangalam estuary with reference to physico-chemical characteristics of water.

MATERIALS AND METHODS:

STUDY AREA:

Rajakkamangalam estuary (Latitude: 8° 114'N; Longitude: 77° 38'E) is situated in the Agastheeswaram Taluk, Kanyakumari district. The climate of the region is greatly influenced by both southwest and northeast monsoon. This district which covers an area of 1493.94 Km^2 is predominantly an agricultural area. It is a bar built type. Pannaivaikkal is one of the river systems that are found in this district. It originates from Vellimalai hills about 25 km northeast of Nagercoil and transverse 12 km before it joins the Arabian Sea at Rajakkamangalam and forms the estuary. The river receives water from heavy rainfall during the monsoon months. At this time it swells up and confluences with the sea. During the rest of the months, the estuary is cut off from the sea by sandbar. When the Pannaivaikkal crosses the intermittent paddy fields and irrigation tanks, it receives the agricultural run off which contains the fertilizer and pesticide effluents. Beside these, there are many retting fields by the side of the estuary. The effluent from the retting grounds also flows into the estuary. Hence, the estuarine part of the river is more productive as well as more destructive in nature with a great diversity of fauna and flora. For the present study four stations were selected for sampling (Fig.1). Station I is located in the bar mouth region. Station II located near the Pannaiyoor Bridge and nearly 300 m away from station I; whereas Station III located 300 m away from station II and it is an effluent mixing zone. Station IV located 400 m away from station III and it is a freshwater zone. Water samples were collected in the different seasons of monsoon period from January 2015 to December 2015. Surface water samples were collected in a clean plastic bucket. Preservation and transportation of the water samples to the laboratory were as per the standard methods.

Atmospheric temperature and water temperature were measured using mercury thermometer. The samples were analyzed for different parameters. pH was measured using digital pH meter (L110). The salinity was estimated by Knudsen's equation titration method (APHA, 1985). The dissolved oxygen and BOD content of water samples were estimated by Winkler's method (APHA, 1985). The carbon-di-oxide content of water samples was estimated by Titrimetric method (APHA, 1985). The conductivity was recorded by using a Conductivity meter (Rao, 1993) and TDS was estimated according to APHA, 1985. The nitrite and nitrate of the water sample was estimated by sulphanilamide (Spectrophotometric) method and brucine-sulphanilic acid method (APHA 1985).

Fig. 1 : Map showing study area and sampling stations (S-I to S-IV)

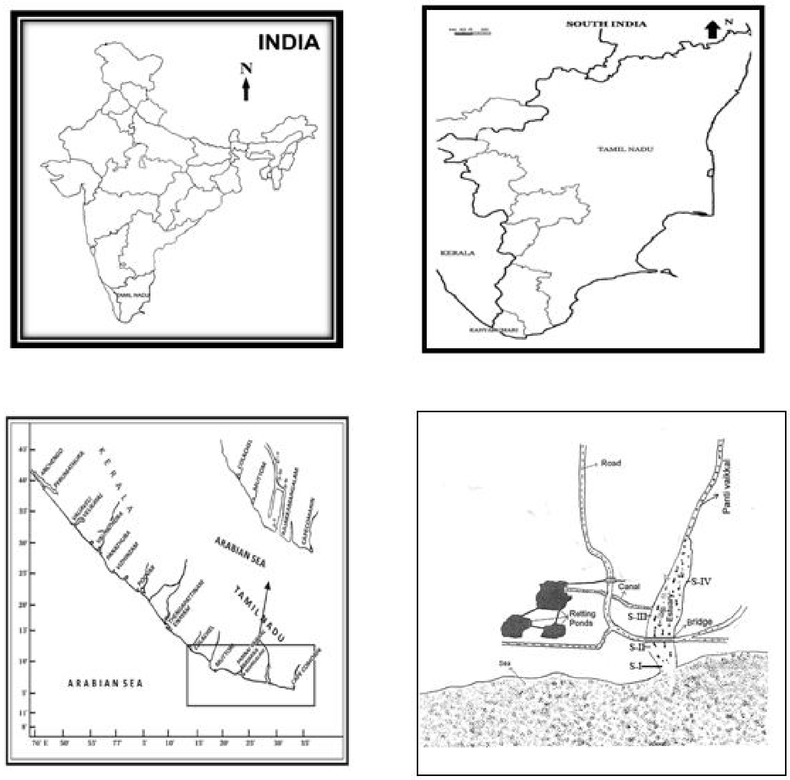


Fig.1. Map of the Study Area

RESULT

In the present study highest atmospheric temperature was observed in S-I (34.8^{0}C) and lowest temperature (29.0^{0}C) was reported in S-IV. Likewise in the surface water temperature the values ranged from 33.4^{0}C in S-I during January to 27.2^{0}C in S-IV during May (Fig.2, Fig.3). Seasonal variations of atmospheric temperature showed maximum value of 33.52 ± 1.11 reported in S-I during nonmonsoon season and minimum value 30.72 ± 1.21 was reported in S-IV during northeast monsoon season (Table.1). Seasonal variation in water temperature revealed that more value (31.97 ±1.27^{0}C) during nonmonsoon season and less (29.02 ± 1.26^{0}C) during north east monsoon at S-IV (Table.1).

During the present investigation a low pH was observed at S-III (5.82) and a high pH value (8.12) was observed at S-IV (Fig.4). Seasonal variation revealed maximum 7.90 ± 1.14 at S-IV during north east monsoon season and minimum 6.21 ± 0.33 at S-III during nonmonsoon season (Table.1). Salinity remains zero at S-IV throughout the study period. Maximum salinity (12 ppt) was reported in August at S-I (Fig.5). Seasonal variation revealed more 9.50 ± 1.31 ppt during nonmonsoon season at S-I and minimum 0.72 ± 0.75 ppt at S-III (Table.1).

In the present observation, low value (0.56 ml/l) of dissolved oxygen was reported at S-III in February and August and high value (5.60 ml/l) was reported at S-IV in October in the experimental estuary (Fig.6). Seasonal variation showed maximum (4.69 ± 0.67 ml/l) at S-IV during northeast monsoon and minimum (1.33 ± 0.75 ml/l) at S-III during nonmonsoon period of the experimental estuary (Table.1). In the present study maximum (12.2 ppm) CO_2 was observed in the polluted zone (S-III) during August and minimum (o ppm) were reported in S-IV in May, October and November, because it is unpolluted fresh water zone (Fig.7). Seasonal variation in CO_2 showed maximum value (9.2 ± 2.96 ppm) in nonmonsoon season at S-III and minimum value (0.17 ± 0.18 ppm) at S-IV during north east monsoon season of the experimental estuary (Table.1).

The maximum 3.08 ml/l BOD was reported in February and August at S-III and minimum 0.28 ml/l was reported in S-IV in October (Fig.8). Seasonal variation revealed that maximum value 2.52 ± 0.52 ml/l in S-III during nonmonsoon season and minimum 0.63 ± 0.23 at S-IV during northeast monsoon season (Table.1). EC was irregular at all sampling stations throughout the study period. Maximum EC 5.60 (ds/m) was reported in August at S-III and minimum EC 0.34 (ds/m) was observed at S-IV in August (Fig.9). Seasonal variation revealed that maximum 4.78 ± 0.79 ds/m was observed at S-I during nonmonsoon season and minimum 1.17 ± 0.48 ds/m was reported at S-IV in nonmonsoon season (Table.1).

TDS showed maximum (355 mgl^{-1}) value in August at S-III and minimum (80 mgl^{-1}) value at S-IV in October (Fig.10). Seasonal variation revealed that high value 197.25 ± 30.88 mgl^{-1} was observed at S-I during nonmonsoon season and low value in 98 ± 12.25 mgl^{-1} at S-IV during northeast monsoon season (Table.1). Nitrite showed low 0.35µg/l in August at S-IV and high 3.10 µg/l in October at S-III (Fig.11). Seasonal variation showed low 0.75 ± 0.31µg/l during nonmonsoon season and high 2.32 ± 0.55 µg/l in northeast monsoon season (Table.1). Maximum nitrate 30.75 µg/l was reported in October at S-IV and minimum 18.12 µg/l was reported in August at S-I (Fig.12). Seasonal variation revealed maximum 33.09 ± 1.74 µg/l at S-III and minimum 20.00 ± 1.38 µg/l at S-I in the experimental estuary (Table.1).

Fig.2. Monthly fluctuations in atmospheric temperature (°C) in...

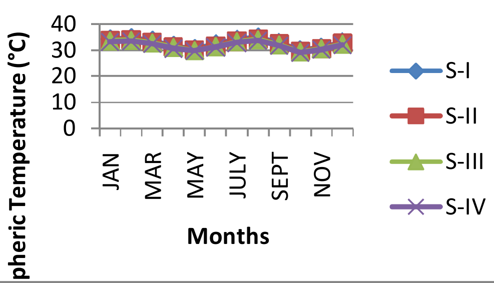


Fig.3. Monthly fluctuations in water temperature (°C) in the experimental...

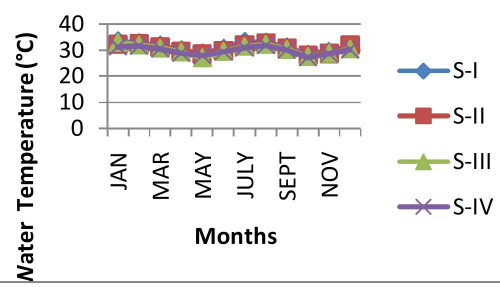


Fig.4. Monthly fluctuations in pH of water in the experimental...

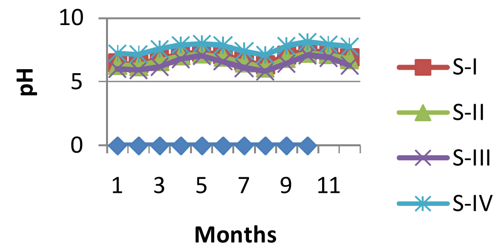


Fig.5. Monthly fluctuations in salinity (ppt) of water in the experimental...

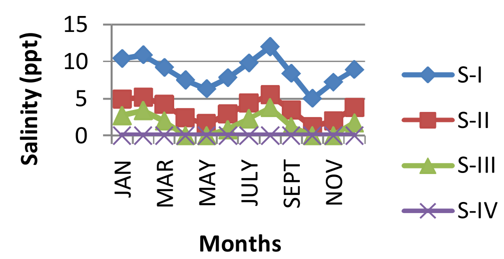


Fig.6. Monthly fluctuations in Dissolved Oxygen (ml/l) of water in...

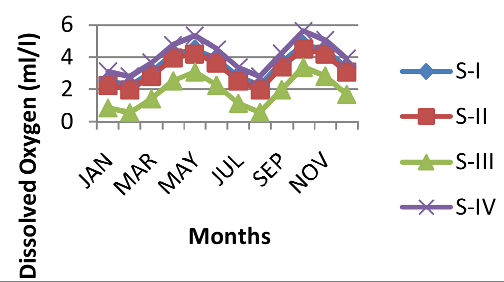


Fig.7. Monthly fluctuations CO_2 of water in the experimental stations (S-I to S-IV) during 2018

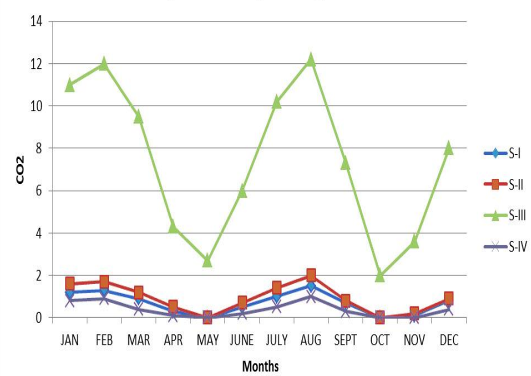


Fig.8. Monthly fluctuations in BOD (ml/l) of water in the experimental...

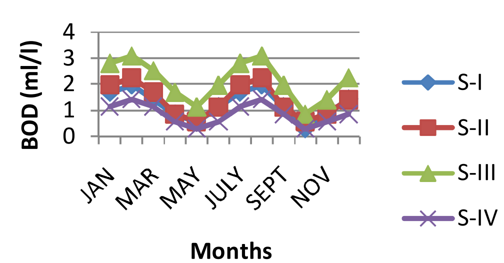
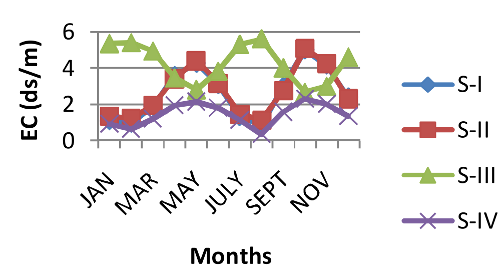


Fig.9. Monthly fluctuations in EC (ds/m) of water in the experimental...



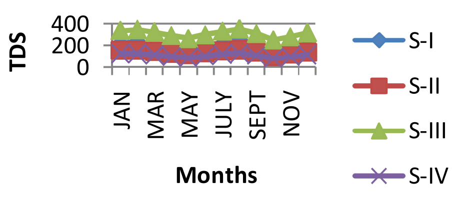


Fig.10. Monthly fluctuations in TDS (µgl^{-1})of water in the experimental...

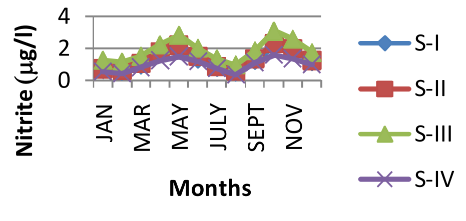


Fig.11. Monthly fluctuations in Nitrite (µg/l) of water in the...

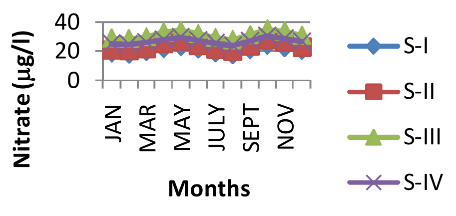


Fig.12. Monthly fluctuations in Nitrate (µg/l) of water in the...

Table. 1 Seasonal variation (Mean ± SD) in physicochemical parameters in the experimental stations (S-I to S-IV) during 2015

Parameters	Stations	Seasons		
		Non Monsoon	South West Monsoon	North East Monsoon
Atmospheric temperature (^{0}C)	I	33.52 ± 1.11	32.90 ± 1.65	31.70 ± 1.25
	II	33.10 ± 1.05	32.40 ± 1.60	31.37 ± 1.27
	III	32.70 ± 1.06	32.07 ± 1.64	30.97 ± 0.19
	IV	32.40 ± 1.05	31.75 ± 1.56	30.72 ± 1.21
Water temperature (^{0}C)	I	31.97 ± 1.27	31.35 ± 1.83	30.05 ± 1.33
	II	31.37 ± 1.07	30.65 ± 1.65	29.87 ± 1.57
	III	31.22 ± 1.39	30.05 ± 2.00	29.22 ± 1.20
	IV	30.62 ± 1.07	30.00 ± 1.55	29.02 ± 1.26
pH	I	6.69 ± 0.31	6.83 ± 0.40	7.17 ± 0.20
	II	6.55 ± 0.33	6.67 ± 0.41	6.99 ± 0.20
	III	6.21 ± 0.34	6.39 ± 0.47	6.68 ± 0.32
	IV	7.45 ± 0.29	7.59 ± 0.36	7.90 ± 0.14
Salinity (ppt)	I	9.50 ±1.31	8.97 ± 2.14	7.37 ± 1.50
	II	4.17 ± 1.09	3.60 ± 1.48	2.62 ± 1.07

	III	2.02 ± 1.27	1.72 ± 1.45	0.72 ± 0.75
	IV	-	-	-
Dissolved oxygen (ml/l)	I	3.01 ± 0.75	3.36 ± 0.88	4.06 ± 0.58
	II	2.73 ± 0.74	3.08 ± 0.87	3.78 ± 0.57
	III	1.33 ± 0.73	1.75 ± 0.98	2.45 ± 0.67
	IV	3.56 ± 0.74	3.99 ± 0.98	4.69 ± 0.68
Parameters	**Stations**	**Seasons**		
		Non monsoon	**South West Monsoon**	**North East Monsoon**
CO_2(ppm)	I	0.92 ± 0.39	0.75 ± 0.56	0.40 ± 0.35
	II	1.25 ± 0.47	1.02 ± 0.75	0.47 ± 0.38
	III	9.20 ± 2.96	7.77 ± 3.69	5.22 ± 2.50
	IV	0.55 ± 0.32	0.42 ± 0.38	0.17 ± 0.18
BOD (ml/l)	I	1.47 ± 0.41	1.33 ± 0.54	0.91 ± 0.42
	II	1.68 ± 0.52	1.47 ± 0.67	0.98 ± 0.31
	III	2.52 ± 0.52	2.24 ± 0.77	1.61 ± 0.54
	IV	1.05 ± 0.30	0.84 ± 0.44	0.63 ± 0.23
EC (ds/m)	I	1.88 ± 1.04	2.37 ± 1.38	3.63 ± 1.02
	II	1.97 ± 0.87	2.53 ± 1.32	3.59 ± 1.12
	III	4.78 ± 0.79	4.38 ± 1.13	3.56 ± 0.78
	IV	1.17 ± 0.48	1.35 ± 0.69	1.80 ± 0.38
TDS (mgl $^{-1}$)	I	197.25 ± 30.88	184.75 ± 44.48	153.75 ± 24.92
	II	143.75 ± 12.09	138.25 ± 17.64	123.50 ± 16.51
	III	327.00 ± 21.93	313.50 ± 34.19	290.75 ± 27.32
	IV	115.50 ± 10.87	109.25 ± 17.43	98.00 ± 12.25
Nitrite (µg/l)	I	0.96 ± 0.42	1.17 ± 0.56	1.59 ± 0.39
	II	1.05 ± 0.46	1.30 ± 0.62	1.73 ± 0.43
	III	1.53 ± 0.43	1.79 ± 0.71	2.32 ± 0.56
	IV	0.75 ± 0.31	0.91 ± 0.43	1.25 ± 0.23
Nitrate (µg/l)	I	20.00 ± 1.38	20.74 ± 2.08	22.39 ± 1.37
	II	22.30 ± 1.91	23.26 ± 2.59	25.34 ± 2.07
	III	30.47 ± 1.91	31.32 ± 2.49	33.08 ± 1.74
	IV	26.26 ± 1.37	27.03 ± 2.24	28.63 ± 1.44

DISCUSSION

Temperature is an important ecological factor which influences the other hydro biological parameters. The role of temperature for animal distribution in a particular area or niche is also well known. In the marine zone, the exclusion of certain species from areas with unsuitable temperature conditions is one of the major obvious effects of temperature on animal distribution (Choudhury *et al.,* 1984). Atmospheric temperature recorded during the study period showed seasonal variations at all stations. In general nonmonsoon season recorded higher temperature compared to the monsoon season. The high temperature recorded during nonmonsoon could be attributed to high solar radiation and low temperature observed during monsoon may be attributed to the monsoonal rain, cloudy sky and cold weather (Murugan and Ayyakkannu, 1991). A similar condition was also noted in the Thengapatanam estuary (Kumaraswamy, 2005).

The surface water temperature showed an increasing trend from January, February and March was influenced by the intensity of solar radiation, evaporation, freshwater influx and cooling and mix up with ebb and flow from adjoining neritic waters (Ajithkumar *et al*., 2006; Saravanakumar *et al*., 2008). The observed low value of October and November was due to strong land sea breeze and precipitation and the recorded high value during summer could be attributed to high solar radiation (Ajithkumar *et al.*, 2006; Ashok Prabu *et al*., 2008; Rajkumar *et al*., 2009). Govindasamy *et al*., (2000) reported that surface water temperature was influenced by the intensity of solar radiation and direction of water currents which bring warm water from equatorial region. Borrego and Borrego (1982) opined that the intensity of solar radiation, bathymetry of the environment, tides and variations in atmospheric temperature influence the temperature variations in estuaries and coastal waters. From the results of the present study it is observed that the atmospheric temperature as expected is relatively higher than the surface water temperature.

pH is a fundamental biogeochemical parameter, which plays a major role in most natural processes and has quite a universal importance in ecosystem. The pH of the water is critical to the survival of most aquatic plants and animals. Many species cannot survive if pH drops under 5.0 or rises above 9.0. Changes in pH can alter the water chemistry, usually to the disadvantage of native species (Smith 1992). The low pH in S-III may be attributed to the mixing of coconut retting effluent in that zone. This may ultimately lead to an increasing concentration of carbonate oxide, hydrogen sulphide and also the microbial activity. Season wise data showed maximum pH during the northeast monsoon season and minimum during nonmonsoon period. Generally, its seasonal variation 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; Bragadeeswaran *et al.*, 2007). The recorded high 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; Saravanakumar *et al.*, 2008).

Salinity stands as the key factor controlling almost all other environmental characteristics of coastal and estuarine waters and their inhabitant flora and fauna. Salinity distribution in the estuaries is mainly influenced by the opening and closing of the sandbar of the estuary. Besides, variation is also caused by rainfall and freshwater discharge (Nair *et al*., 1984). In the present study January, February and August showed increase in salinity in the sampling stations and the lowest values were recorded during October, which may be due to the rainy season associated with the monsoon period. Being barmouth region S-I recorded more salinity compared to other experimental stations. Similar observations were made by Sampathkumar and Kannan (1998) in Nagapattinam - Tranquebar Coast and also by Zingde *et al.* (1987) in Thal waters. Dwivedi *et al.* (1975) observed similar salinity fluctuation in inter tidal area of Mondavi estuary. The values of salinity showed an increasing trend during the nonmonsoon season and drop in salinity during monsoon seasons. Such fluctuation in salinity values, observed in the present study also correlates with the findings of Suseelan (1975) in the Manakudy estuary.

Dissolved oxygen is obviously essential for the metabolism of all aquatic organisms that process aerobic respiratory bio-chemistry (Wetzel, 1975). The concentration of dissolved oxygen showed a wide range of variations throughout the study period. Generally higher dissolved oxygen concentration observed during monsoon season might be due to the cumulative effect of the higher wind velocity coupled with heavy rainfall and the resultant freshwater mixing (Prabu *et al.*, 2008; Prasanna and Ranjan, 2010) During the present investigation S-III registered low values of dissolved oxygen during some of the sampling months. This may be due to high biological oxygen demand and the high production of organic matter in that station. The rapid decline in dissolved oxygen of polluted zone is attributed to the utilization of oxygen in the process of biodegradation by sewage borne bacteria and fungi (Hosetti and Patil, 1988).

In the present study, maximum CO_2 was observed in the polluted zone (S-III). Kotpal and Bali (1989) reported increasing level of CO_2 may affect the water pH. Umayorubhagan *et al.* (1998) reported that high CO_2 in polluted zone of AVM canal. Verma (1964) observed the presence of CO_2 throughout the study period. These reports are in agreement with the present investigation.

The BOD values recorded at S-III in the experimental estuary was higher in February, March and August. Vareethiah and Haniffa (1998) reported minimum BOD levels during monsoon due to the entry of floods. Vijayaram *et al*. (1988) observed that high BOD not only in the effluent mixed zones, but also in the mixed and recovery zones. During the present study in S-I to S-IV high values of BOD was recorded during nonmonsoon season. This could be due to the microbial utilization of oxygen and cessation of fresh water input. Bijoy Nandan and Abdul Azis (1990) suggested that very high organic load would result in greater microbial decomposition and depletion of oxygen with high BOD values and eventually to a state of anoxia. Low values of BOD were observed during monsoon season indicate the absence of gross organic pollution.

Water becomes a conductor of electric current when substances are dissolved in it and the conductivity is proportionate to the amount of dissolved substances (Bhadawia, 1998). In the present observation high values of EC were recorded in February and August at S-III and low value was reported at S-IV. Seasonal changes revealed that EC was high during non monsoon period at S-III. Phiri *et al.* (2005) reported that during rainy season values were higher than that of the summer season. Selvamohan (2006) reported that EC was high during northeast monsoon in the bar mouth of the experimental estuary and lower during nonmonsoon at fresh water zone.

TDS is generally associated with inorganic and organic salt and there is a close parallelism between TDS and conductivity. In the present investigation TDS is more at S-III may be due to the mixing of retting effluents in that zone. Maximum TDS was reported in nonmonsoon season and minimum value at northeast monsoon season. Prasanna and Rajan (2010) had reported that maximum range of TDS during the month of April and May at Dhamra estuary.

In the present study, the dissolved nitrite concentration was lower than the nitrate, since nitrite is in unstable form, its oxidation in to nitrite can be considered as the main reason for the low nitrite. The maximum nitrite content was recorded during northeast monsoon season and minimum values were obtained during nonmonsoon. S-I showed a low nitrite throughout the study period and this may be due to high salinity as observed by Panigrahy *et al*. (1999) in the coastal waters around Orissa. Sampathkumar and Kannan (1998) reported that an increase in nitrite concentration could attribute the bacterial decomposition of planktonic detritus by the activity of nitrifying bacteria and air-sea interaction of exchange of chemical elements. Anbazhagan (1998) observed the peak values of nitrite during the monsoon season could be attributed to the influence of seasonal floods. Further excretion of phytoplankton, reduction of nitrate and oxidation of ammonia could all contribute together or individually to increase the concentration of nitrite in the environment. Minimum values of nitrite in nonmonsoon and southwest monsoon may be due to reduction of river flow and utilization by phytoplankton as reported by Subramanian and Mahadevan, (1999).

Nitrate is released in the water by biological oxidation of nitrogenous compounds. In the present study S- I recorded a low level of nitrate due to high salinity. Maximum nitrate values were recorded in the northeast monsoon season and minimum nitrate values in nonmonsoon season. The higher nitrates value during monsoon season might be mainly due to the organic materials receiving from the catchment area during rainfall (Das *et al.*, 1997). The increasing nitrates level is also due to freshwater inflow, litter fall decomposition and terrestrial run-off during the monsoon season as reported earlier for various researchers (Bragadeeswaran *et al.,* 2007). The maximum value was observed at S-III during the northeast monsoon season. Similar trend was also reported by Devaraj *et al*. (1988) in Hemavathy reservoir and Swami *et al.* (1996) in Karwar coastal waters. Gouda (1996) also reported similar trend in Indian estuaries.

CONCLUSION

The physico chemical parameters exhibited variations in four different sampling stations. The present water quality of Rajakkamangalam estuary reveals that station –III was more polluted, it may be due to the admixture of retting effluents from nearby retting ponds deteriorating the quality of water in the estuarine ecosystems.

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