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Diversity of fishes in relation to physcio-chemical properties of Manakudy estuary, Southwest coast of India

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Present study deals with fish diversity and physico-chemical properties of Manakudy estuary. Thirty-eight (38) species of fin and shell fishes of commercial importance were recorded during the study period (February 2010 to January 2011), higher than that of previous observations. Average fish catch in these estuary ranged from 80 to 280 kg/day, comprising mainly *Etroplus suratensis* (Pearl spot), *Arius maculatus* (Cat fish), *Sillago sihama* (Silver whiting), *Lates calcarifer* (Sea boss), *Gerres abbreviates* and *Chanos chanos* (Milk fish). Various physico-chemical parameters and nutrients such as air temperatures, surface water temperatures, salinity, pH, turbidity, total suspended solids, dissolved oxygen, nitrite, nitrate, ammonia, total nitrogen, inorganic phosphate, total phosphorus and silicate were at the ranges of 23 to 32.5°C, 24 to 31.0°C, 7.5 to 28‰, 7.5 to 8.4, 48 to 327 NTU, 97 to 558 mg/l, 3.29 to 5.44 mg/l, 0.15 to 1.28 µmol/l, 0.61 to 6.42 µmol/l, 0.03 to 0.22 µmol/l, 7.2 to 17.6 µmol/l, 0.31 to 1.13 µmol/l, 0.74 to 4.03 µmol/l and 10.12 to 39.30 µmol/l, respectively, which were suitable for growth of flora and stocking of fish species. During the monsoon and pre-monsoon seasons, higher species diversity of fish was recorded at Manakudy estuary. Salinity appears to be a major factor influencing the abundance and diversity of fin and shell species in the estuary.

Key words: Fish diversity, Manakudy estuary, physico-chemical properties.

INTRODUCTION

Estuaries are known in many parts of the world as breeding and nursery grounds for a wide variety of fishes. Although, estuaries provides a rather harsh environment because of change in salinity, many species of fish have found them to be an ideal place for spawning, development and growth during early life, that way productivity tends to be high here. A large variety of fishes inhabit the estuarine environment. Most of them are migratory marine species, which use this habitat in their early life cycle as a necessity. Some others are permanent residents of the estuaries, which spend their entire life cycle in this ecosystem. Still, others like anadromous and catadromous fishes use estuaries as a way during their migration from their spawning and main feeding areas (Haedrich, 1983; Dando, 1984). Some species of fishes are able to complete their whole life cycle within the estuaries and a few fresh water species are occasionally found in the upper reaches of estuaries (Day et al., 1981). The environment variables such as salinity and distance from the estuary mouth influence the distribution, abundance and community structure of fishes in estuaries (Hoff and Ibara, 1977; Bell et al., 1988). The

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fauna of a brackishwaters system is generally composed of marine and fresh water organisms which can adapt waters of varying, salinities besides truly residents estuaries species. As for the fishes concerned, they are grouped as residents and transients; the former being present in estuarine waters throughout the year in some or all size groups and the transients enter and remain in one or more zones for short duration.

In India, marine fishes are predominant in all brackish waters and the fluctuations. It has been observed that there is a marked difference between the estuarine fauna of the east and west coast of India, very dense population both with regard to species and individuals, being observed on the estuarine side. This is through to be due to presence of large rivers on the west coast pushing the estuarine fauna to the Arabian Sea (Kennedy, 1990). The present account, therefore, is an attempt to briefly review the estuarine fishery potential in India. Accurate estimate of the total area covered by estuarine waters and yields from them are not available, although, such data have been gathered from some of them, mainly through the investigations carried out by the central Inland Fisheries Research Institute, Barrackpore. Rough calculation indicate that about 214,500 ha of deltaic estuaries, lagoons and lakes and 2,020,000 ha of cultivable brakish water area are available in the country for development of estuarine fisheries and coastal aquaculture. The fisheries of estuaries are above subsistence levels and contribute significantly to the production. According to Jhingran (1991), the average yield varies from 45 to 75 kg/ha. India has vast inland water resources in the form of rivers and canals (0.2 million km), reservoirs (3.1 m ha) and tanks and ponds (2.2 m ha) offering tremendous scope for fish production. India ranks second to China in inland capture fisheries (FAO, 2001). However, the reported productivity from inland capture fisheries is very low and production has declined during the last 2 to 3 decades. This depletion in production is due to various anthropogenic interventions and multi-user conflicts. However, the country has to develop inland water resources, especially the reservoirs and the floodplain lakes to meet the growing demand of food fish in future.

The major estuarine system in the country are Hooghly-Matlah in West Bengal; Mahanadi and Chilka lake in Orissa; Godavari, Krishna and Pulicat lake in Andhera Predesh; Cauvery in Tamil Nadu; Vembanad lake in Kerala and Narmada-Tapti in Gujarat. In addition to these, there are a number of smaller estuaries which are known to contribute their mite to the estuarine fishery wealth of India. Some valuable contributions on the various aspects of fish and fisheries of Indian estuaries are available. Kurup and Samuel (1987) discussed the ecology and fish distribution pattern of Cochin backwaters and Balasubramanian et al. (1995) evaluated the ecological status of two prawn culture fields in the same area. Fish population of Ponnani estuary was analysed by Bijukumar and Sushama (2000). Thangaraja (1995) concentrated on the finfish seed resources of the Vellar estuary. Manickasundaram et al. (1987) studied the finfish eggs and larvae of the Coleroon estuary. The fisheries of Hooghly-Matlah estuarine system were studied by Mukhopadhyay et al. (1995). Other related contributions on the estuarine fisheries belong to the works of Jhingran and Gopalkrishnan (1973) on the estuarine fisheries resources of Indian in relation to the adjacent seas.

No information is available on the fishery potential of Manakudy estuary. Therefore, in the present study, the quantum of catch of various fishes in the Manakudy estuary has been studied.

MATERIALS AND METHODS

Study area

Manakudy estuary, located in the Southwest coast of Kanyakumari district has a total area of about 150 ha, extending over 2 km and is located between 8° 4' N latitude and 77° 26' E longitude. It is a tropical bar- built estuary. The estuary is connected to the sea during the rainy season and remains land locked for the rest of the year by a sand bar, the local inhabitants cut open the sand bar.

Hydrobiological parameter

The formation and closure of the sand bar at the bank leads to pronounced changes in the hydrobiological conditions of the backwater. Monthly analysis for a period of one year from February 2010 to January 2011 was carried out using surface water samples collected from four ecologically different stations of Manakudy estuary. Station I, it is located near the mouth of the estuary where the river flow is interrupted by the periodical occurrence of sand bar. Station II, it is a few kilometres away from the upstream from station I and it is flanked by coconut husk retting pits, its heavily polluted retting liqueur directly being discharged into the estuary and the domestic waste from the neighbour villages into the estuary. Station III, it is one among the major area of fishing the main flora of this mangrove forest is *Rhizophora mucronata* and *Avicennia officinalis* occurs rarely. This forest was created by the pilot project of afforestation in the year 1991, by the Society for Environmental Education and Development (SEED) Nagercoil. Station IV, this station is located about 1 km northwest of station III towards the head of the estuary, which also the entrance of freshwater into the estuary. Three seasons are recognized in the present study namely, 'premonsoon season' from February to May, southwest monsoon from June to September and post monsoon season from October to January (Figure 1).

Physico-chemical parameters were measured by standard analytical method (Strickland and Parson, 1968).

Fishery resource

In Manakudy estuary, local fishermen go for intensive fishing soon after the water levels falls following the opening of the sand bar. Night fishing is not common in the estuary. The time between 5 and 9 am is the usual fishing time and the catches are landed by 8 to 9 am. Fishing activities usually slow down during the monsoon months when the estuary experiences flooding. However, intermittent fishing is resorted to when the weather is slightly favourable

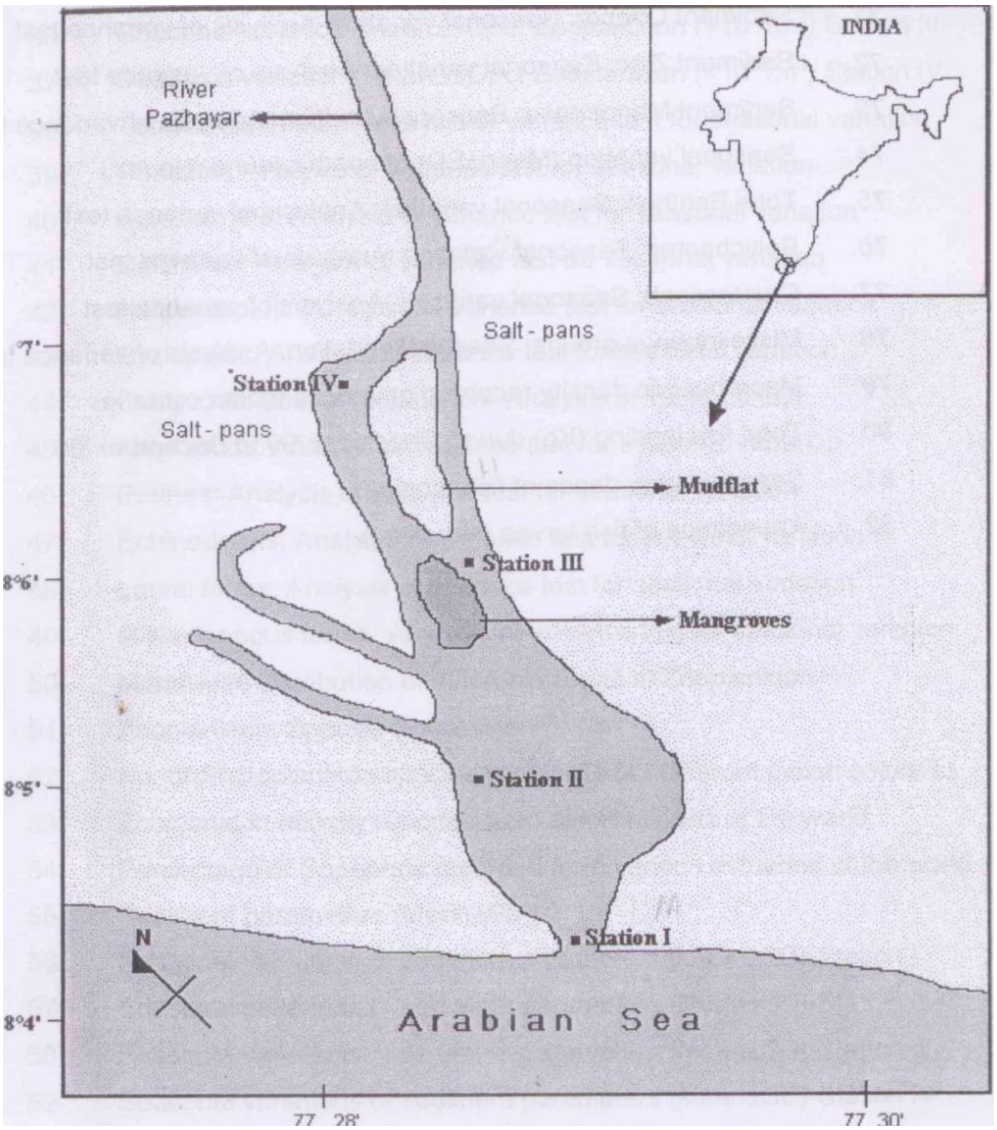

Figure 1. Map of the Manakudy estuary showing different locations.

during this period. Regular bimonthly observations were made at a fixed point on the western bank of the estuary near the bar mouth where normally the entire catch is inlanded. The number of units operated in the day of collection and species composition of the catch by random sampling was noted. The catches are assorted into major categories like fishes, crabs, shrimps and prawns etc. Approximate weight of each group is taken using a monopan balance. When sorting of the catches was not possible, eye estimation was made. The total catch per day is calculated by multiplying the average weight of each category with the number of crafts operated on the day of observation. The quantity thus obtained is that quantified to total monthly catches by multiplying with total number of actual fishing days in that particular month.

Fishing crafts and gears

The total number of craft used here is enumerated to be 25 fibreglass boats and 15 numbers of dugout canoes. The main gears employed for fishing here are cast nets, gill net nets, drag nets and small shore seines. Among these, cash nets or 'veechu valai' with varying mesh sizes (12, 16 and 20 mm) is the common gear. Each boat used two to three cast and gill nets. It is mostly operated either in knee-deep water or form a small catamaran or dugout canoe manned by two persons, in deeper areas of the estuary.

RESULTS AND DISCUSSION

Totally, 38 species were recorded, among them, 30 species were most popular as food as well as game fishes and posses high economic value. Identified fishes including 3 groups, belonging to diverse groups, namely, fishes (30), shrimps/prawns (5) and crabs (3) were recorded. In fishes, 13 families, 23 genuses were recorded; the majority of fish was landed followed by *Arius* forms

Table 1. Total fish catches (kg) in Manakudy estuary during (February 2010 to January 2011).

Fish	Shrimp/prawn	Crab
Mugil cephalus	*Penaeus monodon*	*Scylla serrata*
Liza parsia	*Penaeus indicus*	*Scylla trangubarica*
L. tade	*Penaeus semisulcatus*	*Portunus pelagicus*
Gerres abbreviatus	*Metapenaeus dobsoni*	
Etroplus maculatus	*Macrobrachium rosenbergii*	
E. suratensis		
Terapon jarbua		
T. theraps		
Lutjanus sp		
Elops machnata		
Chanos chanos		
Lates calcarifer		
Anguilla bengalensis		
Hilsa kelee		
Tilapia nilotica		
Oreochromis mossambica		
Tilapia mossambica		
Ophiocephalus punctatus		
Arius thalassinus		
Arius dussumieri		
Arius maculatus		
Anguilla bicolor		
Ambassis ambassis		
Lutjanus gibbus		
Cynoglossus lingua		
Sillago sihama		
Mene maculata		
Channa orientalis		
C. punctatus		
Anabas testudineus		

(3 sp.), *Mugil* forms (3 sp.), *Tilapia* forms (3sp.), *Etroplus* forms (2sp.), *Terapon* forms (2sp.), *Channa* forms and *Anguilla* forms (2sp.). In shrimps/prawns, *Penaeus* shrimp were the dominated species. The mud crab *Scylla serrata* was the only representative observed in the commercial catches. Data on the seasonal variations of fish landings in the Manakudy estuary show maximum landing during the premonsoon comprising about 46.67% of the total catch. During the monsoon it was about 30.65%. The lowest catch was during the post monsoon (22.68%) (Table 1).

Physico-chemical properties

Atmospheric temperature varied between 23.0 and 32.5°C in stations 4 and 2, respectively. The minimum (23.0°C) was recorded during monsoon season in December and the maximum (32.5°C) was observed during summer in May (Figure 2). Surface water temperature ranged from 24 to 31.0°C in stations 3 and 2, respectively. The minimum (24.0°C) was recorded during monsoon season in December while the maximum (31.0°C) was during summer in May (Figure 3). Salinity varied between 22.5 and 35‰ in stations 3 and 2, respectively. The minimum (22.5‰) was recorded during monsoon season in December, while the maximum (35.0 ‰) was observed during summer in May (Figure 4). Water pH fluctuated between 7.5 and 8.4 in stations 2 and 3, respectively. The minimum (7.4) was recorded during monsoon season in December, while the maximum (8.4) was observed during summer in May (Figure 5). The turbidity varied from 48.0 to 327.0 NTU in stations 1 and 2, respectively. The minimum (48.0 NTU) was observed during summer in June, while the maxi-mum (327.0 NTU) was recorded during monsoon season in December (Figure 6). The total suspended solids varied from 97.0 to 558 mg/l in stations 1 and 3, respectively.

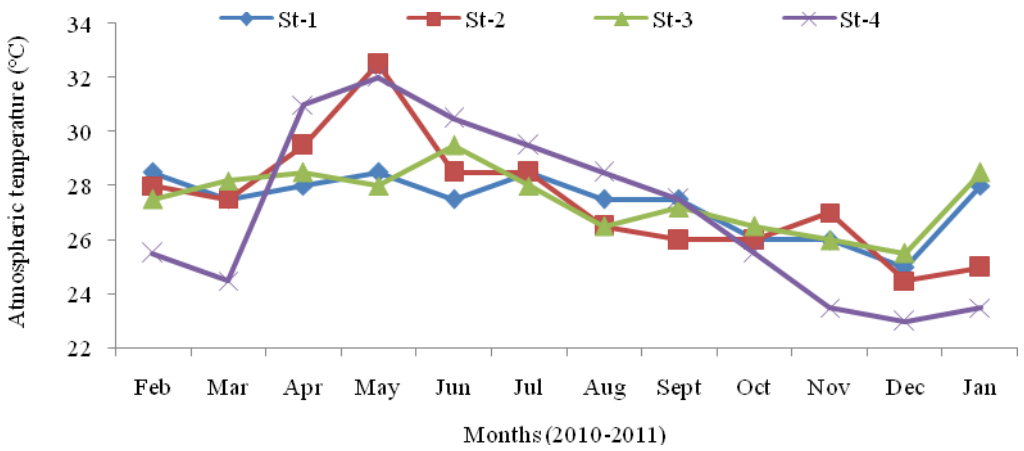

Figure 2. Variations in atmospheric temperature (°C) recorded at four different stations.

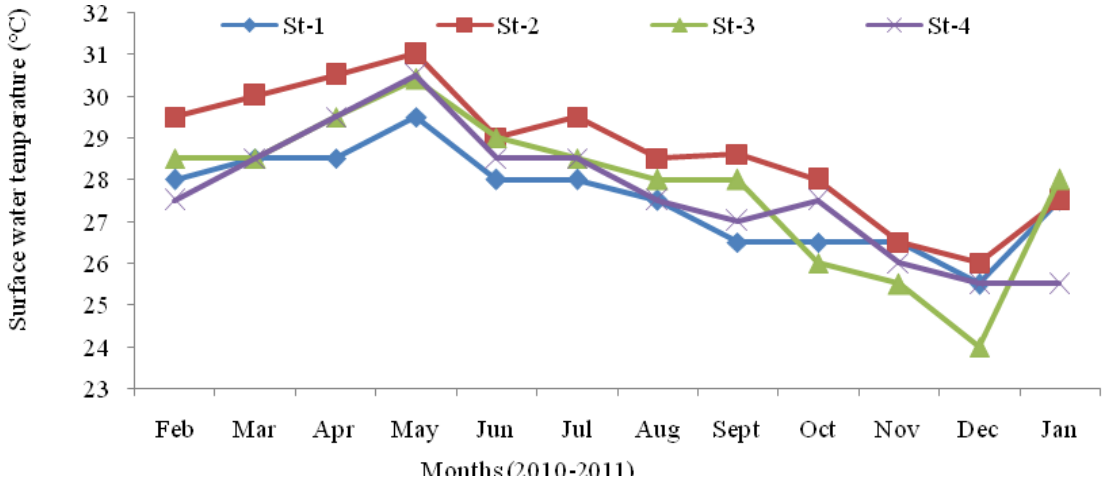

Figure 3. Variations in surface water temperature (°C) recorded at four different stations.

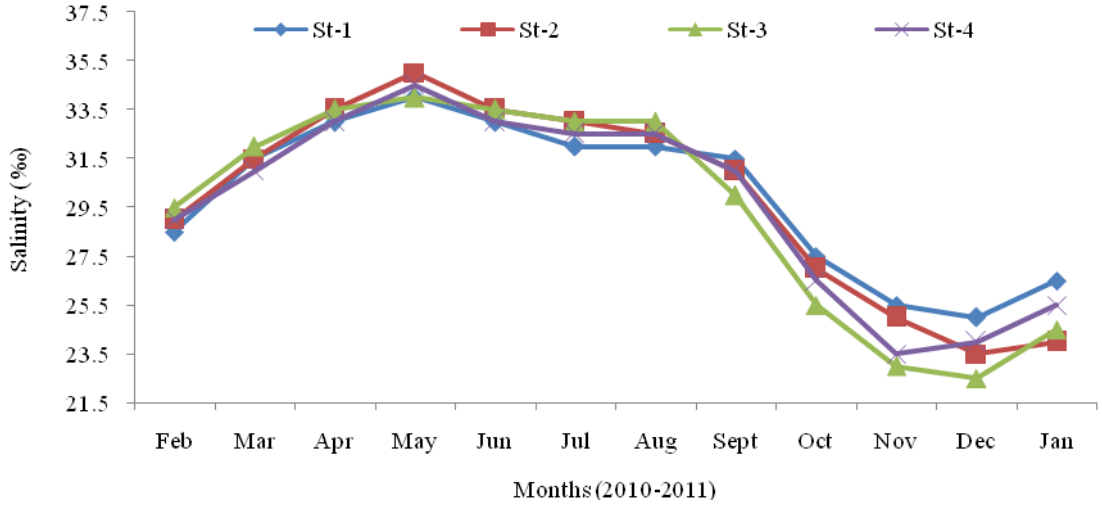

Figure 4. Variations in salinity (‰) recorded at four different stations.

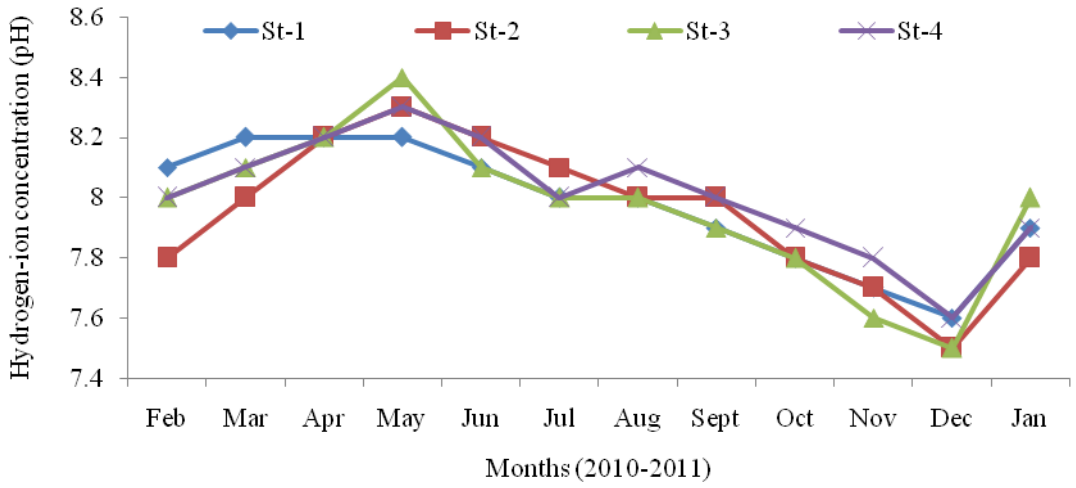

Figure 5. Variations in water pH recorded at four different stations.

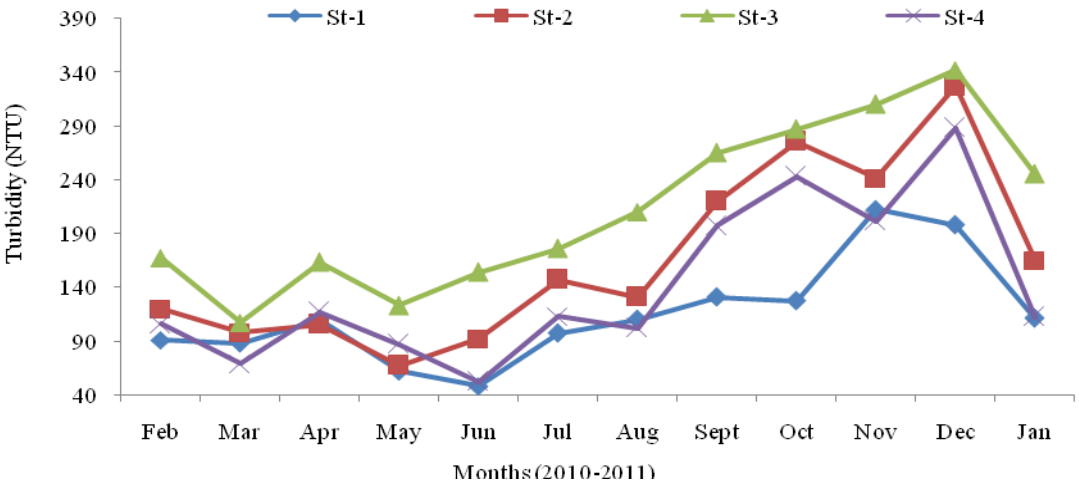

Figure 6. Variations in turbidity (NTU) recorded at four different stations.

The minimum (97.0 mg/l) was noticed during summer in June, while the maximum (558 mg/l) was recorded during monsoon season in December (Figure 7).

Dissolved oxygen was recorded from 3.29 to 5.44 mg/l in stations 2 and 3, respectively. The minimum (3.29 mg/l) was noticed during postmonsoon season in February, while the maximum (5.44 mg/l) was recorded during monsoon in October (Figure 8). Nitrite concentration ranged from 0.148 to 1.282 µmol/l in stations 2 and 3, respectively. The minimum (0.148 µmol/l) was noticed during summer in May, while the maximum (1.282 µmol/l) was recorded during monsoon season in November (Figure 9). Nitrate concentration ranged from 0.611 to 6.416 µmol/l in stations 4 and 3, respectively. The minimum (0.611 µmol/l) was noticed during summer in May, while the maximum (6.416 µmol/l) was recorded during monsoon season in December (Figure 10). The ammonia concentration ranged from 0.031 to 0.222 µmol/l in stations 2 and 3, respectively. The minimum (0.031 µmol/l) was noticed during premonsoon in August, while the maximum (0.222 µmol/l) was recorded during postmonsoon season in February (Figure 11). The total nitrogen concentration ranged from 7.213 to 17.618 µmol/l in stations 2 and 3, respectively. The minimum (7.213 µmol/l) was noticed during summer in June, while the maximum (17.618 µmol/l) was ob-served during monsoon season in December (Figure 12). The value of inorganic phosphate ranged from 0.310 to 1.132 µmol/l in stations 2 and 3, respectively. The mini-mum (0.310 µmol/l) was recorded during summer in July, while the maximum (1.132 µmol/l) was observed during monsoon season in December (Figure 13).

Total phosphorus concentration ranged from 3.29 to 5.44 µmol/l in stations 4 and 2, respectively. The mini-

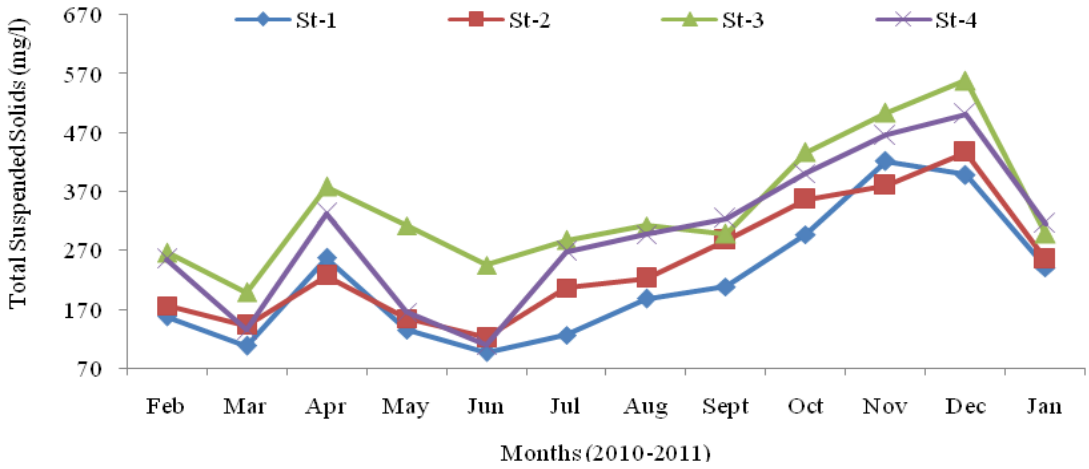

Figure 7. Variations in total suspended solids (mg/l) recorded at four different stations.

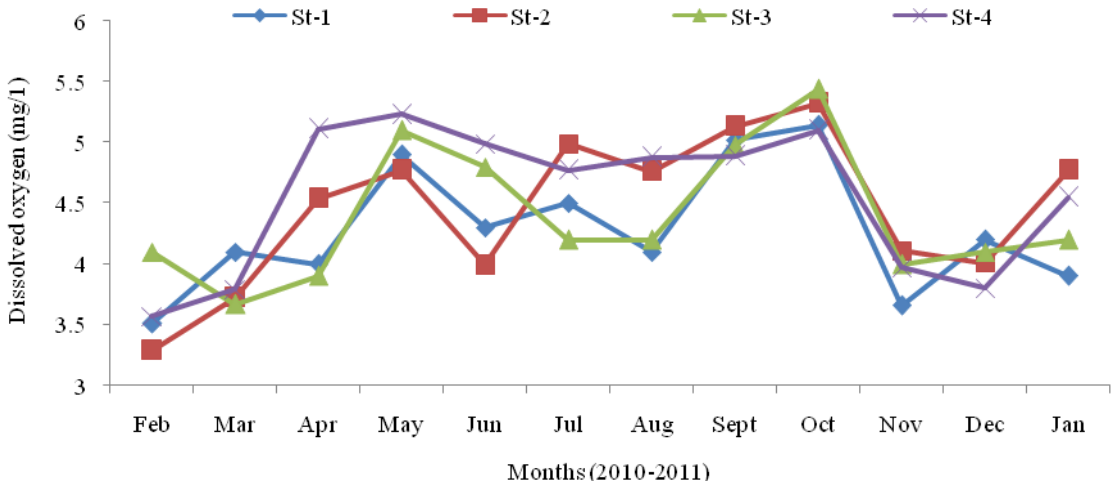

Figure 8. Variations in dissolved oxygen (mg/l) recorded at four different stations.

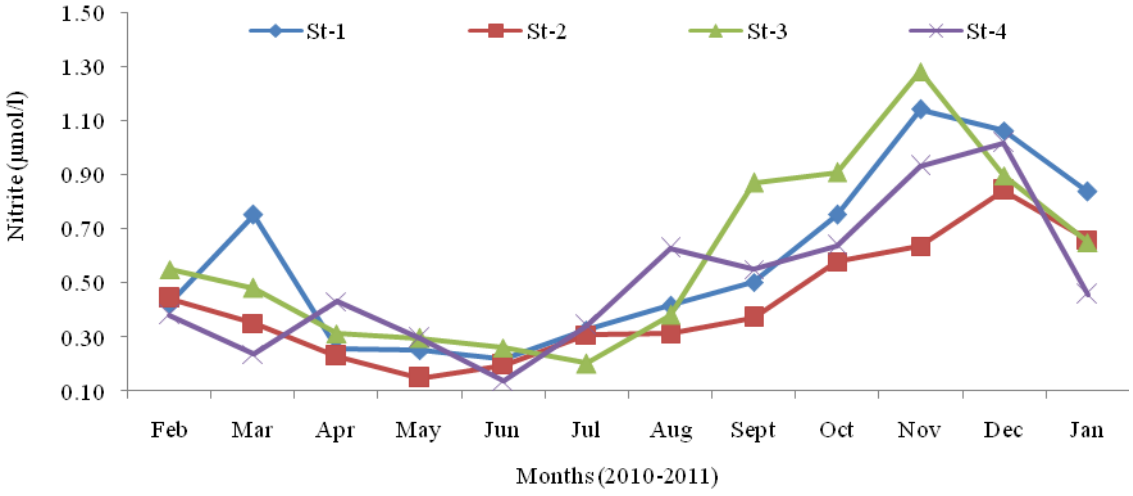

Figure 9. Variations in nitrite (µmol/l) concentration recorded at four different stations.

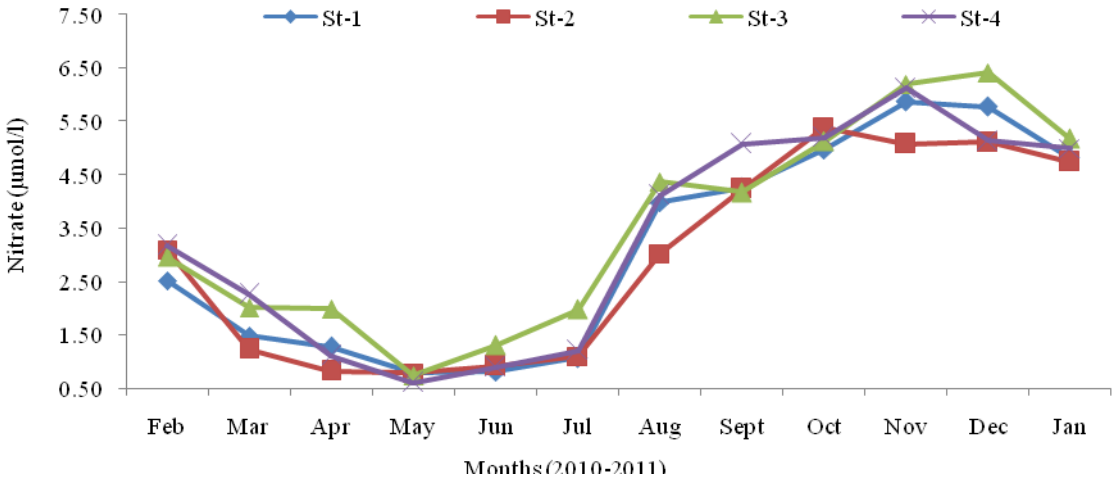

Figure 10. Variations in nitrate (µmol/l) concentration recorded at four different stations.

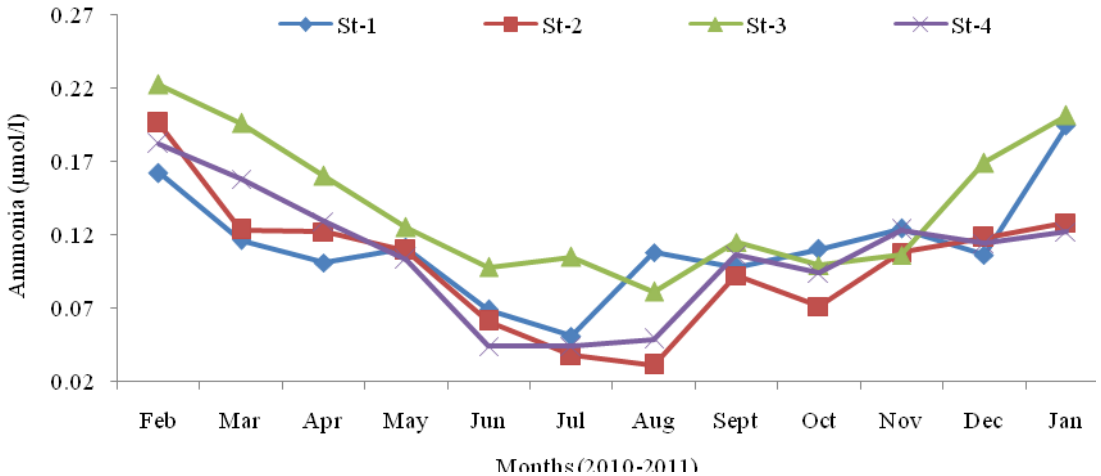

Figure 11. Variations in ammonia (µmol/l) concentration recorded at four different stations.

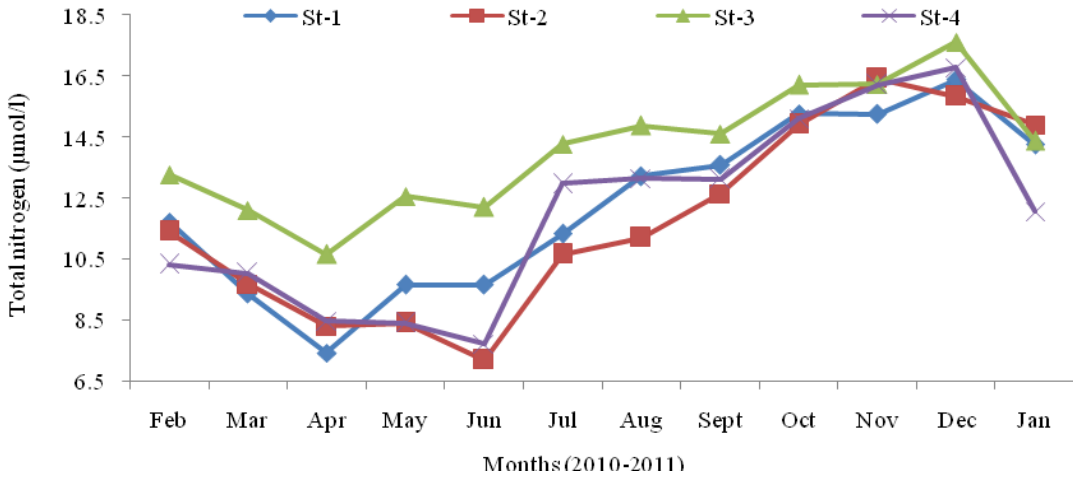

Figure 12. Variations in total nitrogen concentration recorded at four different stations.

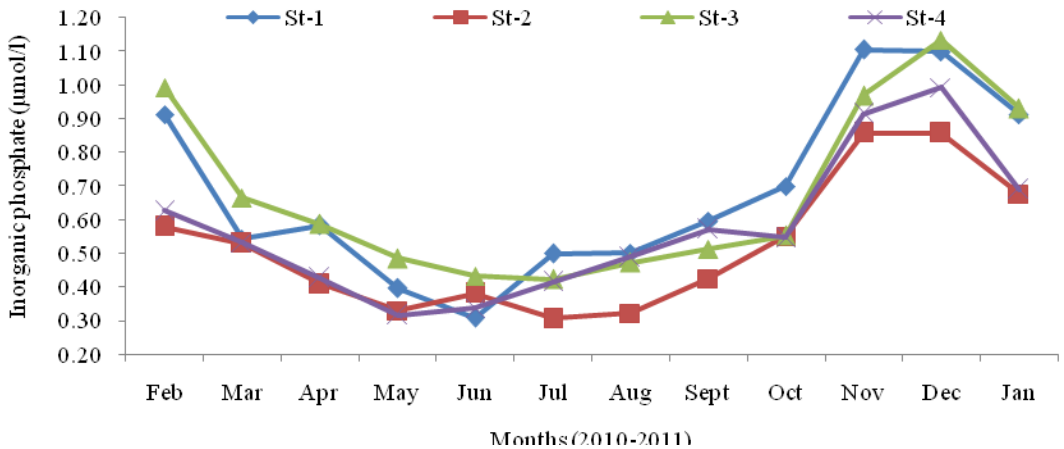

Figure 13. Variations in inorganic phosphate concentration recorded at four different stations.

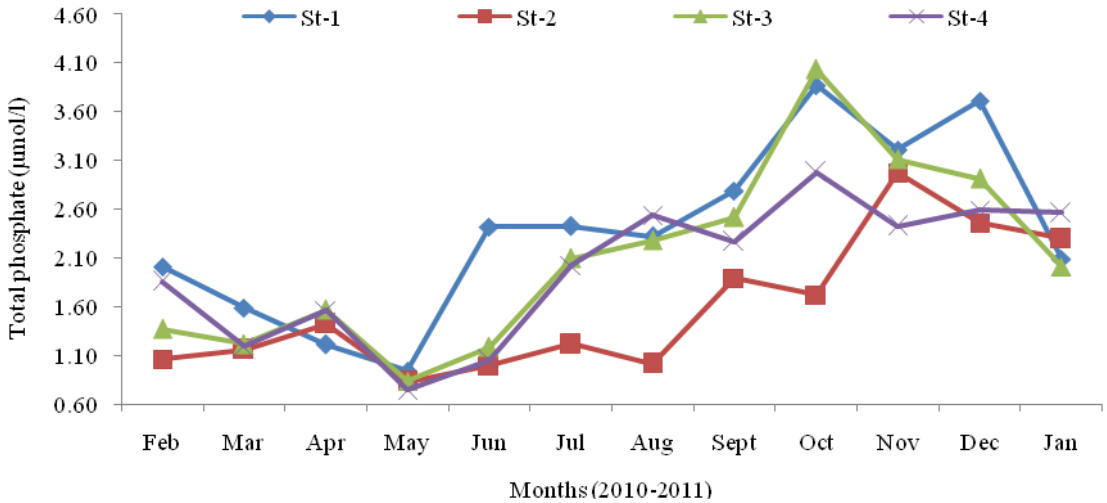

Figure 14. Variations in total phosphorus concentration recorded at four different stations.

mum (3.29 µmol/l) was noticed during summer in February, while the maximum (5.44 µmol/l) was observed during monsoon season in October (Figure 14). The reactive silicate concentration ranged from 10.123 to 39.296 µmol/l in stations 2 and 3, respectively. The minimum (10.123 µmol/l) was noticed during summer in June, while the maximum (39.296 µmol/l) was observed during monsoon season in November (Figure 15) (Table 2). Manakudy estuary is significant intended for different aspects such as resource of mangroves nursery ground, irrigation, flora, fauna and source of fishery production. Suseelan (1975) estimated that 4 tons of penaeid prawns were obtained from the estuary and Tharadevi (2002) has recorded 23 fish species comprising eight genera and five families reported. Consequently, present studies have been conducted for investigation of fish diversity and physico-chemical properties of Manakudy estuary, 30 fin fishes and eight shell fishes have been identified during present studies, which were higher than that of previous observations. It might be further increase in fish diversity for upcoming few years. The present study has recorded several important environmental factors that are influencing the estuarine waters. In general, higher air and surface water temperatures were recorded during the summer season.

The minimum temperature recorded during the monsoon season could be ascribed to the rainfall caused by the northeast monsoon at Manakudy estuary. During the present study period, the surface water temperature was always lower than that of air temperature. This indicates that the water temperature was mainly influenced by air temperature, besides water currents. Similar seasonal patterns were reported by Arumugam (2003) and Jeena (2010) from the Manakudy estuary, west coast of India. Salinity is one of the important factors that influences the functional physiology and reproductive activity of the

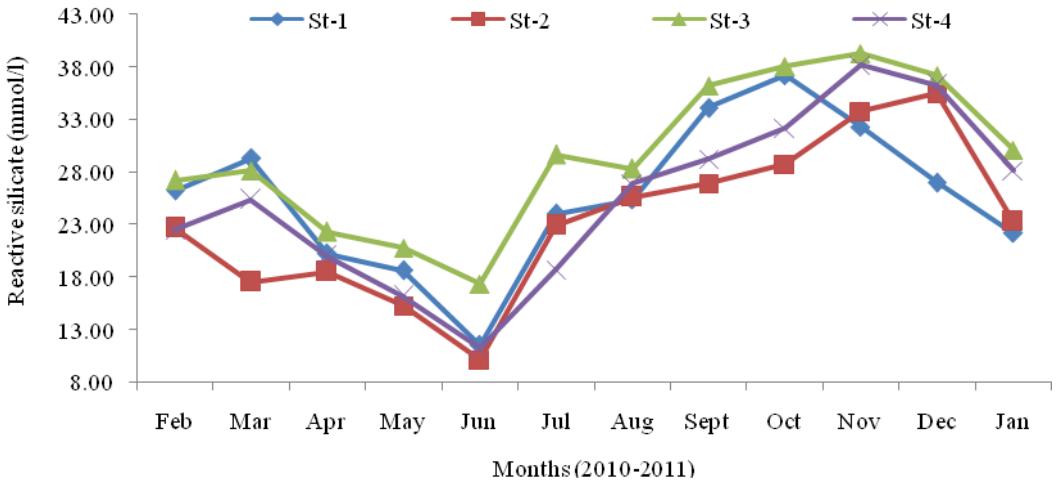

Figure 15. Variations in reactive silicate concentration recorded at four different stations.

Table 2. Minimum and maximum range Mean ± SD of physico-chemical parameters from Manakudy estuary, during February 2010 to January 2011.

Parameter	Maximum minimum	Maximum minimum
Air temperatures (ºC)	32.5±2.5	23±1.8
Surface water temperatures (°C)	31.0±1.5	24±1.4
Salinity (‰)	28±3.1	7.5±2.1
pH	8.4±0.73	7.5±0.56
Turbidity (NTU)	327±14.5	48±8.3
Total suspended solids (mg/l)	558±24.5	97±11.2
Dissolved oxygen (mg/l)	5.44±0.87	3.29±0.4
Nitrite (µmol/l)	1.28±0.21	0.15±0.1
Nitrate (µmol/l)	6.42±0.91	0.61±0.5
Ammonia (µmol/l)	0.22±0.02	0.03±0.01
Total nitrogen (µmol/l)	17.6±1.3	7.2±0.8
Inorganic phosphate (µmol/l)	1.13±0.2	0.31±0.1
Total phosphorus (µmol/l)	4.03±0.81	0.74±0.2
Silicate (µmol/l)	39.30±5.1	10.12±3.4

organisms (Karuppasamy and Perumal, 2000). In the present study, salinity was higher during the summer. This could be due to the continuous evaporation of water from the study area especially during these seasons as also observed by Krishnamurthy (1954), Sundararaj and Krishnamurthy (1975), Anilakumary and Abdulazis (1998) and Karthikeyan (2007). Dissolved oxygen showed higher values during the monsoon season and lower values during the postmonsoon season. The latter could be due to the decrease in oxygen solubility because of increase in temperature and salinity of the water column during the summer season. Similar observations have been made by Indharani and Natarajan (2005) from Manakudy estuary, Anilakumary and Abdulazis (1998) from Poondhura estuary.

Nutrient concentrations showed distinct seasonal variations. Total phosphorus and inorganic phosphate showed little fluctuation, recording the maximum during the monsoon season and the minimum during the summer season. The increased phosphate concentration observed during the monsoon season in the study area could be due to the land runoff from the irrigation channels and release of phosphate from the sediments due to high wind action during this season. The lower phosphate concentration during the summer season could be attributed to the utilization of the nutrient by the living organisms, which occurred in higher densities during the postmonsoon and summer seasons. Higher and lower values of nitrate were recorded during the monsoon and summer seasons respectively. Balasubramanian and

Kannan (2005) also observed a similar trend in the Gulf of Mannar coastal water. Nitrite concentration showed a marginal difference in its sea-sonal distribution. Monsoon recorded higher concen-tration and summer season recorded lower concentration of nitrite. The range of various physicochemical parameters as shown in Figures 1 to 14, which was found to be within the tolerance limit and appropriate for growth of aquatic fauna, flora and stocking of fishes.

Water temperature showed minor fluctuation over the seasons (24 to 31.0°C); the higher water temperature values in general were recorded during summer and lower water temperature values during monsoon, when water temperature increase salinity also increases. Salinity fluctuation observed during the study ranged from 7.5 to 28‰, which agree with those reported earlier for Manakudy estuary. Salinity variation in tropical estuaries is considerable and this generally controls the species composition and succession of planktonic organisms (Arumugam, 2003). Generally, a higher abundance of fin and shell fishes was associated with higher salinity water in Manakudy estuary. Relationship between fish abundance and salinity was more closely related than that temperature. Suseelan (1975) have reported that among all physic-chemical variable, salinity plays a vital role in controlling the distribution and abundance of shell fish in the Manakudy estuary. Abundance of fin fish also followed the same trend in the estuary studied, suggesting that salinity is a critical factor for the fish resource in the estuary. Oxygen distribution provides a good index of productivity and quality of the environment. Higher oxygen concentration is indicative of higher photosynthetic efficiency and phytoplankton production. In the present study, dissolved oxygen concentration was found to vary from 3.29 to 5.44 mg/l, indicating a well oxygenated water bodies. It has been well established that estuarine environment acts as a nursery for a number of species of shell and fin fishes. This is evident from the fact that several reports on their occurrence are available from the estuarine along the Indian coast (Jhingran and Gopalakrishnan, 1973; Thangaraja, 1995; Tharadevi, 2002; Karthikeyan, 2007).

Salinity and temperature are considered to be important factors responsible to make the estuary as a nursery ground for fin fish as well as shell fish. But presently, many authors have come to the conclusion that it is the combination of several factors such as low salinity relatively high temperature, sufficient nutritionally rich food and protection from the predators that provide stable environments for growth of the young fish (Mukhopadhyay et al., 1995). A similar trend is also observed in Manakudy estuary. Fish population can be roughly classified into those that spawn in the monsoon, post monsoon, summer and pre monsoon. This type of seasonal spawning is prominent in species inhabiting cold waters. But in some warm water species, the spawning period is extending from one to another season (Qasim, 1956).

Conclusion

Considering the fishery potential of the Mankudy estuary with special reference to their conservation, it can be concluded that the system is a valuable source for the seeds of a number of cultivable species of fishes and crustaceans. Further, it offers a good support to the livelihood of fishermen residing in the adjoining villages by offering a considerable quantity of fish and crustacean protein. The plantation of mangrove has increased the fish production in the estuary, as revealed in the present study.

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