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PHYSICO CHEMICAL AND MICROBIAL ANALYSIS OF MUTHUPETTAI SALAINE SWAM

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ABSTRACT :

The Southern coast of India is an important stretch of coastline, where many major rivers drain into the Bay of Bengal and were richest source of marine fauna and flora. Assessment of water resource quality of any region is an important aspect of developmental activities of the region. Hence an attempt has been made to study the physic-chemical parameters of the Muthupettai saline swamp. The study revealed the following observation. The levels were found low during the premonsoon and the increases in levels were found during. The BOD level were found to be high during premonsoon 328.5±71.41 mm/l and low level were recorded during monsoon period 96±9. The COD levels were found to be high during summer 64.66±13.05 mm/l and low level during monsoon period 56±8.5 mm/l^{-1}. Very trace levels of heavy metals were observed in all the four seasons. The analyses of heterotrophic bacteria revealed that totally 17 bacteria were analysed. The analysis include Vibrio sp, Marinobacter, Gamma Proteobacteria, Mthylophaga, Alcanovorax, Francisella, Alpha Proteobacteria, Psychrobacteria, Marichromatoum, Shewanella, Halothiobacillus sp, Alteromonas sp, Reseovarius, Rhodobacterium, Mesorhizobium, Acidothiobacillus and Halomonas sp.

KEYWORDS : *Estuary, Physico-chemical, BOD, COD, Vibriosis sp.*

INTRODUCTION:

Estuarine and coastal areas are complex and dynamic aquatic environment. India has a long coast line of 8,129 km and of this 6,000 km is rich in estuaries, creeks, brackish water, lagoon and lakes. The southeast coast of India is an important stretch of coastline, where many major rivers drain into the Bay of Bengal and them also richer in marine fauna and flora (Rajkumar *et al*., 2011). The rapid industrialization and aquaculture practices along the estuarine system and also in the mangrove areas have brought considerable decline in the water quality of brackish water and the estuaries and mangrove swamps have been regarded as convenient place for the disposal of sewage and waste water due to the tendency of pollutants to be recycled within these naturally eutropic systems (Laws, 2000).

As estuary is the area where river get emptied into the ocean it has hydrological characteristics different from sea and river. Since the hydro-geographical characters prevailing in the estuarine habitat is well suited for the breeding and feeding activities of a wide variety of fauna and flora, more than 90 percent of marine fish and other living resources are found in the estuaries and in the adjacent coastal water bodies (Croot and Hunter, 1998). Mangrove provides an ecologically important habitat for a wide diversity of many species. Their distribution depends upon the geographical, biological, ecological and

physicochemical characteristics of the water. Different species of shellfish and fin fish that benefit from conditions advantageous for reproduction, feeding and wintering (Kathiresan and Rajendran, 2006).

The word mangrove is formed by two words: in portugues "Mangue" (Meaning tree bush) and the English "Grove" (Macnae, 1968). Coined a new name "mangal for mangrove community and retained the term mangrove" for individual species. These complex ecosystems are found between the latitudes of 300 North and 380 South, along the tropical coast of Africa, Australia, Asia and America. Mangroves include approximately 16 to 24 families and 54 to 75 species. Mangroves are well distributed in Asia, North America, Africa, Australia and New Zealand. The greatest diversity of mangrove species exists in South-East Asia (Chapman, 1976).

Mangroves are distributed circum tropically occurring in 112 countries and territories of the total coverage 41.4% exist in Southeast Asia. Mangrove communities develop in the intertidal and sub tidal area, but more between mid-tidal levels to extreme high water mark. The total global area of the mangrove is estimated at 18.1 million ha. Mangroves are the fragile and highly productive ecosystem occurring along the coastal belt of our country. Indian mangroves are distributed in about 6740 sq km area constituting about 71% of the world's mangrove and 8% of the total coverage of the Indian coastline. The mangroves are divided into deltaic, back water estuarine and insular categories. Mangrove forests are important wetlands among the tropical and subtropical coasts, providing environmental sustainability, ecological security and economic prosperity.

Human activities have already negatively influenced water quality and aquatic ecosystem functions. This situation has generated great pressure on these ecosystems, resulting in a decrease of water quality and biodiversity, loss of critical habitats, and an overall decrease in the quality of life of local in habitants (Herrera-Silveira and Morales-Ojeda, 2009). Assessment of water resource quality of any region is an important aspect of developmental activities of the region because rivers, lakes and manmade resevoirs are used for water supply to domestic, industrial, agricultural and fish culture (Saravana Kumar *et al*., 2008).

The mangrove system plays a major role in the global cycle of carbon, nitrogen as well as sulphur and acts as reservoirs of waste materials (Kathiresan and Bingham 2001; Kathiresan, 2000). Coastal wetlands play a significant as a transition water body between land and the sea. Understanding the present characteristics of the ecosystem and the impacts that may arise due to future activities Muthupet lagoon (Vedaranyam) located along the coromandal coast in one of the least disturbed ecosystem and it would be ideal location for ecosystem modelling.

Within the delta, the distributary system of Cauvery river stands exposed as palaeo channels only, the present day Vennar, Vettar, Arasalar and many other ephemeral streams are following (Ramasamy *et al*., 1995). Mainly the productivity and faunal distribution in estuaries and mangroves depend on various physico-chemical factors such as temperature, pH, salinity, DO and nutrients such as ammonia, nitrate, nitrite and silicate (Vijayakumar *et al*., 2000). They also from the centres for natural seed collection of most of the commercially important fin fishes and shell fishes suitable for aquaculture. Hence an attempt has been made to study the physic-chemical parameters of the Muthupettai saline swamp.

MATERIALS AND METHOD

Location of sample collection area

Muthupet (Lat. 11°-42° N, Long 79°-39°E) is a panchayat town in Thiruvarur district in the Indian state of Tamilnadu. The town lies adjacent to the Bay of Bengal and is in the southern most part of the Cauvery delta. Muthupet is bounded by Korayar and Baminiyar rivers to the east and west respectively. The rivers Koraiyar and Baminiyar join near Muthupet, and there is a lagoon, which is rich in fish. Muthupet is an ideal place for fishing, pearl hunting and bird hunting. It is well known for its fishing industries such as finfish (Koduva), shrimp and crab. Muthupet estuary is formed by the tributaries of Cauvery River and opens into estuary on the South East coast of India.

The water samples were collected from Muthupet estuary, Muthupet east cost, Thiruvarur district, Tamilnadu, India. The present study was carried out for Muthupet estuary and the coastal

water of Muthupet east coast. The samples were collected during Aug-2016 to July-2017. The samples were brought to the laboratory aseptically. In order to have uniformity, water samples were collected from fixed locations on the study sites. The four distinct seasons were summer, premonsoon, monsoon and postmonsoon of periods.

The temperature was recorded using thermo meter and the pH was recorded using pH meter. The other parameters such as Dissolved Oxygen (DO), BOD, COD, Carbonate, Salinity, Calcium, Chloride, Nitrate and Nitrate were estimated by using standard procedures (Eaton *et al*., 1994). The trace metals and heavy metal were estimated at district watershed Development Agency, Tiruchirappalli, Tamil Nadu, India.

The microbial analyses were performed out shrimptex laboratory Chennai. The samples were plated on the Thiosulphate Citrate Bilesalt Sucrose Agar (TCBS Himedia, pH 8.2±2 Mumbai) and Nutrient Agar (Himedia, pH 7.8±0.2 Mumbai) and Zoobel agar medium (Aneja, 1994). The isolates were subjected to biochemical batteries and the bacteria were characterized (Holt *et al*., 1994; Alsina and Blanch, 1994).

Results

The study on the physicochemical and microbial analysis revealed the following observation. Among the physicochemical parameters analysed variations were observed in pH, temperature, BOD and COD and were to and to be significant difference between the physicochemical parameters and seasons. The levels were found low during the premonsoon and the increases in levels were found during summer. The BOD level was found to be high during premonsoon 328.5±71.41 mm/l and low level during monsoon period 96±9. The COD levels were found to be high during summer 64.66±13.05 mm/l and low level during monsoon period 56±8.5 mm/l^{-1}. Very trace levels of heavy metals were observed in all the four seasons (Table-I).

The analyses of heterotrophic bacteria revealed that totally 17 bacteria were analysed. The analysis include *Vibrio* sp, *Marinobacter*, *Gamma Proteobacteria*, *Mthylophaga*, *Alcanovorax*, *Francisella*, *Alpha Proteobacteria*, *Psychrobacteria*, *Marichromatoum*, *Shewanella*, *Halothiobacillus* sp, *Alteromonas* sp, *Reseovarius*, *Rhodobacterium*, *Mesorhizobium*, *Acidothiobacillus* and *Halomonas* sp (Table – II).The total count study revealed that the *Vibrio* were found to be during Monsoon and Post monsoon period. *Marinobacteria* were found maximum of the months of year such as Monsoon, Post monsoon and summer seasons. The *Shewanella* sp were found Pre monsoon, Monsoon and Post monsoon periods. The study revealed that the bacterial population was directly related to the season representing that fewer were found during summer seasons (Table – III & IV).

DISCUSSION

Physical parameters of water include mainly temperature. Water temperature is crucial to aquatic life. Temperature is importance to physiological process such as photosynthesis and respiration. Physiological stress may be experienced when high temperature is combined with full sunlight. The tractors may be due to decomposition of mangrove litter. Electrical conductivity (EC) of water is a measure of ability of the water sample to conduct electric current, which is the reciprocal of resistance. It provides a very rapid means of obtaining a good estimate of the total dissolved solid concentration and salinity of water samples. Most of the dissolved inorganic substances in water are in an ionized state are found dissolved in natural water, the common ones being carbonates, chlorides, sulphates, phosphates and nitrates of Ca, Na, K, etc. which contribute to electrical conductivity in water samples analysed (Lakshmi, 2002). Estuaries and finally ends up in the sea. Estuaries, the important contributors of fisheries in India, suffer from severe loss of fish production due to increased industrialization and urbanization along the coastal zone by continuous discharge of industrial effluents (Padmini *et al*., 2004). Under the influence of a variety of inter-related biotic and abiotic structural compounds and intensive chemical, physical and biological process, estuaries are highly variable systems.

Jayakumar *et al*., (2009) discussed the temperature also influences the concentration of dissolved oxygen and many other physical and biological factors in the water bodies. It also controls the reproduction, diversity, migration and behavioral characteristics of animals and plants. The range of temperature generally varies in different environments like terrestrial, fresh water and marine media. Higher temperature values recorded in the dry months are expected since heat from the sunlight increases temperature of surface water similarly the sudden drop in water temperature in the wet season's month is attributable to heavy rainfall, strong land sea breeze and precipitation experienced during the period (Abowei and George, 2009).

Arumugam *et al*., (2014) reported that the Dissolved oxygen (DO) is an important parameter of water quality, which is an index of physical and biological processes taking place in water. Dissolved oxygen in water maintains the higher form of life and keeps the proper balance of various populations, thus making the water body healthy. Dissolved oxygen concentrations in mangroves vary according to areas and zonation of plants. The results indicate that dissolved oxygen is maximum in postmonsoon season 0.4±0.28 mg/l and minimum summer season in 0.04±0.02 mg/l in Muthupet estuary respectively. The rate of removal of oxygen by microorganisms through the anaerobic degradation of dissolved organic matter is reflected as Biological Oxygen Demand (BOD). BOD is an index of organic pollution in water. The BOD of tidal waters and estuaries is affected by salinity and only low values were obtained. The BOD values for during premonsoon range from 328.5±71.41 mg/l and 96±9 mg/l during monsoon. Total alkalinity depends on the concentration of the substance which would raise the pH of the water. The high levels of alkalinity indicate the presence of strongly alkaline industrial waste water and sewage in the estuary (Safari *et al*., 2012). Wang *et al*., (2006) observed the degradation of plants, living organisms and organic waste in the estuary might also be one of the reasons for increase in carbonate and bicarbonate levels. Mohanraj *et al*., (2013) discussed that total hardness is the parameter of water quality used to describe the effect of dissolved minerals (Mostly Ca and Mg) determining suitability of water for domestic, industrial and drinking purpose attributed to presence of bicarbonates bicarbonates, sulphates, chloride and nitrates of calcium and magnesium. High values of hardness are probably due to regular addition of large quantities into lakes which drains into estuaries.

Govindasamy *et al*., (2012) reported that at the sediment bacterial population found to be higher than that of the water. The difference between the bacterial population of water and sediment at the end of the experiment and the variation in the density between these two populations during the first collection were found to be closer. Sundaravanam *et al*., (2012) reported that the mangrove lagoon is unique to have physicochemical parameters that mostly did not vary significantly from landward site towards seaward sites. Mangroves provide a unique ecological environment for diverse bacterial communities. The study also revealed that total Heterotrophic Bacterial (THB) counts were recorded many-fold higher in the lagoon proper lined with a dense growth of *Avicennia marina* also in the site enriched with *Excoecaria agallocha* than the coastal shelf area or the landward site and or the mouth region.

Globally, mangrove ecosystem are an important natural resource that should be protected. The detritus generated by the mangrove is the base of an extensive food web that sustains numerous organisms of ecological and commercial importance. Furthermore, mangrove ecosystem provides indispensable shelter and nurturing sites for many marine organisms. The well-being of mangroves is dependent on the diverse and largely unexplored, microbial and faunal activities that transform and recycle nutrients in the ecosystem.

Table:I

Seasonal variation of physico-chemical parameters of Muthupettai estuary.

S.No	Parameters	Pre Msonsoon	Monsoon	Post Monsoon	Summer

PHYSICAL PARAMETERS					
1	Colour	<1hue	<1hue	<1hue	<1hue
2	Odour	Agreeable	Agreeable	Agreeable	Agreeable
3	Tubidity	67.5±3.535	10±5	18.33±7.637	15±5
4	Total dissolved Solids (mg/l)	1901±8.4852	495±68.73	667±135.125	680.6±105.26
5	pH	7.57±0.0282	7.083±0.068	7.84±0.539	7.876±0.3326
6	Electrical conductivity	2.97±0.01414	0.773±0.1068	1.046±0.2203	0.986±0.0776
7	DO	Nil	Nil	0.4±0.282	0.04±0.02
8	BOD	328.5±71.417	96±9	157.6±54.72	172±7.5498
9	COD	63.525±88.352	56±8.5440	60.33±4.725	64.66±13.051
ANIONS					
10	Carbonate	Nil	Nil	0.57±0.0707	0.236±0.0808
11	Bicarbonate	435±70.710	147±4.582	204.3±64.29	227.33±24.193
12	Chloride	902.5±122.32	145.6±9.073	175±28.930	179±7.9372
13	Sulphate	162±48.083	69.33±5.507	85.33±17.616	90±5
14	Phosphate	0.255±0.1343	0.02±0.01	0.033±0.152	0.0566±0.0251
15	Silicate	7.17±3.5072	3.543±0.378	4.433±0.779	5.173±0.1484
16	Nitrate	0.375±0.2616	0.046±0.015	0.16±0.1228	0.236±0.0602
17	Nitrite	0.305±0.3606	Nil	Nil	0.366±0.04163
18	Fluoride	6.61±2.8567	4.32±0.173	4.94±0.8838	4.98±1.2932
19	Aluminium	Nil	Nil	Nil	Nil
CATIONS					
20	Calcium,	839.5±71.417	116±3.605	201.66±80.214	264.33±15.0443
21	Magnesium	207.5±112.42	58.66±10.016	108.6±46.479	124.33±15.0443
22	Sodium	797±26.870	67±9.165	64±13.228	53.66±6.0277
23	Potassium	0.27±0.0707	0.203±0.0208	0.153±0.0404	0.243±0.1050
HEAVY METALS					
24	Zinc	0.175±0.0777	0.01±0	0.03±0.02	0.0266±0.0115
25	Copper	0.14±0.0707	0.01±0	0.016±5.773	0.0166±0.0115
26	Iron	0.335±0.1202	0.016±5.773	0.035±8.660	0.0566±0.0251
27	Manganese	0.155±0.0636	0.01±0	0.016±5.773	0.0133±5.773
28	Chromium	Nil	Nil	Nil	Nil
29	Lead	Nil	Nil	Nil	Nil

Table: II - Heterotrophic bacteria isolated from Muthupet estuary.

S.No	Bacteria
1	*Vibrio* Unclassified
2	*Marinobacter*
3	*Gamma Proteobacteria*
4	*Methylophaga*
5	*Alcanivorax*
6	*Francisella*
7	*Alpha Proteobacteria*
8	*Psychrobacter*

9	*Marichromatium*
10	*Shewanella*
11	*Halothio* *Bacillus*
12	*Alteromonas*
13	*Reseovarius*
14	*Rhodobacteria*
15	*Mesorhizobium*
16	*Acidiothibacillus*
17	*Halomonas*

Table-III Total count and Percentage of heterotrophic bacteria observed from Muthupet estuary.

S.No	Bacteria	June		July		August		Sep.		Oct.		Nov.	
		C	%	C	%	C	%	C	%	C	%	C	%
1	*Vibrio* Unclassified	-	-	-	-	-	-	938	11.44	1257	11.82	-	-
2	*Marinobacter* sp	1027	25.13	-	-	-	-	-	-	-	-	-	-
3	*Gamma Proteobacteria* sp	1420	34.74	1113	36.78	1320	42.74	3051	37.21	2937	27.61	-	-
4	*Methylophaga* sp	-	-	-	-	-	-	-	-	-	-	-	-
5	*Alcanivorax* sp	-	-	486	16.06	-	-	1673	20.4	-	-	-	-
6	*Francisella* sp	-	-	-	-	873	22.73	-	-	-	-	-	-
7	*Alpha Proteobacteria* sp	405	9.91	-	-	-	-	-	-	-	-	-	-
8	*Psychrobacter* sp	-	-	-	-	-	-	-	-	-	-	-	-
9	*Marichromatium* sp	-	-	-	-	-	-	-	-	-	-	-	-
10	*Shewanella* sp	813	19.89	696	23	-	-	1054	12.85	2178	20.48	2278	31.42
11	*Halothio Bacillaceae* sp	422	10.33	-	-	420	13.73	-	-	-	-	-	-
12	*Alteromonadaceae* sp	-	-	372	12.29	297	9.42	-	-	148	18.1	2513	23.63
13	*Reseovarius* sp	-	-	359	11.86	-	-	1484	18.1	2513	23.63	1752	25.47
14	*Rhodobacteriaceae* sp	-	-	-	-	-	-	-	-	-	-	-	-
15	*Mesorhizobium* sp	-	-	-	-	330	11.49	-	-	-	-	1507	15.84
16	*Acidiothibacillus* sp	-	-	-	-	-	-	-	-	-	-	1230	14.94

17	*Halomonas* sp	-	-	-	-	-	-	-	-	-	-	-	-

Continued….

S.No	Bacteria	December		January		February		March		April		May	
		C	%	C	%	C	%	C	%	C	%	C	%
1	*Vibrio* Unclassified	15633	59.9	1500	36.96	2359	44.78	-	-	-	-	212	5.73
2	*Marinobacter* sp	2209	8.46	1051	24.49	589	11.18	415	10.93	-	-	2199	59.4
3	*Gamma Proteobacteria* sp	4978	19.07	657	15.31	1469	27.89	1512	39.81	867	16.37	393	10.62
4	*Methylophaga* sp	-	-	617	14.38	-	-	-	-	-	-	-	-
5	*Alcanivorax* sp	-	-	366	10.86	-	-	-	-	2646	49.95	747	20.18
6	*Francisella* sp	-	-	-	-	444	8.43	483	12.72	-	-	-	-
7	*Alpha* sp *Proteobacteria* sp	1764	6.76	-	-	407	7.73	867	22.83	-	-	-	-
8	*Psychrobacter* sp	-	-	-	-	-	-	-	-	758	14.31	151	4.08
9	*Marichromatium* sp	-	-	-	-	-	-	-	-	424	8.0	-	-
10	*Shewanella* sp	-	-	-	-	-	-	-	-	-	-	-	-
11	*Halothio* sp *Bacillaceae* sp	-	-	-	-	-	-	-	-	-	-	-	-
12	*Alteromonadaceae* sp	-	-	-	-	-	-	-	-	-	-	-	-
13	*Reseovarius* sp	-	-	-	-	-	-	-	-	-	-	-	-
14	*Rhodobacteriaceae* sp	-	-	-	-	-	-	521	13.72	-	-	-	-
15	*Mesorhizobium* sp	-	-	-	-	-	-	-	-	-	-	-	-
16	*Acidiothibacillus* sp	-	-	-	-	-	-	-	-	-	-	-	-
17	*Halomonas* sp	1513	5.8	-	-	-	-	-	-	-	-	-	-

Count = Total number of bacterial cells
% = Percentage composition of bacterial cells.

Table: IV
Seasonal variation of heterotrophic bacteria isolated from Muthupettai estuary.

S.No	Bacteria	Pre Msonsoon		Monsoon		Post Monsoon		Summer	
		count	%	Count	%	count	%	Count	%
1	*Vibrio* Unclassified	938	11.44	16890	35.86	3859	40.86	212	5.73
2	*Marinobacter*			2209	8.46	2055	15.53	3226	42.26
3	*Gamma Proteobacteria*	5484	39.07	7915	23.34	3638	27.67	2680	20.57
4	*Methylophaga*	-	-	-	-	617	14.38	-	-
5	*Alcanivorax*	2159	18.23			366	10.86	3393	35.05
6	*Francisella*	-	-	-	-	927	10.57	-	-
7	*Alpha Proteobacteria*			1764	6.76	1274	15.28	405	9.91
8	*Psychrobacter*	-	-	-	-	-	-	909	9.19
9	*Marichromatium*	-	-	-	-	-	-	424	8
10	*Alcanivoracaceae*	-	-	-	-	-	-	602	11.36
11	*Shewanella*	1750	17.92	4456	25.95			813	19.89
12	*Halothio Bacillaceae*	420	13.73	-	-	-	-	422	10.33
13	*Alteromonadaceae*	669	10.85	2661	20.86	-	-	-	-
14	*Reseovarius*	1843	14.98	2003	24.55	-	-	-	-
15	*Rhodobacteriaceae*	-	-	-	-	521	13.72	-	-
16	*Mesorhizobium*	330	11.49	1507	15.84	-	-	-	-
17	*Rhizobiales*	-	-	1507	15.84	-	-	-	-
18	*Acidiothibacillus*	-	-	1230	14.94	-	-	-	-
19	*Halomonas*	-	-	1513	5.8	-	-	-	-

REFERENCE

Abowei, JFN., George, ADI., 2009. *Research Journal of Environmental and Earth Sciences*. 1(2), 45-53.

Alsina, M., Blanch, A.R. 1994. A set of keys of identification of environment of *Vibrio* species. *J. Appl. Bacteriol.* 57-64.

Aneja, K.R.1994. Biochemical activities of microorganism. In experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Production Technology, *New Age International Publishers III (ed)*, 245-275.

Arumugam, Sugirtha, P. Kumar. 2014. Evaluation of physico-chemical parameters and nutrients in the mangrove ecosystem of Manakudy estuary, South West coast of India. *International Journal of Latest Research in Science and Technology*, 3 (6): 205-209.

Chapman, V.J., 1976. Mangrove vegetation. *Vaduz Cramer*.

Croot, P.L. and Keith, A. Hunter, 1998. Trace metal distribution across the continental shelly near otango Peninsula, New Zealand. *Mar. Chem*, 62:185-201.

Eaton, A.D., Clesceri,L.S and Green berg, A.E. 1995. Standard methods for the examination of water and waste water (19th Edn.). *American Public Health Association*, New York, Washington. DC, pp 2:10-15.

Govindasamy, C., Arulpriya, M., Ruban, P., Meenakshi, VR., 2012. Hydro-Chemical Evolution of Palk Strait region, Bay of Bengal. *J Trop Life Sci*. 2(1); 1-5.

Herrera-Silveira, J.A., and Morales-Ojeda, S.M. 2009. Evaluation of health status of a coastal ecosystem in southeast Mexico: assessment of water quality, phytoplankton and submerged aquatic vegetation. *Marine Pollution Bulletin*, 59, 72-86.

Holt, J.G., Krieg, N.R., Sneath, P.H.A., Staely, J.T. and Williams Bergy's, S.T. 1994.
Manual of Determinative Bacteriology, IX, Ed. 259-274.
Jayakumar, P., Jothivel, N., Thimmappa, A., Paul, VI., 2009. Continental. *J. Aquatic Fish. Sci.* 2, 6-12.
Kathiresan, K and Rajendran N, 2006. *Est.Coast.Sci*. 67:542.
Kathiresan, K., 2000. Studies on Pichavaram mangroves Southeast India. *Hydrobiologia*, 430:185-205.
Kathiresan, K., and Bisgham, B.L., 2001. Biology of mangroves and mangrove ecosystem. *Adv.Marin.Biol*; 40: 81-251.
Lakshmi, k., 2002. Ecological studies on the mangrove ecosystems of Valapattanam and Thalassery river Basin. Ph.D Thesis, University of Calicut.
Laws, E.A., 2000. *Aquatic Pollution*: *an introductory text*, John Wiley & Sons, Inc, New York.
Macnae, W.A., 1968. General account of the fauna and flora of mangrove swamps and forests in Indo-West Pacific region. *Adv Mar Biol*, 6: 73-270.
Mohan Raj, V., Padmavathy, S., Sivakumar, S. 2013. Water quality parameters and it influences in the Ennore estuary and near coastal Environment with respect to industrial and domestic sewage. *Int. Res. J. Environment Sci*. 2(7): 20-25.
Padmini, E., Thendral Hepsibha, B., Shanthalin Shellomith, AS., 2004. Lipid alteration as stress markers in gray mullets *Mugil cephalus Linnaeus* caused by industrial effluents in Ennore estuary oxidative stress in fish, *Aquaculture*, 5:115-118.
Rajkumar, J.S.I., John, M.C., Ambrose, T, 2011. Seasonal variation of water quality parameters in Ennore estuary with respect to industrial and domestic sewage, *Int.J.of Cur. Res*: 33 (3): 209-218.
Ramasamy, S.M., Balaji,S., Venkat Subramaniam, V and paul, M.A., 1995. Evidence of neotechnism along coromandal coast of Tamilnadu using IRS imagery Interface, *Bulletin of the Natiuonal Remote sensing Agency*, pp. 5-6.
Safari, D., Mulongo, G., Byarugaba, D., Tumwesigye, W., 2012. Impact of Human activities on the quality of water in Nyaruzinga wetland of Bushenyi District Uganta, *Int.Res.J. Environment Sci*., 1 (4): 1-6.
Saravanakumar, A., Rajkumar, M., Sesh Serebiah, J., and Thivakaran, G.A. 2008.
Seasonal variations in physico-chemical characteristics of water, sediment and soil texture in arid zone mangroves of Kachchh-Gujarat. *Journal of Environmental Biology*, 29,725-732.
Sundaravarman, K., Kathiresan, K., Saravanakumar, A., Balasubramanian, T., 2012.
Studies on a mangrove lagoon at Muthupet, Southeast coast of India. *International Journal of Current Research*. Vol.4, pp: 015-022.
Vijayakumar, S., Rajan, K.M., Mridula, R., Hariharan, M., 2000. *Mar. Biol. Ass. India,* 42 (1&2).21-23.
Wang, YS., Lou, ZP., Sun, CC., Wu, ML., Han, SH., 2006. Multivariate statistical analysis of water quality and phytoplankton characteristics in Daya Bay, China, from 1999 to 2002. *Oceanologia*, 48: 193-211.