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STUDIES ON THE PHYSICO-CHEMICAL ANALYSIS OF PICHAVARAM MANGROVES, TAMILNADU, INDIA

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ABSTRACT

The present study is aimed to analyse the physico-chemical parameters in two stations of Pichavaram mangroves. In the present study the physico-chemical parameters such as temperature, pH, salinity, dissolved oxygen and total dissolved solids were analysed during 2009. The station was selected for the present study (Station-1: Agricultural land and Station-2: Mud flats). The temperature, pH and salinity were increased during summer season and dissolved oxygen and total dissolved solids were lowered in summer season.

INTRODUCTION

Mangroves are the ecologically important coastal wetland systems. In the tropics, they are especially rich in flora and fauna. They are one of the most productive ecosystems of great ecological and economical significance. Several reports have emphasized that the mangroves are one of the world's richest store house of the biological and genetic diversity (Kathiresan, 1996; 2000; Sandilyan, 2007). Mangroves are distributed circumtrophically, occurring in 112 countries and territories. Of the total mangrove coverage, 41.4% exists in South and South East Asia. Mangrove communities develop in the intertidal and sub tidal regions, but more between mid tidal level to extreme high water mark. The total global area of the mangroves is estimated at 18.1 million ha. (Spalding *et al.*, 1997). Mangroves are fragile and highly productive ecosystems occurring along the coastal belts of our country. Indian mangroves are distributed in about 6,740 sq. km. area (Kathiresan and Bingham, 2001), constituting 7% of the world mangroves and 8% of the total Indian coastal line. There are three different types of mangroves in India viz., deltaic, backwater -estuarine and insular categories. The deltaic type occurs along the east coast (Bay of Bengal) where the mighty rivers (the Ganges, Mahanadhi, Godhavari, Krishna and cauvery) make the deltas. Mangrove forests are important wetlands among tropical and sub tropical coasts, providing environmental sustainability, ecological security and economic prosperity (Tomlinson, 1986; Kathiresan and Bingham, 2001).Mangrove forests are among the world's most productive ecosystems. These are often called as 'tidal forests', 'coastal woodlands' or 'oceanic rainforests. Mangroves are woody plants that grow in tropical and subtropical latitudes along the land - sea interface, bays, estuaries, lagoons, backwaters, and in the rivers, reaching upstream upto the point where the water still remains saline (Qasim, l998). These plants and their associated organisms (microbes, fungi, other plants and animals), constitute the 'mangrove forest community' or 'mangal'. The mangal and its associated abiotic factors constitute the mangrove ecosystem, as has been illustrated Kathiresan and Bingham, (2001). The Pichavaram mangroves are considered among the healthiest mangrove occurrence in the world. Pichavaram consists of a number of islands interspersing a vast expanse of water covered with green trees. They are the only large area of mangroves, covering an area of 11,000 ha, with 51 islets separated by a complex network of creeks and channels. The Pichavaram mangrove biotope, consisting of rare species like Avicennia and Rhizophora, presents a special attraction with its peculiar topography and environmental condition. It supports the existence of many rare varieties of economically important shell and finfishes. Mangrove trees are the most prominent salt – tolerant forest trees of the intertidal areas. (Kathiresan, 2002). In a broadsense, the mangrove wetlands provide asylum to number of species, among them crustaceans, mollusks, fishes and birds are the important group. Physiochemical characteristics of the water largely determine the water bird community of aquatic habitats, primarily by their direct and indirect impact on the availability and abundance of the birds' prey (Nagarajan and Thiyagesan 1996). Furthermore the undesirable changes in the water

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quality due to developmental activities such as industrialisation, urbanisation, construction of roads and dams, intensification of agriculture, expansion of aquaculture and eco-tourism alter the habitat utilization of waterbirds and are often used as indicators of water quality (Feck and Hall 2004, Nagarajan & Thiyagesan 1996). Water quality influences the availability and accessibility of prey items to various aquatic predators (Nagarajan Thiyagesan, 1996).

MATERIALS AND METHODS

Study area

The Pichavaram mangroves (11^0 25'N; 74^0 47'E) are situated about 190 km south of Madras at the mouth of the Vellar, Coleroon and Uppanar rivers on the south east coast, known as the Coramandal coast (Bay of Bengal), of India. The two area were selected for the present study Agricultural land (Station-1) and Mud flats (Station-2).They are the only large area of mangroves, covering an area of 11,000 ha, with 51 islets separated by a complex network of creeks and channels (Figure 1). It is situated at mouth of the Rivers Vellar, Coleroon and Uppanar in Cuddalore district of Tamil Nadu, India. Further it is located in the Coramandal coast of the Bay of Bengal. Pichavaram, is the second largest mangrove of India, which covering an area of 1100 ha. and consisting 51 Islets in it. These Islets are ranging from 10 m^2 to 2 km^2, which are separated by intricate waterways, creeks and channels – all are connected with the three river's estuary.

Study Period

Data collection were made from January 2009 to December 2009.

Analysis of Physico-chemical parameters

The soil samples were collected from paddy field of both areas from January, 2010 to December, 2010 for the estimation of physicochemical studies. The samples were taken in 100 ml pet bottles. The physico-chemical analysis (pH, temperature, salinity and dissolved oxygen) of the samples were carried out by the method of APHA (1995). The statistical data were analysed by using a program SYSTAT (Wilkinson, 1986). Results of the above analyses were interpreted using standard statistical procedures (Sokal and Rohlf, 1981).

RESULTS

The physico-chemical parameters were shown in Table 1 and 2. The physico-chemical analysis of water revealed that the temperature ranged from 23□C to 35□C in two stations of Pichavaram mangroves. The maximum soil temperature (35□C) was observed during may, 2010 and minimum temperature (23□C) was observed during January, 2010. The maximum water temperature (33□C) was observed during May, 2010 and minimum temperature (22□C) was observed during January and October, 2010. pH ranged from 7.8 to 8.4 was observed in two station of Pichavaram mangroves. The maximum pH (8.4) was observed during may, 2010 and minimum pH (7.8) was observed in January and November, 2010. pH ranged from 7.3 to 8.3 was observed in agricultural land of Pichavaram mangroves. The maximum pH (8.3) was observed during July, 2010 and minimum pH (7.3) was observed in January, 2010 (Table 1and 2). The salinity was higher in March (1.9%) in both areas. The Dissolved oxygen ranged from 7.8 to 8.2 in station-1 and 7.47 to 8.27 in station-2. The total dissolved solids ranged from 2.1 to 3.9 mg/l.

DISCUSSION

In the present study, the physicochemical parameters ware analyzed in two stations of pichavaram mangroves. The temperature ranged from 22□C to 35□C was observed in two stations of pichavaram mangroves. This may be due to optimal temperature for the growth of blue green algae. In this condition BGA grow because the range of temperatures permitting the growth of BGA is larger than that required by rice; however, it influences both algal biomass composition and productivity. Low temperatures decrease productivity and favour eukaryotic algae. Roger and Reynaud (1979) reported the high temperatures favour both the phytoplankton productivity and blue green algae. The present study correlates with BGA abundance. Allen and Stanies, (1968) observed temperature ranges between 25□C to 35□C in soil of the rice fields. The temperature was slightly higher in June and July at two stations of paddy fields when compared with other months. This may be due to the influence of summer season and the role of solar radiation. Nouchi *et al*. (1990; 1994) reported that temperature variation observed in rice cultivation area. Uchijima (1959, 1963) investigated annual variations in water temperature and heat balance in shallow water with no rice plants and evaluated the climatic aspects of seasonal and spatial variations of paddy water temperature in Japan by using a simplified heat balance equation. Because the actual water temperature is influenced by the canopy density of rice plants (Uchijima, 1961). Takami *et al.* (1989) presented a simple scheme for evaluating the daily mean water temperature under a plant canopy by using a simplified heat balance equation. Similar models have been developed by Maruyama *et al*.,(1998) and Ohta and Kimura (2007) to estimate the daily mean paddy water temperature under various weather conditions.

pH is an essential parameter for the determination of water character and to differentiate the medium. The pH is a variable, influencing biochemical relations and possibly affecting species distribution. The present study showed that pH ranges from 7.3 to 8.4 in analysed in two station of Pichavaram mangroves. The pH of these soils was very acidic (4.5–4.6), which is much lower than optimum pH (7–10). The pH of water was relatively high in the winter months and low in the monsoon and summer. The lower pH during monsoon is due to high turbidity, and in summer, the high temperature enhances microbial activity, causing excessive productivity leads to increase production of CO_2 and reduced pH (Khan and Khan, 1985; Narayani, 1990). The higher value of pH recorded during winter months could be attributed to increased primary productivity. Higher value of pH can be attributed to higher growth rate of algal population which utilized CO_2 through photosynthesis (Chaterjee and Raziuddin, 2006). Rippka *et al*. (1979) observed the pH variation recorded in soil. In the present study the level of salinity, dissolved oxygen and total dissolved solids were observed during 2009. The salinity ranged from 1.5 to 1.9% during the study period in both the study area. In both the study area the lower amount of

Table 1. Seasonal variation of physico-chemical parameters in Pichavaram mangroves at station -1

Period	Temperature (^0C)	pH	Salinity (%)	Dissolved oxygen(O_2)(mg/l)	Total dissolved solids(mg/l)
January	22±0.1	7.8±0.01	1.7±0.08	8.1±0.9	3.4±1.02
February	23±0.07	8.2±0.02	1.8±0.07	8.2±0.8	3.6±1.04
March	25.6±0.08	8.3±0.02	1.9±0.6	8.2±1.2	3.9±1.07
April	24±0.09	8.2±0.01	1.7±0.8	8.2±0.9	2.4±0.9
May	33±0.07	8.4±0.04	1.9±1.2	8.0±1.2	2.1±0.8
June	34±0.07	8.0±0.04	1.9±1.0	7.8±1.0	2.4±1.1
July	24±0.07	8.3±0.07	1.8±0.8	7.9±0.8	2.6±1.2
August	25.4±0.5	7.9±0.02	1.6±1.0	7.8±1.0	2.5±1.4
September	23±0.07	8.0±0.03	1.7±0.8	8.1±0.8	3.1±0.9
October	22±0.09	8.0±0.01	1.6±0.8	8.0±0.9	3.4±0.8
November	23±0.05	7.8±0.01	1.5±0.4	8.1±0.8	3.5±0.8
December	25.8±0.09	7.9±0.02	1.5±0.5	8.1±0.7	3.4±0.9

Table 2. Seasonal variation of physico-chemical parameters in Pichavaram mangroves at station -2

Period	Water Temperature (^0C)	pH	Salinity (%)	Dissolved oxygen(O_2)(mg/l)	Total dissolved solids(mg/l)
January	22.2±0.09	8.5±0.01	1.80±0.8	8.14±1.2	3.3±1.2
February	23.4±0.07	8.3±0.02	1.84±0.7	8.25±1.5	3.6±1.5
March	25.6±0.09	8.3±0.03	1.98±0.5	8.27±0.9	3.9±0.9
April	24.2±0.07	8.3±0.01	1.77±0.9	8.26±0.8	2.4±0.8
May	24.8±0.04	8.1±0.02	1.88±0.7	8.25±1.2	2.1±1.2
June	28.5±0.9	8.0±0.01	1.8±0.7	7.47±1.1	2.4±1.1
July	28.8±0.1	8.3±0.02	1.54±0.8	7.74±1.5	2.6±1.4
August	24.4±0.12	7.9±0.01	1.67±0.8	7.66±1.4	2.5±1.0
September	26±0.04	8.0±0.06	1.74±0.4	8.0±1.4	3.1±1.1
October	24.8±0.07	8.0±0.04	1.66±0.5	7.84±8.1	3.4±1.0
November	25±0.7	7.8±0.04	1.54±0.7	8.02±1.2	3.5±1.2
December	25.8±0.9	8.0±0.04	1.58±0.8	8.01±1.5	3.4±1.0

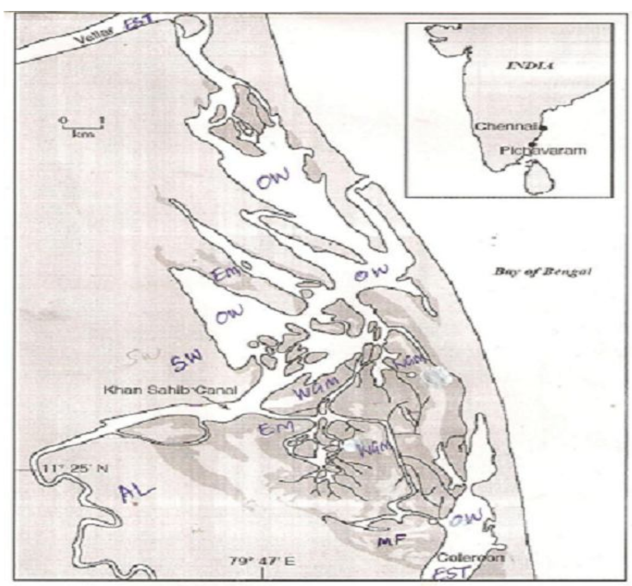

Fig. 1.Map of study area

salinity was observed. This may be nature of the salt accumulated in the soil and also flooded condition. In the present study, the low amount of dissolved oxygen was observed in June, 2009. This result may be due to the increased temperature, salinity and total dissolved solids. The low dissolved oxygen is common in aquatic system especially estuarine and marine system that have high nutrient loading and are seasonally stratified into water with different densities. This stratification allows microbial degradation of organic matter to deplete dissolved oxygen and reaction of water (Kolar and Rahal, 1993). In the present study, it is shown that the rate of dissolved oxygen is more in the September, October and November periods. The influx of freshwater may be the cause for the high rate of dissolved oxygen content. The decreased level of dissolved oxygen content recorded in November month may be due to the release of industrial effluents from various industries. The rate of dissolved oxygen is controlled by various factors such as temperature, salinity and dissolved solids (Patnaik and Misra, 1990). The present study concludes that the normal range of various physico-chemical parameters favourably increase the cyanobacterial growth which enhance the growth of paddy.

The water quality parameters such as dissolved oxygen, salinity, silicate, nitrate, phosphate and soil pH were having significant impact on the water bird populations. Several reports advocate that the water quality is the major factor influencing water bird population (Wetzel, 1975). According to Murphy *et al.* (1984) inclusion of hydrological considerations in waterbird habitat evaluation had considerable merits owing to the levels of primary productivity in the aquatic systems and the tropic structures and total bio mass throughout the aquatic food web are mediated via a host of interacting physical and chemical factors (Wetzel, 1975). Mittel *et al*. (1990) had stated that functioning of an aquatic ecosystem and its ability to support life forms depends to a greater extent on the physic-chemical characteristics of water. Nagarajan (1990) found a significant correlation between mud pH and water bird diversity in the Pichavaram mangrove wetlands. Wetland pH was reported to influence habitat diversity and species richness of phytoplankton (Almer *et al.,* 1974) and diversity and abundance of aquatic invertebrates (Parker et al., 1972). Mud pH was found to be significantly influence the water bird density of Pichavaram wetlands (Nagarajan and Thiyagesan, 1996). Dissolved Oxygen is varied in the present study and is found to influence the water bird population in the present study. Sridharan (2003) also reported that the dissolved oxygen levels to influence the density and diversity of water birds and small wader richness in Vaduvoor Lake in south India. Wetzel and Linken (1979) reported that among all the abiotic factors, dissolved oxygen is the prime factor which influences the water bird density. A relationship between water bird population and dissolved oxygen in aquatic ecosystems was well established by Murphy et al. (1984). Sampath and Krishnamoorthy (1990) have also reported that the dissolved oxygen could have influenced the water bird population in Pichavaram mangrove wetlands. Dissolved oxygen is being an important biological productivity of any aquatic ecosystem, its influence on the Water bird population characteristics of the present study area might well be indirect. During the current study salinity was found to influence the water bird population characteristics in the study area Pichavaram mangrove wetlands. Salinity had been reported to influence a large extent the succession and dominance of various aquatic organisms (Ramachandran, 1995). Higher salinity would cause a profound impact on animals such as benthic forms, shrimps. Carbs, fishes and other wildlife which live in and around the mangrove weland, For instance, Balasubramaniam (1994) reported a notable decrease of terrestrial gastropods due to increasing salinity in Pichavaram mangroves. Similarly Nagarajan (1990) observed a decline of migratory waterbirds whenever there were changes in salinity levels in Pichavaram wetlands. Apart from that, Katthiresan (2000) also reported that higher salinity in the mangrove region to bring down the availability of nutrients consequently. The poor nutrients influence the population of plankton, benthic organism and other macro invertebrates in the ecosystems (Ramachandran *et al.* 1965) on which the waterbirds thrive on. Furthermore it is well established that the changes in the water salinity could alter the prey characteristics, distribution and abundance, and thus it altered the density, diversity and behavior of the waterbirds in aquatic ecosystem (Nagarajan *et al.,* 2006).

Higher salinity would cause a profound impact on animals such as planktons, fungi, benthic forms, shrimps, crabs, fishes, water birds and other wild fauna which live in and around mangroves. In addition, Kathiresan (2000) states that higher salinity in mangroves leads to depletion of nutrients. The reduced availability of nutrients in this habitat might influence the population of planktons, benthic organisms and other macro invertebrates (Ramachandran, 1995). The changes in invertebrate population of any wetland could affect the top level predators such as birds (Sumathi *et al.,* 2008). It is needless to state that poor nutrients at higher salinity are the two great challenges to invertebrate diversity, which adversely reflects on untapped bio diversity of the mangroves wetlands. Increasing in the salinity level in mangroves is the universal problem which has existed for several decades; but in recent years, the condition has been exacerbated due to global warming, over evaporation, sea water intrusion, reduction of fresh water influx and coastal shrimp farming discharges (Hoque *et al.,* 2006).

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