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Nutrient characteristics and sediment texture of the seagrass beds of the Gulf of Mannar

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Abstract: *Changes in nutrient concentrations and sediment texture of the seagrass beds were recorded for two years from July 1996 to June 1998 at monthly intervals at two stations (Station 1 - Manoli island; Station 2 - Chinnapalam) of the Gulf of Mannar Marine Biosphere Reserve. Different nutrients in water showed varied concentrations in different seasons. Phosphate concentration varied between 2.32 and 7.32μM, nitrate concentration ranged from 5.2 to 18.78μM and nitrite concentration from 1.92 to 7.32μM. Sand was a major component of the sediments, followed by silt and clay at both the stations. At station 1, sand composition varied between 85.9 and 95.3% while at station 2, it varied between 81.9 and 93.6%. Silt composition varied between 3.1 and 9.4% at station 1and at station 2, it varied between 4.0 and 12.4%. At station 1, clay composition varied from 1.6 to 4.6% and at station 2, it varied between 2.1 and 5.6%. The present study revealed that the nutrients and sediment characteristics of the seagrass beds of the Gulf of Mannar has clear spatial and temporal variations. They are largely interlinked and influenced by the human activities and climatic changes and are individually or jointly governing the distribution, diversity, biomass and productivity of the seagrasses of the Gulf of Mannar.*

Key words: *Marine plants, Water quality, Soil texture*

Introduction

Seagrasses are the marine flowering plants, which represent the only group of higher plants that have established successfully in the subtidal and tidal environments of world oceans except the polar region. Even though the importance of seagrasses was realized in the beginning of the 20th century, only in the past two decades, the seagrasses attracted the attention of the marine scientific community. Their role in coastal ecosystem has been recognized by various research groups only after several experimental and field research works.

Various ecological parameters have direct or indirect relations with the physiology of seagrasses. Temperature nutrients, light intensity and photoperiod, salinity, pollution, epiphytes *etc.* are such factors causing impacts on the seagrass ecosystem. Factors, most frequently associated with the disappearance of seagrass beds throughout the world, are the nutrient enrichments from sewage and agricultural discharges and reduction in available light caused by increased suspended solids and epiphytic algae (Twilley *et al.,* 1985; Wetzel and Neckles, 1986; Dennison *et al.,* 1993; Abal and Dennison, 1996).

Macrophytes have the ability to accumulate nitrogen and phosphorus thereby accelerating the nutrient turnover in the aquatic ecosystems (Brock *et al.,* 1983). Seagrasses absorb nutrients through their root and leaves and thereby act as nutrient pumps to increase the concentrations of inorganic phosphates in the water column (McRoy and Barsdate, 1970) which in turn is an important medium for the transfer of organic matter from seagrasses to other organisms and localities (Moriarty *et al.,* 1986; Roberts and Moriarty, 1987). Further, leaching and microbial mineralization would release the internal nutrients from the seagrass detritus pool (Velimirov, 1987; Pellikaan and Nienhuis, 1988).

Due to the removal or loss of seagrasses, sediments are rendered unstable and shifted by currents or storms and may impact deleteriously on adjacent seagrass beds and coral reefs. Thus, seagrasses play a major role in maintaining the local coastal ecosystems and their ecology. At the same time, seagrasses can be strongly influenced by various ecological factors including nutrients and sediment factors that control the ecosystem processes. The present study was undertaken to record the changes in nutrient concentrations and sediment texture of the seagrass beds of two selected stations of the Gulf of Mannar.

Materials and Methods

Field trips were undertaken for two years (July 1996 to June 1998) at monthly intervals to record the changes in nutrient concentrations and sediment composition of the seagrass beds at two stations (Station 1 - Manoli island; Station 2 - Chinnapalam) of the Gulf of Mannar Marine Biosphere Reserve (Fig. 1).

Concentrations of water nutrients *viz*. phosphate (PO_4), nitrate (NO_3) and nitrite (NO_2) were determined by following the methods described by Strickland and Parsons (1972). Sediment grade analysis of the soil collected randomly in polythene bags from the seagrass beds was done. Soil was air dried and sieved through a mechanical sieve to remove shells, coral pieces *etc.* Dried sediment samples were subjected to size fraction analysis following the procedure of Udden modified by Wentworth (1922). Sample weighing 100 g was taken and sieved through a mesh (size of 62μ) for 10 minutes in a sieve shaker. The sample

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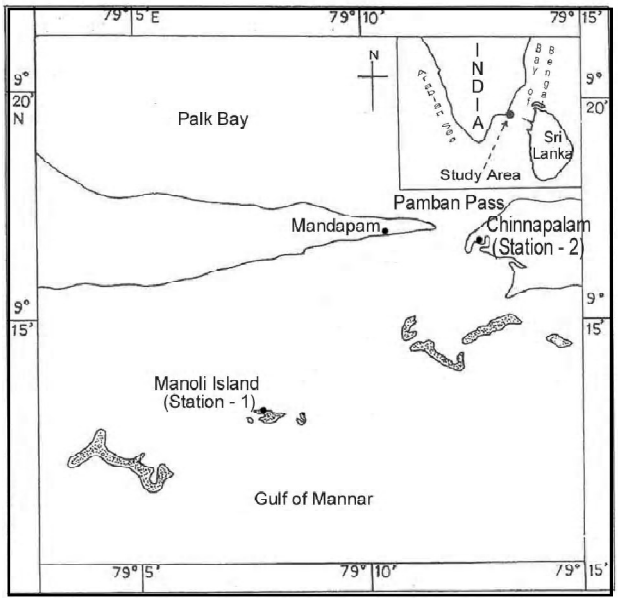

Fig. 1: Map showing the study areas

remained in the sieve was weighed and treated as sand. The sediment samples which passed through the 62μ sieve were the mud and clay. The mud and clay were then separated by means of pipette method described by Lindholm (1987). For the sake of convenience and easy interpretation, a calendar year of study period was divided into four seasons *viz*. post monsoon season (January to March), summer season (April to June), pre monsoon season (July to September) and monsoon season (October to December). The simple correlation co-efficient (r) and ANOVA were employed for the statistical interpretation.

Results and Discussion

Present investigation on the seagrasses of the Gulf of Mannar has brought out the importance and influence of nutrient concentrations and sediment texture on the seagrass populations of the Gulf of Mannar Biosphere Reserve. Since the seagrasses are having the ability to absorb nutrients from both water and sediments, these nutrients constitute an important factor, influencing greatly the biomass of the seagrasses.

Phosphate concentration in water varied between 2.32 and 7.32μM at both the stations (Fig. 2) registering the minimum during summer season and the maximum during pre monsoon and monsoon seasons. Nitrate and nitrite content in water varied between 5.2 and 18.78μM and 1.92 and 7.32μM respectively at both the stations (Fig. 3 and 4). The concentrations of nutrients (PO_4, NO_3 and NO_2) were more during the monsoon season. From this, it is clear that the rainfall associated with the land runoff would have brought the nutrients to the marine environment. This was evidenced by the significant positive correlation obtained between the rainfall and nutrients *viz.* PO_4 ($p < 1\%$ at stations 1 & 2), NO_3 ($p < 1\%$ at stations 1 & 2) and NO_2 ($p < 1\%$ at station 1 and 0.1% at station 2). Kannan and Kannan (1996) have also recorded such monsoonal increase in the nutrient concentrations in the vicinity of the seagrass beds of the Palk Bay. Of all the nutrients studied, inorganic phosphate, one of the important nutrients for all the marine photosynthetic organisms, recorded maximum in monsoon and minimum in summer at both the stations. In summer minimum could be attributed to the greater utilization of this nutrient by the phytobenthic communities including the seagrasses.

Higher concentrations of various nutrients were recorded at Chinnaplam (station 2) than the Manoli island (station 1) and this was mainly due to the discharge of domestic wastes and solid wastes in the coastal area of station 2 in addition to human excreta. This indicates the anthropogenic pressure posed on the seagrass beds of this station. Though the seagrasses are capable of withstanding the higher nutrient concentrations, there are reports (Burkholder *et al.,* 1992; Short *et al.,* 1995) on loss of seagrass biomass in relation to the prolonged increase in the nutrients concentration. In the present study also the biomass of all the genera of seagrasses were found to be reduced during the post monsoon season. Short *et al.* (1995) have stated that the higher nutrient concentrations would increase the algal growth and thereby reduce the light intensity, subsequently leading to the loss of seagrasses. Interestingly, dominance of algal growth on the seagrass beds is the common phenomenon in the study areas during the late monsoon and entire post monsoon season.

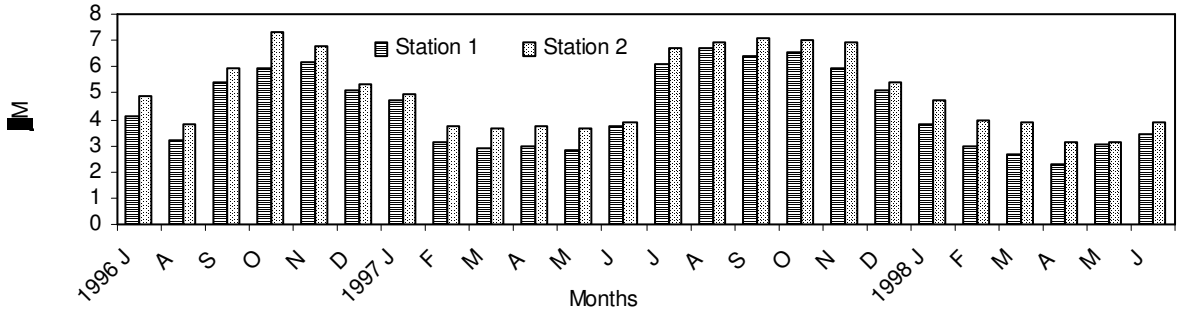

Fig. 2: Monthly variations in inorganic phosphate concentration recorded from July 1996 to June 1998 at stations 1 and 2

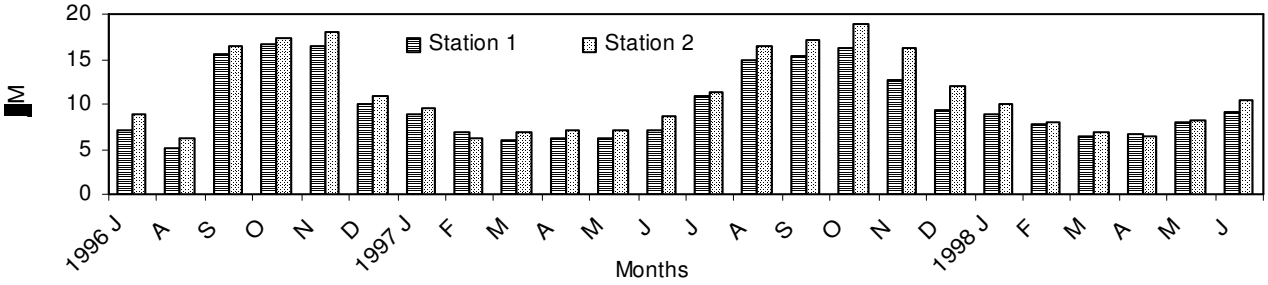

Fig. 3: Monthly variations in nitrate concentration recorded from July 1996 to June 1998 at stations 1 and 2

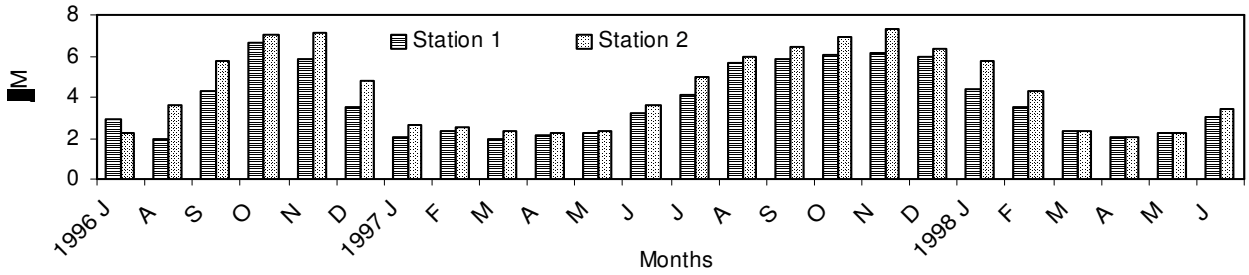

Fig. 4: Monthly variations in nitrite concentration recorded from July 1996 to June 1998 at stations 1 and 2

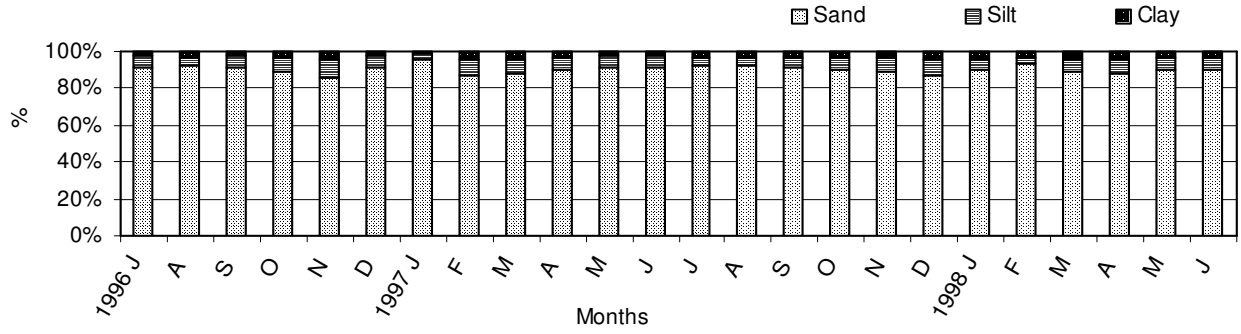

Fig. 5: Monthly variations in sediment composition recorded from July 1996 to June 1998 at station 1

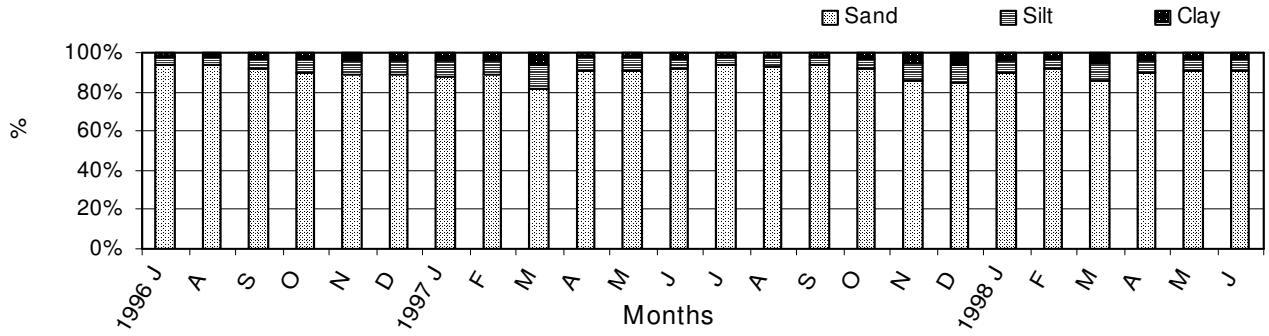

Fig. 6: Monthly variations in sediment composition recorded from July 1996 to June 1998 at station 2

Sediment composition plays a major role in determining the seagrass distribution. Rajeswari and Kamala (1987) noted that the habitats such as sand, mud or sand and mud with thin layers of sand are the most suitable substrates for the growth and establishment of seagrasses. In the sediment samples collected, the sand was represented as the major component of the sediments followed by silt and clay at both the stations (Fig. 5 and 6). At station 1, sand composition varied between 85.94 and 95.30% while at station 2 sand composition varied between 81.93 and 93.66%. At station 1, silt composition varied between 3.10 and 9.44% recording the minimum during the post monsoon season and the maximum during the monsoon season. At station 2, silt composition varied between 4.00 and 12.42% registering the minimum during the pre monsoon season and the maximum during the post monsoon season. Clay composition varied from 1.60 to 4.62% at station 1, recording the minimum during the post monsoon season and the maximum during the monsoon season where as at station 2, it varied between 2.11 and 5.65% recording the minimum during the pre monsoon season and the maximum during the post monsoon season.

During the present study, sand was represented as the major component of the sediments followed by silt and clay at both the stations. Vinithkumar *et al*. (1999) reported higher percentage of stone, gravel and sand fractions in coral reef areas and seagrass beds of the Gulf of Mannar while Jagtap and Untawale (1984) have recorded 100% sand in the seagrass beds of Lakshadweep. This shows that the seagrasses can grow in varied sediment compositions; however, the species composition and biomass of seagrasses will definitely vary with varying sediment composition.

Higher amount of silt composition has been recorded during the monsoon season at station 1 and post monsoon season at station 2. This indicates that the sedimentation promoted by the seagrass leaves during the monsoon season would have resulted in such increase in silt content. This was evidenced by the significant positive correlation ($p< 5\%$) obtained between rainfall and silt content. Balakrishnannair *et al.* (1983) has also reported that the silt-clay percentage was high in seagrass areas when compared to the surrounding areas during the post monsoon season. The present study showed significant negative correlation between sand and silt and clay while silt and clay showed positive correlation between them.

The study also showed a significant difference (ANOVA, $p < 5\%$) in nutrient concentrations and silt composition between the stations. From this, it is concluded that the differences in nutrient concentrations and silt composition would have favoured the higher diversity and density of seagrasses at station 2 which registered comparatively higher nutrient concentration and silt composition than station 1. Terrados *et al*. (1997) reported higher seagrass species richness in the sediments with the silt composition up to 12% as recorded in the present study. They also reported the reduction in species richness beyond 15% of silt composition.

From the present study, it is evident that the nutrient and sediment characteristics of the Gulf of Mannar have distinct spatial and temporal variations. It is also clearly understood that nutrients are largely interlinked and influenced by the other physico chemical characters depending up on the seasonal changes. Further, the presently observed nutrient and sediment characters might individually or jointly influence the distribution, diversity, biomass and productivity of the seagrasses of the Gulf of Mannar.

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