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# A preliminary study on the environmental condition of the coral reef habitat

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**ABSTRACT:** The present investigation was carried in coral reef areas of Palk Bay, Madapam. Palk Bay corals were found disturbed by human beings due to oil pollution, waste discharge from processing units and discharge of domestic household wastes from the nearby Mandapam town. Environmental conditions of the coral reef habitat in the Palk Bay, Mandapam was analyzed for a period of six months at fortnightly intervals for March to August 2001 on the coral reef areas. Temperature, pH, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Total Organic Carbon (TOC) were analyzed at five different stations of Palk Bay, Madapam. The maximum mean values of temperature, pH, DO, BOD and TOC for the four experimental and control stations were 32.6°C, 8.7, 7.02ppm, 8.29ppm and 2.13% and 31.5°C, 8.3, 7.98ppm, 5.71ppm and 0.48% respectively. The sampling stations were selected on the basis of their importance.

**Key words:** *Coral reefs, oil pollution, waste discharge, environmental condition*

## INTRODUCTION

Corals are one of the most significant symbiotic associations in animal kingdom in which partnership between tiny unicellular algae and various marine animals together enable the formation of coral reefs (Gopinatha Pillai, 1969). Corals are made up of calcareous skeletons of millions of tiny marine organisms. The lower organisms lay down calcium, so that the reef growth beneath the cell layers builds the corals continuously over hundreds of thousands of years. Corals belong to the phylum Colenterata or Cnidaria (Sethi and Iqbal, 1998). The annual growth of corals is very slow. Based on environmental conditions, they may increase in size from a few mm to 5 cm every year. Fresh corals have grown over 30 cm within Tuticorin harbor where the breakwaters had only recently been constructed (Imtiazkhan, 1999). Corals are some of the most valuable and spectacular places on earth covering less than 1% of the planet's surface. Coral reefs are associated with mangroves, seagrass and other world's most biologically diverse marine ecosystems. Corals mainly grow in warm tropical areas (70°F-85°F) with shallow and clean waters and such conditions are suitable for symbiotic algae to grow as they can receive sunlight through water above for photosynthesis. Since corals do not grow beyond 150 feet (Mahadevan and Nagappannayer, 1972) even minor pollutants can present the sea and prevent sun light reaching the sea bed and there by alter growth of corals. Coral reefs are extremely sensitive to changes in the environment. Even slight changes in the reef environment may have detrimental effects on the health of entire coral colonies. These changes may be due to a variety of factors, but they generally fall within two categories viz., natural disturbances and anthropogenic disturbances have been linked to vast majority of decreases in coral cover and general health, when coral reefs and humans occur together (Wilkinson and Buddemeier, 1994). One quarter of the marine fishes originate form the coral reef areas. Coral reefs provide shelter and breeding grounds for fishes of all kinds including a great variety of ornamental fishes of export

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value (Gopinatha Pillai, 1969). A number of patch reefs are also found closer to the shore in Palk Bay and is a base for fishery resources in this region. Palk Bay has lagoons with depths ranging from 1 to 2 meter but they are generally devoid of corals except for a single reef (Patterson and Ayyakannu, 1996). Coral reefs act as one of the major food reservoirs in the ocean. Although they cover only about 0.2% of the ocean, coral reefs provide habitats from about 10% of the fish caught for human consumption, and they are spawning grounds for 15% of the world's fish catch (Mohiuddin, 1999). Palk Bay is known for its rich variety of marine life such as fish resources, and hence the water quality of Palk Bay has been a focal point in recent times. The export of seafood in recent times had become more profitable and this lead to the opening of a number of seafood-processing units near coastal areas. Dumping of untreated effluents from such industries has caused pollution problems in coastal waters and coral reefs. Other anthropogenic activities around Palk Bay, particularly in Mandapam region, also have been exerting considerable stress on the aquatic and reef environment. The sewage waters of coastal towns bordering the Palk Bay are also released into the sea without any treatment. Therefore, there appears to be a constant threat to the coral reefs and fishery resources in the Palk Bay. Therefore, this present investigation was attempted to assess the environmental condition of the coral reef habitat of Palk Bay, Mandapam.

## MATERIALS AND METHODS

Palk Bay is located on the northern side of Mandapam (Long. 79° 09' E and Lat. 09° 16' N) a coastal town on the southeast coast of India on a small peninsular extension of the main land leading to Rameswaram (Long. 79° 09' E and Lat. 09° 17' N). Coral reefs are lying in an east-west direction along the mainland at Mandapam and Rameswaram island extending from longitude 70° 08' E to 79° 20' E 09° 17' N latitude. The reef is discontinuous at the Pamban visduct. Five sampling stations were selected in the Palk Bay region of Mandapam (Fig. 1). A hand held GPS (Global Positioning System) GARMIN MODEL 12XL was used to identify and locate the sampling stations. The first sampling station was located nearly 300 meter away from the Pamban over Bridge (Lat. 09° 19' 32.7'' N and Long. 79° 11' 56.6'' E). This station was known to be disturbed by Monsoon winds caused by southwest monsoon affecting the Gulf of Mannar. The second sampling station was nearly 275 meters away from the Bison house (Lat. 09° 19' 18.35'' N and Long. 79° 11' 24.2'' E). The third sampling station was located nearly 300 meters away from the sea-food processing unit (Lat. 09° 19' 33.1'' N and Long. 79° 10' 28.9'' E) in the Palk bay. The fourth sampling station was located 250 meters away from CMFRI fish form (Lat. 09° 19' 37.3'' N and Long. 79° 10' 20.5'' E) in the Palk Bay region of Mandapam. The fifth sampling station selected in the present study was the control point and was located in the open sea (Lat. 09° 19' 54.3'' N and Long. 79° 07' 20.1'' E) opposite to the village vedhalai. This station was observed to be free from all sorts of pollution including domestic sewage, sea food-processing unit effluents and other wastes in the Palk Bay region of Mandapam. Therefore, it was considered as control station to compare the water quality of all the other four stations called experimental stations. Water samples were collected at fortnightly intervals during the period of March to August 2001 in Palk Bay, Mandapam. The samples were collected during the morning hours from each station. The water samples collected in Pyrex flasks of 5 L capacity which was tightly corked and triplicates were collected from each station. The water temperature was noted at the site it self and the collected samples were sealed and carefully arranged in an ice-box and immediately brought to the laboratory. Great care was taken to guard these samples against undue shaking and exposure to atmosphere during transport. The water samples were stored in a refrigerator until further processing and analysis for various physico-chemical parameters viz., hydrogen ion concentration (pH), Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Total Organic Carbon (TOC). pH values were measured using Beckman pH meter. DO, BOD and TOC analysis of water were based on the standard methods for the examination of water and waste water, published jointly by American Public Heath Association (APHA) and Water Pollution Control Federation (WPCF). They were considered significant in deciding the environmental conditions of the coral reef habitat. All the parameters were analyzed using standard methods (APHA, 1992). Data on all parameters were analyzed statistically using mean, standard deviation and analysis of variance (ANOVA).

## RESULTS

The mean values of all the physicochemical parameters were presented in Fig. 2A-E. The observed values of temperature showed only a narrow fluctuation among all the stations including the control station. The temperature range between 29.4 ± 0.29°C to 32.6 ± 0.31°C.

The minimum temperature of 29.4 ± 0.29°C was recorded in station-1 in the I half of March 2001 at the same time the control station had a minimum temperature of 29.1 ± 0.42°C in the I half of March 2001 and the maximum mean temperature of 32.6 ± 0.31°C was noted in station-3 in the II half of May 2001 and a maximum temperature of 31.5 ± 0.52°C was recorded in the control station in the II half of May 2001 (Fig. 2A). ANOVA indicated that the mean temperature values of the four experimental stations were significantly higher than that of the control station (F 4, 59: 3.195, P<0.05).

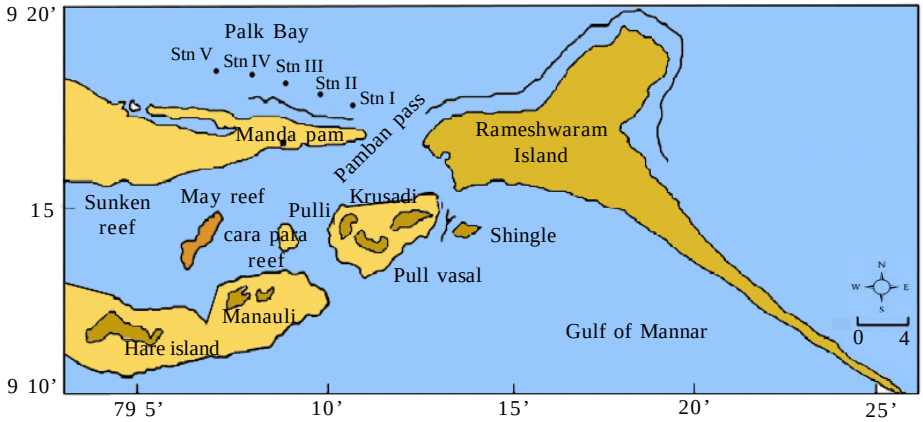
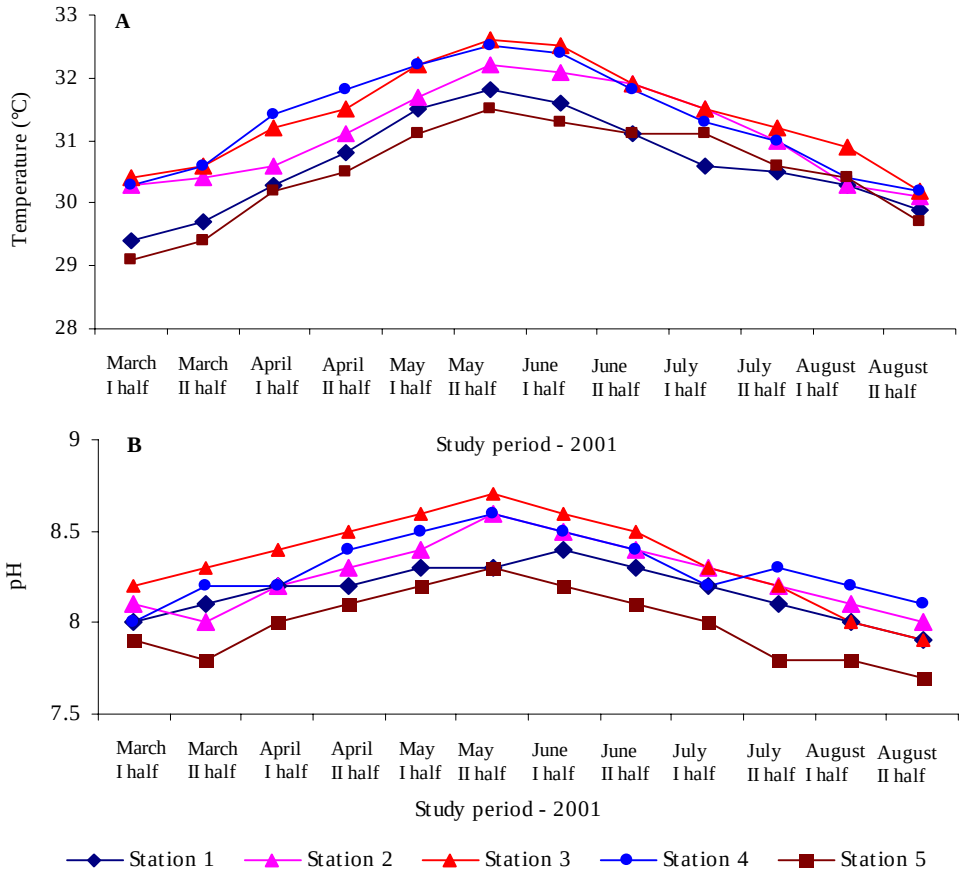



Fig. 1: Map of part of the Palk Bay, Mandapam showing the sampling stations



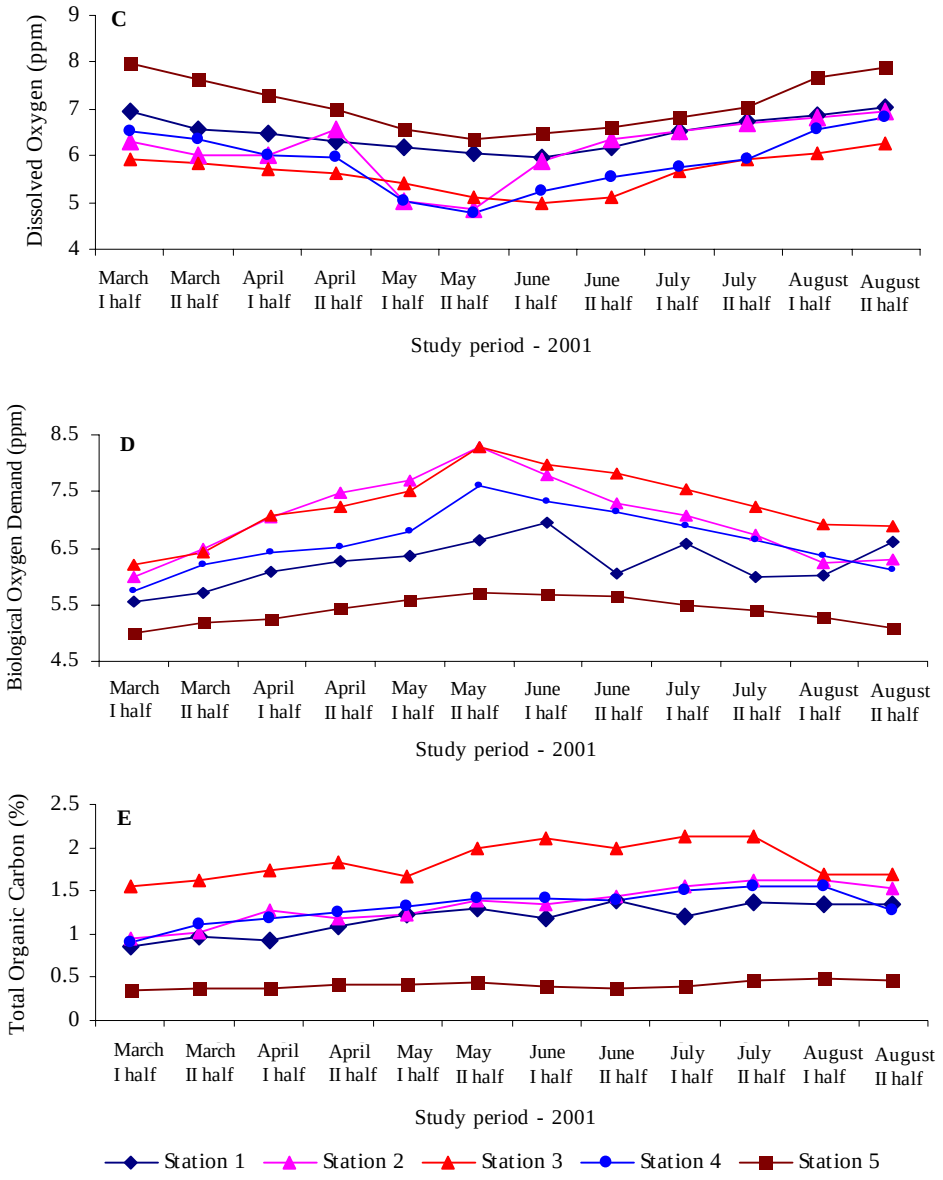



Fig. 2: Physico-chemical parameters of Palk Bay, Mandapam sea water samples on coral reef areas were collected from March to August 2001

The pH value fluctuated between 7.9 ± 0.11 to 8.7 ± 0.20. The minimum mean pH of 7.9 ± 0.11 was recorded in station-3 in the II half of August 2001 and at the control station minimum mean pH of 7.7 ± 0.12 was observed in the II half of August 2001. The maximum pH of 8.7 ± 0.20 was noted in station-3 in the II half of May 2001 at the same time the control station had a maximum pH of 8.3 ± 0.14 in the II half of May 2001 (Fig. 2B). ANOVA indicated that the pH values of all the four experimental stations were significantly higher than that of the control station ($F_{4, 59}$: 6.264, $P<0.05$). In the present study area, the amount of DO ranged between 4.75 ± 0.06 ppm to 7.02 ± 0.04 ppm. Among the all the stations, the lowest mean DO was of 4.75 ± 0.06 ppm was recorded in station-1 in the II half of August 2001 and at the control station the minimum DO of 6.35 ± 0.10ppm in the II half of May 2001.

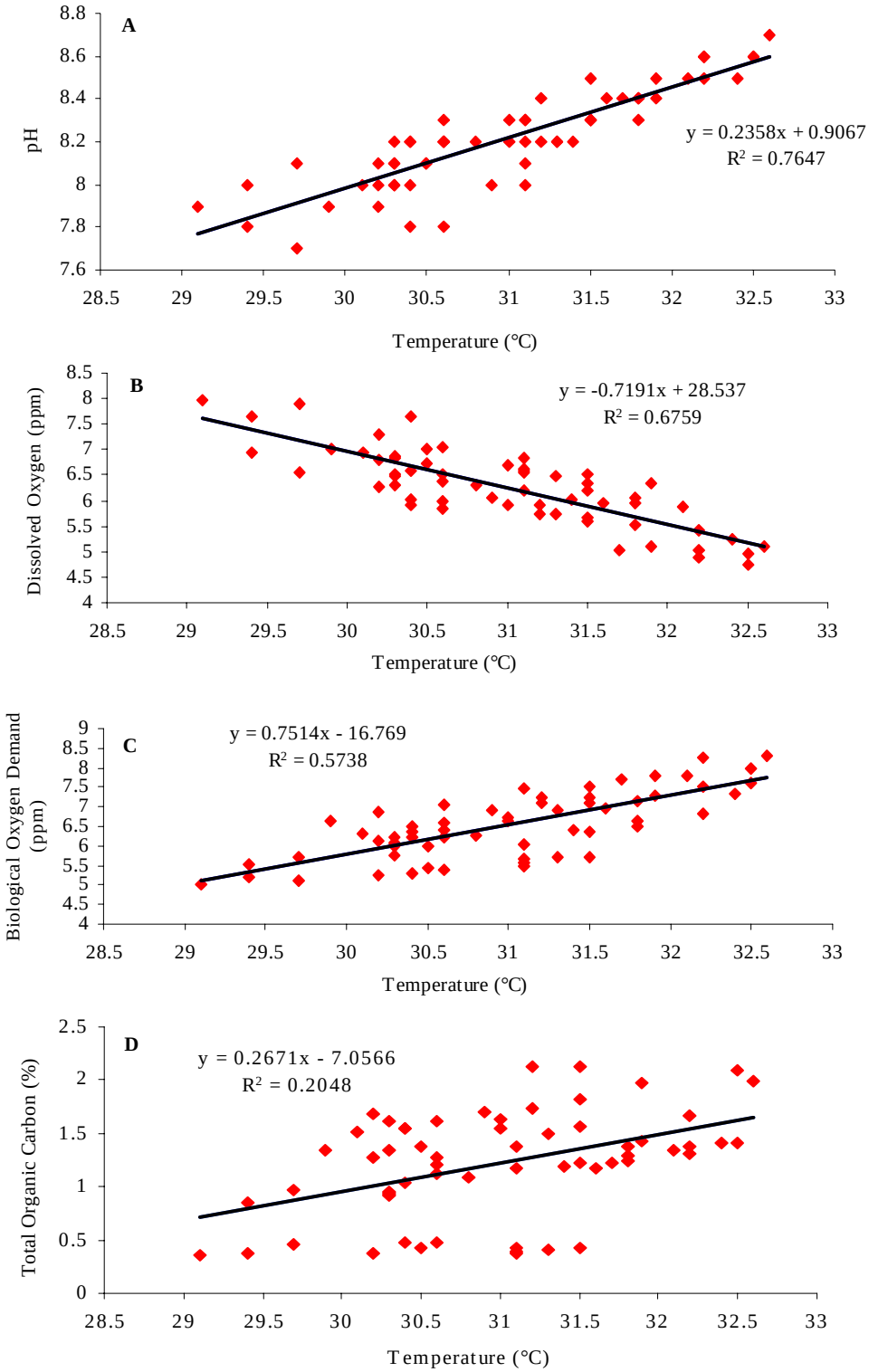



Fig. 3: Comparison of temperature with other physico-chemical parameters. A) Temperature Vs pH, B) Temperature Vs Dissolved Oxygen, C) Temperature Vs Biological Oxygen Demand and D) Temperature Vs Total Organic Carbon

The highest mean DO of 7.02 ± 0.04 ppm was recorded in station 4 in the II half of May 2001 and maximum mean DO of 7.98 ± 0.06 ppm was observed in control station in the I half of March 2001 (Fig. 2C). ANOVA indicated that in all the four experimental stations, the mean DO values were significantly lower compared to that of the control station ($F_{4, 59}$: 13.508, $P<0.05$). The BOD ranged between 5.54 ± 0.0.54 ppm to 8.29 ± 0.09 ppm. The minimum BOD value of 5.54 ± 0.54 ppm was observed in station 5 in the I half of March 2001 and the control station had minimum mean BOD of 5.00 ± 0.06 ppm in the I half of March 2001. The maximum BOD of 8.29 ± 0.09 ppm was recorded in station 3 in the II half of May 2001 and the maximum mean BOD value of 5.71 ± 0.08 ppm was observed in the control station in the II half of May 2001 (Fig. 2D). ANOVA indicated that in all the four experimental stations, the mean BOD values were significantly higher than that of the control station ($F_{4, 59}$: 23.336, $P<0.05$). The mean TOC values ranged between 0.85 ± 0.04% to 2.13 ± 0.02%. The minimum TOC of 0.85 ± 0.04% was recorded in station-1 in the I half of March 2001 and the control station had minimum TOC of 0.35 ± 0.03% in the I half of March 2001. The maximum mean TOC of 2.13 ± 0.02% was noted in station-3 in the I half of July 2001 and the maximum mean TOC of 0.48 ± 0.05% was recorded in the control station in the I half of August 2001 (Fig. 2E). ANOVA indicated that in all the four experimental stations the mean TOC values were significantly higher than that of the control station ($F_{4, 59}$: 97.077, $P <0.05$). Regression analysis showed a significant positive correlation between temperature and pH ($r = 0.76$, $n = 60$, $P<0.001$, $y = 0.2358x + 0.9067$), temperature and BOD ($r = 0.57$, $n = 60$, $P <0.001$, $y = 0.7514x - 16.769$), and temperature and TOC ($r = 0.20$, $n = 60$, $P<0.001$, $y = 0.2671x - 7.0566$). On the other hand temperature and DO showed a negative correlation ($r = 0.68$, $n = 60$, $P <0.001$, $y = -0.7191x + 28.537$) (Fig. 3A-D).

## DISCUSSION AND CONCLUSION

Mathew and Gopukumar (1986) had reported maximum surface water temperature value 31.0°C was registered in the April in Minicoy Island, Lakshadweep. Compared to the findings of Mathew and Gopukumar (1986) maximum temperature observed in the present study was higher. Rao and Valsaraj (1984) had reported maximum pH values 7.6 and 8.4 in the month of April and May respectively in the Bay of Bengal. When compared to the above findings the values in the present study were high. The higher concentration of pH value may be due to biological activities besides the addition of chemical substrates (Mogal, 1996). Krishnapillai, *et al*. (1986) had reported maximum DO of 6.04 mg/L in the surface water during November 1979 in the Palk Bay region. Radhakrishna and Krishnapillai (1978) observed maximum DO of 5.17 mg/L in the shelf waters off Bombay. Compared to these findings, low values of DO were noticed in the present study. In the present study, DO level was very low in station 4 and station 2 because these stations were found more polluted compared to the control station. Shaosai and Shilai (1998) had reported maximum BOD of 6.98 mg/L in Dingi Bay, China. The maximum BOD value observed in the present study was 8.29 ± 0.09 ppm in station-3 in the II half of May. When compared to the findings of Shaosai and Shilai (1998) the values seen in the present study was high. The high BOD load of sewage can produce high algal biomass in 10-12 days period and the conversion coefficient would be 0.95 i.e., 1 kg of BOD can produce 950 g of algae. The algae would prevent the sunlight entering the sea, which will automatically affect the growth of coral reefs (Chandraprakash and Reddy, 1999). The higher BOD values indicate entry of organic waste in the sea. It is an alarming condition in near future and hence prevention in needed to disposing waste in to the sea. Buscail, *et al*. (1999) had reported minimum TOC of 0.9 % in surface sediments of the Gulf of Andrew, in the South Mediterranean sea of Algeria. In the present investigation TOC values were similar to these observations. Olsson and Anderson (1997) had reported minimum TOC of 0.35 % in the Siberian Shelf Sea. Giordano, *et al*. (1999) had reported TOC value of 0.34 ± 0.20 % in Terranova Bay, Antartica. In the present study, TOC values were higher than those findings of Olasson and Anderson (1997) and Giordano *et al*. (1999). It could be concluded from the present study, that all the sampling stations were polluted compared to the control station. The TOC load was probably due to addition of sewage water from near by Mandapam town, and effluents discharged from seafood processing unit. The present study on the quality of seawater along coral reefs of the Palk Bay, Mandapam coasts showed that many areas are highly polluted due to the disposal of sewage or oil and also due to the carelessness of man in keeping the environment clean. The problem is severe in the sewage disposal site, affecting not only the quality of seawater and the flora

and fauna inhabiting there nut also the health of the residents living in the seashore area. In view of the expected increase in industrialization and urbanization in Palk Bay, Mandapam region during the next decade or so, it is important to formulate pollution control policies that take into account the need to find the source of origin and regulate discharges of contaminants into the coastal waters. Various laws to control aquatic pollution have to be formulated and should be enforced. The control measures should include the formulations of standards and criteria, effluent treatment, monitoring and environmental training. It is also important that emphasis should be placed on the need to minimize waste generations. Sewage treatment plants should be set up in healthy affected areas which will minimize the changes of the quality of seawater when it is mixed with the inflow of sewage water. The results of present study indicated that coral reefs could be affected by temperature. If the temperature goes beyond the optimum level then it will affect the coral reefs and some times it will lead to coral bleaching. Sewage water and other pollutants should be treated properly before released; otherwise, it will lead to destruction of marine organisms particularly coral reefs. We have to conserve coral reefs, because the entire marine fishery depends on coral reefs.

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