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Macro benthic fauna of two differently polluted coastal waters of Gulf of Mannar, southeast coast of India

T.Mohanraj*, H.Sivanesh, A.Nirojan
Tuticorin Research Centre of Central Marine Fisheries Research Institute,
South beach road, Tuticorin - 628 001, Tamil Nadu, (INDIA)
E-mail: mohancmfri@gmail.com

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ABSTRACT

Macrobenthic community structure of two differently polluted coastal waters of Tuticorin was studied for the period of July 2008 to June 2009. The station I is LWDP and station II is Threspuram. The annual mean variance of temperature of station I and station II is 37.8 and 29.4 respectively. The distribution of benthos was higher in station II than station I. The species diversity is higher at station II with the value of value 3.20 in the month of December 2008 and 2.28 in the month of March 2009 at station I. DO is calculated in station I as 4.12 and station II with 4.60. Station I has distinguished percentage of very fine sand. There are totally 35 species of benthic fauna were collected during this study. The water temperature has a distinct influence on species diversity and abundance in this study.

KEYWORDS

Macrobenthic fauna;
Thermal effluent;
Sewage discharge;
Gulf of Mannar;
Gastropods;
Temperature.

INTRODUCTION

Benthic zone and the dwelling organisms are more important to the ecosystem of any water body. They are great indicators of any changes that occur in the area. Specific species or species types can show the information on the status of the benthic environment[4]. For instance pollution, physical and chemical disturbances in the seabed etc. colliery wastes and fly ash dumping will cause the water to turbid and covers the entire seabed and decrease the reduction potential of the substrate, thus lowering the density and diversity of the benthic organisms[2,6]. Oil spills leads to entire eradication of the benthic organisms of affected area due to unavailability of dissolved oxygen[4]. Benthic organisms have a stable life cycle and community composition and therefore can often used as a monitoring index for pollution[9]. Fishing gear (trawls and dredges) are dragged across the seafloor made an impact through disturbance to benthic habitats[19]. The macrobenthos are mostly non-migrant inhabitants, and can be used as indices of ecological changes in the sea water environment. The surface deposit-feeding polychaetes and crustaceans commonly live in more or less permanent V-shaped burrows or tubes with at least two openings to the surface, while bivalves usually live permanently buried with their siphons extended to the surface. Benthos plays an important role in the aquatic marine ecosystem because of their importance in the marine food chain. Structural changes in marine benthic communities caused by different disturbances such as organic enrichment and physical forces seem to be rather predictable and were followed by the models presented by Pearson and Rosenberg[12] and Rhoads and Germano[15]. Benthic macro faunal structural changes in relation to various degrees of disturbance and on the impact of the internal activity for biogeochemical process in the sediment[16]. The continuous operation of thermal power plant with a parallel discharge of thermal effluent has resulted the possibilities for increasing the temperature of receiving water. Thermal effluent not only can produce adverse effects on the coastal water but also can affect the aquatic organisms such as planktonic community and bottom fauna[10,11]. Living as sedentary and sessile, the benthic fauna are the major causalities of any type of environmental changes. The interrelationship between environmental parameters and benthic community structure, anthropogenic impacts and modeling of the ecosystem were achieved by the benthic ecologists.

This study reports on the macro benthic faunal community of two differently polluted areas of Tuticorin coast. Water quality measurements were also compared so as to assess the impacts of existing industrial and domestic pollution in this area.

MATERIALS AND METHODS

Tuticorin is under the severe pressure on pollution. Due to the various industrial establishments around this city leads to the threat to the biodiversity. Moreover emerging population increases the domestic pollution such as discharge of sewages. The Tuticorin Thermal Power Station discharges thermal effluent at the rate of 115x 10^6 liters/day into the adjacent water body with the temperature range between 40 and 44°C. There is also a high deposition of ash (at the rate of 4000 mt/day)[8]. This study carried over in the two selected areas of this Gulf of Mannar marine national park. Station I is the Karapad bay where the Liquid Waste Discharging Point of TTPS is located. And the Station II is domestic sewage mingling with the sea (Threspuram). Station I is always experienced with hot water and fly ash. The station II is exposed to the organic enrichment of sewage waste. The above two station were polluted differently, station I is affected by industrial pollution and station II is affected with domestic pollution. This can help us to establish knowledge on effect of different type of pollution in the benthic zone.

Environmental parameters and samples of benthic fauna were collected from the identified stations at regular monthly interval for the period of one year (July 2008 to June 2009). Bottom water samples were collected for temperature, salinity, pH and estimation of dissolved oxygen concentration. Van-Veen grab (0.1 m^2 area) was used for collecting bottom fauna and sub samples were also collected for sediment analysis. The water temperature was determined using thermometer with the accuracy of 0.5°C. Salinity and dissolved oxygen were estimated as mentioned by Strickland & Parsons[18]. pH of the water was measured with a digital pH meter. The sediment particle size composition was made by following standard procedures[17]. Benthic fauna was separated by passing the sediment through a 0.5 mm mesh sieve. The organisms remained in the sieve were undergone for macrobenthic faunal analysis. The collected fauna were preserved in 5% formalin solution for further analysis. Species diversity, population density, evenness and richness were calculated by following standard methods.

RESULTS AND DISCUSSION

Environmental parameters

The environmental parameters are given in TABLE 1. The temperature of water is high at station I 37.8 ± 1.24 and station II shows 29.4 ± 2.28. Salinity was recorded in station I and II 34.1 ± 0.63 and 34.22 ± 1.12 respectively. The dissolved oxygen calculated from station I was 4.09 ± 0.28 and station II was 4.36 ± 0.32. The rate of dissolved oxygen was higher in station II than station I. The highest pH was recorded station I 8.1 ± 0.14 and station II was 8.2 ± 0.2.

Sediment composition

The mean variance of sediment composition is presented in TABLE 1. Sediment particle size composition constitutes medium sand ranged from 18.5% (S-I) to 63.8% (S-II), fine sand ranged from 16.24% (S-I) to 59.12% (S-II) and very fine sand from 8.92 to (S-II) to 54.61% (S-I). The station II covers high percentage of medium and fine sand particles. Station I has distinguished percentage of very fine sand.

TABLE 1 : Environmental physico - chemical parameters of the study area

Environmental parameters	Station 1	Station 2
Temperature	38.0 ± 1.10	28.9 ± 2.61
Salinity	33.6 ± 1.0	34.52 ± 1.18
Dissolved oxygen	4.12 ± 0.392	4.60 ± 0.23
pH	8.22 ± 0.16	7.6 ± 0.29
Medium sand %	44.1 ± 11.96	50.1 ± 8.9
	(19 – 61.38)	(33 – 64.08)
Fine sand %	32.28 ± 8.11	35.26 ± 9.13
	(15.72 – 45.17)	(22.61 – 57.19)
Very fine sand %	25.69 ± 14.12	17.1 ± 3.93
	(3.23 – 51.92)	(8.19 – 25.59)

Benthic faunal composition and distribution

The distributions of benthic organisms were shown in TABLE 2. Among all faunas gastropods shares a remarkable percentage in the two stations. The highest percentage of gastropods was found in station II 84% during the month of October 2008. The least percentage of gastropods was found in the station I during the month of December 2008. The bivalves are the second largest group of benthos found in the samples. 34 % was highest record in the month of December 2008 at station I. And 10% is the least amount composition during the month of March 2009 in station II. Polychaetes were given up 11% is the higher in the month of March 2009 at station I. Lowest percentage value is 1% in the month of June 2009 during station I. Crustaceans holds highest percentage 12% during the month of July 2009 in the station I and 2% was the lowest composition during the month of July 2008 at station II. Echinoderm gives up 5 % during December 2008 at station II and 1 % at station II during June 2009. There are totally 35 species of benthic fauna were collected during this study. Among them *Cerithidium morus, Euchelus asper, Trochus tentorium, Umbonium vestiarium*, Donax sp, *Gafrarium tumidum*, Capitellids, Nerieds, Terebellids, Balanus sp, *Peneaus semisulctus* were found in both stations. Station I harbours only 18 species of benthos during this study. In that 8 species were presented only in the station I. Station II recorded 26 species of benthic faunas in this study. 17 no of species only found in station II. Echinoderms were only recorded in station II. And majority of gastropods were also recorded at station II.

TABLE 2 : Macrobenthic faunal diversity of the study area

Benthic fauna	Station 1	Station 2
Crustaceans		
Amphipods	*	--
Balanus sp	*	*
Clibanarius clibanarius	--	*
Isopod	--	*
Peneaus semisulctus	*	*
Scylla serrata	*	--
Polychaetes		
Capitellids	*	*
Nerieds	*	*
Terebellids	*	*
Bivalves		
Anodontia edentula	--	*
Dona-- sp	*	*
Epicodakia sp	--	*
Glycermis sp	*	--
Gafrarium tumidum	*	*
Mesodesma sp	*	--
Placenta placenta	*	--
Semele sp	*	--
Tellina ala	--	*
Gastropods		
Agaronia nebulosa	--	*
Bulla ampulla	--	*
Calyptrea extinctorium	--	*
Callistoma sp	--	*
Cerithidea cingulata	--	*
Cerithidium morus	*	--
Cerithium sp	--	*
Euchelus asper	*	*
Harpulina lapponica	--	*
Mitra sp	*	--
Phasianella solida	--	*
Rhinoclavis sp	--	*
Trochus tentorium	*	*
Umbonium vestiarium	*	*
Echinoderms		
Brittle star	--	*
Peronella lesueuri	--	*
Pentaceraster regulas	--	*

*** Present; --- Absent**

Faunal diversity, richness and evenness

The species diversity and richness was calculated with the shannon's index and Margalef's index respectively. The species evenness was also calculated. The species richness is higher in the station II with value of

2.11 in the month of December 2008. And the same is higher in station I with the value of 1.72 during the month of September 2008. Evenness was recorded with the highest value of 0.982 in station I in the month of July 2008 and the station II holds 0.92 in the month of March 2009. As far as diversity is concerned station II shows highest value 3.20 in the month of December 2008 and the station I give up 2.28 in the month of March 2009.

This study proves that the benthic organisms can easily be affected by environmental changes such as temperature, salinity and pH. The diversity and richness were recorded higher in the station II than station I. This is due to the discharge of thermal effluent in the station I. The density of benthic fauna could be largely decreased when associated with the increased temperature range of 34.0°C-37.0°C[7]. The diversity and rich-

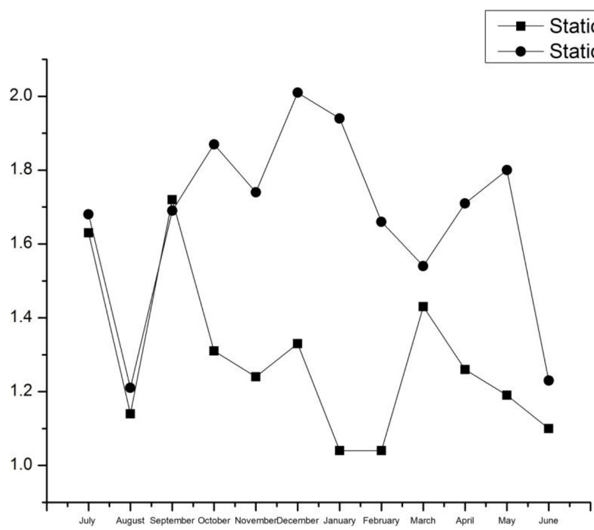

Figure 1 : Species richness of station I and station II

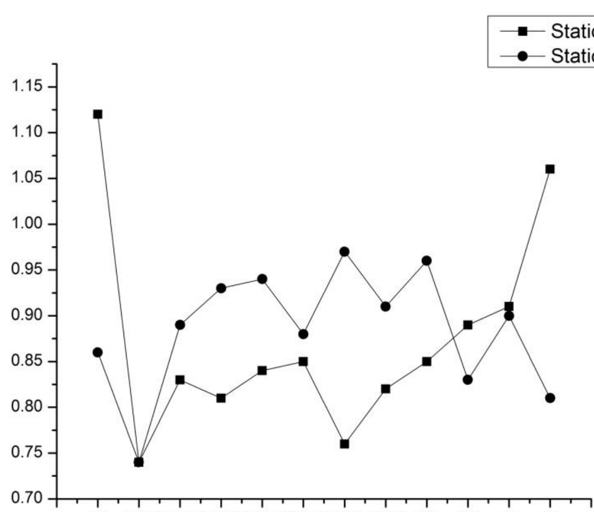

Figure 2 : Species evenness of station I and station II

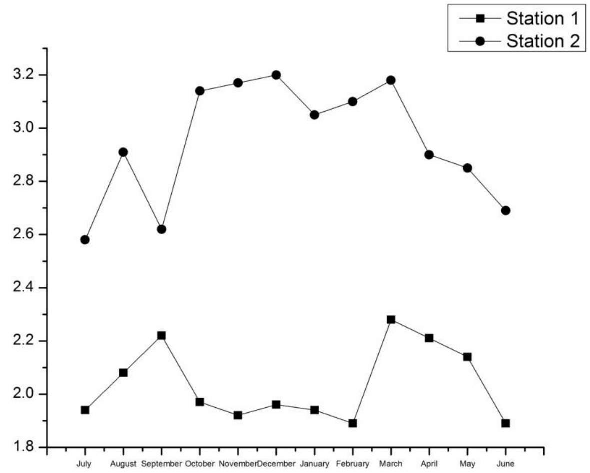

Figure 3 : Species diversity of station I and station II

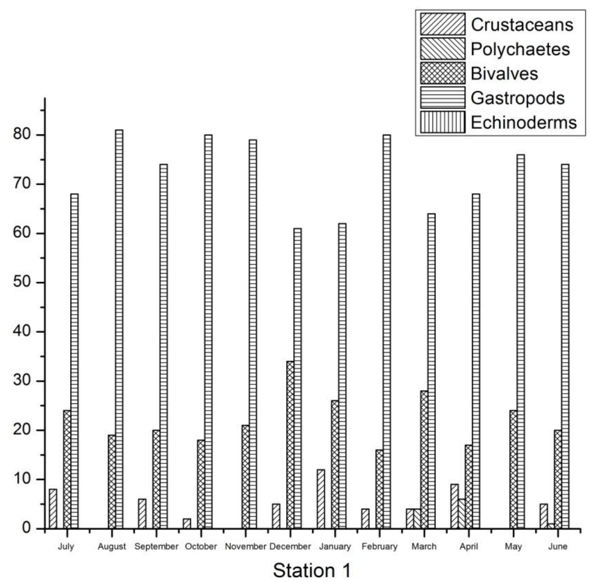

Figure 4 : Percentage of benthic organisms from station I

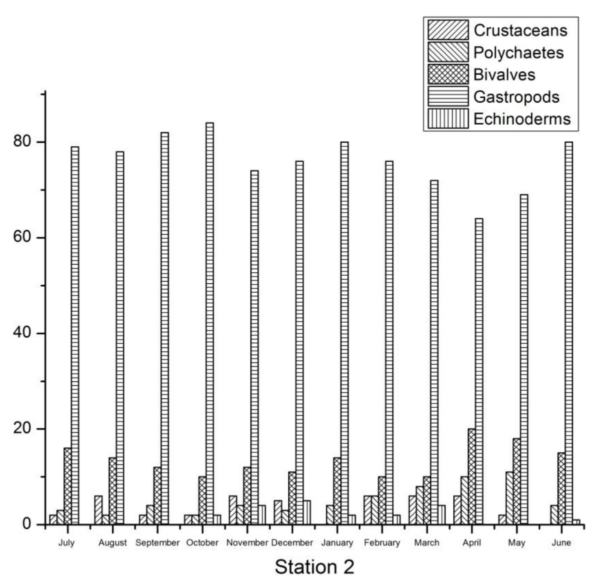

Figure 5 : Percentage of benthic organisms from station II

ness were recorded higher in the station II than station I. The average annual mean temperature of station I is 37.8° C, this factor may reduce the density of benthic organisms[1]. The scarcity of the biota revealed the ill effects of the fly ash deposits and turbidity coupled with enhanced temperature in the Bay waters of Tuticorin[3]. Temperature showed significant negative correlation with faunal density and biomass while species diversity had insignificant negative correlation[8]. High temperature recorded in premonsoon season influence the distribution of marobenthic organisms. Low temperature recorded that influences the higher faunal density[20]. As suggested by Gage and Tyler, seeped fluids exhibit a fauna taxonomically similar to that of hydrothermal vents such as tubeworms, vesicomid and mytilid bivalves, which can use the carbon from dissolved methane through symbiotic bacteria. High temperature regime can alter the normal physiological functions of aquatic fauna by creating stress to the organisms and thereby affecting the population density[7]. The dissolved oxygen and pH didn't play an important role in the faunal distribution and abundance. This was reported by Prabha devi and Ayyakannu[13]. Kulai receives large quantities of industrial and sewage effluents responsible for alteration of the ecosystem structure, the excellent wind driven mixing and tidal flushing keep the waters well aerated thus reducing the severe pollution stress by dispersing the organic and other pollutants[21]. The spatiotemporal variations in the results recorded do not suggest that the benthic phytomacrofauna communities were influenced by site specific and seasonal factors, but by the generally degraded water quality[14]. The continuous discharge of sewage water leads to high attribution of organic enrichment in the station II. This may help to build a high population density. The study clears those environmental criteria such as temperature affects faunal density and diversity of any water body.

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