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RESEARCH ARTICLE

IMPACT OF WATER AND SEDIMENT QUALITIES ON THE BENTHIC COMMUNITIES OF PUNNAKAYAL, ROCHE PARK AND THIRESPURAM COASTAL WATERS OF TUTICORIN SOUTH EAST COAST OF INDIA

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ABSTRACT

Tuticorin is an industrial city located in the south east coast of India and it receives untreated sewage and industrial effluents. The present investigation was carried out to find out the changes in physico-chemical and biological parameters including fecal coliforms of Thirespuram coastal waters, Roach Park and Punnakayal estuary of Tuticorin coast to assess its impact on the benthic communities of these areas. Among the various parameters, salinity was low during monsoon at certain stations due to the river run off. Turbidity, TSS and fecal coliforms were high in water and sediment samples, dissolved oxygen and benthic population were lower, at certain stations where the discharge of untreated sewage and domestic waste disposal were found to be abundant. Untreated sewage and domestic waste have been observed to increase the turbidity, TSS, nutrients and induce fecal coliform growth and reduced dissolved oxygen. These factors are found to affect benthic population of the study sites in the Tuticorin coastal region.

INTRODUCTION

Water quality is an important factor for the survival of marine living organisms. When the quality of water is deteriorated it will lead to dangerous consequences. Water quality has been often challenged by natural and anthropogenic inference. Seasonal changes are a natural factor affects the physical and chemical properties including fecal coli form abundance in the marine environment. Karande, (1991) reported that temperature, salinity, dissolved oxygen and nutrients influence the composition, distribution and growth of biota. Sometimes coastal environment is affected by few factors such as mixing of sewage, industrial, domestic waste and river run off which invariably alter the nature of water and sediment and also induce pathogenic micro organisms in coastal environment. This may subsequently affect the benthic community of that area. Thirespuram coastal zone in Tuticorin is stressed due to anthropogenic pressures such as loading of untreated domestic sewage, fish waste, animal and human fecal matters. A fishing boat yard also significantly reduces the water quality in this region. In Punnakayal estuary, seasonal changes are one of reason for altering the water quality due to river run off from tributary of the perennial river, Thamirabarani. Elevated level of fresh water inflow, fishing practices, animal and human waste mixing also alters the environmental condition of this region. Roche Park is also affected by seasonal variations apart from the localized anthropogenic inputs. In this content it is water mentioning that pathogenic micro-organisms, especially fecal coli forms are found in abundance, sometimes alarmingly abundant in such nutrient rich organically polluted coastal water (Sugumar *et al.,* 2008). Abundance of such bacteria in relation to temperature, salinity, pH, dissolved oxygen and nutrients has been well studied (Azam *et al.,* 1983; Ducklow and Hill, 1985). Hence, the present attempt has been made to assess the impact of such organic pollutants and seasonal changes on the benthic communities in these areas.

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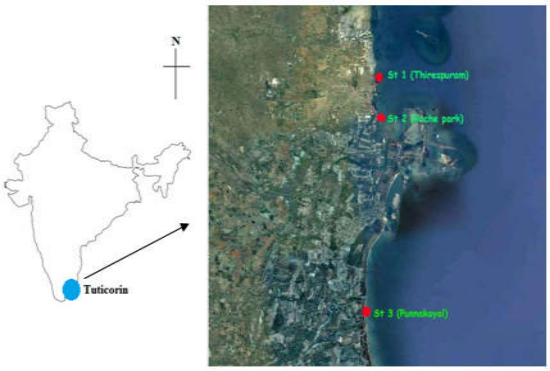
Study area

Station 1: Thirespuram (N' 8^0 48. 456 E' 78^0 09. 485) is a coastal village of Tuticorin located on 8 km away from Tuticorin Thermal power station and 5 to 6 km distance from Tuticorin fishing harbor. Hereby load of untreated sewage, human and animal fecal matter are mixed with coastal water in this station. Salt pans and small fish processing industries located around this station release fish wastes and salt pan effluents in this area.

Station 2: Inigo nagar area is where an amusement Park, the Roach Park (N' 8^0 47. 006 E' 78^0 09. 334) is situated and mangroves vegetation is located and is 3 km distance from Tamil Nadu Thermal Power Plant. Fishing is main effort in this region and recreational activities are done by local people. Domestic wastes and garbage is dumped near to this station.

Station 3: Punnakayal estuary (N' 8^0 38. 266 E' 78^0 07. 317) is the only estuary in Tuticorin region of Gulf of mannar. Tambraparani which arises in the Western Ghats and flows through Srivaikundam and Thiruchendur taluks joins the Arabian sea at Punnakayl. Mangroves are abundant in this

area especially *Avicennia sp*. (Jeyseeli and Murugan, 2002). In punnakayal, around 80 families depend on the mangrove forest for their livelihood. Dumping of domestic sewage, fish waste disposal and discarding of human and animal waste is found in this area (Jeyseeli and Murugan, 2002).



Locations of sample collection

MATERIALS AND METHODS

Collection of samples

Water and sediment samples were collected once every month for one year from February 2010 - January 2011 in Thirespuram, Roch Park and Punnakayal estuary along Tuticorin coast. Water samples were collected in nitric acid washed plastic container and sediment samples were collected using Sterile Peterson's grab and transferred in sterile plastic cover. Samples were kept in an ice box at 4^0C and immediately transferred to laboratory. For fecal coli form analysis, sterile screw tubes were used and analysis had been made with in 4 to 6 hours.

Analysis of samples

Temperature was measured in water samples using a (Digital stem thermometer -50~200^{0}C). Salinity was measured by Hand Held Refractrometer (ATAGO, 0~100‰). pH was measured using a (HANNA pH 213, 0 to 14) and turbidity was analyzed by water quality analyzer (ELICO PE 138). Total Suspended Solid was calculated following (APHA, 1989). Dissolved oxygen was estimated using Winkler's methods and nutrients such as nitrate, nitrite, phosphate and silicate were measured spectrophotometrically (ELICO SD 164) following Strickland and Parsons, 1982. Fecal coliform count was calculated by Most Probable Number (MPN) technique in water and sediment samples (APHA, 1998). For benthic faunal analysis sediment was collected using a Peterson's grab and fixed with 10% formalin in seawater. The samples were transported to laboratory and filtered through 0.5 mm sieve to separate macro benthos. Then the samples of macro benthos were transferred into 10% formalin containing Rose Bengal stain for quantitative identification (McIntyre 1984, Aswandy *et al*., 1991 and Zaleha *et al*., 2001).

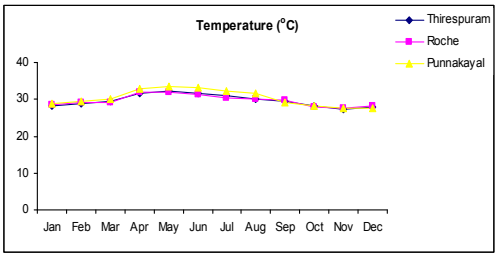
RESULT AND DISCUSSION

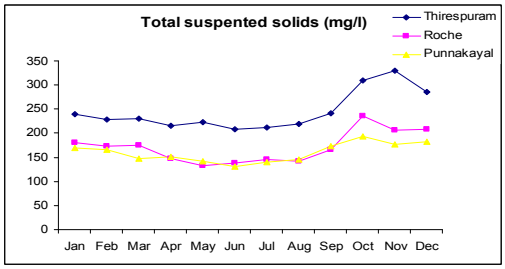
Water temperature ranged between 27.5 and 33.5 ^{0} C with highest in station 3 and lowest in station 1. Temperature fluctuation occurred seasonally such as during summer and low during monsoon season. Temperature gradually increased from April to May and declined from September to November in all the three stations. During the monsoon season (October to November) cooling occurs and high level of fresh water inflow reduces the water temperature. Temperature variation is one of the factors in the coastal and estuarine system, which influences the physico – chemical characteristics and also influences the distribution and abundance of flora and fauna. Water temperature during November was low because of strong land breeze and precipitation but the high temperatures during summer might be attributed to solar radiation (Ashok Prabu, *et al.,* 2008). Similar observations have been reported by Thangaraj (1985), Gothandaraman (1993) and Seenivasan (1998) from Vellar estuary. Mani (1989), Vasantha (1989), Kaliyaperumal (1992) and Karuppusamy (1997) from Pichavaram mangroves have reported similar conditions. Saraswati (1993) from Arasalar and Kaveri estuarine complex and Kannan and Kannan (1996) from Palk Bay have also reported similar finding as the present investigation.

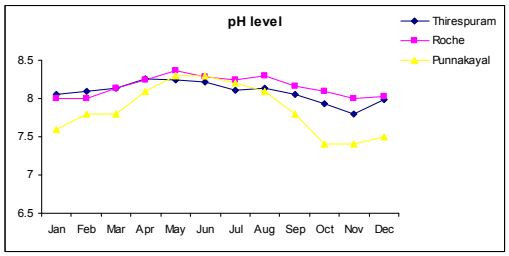
Salinity and pH did not vary significantly in station 1 and 2 because of no river run off, but slight variation was observed in station 3 during monsoon than other two stations (Fig: 1). Salinity was very low in station 3 during October, November and December with 22 ppt, 15 ppt and 18 ppt respectively, because of copious river water inflow during these months. The effect of river water inflow was enduring up to January and February. During summer higher salinity it could be attributed to faster evaporation. (Rajasegar, M., 2003) have reported runoff due to rains can reduce salinity. The similar observation has been made in Pondicherry mangroves by Satheeshkumar *et.al.,* (2009). Turbidity was highest in October and November (Monsoon) at station 1 with 12.8 and 13.6 NTU respectively. Lowest level was recorded in January and February at station 2 with 4.6 and 4.5 NTU respectively. Large quantity of untreated domestic sewage and high amount of organic waste including fresh water mix at station 1. Heavy land runoff influences the turbidity of these stations during monsoon. The same trend was observed by Lgbinosa *et al.,* (2009) in South Africa. Easterson *et al.,* (2000) have reported turbidity between 13.4 to 45.6 NTU from Tuticorin coastal waters similar to the present study. Total Suspended Solids were also high in station 3 comparatively than other stations, the range varied between 208 to 330 mg/l with highest in November and lowest in June. TSS level was slightly high mainly because of sewage waste mixed with coastal water. Low level of TSS observed than the present was recorded in Gulf of Mannar by Kaladharan *et al.,* (2009).

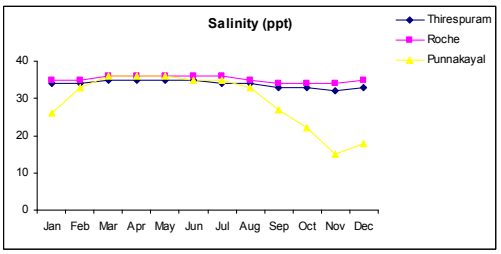
Dissolved oxygen was observed to be low in Thirespuram coastal waters during all the months compared to other stations and ranged between 2.0 to 4.1 mg/l with highest in November and lowest in May. This may be due to elevated amount of sewage mixing which has increased TSS, turbidity, heavy metals and bacterial load in the water column. The heavy metal attracts and binds with dissolved oxygen from water and as a reducing agent and bacteria utilize dissolved oxygen for respiration and products of organic matter degradation also interfere with DO concentration. 2.0 to 4.93 mg/l of dissolved oxygen was reported from Indian Ocean by Vijayakumaran *et al* (2009). Igbinosa, *et al.,* (2009) have reported that Dissolved Oxygen content in treated final effluent was observed to deplete faster because of the presence of degradable organic mater. The Dissolved Oxygen values

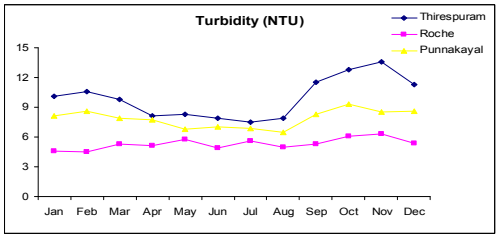
obtained from this study are similar to those reported elsewhere (Fatoki *et al.,* 2003; Jaji *et al.,* 2007; Obire *et al.,* 2003). DFID, (1999) has reported that oxygen balance is essential for maintaining biological life with in a system. Dissolved Oxygen standard for drinking purpose is 6 mg/L whereas for sustaining fish and aquatic life is 4-5 mg/L (Rao, 2005). Nitrate level marginally varied between three stations and highest value was recorded in Thirespuram coastal waters. The highest value was observed in January (48 µg at /L) and lowest value (21 µg at /L) was found in April (Fig: 1). Nitrate values seasonally varied in all the stations and highest level observed during post monsoon and lowest level was observed during summer. Nitrite level, as nitrates was highest during post monsoon season and lowest in summer in all the three stations. Jansi *et al.,* (2009) have reported similar concentrations of nitrates (6.26 to 50.62 µg at /L) from Manakkudy estuary, South west coast of India. The enrichment of nitrites and nitrates could be attributed to various factors. It is stated that unpolluted waters have nominal quality of nitrates (Jaji *et al.,* 2007). However the enrichment of nutrients viz; nitrates and nitrites are mainly due to sewage outlets rich in protein and poly phosphoric products (Young-Jin Suh and Rousseaux P., 2001). Also it enhanced level of these nutrients may be due to mixing of subsurface waters higher in nutrient concentration and the terrestrial run off (Ramachandran *et al*., 2005). Phosphate level was found high in Thirespuram waters during monsoon (3.81µg at/L) and low level during summer (1.35 µg at/L). Phosphate level was comparatively low in Roche park area. The lowest value at this site was observed during May with 0.51µg at/L and highest level during November with 2.33µg at/L. Elevated level of domestic sewage mixed in water column and fisheries waste, animal and human wastes are also observable reasons for the higher concentration. Phosphorus level increases due to runoff from domestic, municipal and agricultural waste (non-point sources) flowing into rivers, as well as washing along the riverside with detergents (Correll, 1998). Asha *et al.,* (2009) have recorded high level of phosphates than the present study in Gulf of Mannar waters. Silicate level was found high in Punnakayal estuary. Highest level was observed during October (11 µg/L) and lowest level (5.8 µg/L) was found during January. . The silicate concentration have seasonally changed and highest concentration was observed during monsoon in Punnakayal estuarine water due to heavy load of river water might be carried silt from terrestrial land. The same result was reported by Vijayakumaran *et al.,* (2009). Jansi et al., 2009 have recorded highest concentration of silicate in Mannakudi estuary than the present investigation. The highest fecal coliform count in water sample in all the stations was observed during October and November with 220 cells/100ml in Thirespuram coastal waters (Fig: 2). The coliform count was high during monsoon season at all the stations because of high amount of domestic sewage and organic waste which include micro organisms were mixed with coastal water during monsoon due to land run off. High numbers of faecal coliforms during monsoon and post-monsoon as in the present study have been reported from Cherai beach, Cochin backwaters, Bhavnagar coast, Port Blair Bay, Andamans and Nigopar, east coast of India (Goyal *et al.,* 1977). Similar trend was recorded in Tuticorin by Sugumar et al., (2008). Nutrients stimulate the bacterial growth in water system. Thirespuram water has high nutrient load (nitrate, nitrite, phosphate and silicate) which could also be the reason to facilitate the presence of high amount of bacteria in water and sediment. High numbers of coli forms have been reported from Andhra coast, because of high amount of sulphate, nitrate and ammonium ions (Swamy *et al.,* 2006). In sediment samples, fecal coliform were found in high number than water samples at all the three stations nutrient levels were high in sediment than water. Sediment sample had more number of fecal coliform than water samples because of their higher binding capacity for organic matter and nutrients that's easily attract the pathogenic organism especially fecal colifrom bacteria. Earlier studies from India reported higher concentration of faecal coliform bacteria in sediment than in water (Vaidya *et al.,* 2001; Mohandass and Bharathi, 2003). The feacal coliform bacteria from sediment samples were higher than those reported from west coast (Srikantaiah *et al.,* 1985). In the macrobenthic community, gastropods were dominant category followed by bivalves at these three stations (Fig: 4). Lowest numbers of benthic fauna were found in Thirespuram sediment samples while highest numbers of benthic fauna was found in Punnakayal sediment samples. In punnakayal mangrove sediments, gastropods were dominant during monsoon season with 195, 201 and 179 no/m^2 in October, November and December respectively while in the Thirespuram sediments it was 8, 6 and 5 no/m^2 during the same months. In general benthic communities were found in very low numbers in Thirespuram sediment. Determination of water and sediment quality is a limited factor for the determination of benthic organisms (Reish, 1979) also heavy load of organic matter, bacterial load, human disturbances such as boating and turbulence due to attacking waves also affect the abundance of benthic communities. Bat *et al* (2001) have reported that benthic diversity was less at sewage outfall point when compared to a further point. The present study also indicates the above reports. The mangrove sediments of Punnakayal lodges more bentic biodiversity where as the polluted (organic and microbial) Thirespuram coastal water lodges very low benthic community. However the Roche park area has seen moderate distribution. Kailasam., (2004) have reported 480 to 1074 no/ m^2 benthic faunal abundance from the Tuticorin coastal water. It is evident from the present study that the physical chemical and microbial characteristics of water and sediment play a vital role in the abundance and distribution of benthic communities.

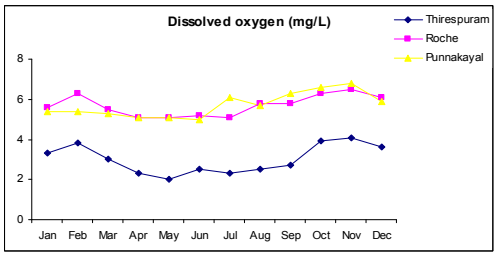


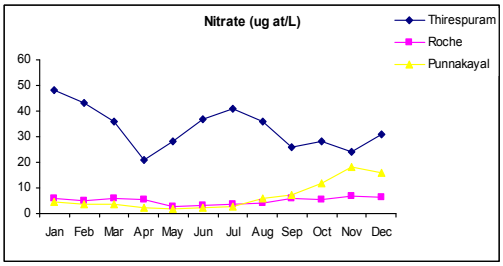


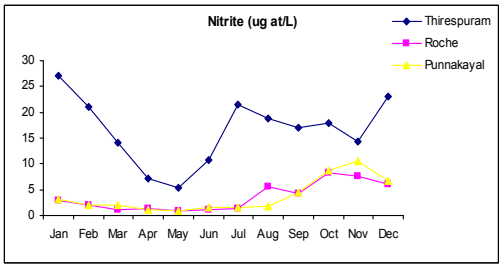


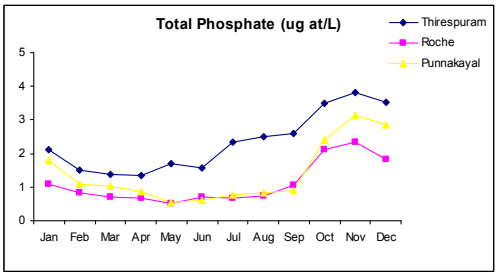












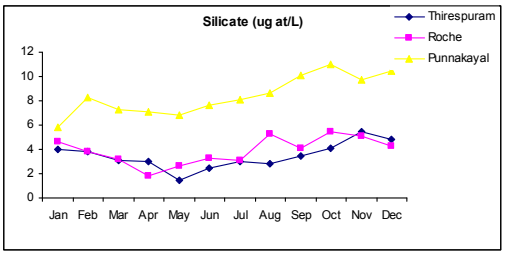


Fig. 1. Physico-chemical characteristics at the three study sites during February 2010 to January 2011

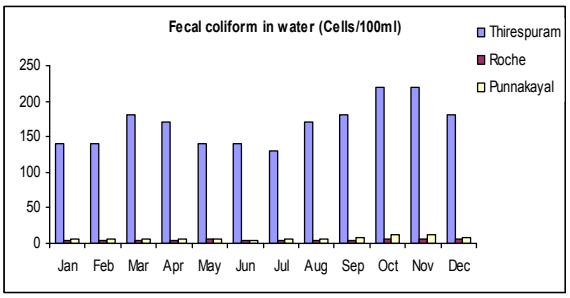


Fig. 2. Abundance of fecal coli forms in water column at the three study sites during February 2010 to January 2011

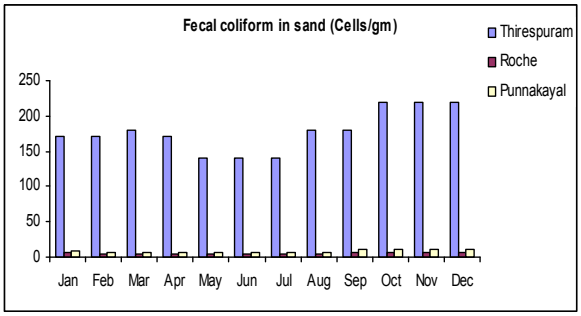
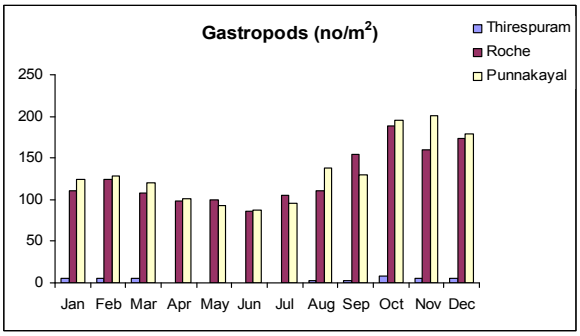
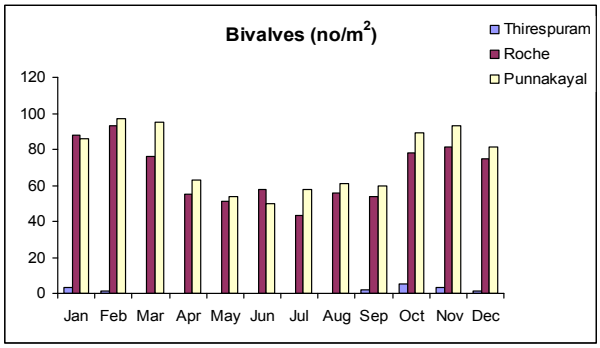


Fig. 3: Abundance of fecal coli forms in the sediment at three study sites during February 2010 to January 2011





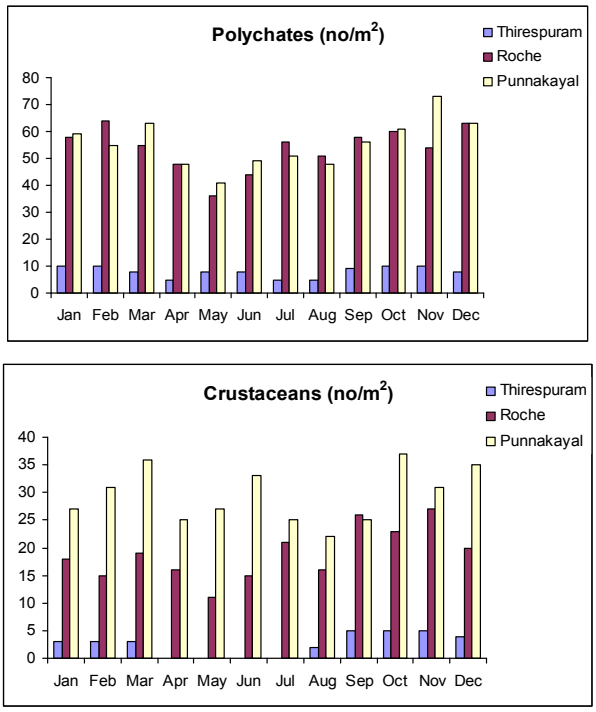


Fig. 4: Abundance of benthic communities at the three study site during sites during February 2010 to January 2011

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