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Macrobenthic Invertebrates as Coastal Ecological Bioindicators of Environmental Health

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The distribution of zoobenthic organisms in relation to the textural characteristics of the sediments in five stations (Veli, Varkala, Alappad, Neendakara and Cochin) was studied along the southwest coast of India. Sampling was done during the post monsoon of the year 2011 followed by the pre monsoon and monsoon seasons of the year 2012. The importance of zoo benthic communities in pollution studies is well established. Results revealed that the sediment texture for Veli, Varkala, Alappad and Neendakara was in the order sand > silt > clay while in Cochin it was silt > sand > clay. Organic carbon varied throughout the study and was expressed in the sequence Cochin>Alappad>Neendakara>Varkala>Veli. Wide variations in zoobenthic species diversity was also observed. The sinking range of coastal surface water received pollutants routed from fresh water input and these were estimated through the evaluation of bottom water nutrient characteristics. The present study thus focuses on the concept that the seabed acts as a sink for most of the pollutants entering the marine ecosystem, and the more stable sediments along with their inhabitant fauna give a clear picture of the severity of contaminants. The study has identified *Littorina scabra, Modiolus metcalfei and Trochida* sp as indicator organisms along south west India.

Key words: *Macrobenthos, sediment, organic carbon, bio-indicator*

Introduction

Macrobenthos play an important role in aquatic communities as they are involved in mineralization, promotion and mixing of sediments, flux of oxygen into sediments, cycling of organic matter and for assessing the quality of inland water[1]. Abundance and distribution of macro benthos is affected by various physical and chemical conditions of the water body such as depth, organic contents of the sediments, contamination of bed sediments, toxicity of sediments and rapid sedimentation. These appear to cause shifts towards lower abundance of macro benthic species. Opportunistic species will dominate in a pollution stressed environment and the conservative species may become rare or may disappear. Therefore, both these species can serve as pollution indicators[2].

Bays and harbours are mostly exposed to pollution because of anthropogenic activities, industries and harbourage operations. Often, the effects of pollution are reinforced by natural features of bays as the organic and inorganic pollutants tend to deposit in the fine sediments, limited circulation of water and the reduced tidal flux[3]. Marine pollution management is based on monitoring various physico-chemical and biological parameters to detect changes in the environment. Recent studies carried out in the coastal waters of India reveal that the coastal belt including the water and sediment is continuously being threatened by various pollutants discharged directly from industrial plants[4]. Zoo benthos are relatively sessile and sensitive to environmental changes such as nutrient level and oxygen concentration. Benthic communities usually have a long life cycle and stable community composition and can therefore often be used as a monitoring index for pollution[5].The objective of the present work was to study the preference of habitat and seasonal abundance of benthic fauna along the Kerala coast,

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southwest India in order to identify animal models as ecological indicators in terms of pollution inflow.

Material and methods

Sampling sites

The sediment texture characteristics and zoobenthic faunal diversity were studied along Kerala coast extending from Veli to Cochin. The locations of the study area along the south west coast of India are presented in Fig1. The sampling sites taken for the present study were Veli, Varkala, Alappad, Neendakara and Cochin (8° 22' N & 76 ° 59' E to 9° 58' N & 76 ° 17' E). The selection of locations was based on the inflow of pollutants from different sources-Veli [characterized by high human settlement and one of the heavily polluted areas along the Kerala coast with organic enrichment of sewage waste effluent directly discharged into the sea], Varkala [characterized by tourist influx and religious pilgrimage center resulting in domestic and organic pollution and massive foot traffic], Neendakara [characterized by oil pollution, being a fishing harbor and port with large scale motor boat / trawler traffic], Cochin [industrial epicenter characterized by inorganic pollution of heavy metals, trace metals, polycyclic aromatic hydrocarbons and organochlorins] and Alappad [control site and presumed to be near pristine being post tsunami and lacking any industrial / agricultural enterprise in the vicinity].

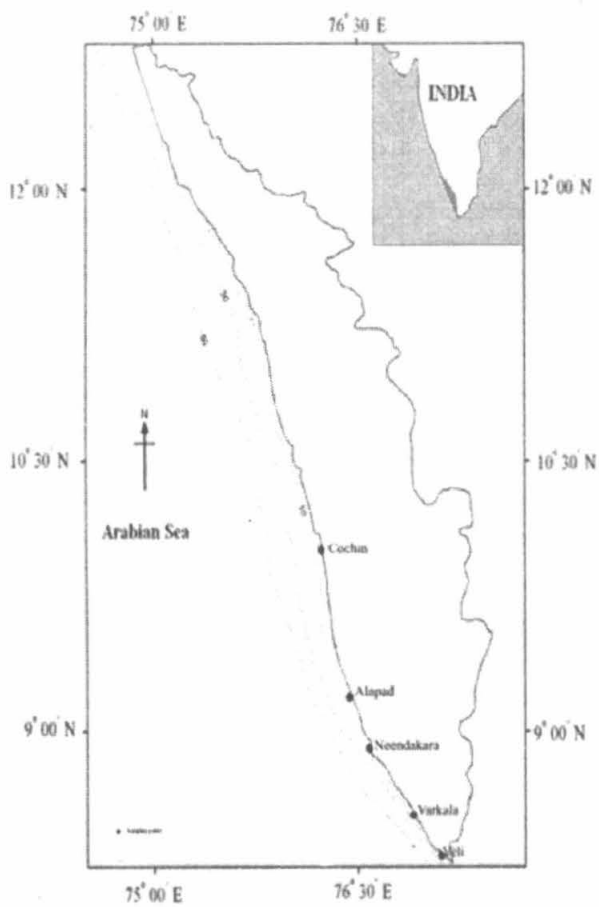

Fig.1: Map of Kerala showing the sampling points

Sampling protocol

Sampling was carried out seasonally (post monsoon, pre monsoon and monsoon) during the year 2011 – 2012. Three replicate sediment samples were collected using a Van Veen Grab (0.02m^{2}mouth area) from a depth of 10- 15m. The pooled sediment was sieved through a 0.5mm pore sized sieve and the macro benthos retained on the sieve was preserved in 4% formalin containing Rose Bengal stain. For chemical analysis, sediment samples were collected in polyethylene plastic bags and kept frozen.

The major macro benthic assemblages were identified using standard keys and expressed in No/ m^2 [6-8]. The sediment texture (sand, silt and clay) was determined by pipette analysis[9] and organic carbon of the composite samples was analyzed using wet digestion (chromic acid) method followed by back titration with ferrous ammonium sulphate[10].

Results

The zoobenthic faunal diversity from Veli to Cochin during the period of study is presented in Fig. 2. These belong to Gastropoda, Bivalvea, Polechaeta, Amphipoda and Nematoda. Highest numerical abundance was recorded in Cochin. The sediment textural analysis of the five stations showed wide variation in the composition of sand, silt and clay (Fig 3). The stations can be sub divided into two zones, according to the sediment textural habitat viz. Zone 1 – representing Veli, Varkala and Neendakara with a sediment texture pattern in the order sand > silt > clay and Zone 2 - comprising Alappad and Cochin having a sediment texture in the order silt>clay>sand. According to the seasonal abundance of organisms, they were marked as target species for coastal pollution monitoring studies and for prediction as an ecological indicator. The species *Littorina scabra, Modiolus metcalfei and Trochidae* sp were recorded as candidate species along the stations in Zone1 in terms of seasonal abundance. The study revealed benthic fauna in Zone 2 to be opportunistic. This can be attributed to the regular engineering modifications being carried out in Zone 2 stations, entailing periodical shifting or disturbance of their

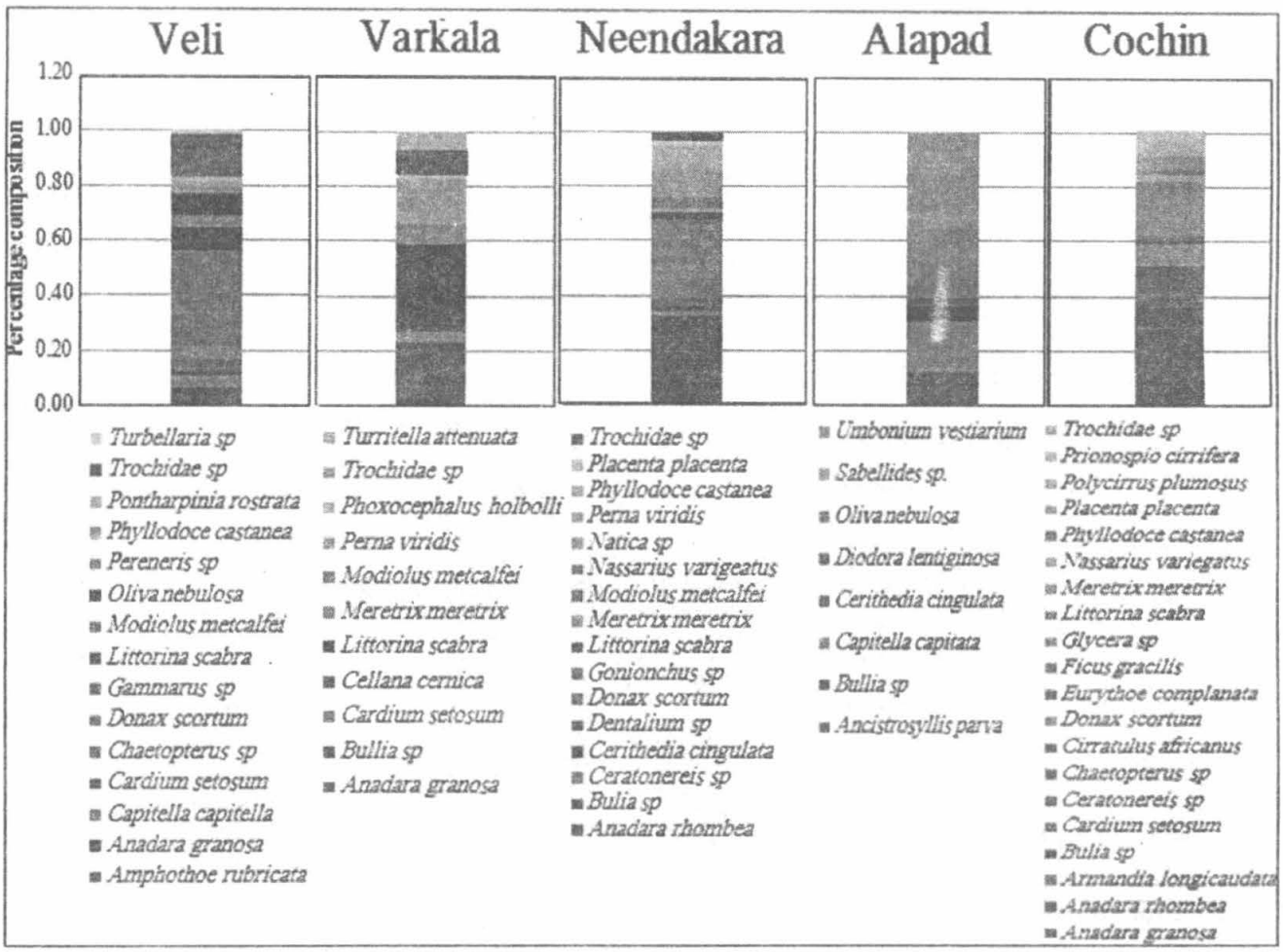

Fig. 2: Zoobenthic faunal diversity along the sampling sites

community structure. Organic carbon varied widely along the southwest coast of India.

Discussion

The importance of zoobenthic communities in pollution studies is well established through the present study. The seabed along the southwest coast of India acts as a sink for most of the pollutants entering the marine ecosystem and the more stable sediments along with their inhabitant fauna give a clear picture of the severity of contaminants and act as an indicator species of that particular area[11].The preference of habitat and seasonal abundance were the two main criteria taken into consideration while selecting benthic animal models for future pollution monitoring studies. The molluscan species *Littorina scabra, Modiolus metcalfei and Trochidae* sp were identified as ecological indicators. These benthic organisms exhibit moderately fast response to stress and being predominantly sessile or slow moving, are vulnerable to the effects of sediment contamination, assimilating pollutants over time[12]. Besides, the effects of industrial effluents on macrobenthic assemblages involve changes in the composition of the community structure, increasing the numbers of opportunistic species, and reducing the general biodiversity and abundance[5, 13]. The criteria proposed for consideration when testing possible indicators of pollution were (1) high numerical density, (2) few species in the fauna, (3) principally scavenging feeding habits and (4) tolerance for low dissolved oxygen environment[14]. It is also important that the same species should have no/ negligible presence in stations with good diversity indices to have bio indicator tag. Polychaetes are one of the most characteristic groups of soft bottom benthic organisms and are dominant in places where the percentage of silt and clay fractions of sediment is higher than that of the sand fraction and thereby have rich organic carbon

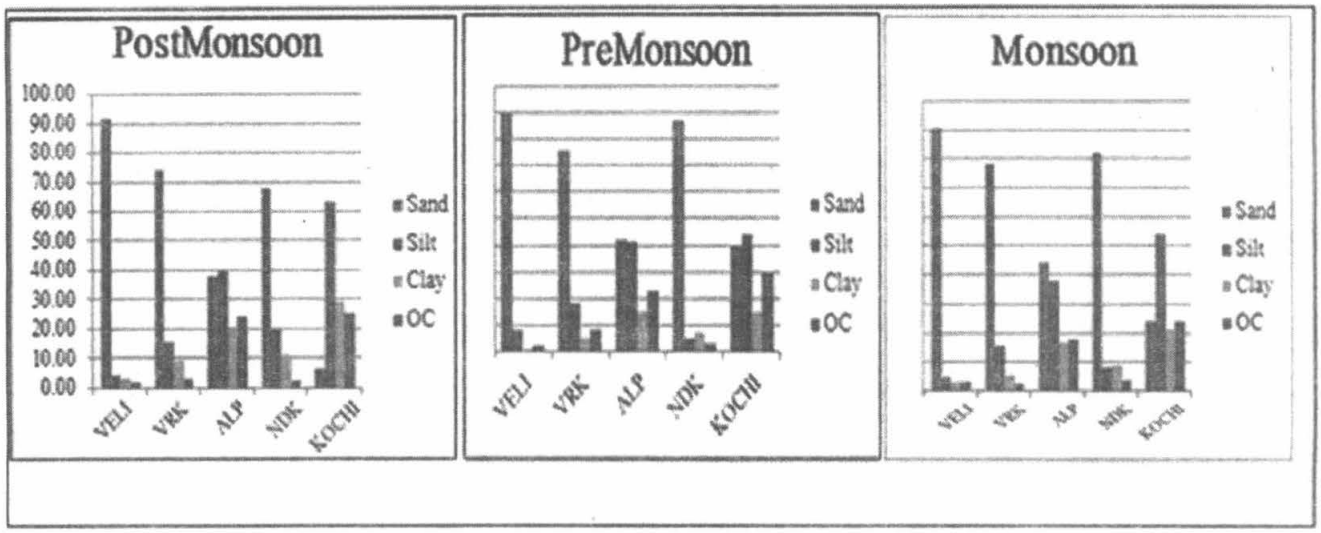

Fig. 3: Variation of textural characteristics and organic carbon in sediment

content[15]. Based on the study, the selected candidate species along the Kerala coast are exclusively molluscans. As such, the dominant seasonal presence of *Littorina scabra, Modiolus metcalfei* and *Trochidae* sp fulfills the entire ecological indicator marking criteria making them useful in pollution monitoring surveys along southwest India.

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