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MACROBENTHIC POLYCHAETE DISTRIBUTION AND ABUNDANCE ALONG THE ARTHUNKAL COAST OF KERALA, SOUTH WEST COAST OF INDIA: RELATIONSHIPS TO ENVIRONMENTAL VARIABLES

Sinu J. Varghese* and Miranda, M.T.P.
Dept. of Zoology, Marine Biology Unit, Fatima Mata National College, Kollam-691001, Kerala, India.
**Email: sinujvarghese@gmail.com*

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Abstract: The marine environment, including the ocean and adjacent coastal areas which form an integrated whole is a positive asset that presents opportunities for development. Quality assessment of ecological changes in the sea can be provided most efficiently by studying the sediment habitat and benthic fauna. Due to their differential tolerance and very restricted movements, benthic organisms are excellent indicators of environmental stress and are used in Environment Risk Assessment and monitoring of coastal waters. The abundance of benthic animals in an area especially polychaetes has close relationship with its environment and are regarded as indicator organisms in discussing the conditions of nature and characteristics of that ecological niche. The present paper focuses on the macro benthic polychaete assemblages along the coast of Arthunkal in Kerala, India during the year 2012-2013. Five stations (I,II,III,IV and V) representing depths of 5m, 10m, 15m, 20m and 30m respectively from the shoreline along one transect were selected for seasonal sampling. Hydrological variables such as temperature, pH, dissolved oxygen, salinity, nitrate-nitrogen, nitrite -nitrogen, phosphate-phosphorus and silicate-silicon of bottom waters were analyzed using standard methods. Sedimentological parameters namely temperature, pH, organic carbon and texture were also analyzed. Benthic polychaetes were identified using standard keys. Biological indices were used in the calculation of taxa richness, general diversity and evenness. Thirteen polychaete species displaying wide seasonal variations on a spatio-temporal scale were recorded. Studies on the species composition revealed *Cossura* sp. to be the numerically abundant polychaete during monsoon whereas the least abundant one was *Glycera* sp. during pre-monsoon. Numerical abundance was high at station V, where the substrate was predominantly sandy. Maximum temperature was recorded during post monsoon (31°C) and pH indicated the alkaline nature of both water and sediment. Dissolved oxygen fluctuated between stations, with low values recorded during pre-monsoon at station I (3.12 ml/l) and high values at station III (6.24 ml/l) during monsoon. Organic carbon recorded maximum values at station III (5.49%) during monsoon. *Prionospio* sp., *Nephtys* sp. and *Lumbrineris* sp. were found to be tolerant to high temperatures, low pH, low dissolved oxygen and low silicate-silicon. *Lumbrineris* sp. was also found to be an organic load indicator. *Glycera* sp. and *Nereidae* sp. preferred high salinity. The abundance of opportunistic species along with the appearance of stress indicators emphasizes the importance of regular biomonitoring of the coastal waters of Arthunkal.

Key words: Marine benthos, Stress indicators, Sediment, Organic matter, Opportunistic species, Environmental monitoring

INTRODUCTION

In marine sediments, macrofauna play an important role in ecosystem processes such as nutrient cycling, pollution metabolism, dispersion and secondary production (Snelgrove, 1998). They act as connecting link between the biotopes of substratum and water column. Polycheates are an important component of macrobenthic community and play a major role in the stability and functioning of the benthic community and the ecology in general (Belan, 2003). Since the taxon contains both sensitive and tolerant species, they have been identified worldwide as groups that respond quickly to environmental disturbances (Zajac *et al.*, 2003).

Arthunkal is a coastal hamlet in Alleppey District of Kerala, the economy of which mainly resides in the fishery sector - the source of livelihood for the fishing communities. Priyalekshmi and Menon (2001) have investigated the possible impact of the tsunami in terms of sediment transport and bioinvasion along the coast of Arthunkal. They recorded interstitial Polycheate

Protodriloides chaetifer for the first time from this region. Except for this study there is a total paucity of information on the in faunal benthic fauna of Arthunkal. The main objective of the present work was to explore the macro benthic polychaete assemblages along the coast of Arthukal and assess their relationship with hydrogeo-chemical variables.

MATERIALS AND METHODS

Study Area

The present study was carried out along the coast of Arthunkal (9°39'19''N and 76°17'23''E) in Kerala during the year 2012-2013. Seasonal (premonsoon,monsoon and postmonsoon) samples were taken from five stations (station I,II,III,IV and V) representing depths of 5m, 10m, 15m, 20m and 30m respectively from the shoreline along one transect (Fig. 1).

Sampling Protocol

Samples were collected in triplicate with a stainless steel corer (1m in length and 7 cm in diameter). The bottom water was collected using a Nessler's bottom water sampler while the sediment samples for chemical analysis were collected from the Van Veen grab. The core samples were sieved through a 0.5 mm mesh sieve and the fauna preserved in 5% neutral formaldehyde for taxonomic identification. Benthic polychaetes were identified using standard keys (Fauvel, 1953).

Physico-chemical analysis of water and sediment.

Temperature of the bottom water and sediment were analyzed using a thermometer having an accuracy of 0.5°C. Hydrogen ion concentration was determined by a digital pH pen. Dissolved Oxygen of water samples were estimated by Winkler's method (Winkler, 1883). Salinity was determined with a water analyzer (Systronics-model 371), Water nutrients such as Nitrate-nitrogen, Nitrite-nitrogen, Phosphate-phosphorous and Silicate- silicon were analyzed. (Strickland and Parsons, 1972 and Grasshoff, 1983). Organic carbon in sediment samples was determined by Wet oxidation method (Wakeel and Riley, 1957) and sediment texture was determined by pipette analysis (Krumbien and Pettijohn, 1938).

Statistical analysis

Biological indices such as Margalef's index (d)(Margalef, 1968), Shannon Weiner index (H')(Shannon *et al.*, 1949), and Evenness index (J') (Pielou, 1966) were used in the calculation of taxa richness, general diversity and evenness. The Pearson's correlation co-efficient was used

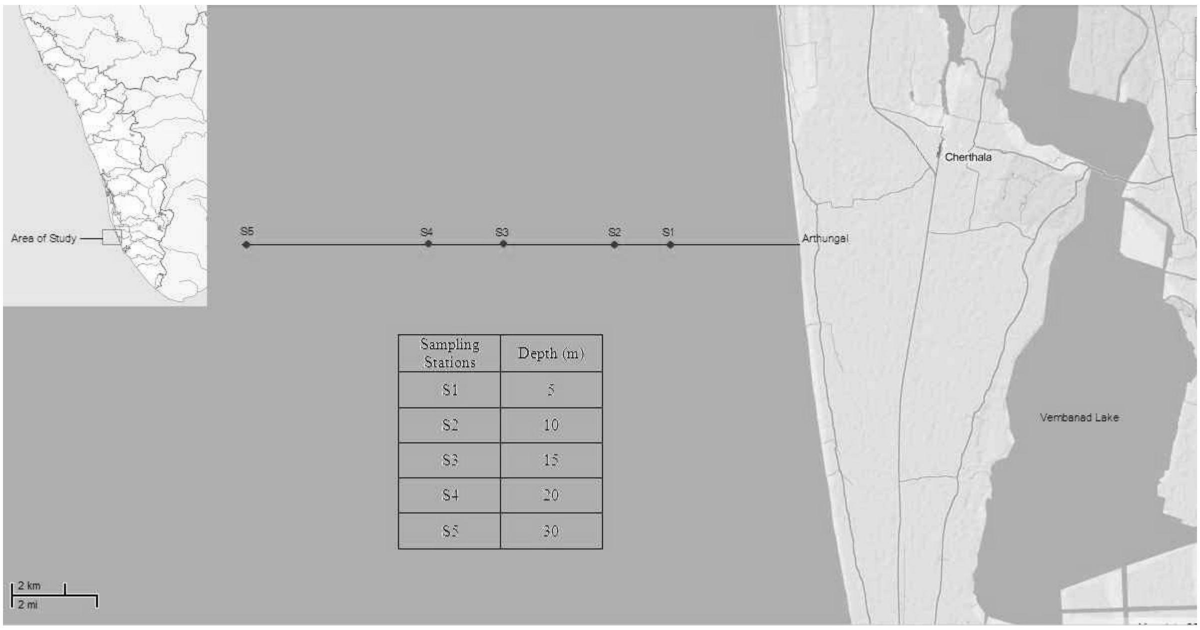

Fig. 1. Study area and Sampling sites.

to analyze the relationship between polychaete abundance and environmental variables.

RESULTS

The faunal composition and abundance (No/m^2) is given in Figs. 2 to 4. Thirteen macrobenthic polychaete species were recorded along the coast of Arthunkal. Macrobenthic polycheate composition highlighted the presence of indicator species at all stations which included *Prionospio* sp., *Nephtys* sp., *Lumbrineries* sp., *Asychis* sp., *Nicomache* sp., *Cossura* sp., *Sternapsis* sp., *Glycera* sp., *Capitella* sp., *Nereidae* sp., *Aricidea* sp., *Polydora* sp. and *Ophiodromus* sp. The most abundant polycheate was *Cossura* sp. recorded at station I (60 no/m^2) and station IV (40 no/m^2) during monsoon and post monsoon respectively. *Asychis* sp. contributed much to faunal abundance at station II (19 no/m^2) during monsoon whereas *Lumbrineries* sp. dominated at station III (10 no/m^2) during premonsoon. *Polydora* sp. recorded high value at station V (10 no/m^2) during post monsoon.

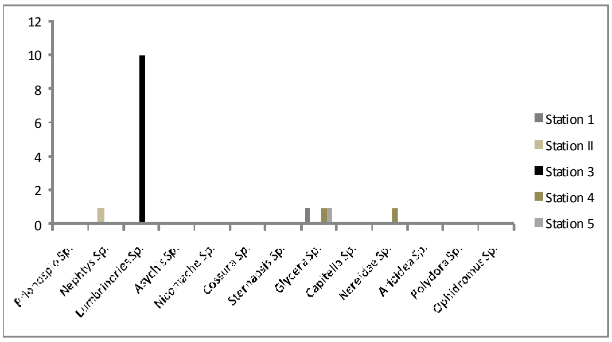

Fig. 2. Numerical composition and abundance (No/m^2) of macro benthic polychaete during Pre monsoon

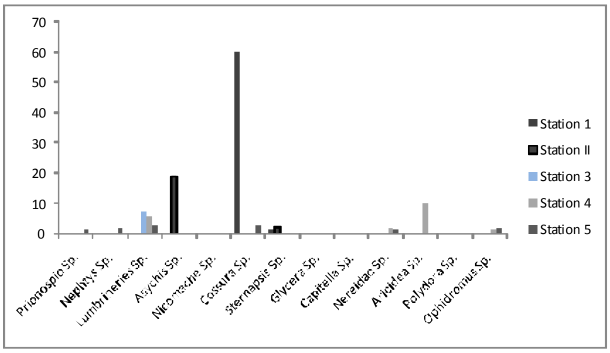

Fig. 3. Numerical composition and abundance (No/m^2) of macro benthic polychaete during monsoon

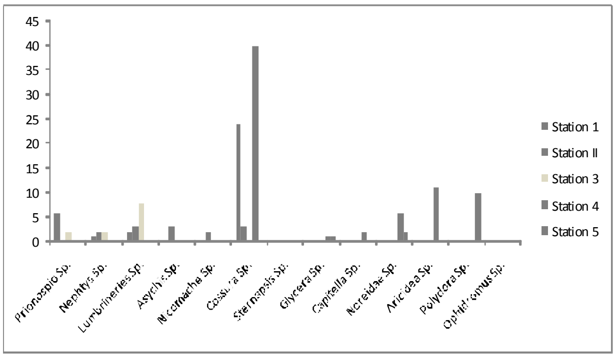

Fig. 4. Numerical composition and abundance (No/m^2) of macro benthic polychaete during post monsoon

The diversity indices for polychaetae fauna is given in Fig. 5. The number of species was higher at station V and also fluctuated seasonally. Shannon diversity (H'), Pielous evenness (J') and Species richness (d) showed maximum values at station V (1.832, 0.881 and 0.269 respectively). Lowest diversity was indicated at station III (0.053). Minimum values for Pielous evenness (J') and species richness (d) were observed at station I (0.881 and 0.053 respectively). Bottom water temperature recorded a positive correlation with polycheate abundance ($P<0.05$) and bottom water pH recorded negative correlation ($P<0.05$). Nitrate -nitrogen was found to be negatively correlated while Nitrite-nitrogen was positively correlated ($P<0.01$). Sediment temperature showed positive correlation while percentage of clay showed negative correlation ($P<0.05$).

The variation in the hydrological parameters of the bottom water is given in Figs 6 to 13. Bottom water temperature ranged from 31°C (station II and IV) during post monsoon to 27°C (station III) during monsoon. Hydrogen ion concentration of bottom water varied from 8.5 (station I) during premonsoon to 7.86 (station I) during post monsoon. The bottom water dissolved oxygen content varied from 6.24 ml/L (station III) during monsoon to 3.12 ml/L (station I) during premonsoon. Salinity of bottom water samples ranged from 34 ppt (station V) during postmonsoon to 32.1 ppt (station IV) during monsoon. Nitrate -nitrogen in bottom water samples varied from 0.56 µg/L (station III) during premonsoon to 0.0058 µg/L (station IV) during post monsoon. Bottom water samples of Nitrite- nitrogen varied from 0.0883 μg/L (station IV) during postmonsoon to 0.0007 μg/L (station IV) during premonsoon. Bottom water Phosphate-phosphorous ranged from 0.014 μg/L (station V) during premonsoon to 0.00087 μg/L (station III and IV) during monsoon. Silicate-silicon in the bottom water varied between 0.247 μg/L (station I) during premonsoon and 0.0315 μg/L (station III) during postmonsoon.

Sedimentological parameters at the five stations is given in Figs 14 to 19. Sediment temperature ranged from 28°C (station III and IV) during monsoon to 31°C (station I and III) during post monsoon. Hydrogen ion concentration of sediment samples varied between 7.78 (Station III) during premonsoon to 8.48 (Station V) during postmonsoon. Organic carbon in sediment varied from 0.087% (station IV) during premonsoon to 5.49% (station III) during monsoon. Sand varied from 0.177% (station I) during postmonsoon to 7.94% (station V) during monsoon. Silt varied from 0.4% (station V) during monsoon to 9.866% (station II) during premonsoon. Clay ranged between 0.15% (station V) during postmonsoon to 2.35% (Station III) during monsoon.

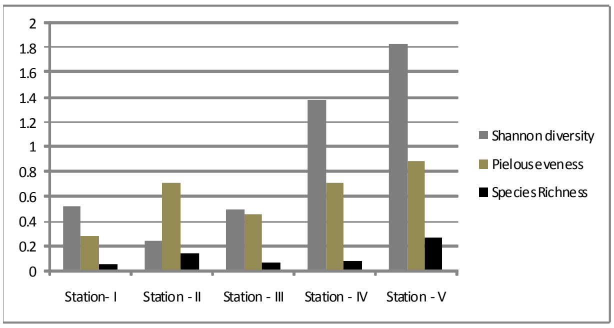

Fig. 5. Diversity indices of macro benthic polychaete

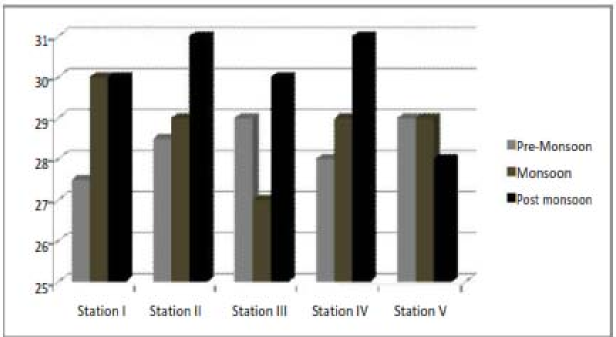

Fig. 6. Variation in the bottom water temperature (°C)

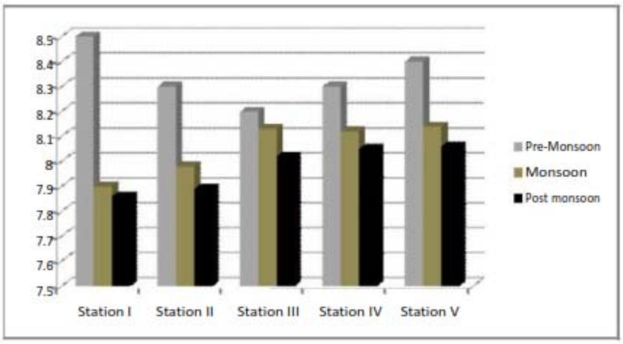

Fig. 7. Variation in bottom water hydrogen ion concentration

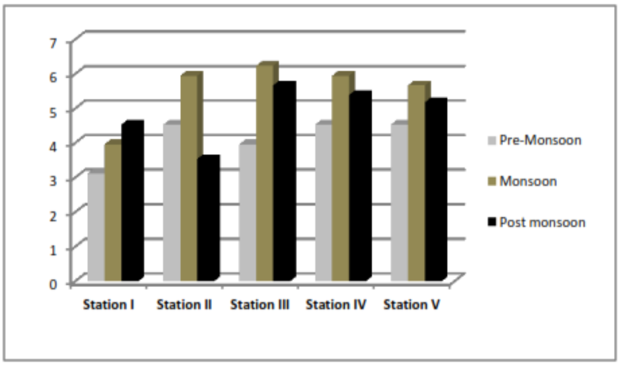

Fig. 8. Variation in the bottom water dissolved oxygen (ml/L)

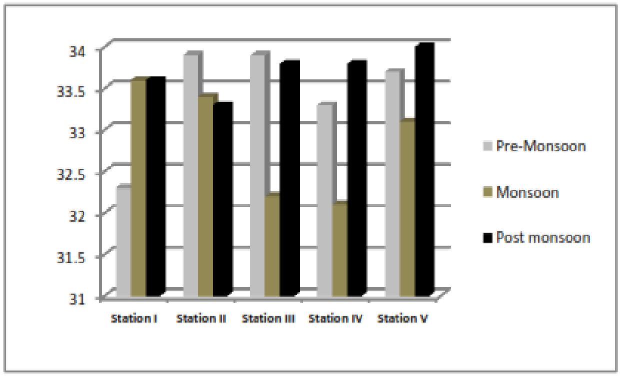

Fig. 9. Variation in the bottom water salinity (ppt).

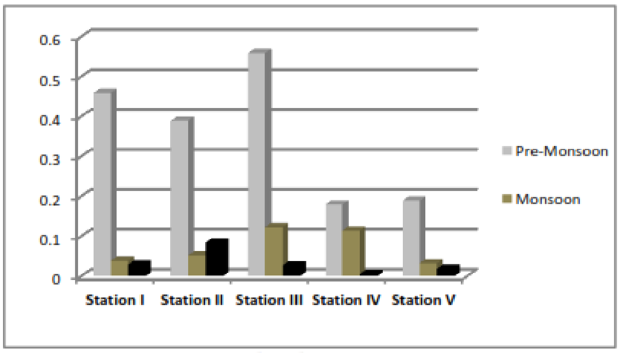

Fig. 10. Variation in the bottom water nitrate-nitrogen (μg/l).

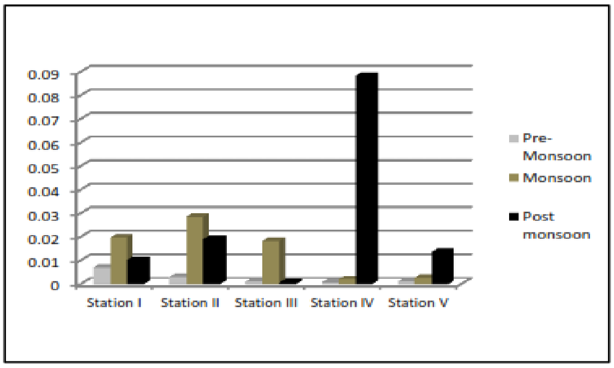

Fig. 11. Variation in the bottom water nitrite-nitrogen (μg/l)

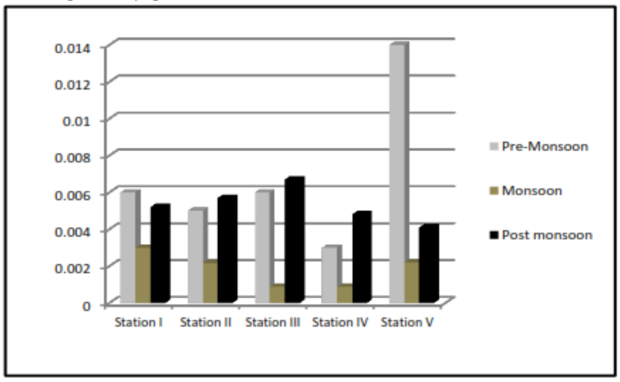

Fig. 12. Variation in the bottom water phosphate-phosphorous (μg/l)

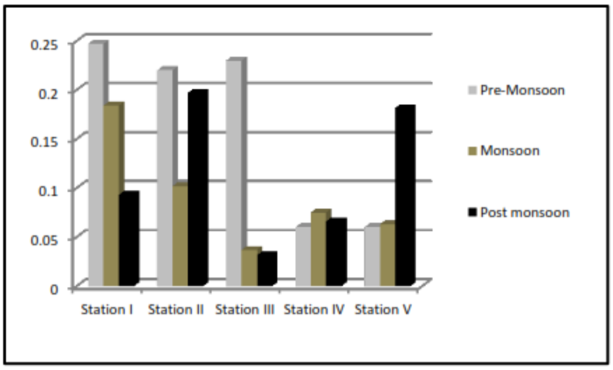

Fig. 13. Variation in the bottom water silicate-silicon (μg/l)

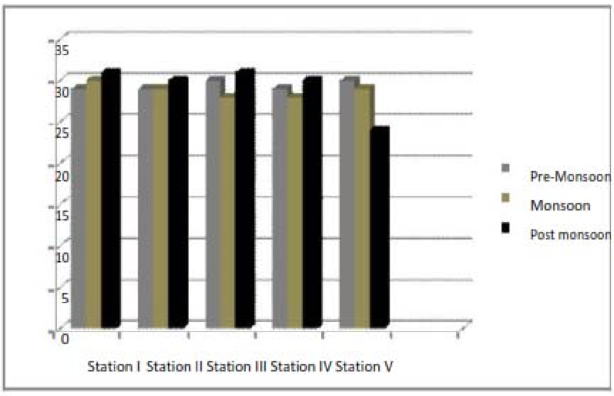

Fig. 14. Variation in the sediment temperature (°C)

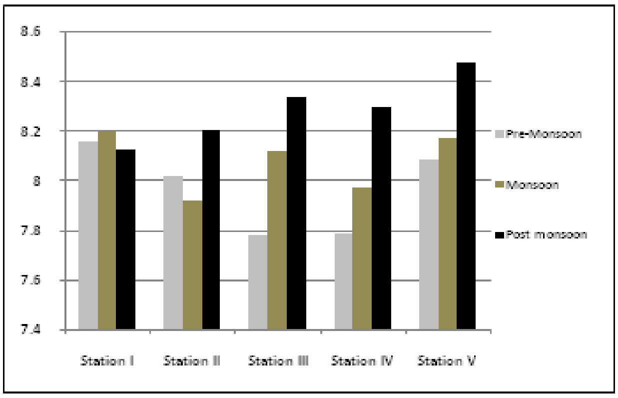

Fig. 15. Variation in the sediment pH

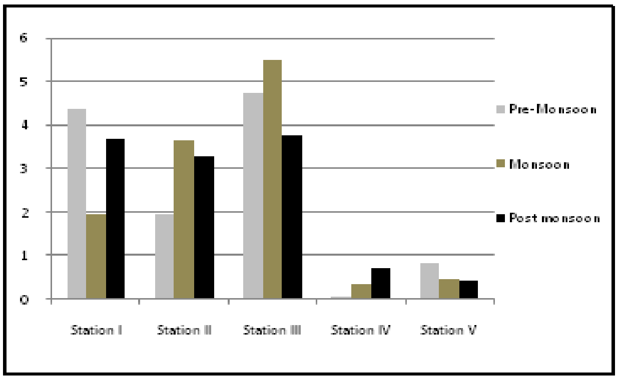

Fig. 16. Variation in the sediment organic carbon (%)

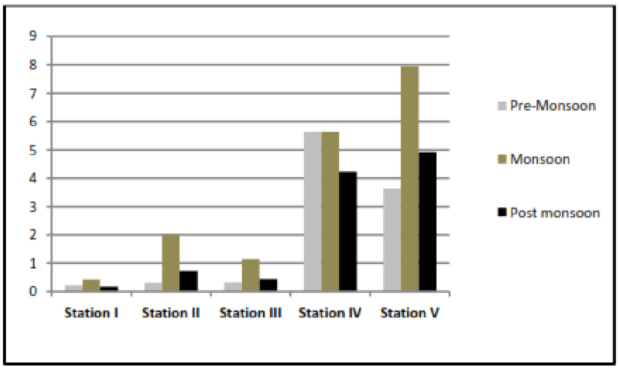

Fig. 17. Variation in the percentage of sand in the sediment

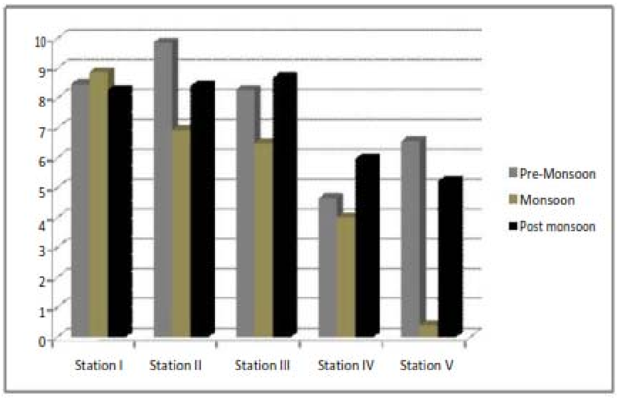

Fig. 18. Variation in the percentage of silt in the sediment.

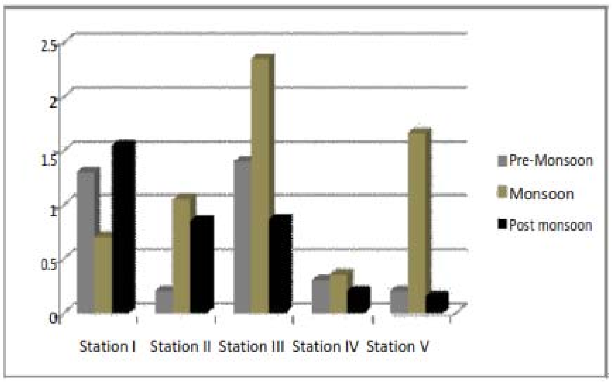

Fig. 19. Variation in the percentage of clay in the sediment

DISCUSSION

Abundance of *Cossura* sp. was observed throughout the study period with high values in monsoon and a marginal decline from post monsoon to premonsoon.This agrees well with the findings of Sivadas *et al* (2010). *Cossura* sp. and *Capitella* sp. have been reported as opportunistic species by several authors (Grassle, 1974; Pearson *et al.*, 1978). Benthic community in an unstable environment is typically dominated by r-selected species, characterized by higher reproduction rate and genetic variation and is therefore more stress tolerant (Jernelov *et al* 1976).The occurance of *Lumbrineries* sp., *Nephtys* sp. and *Prionospio* sp. was found to be significantly correlated with the organic content of the sediment. Harriague *et al* (2007) have reported the relative instability of these polychaetes. They are also considered to be organic load indicators. *Cossura* sp., *Prionospio* sp and *Lumbrineries* sp. were found to be tolerant to high temperatures, low pH, high nitrite-nitrogen, low dissolved oxygen and low silicate-silicon. They were also found to prefer muddy sediment. Salinity can be considered as an important limiting factor in the distribution of benthic fauna (Varadharajan *et al.*, 2010). *Glycera* sp. and *Neriedae* sp. were found to prefer high salinity. The present study also reveals the effect of trawling on benthic community dynamics. Seasonal vessel movements for trawling and tourist traffic probably constitute a notable factor influencing the infaunal community structure. The appearance of *Sternapsis* sp., *Cossura* sp. and *Lumbrineries* sp. during monsoon season indicates the negative impact that may occur after trawling due to disturbances on the top layer of the sediment. Most of the polycheates observed throughout this study were of smaller size and this is a clear indication of extreme disturbance imposed on the sediment. Bottom trawling alters the seafloor habitat complexity leading to increased predation on infaunal species which inturn drastically alters the total ecosystem productivity.

The present findings support the proposed relationship between benthic diversity and water-sediment variables. *Prionospio* sp., *Nephtys* sp., *Lumbrineries* sp., *Glycera* sp. and *Nereidae* sp. were found to be stress indicators. The study also reveals the detrimental effects of bottom trawling on benthic communities. Regular bio- monitoring of the coastal waters of Arthunkal is recommended.

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