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ENVIRONMENTAL IMPACT ASSESSMENT BASED ON POLYCHAETE SPECIES IN COCHIN BACKWATERS (SOUTHWEST COAST OF INDIA)

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Abstract: Polychaetes are important indicators of water quality. It can be used in a variety of monitoring programmes to assess overall estuarine health and to follow the effects related to anthropogenic impacts. The distribution of benthic macrofauna in Cochin backwaters was well documented since 1974. The present investigation is a revisit of five selected stations of Cochin backwaters using similar methodologies used by earlier investigators to assess the present status of polychaete species in the area . The detrimental environmental conditions resulted notable changes in the community parameters such as diversity, abundances and dominance. 25 species once reported from the backwaters were found to be absent in the current study. *Diopatra neapolitana ,Glycera tridactyla , Heteromastus bifidus , Notomastus sp., Paraheteromastus tenuis, Prionospio cirrifera* and *P. polybranchiata* can be used as positive indicators of stressed environment. *Owenia sp , Eteone sp, Exogone sp,Maldane sp ,Ophelia sp* and *Syllis spongicola* can be considered as negative indicators of stressed environment. The polychaete species characteristic of a particular environmental condition may vary spatially. The study illustrates the ability of the polychaetes to respond quickly to changes in their environment over the period 1974-2004.

Key words: Benthos, Indicator species, Bio-monitoring, Pollution, Temporal change

INTRODUCTION

The quest of man to conquer the nature has led to ever increasing degradation of the environment than envisaged. Loss of biodiversity is growing concern among worldwide. Integrated environmental management and environmental impact assessment are among the most powerful conservation tools to protect the environment. Long term studies can provide information to decision makers. Biological variables are important components in water quality assessment because they may uncover problems undetected in the measurements of different physicochemical parameters or under estimated by other methods (Dauer, 1993 and Harlan, 2008). The Benthic environment is the most wide spread habitat on earth and which support high biodiversity and key ecosystem services. Polychaetes are most important component of benthic community. The quality of water will have a direct impact on their health and survival. They are important bio-indicators for monitoring the quality of estuarine environments (Papageorgiou, 2006). They are characterized by high species richness, diversity, sessile nature and different levels of tolerance to adverse effects (Jayaraj *et al.,* 2007). These characteristics make them excellent indicators of environmental stress. The community structure of benthos in Cochin backwaters was studied earlier by Pillai, 1978; Batcha, 1984; Sarala, 1986 and Sheeba, 2000. Cochin backwaters are subjected to developmental pressures, land reclamation, dredging operations, deforestation, sewage disposal, organic enrichment, mining activity and nutrient enrichment (Hema Naik,2000; Menon *et al.,* 2000; Babu *et al.*, 2006; Balachandran *et al.,* 2008; and Revichandran *et al.,*2012.). The present investigation was a revisit of five selected stations of Cochin backwaters using similar methodologies to assess the present status of polychaete species in the area and to evaluate changes observed with the old data over the period 1974-2004.

MATERIALS AND METHODS

Cochin estuary the second largest wetland system in India is located in the humid tropical region between 09°40'- 10°40' N and 76°-77°30'E (Fig. 1). It is a bar-built estuary constituting a network of shallow canals and situated on the southwest coast of India. Although the estuary has openings at Cochin and Azhikode, the former inlet is wider (450 m) and forms the main entrance to the Arabian Sea. It is unique in-terms of geology, climate, hydrology, land use and flora and fauna (Madhupratap, 1987; Menon *et al.,* 2000).

Monthly sampling was conducted from 5 stations of Cochin estuary (Fig. 1) during the period 2002 - 2004. Four 0.05m^2 van Veen Grab hauls were taken from each station. The sediment samples were sieved through 0.5 mm mesh and fixed in 5% neutral formalin mixed with Rose Bengal. Polychaetes were sorted and identified up to species level (Fauvel, 1953; Day, 1967; Boggemann, 2005) followed by counting of individuals. Different physicochemical parameters were also studied using standard methods.

RESULTS AND DISCUSSION

Long term changes in the community structure of polychaetes in Cochin backwaters were studied. The study confirmed that among benthos polychaetes had the highest population density in the estuary for the past thirty years. At station 1, during the period 1974-1976 *Lumbriconereis* sp, *Nephthys oligobranchiata, Prinospio polybranchiata* and *Paraheteromastus tenuis* were the dominating species. However the period 1977-78 witnessed the preponderance of *Ancystrosyllis constricta, Nephthys oligobranchiata, Nephthys polybranchiata* and *Prinospio pinnata*. During the year 1996 *Ancystrosyllis constricta, Notomastus* sp and *Prinospio polybranchiata* contributed a major share towards the total density of polychates. However during the period 2002-04, *Prinospio cirrifera* and *Heteromastus bifidus* were exceedingly abundant.

With respect to station 2, during 1974-76 period *Nephthys oligobranchiata* and *Prinospio polybranchiata* were the dominating species. During 1977-78 period *Ancystrosyllis constricta* and *Diopatra neapolitana* proliferated

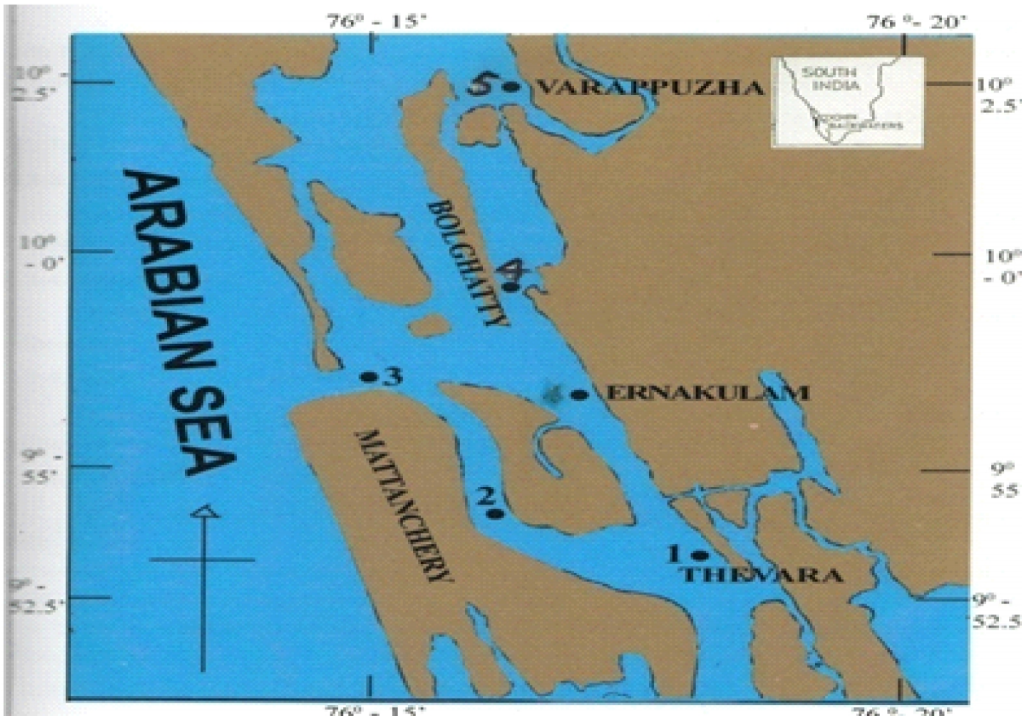

Fig. 1. Map of Cochin estuary, Kerala

remarkably. The period 2002-04 was characterized by the abundance of *Prinospio polybranchiata* and *Paraheteromastus tenuis*. At station 3, during 1974-75 period *Ancystrosyllis constricta, Prinospio cirrifera, P.pinnata and P.polybranchiata* showed dominance over other species. During the period 1977-1978 *Ancystrosyllis constricta* and *Diopatra neapolitana* were the common species. In the year 1981 *Diopatra neapolitana, Heteromastus bifidus, Lumbriconereis simplex, Pistia* sp and *Prinospio polybranchiata* were widespread. Again during the period 1996-1997 *Ancystrosyllis constricta* and *Diopatra neapolitana* were contributed considerably to total density.The period 2002-2004 was characterized by the dominance of *Prinospio cirrifera* and *Paraheteromastus tenuis.*

When we consider station 4, during the year 1981 *Heteromastus bifidus* dominated in the sample followed by *Aphrodita* sp*, Dendronereis estuarine, Lycastis indica* and *Prinospio polybranchiata*. During the period 1996-1997 the area was dominated by *Notomastus sp.* However *Diopatra neapolitana and Prinospio polybranchiata* also showed considerable numerical density. The period 2002- 2004 witnessed the abundance of *Heteromastus bifidus, Paraheteromastus tenuis, Prinospio cirrifera* and *P. polybranchiata.* As far as station 5 is concerned the representation of macrofauna was rather poor in the base line survey itself. In the year 1981 *Dendronereis estuarine* was the dominating group. During 1996-97 period dominance of a particular group was not reported from this station. *Prinospio cirrifera* has comparatively better representation at this station during 2002-04.The distribution of sporadic species are explained in Table 1.

Ancistrosyllis constricta, Diopatra neapolitana, Lumbriconereis simplex, Prionospio polybranchiata, Prionospio pinnata, and *Paraheteromastus tenuis* were found to be permanent component of the polychaete assemblage for the past thirty years in the estuary. Among them *Diopatra neapolitana* were abundant in distribution during the period 1977-2004. *Ancistrosyllis constricta* showed highest density during 1977-78 and 1996-97 . *Lumbriconereis simplex* has highest numerical abundance during 1981. *Prionospio polybranchiata,* and *Paraheteromastus tenuis* showed highest density during 2002-2004.

Present survey *Maldane* sp, *Scyphoproctus djiboutiensis* and *Syllis spongicola* showed spatial variation in their distribution when compared to the baseline survey .

Cochin backwaters, the life line of central Kerala, are subjected to developmental pressures. Estuary receives 1.37 $kg.d^{-1}$ of inorganic phosphate and 2.69 $kg.d^{-1}$ of inorganic nitrate and the export to the coastal waters is only 0.91 $kg.^{d-1}$ of inorganic phosphate and 1.71 $kg.^{d-1}$ of inorganic nitrate (Hema Naik, 2000 and Balachandran *et al*., 2008) indicating that the estuary act as a sink of nutrients. The deterioration of the estuary is indicated by an increase in the nutrients and chlorophyll levels by 6-fold during the last few years (Martin *et al*., 2011). Flow restrictions in the lower estuary have lead to a 4-fold increase in sediment organic carbon over the period of three decades (Martin *et al*., 2011). The high biomass of chlorophyll *a* in the central and the north eastern estuary are possibly due to the enrichment of nutrients by industrial and domestic activities (Jyothibabu *et al.,* 2006 and Madhu *et al.*, 2007). Moreover, the high organic production are not transferred to the higher tropic level due to the lack of effective grazers, which leads to settling of the execs chlorophyll to the sediment (Jyothibabu *et al.*, 2006).

Climate change affects biodiversity. Benthic communities are dynamic and the presence or absence of species may change as the environment varies. An individual assessment at a site provides a snapshot of current conditions, where as the sequential assessments allow analysis of environmental degradation or remediation for a long period. Comparison of current data with that of previous studies revealed striking differences in the community structure of polychaetes . Altogether 55 species of polychaetes were reported from the study area during the period 1974-2004. However 30 species were present in the present survey. 25 polychaete species, which, were reported once from Cochin backwaters, were absent in the current survey. Presently these species may be either disappeared or severely decreased in abundance. It is clear that the density of polychaetes increased considerably

Table 1. Long term changes in the community structure of polychaetes in the Cochin Estuary

SPECIES	YEAR				
Polychaetes	1974-76	1977-78	1981	1996-97	2002-04
Ancystrosyllis constricta	++	+++	++	+++	++
Aphrodita sp	---	---	++	+	---
Cossura coasta	+	+	---	---	+
Capitella sp	++	---	+	++	++
Dendronereis aestuarine	+	+	+++	+	+
Diopatra neapolitana	.++	+++	+++	+++	+++
Disoma sp	+	+	---	+	---
Eteone sp	---	---	---	---	+
Eulalia viridis	---	+	---	---	---
Eunice tubifex	---	---	+	---	---
Exogone sp	---	---	---	---	+
Fabricia sp	+	+	---	---	---
Glycera alba	+	+	+	---	---
Glycera convoluta	---	---	+	---	---
Glycera longipinnis	+	+	---	+	---
Glycera tridactyla	---	---	---	---	+++
Goniada emerita	---	---	+	---	---
Glycinde bonhourei	---	---	---	---	+
Heteromastus bifidus	---	---	+++	+	+++
Heteromastus similis	---	---	+	+	---
H.filiformis	---	---	---	+	---
Lepidonotus sp	+	---	---	+	---
Lumbriconereis heteropoda	+	+	---	---	---
Lumbriconereis simplex	+	++	+++	+	+
Lumbriconereis sp	+++	+	++	+	+
Lycastis indica	+	---	++	+	+
Lumbrineris latreilli	++	+	---	+	++
Marphysia sp	---	---	---	+	+
Maldane sp	---	---	---	---	+
Mediomastus capensis	---	---	---	+	---
Mesochaetopterus sp	+	---	---	---	---
Mercierella elongata	+	+	---	---	---
Nephthys oligobranchiata	+++	+++	+	---	++
Nephthys polybranchia	---	++	+	---	---
Nereis sp	---	+	---	++	+
Notomastus sp	---	---	---	++	+++
Notopygos sp	---	---	+	+	+
Odontosyllis	---	---	+	---	----
Ophelia sp	---	---	---	---	+
Owenia sp	+	+	+	+	---
Paraheteromastus tenuis	++	++	++	+	+++
Perinereis cavifrons	+	---	+	---	---
Phyllodoce gracilis	+	+	---	---	---
Pistia sp	---	+	+++	+	---
Prionospio cirrifera	++	+	---	+	+++
P.pinnata	++	++	+	+	++
P.polybranchiata	++	++	++	++	+++
Polycirrus sp	---	---	---	+	---
Polydora kempi	+	+	---	---	+
Serpula sp	---	---	+	---	---
Sthenelais boa	+	---	++	+	+
Sternaspis sp	+	---	+	---	+
Sternaspis scutata	+	+	---	---	---
Scyphoproctus djiboutiensis	---	---	---	+	++
Syllis spongicola	---	---	---	---	+

*(Sources : 1974-76 (Pillai, 1978); 1977-78 (Batcha ,1984); 1981 (Saraladevi, 1986); 1996-97 (Sheeba, 2000); 02002-2004 (Present study); **(+++ - abundant, ++ - frequent , + -rare , — - absent.)

at stations 1 to 4.Yet its density decreased at station 5. A sharp decrease in species richness and increase in abundance of some polychaetes was noticed. However some species were quite permanent. But the amplitude and the frequency of these changes were different among the stations. Compared to the baseline survey, the number of suspension feeders declined and deposit feeders increased. This may be related to the nature of the food available in the environment. Owing to the differing sensitivities of the organisms the composition of the community present can be used as an indicator of the water quality and general estuarine health.

The occurrence of *Diopatra neapolitana, Glycera tridactyla , Heteromastus bifidus, Notomastus sp, Paraheteromastus tenuis, Prionospio cirrifera* and *P. polybranchiata* in high density could be used as positive indicators of stressed environment. Mendez *et al.* (1998), Dix *et al.* (2005) and Elias *et al. (*2005) found *Prionospio* sp as indicator species for organic enrichment. According to Belan, 2003 and, Rivero, 2005 the capitellids are positive indicators of a stressed community .This is in agreement with present study. According to Ahn *et al.,* 1995 *Heteromastus filiformis* to be associated with polluted areas. This is against the observation of present study. Harkantra and Rodrigues (2004) noted *Diopatra neapolitana* negatively affected by increased industrial and sewage pollution. This is not in agreement with present study. It is apparent that there are no cosmopolitan indicator polychaete species. The polychaete species characteristic of a particular environmental condition may vary spatially.

The species like *Lumbriconereis heteropoda , Mercierella elongata* and *Fabricia sp* disappeared from the estuary after 1977-78. The species like *Disoma* sp, *Eulalia viridis, Eunice tubifex, Glycera alba, Glycera convoluta, Glycera longipinnis, Goniada emerita, Heteromastus similis, Heteromastus filiformis, Lepidonotus sp, Mesochaetopterus sp, Mediomastus capensis, Nephthys polybranchia, Odontosyllis, Owenia* sp, *Perinereis cavifrons, Phyllodoce gracilis, Pistia* sp, *Polycirrus, Serpula* sp and *Sternaspsis scutata* were not encounted in the current study. The perceived loss of these organisms may be the result of poor settlement and recolonization due to altered environmental conditions. Their absence in a community may be an indication of poor environmental conditions. Members of Terebellidae (Olsgard *et al.,* 2003) have been used as negative indicators of poor benthic conditions. Pearson (1975) and Rosenberg (1976), characterized Glycera *alba* and *Lumbrinereis* spp as indicators of unpolluted conditions. According to Rivero *et al.* (2005), Areas with healthy environmental conditions were characterized by the capitellid *Mediomastus* sp. *Owenia sp* is an indicator species for non-polluted areas Pearson and Rosenberg (1978) and Rygg (1985). These findings are in agreement with present investigation.

Belan (2003) and Rygg (1985) showed that the absence of *Maldane sp* as an indication of poor environmental conditions. Elias *et al.* (2005) found Maldanidae as indicative of low organic content sediments. According to Rygg, (1985), Elias *et al.* (2005) and Rivero *et al.* (2005) areas with healthy environmental conditions were characterized by members of the Maldanidae. Mendez *et al.* (1998) considered the *Exogone sp* tolerant of pollution but not indicator species. In the study area *Eteone sp, Exogone sp, Maldane sp, Ophelia sp* and *Syllis spongicola* were sporadic in occurrence with limited number. These organisms can be considered as positive indicators of healthy environmental conditions.

CONCLUSIONS

The temporal changes in the community structure of polychaete species for a period of 30 years were studied. In shallow water the polychaete dynamics is tightly related to the process occurring in the overlying water column. They respond to various effects by different ways. The results illustrate the ability of the polychaetes community to respond quickly to changes in their environment. The use of polychaete diversity as an indicator of health of ecosystem is the most advantageous and cost-effective approach. Comparison of present data with that of previous studies revealed striking differences in the species composition of polychaetes .The occurrence of a few species like *Diopatra neapolitana, Glycera tridactyla, Heteromastus bifidus, Notomastus sp, Paraheteromastus tenuis, Prionospio cirrifera and P. polybranchiata* with high abundance

could be used as positive indicators of stressed environment. 25 polychaete species, once reported from Cochin backwaters, were absent in the present survey. Present investigation also highlights the need to collect benthos samples for a regional assessment of environmental health and to use this benthic knowledge for impact assessment, pollution control, and resource conservation etc.

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