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Temporal changes in the benthic community structure of the marine zone of Vellar estuary, southeast coast of India

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Abstract

The temporal changes in community structure of benthos were assessed using advanced statistical tools in the marine zone of Vellar estuary (11^0 29'N lat.; 79^0 46'E long.). The data were compared with the one collected three decades before. At present 54 species of macro fauna have been recorded as against 43 of the earlier study. Among the benthic groups, polychaetes were the most abundant in the present study while crustaceans were dominant in the previous study. The diversity values were found comparable to the earlier work. There are changes in the species mix, but the benthic biodiversity is within safe level.

Keywords: Benthos, temporal changes, community structure, Vellar estuary

Introduction

Benthos constitute a major component in the estuarine as well as marine realm and play a main role in the ecology and food of many bottom feeding finfishes and shellfishes (Parulekar *et al*., 1980). The benthic organisms are used as "pollution indicator" in Environment Impact Assessment (EIA) studies around the globe for many years. There are several reasons why the benthos are used as an indicator of ecosystem change. First the longevity of the benthos provides long-term exposure to toxic substances; secondly they live in close intimacy with sediments, which enhances their closeness with many pollutants and lastly majority of the species are sedentary and therefore changes in their community structure and diversity can be examined in relation to pollutants (Warwick, 1993). Considering the above, a study was carried out to find out the temporal changes in the benthic community structure of marine zone of Vellar estuary.

Materials and methods

Sediment samples were collected in duplicate every month from January to December 2000 in the marine zone of Vellar estuary, Parangipettai (Porto Novo) (11^0 29'N lat.; 79^0 46'E long.) (Fig. 1). The larger of the two samples was considered for analysis. Sampling was carried out in five transects with a distance of 100 m between transects. In each transect, samples were collected from ten stations using a long-armed Peterson grab, which

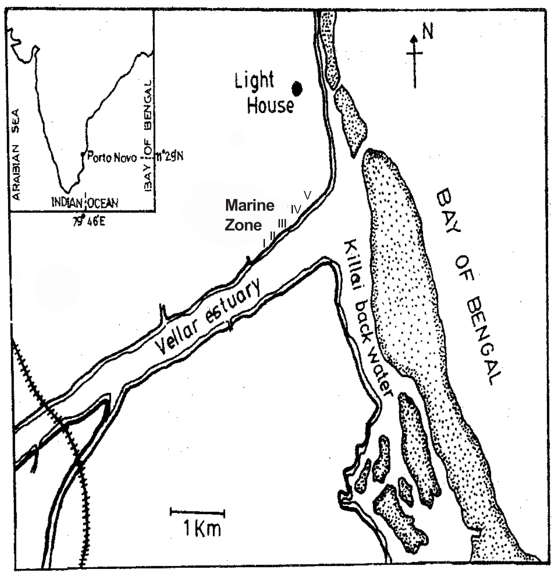

Fig. 1. Map showing the study area (Transects I – V)

covers an area of 0.0251m^2 (Mackie, 1994). The larger organisms were handpicked and then the sediments were sieved through a 0.5mm mesh screen. The organisms retained by the sieve were placed in a labelled container and fixed in 5% formalin. Once the fixative was added, each sealed sample container was gently upturned and rotated to distribute the formalin evenly throughout the sieved sample. Subsequently, the organisms were stained with Rose Bengal solution (0.1 g in 100 ml of distilled water) for enhanced visibility during identification. In the laboratory, the sieved samples were gently but thoroughly washed in freshwater. This helped in removing formalin and salt, preventing the former from dissolving the shells of delicate molluscs. All the specimens were sorted, enumerated and identified to the advanced level possible with the aid of available literature (Fauvel, 1953; Day, 1967; Shanmugam *et al*., 1997; Rajagopal *et al*., 1998; Lyla *et al*., 1999). Physico–chemical parameters were analyzed following standard methodology (Strickland and Parsons, 1972). A small sample of soil was taken from each grab haul and transferred into cleaned polythene bags, air dried and used for analysis of organic carbon and soil nutrients (el Wakeel and Riley, 1956).

The data were compared with an earlier study by Ajmal Khan *et al*. (1975) from the same area. They made monthly collections for a period of one year in the same five transects, but in five stations only per transect. The data of both the studies were analyzed by univariate and multivariate methods available in PRIMER statistical package (Clarke and Gorley, 2006).

Results

The results of water quality variables recorded in both the investigations were found to be similar. During different months, the temperature varied from 26^0 to 32^0 C; salinity from 28 to 32 psu; pH between 7.6 and 8.2 and dissolved oxygen from 4.5 to 5.3 ml/l.

There were 54 species of macro fauna as against 43 in the earlier study. The number of organisms varied between 298/m^2 in transect IV and 5,125/m^2 in transect I with those of 16/m^2 and 18,128/m^2 respectively of the earlier work. With regard to the animal composition in the present collections, polychaetes emerged as the dominant group with 45% followed by crustaceans constituting 24%. The other groups such as bivalves contributed 16.0% to the total fauna. The gastropods and 'others' came next in the order of abundance with 12% and 3% respectively (Fig. 2).

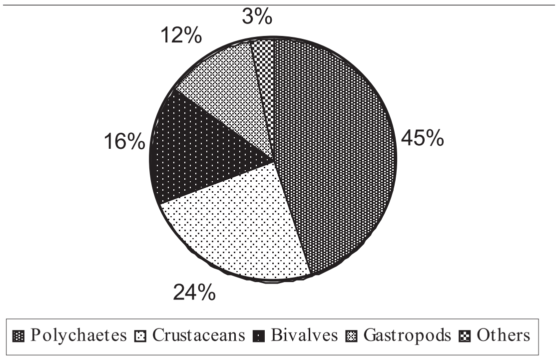

Fig. 2. Percentage composition of benthic faunal groups in the present sample

In the previous investigation, crustaceans topped the list with major share of 68% followed by polychaetes (16%), gastropods (8%), bivalves (7%) and others (1%) (Fig. 3).

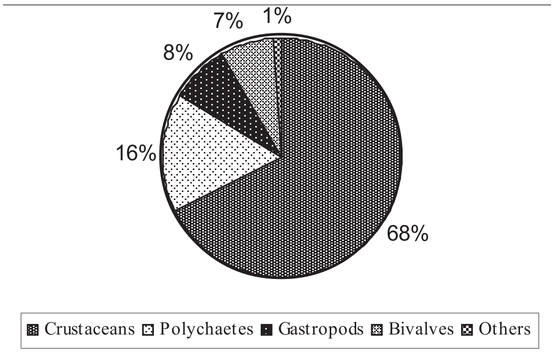

Fig. 3. Percentage composition of benthic faunal groups in the previous study (Ajmal Khan *et al*., 1975)

Among polychaetes, *Ancistrosyllis constricta*, *Ceratonereis costae*, *Cossura delta*, *Diopatra neapolitana*, *Nephtys polybranchia* and

Lumbreneris spp. showed consistency in their occurrence in both the studies. Similarly, the crustaceans such as *Tanaeus* spp. and *Apseudes killaiyensis* were common in both the studies. In addition to these, *Gammaropsis* spp., *Quadriovisio bengalensis* and *Diogenes avarus* were recoded throughout the study period along with bivalves *Meretrix meretrix*, *M. casta*, *Katelysia opima* and *Tellina* spp. The list of species recorded in both the studies is given in Table 1.

Table 1. *List of macrofaunal species recorded in the present and previous collections*

Sl. No.	Species in present collection	Species in previous collection (Ajmal Khan *et al*. 1975)
	Polychaetes	
1.	*Ancistrosyllis constricta*	*Cossura delta*
2.	*Prionospio* spp.	*Ancistrosyllis constricta*
3.	*P. polybranchiata*	*Glycera* spp.
4.	*P. cirrobranchiata*	*Heteromastus similis*
5.	*P. cirrifera*	*Nephthys polybranchia*
6.	*P. pinnata*	*Lumbriconereis* spp.
7.	*Glycera* spp.	*Ceratoneries costae*
8.	*Nephtys polybranchia*	*Prionospio cirrifera*
9.	*Lumbrenereis* spp.	*Laonome indica*
10.	*Cossura delta*	*Sternaspis scutata*
11.	*Ceratonereis costae*	*Harmothoe* spp.
12.	*Sternaspis scutata*	*Sigalion* spp.
13.	*Clymene annandalei*	*Nerine cirratulus*
14.	*Heteromastus similis*	*Stylarioides* spp.
15.	*Malacoceros indicus*	*Polynoe* spp.
16.	*Diopatra neapolitana*	*Pectinaria* spp.
17.	*Cirratulus* spp.	Eunicid spp.
18.	*Syllis* spp.	Spionid spp.
19.	*Hesionid* spp.	*Diopatra neapolitana*
20.	*Serpula vermicularis*	*Polydonotes* spp.
21.	*Sabella* spp.	*Ammotrypane aulogaster*
22.	*Amphicteis gunneri*	*Nereis* spp.
23.	*Poecilochaetus serpens*	*Clymene annandalei*
24.	*Armandia* spp.	*Magelona* spp.
25.	*A. lanceolata*	*Sabella* spp.
26.	*Syllis longissima*	
27.	*Exogone normalis*	
28.	*E. clavator*	

Sl. No.	Species in present collection	Species in previous collection (Ajmal Khan *et al*. 1975)
29.	*Perenereis cultrifera*	
30.	*Owenia fusiformis*	
31.	*Eunice* spp.	
32.	*Orbinia* spp.	
33.	*Lysidice collaris*	
	Crustaceans	
34.	*Tanaeus* spp.	*Apseudes killaiyensis*
35.	*Apseudes killaiyensis*	*A. gymnophobia*
36.	*Quadriovisio bengalensis*	*Ochaetostoma septomyotum*
37.	*Grandiderella* spp.	*Tanaeus* spp.
38.	*Gammaropsis* spp.	*Odontamblyoous rubicundus*
39.	*Eriopisa chilkensis*	*Alpheus* spp.
40.	*Calanus* spp.	*Gammaropsis* spp.
41.	*Paracalanus* spp.	*Grandiderella* spp.
42.	*Diogenes avarus*	*Diogenes avarus*
		Phoronis spp.
	Molluscs	
43.	*Meretrix meretrix*	*Nautica* spp.
44.	*M. casta*	*Oliva* spp.
45.	*Anadara granosa*	*Nassa* spp.
46.	*A. rhombea*	*Meretrix meretrix*
47.	*Katelysia opima*	*Cerethidia fluviatilis*
48.	*Cerithidea cingulata*	
49.	*Perna viridis*	
50.	*Turitella* spp.	
51.	*Umbonium vestiarium*	
	Others	
52.	Brittle star	Echiurids
53.	Sea anemone	Sea anemone
54.	Foraminiferans	Foraminiferans

The results of diversity indices revealed striking variations between transects in both the studies. In the present study, the Shannon diversity varied between 2.32 (transect IV) and 4.10 (transect I) while the values of species richness ranged from 0.805 in t III to 2.56 in t I. Similarly, Pielou's evenness fluctuated between 0.87 in t III and 0.95 in t II. In the earlier results also, the minimum (0.41) and maximum of (3.55) diversity values were registered in t IV and t I respectively. The species richness varied from 0.20 in t IV to 1.95 in t I. On the contrary, the species evenness ranged between 0.29 in t IV and 0.98 in t I.

BIO–ENV method (Biota–Environment matching) was employed to match the environmental entities with biological entities of both the studies. The results showed that sand, organic carbon, iron, copper and cadmium were found to be the major variables explaining the best match faunal distribution barring zinc which was featured as an additional parameter explaining faunal distribution in the previous study. The results are given in Table 2.

in the earlier observation, while polychaetes topped the list in the present study. Dominance of polychaetes in terms of density and species composition in diverse ecological niches is owing to their high adaptability to a wide range of environmental factors. In Indian waters the polychaete dominance was noticed both along the west and east coasts by Antony and Kuttyamma (1983) and Ansari *et al*. (1986). Such preponderance of polychaetes was reported in benthic communities of temperate waters also by earlier workers (Buchanan and Warwick, 1974; Fauchald and Jumars, 1984). The polychaete dominance could be attributed to possible changes in the ecosystem besides high organic carbon content in the sediments. In BIO-ENV method, organic carbon is manifested as the best matching variable with biological entities. With respect to diversity, the values of diversity indices were found to have increased to 4.09 compared to 3.55 of the earlier collection. Species diversity is a simple and useful measure of biological system since it is viewed as the indicator of the well–being of the ecosystem.

Table 2. *Harmonic rank correlations (ρω) between faunal and environmental variables*

No. of variables	Best variable combinations	Correlation (ρω)
3	Sand-cadmium-organic carbon	0.68
3	Sand-iron- organic carbon	0.68
3	Sand-copper-iron	0.67
3	Copper-iron-cadmium	0.67

Discussion

There were 54 species of macro-fauna as against 43 in the earlier analysis by Ajmal Khan *et al*. (1975). The difference in the number of species may be attributed to the sampling effort since the collections were made from five stations per transect in the earlier investigation while ten stations per transect were sampled in the present study. With respect to population density in transects I and II, it was low compared to the earlier work. This might be due to the preponderance of *Apseudes* spp. and *Tanaeus* spp. in the first two transects because they constituted more than any other groups in the earlier collections. The crustaceans were dominant

Sanders (1968) observed a high level of agreement between the species diversity and nature of the environment and regarded the nature of species diversity as an ecologically powerful tool. There are reports stating that when the diversity value is more than 3, the system is considered to be pristine and free from disturbances. The richness and evenness values were also found to be within safe levels. Added to these, BIO–ENV method yielded the combinations of five environmental variables, namely, sand, organic carbon, cadmium, iron and copper as best match explaining the faunal distributions. The *rho* value was greater than 0.6 in all the combinations. Generally if the value is more than 0.6, it indicates the best matching variables defining faunal distributions (Clarke and Ainsworth, 1993).

It is concluded that there are changes in the species mix of benthos, but the benthic biodiversity is within safe level in the marine zone of Vellar estuary.

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References

Ajmal Khan, S., E. Vivekanandan and K. Balasubrahmanyan. 1975. Bottom fauna in two regions of the Vellar estuary. *In*: Natarajan R. (Ed.), *Recent Researches in Estuarine Biology*. Hind. Publ. Corporation, New Delhi. p. 255-272.

Ansari, Z. A., B. S. Ingole, G. Banargee and A. H. Parulekar. 1986. Spatial and temporal changes in benthic macrofauna from Mandovi and Zuari estuaries of Goa. *Indian J. Mar. Sci.*, 15(4): 223-229.

Antony, A. and V. J. Kuttyamma. 1983. The influence of salinity on the distribution of polychaetes in the Vembanad estuary, Kerala. *Bull. Dept. Mar. Sci. Univ., Cochin*, 13: 121-133.

Buchanan, J. B. and R. M. Warwick. 1974. An estimate of benthic macro fauna production in the offshore mud of the Northumberland coast. *J. Mar. Biol. Ass. U. K.*, 54: 197- 222.

Clarke, K. R. and M. Ainsworth. 1993. A method linking multivariate community structure to environmental variables. *Mar. Ecol. Prog. Ser.*, 92: 205–219.

Clarke, K. R. and R. N. Gorley. 2006. *Primer v6: User manual/ Tutorial.* Primer-E, Plymouth. 190 pp.

Day, J. H. 1967. A monograph on the polychaeta of southern Africa. Parts 1 and 2, *British Museum* (*Nat. Hist*.), London. 878 pp.

el Wakeel, S. K. and J. P. Riley. 1956. The determination of organic carbon in marine muds. *J. Cons. int. Explor. Mer*., 22 :180-183.

Fauchald, K. and P. A. Jumars. 1984. The diet of worms: A study of polychaete feeding guild. *Oceanogr. Mar. Biol. Ann. Rev*., 17: 193-284.

Fauvel, P. 1953. The fauna of India including Pakistan, Ceylon, Burma and Malaya. Annelida: *Polychaeta*, Allahabad, 507 pp.

Lyla, P. S., S. Velvizhi and S. Ajmal Khan. 1999. A monograph on the amphipods of Parangipettai coast. Annamalai University, India. 78pp.

Mackie, A. S. Y. 1994. Collecting and preserving polychaetes. *Polychaete Res.*,16: 7-9.

Parulekar, A. H., V. K. Dhargalkar and S. Y. S. Singbal. 1980. Benthic studies in Goa estuaries, Part- III – Annual cycle of macro faunal distribution, production and trophic relation. *Indian J. Mar. Sci*., 9: 189- 200.

Rajagopal, S., S. Ajmal Khan, M. Srinivasan and A. Shanmugam. 1998. A monograph on the gastropods of Parangipettai coast. *Annamalai University,* India. 38pp.

Sanders, H. L. 1968. Marine benthic diversity: A comparative study. *American Naturalist*,102: 243-282.

Shanmugam, A., S. Rajagopal and R. A. Nazeer. 1997. A monograph on the common bivalves of Parangipettai coast. *Annamalai University,* India. 65pp.

Strickland, J. D. H. and T. R. Parsons. 1972. A practical handbook of seawater analysis. *Bull. Fish. Res. Bd.* Canada, 167: 310pp.

Warwick, R. M. 1993. Environmental impact studies on marine communities: pragmatical considerations. *Aust. J. Ecol*., 18: 63–80.

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