J. Mar. Biol. Ass. India, **50** (1) : 23 - 28, January - June 2008

Diversity of meiobenthic nematodes in the Poonthura estuary (southwest coast of India)

K. S. Anila Kumary

School of Applied Life Sciences, M. G. University Regional Centre, Pathanamthitta-689 645, Kerala, India. E-mail: ksanilakumary@yahoo.co.in

Abstract

Community structure of meiobenthic nematodes was studied in 4 stations of Poonthura estuary. Maximum values of species diversity index coincided with the presence of maximum number of species. Moderate diversity, richness and evenness indices were observed at all stations due to low density of meiobenthos in the estuary. The community indices showed the minimum values during monsoon season coinciding with a fall in density. Notable changes in community structure were associated with organic enrichment. A decrease in abundance as well as species diversity and an increase in species dominance were recorded at the station close to sewage outfall.

Keywords: community structure, nematodes, pollution, estuary

Introduction

Meiofauna play a vital role in the management of estuarine system not only because they are qualitatively and quantitatively rich, but also because of their importance in the economy of estuarine waters. Meiobenthic communities are highly sensitive to man-made stress such as pollution. Changes in the species composition of the communities are indices of pollution disturbances. Many studies have reported the dominance of nematodes in meiofaunal population in the Indian estuaries (Damodaran, 1973; Varshney, 1985; Ramanamurthy and Kondala Rao, 1987; Sarma and Willsand, 1994; Ansari and Parulekar; 1998; Chinnadurai and Fernando, 2006). The present study reveals the qualitative and quantitative structure of meiobenthic nematode community in the Poonthura estuary exposed to organic pollution.

Materials and methods

The study was carried out in the Poonthura estuary (08^0 25′ - 08^0 30′ N. Lat. and 76^0 55′ – 77^0 00′ E Long.) in the southwest coast of India near Thiruvananthapuram city. The estuary is exposed to untreated sewage from the city sewage farm after flowing through a canal for 2.4 km. Regular monthly replicate meiofauna samples (each 5.5 cm diameter and 25 cm long) were collected from four sampling stations (Fig.1) covering a distance of 4.5 km for a period of one year from February 1995 to January 1996. Station I was on the upper reaches of the estuary comparatively free from sewage pollution and exposed to freshwater influx from the Karamana river; station II on the western segment of the estuary where the sewage drains open directly into the estuary; station III on the interior segment of the estuary where the sewage is comparatively diluted; and station IV on the estuary mouth into the Arabian Sea. The meiofauna samples were sieved through a set of 0.5 mm and .062 mm sieves and stored in 5% neutral formalin solution stained with Rose Bengal. Meiobenthic individuals were sorted out into various invertebrate groups and the nematode individuals were counted and identified to species level. The replicates from each station were pooled and the total numbers for each species were determined. From the species composition at each station, the

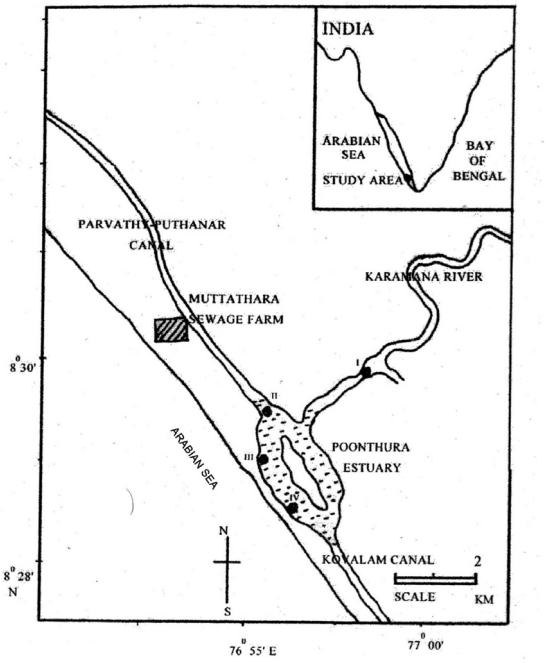

Fig.1. Map of Poonthura estuary showing sampling stations

descriptive measures such as the species diversity index, species richness, evenness index and dominance index were computed by following the methods of Shannon and Weaver (1963), Margalef (1958), Pielou (1966) and Simpson (1949).

Results and Discussion

Nematodes were the most dominant meiobenthos at the stations studied in the Poonthura estuary. The ranges of nematode population density (number/m^2) were 0-778 (st. I); 4-842 (st. II); 0-2269 (st. III) and 60-4611 (st. IV). The nematode community was composed of 9 species belonging to 9 genera of 7 families. The nematode species recorded and their contribution (%) to the density of total nematodes at stations I – IV are given in Table 1. At station II, where the sewage outfall enters the estuary, only 3 species of nematodes were present and the community was dominated by *Desmodora extensa* (58.3%). However, the dominance of this species was limited to the pre-monsoon (February–May) and late post-monsoon months (December and January) when the sewage mixing was at its maximum at this station.

Table 1. Composition (% of species density) of meiobenthic nematodes in the Poonthura estuary

Family / Species	Station I	Station II	Station III	Station IV
Thoracostomopsidae				
Enoploides labiatus	10.7	0.0	8.3	9.3
Mesacanthion armatus	54.8	0.0	39.4	18.4
Oncholaimidae				
Oncholaimus oxyuris	0.0	27.0	0.0	1.0
Pontonema valviferum	0.0	0.0	0.0	0.9
Enchelidiidae				
Euristomina sp.	3.3	0.0	0.0	0.0
Cyatholamidae				
Cyatholaimus ocellatus	0.0	0.0	6.7	18.9
Comesomatidae				
Sabatieria intermissa	12.6	14.8	4.9	0.0
Desmodoridae				
Desmodora extensa	18.6	58.3	31.6	30.2
Xyalidae				
Theristus alternus	0.0	0.0	9.1	21.3

Species diversity: Species diversity is at a minimum when all the individuals belong to the same species and at a maximum when the individuals belong to different species. In the present study, the nematode diversity was minimum at station II and maximum at station IV. The ranges of diversity index were 0-1.3 (st.I); 0-1.0 (st.II); 0-1.4 (st.III) and 0-1.5 (st.IV). Monthly variations in the species diversity of meiobenthic nematodes at the four stations are shown in Fig. 2. The application of diversity indices to biological monitoring of water quality is based on the premise that stressed communities undergo a reduction in diversity. The present study indicates that considerable changes occur in the community structure associated with organic enrichment caused by sewage pollution. Station II recorded the lowest number of species and lowest diversity values. Reduction in species diversity has widely been reported as a response to organic enrichment (Gray, 1971; Marcotte and Coull, 1974; Vidakovic, 1983; Simboura *et al.,* 1995; Ansari, 2000).

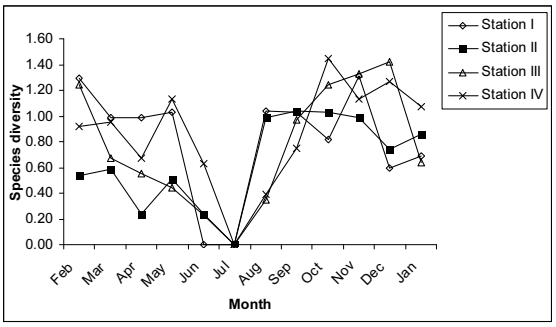

Fig. 2. Monthly variation in species diversity of meiobenthic nematodes at four stations

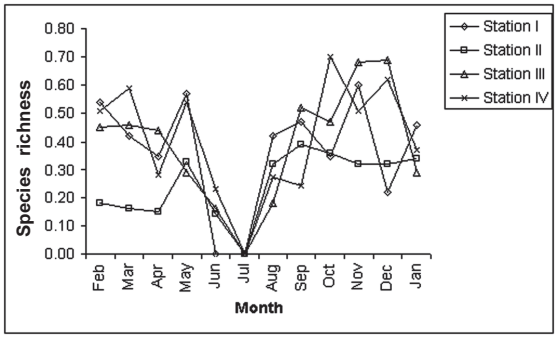

Fig. 3. Monthly variation in species richness of meiobenthic nematodes at four stations

Seasonal analysis revealed that the highest diversity index of nematodes was during the pre-monsoon period (February - May) and the lowest during the monsoon period (June – September) at station I whereas at station II maximum diversity was noted during the post-monsoon period (October – January) and the minimum during the pre-monsoon period. Stations III and IV had the highest diversity during the post- monsoon while the lowest values were during the monsoon period. The monsoon period was generally characterised by poor density of fauna. The shift in the community structure coinciding with a fall in density was probably caused by heavy rain and floodwater discharge, which might have flushed out the surface layers of sediment. Nematodes were totally absent during June at station I and during July at station III. Species such as *Sabatieria intermissa, Pontonema valviferum, Oncholaimus oxyuris* etc., totally disappeared from the estuary during the flood period. Such a fall in values of diversity indices during the monsoon season was earlier reported from other Indian estuaries (Chandran *et al.,* 1982; Bouman *et al.,* 1984; Jagadeesan and Ayyakkannu, 1992; Sajan and Damodaran, 2005). The minimum diversity during the pre-monsoon period at station II was associated with anoxic situations and high nutrient concentrations due to sewage mixing.

Species richness: Species richness is expressed by simple ratios between the total number of species and total number of individuals. Fig. 3 represents the monthly variations in species richness of meiobenthic nematodes at the 4 stations. At station I, the peak value of species richness was during November (0.60) along with the peak value of H' (1.31). A similar trend was noted during September at station II, December at station III and October at station IV (Table 2). Higher values of species richness were due to the occurrence of several species without allowing a single species to dominate the community completely (Redding and Cory, 1975). Values of species richness were more at stations III and IV where the values of H' were high, and lower values for species richness were encountered at station II where the H' values were minimum. The lowest value of species richness was recorded during the period of monsoon floods (June and July) at all stations when the diversity index was also minimum.

Species evenness: Evenness index varied between 0.00 and 0.94 at station I, between 0.00 and 0.74 at station II, between 0.40 and 0.92 at station III and between 0.00 and 0.90 at station IV

Table 2. Relationship between species diversity (H') and species richness in the Poonthura estuary

Stations	Month	Species diversity (H')	Number of species	Species richness
I	November	1.31 (Max)	5	0.60
	July	0.00 (Min)	1	0.00
II	September	1.04 (Max)	3	0.39
	July	0.00 (Min)	1	0.00
III	December	1.42 (Max)	5	0.69
	June	0.23 (Min)	2	0.16
IV	October	1.45 (Max)	6	0.70
	July	0.00 (Min)	1	0.00

(Fig. 4). Evenness index was comparatively higher during the post monsoon period at all stations which shows that the meiobenthic nematodes were

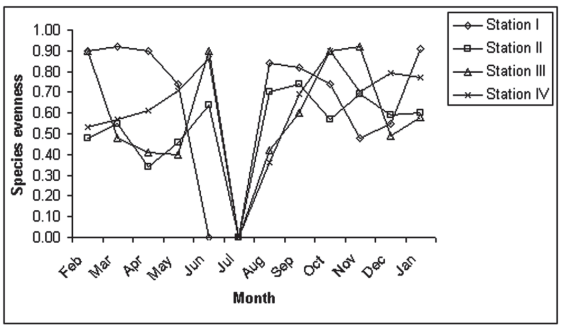

Fig. 4. Monthly variation in species evenness of meiobenthic nematodes at the four stations

evenly distributed and were in a healthy condition during the post-monsoon period at all stations. The evenness index was minimum during the monsoon period at stations I, III and IV and during the pre-monsoon period at station II. The evenness of distribution of individuals among species may be the result of competition under optimum conditions or may be a response to unfavourable conditions (Patrick, 1971). Unfavourable conditions in the form of physico-chemical and biological factors may be the reason for the premonsoon minimum of evenness index at station II.

Dominance index: Dominance index is an important component of species diversity used to identify the main species (Rosenberg, 1975). This index has been defined as the opposite to equitability and whenever dominance index is maximum, the evenness index is the least and *vice versa*. The dominance index of nematode species varied from 0.20 to 1 at station I, 0.38 to 1 at station II, 0.23 to 0.88 at station III and from 0.25 to 1 at station IV (Table 3). At stations I, II and III the peak dominance index was during July due to complete dominance (100%) of *Enopliodes labiatus* at station I, *Oncholaimus oxyuris* at station II and *Cyatholaimus ocellatus* at station IV. At station III, the peak dominance index was obtained during May when *Mesacanthion armatus* marked

Table 3. Relationship between species dominance and evenness indices in the Poonthura estuary

Stations	Month	Dominance index	Evenness index
I	July	1.00 (Max)	0.00 (Min)
	March	0.20 (Min)	0.92 (Max)
II	July	1.00 (Max)	0.00 (Min)
	September	0.38 (Min)	0.74 (Max)
III	May	0.88 (Max)	0.40 (Min)
	November	0.23 (Min)	0.92 (Max)
IV	July	1.00 (Max)	0.00 (Min)
	October	0.25 (Min)	0.90 (Max)

a clear dominance (88.37%) over the other species. The values for the index of dominance were comparatively higher at station II when compared to the other less polluted stations of the estuary especially during the pre-monsoon period (Fig. 5). This could be due to the low diversity of the fauna and dominance of *Desmodora extensa* over other species at the station.

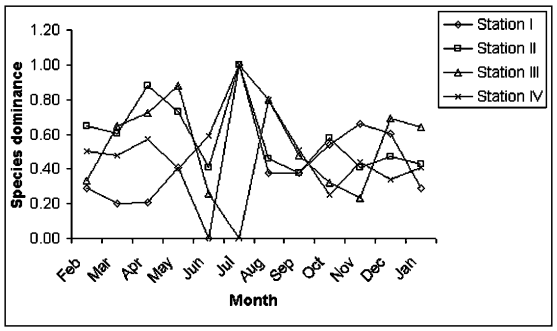

Fig. 5. Monthly variation in species dominance index of meiobenthic nematodes at the four stations

Moderate diversity, richness and evenness indices were observed during the present study at almost all stations in the estuary. Estuarine ecosystems are generally characterised by low species diversity (Pielou, 1975; Ansari and Parulekar, 1998) because of various factors such as hydrological extremes, effect of sediment characteristics and pollution. Differences in substrate type and tidal exposure are usually reflected in obvious differences in community structure (Kastoro *et al.,* 1989). Higher values of diversity, richness and evenness indices in the

present study were recorded in the sandy substratum and low values in the muddy deposits (Table 4). The open nature of the mouth of the estuary during major part of the study resulted in tidal incursion and excursion bathing the estuary. The seasonal

Table 4. Range in sediment grain size composition (% weight) at different stations

Stations	Sediment type	Range	
		Minimum	Maximum
	Sand	22.3	52.3
I	Silt	44.7	76.5
	Clay	1.9	16.0
	Sand	22.1	41.3
II	Silt	29.6	70.7
	Clay	1.5	16.0
	Sand	41.8	100
III	Silt	0	47.7
	Clay	0	8.2
	Sand	41.8	100
IV	Silt	0	53.3
	Clay	0	8.2

rains during the monsoon and post-monsoon periods influenced the water quality conditions in the estuary. All these factors had a remarkable influence on the community structure. Spatial diversity factor also appears to play a major determining role with highest number of species and high diversity at the downstream stations. Diversity index was comparatively low at station closest to sewage outfall especially during the pre-monsoon period. High temperature, high turbidity, low dissolved oxygen, high hydrogen sulphide and fluctuating salinity are important water quality parameters leading to ecologically stressed conditions in estuaries. However, the Poonthura estuary is shallow and perhaps low oxygen events and anoxia were of shorter durations and spatially limited. Hence there were only slight variations in the diversity values at different stations.

Acknowledgement

The author sincerely expresses her gratitude to Dr. P.K. Abdul Azis, Vice Chancellor, Aligarh University for encouragement.

References

Ansari, Z .A. 2000. Distribution of deep-sea benthos in the proposed mining area of central India basin. *Mar. Georesour. Geotechnol.*, 17: 201- 207.

Ansari, Z. A. and A. H. Parulekar. 1998. Community structure of meiobenthos from a tropical estuary. *Indian J. Mar. Sci*., 27: 362– 366.

Bouman, L. A., K. Romeijn and W. Admiral. 1984. On the ecology of meiofauna in an organically polluted estuarine mud flat. *Estuar. Coast. Shelf. Sci.*, 19: 633 – 653.

Chandran, R., G. S. Thangaraj, V. Sivakumar, B. Srikrishnadas and K. Ramamoorthi. 1982. Ecology of macrobenthos of Vellar estuary. *Indian J. Mar. Sci.,* 11: 122 – 127.

Chinnadurai, G. and O. J. Fernando. 2006. New records of five free-living nematodes of an artificial mangrove of India. *J. Mar. Biol. Ass. India,* 48: 105 – 107.

Damodaran, R. 1973. *Studies on the benthos of the mudbank regions of Kerala coast.* Ph. D Thesis, University of Cochin, Kerala, India.

Gray, J. S. 1971. The effect of pollution on sand meiofauna communities. *Thalass. Jugosl.*, 7: 79 – 89.

Jagadeesan, P. B. and K. Ayyakkannu. 1992. Seasonal variation of benthic fauna in marine zone of Coleron. *Indian J. Mar. Sci.*, 21: 67– 69.

Kastoro, W., I. Aswandy, A. L. Hakim, P. A. W. Dewilde and J. M. Evrarts. 1989. Soft bottom benthic community in the estuarine water of east Java. *Neth. J. Sci. Res.,* 23*:* 463 – 472.

Marcotte, B. M. and B. C. Coull. 1974. Pollution, diversity and meiobenthic communities in the North Adriatic (Bay of Pyran, Uyougoslavia). *Vie Milieu*, 24: 281 – 300.

Margalef, D. R. 1958. Information theory in ecology. *Gen . Syst.*, 3: 36–71.

Patrick, R. 1971. The effect of increasing light and temperature on the structure of diatom communities. *Limnol. Oceanogr.,* 16: 405-421.

Pielou, E. C. 1966. The measurement of diversity in different types of biological collection. *J. Theor. Biol*., B: 131 – 144.

Pielou, E. C. 1975. *Ecological Diversity*. A Wiley – Inter Science Publication. 162 pp.

Ramanamurthy, K. V. and Kondala Rao. 1987. Survey of meiofauna in the Gautami – Godavari estuary. *J. Mar. Biol. Ass. India*, 29: 37-44.

Redding, J. M. and R. L. Cory. 1975. Macroscopic benthic fauna of three tidal creeks adjoining the Rodhe river,

Maryland. In *U. S. Geological Survey – Water Resources Investigations*. 39: 1-28.

Rosenberg, R. 1975. Stressed tropical benthic faunal communities of Miami, Florida. *Ophelia,* 14: 93 – 112.

Sajan, S. and R. Damodaran. 2005. On the vertical distribution of marine nematodes from the shelf sediments off west coast of India with focus on their community structure. *J. Mar. Biol. Ass. India,* 47: 133 – 138.

Sarma, A. L. N. and V. Wilsand. 1994. Littoral meiofauna of Bhitarkanika mangroves of river Mahanadi system, east coast of India. *Indian J. Mar. Sci.,* 23: 221 – 224.

Shannon, E. C. and W. Weaver. 1963. *The Mathematical Theory of Communication*, University of Illinois, 117 pp.

Simboura, N., A. Zenetes, P. Panayotidis and A. Makra. 1995. Changes in benthic community structure along an environmental pollution gradient. *Mar. Pollut. Bull*., 30: 470 – 474.

Simpson, E. H. 1949. Measurement of diversity. *Nature,* 163: 688– 704.

Varshney, P. K. 1985. Meiobenthic study off Mahim (Bombay) in relation to prevailing organic pollution. *Mahasagar,* 18: 27 – 35.

Vidakovic, J. 1983. The influence of raw domestic sewage on density and distribution of meiofauna. *Mar. Pollut. Bull.,* 14: 84 – 88.

Received: 23 January 2008
Accepted: 15 April 2008