EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 5
Issue: 8
441-445
Year: 2018

COMMUNITY STRUCTURE OF BENTHIC FORAMINIFERA IN THE POONTHURA ESTUARY, THIRUVANANTHAPURAM, KERALA

***K. S. Anila Kumary**

Department of Zoology, Kuriakose Gregorios College, Pampady, Kottayam, Kerala 686502 India.

***Corresponding Author: K. S. Anila Kumary**
Department of Zoology, Kuriakose Gregorios College, Pampady, Kottayam, Kerala 686502 India.

Article Received on 15/06/2018 **Article Revised on 05/07/2018** **Article Accepted on 25/07/2018**

ABSTRACT
The present investigation reveals the spatio-temporal variations in the distribution, abundance and diversity of benthic foraminifera in the Poonthura estuary (latitude $8^0$25' - $8^0$30'N and longitude $76^0$55'- 77^0 00'E) on the southwest coast of India lying in the outskirts of Thiruvananthapuram, the capital city of Kerala. Sediment samples were collected from 3 stations in the Poonthura estuary and totally 108 core samples were collected in order to study the assemblages of foraminifera. Density of total foraminifera (No/m^2) in the estuary seasonally varied from 144 to 422. Upstream stations were poorly populated while middle and downstream stations have a large population. Foraminiferal species richness was very low, only 12 species were identified. Among the different foraminiferal species *Ammobaculites catenulatus*, *Textularia agglutinans*, *Textularia sagittula* and *Ammonia becarii* are found wide spread and abundant. Preferences for substrate type coupled organic enrichment and higher salinity conditions explain for the occurrence of benthic foraminifera in the Poonthura estuary.

KEYWORDS: Benthic foraminifera, Poonthura estuary, Species diversity.

INTRODUCTION
The occurrence and abundance of benthic species is determined by physical factors such as water depth, temperature, light availability, turbidity and turbulence of water as well as bottom sediment, chemical factors like salinity and biological factors such as food supply, presence of symbiotic organisms, parasites and predators (Murray, 1991; Jorissen, 1999; Elakkia and Manivannan, 2013). Foraminifera are unicellular microorganisms with the outer hard covering known as test which is generally either calcareous or agglutinated in nature. They are successful inhabitants of every aquatic environment from deep oceans to brackish water lagoons, estuaries, and even rarely in freshwater streams, lakes etc. Benthic foraminifera are extremely sensitive towards even subtle changes in environmental conditions and therefore, are considered to be the best proxies for understanding environmental disturbances. The application of benthic foraminifera has emerged as an excellent environmental monitoring tool for contaminated and polluted waters (Alve, 1995; Yanko *et al*., 1999; Jorissen, 1999; Scott *et al*., 2005).

Population growth and the resultant acceleration of domestic, industrial, agricultural and recreational activities are the major causes of anthropogenic pollution of the aquatic environment. Almost all estuarine environments traditionally serve as recipients for domestic and industrial effluents. Such pollution produces numerous obvious biological changes in community structure of biota inhabiting in such environment. Poonthura estuary on the southwest coast of India (latitude $8^0$25' - $8^0$30'N and longitude $76^0$55'-$77^0$00'E) is in the outskirts of Thiruvananthapuram, the capital city of Kerala. Downstream sections of Karamana River are designated as Poonthura estuary which is separated from the Arabian Sea by a sand bar at Poonthura. The estuary is freely connected with the Arabian Sea during monsoon season following heavy discharge of water from the Karamana River. The total length of the estuary is 4.35 km and encloses a small island called Edayar. Parvathy Puthanar canal, the most polluted canal of the city by the sewage spilled from the city sewage farm at Muttathara joins the estuary. Poonthua estuarine habitat also serves as coconut retting ground. Although some physico- chemical studies of water and baseline data on biota is available from the Poonthura estuary (Anila Kumary and Abdul Azis, 1992; Anila Kumary *et al*., 2001; Anila Kumary, 2008; 2016), absolutely no information on the foraminiferal assemblages of Poonthura estuary. The objective of the present study was to document the benthic foraminiferal abundance, distribution and diversity in the Poonthura estuary, Thiruvananthapuram on the southwest coast of India.

MATERIALS AND METHODS

Samples of sediment were collected using a hand operated steel corer (5.5 cm inner diameter and 25 cm long) from three selected stations in the Poonthura estuary, station I located in the upper reaches, Station II in the middle reaches and Station III in the lower reaches. Totally 108 undisturbed core samples were collected manually and transferred to clean polythene bags and were preserved immediately in 10% neutralized formaldehyde solution. The isolation and extraction of benthic organisms were carried out by flotation decantation method (Holme and McIntyre, 1971). To identify the specimens, the samples fixed in neutralized formaldehyde solution were stained with Rose Bengal and the foraminifera specimens were sorted out. The specimens were identified and classified following Loeblich and Tappan (1987). From the species composition at each station the descriptive measures of diversity indices were worked out following the expressions.

Shannon and Weaver (1963) index of species diversity $H' = -\sum (ni/N) \log (ni/N)$

Simpson (1949) index of Dominance $C = \sum (ni/N)^2$

Margalef (1958) species richness index $d = S-1/ \log N$

Pielou's (1966) evenness index $e = H'/ \log s$

Where, ni = importance value of each species
N = total of importance values
S = number of species

Sediment samples were analyzed for grain size, redox potential and organic carbon percentage following standard procedures (Krumbein and Pettijohn, 1938; El Wakeel and Riley, 1956). Bottom water samples were analysed for salinity, Dissolved Oxygen and hydrogen sulphide (Strickland and Parsons, 1972).

RESULTS AND DISCUSSION

The study of foraminifera in the Poonthura estuary revealed a total number of 12 species belonging to 8 genera and 5 families. Among the total foraminifera, dominant families were Textulariidae, Rotalidae and Nonionidae. The most abundant genera were *Textularia*, *Ammonia*, *Elphidium* and *Nonion* and these were the common genera occur in many samples at the various stations of the Poonthura estuary. Density of total foraminifera (No/m^2) seasonally varied from 144 at station I to 422 at station III. Upstream station was poorly populated while the middle and downstream sections of the estuary have a large population together with better species richness. Density and species richness of foraminifera in the Poonthura estuary is presented in Table I.

Foraminiferal zonations are frequently shown to be related to natural water- mass boundaries (Denny and Sen Gupta, 1993), river runoff, seasonal changes, current and bio-geo chemical process (Elakkia and Manivannan, 2013). Some benthic foraminifer's species rapidly react with the input of organic matter from primary production exhibiting an increase in population size with organic enrichment (Murray, 1991). Several benthic foraminifera are known to exist in oxygen depleted environments (Murray, 1991; Fontanier *et al.*, 2002). The diversity of foraminifera depends largely on the ecological conditions at a site. The general trend in the distribution of foraminiferal assemblages of the Poonthura estuary is the increasing species diversity in line with increasing salinity gradients and environmental stability. Species richness was very low at the upstream station and maximum in the lower reaches of the estuary were the marine influence is maximum. Table II shows the composition (%) of foraminifera at the different stations of Poonthura estuary.

Almost all estuarine environments traditionally serve as recipients for domestic and industrial effluents. Their effects on the local fauna depends mainly on factors such as the nature and volume of the effluents, whether the effluents are discharged directly into the estuary from the point of sources or indirectly through the river system and on the hydrographical and geomorphplogical properties of the estuary. Among the different foraminiferal species *Ammobaculites catenulatus, Textularia agglutinans, Textularia sagittula, Ammonia becarii* and *Elphidium advenum* are found wide spread and abundant in the Poonthura estuary. These species have high tolerance for salinity variations and surviving successfully in estuarine environments and is comparable with species abundance in other estuaries with similar climatic condition (Reddy and Reddy, 1982; Narappa *et al*., 1982; Kameswara Rao and Balasubramanian, 1996; Jayaraju *et al*., 1998; Kameswara Rao *et al*, 2000, Naresh Kumar *et al*., 2012). In the upper reaches of the estuary only the arenaceous species were found while the area near the bar mouth was chiefly characterised by calcareous foraminifers. *Ammonia becarii* is reported to be highly tolerant to different ecosystems and widely considered as a cosmopolitan species (Suresh Gandhi *et al*., 2014, 2017). *Ammonia becarii* was the dominant species at the upper and middle reaches of the Poonthura estuary. This species was highly tolerant to the low dissolved oxygen and was resistant to the large amount of hydrogen sulphide and low Eh persistent at these stations. Negative effects of sewage effluents on benthic foraminiferal assemblages have been reported (Alve, 1995) in association with the presence of an abiotic zone or a zone of low oxygen and pH values. Reduced number of species has been noted in the upper and middle reaches of estuary which is the immediate vicinity of sewage out fall in to the estuary.

The character of substratum is an important factor in the distribution of foraminifera. A number of studies have revealed a close correlation between the nature of sediment, especially the texture of the sediment and the foraminiferal population (Reddy and Reddy, 1982; Setty and Nigam, 1982; Murray, 1991; Rao and Balasubramanian, 1996; Jannink *et al*., 1998; Fontanier *et al*., 2002; Suresh Gandhi *et al*., 2014). Silty and

muddy substrates are often rich in organic debris together with bacterial blooms. Such substrates are attractive to foraminifera species and usually support large populations. The abundance of foraminifera was associated with the sandy nature of the substratum with varying percentage of silt and clay in the present study. The relative abundance of sand, silt and clay in the sediments of Poonthura estuary indicates that most of the sediments are silty sand followed by sand while few are clayey sand. The accumulation of organic matter in the fine sediments favours the occurrence of stress- tolerant genera such as *Ammonia*, *Elphidium* etc. in the middle and lower regions of the estuary. Murray (1991) reported that *Ammonia* prefers muddy sand while *Nonion* prefers fine mud and silt. The variation in the abundance of total foraminifera as well as their species composition in the estuary is mainly due to substrate together with organic matter enrichment as well as tidal current action. Table III explains water quality and Sedimentological ranges preferred by Foraminifera species in the Poonthura estuary. Fresh water influx from the Karamana River and the low salinity control the foraminifer's abundance at the riverine station (Station I). Preferences for substrate type coupled organic enrichment and higher salinity conditions explain for the occurrence of benthic foraminifera in the estuary.

The variation in the total abundance of foraminifera in the Poonthura estuary is mainly due to substrate as well as tidal current action. Main ecological parameters which govern the distribution and abundance of foraminifera in the Poonthura estuary are organic matter content, salinity and the nature of the sediment.

Table I: Density of total foraminifera (No/m^2) and the species richness (No. of species) at the different stations of Poonthura estuary.

Season	Station I		Station II		Station III	
	No/m^2	No. of species	No/m^2	No. of species	No/m^2	No. of species
Premonsoon	144	5	188	7	362	10
Monsoon	157	4	259	5	226	9
Postmonsoon	242	5	342	9	422	11

Table II: Composition (% of species density) of foraminifera at the different stations of Poonthura estuary.

Species	Station I	Station II	Station III
Ammobaculites taylorensis	5.01	14.17	0
Ammobaculites catenulatus	1.22	9.11	3.15
Textularia agglutinans	41.76	15.99	6.01
Textularia polustris	0	7.07	0.88
Textularia sagittula	8.80	6.63	0.88
Ammonia becarii	43.21	30.17	14.57
Rotalia becarii	0	1.62	9.54
Elphidium advenum	0	0	50.07
Nonion boueanum	0	11.91	11.37
Nonion scaphum	0	0	0.59
Globigerina dubia	0	0	2.06
Orbulina universa	0	3.33	0.88

Table III: Water quality and Sedimentological ranges of Foraminifera species in the Poonthura estuary.

Species	Salinity BW ($S.10^{-3}$)	DO BW (mg/l)	H_2S BW (mg/l)	Eh BS (mv)	OC BS (%)	Sand BS (%)	Silt BS (%)	Clay BS (%)
Ammobaculites taylorensis	0.66-25.76	0.0-6.06	0.0-4.56	-211-+101	0.84-8.43	22.30-52.25	39.28-65.46	1.18-10.82
Ammobaculites catenulatus	0.66-11.17	1.10-5.49	0.0-1.03	-199-+86	0.84-3.75	22.10-79.37	18.55-70.67	2.57-38.05
Textularia agglutinans	0.34-23.99	0.0-6.06	0.0-4.56	-211-+133	0.78-8.43	22.30-93.25	6.75-64.75	1.94-38.05
Textularia polustris	0.34-23.99	0.0-5.49	0.0-4.56	-211-+133	1.07-8.43	22.10-81.58	10.20-70.67	6.56-23.02
Textularia sagittula	0.34-23.99	1.93-5.23	0.0-1.03	-67-+108	0.84-3.75	26.38-77.17	17.45-58.75	0.0-35.01
Ammonia becarii	0.34-11.27	0.0-6.06	0.0-4.56	-211-+101	0.84-8.43	22.30-100	0.0-70.67	0.0-38.05
Rotalia	1.29-	2.21-	0.0-	-17-	0.24-	44.18-	0.0-	0.0-

becarii	26.27	5.51	0.23	+156	2.81	100	41.95	23.02
Elphidium advenum	0.34-26.27	1.65-6.33	0.0-0.99	-23-+156	0.24-3.32	59.90-100	0.0-40.10	0.0-17.20
Nonion boueanum	0.66-17.94	2.21-6.59	0.0-1.15	-133-+136	0.67-3.75	41.75-93.25	6.75-40.35	0.40-8.22
Nonion scaphum	2.90-26.27	3.77-6.33	0.0	+ 47-+156	0.24-268	74.75-81.58	5.0-30.63	2.40-5.99
Globigerina dubia	2.90-26.27	3.77-6.33	0.0	+ 47-+156	0.24-268	74.75-81.58	5.0-30.63	2.40-5.99
Orbulina universa	0.66-23.99	2.12-6.19	0.0	-32-+142	0.67-2.68	22.10-81.58	10.20-70.67	6.56-23.02

REFERENCES

1. Alve, E. 1995 Benthic foraminiferal responces toestuarine pollution: A review. *Journal of Foraminiferal Research*, 25(3): 190-203.
2. Anila Kumary, K.S. 2008 Diversity of meiobenthic nematodes in the Poonthura estuary (southwest coast of India). *J. Mar. Biol. Ass. India*, 50(1): 23-28.
3. Anila Kumary, K.S. 2016 Distribution of meiofauna in the Poonthura estuary, Thiruvananthapuram, Kerala. *International Journal of Pure and Applied Bioscience*, 4(5): 121-126.
4. Anila Kumary, K.S. and P.K.Abdul Azis 1992 Water quality of the Poonthura estuary, Thiruvananthapuram. Mahasagar, 25(1): 1-9.
5. Anila Kumary, K.S., P.K.Abdul Azis and P.Natarajan 2001 Sediment characteristics of Poonthura estuary (southwest coast of India) in relation to pollution. *Indian J. Mar. Sci*., 30: 75-80.
6. Denny, R.A. and B.K Sen Gupta. 1993 Matching of benthic foraminiferal depth limits and the water masses boundaries in the north-western Gulf of Mexico: An investigation of species occurrences. *Journal of Foraminiferal Research*, 23(2): 108-117.
7. Elakkia, P. and V.Manivannan 2013 Recent benthic foraminifera from off the coast of Arkattuthurai (near Nagapattinum), south east coast of India. *Indian J. Geo-Mar. Sci*., 42(7): 877-887.
8. ElWakeel S.K. and J.P.Riley 1956 The determination of organic carbon in marine mud. *J.Cons. Perm. Inst.Explor. Mer*., 22: 180-183.
9. Fontanier, C., F.J. Jorissen, L.Licari, A.Alexandre, P.Anschutz and P.Carbonel 2002 Live benthic foraminiferal faunas from the bay of Biscay: faunal density, composition and microhabitats. *Deep-Sea Res*. Part I, 49(4): 751-785.
10. Holme, N.A. and A.D. McIntyre 1971 *Methods for the study of marine benthos*. IBP hand book No.16. Blackwell Scientific Publications, 334.
11. Krumbein W.C. and F.J.Pettijohn 1938 *Manual of sedimentary petrography* (Appleton Centuary Croftsinc N.Y.)549 pp
12. Murray, J.W. 1991 Ecology and distribution of benthic foraminifera. In: Lee, J.J. and Anderson, O.R.(Eds.), *Biology of Foraminifera*. Academic Press, New York, pp221-254.
13. Jannink, N.T., W.J.Zachariasse and G.J.Van-der Zwaan, 1998 Living (Rose Bengal stained) benthic foraminifera from the Pakistan continental margin (Nothern Arabian sea). *Deep-Sea Res*., 145: 1483- 1513.
14. Jayaraju, N., I.Suryakumar, K.Srinivas and K.R.Reddy 1998 Recent benthic foraminifera genera from Pulicat lake, east coast of India. An appraisal using factor analysis. *Jour. Geol. Soc. India*, 51: 69-74.
15. Jorissen, F.J. 1999 Benthic foraminiferal micro habitats below the sediment-water interface. In: Gupta, S. (Ed)., *Modern Foraminifera*. Kluwer Academic Publishing Dordrecht, pp 161-179.
16. Kameswara Rao, K. And T. Balasubramanian 1996 Distribution of foraminifera in the Cochin estuary. *J. Mar. Biol. Ass. India.*, 38(1&2): 50-57.
17. Kameswara Rao, K., K.V.Jayalekshmy, P.Venugopal, T.C.Gopalakrishnan and M.D.Rajagopal 2000 Foraminifera from the Chilka lake on the east coast of India. *J. Mar. Biol. Ass. India.*, 42(1&2): 47-61
18. Loeblich, A.R. Jr. and H. Tappan 1987 *Foraminiferal genera and their classification*. Von Nostrand Rinhold, NewYork, 970 pp.
19. Margalef, D.R.1958 Information theory in ecology. *Gen. Syst*., 3: 36-71.
20. Narappa, K.V., M.Subba Rao and R.Rao 1982 Comparison of foraminiferal assemblages from Godavari and Krishna estuaries. *Indian J. Mar. Sci*., 11: 220-224.
21. Naresh Kumar, N., B.Ganesh, T.Karunakarudu and M.Jagannadha Rao 2012 A record on benthic foraminiferal abundance and distribution in the Gosthani estuary, Bheemunipatnam, Andra Pradesh. *IndianJ. Geo. Mar. Sci*., 41(5): 425-429.
22. Pielou, E.C. 1966 The measurement of diversity in different types biological collections. *J. Theor. Biol*., 13: 131-144.
23. Reddy, A.N and K.R.Reddy 1982 Recent benthonic foraminifera from the Araniyar river estuary, Tamil Nadu, India. *Indian J. Mar. Sci*., 11: 249-250.
24. Rao, K.K. and T.Balasubramanian 1996 Distribution of benthic foraminifera in the Cochin estuary. *J. Mar. Biol. Ass. India*, 38(1&2): 52-57.
25. Scott, D.B., R.Tobis, M.Williams, F.S.Medioli, J.S.Latimer, W.A. Boothman, A.Asioli and V.Haury 2005 Pollution monitoring in two north American estuaries: Historical reconstruction using benthic foraminifera. *Journal of Foraminiferal Research*, 35(1): 65-82.

26. Setty, MJAP and R.Nigam 1982 Foraminiferal assemblages and organic carbon relationships in benthic marine ecosystems of western India continental shelf. *IndianJ. Mar. Sci*., 11: 225-232.
27. Shannon, E.C. and W.Weaver 1963 *The mathematical theory communication*. Urbana: university of Illinois 117pp.
28. Simpson, E.H. 1949 Measurement of diversity. *Nature*, 163: 688.
29. Strickland, J.D.H. and T.R.Parsons 1972 A manual for sea water analysis (2nd edition). *Bull. Fish. Res. Board. Canada*, 167: 310pp.
30. Suresh Gandhi, M., K.Jisha and N.Rajeswara Rao 2014 Recent benthic foraminifera and its ecological conditions along the surface samples of Pichavaram and Mathupet mangroves, Tamil Nadu, east coast of India. *International Journal of Current Research and Academic Review*, 2(9): 252-259.
31. Suresh Gandhi, M., K.Kasilingam, T.Arumugam, Lalthansangi and N.Rajeswara Rao 2017 distribution of benthic foraminifera, sediment characteristics and its environmental conditions in and around Manalmelkudi Spit, Palk Strait, Tamil Nadu, East coast of India. *Indian J. Geo. Mar. Sci*., 46(4): 519-533.
32. Yanko, V., A.J.Arnold and W.C. Parkes 1999 Effects of marine pollution on benthic foraminifera. In: Modern foraminifera. Springer, Dordrecht. pp 217-235.