Research Paper
Impact Factor: 5.389
Refereed Journal

IJMDRR
E- ISSN –2395-1885
ISSN -2395-1877

DIVERSITY AND DISTRIBUTION OF BENTHIC FORAMINIFERA ALONG THE COAST OF THIRUVANANTHAPURAM, SOUTHWEST COAST OF INDIA

K.S. Anila Kumary
Department of Zoology, Kuriakose Gregorios College, Pampady, Kottayam, Kerala.

Abstract
Foraminifera are the most abundant, diverse and widely distributed protists in the marine realm. The study examined diversity and distribution of foraminiferal assemblage on the intertidal coast of Thiruvananthapuram, Kerala (between 8^0 20' - 8^0 30' North latitudes and 76^0 55' - $77^0$03' East longitude) on the southwest coast of India. The intertidal sediment samples, collected for a period of one year from two coasts were analysed for foraminiferal diversity and distribution. A total of 12 foraminiferal species belonging to 7 genera and 4 families were recorded. Rotalia becarii, Elphidium advenum, Discorbis globularis and Elphidium crispum were the most abundant species at both the sites surveyed. The Shannon-Wiener diversity index (H') annually ranged from 0 to 1.411, the Margalef species richness index (d) from 0 to1.27, Pielou's Equitability index (e) from 0 to 0.999 and Simpson's index of dominance (C) from 0 to 1. Relatively moderate to low index values were observed at both the stations of Thiruvananthapuram coast and the values were least during the southwest monsoon coincided with a fall in the density of benthic foraminifera.

Key Words: Foraminifera, diversity, Intertidal coast, Kerala.

Introduction

Foraminifera are the inconspicuous protozoan, yet are among the most abundant and scientifically important group of shelled organisms in marine environment enough to be an important part of the marine food chain. They are found in all marine environments, from the intertidal to the deepest ocean trenches and from the equator to poles. Species of foraminifera can be very particular about the environment in which they live and are sensitive even to subtle changes in ambient environmental conditions and, there for have emerged as potential tools for assessing any environmental changes. The importance of foraminifera in oceanic research is well known (Bhalla and Raghav, 1980; Bhalla and Gaur, 1987; Nigam and Khare, 1995; Khare et al., 1995; Gooday, 2001; Goldstein, 2003; Nigam, 2005; Murray, 2006; Bhalla et al., 2007; Kathal and Singh, 2010; Muruganathan et al., 2017; Suresh Gandhi et al., 2017). These investigations have revealed that the distribution of foraminifera is not random, but are very particular and controlled by environmental gradient and therefore, have emerged as potential tools for assessing any climatological or environmental changes (Bhalla et al., 2007). To utilize these microorganisms effectively, adequate knowledge of their distribution pattern in diverse environments is of utmost importance.

Despite of the large number of literature available on benthic foraminifera from world oceans, there is still limited work to establish the distribution of foraminifera in different ecosystems in India. Very scanty literature is available on foraminifera of Kerala coast (Subhadra Devi and Rajasekhar, 2009). The present study is an attempt to make a quantitative documentation of foraminiferal assemblage and their diversity statistics along the coast of Thiruvananthapuram, Kerala on the southwest coast of India.

Materials and Methods

The study on the abundance and diversity of foraminifera was carried out along the coast of Thiruvananthapuram, the capital district of Kerala on the south west coast of India. Samples of sediment were collected using a hand operated steel corer (5.5 cm inner diameter and 25 cm long) from two selected beaches, station I located at Poonthura coast and Station II at Adimalathura coast, lying between 8^0 20' - 8^0 30' North latitudes and 76^0 55' - $77^0$03' East longitude. Totally 144 core samples were collected manually from the sediment – water interface in clean polythene bags and were preserved immediately in 10% neutralized formaldehyde solution. 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.

Results and Discussion

Foraminifera are among the most abundant and scientifically important group of organisms. The distribution of foraminifera is not random, but is controlled by environmental gradient. The factors which influence their distribution and abundance include bathymetry, sediment texture and physico - chemical characteristics of sediment as well as water (Khare et al., 1995; Subhadra Devi and Rajashekhar, 2009). The diversity of foraminifera depends largely on the ecological conditions at a site. The general trend in the distribution of foraminiferal assemblages is the increasing species diversity in line with increasing salinity gradients and environmental stability (Suresh Gandhi et al., 2017). A total of 12 species of foraminifera belonging to 7 genera and 4 families were identified in the intertidal beach samples of Thiruvananthapuram coast. Occurrence of foraminifera species at the two stations of Thiruvananthapuram coast are presented in Table I.

The dead and living foraminifera collected from the sediment constituted both perforate and imperforate calcareous forms among which the family Nonionidae was the dominant group followed by family Rotalidae. The imperforate group was represented by family Miliolidae only. Elphidium advenum (47%) was the predominant foraminifer at both the stations of the Thiruvananthapuram coast followed by Rotalia becarii (34%). The contribution of various foraminifera species to their total density (Mean of two stations) are presented in Fig.1. The average monthly distribution of foraminifera was 592 and 845 m^{-2} at stations I (Poonthura coast) and II (Adimalathura coast) respectively. The character of substratum is an important factor in the distribution of foraminifera. The abundance of foraminifera was associated with the sandy nature of the substratum with varying percentage of silt and clay. Abundance of foraminifera in the sandy substratum has been reported from Indian beaches (Damodaran, 1973; Varshney et al., 1981, 1984). Elphidium advenum and Rotalia becarii were the two species present throughout the year at both the stations. Spiroloculina depressa accounted negligible percentage of total foraminifers. The highest incidence of the species was in March at the Poonthura coast (37.31%) and during September at the Adimalathura coast (14.93%). The species was totally absent during the monsoon months along the coast of Thiruvananthapuram. Quinqueloculine agglutinans was encountered only at the Adimalathura coast during April with only few numbers of specimens. Rotalia translucens and Discorbis rosacea are characteristic to the Adimalathura coast and had the least contribution to the total foraminifers encountered. Table II shows the monthly percentage distribution of foraminifera species along the coast of Thiruvananthapuram (mean of two stations). There is considerable spatio- temporal variability in the foraminifera groups encountered. The sediment turbulence caused by factors like currents, depths, morphology of shores and monsoon have been identified as the factors controlling the variation in the morpho-groups of foraminifera (Khare et al., 1995; Jayaraju and Reddy, 1997; Raj and Chamyal, 1998).

A distinct feature of the Indian beaches is the influence of the monsoon rains which adversely affect the density of benthic fauna as a whole. In general population density of foraminifera was poor during the south west monsoon period (June-Sept). During this period the beach configuration changes drastically at short intervals due to severe erosion or heavy deposition. The ambient physico - chemical conditions and the physical changes in sediment are responsible for the temporal distribution of foraminifera. Strong wave action during the monsoon has the capacity to completely remove or deposit large amount of sand. Thus the sediment particles get rearranged affecting the interstitial spaces available for benthic organisms which might uproot the benthic organisms of sandy beaches. Density of foraminifera was generally higher during the post and pre monsoon months. Their abundance was maximum during December at both the stations I (18.71%) and II (35.43%). Increasing temperature, high salinity, stable beach conditions and probably greater food availability might have favoured rich summer populations of foraminifera.

The purpose of measuring community diversity is to judge its relationship either to community properties such as productivity and stability or to the environmental conditions to which the community is exposed to (Pielou, 1975). Species diversity has a number of components which may respond differently to geographical, developmental or physical factors. A species diversity index is a measure of the way in which individuals of an ecological community are distributed among species. Species diversity index (H') of foraminifera annually varied from 0 (Station II) to 1.411(Station I). Higher species diversity index at both the stations was during the post monsoon season (Oct-Jan). Species richness index is the ratio between the total number of species and total number of individuals. Values of species richness varied between 0.244 and 0.758 at station I and between 0 and 1.127 at station II. The degree to which dominance in a community is concentrated in one, several or many species can be expressed by an appropriate index of dominance (Simpson, 1949) that sums up the importance of each species in relation to the community as a whole. This important component of biodiversity is used to identify the main species of the community (Rosenberg, 1975). Dominance index of foraminifera was within the range of 0.254 - 0.518 at station I and 0 – 1 at station II. Species evenness index is the expression just opposite to dominance index, high evenness occurs when species are equally distributed in a community. High values of evenness in the distribution of individuals among species may be the result of competition under optimum conditions (Patrick, 1971).

Monthly fluctuations in species diversity indices of foraminifera along the coast of Thiruvananthapuram (mean of the two stations) are shown in Fig.2.The oceanographic conditions of the southwest coast of India provide variations in ecological conditions. The geographical and oceanographic conditions seem to influence a differential diversity of foraminifers. They are sensitive even to subtle changes in ambient environmental conditions and their diversity depends largely on the ecological conditions at a site. Moderate values of foraminifera density as well as diversity indices were obtained at the two stations of Thiruvananthapuram coast. Extremely low organic matter in the intertidal sandy beaches of Kerala (Anila Kumary and Rajimol, 2011; Priyankalakshmi and Menon, 2014; Sini J. Varghese and Miranda, 2015; Anila Kumary, 2016) in combination with other environmental factors may be related to the moderate to low density and diversity of foraminifera. However, intertidal foraminiferans of other regions of the Indian coasts are comparable to the assemblage found in the present study.

References

1. Anila Kumary, K.S. 2016 Temporal variations in the distribution of interstitial meiofauna along the southwest coast of India. J.Climatol. Weather Forcasting 4(3): 178.
2. Anila Kumary, K.S. and K.R. Rajimol 2011 Intertidal sedimentology along the Ambalappuzha coast, Kerala. J.Mar.Biol.ASS.India. 53(1):116-120.
3. Bhalla,S.N. and K.S.Raghav 1980 Recent foraminifera from beach sands of Malabar coast. IndianJ. Mar.Sci. 9: 288-90.
4. Bhalla,S.N. and K.N.Gaur 1987 Recent foraminifera from Colva beach sands, Goa. Journal of Paleontological Society 32: 122-130.
5. Bhalla,S.N., N. Khare, D.H. Shanmukha and P.J. Henriques 2007 Foraminiferal studies in nearshore regions of western coast of India and Lacadives Islands: a review .IndianJ. Mar.Sci. 36(4):272-287.
6. Damodaran, R.1973 Studies on the benthos of the mud bank regions of Kerala coast. PhD thesis, University of Cochin.
7. Goldstein, S.T. 2003 Foraminifera: a biological overview. In SenGupta, B.K. (ed) Modern Foraminifera. London, Kluwer pp 37-55.
8. Gooday,A.J. 2001 Benthic foraminifera. In: Turekian,K.K.(ed),Climate and Oceans, Princenton: Elsevier pp. 425-436.
9. Haynert,K., J.Schonfeld, P.I. Asteman and J, Thomson 2012 The benthic foraminiferal community in a naturally CO_2 rich coastal habitat of the south western Baltic sea. Biogeosciences, 9: 4421-4440.
10. Jayaraju,N. and K.R.Reddy 1997 Effect of river discharge on the test morphology of benthic foraminifera on the south east coast of India. Jour.Geo.Soc.India. 50: 435-439.
11. Kathal, P.K. and V.K.Singh 2010 First report of some recent benthic foraminifera from the east coast of India. Jour. Geol. Soc. of India. 76: 69-74.
12. Khare,N., R.Sinha, A.K.Rai and R.Nigam 1995 Distribution pattern of benthic foram. Morphogroups in the shelf region off Mangalore: Environmental implications. IndianJ.Mar.Sci. 24:162-165.
13. Loeblich, A.R. Jr. and H. Tappan 1987 Foraminiferal genera and their classification. Von Nostrand Rinhold, NewYork, 970 pp.
14. Margalef, D.R.1958 Information theory in ecology. Gen.Syst. 3:36-71.
15. Murray, 2006 Ecology and applications of benthic foraminifera. NewYork, Cambridge.
16. Murugananthan,M., P. Ragavand and P.M. Mohan 2017 Diversity and distribution of larger benthic foraminifera from coral reef environment, South Andaman island, India. Journal of Foraminiferal Research, 47(3): 252-257.
17. Nigam, R. 2005 Addressing environmental issues through foraminifera- Case studies from the Arabian Sea. Journal of Paleontological Society 50:25-36.
18. Nigam, R. and N. Khare 1995 Recent foraminifera along the west coast of India: Retrospect, perspect and prospect. Journal of the Indian Academy of Sciences, 38(2): 7-24.
19. Patrick, R. 1971 the effect of increasing light and temperature on the structure of diatom communities. Limnol. Ocenogr., 16: 405-421.
20. Pielou,E.C. 1966 The measurement of diversity in different types biological collections.J.Theor.Biol.,13:131-144.
21. Pielou,E.C. 1975 Ecological diversity A Wiley – Interscience Publication, USA.162pp.
22. Priyankalakshmi, G. And N.R.Menon 2014 Ecology of interstitial faunal assemblages from the beaches along the coast of Kerala, India. Int. J. Oceanogr.,1-9.
23. Raj,R. and L.S. Chamyal 1998 Microfauna from the middle Holocene terrace lower Mahi Valley, western India. Journal of Paleontological Society 43:59-71.
24. Rosenberg,R. 1975 Stressed tropical benthic faunal communities of Miami, Florida. Ophelia, 14: 93-112.
25. Shannon,E.C. and W.Weaver 1963 The mathematical theory communication. Urbana: university of Illinois 117pp.

26. Simpson,E.H. 1949 Measurement of diversity. Nature 163:688.
27. Sinu J.Varghese and M.T.P. Miranda 2015 Meiobenthic diversity and abundance along the Arthunkal coast in Kerala, southwest coast of India. J.Mar.Biol.ASS.India. 57(1): 78-83.
28. Subhadra Devi, G. and K.P.Rajasekhar 2009 Intertidal foraminifera of Indian coast – a scanning electron photomicrograph- illustrated catalogue. Journal of Threatened taxa 1(1): 17-36.
29. 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. IndianJ. Geo. Mar. Sci. 46(4):519-533.
30. Varshney,P.K., K.Govindan and B.N.Desai 1981 Benthos of the Narmada estuary. Mahasagar – Bull. Natn. Inst Oceanogr. 14(2):141-148.
31. Varshney,P.K., K.Govindan and B.N.Desai 1984 Meiobenthos of polluted and unpolluted environments of Versova, Bombay. Mahasagar – Bull. Natn. Inst Oceanogr. 17(1-3):151-160.

Table I List of Foraminifera Species Identified From the Intertidal Coast of Thiruvananthapuram

Family	Species	Poonthura coast	Adimalathura coast
Miliolidae	Spiroloculina depressa	+	+
	Quinqueloculine agglutinans	_	+
Rotalidae	Rotalia becarii	+	+
	Rotalia calcar	+	+
	Rotalia translucens	_	+
	Discorbis rosacea	_	+
	Discorbis globularis	+	+
Nonionidae	Elphidium advenum	+	+
	Elphidium crispum	+	+
	Nonion sloanii	+	+
	Nonion scaphum	+	+
Globigerinidae	Globigerina dubia	+	+

Table II Monthly Percentage Distribution of Foraminifera along the Coast Of Thiruvananthapuram

Species	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Spiroloculina depressa	14.93	37.31	30.78	12.36	0	0	0	0	0	0	2.02	2.60
Quinqueloculine agglutinans	0	12	88	0	0	0	0	0	0	0	0	0
Rotalia becarii	8.2	6.29	25.12	4.47	1.04	1.27	0.32	6.12	6.93	15.71	16.5	8.03
Rotalia calcar	30.77							6.58	7.69	8.20	40.48	6.58
Rotalia translucens	0	50	50	0	0	0	0	0	0	0	0	0
Discorbis rosacea								100				
Discorbis globularis		23.62	3.62						1.97		33.46	22.82
Elphidium advenum	4.91	3.03	9.94	3.81	0.77	0.71	0.86	8.82	10.23	17.0	30.55	9.37
Elphidium crispum			14.68						6.65	27.75	41.74	9.17
Nonion sloanii						15.64	16.32	24.36	11.20	6.10	24.89	1.49
Nonion sloanii	5.01	19.09	32.73						6.40	5.62	9.42	21.73
Globigerina dubia	3.56	7.17	10.86	0	0	5.34	8.32	32.68	26.19	4.10	1.78	0

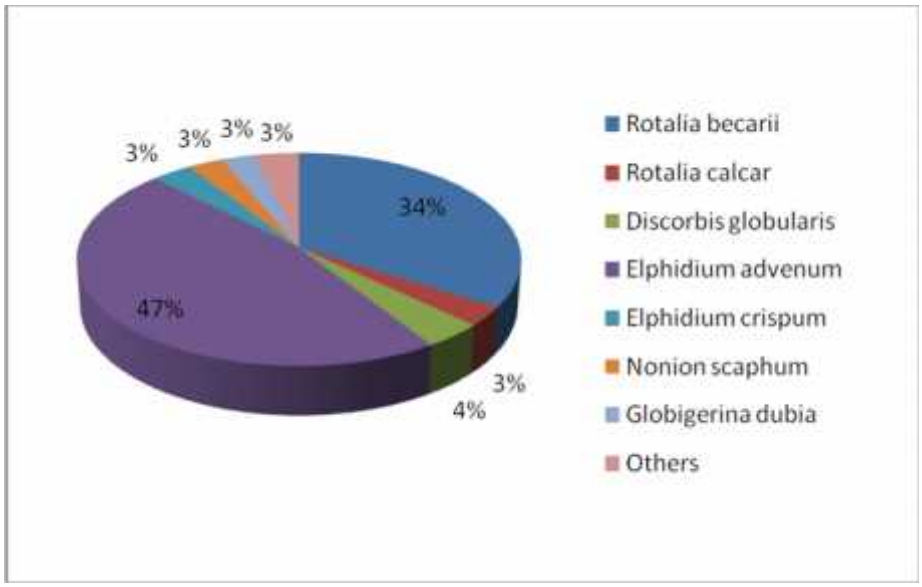

Fig.1. Composition of Foraminifera (mean) along the coast of Thiruvananthapuram

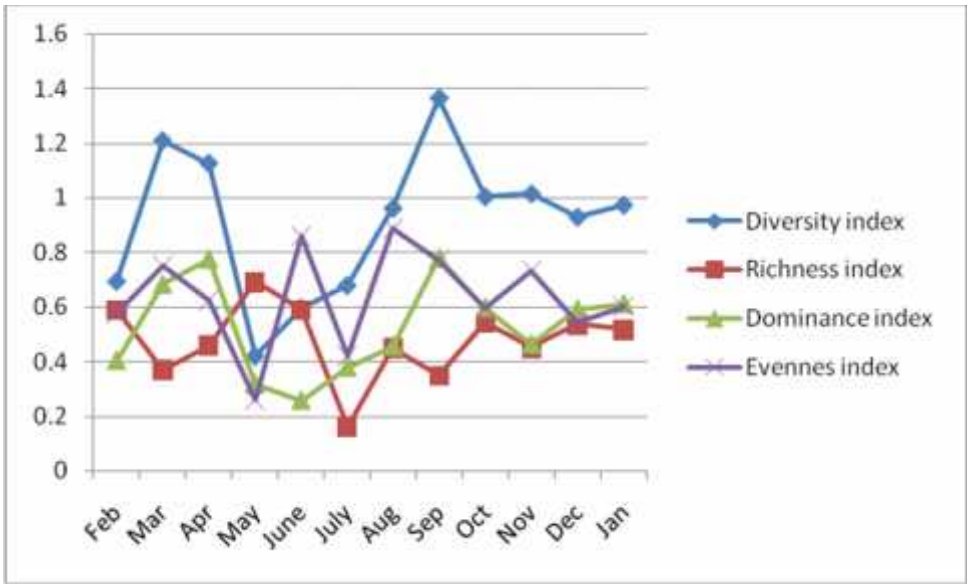

Fig.2. Monthly Fluctuations In Species Diversity Indices Of Foraminifera (Mean) Along The Coast of Thiruvananthapuram