

# Foramgeographical Affinities of the West and East Coasts of India: An Approach Through Cluster Analysis and Comparison of Taxonomical, Environmental and Ecological Parameters of Recent Foraminiferal Thanatotopes

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## ABSTRACT

Q-Mode cluster analysis of one hundred sixty species of Recent foraminifera from twenty nine Recent littoral-thanatotopes from 4000 km long coastal-stretch of India reveals that its west and east coasts belong to two separate foramgeographical realms as their assemblages form two separate 'clusters' with only 0.1 level of 'Degree of Association' amongst them. The pattern of clusters shows two faunal assemblages namely- 'Inner' and 'Outer East Marginal Assemblage of Arabian Sea' along the West Coast and similarly two assemblages namely, 'Inner-' and 'Outer West Marginal Assemblage of Bay of Bengal' along the East Coast of India. A taxonomic comparison of one hundred sixty reported species of Recent foraminifera from littoral-thanatotopes of the region shows that only twenty six of them are common to the West and the East Coast of India. A comparison of plots of suborders- Rotaliina, Miliolina and Textulariina on

'triangular model for environmental and ecological interpretations' also attests to their different affinities.

## INTRODUCTION

The real nature and affinities of the Recent foraminiferal fauna along the west and the east coasts of India has received little attention from the foraminiferologists so far.

Cushman (1948), while demarcating the provincial boundaries of the warm-water foraminifera of the modern oceans, opined that 'East African Province' exists in the western part (Arabian Sea) of the Indian Ocean and 'East Indian Province' in the eastern part and extends up to Polynesian islands, running northwards up to Southern Japan, including Hawaii. The 'East Indian Province', however, has been referred to 'Indo-Pacific Province' in subsequent studies, including the present one.

The foraminiferologists in India, however, have expressed views contradicting each other as for as the foramgeographical affinity of the two coasts of India. Bhatia (1956) assigned 'Indo-Pacific' affinity to three beach-assemblages along the West Coast, while Bhalla (1968 and 1970) suggested 'Indo-Pacific' affinity to two beach-assemblages from the East Coast of India on the basis of comparison of taxa of his studies with those of the West Coast of India and the east coast of Africa. Bhalla (1970) also concluded that the West and the East Coast of India belong to two different

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foramgeographical realms and the East Coast of India falls under the 'mixed-zone' of the two realms. However, Boltovskoy and Wright (1976) illustrated the west and the east coasts of India in the 'East African' and 'Indo-Pacific' provinces respectively in the accompanying map without a 'mixed-zone' between the two. Bhalla and Nigam (1988) compared the Recent foraminifers from five beaches of both the coasts of India and corroborated the views of Bhalla (1970). Talib and Farooqui (1994) compared the beach-fauna of Dwarka, West Coast of India with four beach-assemblages of the East Coast of India, and opined that the West Coast and the East Coast of India are a part of the 'mixed-zone' of the 'East African' and the 'Indo-Pacific' foramgeographical provinces. Satyanarayana Rao (1979) on the basis of distribution of planktons in the Indian Ocean pointed out that the east and west coasts of India belong to two different faunal provinces.

The above cited studies from the Indian coast-line were based on manual taxonomic comparison of only a few foraminiferal species from only five beaches. Bhalla and Nigam (1988), Talib and Farooqui (1994) Kathal and Bhalla (1998), and Kathal and Bhalla (in press) attempted statistical methods on the reported species of Recent foraminifers from only five beaches of the two coasts of India. Studies on such a long coastal stretch of 4000 km requires a detailed sampling programme and a proper statistical analysis of all the reported taxa of the region vis-a-vis a taxonomic comparison using standard methods. A programme for such a study, however, is very expensive and will require many years to achieve. Thanatocoenoses being the resultant products of all the seasons have been found to be more significant for ecological, environmental and statistical analyses of foraminiferal fauna as compared to the biocoenoses of the same region (Kaesler, 1966 and Ujiie and Kusukawa, 1969). It was, therefore, found desirable by us to analyse Recent foraminiferal thanatocoenoses of the littoral-zone up to a depth of 3 m, along the Indian coasts-

line in order to solve the problem of foramgeographical affinity of the region quantitatively, through Q-mode cluster analysis (Kaesler, 1966; Ujiie and Kusukawa, 1969 and Ujiie and, Nagase, 1971) and qualitatively, through 'triangular model method' (Murray, 1973) for environmental and ecological interpretations.

## METHODS

Samples of littoral-sediments were collected up to a depth of 3 m from twenty nine stations (Fig. 1) and analysed for their Recent foraminiferal thanatocoenoses. One hundred and sixty dead species of Recent foraminifera were identified (Bhalla and Nigam, 1982; Bhalla and Kathal, 1992; Kathal, 1992; Kathal and Bhalla, 1996 and, Kathal and Bhalla, 1998). One hundred and six species, which were common to at least two beaches were selected for the 'cluster analysis' (Table 1).

## Q-MODE CLUSTER ANALYSIS

Schaffer and Scott (1976) have found 'Jaccard's Coefficient of Association' suitable for environmental analysis and the same has been applied in the present study.

Jaccard's Coefficient of Association (Sj):  $S_j = C / (N_1 + N_2 - C)$ , where C represents the 'number of species common to two stations' being compared;  $N_1$  represents the 'total number of species at first station'; and  $N_2$  represents the 'total number of species at second station'.

Schaffer and Scott, (1976) used this coefficient for the studies of thanatopes. This ignores negative matches and thus, prevents a high degree of similarity occurring between stations which have a large number of absent species in common (Sokal and Sneath, 1963). The values of the Association range from 'O' (complete dissimilarity) to 'I' (complete similarity).

**Table 1. Distribution of the Recent foraminiferal species referred to in cluster analysis**

S. No	Name of species	Stations	2	4	6	8	10	12	14	16	18	20	22	24	26	28
			1	3	5	7	9	11	13	15	17	19	21	23	25	27
1.	<i>Ammobaculites persicus</i> Lutze*		1	0	0	1	0	0	0	1	1	1	0	0	0	0
2.	<i>Textularia conica</i> D' orbigny*		0	1	1	0	0	0	0	0	0	0	0	0	0	0
3.	<i>T.foliacea</i> Heron-Allen and Earland*		0	1	1	0	0	0	0	0	0	0	0	0	0	0
4.	<i>Spiroloculina aequa</i> Cusshan*		1	1	0	0	0	1	0	0	0	0	0	0	0	0
5.	<i>S. antillarum</i> D' orbigny		0	1	1	0	1	1	0	1	0	0	0	0	0	0
6.	<i>S. angulata</i> Cushman*		0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.	<i>S. communis</i> Cushman and Todd*		1	1	1	0	0	0	0	1	0	0	0	0	0	0
8.	<i>S. depressa</i> D' orbigny		0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.	<i>S. excavata</i> D' orbigny*		0	0	0	0	1	0	1	1	1	0	0	0	0	0
10.	<i>S. eximia</i> Cushman*		1	1	1	1	1	1	1	1	0	0	0	0	0	0
11.	<i>S. Indica</i> Cushman and Todd		0	0	1	0	0	0	0	1	0	0	0	0	0	0
12.	<i>S. pianissimo</i> Wiesner*		1	1	1	1	1	0	1	1	0	0	0	0	0	0
13.	<i>S. planulata</i> Cushman**		0	0	0	0	0	0	0	0	0	0	0	0	0	0
14.	<i>S. tricarinata</i> D' orbigny*		0	1	0	0	1	1	0	0	0	0	0	0	0	0
15.	<i>S. tricarinata</i> Terques**		0	1	0	1	1	1	1	0	0	0	0	0	0	0
16.	<i>Quinueloculina</i> cf. <i>Q.bicarinata</i> D' orbigny**		1	1	0	0	1	1	0	0	0	0	0	0	0	0
17.	<i>Q. biconis</i> (Walker and Jacob)**		1	0	0	0	0	0	0	0	0	0	0	0	0	0
18.	<i>Q. kerimatic</i> (Heron-Allen and Earland)*		1	1	1	0	0	1	0	0	0	0	0	0	0	0
19.	<i>Q. laevigata</i> D' orbigny		1	0	1	0	0	0	0	0	0	0	0	0	0	0
20.	<i>Q. lamarkiana</i> D' orbigny		1	1	0	0	0	1	0	0	0	0	0	0	0	0
21.	<i>Q. ludwigi</i> Reuss		1	1	1	0	1	1	0	0	0	0	0	0	0	0
22.	<i>Q. oblonga</i> (Montagu)*		1	1	1	1	1	1	1	0	0	0	0	0	0	0
23.	<i>Q. parkeri</i> (Brady)		1	1	1	0	0	1	0	0	0	0	0	0	0	0
24.	<i>Q. phoenica</i> Coloa*		1	0	0	0	0	0	0	0	0	0	0	0	0	0
25.	<i>Q. polygona</i> D' orbigny*		1	0	0	1	0	0	0	0	0	0	0	0	0	0
26.	<i>Q. pseudoreticulata</i> Parr		1	1	1	0	1	1	0	0	0	0	0	0	0	0
27.	<i>Q. rugosa</i> D' orbigny*		1	0	1	0	0	0	0	0	0	0	0	0	0	0
28.	<i>Q. schlumbergeri</i> (Wiesner)		1	1	0	0	0	0	1	0	0	0	0	0	0	0
29.	<i>Q. seminulum</i> (Linne)*		1	1	1	1	1	1	1	0	0	0	0	0	0	0
30.	<i>Q. singhi</i> n.sp.*		0	1	0	1	1	0	0	0	0	0	0	0	0	0
31.	<i>Q. sulcata</i> D' orbigny**		0	0	0	0	0	0	0	0	0	0	0	0	0	0
32.	<i>Q. undulose-costata</i> Terquem		1	1	1	0	0	1	0	0	0	0	0	0	0	0
33.	<i>Q. venusta</i> Karrer		1	1	1	0	1	1	0	0	0	0	0	0	0	0
34.	<i>Q. aff. Q. viennensis</i> Le Calve*		1	1	1	0	1	1	0	0	0	0	0	0	0	0
35.	<i>Q. Valgaris</i> D' orbigny**		1	1	1	1	1	1	1	1	0	0	0	0	0	0
36.	<i>Q. tropicalis</i> Cushman**		0	0	0	1	0	0	0	0	0	0	0	0	0	0
37.	<i>Q. sp. A Nigam (1982)*</i>		1	1	1	0	0	0	1	1	0	0	0	0	0	0
38.	<i>Q. sp. C Kathal (1989)**</i>		0	0	1	0	1	0	0	0	0	0	0	0	0	0
39.	<i>Q. sp. C Kathal(1989)**</i>		0	0	0	0	0	0	0	0	0	0	0	0	0	0
40.	<i>Q.sp. D Kathal (1999)**</i>		0	0	0	0	0	0	0	0	0	0	0	0	0	0
41.	<i>Triloculina insignis</i> (Brady)*		1	1	0	0	0	0	1	0	0	0	0	0	0	0
42.	<i>T aff. T. echinata</i> D' orbigny*		1	0	0	0	0	0	0	1	0	0	0	0	0	0
43.	<i>T. quasimi</i> n.sp. (Nigam, 1978)*		1	0	0	0	0	0	1	0	0	0	0	0	0	0
44.	<i>T. rotunda</i> D' orbigny		1	0	0	0	0	0	1	0	0	0	0	0	0	0
45.	<i>T rupertiana</i> (Brady)*		0	1	0	0	1	0	0	0	0	0	0	0	0	0
46.	<i>T. terquemiana</i> (Brady)		0	1	1	0	1	1	0	0	0	0	0	0	0	0
47.	<i>T. tricarinata</i> D' orbigny		1	1	1	0	1	0	1	1	1	0	0	0	0	0
48.	<i>T. trigonula</i> (Lasarek)		0	0	1	0	0	0	0	1	0	0	0	0	0	0
49.	<i>Miliolinella australis</i> (Parr)*		1	0	0	0	1	0	0	0	0	0	0	0	0	0
50.	<i>M. oblonga</i> (Montagu)*		1	0	0	0	0	1	0	0	0	0	0	0	0	0
51.	<i>Siphogenerina rephanus</i> (Parker and Jones)*		1	1	0	0	0	0	0	0	0	0	0	0	0	0



Hundred and six foraminiferal species (Table 1), which were common to at least two stations, from the twenty nine selected stations (Fig. 1) were compared applying this coefficient and a matrix of 'four hundred and six' Jaccard's coefficient (Sj) were obtained (Table 2) using a computer programme on the BASIC language. The 'weighted pair group method with simple arithmetic average' (Sokal and Sneath, 1963) was used for clustering and plotting of two dimensional hierarchy dendrograms (Fig. 1) on a FORTRAN IV (Davis, 1988).

**RESULTS**

The dendrogram (Fig. 1) of twenty nine

thanatopes reveals that all the thirteen of the west coast form cluster 'W similarly all the sixteen of the east coast form cluster 'E' at the 0.1 level of clustering. Also that thanatocoenoses of stations from 1 to 10 and 11 to 13 of the west coast and stations from 23 to 29 and from 14 to 22 of the west coast of India form sub-cluster 'W1', 'W2', 'E1' and 'E2' respectively at 0.17 level.

**INTERPRETATIONS**

As recognised in the areal distribution of the two clusters - 'W and 'E' of the stations of the West Coast and the East of India, and their sub-clusters—'W1', 'W2', 'E1' and 'E2', their occurrences

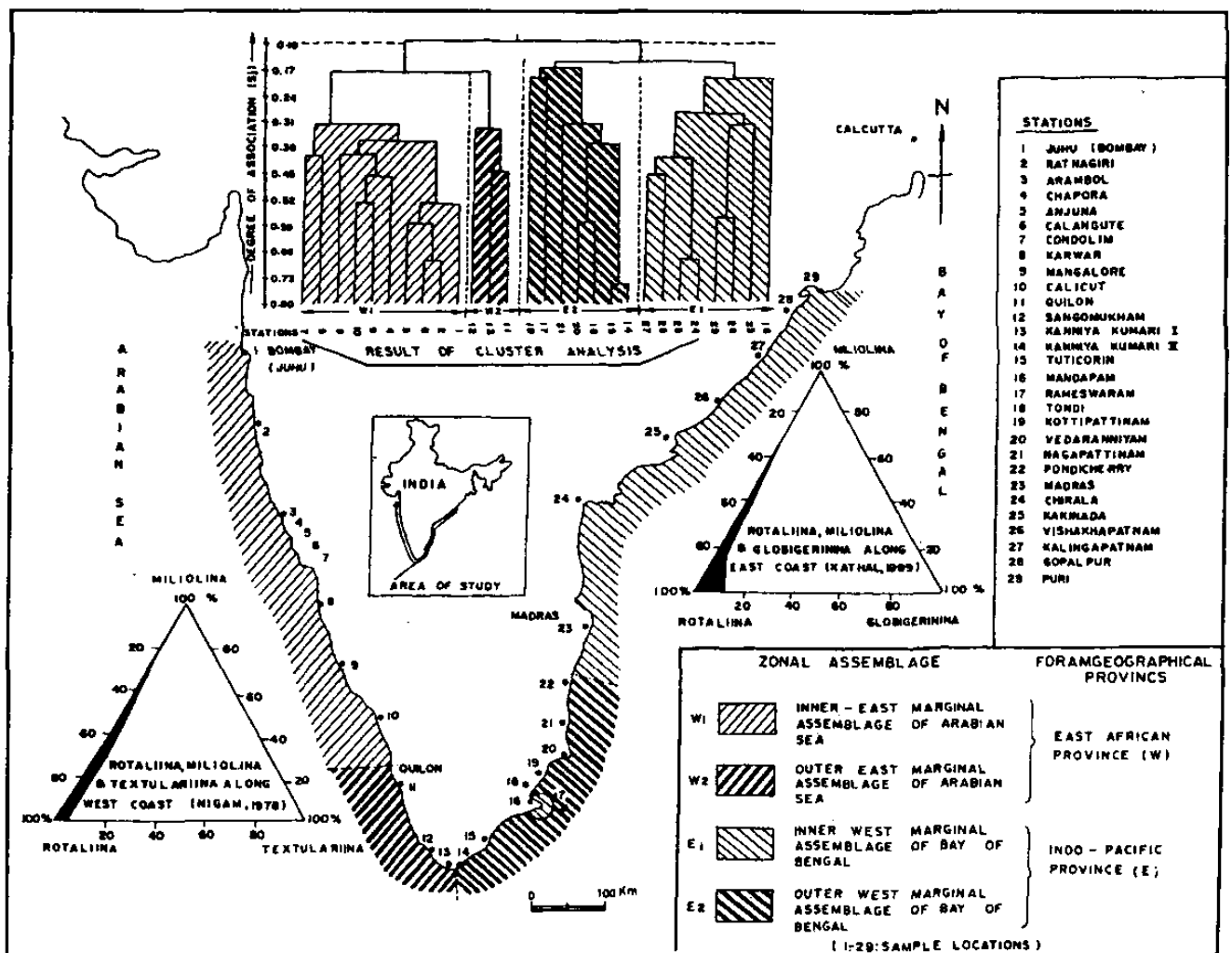


Fig. 1. Dendrogram of the results of a Q-mode cluster analysis, latitudinal zonation of Recent foraminiferal assemblages and forameogeographical affinities of the west and east coasts of India.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
1.000	.594	.506	.353	.543	.569	.269	.429	.377	.294	.182	.075	.343	.061	.076	.072	.061	.062	.047	.077	.032	.000	.139	.155	.160	.165	.110	.129	.143	1
	1.000	.646	.344	.517	.698	.276	.403	.413	.302	.200	.100	.292	.050	.083	.079	.068	.067	.052	.103	.054	.000	.151	.169	.132	.178	.119	.141	.156	2
		1.000	.350	.456	.569	.278	.348	.355	.400	.241	.130	.339	.074	.111	.105	.074	.073	.077	.113	.059	.000	.127	.164	.143	.151	.129	.151	.169	3
			1.000	.378	.357	.412	.417	.537	.436	.243	.111	.339	.088	.083	.050	.121	.118	.094	.151	.064	.000	.136	.136	.109	.132	.114	.122	.171	4
				1.000	.566	.429	.321	.444	.261	.263	.135	.277	.083	.108	.100	.114	.111	.088	.176	.094	.000	.182	.182	.152	.192	.159	.213	.219	5
					1.000	.327	.351	.500	.351	.264	.151	.339	.054	.091	.086	.074	.093	.057	.113	.059	.000	.145	.164	.125	.191	.111	.169	.190	6
						1.000	.302	.417	.294	.308	.120	.314	.087	.080	.111	.136	.130	.095	.182	.105	.000	.187	.187	.114	.143	.156	.162	.161	7
							1.000	.479	.362	.174	.067	.245	.046	.068	.087	.071	.095	.075	.095	.051	.000	.160	.160	.113	.172	.140	.125	.143	8
								1.000	.553	.289	.162	.356	.026	.077	.125	.081	.108	.086	.108	.095	.000	.178	.128	.102	.125	.106	.137	.186	9
									1.000	.312	.161	.385	.064	.129	.187	.100	.057	.148	.133	.074	.000	.179	.150	.146	.143	.154	.133	.189	10
										1.000	.444	.467	.095	.136	.120	.095	.143	.050	.200	.187	.000	.161	.091	.088	.179	.129	.171	.214	11
											1.000	.267	.062	.118	.100	.133	.125	.071	.200	.182	.000	.071	.034	.069	.111	.115	.129	.167	12
												1.000	.129	.193	.176	.129	.125	.100	.200	.107	.000	.171	.116	.089	.184	.119	.178	.210	13
													1.000	.778	.118	.273	.364	.200	.364	.250	.000	.174	.038	.000	.156	.182	.231	.250	14
														1.000	.235	.231	.417	.167	.417	.333	.000	.261	.074	.034	.182	.217	.259	.286	15
															1.000	.187	.250	.210	.250	.071	.000	.280	.143	.138	.235	.240	.193	.250	16
																1.000	.154	.200	.367	.111	.000	.287	.080	.077	.193	.182	.231	.250	17
																	1.000	.300	.600	.375	.000	.273	.120	.115	.187	.286	.269	.300	18
																		1.000	.300	.143	.000	.190	.136	.130	.094	.200	.154	.200	19
																			1.000	.375	.000	.217	.167	.160	.226	.286	.320	.368	20
																				1.000	.000	.150	.045	.043	.100	.158	.120	.167	21
																					.000	.000	.000	.000	.000	.000	.000	.060	22
																						1.000	.379	.323	.282	.300	.364	.320	23
																							1.000	.708	.429	.393	.216	.111	24
																								1.000	.457	.481	.278	.147	25
																									1.000	.485	.447	.333	26
																										1.000	.467	.370	27
																											1.000	.593	28
																												1.000	29

Table 2. Matrix of (29-1) = 406 Jaccard's Coefficients among 29 assemblages encountered along the West and East Coasts of India

are closely related to their geographical locations (Fig. 1). However, the exception of station 16, falling in the sub-cluster 'E<sub>1</sub>' may be attributed to the lesser number of species here.

On the basis of the present analysis, a map showing latitudinal zonation (Fig. 1) has been prepared in order to solve the forameogeographical affinities of the West Coast and the East Coast of India. Table 3 shows the geographical distribution and faunal characters of the thanatopotes separated on the basis of the present study.

## TAXONOMIC COMPARISON

A taxonomic comparison of the Recent foraminiferal fauna of the West Coast and the East Coast of India reveals that out of one hundred sixty species, which have been reported from these regions, only twenty six are common to both the coasts. *Spiroloculina eximia*, *S. pianissimo*, *S. tricarinata*, *Quinqueloculina oblonga*, *Q. seminulum*, *Ammonia papillosus*, *Asterorotalia dentata*, *Pararotalia minuta*, *Poroepionides cribroropandus*, *Florilus elongatus*, *F. scaphus*,

Table 3. Latitudinal zonation and characteristic species of the foraminiferal assemblages along the west and east coast of India

Thanatopotes	Latitudinal Zone of Subthanatopotes	Characteristic Species
C L East Marginal U Assemblage of S Arabian Sea, T Along West E Coast of India R  W	<b>Subcluster W1</b>  Inner East Marginal Assemblage of Arabian Sea (Bombay to Calicut: 19° - 10°N)	<i>Quinqueloculina vulgaris</i> , <i>Spiroloculina eximia</i> , <i>S. oblonga</i> , <i>Nonion boueanum</i> , <i>Ammonia papillosus</i> , <i>A. sobrina</i> , <i>A. tepida</i> , <i>Pararotalia nipponica</i> , <i>Poroepionides cribroropandus</i> , <i>Florilus elongatus</i> , <i>F. scaphus</i> , <i>Spiroloculina tricarinata</i> , <i>S. planulata</i> , <i>Triloculina tricarinata</i> , <i>Elphidium indicum</i> , <i>E. discoidale</i> , <i>E. minutum</i> , <i>E. simplex</i> , <i>Asterorotalia dentata</i> , <i>Pararotalia minutum</i> , <i>Proroepionides lateralis</i>
	<b>Subcluster W1</b>  Outer East marginal Assemblage of Arabian Sea (Quilon to Kanniyakumari-I: 10° - 8° N)	<i>Amphistegina radiata</i> , <i>Pararotalia nipponica</i> , <i>Ammonia papillosus</i> , <i>Poroepionides cribroropandus</i> , <i>Elphidium craticulatum</i> , <i>Triloculina aff. T. tricarinata</i> , <i>Amphistegina madagascariensis</i> , <i>Elphidium macetum</i> .
C L West Marginal U Assemblage of S Bay of Bengal. T Along East E Coast of India R  E	<b>Subcluster E1</b>  Inner West Marginal Assemblage of Bay of Bengal (Puri to Madras: 20° - 12° N)	<i>Florilus grateloupi</i> , <i>Ammonia sobrina</i> , <i>Poroepionides lateralis</i> , <i>Triloculina trigonula</i> , <i>Ammonia beccarii</i>
	<b>Subcluster E2</b>  Outer West Marginal Assemblage of Bay of Bengal (Rameswaram to Kanniyakumari: II: 12° - 8° N)	<i>Ammonia beccarii</i> , <i>A. sobrina</i> , <i>A. tepida</i> , <i>Hanzawia concentrica</i> , <i>Elphidium sp. B</i> (Nigam, 1988), <i>Quinqueloculina subcaneata</i> , <i>Q. venusta</i> , <i>Ammonia dentata</i> , <i>Quinqueloculina sc'nlumbergeri</i>

*Elphidium minutum*, and *E. simplex* which are 'abundant' to 'common' in occurrence (Table 1) on the west coast, are totally absent on the East Coast of India. However, *Quinqueloculina vulgaris*, *Q. ludwigi*, *Quinqueloculina cf. Q. bicarinata*, *Triloculina tricarinata*, *Nonion boueanum*, *Pararotalia nipponica*, *Ammonia tepida*, and *A. indica*, which are commonly found along the west coast, occur rarely or are totally absent along the east coast of India. Species like *Quinqueloculina subcaneata*, *Q. schlumbergeri*, *Ammonia dentata*, *A. beccari*, *Elphidium sp. B* (Nigam, 1978), *Pseudorotalia schroeteriana*, *P. indopacificana*, *Rosalina bradyi*, *Rotorboides granulosum*, and *Asterorotalia trispinosa* which occur commonly or frequently on the east coast are totally absent on the west coast of India. Species namely - *Quinqueloculina schlumbergeri*, *Ammonia dentata*, *Pseudorotalia indopacificana*, *P. schroeteriana*, *Rosalina bradyi*, *Rotorboides granulosum* and *Asterorotalia trispinosa* of the east coast assemblage are characteristic species of Indo-Pacific province, and have been widely reported from Malaysia, Indonesia, Taiwan, Japan and other countries. Similarly *Spiroloculina communis* and *Quinqueloculina tropicalis* of the east coast occur rarely at one or two places along the West Coast of India.

The above taxonomic comparison reveals that the west and the east coast assemblages show a marked difference from each other and also that 'species diversity' along the east coast is markedly for less than that along the West Coast of India. It has been noted that the 'species diversity' along the west coast decreases southwards whereas it increases southwards along the East Coast of India. At the southern tip of India, i.e., Kanniyakumari, where both, Bay of Bengal and Arabian Sea meet, abundant foraminifera - quantitatively as well as qualitatively - have been recorded in all the studies (Bhalla, 1968) including the present one.

Table 4 shows comparison of three dominating suborders - Rotaliina, Miliolina and

Table 4. A comparison of quantitative and qualitative parameters of Recent foraminifera from the west and east coast of India

Characters of assemblages	West Coast of India	East Coast of India
a. Total species reported	105	55
b. Total species selected in the present cluster analysis	81	51
c. Total species common to the other coast of India	26	26
d. Species restricted to west coast of India	55	—
e. Species restricted to East coast of India	—	25
f. Foraminiferal Composition	Rotaliina (upto 100%) Miliolina (up to 5%) Textulariina (up to 5%)	Rotaliina (upto 100%) Miliolina (up to 60%) Textulariina (up to 0.0%)

Textulariina of foraminifera from the west and east coasts of India.

Bhalla (1968 and 1970) has opined that a taxonomic comparison of the foraminifera from the west and east coasts of India shows that there are two distinct faunal provinces— the western covering the major part of the Arabian Sea and the eastern covering the Bay of Bengal and the coast along Thailand, Malaysia and Sumatra. Also that the major part of the East Coast of India is covered by 'mixed-zone' of the East African and Indo-Pacific provinces, so far its occurrence within the littoral-zone is concerned. However, its presence beyond the littoral zone may not be ruled out completely.



## COMPARISON OF MODELS FOR ENVIRONMENTAL AND ECOLOGICAL INTERPRETATIONS

Plots of the three dominating suborders, i.e., Rotaliina, Miliolina and Textulariina of the two coasts of India, (Fig. 1) on the 'triangular model for environmental and ecological interpretations' (Murray, 1973) show that the west coast thanatocoenose includes forms belonging to 'normal salinity lagoons/platforms' to 'hyper saline lagoons' (Nigam, 1978). A similar model from the eastern coast of India, where textularids are totally absent (Kathal, 1989), however, indicates 'normal salinity lagoons/platforms'.

Table 5 shows differences in environmental parameters from the west and the east coasts of India.

## CONCLUSIONS

The cluster analysis of the present study reveals that the Recent foraminiferal thanatocoenoses of the western and the eastern Indian coasts belong to two different foramgeographical realms as their assemblages form two separate clusters with a 'Degree of Association' of only 0.1 level. The two cluster seem to represent 'East Marginal Assemblage of Arabian Sea' along the west coast, and 'West

Marginal Assemblage of Bay of Bengal' along the east coast of India. The analysis also depicts that 'Inner East Marginal Assemblage of Arabian Sea' (19° N to 10° N) and 'Outer East Marginal Assemblage of Arabian Sea' (10° N to 8° N) exist along the west coast and 'Inner West Marginal Assemblage of Bay of Bengal' (20° N to 12° N) and 'Outer West Marginal Assemblage of Bay of Bengal' (12° N to 8° N) exist along the East Coast of India as the assemblages within these zones form sub-clusters 'W<sub>1</sub>', 'W<sub>2</sub>' 'E<sub>1</sub>' and 'E<sub>2</sub>' respectively. The northern limits of 'W<sub>1</sub>' and 'E<sub>1</sub>', however, are not defined.

A manual taxonomic comparison of the reported Recent foraminiferal thanatocoenoses shows a marked difference in the faunal characters of the two coasts - qualitatively as well as quantitatively - as only 16.25% elements are common to both the regions.

A comparison of models for ecological and environmental interpretation from the east and west coasts of India also attests to a marked difference in the composition of foraminiferal assemblages because:

- The elements of agglutinated forms are totally absent in the east coast littoral

Table 5. A comparison of environmental parameters of Arabian Sea and the Bay of Bengal

Environmental Parameters	West Coast (Arabian Sea)	East Coast (Bay of Bengal)	Authors
1. Temperature	23 - 29° C	27 - 29° C	Pannikar & Jayaraman (1966)
2. Salinity	34 - 37 ‰	30 - 33 ‰	- d o -
3. Organic carbon	1.5%	0.88 %	Wiseman & Bennett (1940) Subba Rao(1960)
4. Biological productivity:			
a. Surface productivity per unit area	Low	High	Qasim (1997)
b. Column productivity	High	Low	

sediments; and

- The percentage of three dominating suborders in the west coast samples (Rotaliina up to 100%; Miliolina up to 80% and Textulariina up to 5%) is different in the east coast thanatocoenoses (Rotaliina up to 100%; Miliolina up to 60% and Textulariina 0.0%).

Presence of 'East African' elements in the 'East Marginal Assemblage of Arabian Sea' along the west coast and presence of 'Indo-Pacific' elements in the 'West Marginal Assemblage of Bay of Bengal' along the East Coast of India also points to their differential faunal affinities with the two known warm-water foramgeographical provinces of the modern oceans.

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