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Benthic Foraminifera from the Littoral Zone, south of Chennai, south-east coast of India

Earth Science

KEYWORDS: Benthic foraminifera; littoral zone; taxonomy; ecology; Chennai

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ABSTRACT

In recent times, very few studies have focused on foraminifers from the littoral zone, as more and more researchers are exploring deeper parts of the continental shelf, slope, or even the abyssal floor. Foraminifers from beach sediments, however, are equally important as they can be of immense utility while understanding the dynamics of wave action during tides, cyclonic storm surges, or rarely tsunamis. The littoral zone south of Chennai has been investigated for Recent benthic foraminifera. Accordingly, 24 species belonging to 15 genera, 11 families, 7 superfamilies, and 3 suborders are reported and majority of them illustrated.

INTRODUCTION

Foraminifera are micro-unicellular organisms. They are almost entirely marine animals though a few live in brackish and even fresh water. These organisms build a shell and for paleontologists, the characteristics of the shell are the primary feature, which can be used to distinguish one species from another and hence, to use these distinction to form interpretation of time or environment. Perhaps the earliest study on foraminifera from the littoral zone was by Gnanamuthu (1943), who illustrated and described 47 foraminiferal species from the littoral zones of Krusadi Island in the Gulf of Mannar. He also pointed out the similarity of this assemblage to that of the Laccadive and Maldive Islands. Ganapati and Satyavati (1958) recorded 103 species of foraminifers, belonging to 65 genera, from sediment samples collected from the littoral zone at 111 stations, extending from Calcutta (Kolkata) in the north to Madras (Chennai) in the south, with concentration of stations off Visakhapatnam. Subsequently, in 1959, the same material was quantitatively examined by Ganapati and Sarojini, who reported 57 additional foraminiferal taxa.

Setty *et al.* (1984) recorded 44 benthic and 1 planktic foraminiferal species from the Miramar-Caranzalem inter-tidal shoreline. Kathal and Bhalla (1998) discussed the taxonomy and paleolatitudinal significance of *Rotorboides granulosum* (Heron-Allen and Earland) obtained from samples collected during the course of investigation of Recent littoral sediments along the Palk Strait and Kakinada Bay, east coast of India. Q-Mode cluster analysis of 160 species of Recent foraminifera from 29 Recent littoral-thanatotopes from a 4,000 km long coastal stretch of India revealed that the west and east coasts belong to two separate foramgeographical realms as their assemblages formed two separate clusters with only 0.1 level of degree of association amongst them (Kathal *et al.*, 2000). They observed that only 26 species were common to the west and east coasts of India. A scanning electron photomicrograph-illustrated (SEM) catalogue of inter-tidal foraminifera from the Indian coast was presented by Devi and Rajashekhar (2009) in which they illustrated 142 species and surface details of some of the species. Kathal and Singh (2013) presented an overview of Foraminiferal studies along the littoral zone of the east coast of India. They opined that the Recent foraminifera along the east coast of India show an affinity with the Indo-Pacific faunal province.

Environmental conditions off Karaikal, south-east coast of India were deciphered from Recent benthic foraminiferal distributions by Suresh Gandhi *et al.* (2013). Their study reiterated the need for examining modern benthic foraminiferal distributions and the assemblages therein from diverse environments, in order to facilitate better interpretation of fossil assemblages. Hussain and Casey (2016) examined the distribution of foraminifers and ostracodes from the inter-tidal zone of the North Chennai coast, and stated that the assemblage was of the 'mixed' type from a shoal environment.

METHODOLOGY

The study area lies between Chennai City in the north and Karikkattukuppam (a small fishing hamlet) in the south, a total distance of about 10 km. This coastal tract is more or less plain terrain, except for a few wave-cut terraces that appear and disappear, depending upon wave action intensity. The climate is tropical with the maximum temperatures of around 39° C during the period between March and May. The annual average temperature varies from 25.9° to 30.6° C with an average humidity of ~68%. The average wind velocity ranges from 8–14 kmph, but can increase dramatically during the depressions that form in the Bay of Bengal and subsequently intensify into cyclones or, rarely, super cyclones; these however, rarely have landfall in this coastal stretch.

Ten representative sediment and water samples were collected from the littoral zone, each sample having been collected at an interval of ~1 km. Sediment samples were collected from the sediment-water interface in clean, polythene bags, which were neatly labeled for further sample processing, analysis and foraminiferal separation. Water samples were collected in pre-cleaned (washed with dilute nitric acid) after rinsing them with the water samples to be collected. The sampling locations were fixed using a hand-held global positioning system (GPS), and the latitudinal/longitudinal readings are presented in Table 1. Figure 1 shows the study area with the sampling locations and some of the fishing hamlets in the region.

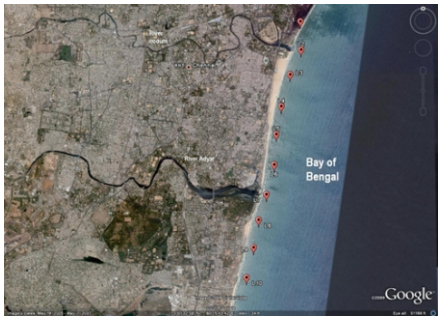
Table 1 Geographical coordinates of sampling locations

S. no.	Sample no.	Latitude (N)	Longitude (E)
1	L-1	13° 04' 29"	80° 17' 33"
2	L-2	13° 03' 51"	80° 17' 39"
3	L-3	13° 03' 12"	80° 17' 41"
4	L-4	13° 02' 33"	80° 17' 47"
5	L-5	13° 01' 54"	80° 17' 29"
6	L-6	13° 01' 13"	80° 17' 31"
7	L-7	13° 00' 32"	80° 17' 38"

8	L-8	12° 59' 56"	80° 17' 44"
9	L-9	12° 59' 19"	80° 17' 39"
10	L-10	12° 58' 38"	80° 17' 30"

As the present study was aimed at only total benthic foraminiferal populations, the sediment samples were not preserved. One ml each of Winkler 'A' and Winkler 'B' solutions was, however, added to the water samples to preserve the dissolved oxygen (as a precipitate) for further analysis in the laboratory. Some parameters, such as depth, pH and bottom water temperature (BWT) were measured *in situ* using a thermometer and an ELICO portable water quality analyzer. Salinity was estimated using the standard titration method and equation proposed by Knudsen (1901). Dissolved oxygen (DO) was determined using the methodology of Duval *et al.* (1974). The sand-mud contents in the sediment samples were estimated using standard sieving procedures.

Fig. 1 Google Earth map showing the sample locations

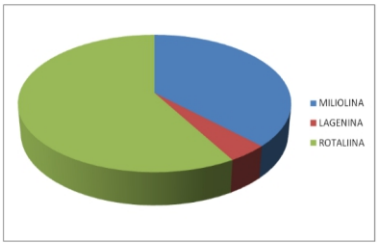


SYSTEMATIC PALEONTOLOGY

The widely utilized classification proposed by Loeblich and Tappan (1987) has been followed in the present study. A species has been regarded as the sum-total of specimens sharing all test characters, with such measurable, countable, or otherwise observable, variation in size and shape of some elements or of proportions between the latter in different ontogenic stages, which fits a pattern of normal distribution and whereby these specimens are separable from other similar groupings regarded as distinct species (Hottinger *et al.*, 1993). All objectively observable and defined test characters and features and their stable combination in (usually) more than one species have been regarded as of generic rank. A strict view of characters regarded as generic has been taken here, leading to the use of the valid genera proposed over the years and enumerated by Loeblich and Tappan (1987).

The identification of the species recorded in this study is based on comparison with the Catalogue of Foraminifera by Ellis and Messina (1940 and onward), innumerable publications and atlases from several parts of the world. In the following pages, 24 benthic foraminiferal species belonging to 15 genera, 11 families, 7 superfamilies, and 3 suborders are reported (Fig. 2) and majority of them is illustrated. Among these, 9 species are calcareous, imperforate, porcelaneous (suborder MILIOLINA), one is a calcareous, hyaline species (suborder LAGENINA), and 14 are calcareous, perforate taxa (suborder ROTALIINA). No arenaceous, agglutinated species or planktic taxa were obtained. As all the species are well established, detailed descriptions are not presented; instead, their original citations are given.

Fig. 2 Pie chart showing representation of sub-orders



Order FORAMINIFERIDA Eichwald, 1830
Suborder MILIOLINA Delage and Herouard, 1896
Superfamily MILIOLACEA Ehrenberg, 1839
Family SPIROLOCULINIDAE Wiesner, 1920
Genus ADELOSINA d'Orbigny, 1826
Adelosina laevigata d'Orbigny, 1826
Plate 1; Figs. 1, 2

Original citation: *Adelosina laevigata* D'ORBIGNY, 1826, Ann. Sci. Nat. Ser. 7, p. 303.

Family HAUERINIDAE Schwager, 1876
Subfamily HAUERININAE Schwager, 1876
Genus QUINQUELOCULINA d'Orbigny, 1826
Quinqueloculina elongata Natland, 1938
Plate 1; Fig. 3

Original citation: *Quinqueloculina elongata* NATLAND, 1938, v. 4, no. 5, p. 141, pl. 4, fig. 5.

Quinqueloculina lamarckiana d'Orbigny, 1839
Plate 1; Fig. 4

Original citation: *Quinqueloculina lamarckiana* D' ORBIGNY, 1839, p. 189, pl. 11, figs. 14, 15.

Quinqueloculina seminulum (Linnaeus, 1758)
Plate 1; Figs. 5, 6

Original citation: *Serpula seminulum* Linnaeus, 1758, p. 786, pl. 2, figs. 1a-c.

Quinqueloculina undulose costata Terquem, 1882
Plate 1; Fig. 7

Original citation: *Quinqueloculina undulose costata* TERQUEM, 1882, p. 185, pl. 20, figs. 18, 19.

Subfamily MILIOLINELLINAE Vella, 1957
Genus TRILOCULINA d'Orbigny, 1826
Triloculina rotunda d'Orbigny, 1826
Plate 1; Fig. 8

Original citation: *Triloculina rotunda* D'ORBIGNY, 1826, v. 7, p. 299, model no. 4.

Triloculina trigonula (Lamarck, 1804)
Plate 1; Figs. 9, 10

Original citation: *Miliolites trigonula* LAMARCK, 1804, v. 5, p. 351, pl. 17, fig. 4.

Genus VARIDENTELLA Luzkowska, 1972
Varidentella neostriatula (Thalmann, 1950)

Original citation: *Quinqueloculina* cf. *neostriatula* THALMANN, 1950, p. 45.

Superfamily SORITACEA Ehrenberg, 1839
Family PENEROPLIDAE Schultze, 1854
Genus PENEROPLIS de Montfort, 1808
Peneroplis pertusus (Forskal, 1775)
Plate 1; Fig. 11

Original citation: *Nautilus pertusus* FORSKAL, 1775, p. 125.

Suborder LAGENINA Delage and Herouard, 1896
Superfamily NODOSARIACEA Ehrenberg, 1838
Family ELLIPSOLAEGINIDAE Silvestri, 1923
Subfamily OOLININAE Loeblich and Tappan, '61
Genus OOLINA d'Orbigny, 1839
Oolina botelliformis (Brady)

Original citation: *Oolina botelliformis* (Brady) – BARKER, 1960, pl. 56, fig. 6.

Suborder ROTALIINA Delage and Herouard, 1896
Superfamily DISCORBACEA Ehrenberg, 1838
Family EPONIDIDAE Hofker, 1951
Subfamily EPONIDINAE Hofker, 1951
Genus EPONIDES de MONTFORT, 1808

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Eponides cribrorepandus (Asano and Uchio, 1951)
Plate 1; Figs. 12, 13

Original citation: *Poroeponides cribrorepandus* ASANO and UCHIO, 1951, p. 18.

Family DISCORBIDAE Ehrenberg, 1838
Genus NEOEPONIDES Reiss, 1960
Neoeponides auberi (d'Orbigny, 1839)
Plate 1; Fig. 14

Original citation: *Rosalina auberi* D'ORBIGNY, 1839, p .94.

Superfamily GRABRATELLACEA Loeblich and Tappan, 1964
Family GLABRATELLIDAE Loeblich and Tappan, 1964
Genus GLABRATELLINA Seiglie and Bermudez, 1965
Glabratellina turriformis (McCulloch, 1977)

Original citation: *Sabinia turriformis* McCULLOCH, 1977, p. 312.

Superfamily ASTERIGERINACEA d'Orbigny, 1839
Family AMPHISTEGINIDAE Cushman, 1927
Genus AMPHISTEGINA d'Orbigny, 1826
Amphistegina lessonii d'Orbigny, 1826
Plate 1; Fig. 15

Original citation: *Amphistegina lessonii* D'ORBIGNY, 1826, p .304, pl. 17, figs. 1-4.

Amphistegina radiata (Fichtel and Moll, 1798)
Plate 2; Fig. 1

Original citation: *Nautilus radiatus* FICHTEL and MOLL, 1798, p. 58, table 8, figs. 9b-d.

Superfamily ROTALIACEA Ehrenberg, 1839
Family ROTALIIDAE Ehrenberg, 1839
Subfamily PARAROTALIINAE Reiss, 1963
Genus PARAROTALIA Y. Le Calvez, 1949
Pararotalia calcar (d'Orbigny, 1826)
Plate 2; Fig. 2

Original citation: *Calcarina calcar* D'ORBIGNY, 1826, p. 276, model no. 34.

Pararotalia nipponica (Asano, 1936)
Plate 2; Figs. 3, 4

Original citation: *Rotalia nipponica* ASANO, 1936, v. 43, no. 515, p. 614, pl. 31, figs. 2a-c.

Subfamily AMMONININAE Saidova, 1981
Genus AMMONIA Brünnich, 1772
Ammonia beccarii (Linnaeus, 1758)
Plate 2; Figs. 5, 6

Original citation: *Nautilus beccarii* LINNAEUS, 1758, v. 1, p. 710.

Ammonia dentata (Parker and Jones, 1865)
Plate 2; Figs. 7, 8

Original citation: *Rotalia beccarii* (Linnaeus) var. *dentata* PARKER and JONES, 1865, pp. 387-388, 422, pl. 19, figs. 18a-c.

Genus PSEUDOROTALIA Reiss and Merling, 1958
Pseudorotalia schroeteriana (Carpenter, Parker and Jones, 1862)
Plate 2; Figs. 9, 10

Original citation: *Rotalia schroeteriana* CARPENTER, PARKER and JONES, 1862, p. 213, pl. 13, figs. 7-9.

Family ELPHIDIIDAE Galloway, 1933
Subfamily ELPHIDIINAE Galloway, 1933
Genus ELPHIDIUM de Montfort, 1808
Elphidium craticulatum (Fichtel and Moll, 1798)
Plate 2; Fig. 11

Original citation: *Nautilus craticulatus* FICHTEL and MOLL, 1798, p. 51, pl. 5, figs. h-k.

Elphidium crispum (Linnaeus)
Plate 2; Figs. 12, 13

Original citation: *Nautilus crispus* LINNAEUS, 1758, p. 709.

Elphidium norvangi Buzas, 1977
Plate 2; Fig. 14

Original citation: *Elphidium norvangi* BUZAS, 1977, p. 96, pl. 7, figs. 1-4.

Family NUMMULITIDAE de Blainville, 1827
Genus ASSILINA d'Orbigny, 1839
Assilina ammonoides (Gronovius)
Plate 2; Fig. 15

Original citation: *Nautilus ammonoides* GRONOVIUS, 1781, p. 282, pl. 19, figs. 5, 6.

RESULTS AND DISCUSSION

Species Diversity

Ten bottom sediment and water samples were collected at depths ranging from 1.0 to 1.5 m in the study area from the littoral zone of the Bay of Bengal. Due to time as well as financial constraints, bottom sediment and water samples could not be collected at deeper parts, off the shoreline. All the collected samples were analyzed for such ecological parameters as depth of the water column, bottom water temperature (BWT), pH, salinity, dissolved oxygen (DO), and sand-mud percentages (Table 2).

It has been well established that foraminiferal species diversity generally increases with increase in the depth of the water column. At very shallow depths, planktic foraminiferal species are very low in number, or even completely absent. Off the south-east coast of India, it has been observed by several workers (e.g., Rajeshwara Rao, 1998) that planktic foraminiferal species increase in number from beyond the 35-m bathymetric contour. The few planktic foraminiferal tests obtained in these littoral sediments are usually the ones that might have drifted with the currents and been deposited on the beaches.

Table 2 Water and sediment parameters estimated in littoral sediment samples

Parameter	Sample locations									
	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
Water depth (in m)	1.4	1.0	1.2	1.1	1.2	1.2	1.1	1.5	1.3	1.2
BWT (in °C)	24.6	24.8	24.7	24.6	24.7	24.9	25.1	24.8	24.9	24.8
pH	8.2	8.3	8.2	8.2	8.3	7.9	7.8	7.9	7.7	7.8
Salinity (in ‰)	32.6	32.3	32.4	32.3	32.2	29.9	30.4	30.1	30.2	30.1
DO (in mg/L)	4.7	4.2	4.6	4.7	4.4	3.8	3.7	3.9	4.0	3.8
Sand (in %)	87.3	92.7	90.9	94.6	93.8	97.1	96.4	95.9	93.7	94.1
Mud (in %)	12.7	7.3	9.1	5.4	6.2	2.9	3.6	4.1	6.3	5.9

The ecological aspects of depth alone are difficult to assess as other factors vary with depth like bottom water temperature, light intensity, pressure, dissolved oxygen, calcium carbonate content etc (Boltovskoy and Wright, 1976). In the study area, all samples were collected at very shallow depth (1.0 to 1.5 m) and the littoral zone samples show species diversity typical of this zone. The maximum species of 14 was observed at L1, while the least value of 3 was recorded at L4; in fact, the diversity values never exceeded 8. One of the reasons for the lower species diversity is the locations of the samples; they were collected in the zone where there is considerable wave action and, therefore, only those robust species that can adapt themselves to the high-energy conditions are present. This could also be the reason for the overall much lower counts of foraminiferal tests in samples L1 through L5.

Relative abundances of species – Ecological significance

Table 3 Relative abundances of benthic foraminiferal species in the study area

S. no.	Name of species	Sample locations									
		L1	L2	L3	L4	L5	L6	L7	L8	L9	
1	*Adelosina laevigata*	R	-	R	-	-	-	-	-	-	-
2	*Quinqueloculina elongata*	-	-	R	-	-	R	-	-	R	R
3	*Q. lamarckiana*	R	-	-	-	-	-	-	-	-	-

4	*Q. seminulum*	R	-	R	R	R	R	-	R	-	-
5	*Q. undulose costata*	-	-	-	-	R	-	-	-	-	-
6	*Triloculina rotunda*	R	-	-	-	-	-	-	-	-	-
7	*T. trigonula*	R	-	-	-	-	-	-	-	-	R
8	*Varidentella neostriatula*	-	-	-	R	-	-	-	-	-	-
9	*Peneroplis pertusus*	C	R	C	R	-	-	R	R	-	-
10	*Oolina botelliformis*	R	-	-	-	-	-	-	-	-	-
11	*Eponides cribrorepandus*	R	-	-	-	-	-	-	-	-	-
12	*Neoeponides auberi*	-	-	-	R	-	-	-	-	-	-
13	*Glabratellina turriformis*	-	R	-	-	-	-	-	-	-	-
14	*Amphistegina lessonii*	-	-	R	-	-	-	R	-	-	-
15	*A. radiata*	R	R	R	R	-	-	-	-	-	-
16	*Pararotalia calcar*	-	-	R	C	-	-	-	-	-	-
17	*P. nipponica*	A	A	A	A	A	A	A	A	C	A
18	*Ammonia beccarii*	C	C	C	C	C	C	C	C	A	A
19	*A. dentata*	R	R	R	R	-	-	R	-	-	-
20	*Pseudorotalia schroeteriana*								R		
21	*Elphidium craticulatum*	-	R	-	R	-	-	-	R	R	-
22	*E. crispum*	C	C	C	A	-	C	R	R	-	R
23	*E. norvangi*	-	R	-	-	-	-	-	-	-	-
24	*Assilina ammonoides*	-	R	-	-	R	-	-	R	-	-

A = Abundant; C = Common; R = Rare

A qualitative estimation of the benthic foraminiferal species was made, although actual counts were not made. Table 3 lists the species recorded in the study area in the taxonomic order. It is evident that the most abundant species is *Pararotalia nipponica* (Asano), followed by *Ammonia beccarii* (Linnaeus) and *Elphidium crispum* (Linnaeus). The abundance of *Pararotalia* spp. in near shore regions has been recorded by several workers (e.g., Kumar, 1988; Murray, 1991; Rajeshwara Rao, 1998). *Pararotalia nipponica* has been observed to be abundant in 9 out of the 10 samples collected, and even in the other remaining sample, it has been recorded to be common. *Pararotalia nipponica* attaches itself by the umbilical side to the alga and some are found in pits on the algal surface. The genus *Pararotalia* by itself is comparatively less abundant on muddy substrates under lower-energy conditions (Murray, 2006).

Boltovskoy and Wright (1976) observed that species of *Elphidium* live in shallow water at all latitudes. According to Murray (1991), *Elphidium* and *Quinqueloculina seminulum* are commonly the dominants in shallow water, normal salinity environments in middle latitudes worldwide. Hayward *et al.* (1997) concluded that *Ammonia beccarii* is capable of coping with wide range of salinity, *A. beccarii* can survive for one or two months in an anaerobic environment, where the dissolved oxygen is zero, and hydrogen sulfide is produced within the sediments (Moodley and Hess, 1992). It is not surprising, therefore, that *A. beccarii* is quite abundant in the study area.

Myers (1943) observed that in the sub-littoral zone, the greatest numbers of *Elphidium crispum* were found on compact, sandy bottoms or in a mixture of sand and gravel. Similarly, in his studies on *Elphidium crispum* from Plymouth Harbour, England, Myers (*op cit.*) noted that when nutritive material was high in spring, the chambers added were large and fat, but those formed in autumn, when nutritive material was less, were relatively reduced in size, and were shorter and narrower. The tests of *E. crispum* in the study area were neither large and fat, nor impoverished, indicating that during the sample collection period, nutrients were neither abnormally higher nor lower in the water. According to Murray (2006), *E. crispum* normally lives on sand or on algae, and positive phototaxis in this species causes it to climb up onto algae or other raised substrates.

Levy *et al.* (1993) observed that *Elphidium crispum* and *Quinqueloculina seminulum* are both sand-dwelling species in their studies on Recent foraminifera from the continental margin off Portugal; they also noted that *Q. seminulum* was more abundant when sand was >90%. According to Levy *et al.* (1996), such taxa as *Quinqueloculina seminulum* and *Peneroplis pertusus* are dominant at depths less than 10 m, while *Amphistegina lessonii* comprises the group dominant at depths of 10 to 50 m. In the near shore waters, *Q. seminulum* has been observed to be quite rare, although the substrate is sandy in nature. *Peneroplis pertusus*, however, is relatively more common in the study area, in concordance with the nature of sediment.

Myers (1942) found that specimens of *Operculina* (*Assilina*) in western Java exhibited episodes of rapid, robust growth corresponding to the two periods of the year in which there was abundant nutritive material. In the Red Sea, *Amphistegina lessonii* lives in large numbers between 10 and 20 m, on the lower, shaded surface of boulders within coarse sediment. *Amphistegina radiata*, which replaces *A. lessonii* at depths of 10–20 m (Troelstra *et al.*, 1996), is well adapted to low light intensities in deeper waters. *Assilina ammonoides* is another species of larger foraminifers that prefers low light intensities. They observed that *Elphidium crispum* flourishes in the Spermonde Archipelago, where water transparencies are very poor combined with high sedimentation rate and low carbonate content. According to Murray (1991), *Amphistegina* spp. are generally abundant in shallow water carbonate reefal sediments in the Indian and Pacific Oceans.

Amphistegina lessonii, *A. radiata* and *A. ammonoides* are all rare in the study area, as the ecology of the area is generally unfavorable. The shallow water depth allows higher light penetration, a condition that is not suited to both *A. radiata* and *A. ammonoides*. The conditions in the littoral zone are also unfavorable for *A. lessonii* as the substrate is sandy without any boulders that could offer shade for the tests.

CONCLUSION

Based on the results obtained, it can be concluded that the littoral benthic foraminiferal assemblage between Chennai City in the north and Karikkattukuppam in the south is dominated by *Pararotalia nipponica*, *Ammonia beccarii* and *Elphidium crispum*. *Ammonia beccarii* is a cosmopolitan species which is tolerant to extreme ranges of salinity; the abundance of *P. nipponica* and *E. crispum* can, however, be used with a degree of certainty to demarcate nearshore areas characterized by sandy substrate and relatively higher algal productivity. Studies on littoral zone benthic foraminifera are, therefore, of high utility in inferring nature of substrate, enhanced algal productivity (blooms), and depth of the water column in the past.

PLATE – 1

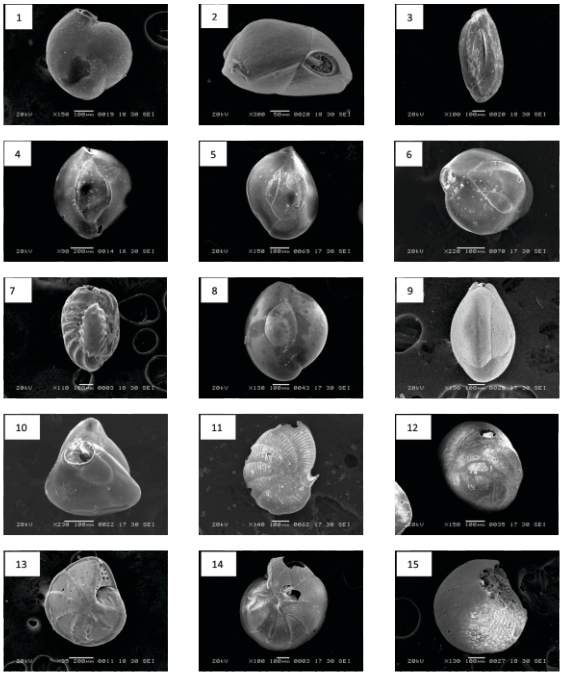

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Plate 1: **1**. *Adelosina laevigata*, SV x 150; **2**. *A. laevigata*, AV x 200; **3**. *Quinqueloculina elongata*, SV x 100; **4**. *Q. lamarckiana*, SV x 90; **5**. *Q. seminulum*, SV x 150; **6**. *Q. seminulum*, IAV x 220; **7**. *Q. undulose costata*, SV x 110; **8**. *Triloculina rotunda*, SV x 130; **9**. *T. trigonula*, SV x 130; **10**. *T. trigonula*, AV x 230; **11**. *Peneroplis pertusus*, SV x 140; **12**. *Eponides cribrorepandus*, DV x 150; **13**. *E. cribrorepandus*, VV x 95; **14**. *Neoeponides auberi*, DV x 100; **15**. *Amphistegina lessonii*, SV x 130.

PLATE – 2

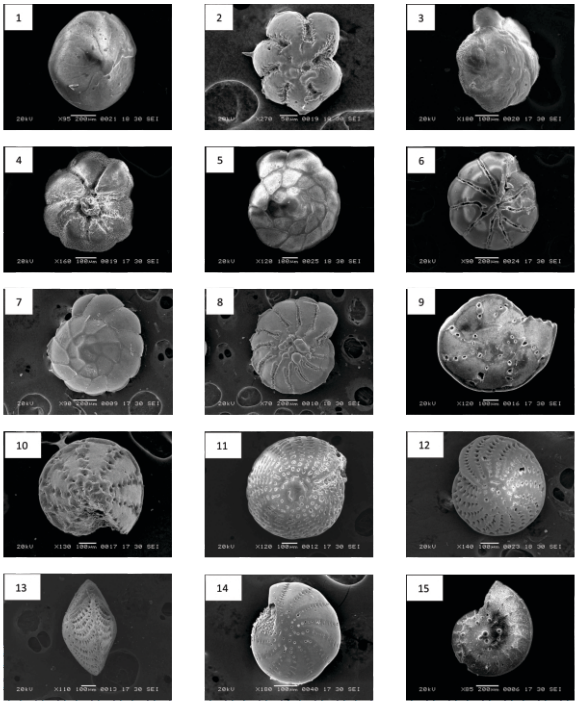

Plate 2: **1**. *A. radiata*, SV x 95; **2**. *Pararotalia calcar*, VV x 270; **3**. *P. nipponica*, DV x 180 **4**. *P. nipponica*, VV x 160; **5**. *Ammonia beccarii*, DV x 120; **6**. *A. beccarii*, VV x 90; **7**. *A. dentata*, DV x 90; **8**. *A. dentata*, VV x 70; **9**. *Pseudorotalia schroeteriana*, DV x 120; **10**. *P. schroeteriana*, VV x 130; **11**. *Elphidium craticulatum*, SV x 120; **12**. *E. crispum*, SV x 140; **13**. *E. crispum*, PV x 110; **14**. *E. norvangi*, SV x 100; **15**. *Assilina ammonoides*, SV x 85.

SV: side view; DV: dorsal view; VV: ventral view; AV: apertural view; PV: Peripheral view

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