Microfaunal Studies In Two Different Marginal Marine Environments

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Abstract— For the present study two core samples were collected from different environments viz., Pichavaram mangroves and Valinokkam lagoon. Aim of the study is to find vertical distribution of sediments and micro fauna in two different marginal marine environments and to bring out the depositional environment of the study area. Various analysis carried out to find $CaCO_3$ concentration, sand silt clay ratio and microfaunal investigations. VC consists of mixture of sand, silty sand to clay sediments. Valinokkam core sample mud and foraminifera population shows positive correlation. In Vc1 core Suborder ROTALIINA constitutes 70% of total foraminifera, suborder MILIOLIINA constitutes 29 % and 1 % of foraminifera belong to Suborder TEXTULARIA. In Vc1, foraminifera population show decreasing trend towards depth. All the samples of VC are falling in the field of mixed hypersaline and normal marine lagoon environment. Two assemblage zones are identified from core sample based on abundance of foraminifera through depth. All the samples of PC are falling in the field of hypersaline lagoon environment except few samples that indicates the mixed normal marine and hypersaline environment.

I. INTRODUCTION

Marginal marine habitats, ranging from coastal marshes to inner parts of continental shelves, are usually areas of high organic productivity and relatively high environmental variability. Numerous species of benthic Foraminifera, both eurytopic and stenotopic, have adapted to these environments. Many of these taxa are so characteristic of marginal marine habitats that their abundance in sediment samples immediately brings to the mind of the specialist words such as brackish, coastal, littoral, shallow-water, marsh, estuarine, and reefal. The macro-environment of a given salt marsh may seem uniform, but a variety of habitats is available to smaller organisms (Teal, 1996).

The biology of foraminifera is not well known, but studies of Recent, fully marine foraminifera have demonstrated that they live both epifaunally and infaunally, commonly down to depths of about 12- 15 cm, depending upon the oxygenation of the sediment (Corliss and Emerson, 1990; Gooday, 1993; Rathbum and Corliss, 1994; Alve and Bernhard, 1995; Jorissen et al., 1995; Kitazato and Ohga, 1995).

Micropaleontological and paleoceanographic studies on coastal eastern Arabian Sea sediments are still in infancy. Several investigations on the carbonate sediments of the western continental shelf of India have been made in the last few decades. But, previous studies were mainly focused to record distribution of Recent foraminifera along the Indian east and west coast (Antony, 1968; Rao, 1974; Bhatia and Kumar, 1976; Setty and Nigam, 1982; and Nigam and Khare, 1999, Manivannan, V. *et.al,* 1996, Nagendra, R. *et.al*, 2005, Reddy, A.N. and Reddy, K.R., 1994 and Gandhi, S. *et.al*,2002). The present study focus to find vertical distribution of sediments & micro fauna in two different marginal marine environment, to understand the depositional environment of the study area.

II. STUDY AREA

The Valinokkam is located along the east coast of India, Tamil Nadu in Ramanathapuram District. It is connected by road and is equidistant (about 95 km) from Mandapam and Tuticorin. The Valinokkam Bay and the adjoining area lie between Lat. 9°9' N and 9° 12' N and Long. 78°30' E and 78°42'E. In the east, the bay opens into the Gulf of Mannar by a wide mouth of about 3.8km and it is bordered on the other three sides by land.

Pichavaram mangroves (Lat. 11º 26' N; Long.79º 48' E) is situated on the Southeast coast of the peninsular India and represents a heterogeneous mixture of mangrove plants. It locates at about 225km south of Chennai and 5km north east of Chidambaram, Cuddalore district, Tamil Nadu. It is between the Northern Vellar and Southern Coleroon estuarine systems and along with Killai lagoon, is referred to as the Vellar - Coleroon estuarine complex. The mangrove region covering an area of approximately 12 km^2, represented by 51 islets, waterways, channels, gullies and rivulets and account for 40% of the total area of the mangrove, of this 50% is forest and the remaining consists of mud flats and sandy plains.

III. MATERIAL AND METHODS

Two core samples are collected from different locations in Pichavaram mangroves and Valinokkam lagoon to carry out the present study. For collecting the core samples, PVC pipes were used. These pvc pipes are manually inserted into the lagoon & estuary by pressing it from the top and was taken out carefully to the surface and capped both side of the core not to fall down the samples. The length of the recovered core samples are 90 cm for VC and 60 cm for PC core respectively. Longitudes of each location were dignified by using GPS (Tab.1, Fig.1).

Table1. Sampling details

S. No	Sample No.	Water depth (m)	Core length (cm)	Latitude	Longitude
1	VC	0.5	90	9^0 10'23.19"N	78^0 38'15.27"E
2	PC	1	60	11^0 25'4.5"N	$79^0$47'5.9"E

The VC core sample was divided into 5 cm interval totally 18 samples and second core sample PC was divided into 5 cm interval and 12 subsamples were generated to carryout $CaCO_3$ analysis, sand silt clay ratio analysis and micropaleontological investigations. The procedure for sand silt clay ratio was carried out following the method described by Ingram (1970). The procedure for calcium carbonate analysis was carried out the following Rapid titration method described by Muller (1967). Microfaunal separation has been carried out as per standard protocol studies and the species were identified under stereo binocular microscope. The isolated foraminiferal tests were taxonomically identified by following Loeblich and Tappan (1988), Brady(1884); Foraminifera Gallery-illustrated catalog (www.foraminifera.eu), and World Modern Foraminifera Database (www. marinespecies.org/foraminifera/).

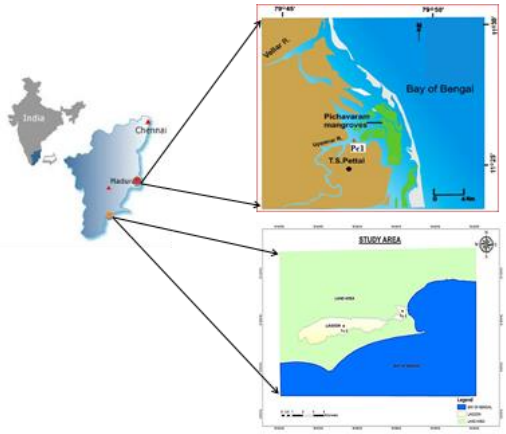

Fig.1. Study area and sample locations

- Sediment distribution in Valinokkam core sample

The sand silt clay ratio analysis is used to determine the how much sand silt and clays are present in the sediment sample. The sediment texture, down core variation, and their implication on physio-chemical parameters of the core samples have been studied in detail. The grain size distribution in the core sediments is important in understanding the depositional environment. In the core mud (silt/clay) dominates over sand indicating relatively calm depositional environment. However, there are local variations in grain size distribution in the core at different depths. The result of grain size analysis for the core (VC) is presented in Table 1.

Table. 2. Sand silt and clay concentration of VC core sample

Depth (cm)	Sand %	Silt %	Clay %	$CaCO_3$ %	Sediment Nature
0-6	8	62	30	1.6	Clayey silt
6-12	15	35	50	2	Silty Clay

17	15	25	60	1.6	Silty Clay
22	31	29	40	1.4	Sand Silt Clay
27	47	43	10	0.9	Silty Clay
31	33	27	40	0.8	Sand Silt Clay
36	54	36	10	0.3	Silty Sand
41	61	9	30	0.8	Clayey Sand
47	1.4	28.6	70	0.2	Silty clay
52	1	29	70	0.7	Silty clay
56	5	25	70	0.8	Silty clay
59.5	3	7	90	0.7	Clay
65	1	9	90	0.5	Clay
71	7	33	60	0.8	Silty clay
75.5	18	32	50	0.5	Silty clay
79.5	85	5	10	0.3	Sand
85	51	39	10	0.1	Silty sand
90	63	17	20	0.5	Clayey Sand

From this table the core Vc1 consists of mixture of sand, silty sand to clay sediments. The sand percentage ranges from 01% to 85%. Maximum percentage of Sand is present at 75.6 cm to 90 cm depth and low percentage of sand is present at the depth interval 47.01 cm to 65 cm. In general all the samples in the core are depleted in sand fraction. The silt content ranges from 05% to 62%. The minimum percentage of silt is recorded in the bottom of the core sample (5%) and the maximum percentage of (62%) is recorded at the depth interval 0 to 6 cm. The clay content of the core sample ranges from 10% to 90% and the lowest value is recorded at a depth of 75.06 cm to 90 cm and highest value is recorded at a depth of 56.01 cm to 65 cm and highest value is recorded at the middle of the core sample.

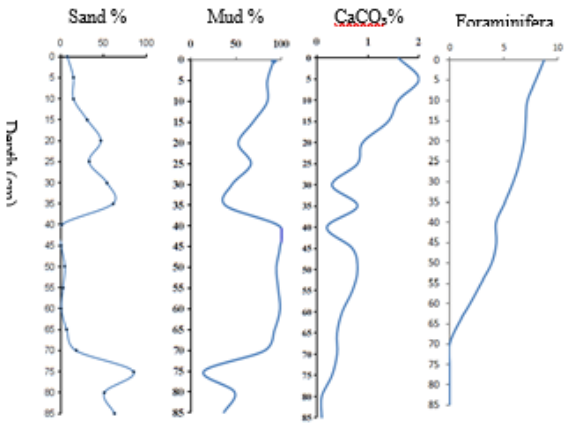

Fig. 2. Down core distribution of sand-silt-clay and Foraminifera in VC

In the case of Valinokkam core samples mud and foraminifera population shows positive correlation. Percentage of $CaCO_3$ high growth of foraminifera is abundant. Core samples are respect to the depth top to bottom percentage of $CaCO_3$ is frequently decreased. Rich in sand % residents of foraminifera is very less.

The estimated values of sand,silt and clay were plotted on trilinear diagrams (Fig.4.1.2). Trefethen's (1950) textural nomenclature has been used to describe the sediment types of present area. Most of the sediment samples are falling on the silty clay and clayey silt.

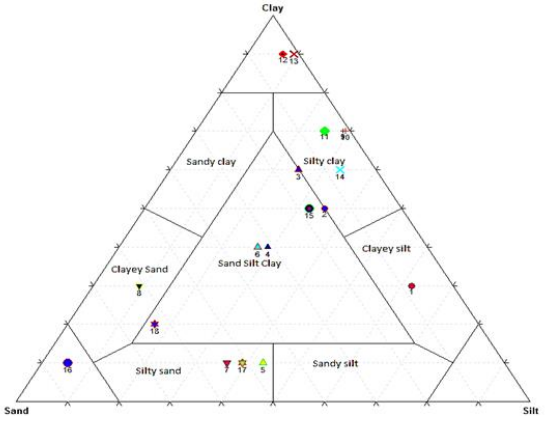

Fig.3. Trilinear plot for the Valinokkam core sample

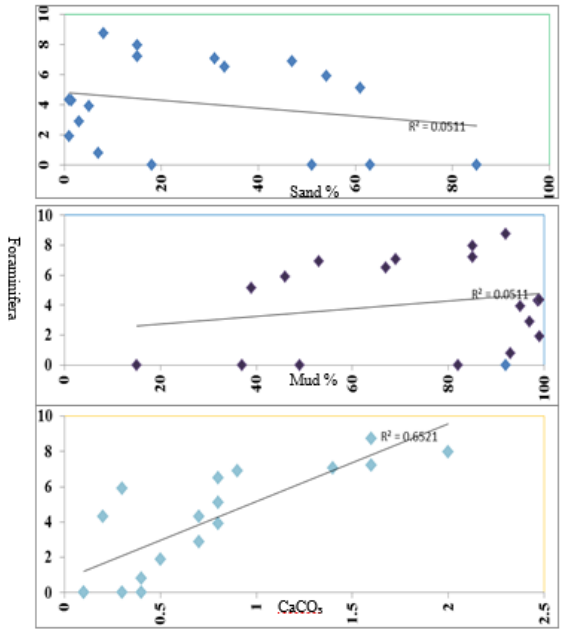

Fig.4. Scatter plat on sediments Vs foraminifera Nature of Valinokkam (VC)

Scatter plot shows the interrelation between sediment nature verses foraminifera. Foraminifera Vs sand show negative correlation (R^2= -0.0511). This indicates sandy environment is not favour for foraminifera population. Foraminifera Vs mud positive correlation (R^2=0.0511) so it indication of suitable material for survival of foraminifera. $CaCO_3$ verses foraminifera are positive correlation (R^2 = 0.6521).

- Sediment distribution in Pc1

Results of the sand-silt-clay analysis of the subsamples of Pichavaram core is given below.

Table. 3. Sand silt and clay concentration of PC.

Depth (cm)	Sand %	Silt %	Clay %	$CaCO_3$ %	Sediment Nature
5	61	19	20	0.5	Sand silt clay
10	57.6	12.4	30	0.6	Clayey Sand
15	56.6	13.4	30	0.5	Clayey Sand
20	57	33	10	0.5	Silty sand
25	61.8	18.2	20	0.4	Sand Silt Clay
30	59	31	10	0.4	Silty Sand
35	52.6	37.4	10	0.4	Silty Sand
40	57.2	32.8	10	0.5	Silty Sand
45	64.4	25.6	10	0.9	Silty Sand
51	56.8	23.2	20	0.9	Sand Silt Clay
56	68	22	10	0.7	Silty Sand
60	75.2	4.8	20	0.8	Clayey Sand

In Pc1 the sand percentage ranges from 52% to 75%. Maximum percentage of Sand is present at 50cm to 60cm depth and low percentage of sand is present at the depth interval 31cm to 35cm. In general all the sub samples in the core are depleted in sand fraction. The silt content ranges from 32.8% to 37.8%. Minimum percentage of silt is recorded at the bottom of the core sample (4.8%) and maximum percentage of (37.4%) is recorded at the depth interval 30 to 35 cm. The lowest value is recorded in the bottom most sample, which is having 4.8% of silt. The clay content of the core sample ranges from 10% to 30% and the lowest value is recorded at a depth of 26cm to 50cm and highest value is recorded at a depth of 6 cm to 15 cm and highest value is recorded at the top most sample. Only few samples show higher concentration of clay.

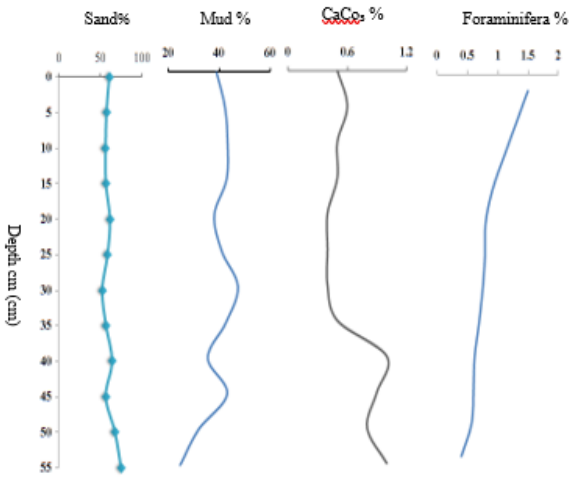

Fig. 5. Down core distribution of sand-silt-clay and Foraminifera of PC.

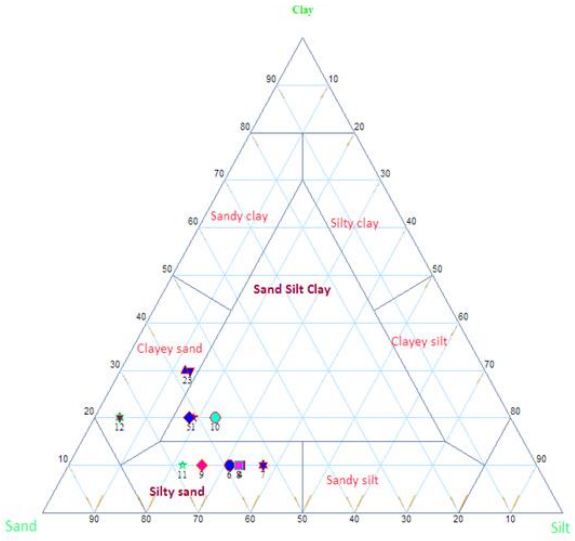

Fig.6. Trilinear plot for the Pichavaram core sample (after Trefethen, 1950)

The analyzed sub-samples data of sand, silt and clay were plotted in a tri-linear diagram for sediment nomenclature (Fig. 4.2. after Trefethen, 1950). Most of the sub-samples fall in the field of clay silt. Thus entire core is mostly dominated by silt sand and clayey sand. The top three samples (depth from surface to 15 cm), (depth 16 cm to 20 cm) and, (depth 26 cm to 45 cm) and (depth 51 cm to 55 cm) fall in the field of silty sandy.

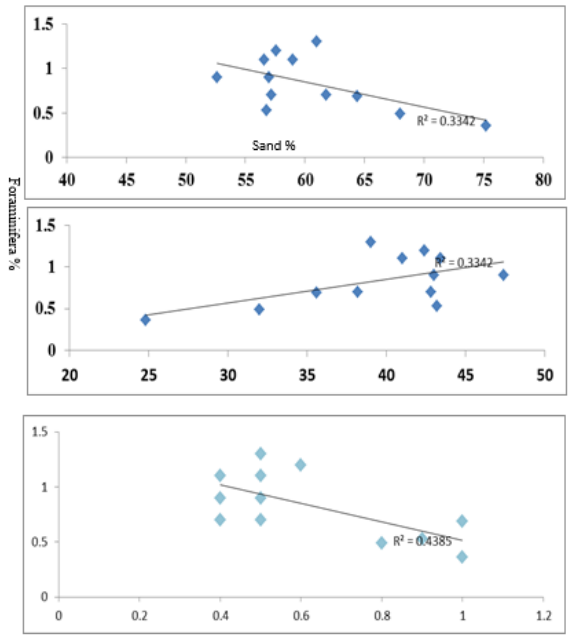

Fig.7. Scatter plat on Foraminifera Vs sediments nature in Pichavaram core sample

Scatter plot shows the interrelation between sediment nature verses foraminifera. Foraminifera Vs sand show negative correlation (R^2= -0.3342). Foraminifera Vs mud positive correlation (R^2=+0.3342). $CaCO_3$ Vs Foraminifera shows negative correlation (R^2 = -0.4385).

- Microfaunal analysis Valinokkam core sample Sub-order Distribution of Foraminifera

Foraminifera in Valinokkam core belong to the three suborders. Suborder ROTALIINA constitutes 70% of total foraminifera, suborder MILIOLIINA constitutes 29 % and 1 % of foraminiera belong to Suborder TEXTULARIA.

Table 4. Down core distribution of Foraminifera (in %) in the core VC

Foraminifera	Vc1	Vc3	Vc5	Vc7	Vc9	Vc11	Vc13	Vc15	Vc17
Ammonia	41.25	56	86	59	52.6	50	66	2	0
Asterorotalina	5	3.5	0	11	5.2	0	0	0	0
Cibicides	2.5	0	0	5	5.2	0	6.6	0	0
Miliolinella	10	10.5	10	19	21	29.1	16.6	0	0
Quinqueloculina	36.25	30	2	5.4	10.5	16.6	10	0	0
Spirulina	2.5	0	0	0	0	0	0	0	0
Elpidium	0	0	0	0	5.2	0	0	0	0
Ammobaculites	2.5	0	0	0	0	0	0	0	0
Trochospira	0	0	0	0	0	4.1	0	0	0

Common foraminifera in this core sample are *Ammonia, Miliolinella and Quinqueloculina.* Rarer foraminifera in core sample are *Ammobaculites, Spirulina and Cibicides*. Juvenile and reworked benthic and few planktonic foraminifera are seen in the core sample.

In down core variation, *Ammonia* shows its abundance from 60 cm to 80cm. This species is enriched in the bottom core seiments. *Miliolinella* sp. present from 0 to 70 cm of the core, shows maximum at the top 40 to 60 cm. *Quinqueloculina* sp. shows its presence from top to bottom and at a depth of 0 to 70 cm. *Cibicides* is maximum at middle of the core sample depth upto 30 to 50 cm and also present in top of the core sample 0 to 10 cm. *Trochospira* are minimum in 50-60 cm. *Ammobaculities* is minimum at top of the core sample. *Elphidium* sp. present only at 40cm to 50 cm depth. *Spiroloculina* sp. is present only at a top of 10 cm. *Asterorotalia* sp. also present at the top and middle of the core depth up to 0 to 20 cm and 30 to 50 cm.

Genetic Distribution of Foraminifera

Table 5. Down core distribution of Foraminifera (in %) in the core PC

Foraminifera	Pc1	Pc3	Pc5	Pc7	Pc9	Pc11
Ammonia	58.82	80	92.3	85	100	88.88
Quinqueloculina	0	0	7.6	0	0	11.11
Cibicides	29.41	0	0	15	0	0
Ammobaculites	0	20	0	0	0	0
Triloculina	11.76	0	0	0	0	0

Based on the presence of foraminifera in this core 3 suborders have been identified. 91% of foraminifera belong to suborder ROTALIINA, and 5% belong to suborder MILIOLIINA. Suborder TEXTULARIA constitutes 4 %. Common foraminifera in core sample are *Ammonia, Cibicides and Quinqueloculina.* Rarer foraminifera in core sample are *Ammobaculites and Triloculina*. Juvenile and reworked benthic are seen in the core sample.

IV. CONCLUSION

In the present study, vertical distribution of sediments and microfauna (foraminifera) in two different marginal marine environments were discussed. The Valinokkam core VC consists of mixture of sand, silty sand to clay sediments. The sand percentage ranges from 01% to 85%. In the core sample mud and foraminifera population shows positive correlation. Common foraminifera in this core sample are *Ammonia, Miliolinella* and *Quinqueloculina.*. Rarer foraminifera in core sample are *Ammobaculites, Spirulina* and *Cibicides*. Sediment characteristics and presence of specific foraminifera indicates the studied

core section falls in mixed hypersaline and normal marine lagoon environment.

In the Pichavaram core PC, the sand percentage ranges from 52% to 75%. Clay content of the core sample ranges from 10% to 30.% and silt content ranges from 32.8% to 37.8%. Foraminifera Vs sand show negative correlation. The studied material represent the core section is falling in the field of hypersaline lagoon environment except few samples that indicates the mixed normal marine and hypersaline environment.

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