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Foraminiferal Distribution and Sediment Characteristics of Palar Estuary Tamil Nadu, India

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Abstract: ***Foraminiferal assemblage in the Palar estuary comprises more than 85% of calcareous perforated benthic fauna with higher abundance of rotalids followed by miliolids and agglutinated forms. The study area exhibits alkaline environment and the fauna is abundant in fine to very fine sand. Textural analysis reveals that the sediments are chiefly composed of sand with less mud in the study area, and are deposited mostly in fluvial condition with less marine impact.***

Keywords: Estuary, benthic foraminifera, sediment, east coast, India.

1. Introduction

Foraminifers are one of the most miscellaneous group of shelled micro-organisms in modern oceans, and they are recognized for their remarkable fossil record than for their diversity and richness [31]. They are found from intertidal to the deepest ocean trenches and from the poles to tropics. Many forms are abundant in the deep ocean, some forms survive only in brackish estuaries or salt marshes and they are more peculiar to certain temperature and depth ranges [17], [22], [30]. Estuaries are transition zone between riverine and oceanic environments and is influenced by tides, waves, and the influx of saline water by oceans and flows of fresh water and sediment by rivers.

Estuarine foraminiferal investigations in the Indian estuaries have received meager attention. Initially taxonomic and ecological studies of foraminifera on beaches and estuaries of eastern coast of India have been carried out [3], [4]. Foraminiferal ecology and size distribution of Pennar estuary [25-28], foraminifera from Suddagedda estuary [30] and seasonal variation of foraminifera in Vellar estuary, east coast of India were also documented [24]. Textural analysis is one of the most important basic parameter to determine the mechanism of transport and deposition of sediments; grain size statistical parameters such as mean and standard deviation replicate the energy condition of the depositional environment [11], [12], [2], [16]. Global scenario shows pioneer study on significance of grain size parameters and frequency of size distribution have been done [38], [18], [11]. In Indian coast investigation on texture and composition of Hooghly estuary and near shore environment [33], mechanism of sediment transport in Vellar estuary [20], textural analysis of Coleroon Estuary and Gosthani River Estuary [1], [14] are documented. The present study is aimed to report foraminifera and sediment characteristics of the study area.

2. Study Area

The river Palar originates from Nandi Hills in Karnataka and flows ESE from the Western Ghats through Karnataka, Andhra Pradesh and Tamil Nadu. Buckingham canal which runs parallel to the seashore and the Cheyyar River which flows towards east in the Kancheepuram district join with Palar estuary and finally confluence to the Bay of Bengal near Pudupattinam colony. Depending on the water flow, the development of the mouth bar varies from 30 m to 500 m in width. The maximum width of the river is around 1.2 km and maximum depth of the estuary is 1.5 m with an average of 0.5 m and the ephemeral river will connect to the open sea only during NE monsoon [36]. Geological settings of the catchment area include various types of pink and grey gneisses forming part of the Peninsular Gneissic Complex extends southward from the states of Karnataka and Andhra Pradesh and occurs north of Palar River along the northern border of Tamil Nadu and also recent studies indicate that the alkaline plutonic activity extends further NNE, beyond River Palar [35].

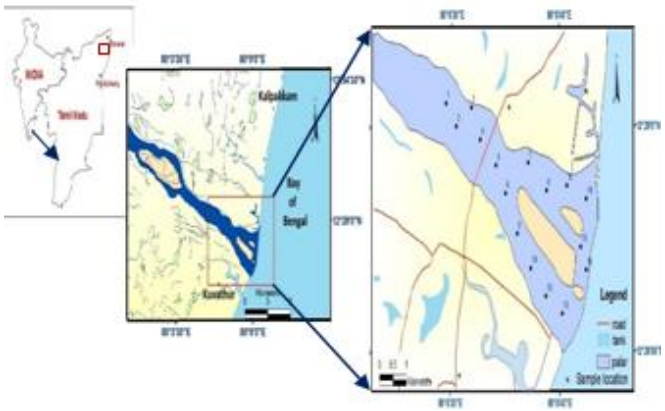

Figure 1: Study area map of Palar estuary

3. Methodology

Both surface sediment and water samples were collected from upstream to mouth of the estuary. A total of 16 sediment samples were retrieved from the study area using corer (PVC pipe) with the diameter of 5cm. Then 50 g of sample worn out from the top and soaked in Rose Bengal stain solution to differentiate living foraminifera from dead forms, and the rest were transformed into a polythene bag. Bottom water samples were collected from the same location and the temperature, salinity and pH were measured in situ.

3.1 Sample processing for foraminiferal study

The stained samples were washed over 63µ sieve to remove saline water, fixatives and the fine silt and clay size sediment particles. Foraminifers were picked from 1 g of sample and mounted on microfaunal slides.

3.2 Sample processing for granulometric analysis

The samples were first air dried then oven dried at 40 ^{O}C overnight in a hot air oven [34], then 100g of homogenized sample was taken by cone and quartering method which was further subjected to sieve analysis using ASTM sieves of ½ phi interval (2mm, 1mm, 0.5mm, 0.25mm, 0.125mm and 0.063mm) for 15minutes [39]. The weight of each size fraction was recorded, and the frequency curves as well as cumulative frequency curve were plotted to calculate grain size statistical parameters [11].

4. Results and Discussion

Foraminiferal assemblage in the Palar estuary composed of mainly benthic forms with a few *Globigerina bulloides*, an open ocean plankton. A total of 37 species belonging to 13 genera and nine families identified from the study area. The most abundant forms in the study area were *Ammonia beccarii, Ammonia tepida, Ammonia parkinsonia, Elphidium advenum* and *Nonion grateloupi* (abundance >5%) and these four forms except *Ammonia beccarii* showed increasing trend towards mouth (Figure 2). *Ammonia beccarii* is a cosmopolitan species which thrive in hyposaline to hypersaline environments since it has been reported from very low salinity lakes to higher marine environments [21]. Relatively low species diversity is noticed in the estuary except the four genera *Ammonia, Elphidium, Triloculina* and *Sprirolоculina.*

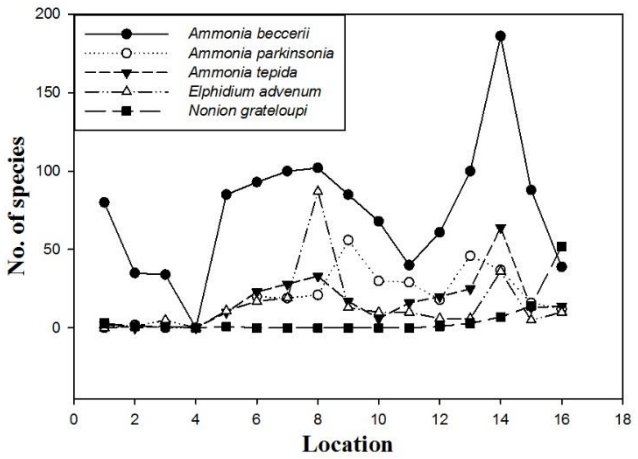

Figure 2: Distribution of abundant species in the estuary

4.1 Faunal distribution

The foraminiferal distribution in the Palar estuary was calculated as relative abundance in one gram sample with >63µ size fraction. The faunal assemblage in the estuary was dominated by calcareous perforated benthic fauna, while calcareous imperforate porcelaneous and agglutinated forms were very less (Figure 3).

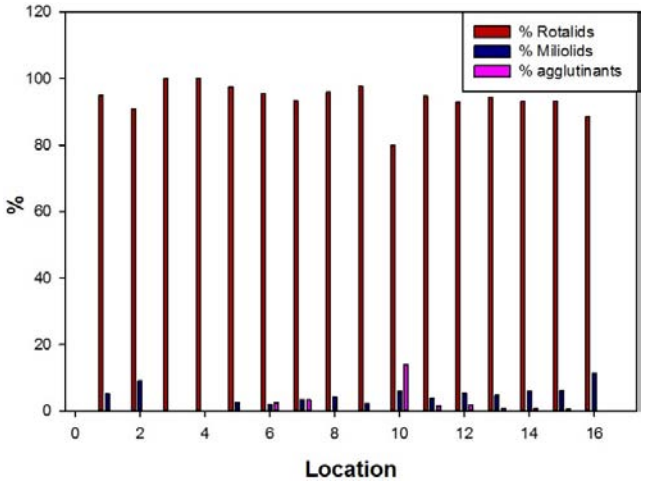

Figure 3: Percentage distribution of foraminifera.

The negligible number of agglutinated forms in the estuary was due to the warm water environment where calcareous forms dominate and the agglutinated forms were under developed since each species has certain tolerance limits as well as temperature optimum [17].

Faunal diversity was high for the samples collected from the river mouth, where more than 75% of total species in the estuary was obtained. Mixohaline calcareous assemblage such as species of ammonia and elphidium dominates towards mouth of the estuary. Presence of *Bolivana lobata, Nonion grateloupi*, *Amphistegina radiata* and broken coarsely perforated calcareous forms directly indicates the marine impact on the estuary. *Globigerina bulloides*, an open ocean plankton, echinoid spines and ostracoda were also acquired from the study area. These allochthonous forms might have been transported from Bay of Bengal to the estuary.

There is no much significant variation in temperature from upstream to mouth of the estuary and it ranging from 30.7^{o}C to 33.1^{o}C. The hydrogen ion concentration of water from the estuary elucidates the alkaline environment prevailing throughout the area. The values ranges from 7.24 to 8.08 and the salinity of the estuary varies between 12.8‰ and 26.2‰. In the study area, more diverse forms were found near mouth where salinity was high.

Table 1: List of species

1	*Ammobaculites agglutinans*
2	*Ammobaculites exiguus*
3	*Ammonia beccarii*
4	*Ammonia parkinsonia*
5	*Ammonia tepida*
6	*Amphistegina radiata*
7	*Bolivina lobata*
8	*Brizalina catanensis*
9	*Brizalina spathulata*
10	*Brizalina striatula*
11	*Cibicides wuellerstorfi*
12	*Elphidium advenum*
13	*Elphidium charlottense*
14	*Elphidium crispum*

15	*Elphidium discodale*
16	*Elphidium excavatum*
17	*Elphidium somaense*
18	*Eponides concameratus*
19	*Eponides repandus*
20	*Globigerina bulloides*
21	*Haynesina depressula*
22	*Nonion grateloupi*
23	*Nonion scaphum*
24	*Pararotalia calcar*
25	*Pararotalia inermis*
26	*Quinqueloculina agglutinata*
27	*Quinqueloculina recta*
28	*Quinqueloculina seminulum*
29	*Rotalidium annectens*
30	*Rotalinoids compressiculus*
31	*Spiroloculina antillarum*
32	*Spiroloculina excavata*
33	*Spiroloculina indica*
34	*Textularia agglutinans*
35	*Triloculina circularis*
36	*Triloculina rotunda*
37	*Triloculina trigonula*

4.2 Granulometric Study

Grain size statistical parameters such as mean, sorting, skewness and kurtosis were obtained through the graphical representation of data from the frequency and cumulative frequency plots. The investigation shows the sediments were moderately sorted to moderately well sorted, negatively skewed to positively skewed and very platykurtic to leptokurtic in nature.

In the Palar estuary the mean size of surface sediments varies from 0.263(Φ) to 2.846(Φ) corresponding to coarse and fine sand and the average mean size is 0.858(Φ). More than 87% (sample PA 1 – PA 14) of the sediments lies between 0(Φ) to 1(Φ) coarse sand which is deposited in moderately high energy environment. The standard deviation of sediments ranges from 0.3914(Φ) to 1.218(Φ) with an average of 0.7439(Φ). In the study area 94.7% sediments were moderately sorted to moderately well sorted. Standard deviation of beach sands normally lies within in the range of very well sorted to moderately sorted whereas river sands are moderately well sorted, moderately sorted and poorly sorted [13]. The skewness values ranges from -0.045(Φ) to 1(Φ) with an average of 0.4356(Φ). Bivariant plot (Figure 3) between skewness and standard deviation shows that the sediments deposited in the riverine environment. The study area is a bar built estuary which restricts the incorporation of marine

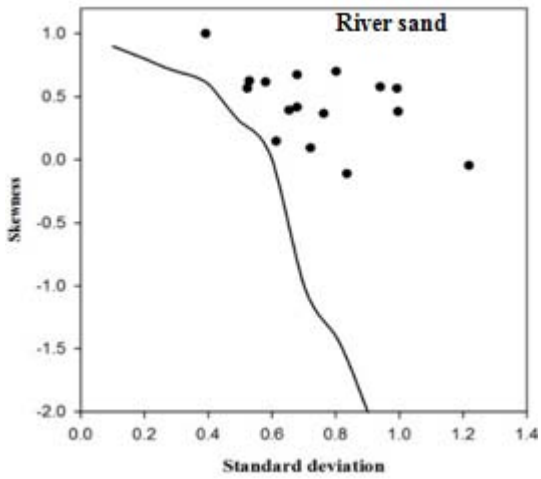

Figure 3: Bivariant plot of standard deviation and skewness

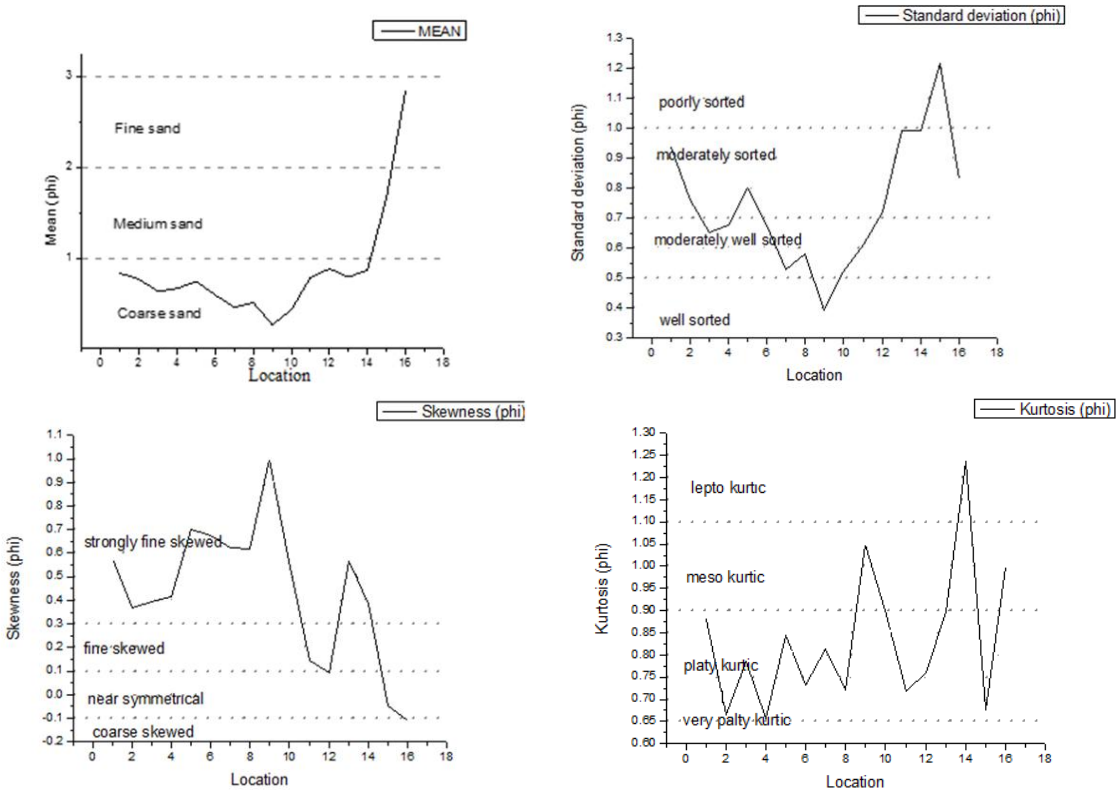

Figure 4: Variogram represents statistical parameters of sediment in the Palar estuary.

sediments. Symmetry of the sample varies from coarse skewed to strongly fine skewed; 87% of samples shows positive skewness which indicates the excessive fluvial input that is unidirectional transport of sediments to the study area [16]. Usually positive skewness of fluvial deposits results from suspension material overlapping the sediments transported on the bottom through traction and salting, due to the reduced turbulence of fluvial current [11]. In the study area the negative skewness found only in the in the river mouth samples. The lower and higher values of kurtosis in the study area is 0.656(Φ) and 1.2367(Φ) respectively with an average of 0.833(Φ), among these 62.5% were platykurtic, 18.75% were mesokurtic, 12.5% were very platykurtic and 6.25% were leptokurtic in nature of distribution (Figure 4).

5. Conclusion

The foraminiferal assemblage in the Palar estuary is composed of 37 species belonging to 13 genera and nine families of benthic forms including one species of planktonic form. The taxa were dominated by species of Rotalina followed by Miliolina and Textularina. *Ammonia, Elphidium, Triloculina* and *Sprirolоculina* genera shows comparatively more species diversity in the estuary and *Ammonia beccarii* is the most dominant taxon. Higher diversity of fauna in the estuary was observed in fine to very fine sand towards mouth where salinity is high. The entire study area exhibits alkaline environment. Presence of coarse sand in the estuary indicates the riverine input, and the winnowing action is responsible for the transportation of finer particles towards the mouth, where the energy is dispersed and fines are deposited due to the development and existence of mouth bar.

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