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DISTRIBUTION OF CALCAREOUS MICROFAUNA (FORAMINIFERA AND OSTRACODA) FROM THE BEACH SANDS OF KOVALAM, THIRUVANANTHAPURAM, KERALA, SOUTHWEST COAST OF INDIA

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ABSTRACT

This study involves the distribution of Recent calcareous microfauna (Foraminifera and Ostracoda) from the Kovalam beach, Thiruvananthapuram, Kerala. A total of eleven beach sand samples were collected from three beaches of Kovalam each separated by rocky terrains. The Foraminifera and Ostracod taxa were separated from the sediments by applying standard micropaleontological techniques. Distribution pattern of individual taxon was examined and their sediment relationship was determined for environmental interpretation. The classification proposed by Loeblich and Tappan (1987) has been followed in the present study for Foraminiferal taxonomy. A total of 24 foraminifera species belonging to 14 genera, 10 families, 8 superfamilies and 3 suborders has been recorded. The classification proposed by Hartmann and Puri (1974) has been followed for ostracods, and 16 ostracod taxa belonging to 14 genera, 10 families, 3 superfamilies and 2 suborders have been identified.

The sedimentological parameters such as $CaCO_3$, organic matter and sand-silit-clay ratio estimation were calculated using the standard procedures. The carapaces and open valves ratio are studied, predation on foraminiferal tests and ostracod carapaces is noticed, and their ecological implications are discussed.

Keywords: Foraminifera, Ostracoda, Distribution, Kovalam beach, Thiruvananthapuram, Southwest coast of India

INTRODUCTION

Foraminifers, almost exclusively marine, unicellular Protists, generally consisting of a hard covering of calcium carbonate called test, have extensively been used for studies related to paleoclimatic reconstruction, sediment transport, archaeology etc. The utility of foraminifers for such studies arises from their high-sensitivity to minute variations in the physico-chemical characteristics of the ambient environment. They are predominantly marine, although a few have been reported from brackish waters of lagoons, estuaries, low salinity lakes, and even some ground water wells in Asia and North Africa (Jones, 1956). Their smaller size and vast abundance in sea floor sediments of the present day and geologic past have resulted in foraminifera becoming the most used fossil group for determining the age and depositional environment. Benthic foraminifers are useful in environmental studies because they are easily acquired, live primarily in the uppermost centimeters of sediments (Buzas 1977; Collison 1980).

Ostracods are abundant and diverse group of tiny Crustaceans with a long fossil record from Ordovician to Recent and carapace around one mm in size, laterally compressed and protected by a bivalve-like, chitinous or calcareous shell, carapace. Ostracods have been successful inhabitants of all aquatic environments and are largely benthic or nekto-benthonic in habit. The major controlling factors governing ostracod distribution in estuarine environments and continental shelf zones are salinity, water temperature and substrate (Yassini and Jones, 1995). The value of ostracods in palaeoenvironmental reconstruction has increased greatly in recent years. Although, ostracods are generally less abundant than foraminifera in marine sequences, their utility has long been recognized. Benson (1988; 1990) and Whatley (1996) reviewed their use in reconstructing deep-sea events and processes. Ostracods have been studied from most of the world oceans. Deep sea ostracods are distinctly different from shelf and marginal marine taxa. Both Foraminifera and Ostracoda are sensitive to changes in a wide range of environmental variables; even slight changes in such parameters can bring about a change in the species composition and structure of living populations. The present study has been taken up to know the distribution of these tiny calcareous microfauna, since there are only limited research work from the study area on foraminifera (Rao and Rao, 1979; Antony, 1980 and Bhalla and Raghav, 1980) and ostracods (Jain, 1981; Gopalakrishna *et al*., 2007 and Hussain *et al*., 2013) from the Kerala coast.

STUDY AREA

The area under investigation is Kovalam, a beach town along the Arabian Sea in Thiruvananthapuram city, Kerala, India, located around 16km from the city centre. Kovalam has three beaches separated by rocky outcroppings in its 17 km coastline; the three together form the famous crescent of the Kovalam beach. They are Lighthouse beach, Hawah beach and Samudra beach. The city has a climate that borders between a tropical savanna climate and a tropical monsoon climate. As a result, it does not experience distinct seasons. Thiruvananthapuram is the first city along the path of the south-west monsoons and gets its first showers in early June. As the district stretches from north to south with the Arabian Sea in the west side, the relative humidity is generally high. It rises up to about 95% during the South-West monsoon.

The total annual average rainfall in the district is around 1700 mm per year. The south-west monsoon, from June to September is the principal rainy season. The district receives most of its annual rainfall in this season. The city also gets rain from the receding north-east monsoons which hit the city by October. The dry season sets in by December. December,

January and February are the coldest months while March, April and May are the hottest. The lowest temperature recorded during winter was 15 °C, and the highest temperature recorded in summer was 39 °C. The district also gets thunderstorm rains in the pre-monsoon months of April and May.

MATERIALS AND METHODS

A total of eleven beach sediment samples were collected during the month of December 2012. Geographical co-ordinates of the collected samples and location map are shown in Table.1 and fig.1, respectively. All the collected sediment samples were subjected to standard micropaleontological techniques. Ostracoda and Foraminifera were separated from a unit weight of 50 ml wet sediment sample under a stereo-binocular microscope and counted. The classification proposed by Loeblich and Tappan (1987) has been followed in the present study for foraminiferal taxonomy. The taxonomy and systematics were dealt using Ostracod treatises by Moore and Pitrat (Eds.) (1961), Van Morkhoven (1963), Hartmann and Puri (1974) and other recent literature. Distribution pattern of individual taxon was examined and their sediment relationship was determined for ecologic/environmental interpretation.

Sand-silt-clay ratio estimation was carried out using the procedure of Krumbein and Pettijohn (1938). Organic matter was determined by titration method of Jackson (1958). Estimation of $CaCO_3$ was made by adopting the procedure proposed by Piper (1947).

RESULTS AND DISCUSSION

Sediment parameters

Puri (1966) stated that ostracods live in an environment in which the controlling factors are temperature, bottom topography, depth, salinity, pH, alkalinity, dissolved oxygen, food supply and substrate and sediment organic matter content. Nature of substrate, organic matter and calcium carbonate contents of the sediments have been determined for all the 11 samples in the present study to find out whether it reflects the species abundance. The organic matter content in the sediments from Kovalam beach ranges from 0.25% to 1.05% (Table 1). The lowest value in Kovalam is recorded in station no.8 and the highest value in station 1. The low organic matter is noticed due to sandy nature of the beach in Kovalam. The low organic matter content in the beach sands of Kovalam appears not favouring the population and distribution of Foraminifera and Ostracoda.

In the present study, it has been found that the calcium carbonate in the sediments of Kovalam ranges from 14% to 36.5% (Table 1). The lowest value was recorded in station no.9 and the highest value in station 8 and it appears that higher value of $CaCO_3$ favours the maximum population and distribution of Foraminifera and Ostracoda. Manivannan *et al*. (1996) observed that $CaCO_3$ is the extensive component that controls the foraminiferal population in the Gulf of Mannar. Hussain *et al*. (2007) noticed that higher amount of $CaCO_3$ is one of the significant factors for higher populations of ostracods in various parts off the southeast coast of India. Hussain *et al.* (1997) observed that a relative decrease in the organic matter along with an increase in $CaCO_3$ of the sediments favours a maximum population of Ostracoda in the Gulf of Mannar, off Tuticorin.

The analytical values of sand, silt and clay contents with sediment types are shown (Table 1). In the Kovalam beach sediment samples, sand is dominantly present and sand percentage ranges from 94.60 to 99.00%, silt and clay were present only in very minor amount and they range from 0.80 to 5.10% and 0.17 to 0.90%, respectively. Because of the thorough ebb and flow and churning of tides, sand is mostly deposited on the beach. Sand, silt and clay values plotted in Trilinear plot diagram (after Trefethen, 1950) are shown in fig. 2. From the distribution of the microfauna and available substrate, it appears that species accommodate themselves in beach sands that exist. The distribution of sand in the area indicates a moderate to high-energy environment of deposition due to tidal currents.

Faunal distribution

A total of 24 foraminiferal species belonging to 14 genera, 10 families, 8 superfamilies and 3 suborders have been identified in the present study area (Table 2). SEM images of foraminifera are given in Fig.3. *Amphistegina lessonii* followed by *Ammonia beccarii* were dominant, abundantly occurring in the beach sands of Kovalam. Hatta and Ujiie (1992) stated that *Ammonia beccarii* shows wide variation in reflecting differences of environmental conditions, because this species prefers to live in brackish to shallow sea-waters where large local and/or diurnal changes in environmental factors can be expected.

Sixteen ostracod taxa belonging to 14 genera, 10 families, and 2 suborders have been identified (Table 3). SEM

Table 1: Sediment parameters of the beach sands of the study area.

Sample No.	Latitude	Longitude	$CaCO_3$ %	Organic Matter %	Sand %	Silt %	Clay %
1	08°23'24"N	76°58'27"E	25.00	1.05	98.61	1.20	0.19
2	08°23'23"N	76°58'28"E	24.00	0.54	97.60	2.20	0.20
3	08°23'21"N	76°58'30"E	25.00	0.83	97.50	2.30	0.20
4	08°23'18"N	76°58'32"E	23.00	0.49	98.52	1.30	0.18
5	08°23'15"N	76°58'34"E	16.50	0.54	96.90	2.20	0.90
6	08°23'10"N	76°58'34"E	16.00	0.88	94.60	5.10	0.30
7	08°23'07"N	76°58'41"E	18.50	0.74	98.40	1.40	0.20
8	08°23'01"N	76°58'45"E	36.50	0.25	96.13	3.70	0.17
9	08°23'48"N	76°58'22"E	14.00	0.64	96.42	3.40	0.18
10	08°23'41"N	76°58'20"E	22.00	0.49	99.00	0.80	0.20
11	08°23'52"N	76°58'22"E	20.50	0.34	98.40	1.32	0.28
		Ave.	23.73	0.61	97.46	2.26	0.27
		Min.	14.00	0.25	94.60	0.80	0.17
		Max.	36.50	1.05	99.00	5.10	0.90

Table 2: Taxonomic chart of Foraminifera in the Kovalam beach.

Order	Suborder	Superfamily	Family	Genus	Species
Foraminiferida	Miliolina	Miliolacea	Spiroloculinidae	*Spiroloculina*	*S.communis*
					S.orbis
					S.costifera
			Hauerinidae	*Quinqueloculia*	*Q.agglutinans*
					Q.costata
					Q.seminulum
				Triloculina	*T.terquemiana*
					T.tricaranata
				Miliolinella	*M.circularis*
				Hauerina	*H.bradyi*
	Rotaliina	Rotaliacea	Elphiidae	*Elphidium*	*E.crispum*
					E.crassa
					E.incertum
			Rotalidae	*Ammonia*	*A.beccari*
					A.tepida
					A.dentata
				Pseudorotalia	*P.schroeteriana*
		Nummulitoicea	Nummulitoidae	*Operculina*	*O.ammonoides*
		Planorbulinacea	Cibicididae	*Cibicides*	*C.lobatulus*
		Nonionoicea	Nonionidae	*Nonionoides*	*N.boueanum*
		Asterigerinacea	Amphisteginidae	*Amphistegina*	*A.lessonii*
					A.radiata
		Globigerinacea	Globigerinidae	*Orbulina*	*O.universa*
	Globigerinina	Globorotaliacea	Globorotaliidae	*Globorotalia*	*G.menardii*

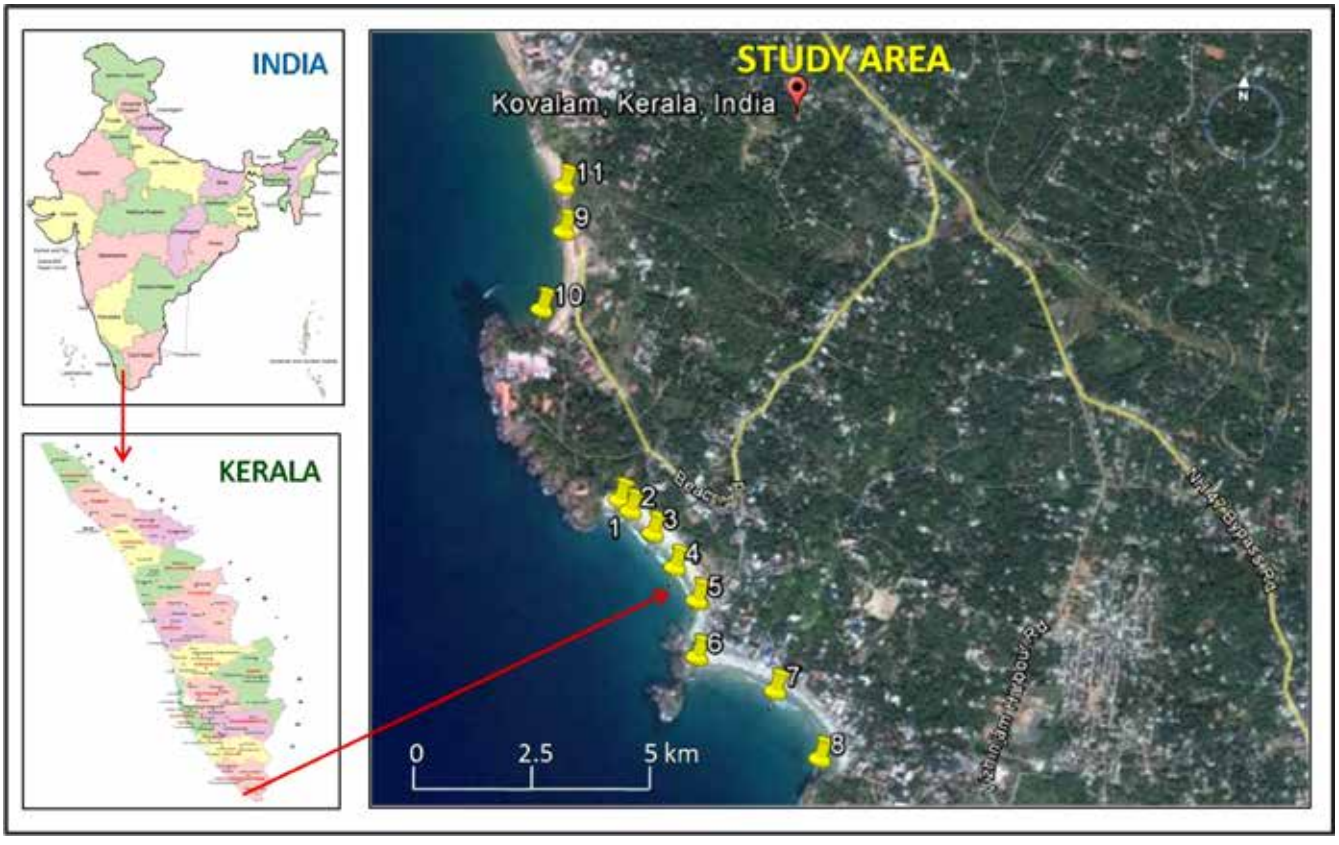


Fig. 1. Study area map showing sample location.

photomicrographs of Ostracoda depicting different views are given in Fig. 4. Of the 16 species of Ostracoda encountered in the study area, most of the species are either moderately calcified, pitted or highly ornate forms, adopting themselves under a turbulent/agitated beach environmental conditions.The Foraminiferal population was observed more in number when compared to ostracod population. The foraminiferal tests and ostracod carapaces are thick, well calcified, robust adopting the sandy beach with moderate to high $CaCO_3$ content environment, of the study area.

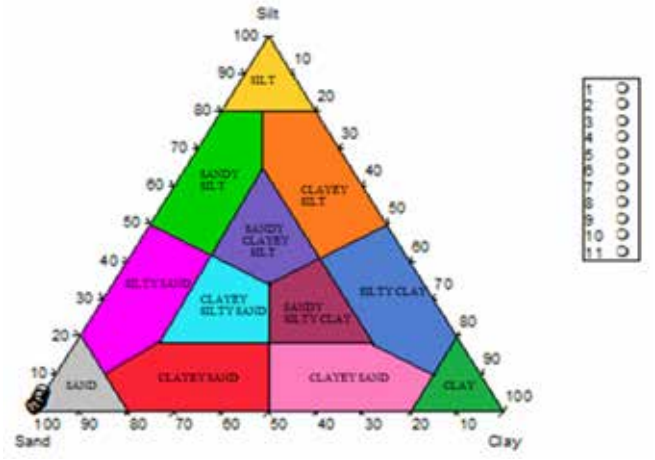


Fig. 2. Trilinear plots of sand, silt and clay ratio, of Kovalam beach sediment samples (after Trefethen, 1950)

Carapace – valve ratio

Oertli (1971) reviewed Pokorny's work and related the carapace-valve ratio to an environment. In environment where deposition of the sediment is low, the carapaces are likely to open up by bacterial action. But in an environment where deposition is very rapid, the carapaces will sink into the soft bottom and will be quickly covered by sediments. Thus, the carapaces will have less chances of opening up, after the destruction of muscles and ligaments. With sufficiently rapid burial, organic matter is not absorbed by mineral particles and so retains potential for conversion into hydrocarbons.

In the present work, the ratio between the carapaces and open valves has been taken into consideration for determining the rate of sedimentation in the study area. Out of the 11 sediment samples, 105 ostracod shells were counted in beach sediment samples. Among these, 42 specimens are carapaces, while the remaining 63 specimens are open valves. The actual number of carapaces and open valves occurring in each station are presented (Table 4). The distribution of carapaces and open

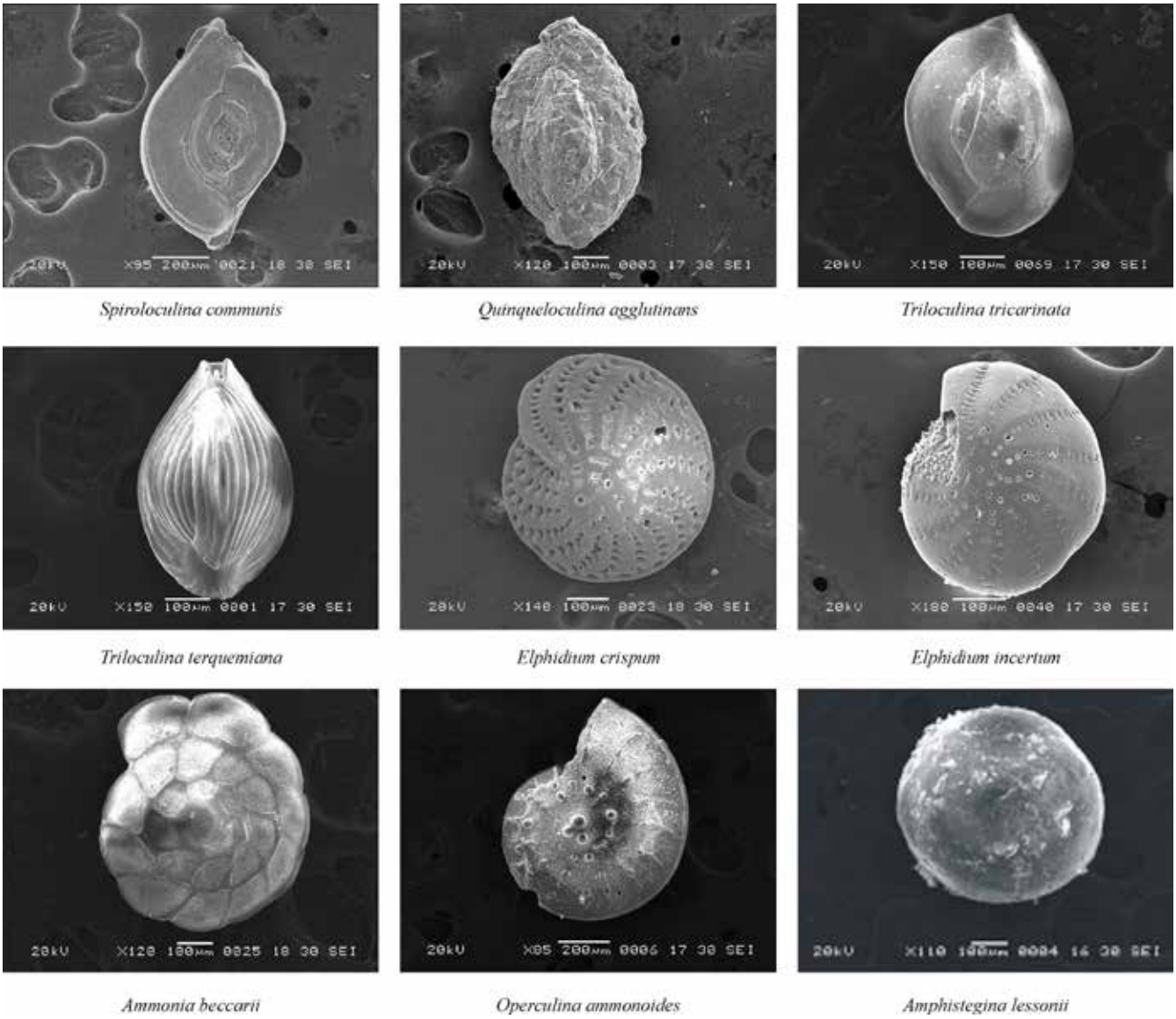
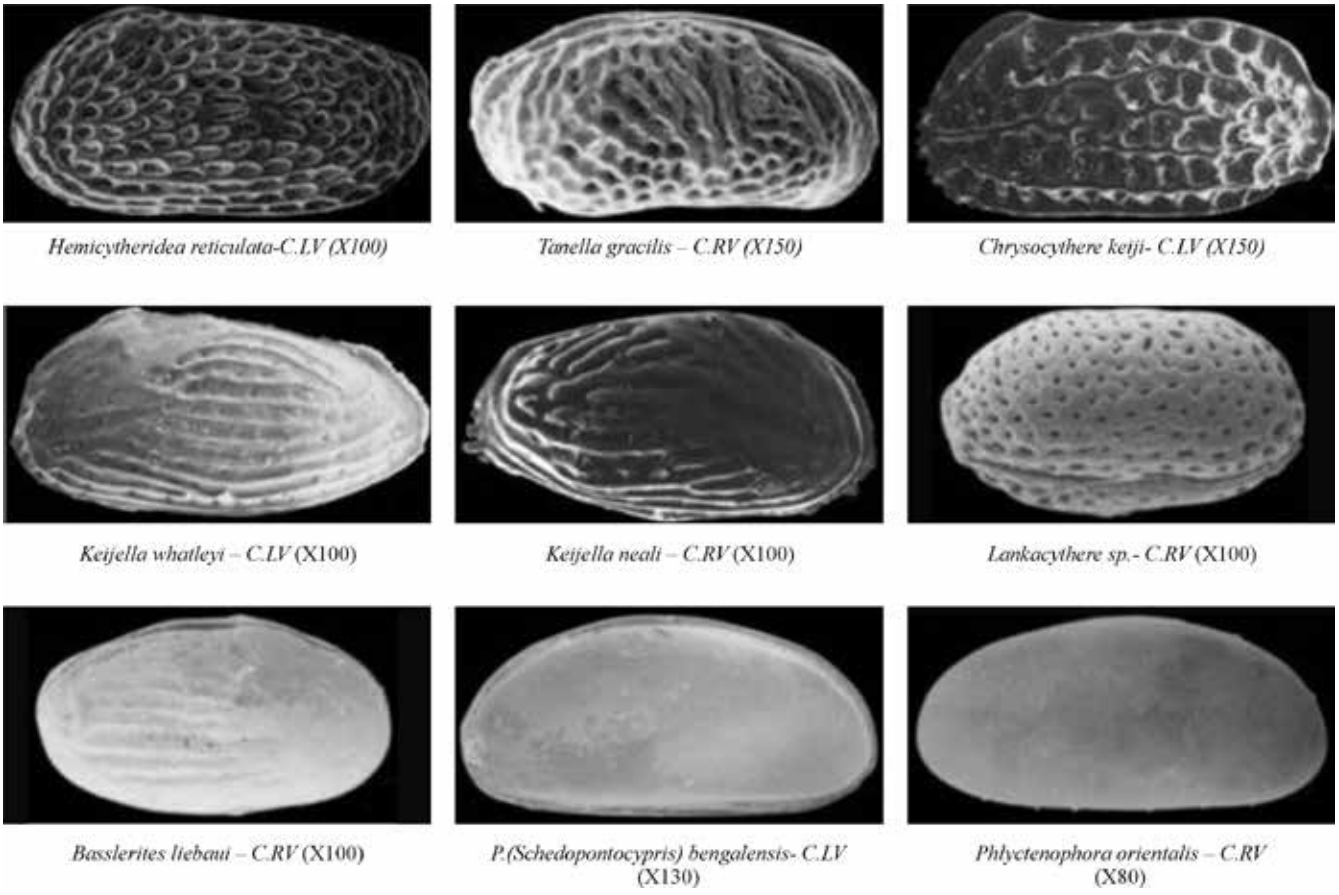


Fig. 3. SEM photogrpahs of Foraminifera (All side views).

Table 3. Taxonomic chart of Ostracoda in the Kovalam beach.

Order	Suborder	Superfamily	Family	Genus	Species
Podocopida	Platycopa		Cytherelloidae	*Cytherelloidea*	*Cytherelloidea* sp.
		Bairdiacea	Bairdiidae	*Paranesidea*	*Paranesidea fracticorallicola*
	Podocopa	Cytheracea	Cytheridae	*Hemicytheridea*	*Hemicytheridea reticulata*
			Leptocytheridae	*Callistocytere*	*Callistocytere flavidofusca intricatoides*
				Tanella	*Tanella gracilis*
			Trachyleberididae	*Chrysocythere*	*Chrysocythere keiji*
				Keijella	*Keijella reticulata*
					Keijella whatleyi
					Keijella neali
				Lankacythere	*Lankacythere* sp.
				Basslerites	*Basslerites liebaui*
			Hemicytheridae	*Neocytheromorpha*	*Neocytheromorpha* sp.
			Loxoconchidae	*Loxoconcha*	*Loxoconcha mandvients*
			Xestoleberididae	*Xestoleberis*	*Xestoleberis* sp.
		Cypridacea	Pontocyprididae	*Propontocypris*	*p.(Schedopontocypris)bengalensis*
			Candonidae	*Phlyctenophora*	*Phlyctenophora orientalis*



C- Carapace, LV-Left Valve, RV-Right Valve

Fig. 4. SEM photogrpahs of Ostracoda.

valves reveals that the open valves are more in number than the carapaces. From this observation, it may be concluded that a comparatively slow rate sedimentation prevails in the Kovalam beach. The presence of more number of open valves corroborates with the medium to high energy condition of deposition of sands and turbulence which forces the carapaces to disarticulate.

CONCLUSIONS

The sedimentological parameters such as $CaCO_3$, organic matter and sand-silt-clay ratio were estimated using the standard procedures The low organic matter content and the higher value of $CaCO_3$ in the beach sands of Kovalam are favouring

Table 4: Distribution of Carapace and Open valve in actual numbers in the Kovalam beach sand samples.

S.No.	Carapace	Open Valve	Total
1	4	6	10
2	1	3	4
3	2	6	8
4	2	7	9
5	2	4	6
6	5	8	13
7	6	4	10
8	7	8	15
9	4	6	10
10	3	5	8
11	6	6	12
Total	42	63	105

the maximum population and distribution of Foraminifera and Ostracoda. The sand-silt-clay ratios were estimated and only sandy substrate has been found in the study area. The foraminiferal population was observed more in number when compared to ostracod population. The recorded assemblage of foraminifera and ostracods are characteristic of tropical, shallow innershelf to neritic environment (about 50m water depth). Both the foraminifera and ostracods are found to accommodate themselves in sand, the only substrate in the Kovalam beach. The distribution of carapaces and open valves reveals that the open valves are more in number than the carapaces which infers that a relatively slow rate of sedimentation prevails in the Kovalam beach. Many foraminiferal tests and ostracod carapaces are broken, abraded indicating the high surf action of the beach. Predation on foraminiferal tests and ostracod carapaces was also noticed, indicating that the fauna is derived from the neritic environment and distributed in the beach sands of the study area. This dispersal of the fauna is due to tides, currents and floating algae.

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REFERENCES

Antony, A. 1980. Intertidal foraminifera of the study beaches of the south-west coast of India. *Bulletin of the Department of Marine Science, University of Cochin*, **11**: 103-132.

Benson, R.H. 1988. Ostracods and paleooceanography, p. 1-26. In: *Ostracoda in the Earth Sciences* (Eds. Deckker, P.D.E., Colon, J.P. and Peyponquet, J.P.), Elsevier, Amsterdam.

Benson, R.H. 1990. Ostracoda and the discovery of global Cainozoic palaeoceanographical events, p. 41-58. In: *Ostracoda and global events* (Eds. Whately, R. and Maybury, C.), Chapman and Hall, London, .

Bhalla, S.N. and Raghav, K.S. 1980. Recent foraminifera from beach sands of Malabar coast. *Indian Journal of Marine Sciences*, **9**: 288-290.

Buzas, M.A. 1977. Vertical distribution of foraminifera in the Indian River, Florida. *Journal of Foraminiferal Research*, **7**: 234-237.

Collison, P. 1980. Vertical distribution of foraminifera off the coast of Northumberland, England. *Journal of Foraminiferal Research*, **10**: 75-78.

Gopalakrishna, K., Hussain, S.M., Mahesh Bilwa. and Ayisha, V.A. 2007. Recent benthic Ostracoda from the inner shelf off Malabar coast, Kerala, southwest coast of India. *Journal of the Palaeontological Society of India*, **52**(1): 59-68.

Hartmann, G. and Puri, H.S. 1974. Summary of Neontological and Paleontological Classification of Ostracoda, *Mitteilungen aus dem Hamburgischen Zoologischen Museum and Institute*, **70**: 7-73.

Hatta, A. and Ujiie, H. 1992. Benthic foraminifera from coral seas between Ishigaki and Iriomote Islands, southern Ryukyu Island Arc, north-western Pacific. *Bulletin of the College of Science, University of Ryukyus*, **53**: 49-119.

Hussain, S.M., Manivannan, V. and Ragothaman, V. 1997. Sediment-Ostracod relationship in the Gulf of Mannar, off Tuticorin, east coast of India. *Journal of the Nepal Geological Society*, **15**: 33-37.

Hussain, S.M., Ganesan, P., Ravi, G., Mohan, S.P. and Sridhar, S.G.D. 2007. Distribution of Ostracoda in marine and marginal marine habitats off Tamil Nadu and adjoining areas, Southern east coast of India and Andaman Island: Environmental implication. *Indian Journal of Marine Sciences*, **36**(4): 369- 377.

Hussain, S.M., Kuleen, E.C., Jisha, K., Elumalai, K. and Ravi, G. 2013. Distribution of Benthic Ostracoda in the surface and subsurface sediments of backwaters of Ernakulam, Kerala, Southwest coast of India: Implications on microenvironment. *Special Issue of Journal of the Geological Society of India*, **1**: 213-224.

Jackson, M.L. 1958. *Soil chemical analysis*. Prentice Hall, New York.

Jain, S.P. 1981. Recent Ostracoda from south-west Kerala Coast. *Bulletin Indian Geologists' Association*, **14**(2): 107-120.

Jones, D. 1956. *Introduction to Mirofossils*. Harper and Brothers, Publihers, NewYork.

Krumbein, W.C. and Pettijohn, F.J. 1938. *Manual of Sedimentary Petrography*. D. Appleton Century Crofts Inc., New York.

Loeblich, A.R. and Tappan, H. 1987. *Foraminiferal genera and their classification* (2 volumes). Von Nostrand Reinhold, New York.

Manivannan, V., Kumar, V., Ragothaman, V. and Hussain, S.M. 1996. Calcium carbonate - a major factor in controlling forminiferal population in the Gulf of Mannar, off Tuticorin, Tamilnadu, p. 381-385. *Proceedings XV Indian Colloquium on Micropaleontology and Stratigraphy* (Eds. Pandey, Jagadish, Azmi, R.J., Bhandari, A. and Dave, A.), 17, Dehradun.

Moore, R.C. and Pitrat, C.W. 1961. *Treatise on Invertebrate Paleontology*, Part Q, Arthropoda 3, Crustacea: Ostracoda. Lawrence, KS. University of Kansas Press and the Geological Society of America.

Oertli, H.J. 1971. The aspects of ostracod faunas – a possible new tool in petroleum sedimentology. *Bulletin du Centre de Recherches Pau - SNPA*, **5**: 137-151.

Piper, C.S. 1947. *Soil and plant analysis*. University of Adelaide Press, Adelaide.

Puri, H.S. 1966. Ecologic and distribution of Recent Ostracoda, Proceedings of Symposium on Crustacea, Part I. *Journal of the Marine Biological Associations of India, Mandapam*, 457-495.

Rao, K.K. and Rao, T.S.S. 1979. Studies on pollution ecology of foraminifera of the Trivandrum coast. *Indian Journal of Marine Sciences*, **8**: 31-35.

Trefethen, J.M. 1950. Classification of sediments. *American of Journal of Science*, **248**: 55-62, **20**: 244-247.

Van Morkhoven, F.P.C.M. 1963. *Post-Palaeozoic Ostracoda. Volume II* Generic Descriptions. Amsterdam, Elsevier.

Whatley, R.C. 1996. The bonds of things unloosed: the contribution of Ostracoda to our understanding of deep-sea events and processes, p. 3-25. In: *Microfossils and oceanic environments* (Eds. Moguilevsky, A. and Whatley, R.C.), University of Wales, Aberystwyth Press, Aberystwyth.

Yassini, I. and Jones, B.G. 1995. *Recent Foraminifera and Ostracoda from Estuarine and Shelf Environments on the Southeastern Coast of Australia*, University of Wollongong Press, Wollongong.

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